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FINANCIAL INNOVATION AND MONEY DEMAND; THE CASE OF ZIMBABWE (2012:1 -2020:5)

BY

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Abstract

Money demand is critical in the conduct of monetary policy in any country such that the identification of the determinants of money demand is most valuable. The study was instigated to investigate the impact of financial innovation on money demand in Zimbabwe using monthly data from 2012:1 to 2020:5. The country witnessed increased adoption of mobile money transaction, which since the introduction of the product has been trending upwards. In addition to mobile money transactions, Zimbabwe saw a rise in the adoption and use of point-of-sale transactions (POS). The demand for money under increased usage of these new financial products and payment methods need to be assessed to find out how much these financial innovations affect money demand. This will ensure effective monetary policy. Using the Augmented Dickey Fuller test, the stationarity of the variables was established to be unit root at level and were stationary at first difference. The Johansen Cointegration test was employed to determine the order of integration and the number of cointegrating equation. Having established cointegration, the Vector Error Correction Model estimation technique was used to analyse the impact of financial innovation on money demand. Using monthly data from Reserve Bank of Zimbabwe, Zimbabwe Statistics Agency (Zimstat) and Confederation of Zimbabwe Industry (CZI). the study found that there is there is a negative relationship between money demand and mobile money transactions while it had a positive relationship with POS transactions in the long run. The short run results revealed that financial innovation had a negative relationship with money demand.

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Abbreviations

ADF	Augmented Dickey Fuller
ATM	Automated Teller Machines
CPI	Consumer Price Index
EFT	Electronic Funds Transfer
GDP	Gross Domestic Product
GoZ	Government of Zimbabwe
OLS	Ordinary Least Squares
POS	Point of Sale
RBZ	Reserve Bank of Zimbabwe
VECM	Vector Error Correction Model
WB	World Bank
ZIMSTAT	Zimbabwe Statistics Agency
ZSE	Zimbabwe Stock Exchange

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Chapter 1

1.0 Introduction

The stability of money demand function has come under scrutiny following the advent of financial innovation and has been a subject of debate among monetarists and policy makers over the past 50 years (Teles and Zhou, 2005). A money demand is specified as a relationship existing between real money, long run interest rate on substitutable non-financial assets, short run interest on money itself, real gross domestic product (GDP) and inflation (Teles and Zhou(2005), Acaravci and Ozturk (2008). The stability of this relationship is paramount for policy making. The money demand relationship was holding until the mid-1980s when the relationship was found to be unstable. Teles and Zhou (2005) attributed this instability to technological innovation and regulatory changes which have resulted in changes in M1 aggregate composition.

Financial innovation is touted to be the major culprit for the instability of the money demand relationship. The period between 1980 and the 1990s was an era of financial sector deregulation, bank deregulations and financial innovation accompanied by the introduction of new modes of payment which prompted the need to redefine the transactions demand for money measure (Teles and Zhou, 2005).

According to Solans (2003), financial innovation is technological advancement that enables access to information, trading and means of payment, and the advent of novel financial products and instruments, new organisational forms, and more robust and comprehensive financial markets (Mbazima-Lando and Manuel, 2020). Bara and LeRoux (2018) quoting Lerner and Tufano (2003) concurs adding that it involves creating and broadcasting newly developed financial instruments, technologies, markets, procedures and business models encompassing the application of existing ideas in diverse market settings.

It is evident that financial innovation increases economic activity by promoting financial inclusion, enabling financial transactions in international trade, enabling remittances and increase financial efficiency, which play a critical role in economic growth. (Qamruzzaman and Wei, 2017) (Solans, 2003). Bara and Mudzingiri (2016) pointed out that financial innovation is undeniably a fundamental part of financial sector advancement and is a vital cog in creating new economic activity.

Further, the growth of new innovations in modes of payments – electronic payments, e-payments) are overtly supported by technological innovation and plunging costs in computing and telecommunications (Nyamongo and Ndirangu, 2013).

Mwangi (2014) also highlighted that technical change in the financial sector has changed the payment patterns in the world with card, web and mobile phone-based payments becoming increasingly diffused in day to day financial transactions. Borrowing from (Rinaldi, 2001), Mwangi (2014) adds that there is an evident substitution effect taking place between cash (M1) and varied types of payment instruments as the world is favouring more efficient, secure, and cheap payment systems.

