FINANCIAL INNOVATION AND DEMAND FOR MONEY IN KENYA

BY

OCHIENG, BEVERLYNE ANYANGO

REG. NO.

X50/36628/2020

A RESEARCH PAPER SUBMITTED TO THE UNIVERSITY OF NAIROBI IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTER OF ARTS DEGREE IN ECONOMICS, DEPARTMENT OF ECONOMICS AND DEVELOPMENT STUDIES.

OCTOBER 2022

DECLARATION

To the best of my knowledge, I declare that the content of this study is my authentic work and that it has not been presented to any other university for examination.

Signature: 

Date: **26th Oct., 2022**

Ochieng, Beverlyne Anyango

X50/36628/2020

This research paper has been submitted for examination with my approval as the university supervisor.

Signature: 

Date: 25/11/2022

Dr. Nyang'oro Owen

Department of Economics and Development Studies.

DEDICATION

I dedicate this work to my lovely parents; Jeremiah (dad) and Beatrice (mother), and my siblings (sister Grace and brother Nickson).They have been of great help to me through their immense support during the entire period of the research work.

ACKNOWLEDGMENT

I thank God for giving me a healthy and whole life in my entire research period and for His unending grace and love.

To Dr. Owen Nyang'oro, my supervisor, I am grateful for your immense support. You have never hesitated to give your well-informed counsel and guidance whenever necessary, which made the entire experience exciting and exploratory. I have learned much from you, and the positive criticisms ignited the critical thinking that led me out of my comfort zone. I consider myself a progressing researcher. May God richly reward and bless your enormous wisdom and knowledge.

I express my gratitude to the African Economic Research Consortium (AERC) for awarding me an opportunity to study for a Masters of Arts degree in Economics at the University of Nairobi through their Collaborative Master's Programme (CMAP) in Economics scholarship. Lastly, I appreciate my day class colleagues (Athman, Joshua, and Monica) for their moral support during my entire period of study. Words will never be enough to acknowledge your support which has been pivotal to my learning experience at the university.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

LIST OF ABBREVIATION

ATM	Automated Teller Machine
ABS	Asset–Backed Securities
ADF	Augmented Dickey Fuller Test
ARDL	Autoregressive Distributed Lag
OLS	Ordinary Least Square
ECM	Error Correction Model
CDS	Central Depository System
CBK	Central Bank of Kenya
CDO	Collateralized Debt Obligation
GDP	Gross Domestic Product
SSA	Sub Saharan Africa
SWIFT	Society for Worldwide Interbank Financial Telecommunications
T–BILL	Treasury Bill Rate
WWII	World War II
AERC	Africa Economic Research Consortium
POS	Point–Of–Sale
KNBS	Kenya National Bureau Statistics
CUSUM	Cummulative Sum
CUSUMSQ	Cummulative Sum Squared
SADC	Southern African Development Community

ABSTRACT

Financial innovations have emerged in recent years, resulting in the launch of new quasi–money products. As a result, financial innovation may have an influence on money demand which cannot be overlooked, thus, highlighting the need of including it when evaluating the money demand function. Kenyans have increased their mobile money services usage and other forms of financial innovation in recent years. In this connection therefore, the primary aim of this study was to ascertain the short term and long term relationship connecting financial innovation and real money demand. The research used the ARDL approach in analyzing the money demand function for Kenya between the 1st quarter of 2000 (Q1: 2000) to the 4th quarter of 2019 (Q4: 2019).

The empirical findings revealed that innovation had a long-run negative effect on real broad money demand. With innovations, financial technology gets better and transaction gets easier, which makes money substitutes easier to find and use, hence you would expect a negative relationship. That is financial innovation may alter behavior to hold money as it increases the availability and use of quasi-money products, which means that users have fewer liquid assets to manage. Other variables that had a negative influence on money demand included inflation and interest rates. Additionally, the CUSUM test revealed that, despite financial innovation, the money demand function remains stable, implying that the CBK monetary aggregate targeting remains effective.

CHAPTER ONE: INTRODUCTION

1.0: Background

The stability of money demand function is key in the formulation and efficient application of monetary polices that will enhance policy–driven reforms (Samreth, 2008; Odeleye and Akam, 2022; Ozcalik, 2014; and others). These policies effectively predict the desirable effects on interest rate, income (output), and finally, the price level (Kumar, Webber, and Fargher, 2013; Sriram, 2001). The reason for an effective control of monetary aggregate is driven by the role monetary authority institutions (world central or reserve banks) play in understanding the cause and effects obtained from the money demand function structure (Anwar and Asghar, 2012). For instance, Ozcalik (2014), as quoted in the work of Odeleye and Akam (2022), postulated that unhinged changes in the money demand function instability and liquidity preference resulted in the overall alteration of crucial national macroeconomic variables such as exchange and interest rates, inflation, and GDP.

Furthermore, Kumar et al. (2013) took note that the switching policies of the post 1980s that centered on central banks bank rates in less developed economies led to structural and institutional developments in the financial markets. Nevertheless, Ozcalik (2014) points out that these changes have witnessed an alteration in the relationship among the vital macroeconomic variables which highly contributed to the demand for money function instability. In addition, Samreth (2015) posit that the main cause for money demand function instability is attributed to the currency substitution. To that end, it is critical therefore that monetary institutions take appropriate measures of monetary policy that can help in mitigating a stable money demand function (Odeleye and Akam, 2022).

Most empirical studies on money demand up to 1980s majorly centred on the partial adjustment framework through which real money demand was derived as a function of a scale and a vector of opportunity cost variables. The money demand functions constructed under the partial adjustment framework including the USA and industrialized nations using data from the post world war two (WWII) pointed out that the demand for money exhibited instability trends in the 1970s. This phenomenon in literature has been named as “missing money episode” and is attributed to the assumption of stability of money circulation (velocity) and model misspecifications. Thus, given these developments, industrial nations were led to relinquish monetary aggregate targeting policy

in support for inflation targeting policy. Nevertheless, this view has changed from the recent past considering that some studies, (Carlson et al., 2000; Hoffman et al., 1995; and others), have used different data illustrations and methodologies to successfully find stable money demand relationships.

Goldfeld and Sichel (1990) defined the demand for money as financial assets held in deposits or in cash. Aggregate money demand consists of money held by different economic agents including households, firms and the government and each of these players have their discrete unique money demand function (Mujuri et al., 2018). For efficient monetary policy formulation by monetary authorities (CBK), money demand function stability is vital. Stability enables the influence of any adjustments in the monetary aggregate on income (output) to be effective (Sriram, 2001). However, the role of monetary or inflation targeting in reference to monetary policy by central or reserve banks in the stableness of money demand has remained a primary concern in the financial global debate. An effective monetary targeting in argued to be a pre-condition to a stable money demand in which the future forecast of money supply growth is possibly effected (Narayan, Narayan, and Mishra, 2009). On the other hand, Fetai (2008) posited that monetary targeting through high dollarization contributed to money demand instability in the economy.

According to Goldfeld and Sichel (1990), the variables that affect the money demand include interest rate and income. Additionally, inflation targeting as a fiscal policy option against the failure of monetary targeting can reduce the unstable relationship that would exist in monetary aggregates and inflation, thus, reducing the inflationary pressure in the economy. However, this would depend on the existance of a close connection linking money demand and the macroeconomic variables in the economy (Al Rasasi and Banafea, 2021; Salisu, Ademuyiwa, and Fatai, 2013). Arrau et al. (1995) nevertheless, observed that traditional money demand formulations were oftenly depited by periods of “missing money”, autocorrelated errors, and unstable parameters. Therefore, to solve these challenges, regression respecifications have to be effected once the shifts (normally associated with financial innovations) are pointed out. This analogy can be attributed to the reality of evolution of money holding systems and household opting to the use of new technologies such as mobile money and electronic cards for transactions. This is due to low transaction charges involved and effeciency of the systems as a result of innovations (Rinaldi, 2001).

Financial innovations continue to gain popularity globally since they have been considered as potential paradigm that influence money demand stability (Ujunwa et al., 2022). The supply of digital monies such as the M–pesa and airtel money transactions, have almost if not completely, made traditional payment channels obsolete or pushed them to the background (Brunnermeier and Niepelt, 2019). Further, Brunnermeier and Niepelt (2019) opine that irrespective of whether private corporations or the public monetary institutions are the primary inssuers of the digital monies or not, the development of these currencies will altimately affect the money demand function stability in the economy. Hence, the high correlated errors, the money demand function instability, repetitive over predictions, and implausible estimates of parameters in the previous studies (moreso for countries which have robust payment systems) is attributed to the neglegence in including financial innovation into the model (Arrau et al., 1995).

1.1: Demand for Money and Financial Innovations

Globalization and change in regulations and digital evolution have brought about dynamism in the financial sector. These systemic changes, both institutional and structural in nature in the financial markets, have led to consumer experience diversity. In an economy that is experiencing steady and gradual innovations that support and easen monetary transactions, the money demand behaviours are likely to change. In this era of new financial innovations coupled with varied general technological innovations, money demand behaviours among various economic players are likely to be highly witnessed presently and in the future in the financial sector.

Tirole (1988) defined innovation as the process through which newly invented products and processes are accustomed for economic use through either adoption, licencing, or by imitation. Tirole also emphasized the important role research and development have in macroeconomic aspects and for the firms in the economy. In his book, Tirole posited that there are three broad steps in research. These steps include; basic research which aim at developing the basic knowledge that is usually carried out in institutions of higher learning and government research agencies. The second step include applied research that is associated with engineering that develop for commercial use products and processes. Lastly, there is post–research stage that include industrial innovations that spread through licences, adoption of non–patented innovations as well as imitations of patented innovations. For industrial economy, a distinct seperation must be made that

distinguish process innovation from product innovation as the former outlines cost of production for the existing goods and services while the latter implies new products and services. Nevertheless, there is no clear distinction between the two as one (for instant, product innovation) may apply for one company whereas the other (for instance, process innovation) may turn for another. A perfect example that illustrates this taxonomy is the one given in the work of Pavitt (1984).

In supplimenting the work of Pavitt (1984), Llewellyn (2009) gives three factors that can be used in the identification of innovation which includes; the cause, the function, and the type. In relation to cause, Llewellyn (2009) opines four categories of financial innovation which includes: defensive innovations which captures changes in regulation and supervision; aggressive innovations which deals with creation of new products or instruments by firms through their introduction into the market in order to derive profits; protective innovations which involves firms adopting new innovative techniques to meet the firms' portfolio contraints; and lastly, response–based innovations in which instruments or services are developed to meet the market or client needs. To that end, it is thus possible that regulation and supervision of financial firms' modifications may lead into varied forms of innovations. These would include products such as asset substitution in banking industry (i.e., banks' financial statements) in order to bring down capital needs and improving the firms' risk exposure. It also important to note that there are innovations that involve the entire system referred to as systemic innovation such as the Society for Worldwide Interbank Financial Telecommunications (SWIFT) mode of payment widely used by the banking industry.

In reference to the function, financial innovation is defined according to the improved functions that the innovation brings to the financial system. Llewellyn (2009) view this aspect as to the relevant functional value that it adds to the already known system. The relevant functions can include risk transfer, creation of equity (such as through debt–equity swaps), and liquidity and credit generation improvements, for instance, Central Depository System (CDS), Asset–Backed Securities (ABS), and Collateralized Debt Obligation (CDO). It is important to take note that Finnerty (1992) provides six obligations that financial system plays. These obligations include: risk management, pooling funds together, transfer of the funds in time and space, facilitating the movement of goods and services through purchase using the payment system laid out, and moral

hazard mitigation and provision of asymmetric information issues. In addition, Merton (1992) laid out a set of functions more similar to those of Finnerty (1992) although clustering together the functions of transfering money and pooling of funds into a single cash management function.