According to Mwangi (2014) economists and central bankers are worried that the development of close substitutes to physical cash would change the nature and mix of monetary aggregates through recently introduced financial instruments and services or transformations in old instruments including change in the terms and conditions of debt and credit arrangements. The effect is the alteration of the demand for money as economic agents shift balances from M1 to riskless financial assets in search for higher returns thus increasing demand for M2 balances. New payments systems also alter the once stable transaction and precautionary demand for money relationship.

1.1 Background to the study

The advent of the Structural Adjustment Programs in Zimbabwe and the concurrent advances in technology have ushered in financial innovations. Zimbabwe has witnessed considerable adoption and diffusion of financial innovations which has taken place over the past two decades, with significant innovation being noticeable for the past ten years (Bara and LeRoux 2018). This led to emergence of diversified payments technology innovations in the financial system such as mobile banking, internet banking, Automated Teller Machines (ATMs), Electronic Funds Transfer (EFT), Point of Sale systems (POS) and agency-banking model which have completely changed the payments landscape (Bara and LeRoux 2018), (Bara and Mudzingiri 2016). The massive diffusion of mobile financial services, a key constituency of financial innovation compared with traditional banking in Zimbabwe has, the integration of financial service with mobile communication technology, greatly increased financial inclusion (Bara and Mudzingiri, 2016).

In Zimbabwe, diaspora remittances through such agents as Western Union, Mukuru.com, Cassava Remit, OK Money wave and other plethora of remittance agents has been made possible through such technology and financial innovation. Bara and Mudzingiri (2016) citing (Bracking & Sachikonye, 2010) point out that such financial innovations have made it abundantly ease for the flow of remittances, which has become the main source of income, foreign currency liquidity, funding and investment for the country. Zimbabwe received a total of USD635 million in 2019 a 2.6% increase on the 2018 remittance amount of USD619 million (RBZ, 2019).

The general waning of confidence in Zimbabwe's financial system following the debilitating 2008 financial crisis increased the appetite of people's holdings of cash balances and demand deposits as opposed to long term deposits. The crisis also increased adoption and diffusion of financial innovation leading to economic agents preferring to carry out monetary transaction outside of banks using mobile phone-based payment systems. The informalisation of the economy also meant that money circulated outside of the control domain of the Reserve Bank of Zimbabwe which ignited the Government of Zimbabwe to suspend all monetary transactions on phone-based mobile money platforms and all trading on the Zimbabwe Stock Exchange (GOZ, 2020). This was to render monetary policy and exchange rate policy effective as the government perceived that financial innovation in the form of ZSE liberalisation and mobile phone payment platforms were the chief culprits in defeating government policies. The effectiveness of monetary policy was compromised because the central bankers would not accurately determine the extent the money demand function in Zimbabwe.

Given that studying money demand in Zimbabwe is paramount in the design, analysis and implementation of macroeconomic policy as well as guaranteeing that monetary policies support economic growth and development (Tuluzawu, 2013), it is trite that such study of money demand incorporates the effect of financial innovations.

Money demand functions serve as the link between money policy and the real sector variables, the level and stability of the demand for money is of paramount importance to economists, researchers and policy makers (Manamba, 2017) and (Tuluzawu, 2013). That makes it absolutely paramount to analyse the impact on financial innovation on the stability of money demand functions.

Zimbabwe, like many other African countries pursues a monetary targeting policy to stabilise inflation which solidifies the importance of a money demand function in conducting monetary policy being anchored on its stability (Tuluzawu, 2013). Therefore modelling, estimating and examining how financial innovation affects the stability of money demand function in the economy is key for the conduct of aggregate monetary targeting policy for inflation control (Manamba, 2017).

1.2 Problem Statement

Zimbabwe faces the challenge of excess velocity of money spurred by technological innovations in payment systems. This increased velocity of money can also be attributed to the profit motive of economic agents who having no alternative store of value instruments resorted to profit from arbitrage opportunities created by the cash crisis and foreign currency shortages. The absence of a robust money market also fuelled the growth of currency in circulation through electronic and mobile payment platforms. The demand for M1 balances increased as money was demanded for speculative purchases. Holding money proved to give higher returns especially in the high inflationary episodes the country encountered. M1 demand incessantly increased following the need by households and firms to buy goods and services at lower prices in cash and also for speculative black market foreign currency trading. The resultant effect was cash crisis.

Financial innovation especially in payment systems aided the increased transaction, precautionary and speculative demand for M1 balances. Financial innovation facilitated easy access to demand and savings deposits through debit cards and mobile phones linked to bank accounts allowing for instant transfer of money further increasing the velocity of money in electronic form. This further increased economic agents' appetite for cash prompted by the rush to liquidate electronic balances for currency.

The collapse of the money market in Zimbabwe exacerbated demand for M1 balances and worsened the cash crisis that the Zimbabwean economy faced. The absence of riskless financial assets such as term deposits, certificates of deposits and very short-term money market instruments that pay a higher return increased demand for currency for speculative purposes. This has continued to exert pressure on M1 perpetuating the cash crisis bedevilling the economy.

1.3 Research Objectives

This study has as its objective the determination of the influence of financial innovation on money demand in Zimbabwe using base money.

The sub objectives of this study are as follows:

1. To ascertain the determinants of money demand in Zimbabwean
2. Identify the financial innovations that affect money demand.
3. To determine the relationship between money demand and financial innovation in Zimbabwe.
4. To proffer policy advice to relevant authorities.

1.4 Research Questions

The study will be steered by the following questions:

1. How does financial innovation influence the direction of money demand movement in Zimbabwe?

2. Is money demand in Zimbabwe stable or unstable in the presence or absence of financial innovations?

1.5 Hypothesis

The study seeks to test the hypothesis that financial innovation and interest rate are negatively related to money demand while income and inflation are positively related to money demand. The study also endeavours to test the hypothesis that the M1 demand function for Zimbabwe is unstable in the face of financial innovation.

1.6 Justification of the Study

Notable studies on money demand in Zimbabwe have been concerned with money demand in hyperinflationary periods (Dzingirai, 2015) and focussed on periods post the 2009 adoption by Zimbabwe of a basket of currencies (Tuluzawu, 2014).

Few studies were devoted to estimating the influences of financial innovations have on money demand in Zimbabwe despite the incessantly rapid diffusion and adoption of new technology based financial products and payment systems.

Financial innovations studies in Zimbabwe have focussed on effects on economic growth and development (Bara and LeRoux, 2018), financial inclusion (Chivasa and Simbanegavi, 2016), mobile banking adoption (Mwere et al, 2013). Few have concerntrated on the money demand effect of financial innovations in Zimbabwe.

The reason why studying financial innovation and money demand is crucial is found in the justification by Appere (2017). Appere (2017), justifies the study of money demand arguing that attention has shifted to understanding the level and stability of the demand for money given that a proper understanding of its causes and effects can vitally inform policy crafting and implementation. Liquidity preference is a function of the demand for money such that when money demand (people preference for cash instead of assets) is stable, monetary authorities can reasonably forecast the level of money supply in the economy (Appere, 2017). Given the foregoing arguments, it is of paramount importance to understand how the demand for money in Zimbabwe is affected by financial innovation in order to inform policy choice.

The proliferation in the use of technological innovation payment systems in the face of cash crisis and return of hyperinflation in Zimbabwe points to a change in money demand which need to be investigated. Given that Zimbabwe operates a money aggregate targeting monetary policy rule to control inflation, there is unrestrained justification that a critical analysis of the influence of financial innovation on money demand be carried out to determine optimal policy direction.

The Government of Zimbabwe has blamed financial innovation in the form of mobile phone payment platforms for the rise in inflation and emergency and sustenance of parallel exchange rate regimes which provides the more reason for the investigation of the impact of financial innovation on money demand and its effect on the transmission mechanism of monetary policy instruments.

The study will also enlighten monetary authorities on how to leverage technological innovations to influence monetary dynamics in Zimbabwe thereby enabling them to come up with monetary policy strategies that support financial inclusion, economic growth, and development.

1.7 Methodology

This study seeks to determine the relationship existing between the financial innovations and money demand with particular reference to Zimbabwe.