Lastly, in the third case (financial innovation according to the type), Llewellyn (2009) postulates that financial innovation is identified according to three dimensions i.e., process innovations which is tied to an improvement such as pricing of transactions or distribution of financial instrument; product innovation which deals with setting up of new financial instruments, markets, and techniques; and finally, innovations that allow risk transfer, component separation and re–assembling them into various distributions. Therefore, the primary components of financial innovation are highlighted as financial instrument number increament, combining the existing instrument features into a variety of forms, increasing possible combinations which would reduce the size and number of financial instrument range discontinuities, and lastly, to palliate the differences among the brokerage forms. Central Depository Systems (CDSs) is an excellent example of a financial innovation that play the role of achieving this goal.

Financial innovations can not be confined to a single definition but rather to the convergence of the creation of new financial instruments and technological progress that enhance proper and smooth running of the financial markets (Muli, 2016). Various researchers have posited different definations of financial innovations as seen in the literature. For example, Solans (2003) defined financial innovation as the technological progress or rather advancements with which key information is accesssed, trading and payments are effected smoothly. Further, Solans (2003) defined financial advancements to imply the coming up of most current financial instruments, new organizational forms and more advanced and complete financial markets. Conversely, Frame and White (2002) opined that financial innovations represent processes or inventions that reduce costs and risks or provides a robust products or services or instruments. Financial innovations ideally must be projected as channels through which costs and risks are mitigated or a provision through which improved services that attains specific needs of the financial system participants (Solans, 2003). Thus, financial innovations can be viewed as the product and organizational innovations that mitigate in bringing down costs and risks for financial players such as banks and the improvement of service delivery in the financial system as a whole.

Innovations in the financial sector are vital becasue they come with new financial products that facilitate transactions, thus, acting as substitutes for cash transactions (Nkoro and Uko, 2013; Jonah et al., 2020; Noyer, 2008; and others). Odularu and Okunrinboye (2009) opined that new financial products as a results of financial innovations alter the monetary aggregate composition vital for effective monetary policy formulation. This would also make the financial atmosphere in which the monetary policy operates extremely complex (Noyer, 2008). Gbadebo (2010) argued that with the existance of modern financial products and services, reducing excess liquidity by the use of contractionary monetary policy would be undermined. This is because economic players can quickly and conviniently transfer money out of less liquid holdings into more liquid packkages that are offered ny financial intermediaries in the economy. Thus, in the process of transfering funds from one form of liquidity to another, the contranctionary monetary policy performance would be undermined greatly. Therefore, the intended outcome of the policy will not be achieved. Since financial innovation evolves over time due to changes in technology, services and products would most likely affect the proper functioning of the money demand function (Jonah et al., 2020).

The role that innovations play in the financial sector have been highlighted clearly not to be missed. For instance, Tirole (1988) shows the importance of patents which allow companies to draw economic benefits from the output they produce through research and development. This would be debated to mean confidentialty that comes along with patent rights which give the producer or innovator 'industrial secrets' to the product in question. By giving the innovator the absolute rights to produce the good or service, then, it would benefit the owner through profits accruing from the innovation as the first mover. This would be in terms of the higher price or commanding a wider market share thereby recovering investment costs in research and development (Carow, 1999).

Despite extensive developments brought about by the financial innovations in the financial markets, limited studies have explored the demand for money function by incorporating both direct and indirect attributes of financial inclusion. Rather, most researchers have endeavoured to investigate the influence of innovations on the money demand stability by only relying on changes in regime models (Folarin and Asongu, 2019). The limited studies that have expounded in–depth the money demand function to include direct and indirect financial innovation variables include Ujunwa et al. (2022); Akosah, Mensah, and Omane–Adjepong (2020); Nchor and Adamec (2016); and others. For instance, Chakravorti and Amromin (2007) established that debit cards and ATMs

greatly decreased cash contact among the economic agents in 30 developed countries for the year ranging between 1998 and 2003. In other studies by Secchi and Lippi (2009), Stix (2004), and Klee and Hayashi (2003), they found that ATM transactions, debit card deductions, and other electronic fund transfers swapped the cash money in countries of Italy, Austria, and USA respectively. Therefore, by relooking into the influence of financial innovation on demand for money is critical because it will help in formulating effective monetary policies. Investigating the relationship between money demand and factors that determine its behaviour will establish a solid macroeconomic theory and provide vital components that will aid in policy formulation for the economy (Goldfeld, 1994).

Kenya has experienced various reforms in the financial system aimed at enhancing the efficiency of monetary operations. For instance, the teller services can be similarly equated to those that characterize the ATMs which has become a significant milestone in the banking sector. Statistics indicate that up to the year 2020, the number of ATMs stood at 29,070. Equally, banks have adopted the debit cards which allow their customers to withdraw money at ATM outlets and make payments in supermarkets, eateries, petrol filling stations, hotels or any other outlets which offer these kind of transactional payments (Mujuri et al., 2018). Kenya's ATMs and Point–Of–Sale (POS) machine transactions between 2010 and 2021 are as shown in Table 1.1.

Table 1. 1: Kenya's ATMs and POS Machines Transactions between 2010 and 2021

Year	No. of ATMs	POS Machines	Total ATM Cards "000"	Number of POS Machines Transactions "000"	Number of ATM Transactions "000"	Volume of POS Machines Transactions (Ksh Millions)	Volume of ATM Transactions (Ksh Millions)
2010	22,216	231,770	54,773	5,496	86,977	43,615	399,698
2011	24,883	201,030	86,585	6,570	115,562	64,523	427,039
2012	26,702	206,013	101,967	11,303	217,291	111,372	392,863
2013	28,461	233,253	114,650	15,765	92,219	103,468	423,200
2014	30,030	216,461	128,338	11,635	89,998	62,183	384,708
2015	30,756	233,188	147,795	13,171	108,205	70,716	403,288
2016	31,356	323,997	159,919	17,153	96,073	91,778	466,462
2017	31,088	399,251	183,346	22,323	96,298	100,764	474,794
2018	30,546	477,737	201,508	25,669	100,534	123,055	484,814
2019	30,077	515,493	153,654	33,210	78,571	164,086	641,138
2020	29,070	542,978	137,549	34,710	66,513	157,716	650,410
2021	28,634	581,572	140,841	42,454	78,645	194,336	754,438

Source: CBK (2022)

In Table 1.1, the volume of transactions through ATMs increased from Kshs 399,698 million to 754,438 million while those for POS machines increased from Kshs 43,615 to 194,336 millions between 2010 and 2021. The low transactional charges, the less time taken to withdraw money, and the readily available ATM outlets spread across the country can be attributed to increased value of transactions. Equally, the amount of ATMs increased from 22,216 to 28,634 within the same period. Nevertheless, the trend started to decline between 2017 and 2020. The likely reason for this trend can be due to some banks scalling down their ATM outlets in order to cut costs but instead replacing them with the use of mobile money and bank agents.

Ndirangu and Nyamongo (2015) observed that perpetual usage of mobile money services in developing economies has been swift vis-à-vis any other technologies in the financial market history. These mobile money services have led to rapid disruptions in the financial market. Kenya has gained for itself the regional leader title in the digital currency as a result of increased number of mobile money users. This has made it possible for increased savings and lending patterns within

the various economic agents. Thus, mobile money has gained the household tag since it is the most common medium of money transfer. One of the most common moble money platforms is M-pesa, which was rolled out in 2007 through mobile network platforms of Vodafone (Tanzania) and Safaricom (Kenya).

Mobile money platforms allow their subscribers either to deposit, transfer, or withdraw money. They also make it possible to make payments using mobile phones for goods and services consumed without necessarily using bank accounts. To that end, mobile money has gained attraction and has expanded rapidly to stand out as one of the advancing world's most successful mobile–wallet financial product. Kasekende and Nikolaidou (2018) opined that from the time M–Pesa service was incepted, customers have been able to conveniently receive and send money from the comfort of their phones.

The M–pesa innovation has made it possible for the unbanked population masses to easly access financial services with no serious limitations. The service has also evolved from being just a money transfer oriented platfrom to a plaform that enables its customers to save (for instance, M–shwari lock savings and KCB M–pesa fixed savings account), access loans (for example, M–shwari, fuliza, and KCB M–pesa loans), and to make marchant payments for goods (by paying directly or use of paybill or till number accounts). Hence, M–pesa remains a constant and most eminent financial innovation in the country today.

Various platforms for mobile money have since emerged since the inception of M–pesa. These platforms include Airtel Money and Orange Money that were rolled out in 2010. Orange money was later superseded by Telkom Kash (T–Kash) in 2018. Kenya’s performance of mobile money from 2010 to 2021 is illustrated in Table 1.2.

Table 1. 2: Kenya's Mobile Money Performance Between 2008 and 2021

Year	No. of Active Agents	Total Registered Mobile Money Accounts (Millions)	Total Agent Cash in Cash Out (Volume in Millions)	Total Agent Cash in Cash Out (Value in Ksh billions)
2008	42,248	39.11	62.74	166.57
2009	198,840	87.17	193.50	473.41
2010	387,244	152.27	311.05	732.22
2011	505,381	218.55	433.00	1169.15
2012	756,828	235.89	577.37	1544.81
2013	1,229,654	282.56	732.60	1901.56
2014	1,445,664	311.02	911.34	2371.79
2015	1,607,424	321.00	1114.18	2816.10
2016	1,943,637	385.21	1331.01	3355.11
2017	1,989,624	418.45	1543.18	3638.47
2018	2,407,847	510.01	1739.57	3984.37
2019	2,657,094	628.80	1839.08	4345.76
2020	3,013,196	743.85	1863.30	5213.54
2021	3,576,771	808.73	2165.54	6868.77

Source: CBK (2022)

It is evident from Table 1.2 that there has been an upward trajectory in the mobile money agent operators. The numbers have increased from as low as 42,248 to 3,576,771 from the inception of M–pesa in 2007 up to 2021. The volume of transactions increased from 62.74 to 2,165.54 million in 2008 and 2021 respectively. On the other hand, transaction value has also witnessed an increase from Kshs 166.57 to 6,868.77 billions in 2008 and 2021. This trend indicates that mobile money would probably be the missing link in Kenya's money market.

Therefore, considering that mobile money unlike other innovations in the financial sector that make it necessary one to have a bank account, it does not make this requirement compulsory. Thus, this has enhanced financial inclusion for the unbanked population masses to access financial services which has positively influenced the increase in the demand for money.

1.2: Kenya's Monetary Policy Instruments

In Kenya, the monetary authourity is the CBK that is mandated in formulating and supervising the implementation of the monetary policy. In addition, it develops and implements the foreign exchange policies, maintains foreign reserves, foresees issuing of coins and notes, and act as a

government's fiscal policy agent (CBK, 2021). The National Treasury provides inflation and economic growth targets in which the moneraty program that guides the monetary policy is anchored. Monetary Policy Management Committee (MPC) oversees the smooth running of the daily monetary activies. Further, the MPC is charged to make monetary policy decisions after conducting data reviews and analysis from various sources.

There are various instruments employed by the CBK to achieve its objectives. These instruments include; lending Rate of the Cental Bank to commercial banks (CBR), Open Market Operations (OMO), and Legal Reserve Requirement (also referred to as the Reserve Ratio). However, these instruments can be used concurrently and not necessarily in isolation. In case the money supply in the economy is above the desirable level, government securities are sold to the public so that to bring the money supply to the level that is desirable. This is referred to as Repurchase Agreements. Likewise, if the supply of money is below the target level, the government buys securities from the public and in turn money is injected into the public. The Central Bank Rate usually impacts the interest rate commercial banks charge on loans they advance to borrowers. The higher the rate banks charge on loanable funds, the more expensive the loans become which will discourage borrowing. Lastly, the Legal Reserve Requirement dictates that commercial banks keep a certain amount of their deposits with the CBK for economic stability and liquidity control. Therefore, increase in regulatory reserve requirement will reduce liquidity of the commercial banks which in turn reduce the money supply.

1.3: Problem Statement

The money demand concept whose precise measurement and stability testing have gotten much attention is vital in monetary policy formulation. For efficient monetary policy implementation, monetary authorities must know the extent to which money is demanded in the economy so as to know the level of money supply to inject into the economy to match this demand. This means that all elements driving money demand, including financial innovation, must be included when doing a proper empirical investigation on the money demand function and its stability. Failure to account for these developments might result in erroneous estimates, which could impact policy choices. This is because financial innovations contributes to the behavioral change in how individuals hold money. Sichei and Kamau (2012) attribute money demand instabilities to innovations in the

financial sector that offer several quasi–money items. In this context therefore, innovations in the financial industry may have an impact on monetary policy implementation. Furthermore, there is scant empirical data enumerating impactual effect of financial innovation on money demand, with inconsistent results. Thus, the primary aim for this study was to examine if innovations in the financial sector significantly affect the broad money demand and influence of this on money demand function stability in Kenya.

1.4: Research Questions

i. Is there any short or long term relationship linking the demand for money and financial innovation in Kenya?
ii. Is the demand for money function in Kenya stable or unstable?

1.5: Study Objectives

The primary goal for this study was finding out the influence of financial innovation on Kenya's demand for money function with the singular objectives of the research being:

i. To investigate the short and long term association connecting financial innovation and real money demand.
ii. To examine the stability of the real money demand function.
iii. To use the findings from (i) and (ii) to make policy suggestions.

1.6: Justification of the Study

Money demand has an effect on the implementation of monetary policies that are important for targeting macroeconomics variables like interest and flation rates, managing aggregate demand, and managing the economy as a whole. Understanding the connection betwixt innovation and the demand for money helps policy planners and researchers create the right monetary policies that will keep the economy in check and on an upward growth trajectory. Therefore, the findings from this study will be central and instrumental to both academician, research analysts as well as policy makers in relevant private and government institutions. Further, the study will contribute to literature on what is known about money demand and the effects of financial innovation on money demand.

CHAPTER TWO: LITERATURE REVIEW

2.0: Introduction

This chapter covers theorical literature review which include the different theories of money demand, empirical literature review on innovation and money demand, and lastly, an overview of the literature.

2.1: Theoretical Literature

This section discusses the theories of money demand which have been put forth to explain various factors influencing the demand for money. These theories include: Keynes money demand theory; Baumol–Tobin theory; and quantity theory.

2.1.0: Quantity Theory of Money

This theory of quantity of money can be trailed back to the work of Nicolaus Copernicus in 1517. Copernucus focus turned to the quest by King Sigismud of Poland to offer suggestions to reform the tangled currency of that time. Although the proposals by Copernicus were not considered, the work, "Essay on the Coinage of Money (1526)" made considerable contributions to monetary thought and by extension; history of economic thought. In 1963, the work of Copernicus gained much interest and popularity after the book titled, "Essay on the Coinage of Money" was published by Friedman and Schwartz (1963).

This theory postulates that money supply determines an economy's price. This means that prices fluctuate in lockstep as quantity of money in circulation changes.Therefore, the quantity theory of money suggests that; forces of demand and supply determine the exchange value of money. This give rise to the basic equation for quantity theory referred to as 'The Fisher Equation' in connection to Fisher (1911). The simplest form of the quantity theory is shown in equation (2.1):

$$MV = TP \tag{2.1}$$

Wherein; M is money supplied, V stands for velocity of circulation of money, T is transaction volume, and P is average price level in the economy.

The transaction volume and circulation speed of money remain constant in the short term since they are exogenously determined (Fisher, 1911). This means the level of prices will directly vary in respect to the level of money supply. However, the Cambridge economists postulate that individuals keep a certain portion of their income in cash balances. Thus, the higher the income earned by an individual, the higher will be the money amounts held by the individual. In order to demonstrate that the quantity theory of money is in fact the money demand theory, equaton (2.1) is transformed by dividing through both sides of the equation by V so that it give rise to the following equation (2.2):

$$M = 1/V(TP) \tag{2.2}$$

If we assume an equilibrium condition, then the quantity of money "M" that economic agents hold is equal to the quantuity of money demanded M_d. Thus, M in equation (2.2) can be replaced by the quantity demand for money (M_d). Using Y to represent income, and q to show quantity $(1/V)$, equation (2.2) can then be reformulated to give rise to the money demand function postulated by Irving Fisher in 1911 as shown in equation (2.3):

$$M_d = q(PY) \tag{2.3}$$

Where; M_d is money demanded, Y is income, q represents the proportion of income held, while P is the level of prices.

2.1.1: Keynes Theory of Money Demand

Keynes (1936) proposed three explanations for the demand for money; transaction motive in which economic agents hold money for day to day transactional purposes (i.e., purchasing of goods and services demanded); precautionary motive and this is to account for unknown future events (such as disease, accidents, and others). Both the transaction motive and precautionary motive are influenced by income level. Finally, in speculative motive, individuals holds money in form of bonds or cash. As a result, when interest rates are high, the consumers will speculate a decrease in interest rates. Bond prices are projected to rise due to this decline hence consumers will retain less cahs and more bonds. This means that interest rates inversely correlate to money demand. Therefore, in light of Keynes' quantity theory of money, the real demand for money can be shown as follows:

$$M_d = L(Y, i) \quad (2.4)$$

Whereby; M_d represents the money demand, L is liquidity preference, Y is income level, whereas i is the nominal interest rate.

2.1.2: Baumol–Tobin Theory

Money has cost and benefit i.e., cost in terms of low return rate and benefit in terms of convenience in transacting business. Thus, an individual will decide on the amount to keep in cash by weighing between costs and benefits accrued. Baumol–Tobin were not satisfactory convinced by Keynes' theory which treated the demand for money under the three broad tenets.

Baumol (1952) and Tobin (1956) developed a model that would explain holding money in terms of transactional demand. The Baumol–Tobin model reveals that money demand positively and negatively depend on income level and interest rate respectively. Thus, economic agents will keep portifolio in terms of monetary asset or non–monetray assets depending on trade–off between interest foregone for liquidity of holding cash and non–interest-earning assets (Serletis, 2001). To that end, the Baumol–Tobin model can be represented using equation (2.5):

$$A = (tc * y/2i)^{0.5} \quad (2.5)$$

Whereby; A represents the money held on average while tc stands for the transaction cost. On the other hand, i and y are defined as before. From equation (2.5), we can observe that money held on average falls with a rise in interest rate.

2.1.3: Diffusion of Innovation Theory

Diffusion of innonation theory is an hypothesis that seek to explain how new technological and other innovative advancements spread out from one society or culture to another and from introduction to widespread adoption. This theory was developed by a communication theorist Rodgers in 1962 while in the University of Mexico (Rogers, 1962). Rogers opined that adoption of technology in a social system does not just occur concurrently, rather, it is a process in which some individuals are disposed to take up a new idea or concept in advance or beforehand of others.

The worldwide application of this theory has been employed widely to explain reasons for embracing new technologies in various aspects of life. The process of technological diffusion

entails four aspects which include; time limit or horizon, communication channels of the social system, social system, and innovations (Rogers, 1995). Nevertheless, the process is not devoid of human capital development level as it strongly depends on it. Hence, the greater the degree in human capital, the swift will be the process of transfer and adoption of the innovation. Areas in which diffusion of innovation has been applied include but not limited to financial systems. For example, the evolution witnessed in information and communication technology (ICT) services, have facilitated faster deepening of the financial innovations which have contributed the rebirth of most current financial instruments, products and services, and up–to–date organizational structures. For instance, these new instruments include ATMs, internet, Point–Of–sale (POS), and mobile banking which have revolutionalized the financial sector.

2.1.4: Financial Innovation Hypothesis

Financial innovation hypothesis can be traced to the empirical studies carried out by various researchers (Grinblatt and Longstaff, 2002; Merton, 1992; and others) and exists in two forms i.e., financial innovation–fragility version and financial innovation–growth hypothesis. The fragility version of financial inventions takes innovation from the sceptical or dark side perspective. Accordingly, invention would be superintending factors causing financial crises since the process of innovation come to a climax in the unprecedented rise in the formation of credit that cause the first boom at the onset and thereafter, the burst (Brunnermeier, 2009). For example, Houston et al. (2010) argued that financial innovation that is driven by arbitrage regulations hinders efficient resource allocation at the same time reinforcing financial fragility which adversely impacts effective and efficient implimentation of monetary policies.

Financial innovation–growth hypothesis, on the other hand, plays a critical role as far as financial system are concerning by aiding a reduction of agency costs and ultimate enhancement of allocative efficiency in the system (Merton, 1992; Grinblatt and Longstaff, 2002; Houston et al., 2010; and others). The growth hypothesis proposes that, financial innovations have the capability of increasing the efficiency of financial systems through a variant of services as well as products with which may cause refinement of matching individual saver requirements with firms searching for financial resources (Chou, 2007). Further, growth hypothesis postulates that fianancial innovation has lead to the emergence of new technologies in the financial sector such as the modern payments channels like Point–Of–Sale (POS), SWIFT, ATMs, mobile and internet banking

transactions. These innovations have led to a reduction in transaction costs and ultimate increase in capital productivity.

2.2: Empirical Literature

The concept of money demand has received overwhelming research efforts for many centuaries both in rich and underdeveloped countries. Notebly, specification of money demand function has gotten a lot of regards over the years, partially because of the conflicting conclusions on money demand stability. Conversely, majority of the research works include money demand specification innovations as a consequence of the recent surge in financial innovation. Innovations need to be incorporated into the money demand function, according to empirical data, aiding in overcoming some of the problems associated with money demand specification. This include autocorrelated errors to chronic overprediction as well as parameter estimates implausability (Arrau et al., 1995).

The majority of research works that have taken financial innovation into account thus extending money demand specifications, have mostly focused on more advanced and transition countries. However, given new legislation, stronger banking systems, financial markets, and growing mobile phone use, there has been amazing growth in financial innovation in emerging nations as well. Adil, Sahoo, and Hatekar (2020) studied how innovations in the financial market impacted India's demand for money function during the post-reform period of second quarter of 1996 (Q2: 1996) to the third quarter of 2016 (Q3: 2016). They employed the linear ARDL approach to cointegration to determine the demand for money function. The findings reveal existance of a steady long term association among the variables of money balances (in real terms) and scale and opportunity cost. Therefore, the study concludes that innovation plays an overall vital significance in India's money demand and its stability in the economy.

Kasekende and Dunne (2018) examined the expansion of innovation and its effect on money demand on SSA using longitudinal data estimation methodologies for 34 African nations. The consideration period for this study extended from 1980 to 2013. The researchers proxied financial innovation with M2/M1 in the study.The findings showed a significant negative association linking invections and money demand. This indicates financial innovation is critical in elaborating on money demand in the SSA region. The negative relationship can be attributed to people embracing highly liquid assets compared to less liquid assets which has a negative consequence on impacting the quantity of money demanded.

Examining Bostwana's money demand and the influence of financial innovations, Motsewakgosi (2019) used the yearly data spanning from 1982 to 2017 in the study. Employing the Autoregressive Distributed Lag (ARDL) bounds tesing approach, the study looked at the role innovation plays on the demand for narrow and broad money in financial markets. The results indicated that in the short term, financial innovation positively affect narrow money while in the long term, it did not have any effect. Nevertheless, even if long term relationship existed in broad money in presence of financial innovation, it only impacted the demand for money negatively in the short term. Therefore, in conclusion, there is a negative general effect of innovations on real demand for money balances.

Neewhord (2019) examined the influence of innovations on money market and money demand in Sierra Leone from the period between 1996 and 2016. Autoregressive Distributed Lag (ARDL) technique was applied for this study. The long run findings show that foreign interest rate, real output (GDP), and financial innovation have a direct positive effect on real broad money while civil war variable has a negative impact. Similary, innovation, inflation and foreign interest rate have an inverse relationship effect on the demand for money. The study also reveals that the model is stable with an effective monetary policy. In conclusion, wealth effects are confirmed by the short-run findings. These findings were confirmed in a similar study by Rao and Acharya (2018) in which they found positive effects of all the derivative variables (equity options, equity futures, and total equity derivatives) on money demand indicating presence of wealth effect. The research employed the ARDL bound test approach to co–integration for data spanning between 2001 and 2014.

Ujunwa et al. (2022) assessed if there was any link between innovation and money demand stability in Nigeria. The study employed quarterly data between the first quarter of 2003 (Q1: 2003) to the fourth quarter of 2019 (Q4: 2019) that was collated using Nigeria's National Bureau of Statistics (NBS), the Central Bank of Nigeria (CBN), and International Financial Statistics (IFS) data. ARDL bound test technique to co–integration was applied in estimating long term relationship between monetary aggregates and their determinants. The findings showed the presence of a long run relationship between demand for money and its determinants including the financial innovation. From the study, inflation rate is seen to be the strongest measure of the opportunity cost of holding money balances in Nigeria's economy relative to interest rates. Of

serious interest to this study, the consistency variable tests i.e., the cumulative sum (CUSUM) and cumulative sum squared (CUSUMSQ), indicated that financial innovation inclusion in the model had no effect on money demand stability across the three estimates of monetary aggregates (i.e., M1, M2, and M3) which would imply that monetary targeting is the most appropriate monetary policy framework in Nigerian economy.

Ndirangu and Nyamongo (2015) looked into effects of financial innovations on monetary policy in Kenya for the period of 1998 to 2013. They endevored to test whether the financial innovation waves that have been witnessed during the study period have had any significant influence on long term stability of money demand. The study applied Autoregressive Distributed Lag (ARDL) to co–integration method and financial innovation was proxied by the ratio of term deposits to cash kept outside banks. Empirical findings showed that financial innovation had an inverse relationship to broad money demand, both M2 and M3. The relationship with M1 was however positive and insignificant. In a similar study, Kasekende and Nikolaidou (2018) examined Kenya's money demand with country specific innovation (M–pesa) that was introduced in 2007 starting from first quarter of 2000 (Q1: 2000) to second quarter of 2014 (Q2: 2014). The study adopted the ARDL approach to co-integration to estimate the model under study. Findings from this study showed a stable and positive correlation between mobile money and money demanded. Consequently, this finding echoes a similar finding from the work carried out by Kasekende and Dunne (2018).

Muli (2019) studied the implications digital finance has on money demand in Kenya using data spanning from the second quarter of 2007 (Q2: 2007) to the fourth quarter of 2018 (Q4: 2018). The study proxied the number of transactions of mobile money to digital finance. The number of mobile money transactions was shown to have a severe effect on money demand. The results indicates that there is a negative influence of digital finance on money demand. This finding can be attributed to the excess use of mobile money which has decreased the demand for cash balances. Therefore, this led to the reduction in the monetary aggregate M1. However these findings contradict those of Mujuri et al. (2018).

Amidst the various structural adjustment programs and technological progress championed by the Kenyan government, the research question still remain as to whether these have been able to influence money demand either positively or negatively. To that end, Mujuri et al. (2018) examined the implications of financial innovation on money demand in Kenya. The study

employed the mpesa transaction volume and ATMs transactions carried via mpesa and ATMs as the explanatory variables. The study period under consideration ranged from 2008 to 2016 taking into account the availability of data. In addition, Error Correction Modeling (VECM model) was used for analysis given that some variables turned to be non–stationary under the unit root test (ADF test). Co–integration and autocorrelation test were carried out using Jahansen Co–integration test and Breausch–Godfrey LM test repectively. The findings from this study reveal a positive correlation between financial innovation and money demand at statistical significance of 5%. Thus, the study recommended government regulation of the volume of transactions through mobile transfers and ATM cards. Further, to ensure money stability, the government has to formulate the minimal interest rate chargable for all money lenders irrespective of sector or medium of money transfers. Other studies that have found a positive association linking money demand and financial innovation include that of (Kasekende and Nikolaidou, 2018).

Sichei and Kamau (2012) studied implications of the conduct of monetary policy on Kenya's demand for money for the period of fouth quarter of 1997 to the second quarter of 2011 (Q4: 1997 to Q2: 2011) using the cointegrated vector autoregression (VAR) analysis approach. In the study, dynamic frameworks were employed in the estimation and uncovering parsimonious and empirically stable functions of money demand. The results showed that nominal 91–Day Treasury bill rate, price, nominal interbank rate, real GDP, foreign interest and the nominal deposit rates all influenced the long–term demand for money functions in varying degrees. Moreover, the money demand functions were found to be unstable in the period within which the parameter values were considered which insinuate that the prevailing monentary targeting policy framework was inppropriate. Notwithstanding this fact, adoption of alternative monetary policy framework would also be challenging.

Asongu et al. (2019) studied money demand stability in the proposed South African Monetary Union (SAMU) over the period of 1981 to 2015 using the countries comprising the SADC. Using the standard demand for money function, the researchers adopted the bounds testing approach to co–integration and Error Correction Modeling (ECM). The results showed stable divergence of the demand for money function across the countries. The divergence would be attributed to the differences in co–integration cumulative sum (CUSUM) and cumulative sum squared (CUSUMSQ) tests, short and long–run determinants, and the Error Correction Modeling (ECM)

in the case of a shock in the economy. To that far, the study recommended policy implications that would lead to feasibility in the proposed regional monetary union for the southern African countries. Similarly, Simawu, Mlambo, and Murwirapachena (2014) carried out a study investigating broad money–M2 demand in South Africa between the 1990 and 2009. They applied the Jahansen co–integration and error correlation model (ECM) and established that there existed steady long run relationship between real broad money demand and its independent variables. Co–integration and vector autoregression (VAR) analysis revealed real broad money and all the independent variables were co–integrated.

Odeleye and Akam (2022) assessed money demand function in sub–regions of the Sub–Saharan Africa using yearly time series extending between 1980 and 2017. For data analysis, panel homogenous Autoregressive Distributed Lag (ARDL), Dumitrescu and Hurlin panel test, as well as co–integration tests were used. Study findings revealed presence of a co–integration relationship between money demand and its determinants in the Sub–Saharan regions. Further, it was shown that there was a divergence both in the short run and long run determinants and the error correlation bbecause of shocks across the sub–regions in the SSA. On the other end, the causality test provided evidence that a linkage of a bi–causal nature existed between the demand for money and its determining factors in the Sub–Saharan African economies. Nevertheless, there was divergence in the causlity findings across the sub–regions. Therefore, it was noted that prices plays a key role in influencing money demand in the SSA region. In conclusion, various Sub–Saharan African government must ensure that policies that are adopted are able to enhance stbilization of prices which will facilitate a robust stable demand for money in these economies as a whole.

Khan and Hye (2011) investigated liberalization effects of financial markets on demand for money (broad money–M2) in Pakistan for the period of 1971 to 2009. The study applied the Jahansen co–integration and ARDL to co–integration in estimating long run equilibrium linkage between broad money (M2) to composite index for financial liberalization and other determinants of money demand. The recursive residuals i.e., CUSUM and CUSUMSQ tests were used to assess the stability of the money function. The results indicated that for the case of broad money, there was presence of a long run demand for money function. Further, liberalization of financial markets, gross domestic product (GDP), and real deposit rate positively impacted the demand for money balances both in short and long terms. In addition, Akhtaruzzaman (2007) found similar results on

financial libearalization significant influencing the M1 (narrow money) and M2 (broad money) money demand balances.

Lastly, Jonah, Egbe, and Richard (2020) explored the influence innovation bear on Nigerian demand for money in the financial market using quarterly time series data for the period between 2009 and 2019. In the study, OLS regression method was applied within the co–integration, granger causality, and the Error Correction Modeling (ECM). The results indicate that financial innovation had mixed influence on money demand in Nigeria for the period under review. Financial innovation positively influenced the demand for money via Automated Teller Machine transactions quantity for the current period, two periods lagged of the mobile money transactions voume, current period and one period lagged of internet banking transactions volume, and current period's Point–Of–Sale (POS) transactions quantity. On the flipside, financial innovations also negatively influenced money demand through one period lagged of volume of POS. Finally, the CUSUM and CUSUMSQ test indicated that money demand function was stable in the entire period of review.

2.3: Overview of the Literature

Financial innovation is an ad hoc process that occurs continuously across the economy. This implies that the literature on this subject is always evolving. Various econometric approaches like Johansen and Juselius, Engel and Granger, and others have been employed in the literature on money demand, new research has also looked at the ARDL approach to cointegration, for instance, in the Kenyan context, the work by Ndirangu and Nyamongo (2015). Evidence suggests that financial innovation may affect money demand either positively or negatively and this is very dependendt on the proxies used for financial innovation. However, it's also challenging to find the right metric to quantify financial innovation. As a consequence, numerous proxies have been examined in the literature, including a dummy variable, ATM concentration, mobile money, currency outside banks to term deposits and M2/M1.

The studies reviewed shows that in Kenya, financial innovations focus on mobile money (M–pesa) and ATMs. However, this specification is limiting. As a result, particular studies have proposed the inclusion of alternative, less often used and more robust proxies of financial innovation such as M2/M1.

CHAPTER THREE: METHODOLOGY

3.0: Introduction

This chapter delves into the theoretical framework, variable definition and measurement, specification of the model are discussed. Data sources, data description and diagnostic tests are also provided.

3.1: Theoretical Framework

The current study is anchored on the Keynesian money demand theory. Keynes postulated that there three fundamental reasons why individuals hold money i.e., transaction and precautionary motives; determined by income level and speculative motive; driven by interest rates. To that end, according to Keynes, the money demand is indirectly and directly associated to the level interest rate and income respectively as illustrated from equation (3.1) and (3.2):

$$M_d = f(Y, i) \tag{3.1}$$

Equation (3.1) is further expanded to give:

$$M_d = kY + L(i) \tag{3.2}$$

Whereas; kY stands for the transaction and precautionary motives of holding money while $L(i)$ is the speculative motive which is influenced by interest rates.

3.2: Model Specification

As illustrated in equation (3.2), Keynes theory of Liquidity Preference postulates that interest rate and income level are the primary factors that affect money demand. This study will extend the money demand function of equation (3.2) by incorporating other relevant variables to achive the primary objective of the study. The variables include; financial innovation (representing technological advancements) and inflation (to capture opportunity cost).
Therefore, the econometric model will follow the specification illustrated in equation (3.3):

$$MD = f(Y_t, INFL_t, R_t, FIN_t) \tag{3.3}$$

Where; MD is Broad Money, Y_t is income level, $INFL_t$ is inflation rate, R_t is interest rate, FIN_t is the financial innovation, and subscript t denotes time.

Linearizing equation (3.3) transfroms the equation into equation (3.4)

$$ln(MD)_t = \alpha_0 + \alpha_1 lnY_t + \alpha_2 R_t + \alpha_3 INFL_t + \alpha_4 FIN_t + \mu_t \quad (3.4)$$

Whereas; α_0 represents the constant while $\alpha_i; i = 1, \dots, 4$ are coefficients to be determined. The other variables remain as explained in equation (3.3).

3.3: Defination and Measurement of Variables

3.3.1: Real Broad Money (MD)

Real Broad Money which represents the explained variable was deflated using CPI $(2009 = 100)$ (Adnan Hye and Islam, 2013; Hye, 2009; Mujuri et al., 2018).

3.3.2: Income (Y)

Income denotes a scale variable used to represent the degree of economic activity. For instance, Kiptui (2014) as well as Sichei and Kamau (2012) employed Real GDP to proxy level of income. A similar approach is adopted for this study. A rise in GDP will increase demand, consequently, leading to arise in transaction volume. Therefore, GDP (in real terms) is expected to positively impact real money demand ($\beta_1 > 0$).

3.3.3: Financial Innovation (FIN)

M2/M1 was used to proxy financial innovation following the example of Adnan and Qazi (2009) and Neewhord (2019). The variable is expected to have mixed effects, i.e., demand for money will be positively (Hye, 2009) or negatively (Ndirangu and Nyamongo, 2015) related with financial innovation.

3.3.4: Interest Rate (R)

The forgone benefit for holding money is denoted by interest rate. The study adopted the nominal 91–day T–BILL as a proxy for interest rate following the work of Sichei and Kamau (2012). Its effect on demand for money is anticipated to be negative ($\beta_2 < 0$).

3.3.5: Inflation (INFL)

The variable represents the rate of fluctuation of prices in Kenya. This study follows Muli (2019), Kiptui (2014), and Mujuri et al. (2018) in factoring the effects of inflation into the econometric specification. Thus, inflation and money demand are predicted to have an inverse relationship, hence $\beta_3 < 0$.

3.4: Pre–Estimation Analysis

3.4.1: Test for Normality

Normality examines whether the mean, median, and mode for the series are constant (same) and that the series have symmetrical curves. Wald test was used to evaluate if it follows that the series is normally distributed (Shapiro and Wilk, 1965).

The test for normality is as below;

$H_o: \beta = 0$; The distribution is normal

$H_A: \beta \neq 0$; Non-normality distribution

The decision is made by looking at the value of t calculated and t–critical. Accepting the H_o ($t_{cal} < t_{critical}$) shows that the series is normally distributed.

3.4.2: Test for Unit Root: Absence of Structural Breaks

For time-series dataset, stationarity test is critical for avoidance of spurious regression and inconsistent regression results. Augmented Dickey–Fuller (ADF) test and Philip–Perron (PP) tests were adopted in testing whether or not unit root was present with the t–test shown below:

$H_0: \beta = 0$; Unit root is present

$H_A: \beta \neq 0$; Unit root is absent

The test statistic for this test is the t–score. Rejecting the H_0 will indicate the series is stationary since the unit root is absent.

3.4.3: Test for Unit Root: Presence of Structural Breaks

Negligence in accounting for structural breaks in the series may result to erroneously acceptance of the null hypothesis. Since conventional unit root tests are insensitive to structural breaks, it result to biasness towards accepting the H_0 when the series is really stationary. To address the limitations of the typical unit root tests in the presence of structural breaks, the research used the Zivot–Andrews unit root test.

The t–test carried out follows the hypothesis:

$H_0: \beta = 0$; Unit root is present

$H_A: \beta \neq 0$; Unit root is absent

The test statistic for this test is the t–score, therefore when $t_{cal} > t_{critical}$, we fail to accept the H_0 thereby concluding that the series is stationary.

3.4.4: Co–integration Test

The study adopted Autoregressive Distrubuted Lag (ARDL) technique that Pesaran and Shin (1999) proposed. The ARDL approach is appropriate for this research since it allows for the use of non–stationary series and the series need not to be integrated of the same order. Equation (3.5) shows the general ARDL (p,q) model:

$$\Delta Y_t = \theta_0 + \sum_{i=1}^{k} \theta_{1i} \Delta Y_{t-i} + \sum_{i=1}^{k} \theta_{2i} \Delta X_{t-i} + \rho_1 Y_{t-1} + \rho_2 X_{t-1} + \mu_t \quad (3.5)$$

The F–test first carried out follows the hypothesis below;

H_0: The series are cointegrated

H_A: The series are not cointegrated

Pesaran et al. (2001) gave critical values for this analysis. The critical upper bound presupposes that the series is 1(1), while the lower critical bound presupposes that the series is 1(0). Narayan (2005), on the other hand, suggested the value estimations for small sample sizes, since these values were derived from large sample sizes. The decision rule follows;

If the $F_{critical}$ > the upper critical bound: There is co-integration

If the $F_{critical}$ < the lower critical bound: There is no co-integration

If the $F_{critical}$ is between the lower and upper critical bound value then the results are inconclusive. Next step is to calculate the optimal lag after establishing co–integration among the variables. SBIC was employed to calculate the lag length.

The OLS model is then used to estimate the specified Autoregressive Distribution Lag model. As indicated in equation (3.6), Error Correction Modelling (ECM) is incorporated into short and long run equilibrium.

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta X_{t-i} + \rho ECM_{t-1} + \varphi_t \quad (3.6)$$

If the value of ρ is positive, it indicates divergence, and if ρ is negative, it shows convergence.

The study employed the CUSUM test that Brown et al. (1975) proposed to test for model stability. If the estimated coefficients fall within a defined boundary, they are stable but unstable if they fall beyond the border.

3.6: Post–Estimation Analysis

3.6.1: Test for Autocorrelation

The test refers to when the stochastic terms from different time periods are related. The study adopted the Breusch–Godfrey LM test in this investigation. This test applies to any order of autocorrelation. In order to rule out order q autocorrelation, right-hand side variable residuals and their lagged values are regressed.

The chi–square test for this test follows the hypothesis below;

H_o: No autocorrelation

H_A: Autocorrelation

3.6.2: Heteroskedasticity

The regression is heteroskedastic if the disturbance variance is not constant across all observations. Thus, Breusch-Pagan test was applied to examine either presence or absence of heteroskedasticity using the χ^2 statistic.

The test used followed the following hypothesis:

H_o: Presence of homoskedasticity

H_A: Presence of heteroskedasticity

3.7: Data and Sources

The study employed quarterly data between 2000 Q1 to 2019 Q4. The data included; M1, M2, nominal 91-day T-BILL, GDP, inflation (INFL), and Financial Innovation (FIN). The variables and their expected signs and the main data used in this study analysis (data sources which include KNBS and CBK) are as shown in Table 4.9 and Table 4.10 repectively in the Appendix section.

CHAPTER FOUR: DISCUSSIONS OF THE STUDY FINDINGS

4.0: Introduction

This chapter presents the empirical findings. It starts with a review of time series properties of the variables, followed by pre–estimation tests, then the study findings.

4.1: Descriptive Data

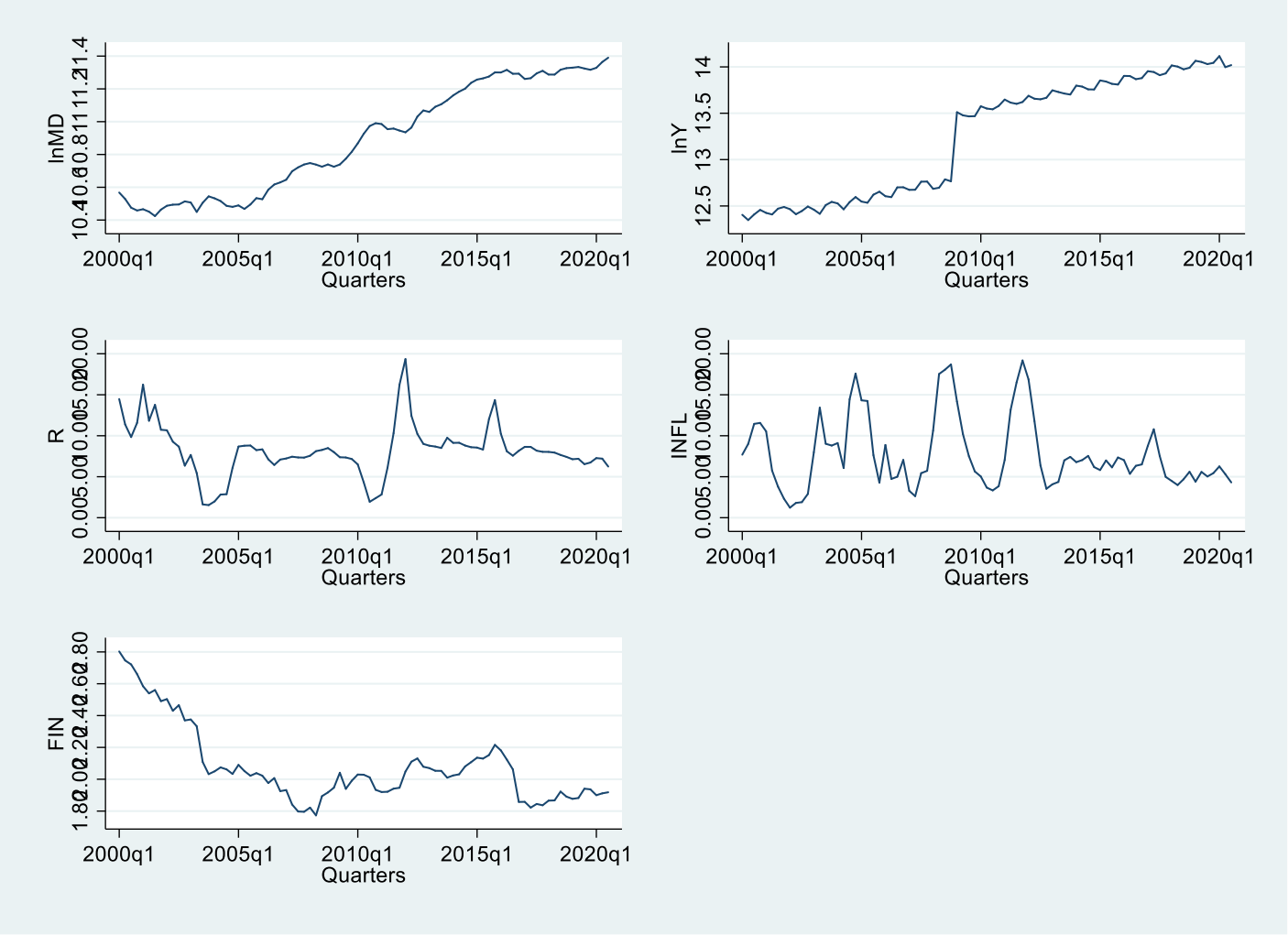
Table 4.1 shows the key summary statistic attributes of the variables under study.

Table 4. 1: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
lnMD	83	10.88	0.33	10.43	11.39	0.82	0.00
lnY	83	13.54	0.64	12.35	14.12	0.48	0.00
R	83	8.23	3.15	1.54	19.35	0.03	0.01
INFL	83	7.73	4.31	1.23	19.19	0.00	0.30
FIN	83	2.08	0.24	1.77	2.80	0.00	0.04

LnMD, lnY and FIN have standard deviations of 0.33, 0.64, and 0.24 respectively. These modest standard deviation values indicate that the statistical values of these variables are near to the mean or do not deviate away from the mean. The skewness of completely symmetrical data is zero. For values greater than 1, it reveals that the curve is skewed to the right while values of less than 1 indicate that the curve is skewed to the left. All the variables have skewed values less than 1 hence their curves are left skewed. In the case of kurtosis, values greater than 1 mean the curve is peaked (i.e., leptokurtic), whereas less than 1 indicates the curve is too flat (i.e., platykurtic). Therefore, it indicates a significant deviation from a normal distribution. From table 4.1, the kurtosis values for lnMD, lnY, R, INFL, and FIN are less than 1, indicating that their curves are flatter. The graphical outputs shown in Figure 4.1, demonstrate the trends of the individual variables.

Figure 4. 1: The Graphical Presentation of the Variables



Authors's Compilation

The graph for lnMD depicts an increasing trend over time. This is the same case with lnY with a sharp increase in 2009 due to the rebasing of the GDP. The graphs for interest, inflation rate, and financial innovation show that these variables have random tendencies.

4.2: Pre-estimation Tests

4.2.1: Test for Normality

Normality examines whether the data set has a normal distribution. That is if the mean, median, and mode for the series are the same and the series have symmetrical curves. The Shapiro & Wilk (1965) W–test was used to evaluate the normality of the series. Table 4.2 highlights the results.

Table 4. 2: Normality Results

Variable	Prob > z	Conclusion
lnMD	0.00	Not normal
lnY	0.00	Not normal
R	0.00	Not normal
INFL	0.00	Not normal
FIN	0.00	Not normal

From the results in Table 4.2, the above data doesn't follow a normal distribution, the curves are not symmetrical.

4.2.2: Stationarity Test

Absence of Structural Breaks

In the case with no structural breaks, the PP and ADF tests were used to determine the unit root as summarized in Table 4.3.

Table 4. 3: Stationarity Test Results

Variable	ADF Test Stat. z(t)		PP test stat.		Conclusion	Order of Integration
	Levels	1st Difference	Levels	1st Difference		
lnMD	-2.96	-5.97	0.08	-5.57	Not stationary	1(1)
lnY	-1.84	-7.52	0.12	-9.76	Not stationary	1(1)
R	-3.74	-5.61	-1.59	-6.39	Not stationary	1(1)
INFL	-4.54		-6.20		Stationary	1(0)
FIN	-2.57	-5.19	-0.52	-8.11	Not stationary	1(1)

***Critical value at 1% - -4.082 – ADF**

***Critical value at 1%- -2.607 – PP**

For all variables in question, except inflation, the PP and ADF test statistics are smaller vis-à-vis the critical levels at 1%. The H_o is that the series are non-stationary, implying presence of a unit root. As a result, since the test statistic values are less than the critical values at the critical level of 1%, therefore, we do not reject the H_o; hence, concluding that the series is not stationary. Non-stationary variables are then differenced to determine their order of integration. Taking the first

difference makes the series stationary indicating it is integrated of first order; 1(1). Money demand, income, interest rate and financial innovation are 1(1) while inflation is 1(0).

Presence of Structural Breaks.

Traditional unit root tests don't pay attention to structural breaks. This makes it more likely that the null hypothesis will be accepted, even if the time series would be stationary. In this study, the Zivot–Andrews unit root for structural break was used to make up for the flaws in the usual unit root test. Table 4.4 illustrates the findings of the Zivot–Andrews Unit Root test.

Table 4. 4: The Zivot–Andrews Unit Root Test

Variable	t–stat.	Critical Value (1%)	Comment	Estimated Break Time
lnMD	-4.07	-5.34	Not stationary	Q3 2009
lnY	-4.18	-5.34	Not stationary	Q2 2010
R	-5.07	-5.34	Not stationary	Q2 2011
INFL	-7.33	-5.34	Stationary	Q3 2004
FIN	-3.46	-5.34	Not stationary	Q3 2003

From Table 4.4, the t–statistic values for all the variables in question are less than the critical values at 1%. As a result, H_0 is accepted thereby concluding that the series is non-stationary. That is, the Zivot–Andrews test results are consistent with ADF and PP test results.

Economic booms and busts, political unrest, and policy shifts are just a few of the variables that may cause structural breaks. The study used a dummy variable to account for these breaks, with one representing break periods and 0 otherwise.

4.2.3: Selection of the Optimal Lag Length

Long lag lengths may lead to loss of degrees of freedom, misspecification errors, and occurrence of multi collinearity amongst the regressors. Thus, Table 4.5 illustrates the findings of the different lag length selection criterion.

Table 4. 5: Optimum Lag Length

LAG	AIC	HQIC	SBIC
0	9.58	9.64	9.73
1	-1.30*	-.93*	-.40*
2	-1.28	-.62	.37
3	-1.29	-.33	1.11
4	-1.27	-.00	1.89

The lag duration is a matter of preference and the rule of thumb is to pick the criteria that yields the lowest number. Following this consideration, using the SBIC criterion, the best lag duration for this study is 1.

4.2.4: Bound Test for Co–integration

This work used Pesaran & Shin (1999) bounds testing technique, which Pesaran et al. (2001) improved. Table 4.6 presents the findings with the following hypotheses:

H_0: There is no co–integration, i.e., $\delta 1 = \delta 2 = 0$

H_A: There is co–integration, i.e., $\delta 1 \neq \delta 2 \neq 0$

Table 4. 6: Bound Test Results

Test	Statistic	5%	
		UB	LB
F	7.28	4.01	2.86

Bound Test finding reveals that the F–statistic calculated is higher than the upper limit bound at 5% critical value. As a result, we reject H_0. This means that the series are co–integrated i.e., the series can be merged into a linear function due to the long-run connection.

4.3: Estimation Results

The study employed ARDL method in determining the short and long run results. ARDL approach was suitable for this study since the variables need not be of the same order of integration.

Furthermore, this method is ideal for small sample sizes. Table 4.7 show the result findings for long and short term estimates respectively together with stability test and post estimation results.

Table 4. 7: Empirical Findings of the Money Demand Model

	(1)	**(2)**
Variables	**Long run**	**Short Run**
LD.lnMD		0.269**(0.11)
D.lnY		0.069***(0.024)
D.R		-0.0023*(0.001)
LD.R		-0.003**(0.001)
D.INFL		-0.002**(0.001)
L2D.INFL		0.002**(0.001)
L3D.INFL		-0.001(0.001)
D.FIN		-0.072(0.043)
lnY	0.449***(0.043)	
R	0.022**(0.010)	
INFL	-0.020**(0.009)	
FIN	-0.478***(0.179)	

Standard errors in parentheses: *** p < 0.01, ** p < 0.05, * p < 0.1

D = 1st difference

LD = 2nd difference

In the short run, a rise in income impacts the demand for broad money positively.This means that as income increase so does that the need for money. This finding confirms the classical theory which states that individuals preserve a predetermined proportion of their income in real money balances. Therefore, as the evidence shows, as income grows, so does the desire for money. This also means that as income increases then individuals tend to hold more money for precautionary and transaction purposes. Interest and inflation rates have a negative impact on real money demand. A negative influence of inflation on money demand means that as prices increase, demand is reduced which then reduce demand for real broad money. Moreover, when interest rate

increases, the opportunity cost of holding cash balances increases hence economic agents will tend to hold less liquid assets and more interest earning assets. These finding are similar to that reached by Mujuri et al. (2018), Kasekende and Dunne (2018), and Kiptui (2014). Innovation has a negative influence on money demand, however, the impact is statistically insignificant. A possible explanation to this is that in the short run, economic agents take time to adopt new technologies. Thus, the adoption of new technologies in the financial sector might not have a significant impact on indivudal money holding behaviour as people take time to adopt to new technologies.

For long run scenario, similar results are seen for income and inflation. This means that the behaviours presented by economic agents in the short run does not change significantly in the long run. However, financial innovation show a negative significant impact on real broad money demand. This shows its importance in the inclusion in the demand for money function modeling in the long term. A likely explanation to this is that, with financial innovations financial technology gets better and transaction gets easier, which makes money substitutes easier to find and use, hence you would expect a negative relationship. That is financial innovation may alter behavior to hold money. New products, including ATMs and mobile money systems, are born out of financial innovation. As a consequence, people are less inclined to demand liquid assets since they can access them faster when needed; hence, causing demand for money to fall. Financial innovation increases the availability and use of quasi-money products, which means users, have less liquid assets to handle. This finding conforms to what Ndirangu and Nyamongo (2015) found while using cash outside banks to terms deposits ratio as a proxy for financial innovation.

The results also illustrate the ECT to be negative and highly significant at 1%. This justifies the presence of co–integration. The ECT measures adjustment rate to equilibrium.

Table 4. 8: Diagnostic Tests

Diagnostic test	Technique	t–statistic	p–value	Remarks
Autocorrelation	Breusch–Godfrey Serial Correlation LM Test (X^2)	1.330	0.249	There is no autocorrelation
Heteroskedasticity	Breusch–Pagan Godfrey (X^2)	chi2(1) = 0.140	0.710	Presence of Homoskedasticity
CUSUM				Stable

The tests from Table 4.8 provide evidence indicating that there is neither serial correlation nor heteroskedasticity. The CUSUM test was employed in checking the stability of the coefficients. This is depicted in Figure 4.2 in the Appendix section. The stability test shows that both model coefficients are stable with the CUSUM test within the 5 percentage confidence bounds.

CHAPTER FIVE: SUMMARY, CONCLUSION, AND POLICY RECOMMENDATIONS

5.0: Introduction

This chapter captures the summary of the key findings, their policy implications, conclusion and further research recommendations.

5.1: Summary

The research investigated short term as well as the long term association linking real broad money demand and financial innovation and the stability of money demand function in Kenya. Financial innovation was proxied by the broad money (M2) to narrow money ratio. This objective was achieved using the Autoregressive Distributive Lag procedure with quarterly data from 2000 Q1 to 2019 Q4. Theoretical foundation was based on the Keynesian Theory of Money Demand, which gives a straightforward explanation on the factors affecting demand for money.

The literature reviewed for this study presented diverging conclusions. Some showed that financial innovation had positive influence on money demand while others indicated negative effect on money demand. The result mainly depended on the proxy used for financial innovation.

The findings showed financial innovation to negatively and significantly affects money demand in the long term. A possible explanation to this would be, financial innovation increases the availability and use of quasi–money products, which means that users have fewer or demand fewer liquid assets to manage hence reduced money demand. Additionally, the CUSUM test revealed that, despite financial innovation, the money demand function remains stable, implying that the CBK monetary aggregate targeting remains effective.

5.2: Conclusion

Financial innovation, as shown in the study findings is influencing real money demand negatively in the long run. This therefore presents the need for the regulatory authority that is the Central Bank to integrate financial innovation effects during policy formulation, since it might complicate monetary policy. Nonetheless, financial innovation has no effect in the overall stability of the money demand function, since stability was maintained even after financial innovation was included.

5.3: Policy Implications

Considering the results from chapter four, policy implications are derived as follows:

The study confirming the stability of real broad money demand when financial innovation is factored into the money demand model has crucial implications for monetary policy efficacy. This is because failing to account for these advances might result in erroneous estimates. The empirical results on money demand stability, indicate that the CBK targeting of monetary aggregates to conduct monetary policy remains appropriate as money demand function remains steady irrespective of these advances. Nevertheless, policymakers should be as accurate as possible when anticipating money demand because financial innovation is a continuous process with unpredictably changing outcomes.

5.4: Recommendations for Further Research

Additional research should be done to determine the effect of financial innovations on monetary policy using other innovation proxies.

REFERENCES

Adil, M. H., Hatekar, N., & Sahoo, P. (2020). The Impact of Financial Innovation on the Money Demand Function: An Empirical Verification in India. *The Journal of Applied Economic Research*, 28–61. doi:10.1177/0973801019886479

Adnan Hye, Q. M. (2009). Financial Innovation and Demand for Money in Pakistan. *The Asian Economic Review*, 219-228.

Adnan Hye, Q. M., & Islam, F. (2013). Does Financial Development Hamper Economic Growth: Empirical Evidence From Bangladesh. *Journal of Business Economics and Management*, 558-582.

Akhtaruzzaman, M. (2007). Globalization, Financial Liberalization, and the Behavior of the Long Run Money Demand in the Bangladesh Economy. *International Economic Journal, 21*, 465-490. doi:10.1080/10168730601027153

Akosah, N. K., Mensah, L., & Omane-Adjepong, M. (2020). Demand for Money, Structural Break and Money's Role in Monetary Policy in Ghana: An Empirical Evidence. *SSRN Electronic Journal*, 1-29. doi:10.2139/ssrn.3179027

Al Rasasi, M. H., & Banafea, W. A. (2021). Estimating Money Demand Function in Saudi Arabia: Evidence from Cash in Advance Model. *Applied Economics, 53*, 4823-4834. doi:10.1080/00036846.2021.1910134

Amromin, G., & Chakravorti, S. (2007). *Debit Card and Cash Usage: A Cross-Country Analysis.* Chicago: Federal Reserve Bank of Chicago, Working Paper Series (WP-07-04).

Anwar, S., & Asghar, N. (2012). Is Demand for Money Stable in Pakistan. *Pakistan Economic and Social Review, 50*, 1-22.

Arrau, P., Jose, G. D., Carmen, Reinhart, M., & Wickham, P. (1995). The demand for money in developing countries: Assessing the role of financial innovations. *Journal of Development Economics, 46*, 317 - 340.

Artan, S., & Kullukçu, E. D. (2020). The Effects of Financial Innovations on Money Demand. *Karadeniz Journal of Economic Research*, 21-33.

Asongu, S. A., Folarin, O. E., & Biekpe, N. (2019). The Stability of Demand for Money in the Proposed Southern African Monetary Union. *African Governance and Development Institute Working Paper (WP/19/025)*, 1-33.

Baumol, W. J. (1952). The Transactions Demand for Cash: An Inventory Theoretic Approach. *The Quarterly Journal of Economics*, 545-556.

Brock, W. A., Scheinkman, J. A., Dechert, W. D., & LeBaron, B. (1996). A Test for Independence Based on the Correlation Dimension. *Economic Reviews*, 197-235. doi:10.1080/07474939608800353

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for Testing the Constancy of Regression Relationships over Time. *Journal of the Royal Statistical Society*, 149-192. doi:10.1111/j.2517-6161.1975.tb01532.x

Brunnermeier, M. K. (2009). Deciphering the Liquidity and Credit Crunch. *Journal of Economic Perspectives*, 77-100. doi:10.1257/jep.23.1.77

Brunnermeier, M. K., & Niepelt, D. (2019). On the Equivalence of Private and Public Money. *Journal of Monetary Economics, 106*, 27-41. doi:10.1016/j.jmoneco.2019.07.004

Carlson, J. B., Hoffman, D. L., Keen, B., & Rasche, R. H. (2000). Results of a Study of the Stability of Cointegrating Relations Comprised of Broad Monetary Aggregates. *Journal of Monetary Economics*, 345-383. doi:10.1016/S0304-3932(00)00029-5

Carow, K. (1999). Evidence of Early-Mover Advantages in Underwriting Spreads. *Journal of Financial Services Research, 15*, 37-55. doi:10.1023/A:1008034303050

Chou, Y. K. (2007). Modelling Financial Innovation and Economic Growth. Why the Financial Sector Matters to the Real Economy? *The Journal of Economic Education*, 78-90. doi:10.3200/JECE.38.1.78-91

Dunne, J. P., & Kasekende, E. (2018). Financial innovation and money demand: Evidence from Sub Saharan Africa. *South African Journal of Economics 86(2)*, 1-18.

Dunne, J. P., & Kasekende, E. (2018). Financial Innovation and Money Demand: Evidence from Sub-Saharan Africa. *South African Journal of Economics*, 428-448. doi:10.1111/saje.12205

Fetai, B. (2008). *Optimal Strategy of Monetary and Fiscal Policy in Function of maintaining Macroeconomic Stability in the Republic of Macedonia.* Ljubljana, Slovenia: University of Ljubljana Repository.

Finnerty, J. D. (1992). An overview of Corporate Securities Innovation. *Journal of Applied Corporate Finance, 4*, 23-39. doi:10.1111/j.1745-6622.1992.tb00215.x

Fisher, I. (1911). *The Purchasing Power of Money, its Determination and Relation to Credit, Interest and crises.* New York: Macmillan.

Folarin, O. E., & Asongu, S. A. (2019). Financial Liberalization and Long-run Stability of Money Demand in Nigeria. *Journal of Policy Modeling*, 963-980.

Frame, W. S., & White, L. J. (2002). Empirical Studies of Financial Innovation: Lots of Talk, Little Action? *Innovation in Financial Services and Payments* (pp. 1-39). Philadelphia: Federal Reserve Bank of Philadelphia.

Friedman, M., & Schwartz, J. A. (1963). *A Monetary History of the United States, 1867-1960.* Princeton University Press.

Gbadebo, O. O. (2010). Does Financial Innovation Affect the Demand for Money in Nigeria? *Asian Journal of Business Management Studies, 1*, 8-18.

Goldfeld, S. M. (1994). Demand for Money: Empirical Studies. In J. Eatwell, M. Milgate, & P. K. Newman (Eds.), *The New Palgrave Dictionary of Money & Finance.* London: Palgrave Macmillan Press. doi:10.1007/978-1-349-19804-7_14

Goldfield, S. M., & Sichel, D. E. (1990). The demand for money. *Handbook of Monetary Economics*, 299-356.

Grinblatt, M., & Longstaff, F. A. (2002). Financial Innovation and the Role of Derivative Securities: An Empirical Analysis of the Treasury STRIPS Program. *Journal of Finance*, 1415-1436. doi:10.1111/0022-1082.00252

Hayashi, F., & Klee, E. (2003). Technology Adoption and Consumer Payments: Evidence from Survey Data. *Review of Network Economics, 2*, 175-190. doi:10.2202/1446-9022.1025

Hoffman, D. L., Rasche, R. H., & Tieslau, M. A. (1995). The Stability of Long Run Money Demand in Five Industrial Countries. *Journal of Monetary Economics*, 319-339.

Houston, J. F., Lin, C., Lin, P., & Ma, Y. (2010). Creditor Rights, Information Sharing, and Bank Risk Taking. *Journal of Financial Economics*, 485-512.

Hye, Q. M. (2009). Financial innovation and money demand in Pakistan. *Asian Economic Review 51(2)*, 219-228.

Jonah, J. N., Egbe, I. S., & Richard, E. B. (2020). Financial Innovation and Demand for Money in Nigeria. *International Journal of Economics and Financial Research*, 257-268. doi:10.32861/ijefr.612.257.268

Kasekende, E., & Nikolaidou, E. (2018). Mobile Money and Money Demand in Kenya. *School of Economics Macroeconomic Discussion Parer Series No. 2018-11, University of Cape Town*, 1-36.

Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money.* London: Macmillan.

Khan, R. E., & Hye, Q. M. (2011). Financial Liberalization and Demand for Money: A Case of Pakistan. *The Journal of Developing Areas, 47*. doi:10.1353/jda.2013.0034

Kiptui, M. C. (2014). Some Empirical Evidence on the Stability of Money Demand in Kenya. *International Journal of Economics and Financial Issues, Econjournals*, 849-858.

Kumar, S., Webber, D. J., & Fargher, S. (2013). Money demand stability: A case study of Nigeria. *Journal of Policy Modeling, 35*, 978-991. doi:10.1016/j.jpolmod.2013.03.012

Lippi, F., & Secchi, A. (2009). Technological Change and the Households' Demand for Currency. *Journal of Monetary Economics, 56*, 222-230. doi:10.1016/j.jmoneco.2008.11.001

Llewellyn, D. T. (2009). Financial Innovation and the Economics of Banking and the Financial System. In L. Anderloni, D. T. Llewellyn, & R. H. Schmidt (Eds.), *Financial Innovation in Retail and Corporate Banking.* London: Edward Elgar Publishing.

Merton, R. C. (1992). Financial Innovation and Economic Performance. *Journal of Applied Corporate Finance*, 12-22.

Merton, R. C. (1992). Financial Innovation and Economic Performance. *Journal of Applied Corporate Finance, 4*, 12-22. doi:10.1111/j.1745-6622.1992.tb00214.x

Motsewakgosi, R. P. (2019). *The Effects of Financial Innovations on Demand for Money in Botswana, (Masters Thesis).* Gaborone: University of Botswana.

Mujuri, B. M., Kibet, L., & Kiprop, S. (2018). Effect of Financial Innovation on Money Demand in Kenya . *Journal of Economics and Sustainable Development*, 2222-2855.

Muli, C. M. (2019). *The Effect of Digital Finance on Money Demand in Kenya.* Nairobi: University of Nairobi.

Narayan, P. K. (2007). The Saving and Investment Nexus for China: Evidence From Cointegration Tests. *Applied Economics*, 1979-1990. doi:10.1080/00036840500278103

Narayan, P. K., Narayan, S., & Mishra, V. (2009). Estimating Money Demand Function for South Asian Countries. *Empirical Economics, 36*, 685-696. doi:10.1007/s00181-008-0219-9

Nchor, D., & Adamec, V. (2016). Investigating the Stability of Money Demand in Ghana. *Procedia - Social and Behavioral Sciences, 220*, 288–293. doi:10.1016/j.sbspro.2016.05.501

Ndirangu, L., & Nyamongo, E. M. (2015). Financial Innovations and Their Implications for Monetary Policy in Kenya. *Journal of African Economies*, 146-171. doi:10.1093/jae/eju029

Ndirangu, L., & Nyamongo, E. M. (2015). Financial innovations and their implications for monetary policy in Kenya. *Journal of African Economies, Vol 24(1)*, 46-71.

Neewhord, A. T. (2019). *Financial Innovation and Money Demand in Sierra Leone: Masters Thesis.* Nairobi: University of Nairobi.

Nkoro, E., & Uko, A. K. (2013). Financial Sector Development-Economic Growth Nexus: Empirical Evidence from Nigeria. *American International Journal of Contemporary Research, 3*, 87-94.

Noyer, C. (2008). Conducting Monetary Policy in Times of Financial Stress. *European Banking and Financial Forum* (pp. 1-5). Prague: Bank for International Settlements (BIS).

Odeleye, A. T., & Akam, D. (2022). Money Demand Function: A Re-assessment in Sub-Saharan Africa. *Iranian Economic Review, 26*, 61-77. doi:10.22059/ier.2020.77207

Ozcalik, M. (2014). Money Demand Function in Turkey: An ARDL Approach. *The Journal of Social and Economic Research, 18*, 172-187. doi:10.30976/SUSEAD.302206

Pavitt, K. (1984). Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory. *Research Policy, 13*, 343-373. doi:10.1016/0048-7333(84)90018-0

Pesaran, H., & Shin, Y. (1999). *An Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis.* Cambridge: Cambridge University Press.

Pesaran, H., Smith, R. J., & Shin, Y. (2001). Bound Testing Approaches to the Analysis of Level Relationship. *Journal of Applied Econometrics*, 289-326.

Rao, S., & Acharya, D. (2018). Financial Innovation and Stability of Money Demand Function in India: Do Equity Derivatives Matter? *IUP Journal of Applied Economics*, 27-40.

Rinaldi, L. (2001). Payment Cards and Money Demand in Belgium. *International Economics: Center for Economic Studies Discussion Paper Series (DPS) 01.16*, 1-27.

Rogers, E. M. (1962). *Diffusion of Innovations* (1st ed.). New York: The Free Press.

Rogers, E. M. (1995). *Diffusion of Innovations* (4th ed.). New York: The Free Press.

Salisu, A. A., Ademuyiwa, I., & Fatai, B. (2013). Modelling the Demand for Money in Sub-Saharan Africa (SSA). *Economics Bulletin, AccessEcon*, 635-647.

Samreth, S. (2008). Estimating Money Demand Function in Cambodia: ARDL Approach. *MPRA WP/16274*, 1-15.

Samreth, S. (2015). An Estimation of the Money Demand Function in Cambodia. *Economics Bulletin, AccessEcon*, 2625-2636.

Serletis, A. (2001). *The Demand for Money.* New York: Springer. doi:10.1007/978-1-4757-3320-4

Shapiro, S. S., & Wilk, M. (1965). An Analysis of Variance Test for Normality (Complete Samples). *Biometrika*, 591-611.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). *Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework. In: Sickles, R., Horrace, W. (eds) Festschrift in Honor of Peter Schmidt.* New York: Springer. doi:10.1007/978-1-4899-8008-3_9

Sichei, M. M., & Kamau, A. W. (2012). Demand for Money: Implications for the Conduct of Monetary Policy in Kenya. *International Journal of Economics and Finance*, 72-82. doi:10.5539/ijef.v4n8p72

Simawu, M., Mlambo, C., & Murwirapachena, G. (2014). An Investigation Into The Demand For Broad Money In South Africa. *International Business & Economics Research Journal (IBER), 13*, 1419-1436. doi:10.19030/iber.v13i6.8931

Singh, P., & Pandey, M. K. (2010). Financial Innovation and Stability of Money Demand Function in Post–reform period in India. *Economic Bulletin* , 2895-2905.

Solans, E. D. (2003). Financial Innovation and Monetary Policy. *38th SEACEN Governors Conference and 22nd Meeting of the SEACEN Board of Governors.* Manila: European Central Bank.

Sriram, S. S. (2001). Survey of Recent Empirical Money Demand Studies. *IMF Staff Papers, Vol. 47*.

Stix, H. (2004). How Do Debit Cards Affect Cash Demand? Survey Data Evidence. *Empirica, 31*, 93–115. doi:10.1007/s10663-004-1079-y

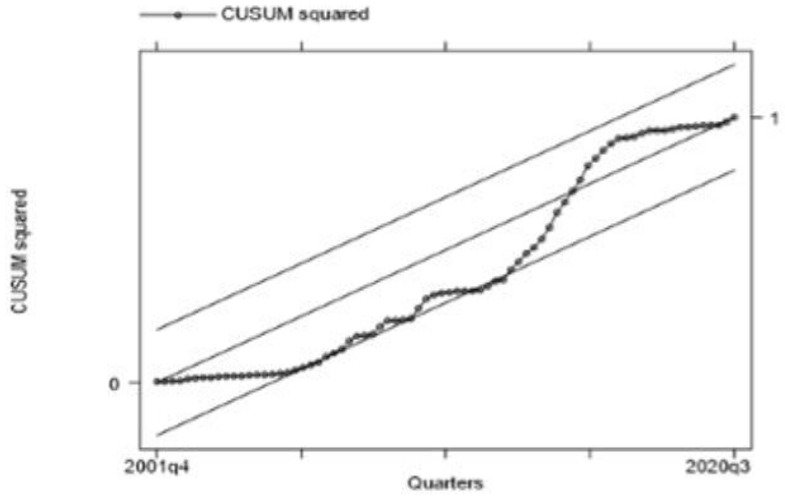
Tirole, J. (1988). *The Theory of Industrial Organization.* Massachusetts, USA: The MIT Press, Cambridge.

Tobin, J. (1956). The Interest-Elasticity of Transactions Demand For Cash. *The Review of Economics and Statistics*, 241-247.

Ujunwa, A., Onah, E., Ujunwa, A. I., Okoyeuzu, C. R., & Kalu, E. U. (2022). Financial Innivation and the Stability of Money Demand in Nigeria. *African Development Review*, 1-17.

APPENDIX

Figure 4. 2: Results for the Stability Test



Author's Compilation

Table 4. 9: Variable and the Expected Sign

Variable	Model Symbol	Expected Sign
Money Demand	MD	-----
Income	Y	Positive
Financial Innovation	FIN	Postive
Interest Rate	R	Negative
Inflation	INFL	Positve

Table 4. 10: Estimation Dataset

Year	Quarter	Broad Money (MD)	GDP (Y)	Interest Rate (R)	Inflation (INFL)	Financial Innovation (FIN)
2000	Q1	38,881	243,956	14.48	7.68	2.80
	Q2	37,382	230,418	11.38	9.00	2.75
	Q3	35,442	244,786	9.84	11.45	2.72
	Q4	34,838	257,177	11.57	11.56	2.66
2001	Q1	35,112	248,992	16.24	10.53	2.58
	Q2	34,585	244,857	11.83	5.75	2.54
	Q3	33,676	260,684	13.77	3.79	2.56
	Q4	35,030	265,474	10.73	2.32	2.49

2002	Q1	35,861	259,267	10.67	1.23	2.50
	Q2	36,102	245,410	9.27	1.80	2.43
	Q3	36,138	254,233	8.67	1.90	2.47
	Q4	36,827	266,673	6.35	2.90	2.37
2003	Q1	36,574	257,855	7.66	7.98	2.38
	Q2	34,536	246,467	5.45	13.43	2.33
	Q3	36,528	270,863	1.63	9.02	2.11
	Q4	37,970	280,467	1.54	8.80	2.03
2004	Q1	37,526	275,761	1.99	9.11	2.05
	Q2	36,915	258,812	2.82	6.06	2.07
	Q3	35,843	279,575	2.87	14.44	2.06
	Q4	35,613	295,386	6.08	17.59	2.03
2005	Q1	35,936	281,335	8.68	14.32	2.09
	Q2	35,170	277,857	8.79	14.24	2.05
	Q3	36,144	303,053	8.81	7.63	2.02
	Q4	37,568	313,004	8.24	4.27	2.04
2006	Q1	37,308	298,153	8.34	8.88	2.02
	Q2	39,535	295,111	7.13	4.73	1.98
	Q3	40,818	327,868	6.44	5.00	2.01
	Q4	41,349	328,338	7.10	7.06	1.93
2007	Q1	42,027	319,289	7.23	3.28	1.93
	Q2	44,256	319,696	7.45	2.63	1.84
	Q3	45,321	348,672	7.35	5.44	1.80
	Q4	46,117	349,189	7.33	5.72	1.80
2008	Q1	46,524	322,884	7.56	10.63	1.82
	Q2	46,098	326,704	8.12	17.53	1.77
	Q3	45,503	357,640	8.27	18.06	1.89
	Q4	46,138	350,036	8.50	18.70	1.92
2009	Q1	45,496	737,906	8.01	14.17	1.95
	Q2	46,124	713,364	7.38	10.21	2.04
	Q3	47,771	705,260	7.35	7.51	1.94
	Q4	49,838	707,159	7.16	5.65	1.99
2010	Q1	52,462	786,481	6.51	5.03	2.03
	Q2	55,612	767,418	4.33	3.68	2.03
	Q3	58,304	761,159	1.94	3.33	2.01
	Q4	59,317	789,245	2.39	3.84	1.93
2011	Q1	59,020	845,684	2.83	7.05	1.92
	Q2	57,202	818,325	6.11	13.16	1.92
	Q3	57,427	807,482	10.30	16.51	1.94
	Q4	56,719	823,748	16.24	19.19	1.95
2012	Q1	56,113	880,802	19.35	16.87	2.05
	Q2	57,764	853,430	12.43	11.78	2.11
	Q3	61,781	847,709	10.22	6.38	2.13
	Q4	64,133	862,398	9.01	3.53	2.08
2013	Q1	63,553	934,348	8.79	4.08	2.07
	Q2	65,577	917,590	8.68	4.37	2.05

	Q3	66,606	902,361	8.51	7.00	2.05
	Q4	68,242	892,522	9.75	7.42	2.01
2014	Q1	70,277	982,917	9.13	6.78	2.02
	Q2	71,917	972,761	9.14	7.03	2.03
	Q3	73,227	944,087	8.81	7.54	2.08
	Q4	75,891	942,421	8.60	6.18	2.11
2015	Q1	77,417	1,039,433	8.56	5.82	2.14
	Q2	77,997	1,026,833	8.31	6.99	2.13
	Q3	78,875	1,001,471	12.03	6.14	2.15
	Q4	80,875	994,165	14.36	7.35	2.22
2016	Q1	80,841	1,091,750	10.24	7.02	2.18
	Q2	82,116	1,089,944	8.11	5.36	2.12
	Q3	80,207	1,053,216	7.57	6.33	2.06
	Q4	80,247	1,065,788	8.17	6.50	1.86
2017	Q1	77,697	1,148,679	8.65	8.77	1.86
	Q2	78,068	1,138,107	8.64	10.80	1.82
	Q3	80,391	1,099,836	8.18	7.52	1.84
	Q4	81,672	1,120,754	8.04	4.98	1.84
2018	Q1	79,817	1,221,619	8.03	4.49	1.87
	Q2	79,800	1,207,059	7.94	3.99	1.87
	Q3	82,208	1,171,760	7.66	4.70	1.92
	Q4	83,020	1,191,735	7.42	5.61	1.89
2019	Q1	83,244	1,284,861	7.14	4.40	1.88
	Q2	83,576	1,268,750	7.19	5.59	1.88
	Q3	82,829	1,239,441	6.53	5.03	1.94
	Q4	82,179	1,256,634	6.73	5.44	1.94
2020	Q1	83,180	1,351,050	7.28	6.26	1.90
	Q2	86,190	1,199,192	7.21	5.31	1.91
	Q3	88,470	1,226,025	6.24	4.31	1.92

Source: KNBS and CBK (2022)