1.7.1 Model Specification

The Keynesian demand for money equation informs the model to be applied in the estimation of the effect of financial innovation for money. The Keynesian demand equation is stated as follows:

$$\boldsymbol{Md = k(Y) + L(r)} \quad \text{----------------------} \quad \textbf{(1)}$$

Where

Md = demand for money,

k (Y) = transaction and precautionary motive, that is dependent income (Y) levels.

L (r) = speculative motive that hinges on interest rate (r).

From the Keynesian money demand equation the empirical log linear equation was derived for testing in the case of Zimbabwe. A model by Mlambo and Msosa (2020), Klymenko (2006) and Mujuri et al (2018) was adopted with modifications.

Klymenko estimated the effect of financial innovation where in a financial innovation index was compiled, Mujuri et al (2018) used volume of M-Pesa transactions and volume of Automated Teller Machine (ATM) transactions as proxies for financial innovation while Mlambo and Msosa (2020) used the number of ATMs and mobile phone subscriptions as proxies for financial innovation.

In this research we use the values of mobile phone monetary transactions and value of Point of Sale (POS) transactions instead of number and volume of ATM transactions. Point of sale have found wide acceptance across Zimbabwe such that they give a clear picture of the card payment systems in Zimbabwe.

$$\boldsymbol{M_t^d = \alpha + \beta_y Y_t + \beta_r R_t + \beta_\pi INF_t + \beta_{POS} POS_t + \beta_{MOB} MOB_t + \beta_m M_2/M_3 + \varepsilon_{tt}} \text{ --------- } \mathbf{(2)}$$

Where M^d_t = natural log of demand for money represented by M3

Y_t = natural log of national income proxied by manufacturing index

R = Natural log of Interest rates

INF = natural log of Inflation proxied by CPI

POS = natural log of value of pos transactions

MOB = natural Log of value of Mobile phone monetary transactions

M_2/M_3 = ration of m2/m3

Ɛ = disturbance term (error term)

1.7.2 Vector Error Correction Model

Secondary data sourced Reserve Bank of Zimbabwe (RBZ), Zimbabwe Statistical Agency (ZIMSTAT) and World Bank (WB) has been used. The study shall employ vector error-correction model in the event the data is found to be non-stationary. The vector error correction model (VECM) is preferred because of its inherent advantage as a popularly efficient method for measuring money demand (Sriram, 1999). This model's distinct merit over other econometric methods is in terms of functionality and use. Most importantly, it enables the researcher to investigate short-run dynamics for variables being studied instead of concentrating on long-run relationship between money demand and exogenous variables explained by theory (Mujuri et al, 2018).

Unit root test shall be done by employing the augmented Dickey Fuller test (ADF). Johansen Co-Integration Test will be done to determine the number of cointegrating equations should the data be found to be non-stationary.

1.8.0 Diagnostic Test

1.8.1 Unit Root Test

When the mean and variance of a stochastic process are constant over time, the stochastic process is said to be stationary. It is covariance stationary if the covariance between a variable and its lag depends only on the lapsed time and not the reference period at which the covariance is calculated. Stationarity tests are essential in order to avoid nonsense results (spurious and inconsistent) and it is necessary to conduct stationarity test on time series data. The standard unit root test of stationarity will be used in time series.

1.8.2 Johansen Cointegration Test

Following unit root testing, cointegration using the Johansen Cointegration Test will be carried out should the time series be found to be non-stationary. Cointegration speaks of long-run linear movement (relationship) of non-stationary time series variables of the same order of integration. Cointegration test ascertains if non-stationary time series variables co-move in the long run.

Time series variables are cointegrated should they have a long-run equilibrium relationship between and or among them. The Johansen-Cointegration test will be applied in the event the ADF proves the time series data is non-stationary. Johansen procedure does not depend on OLS estimators in assessing if variables are cointegrated but builds directly on the maximum likelihood estimation and can identify more than one cointegrating relationship should more than one cointegrating relationship exist. The Johansen procedure uses two likelihood ratio tests that; the trace test and the maximum eigenvalue to come up with the number of cointegrating vectors (Mujuri et al, 2018).

1.9 Conclusion

It is without doubt that the stability of the money demand function is a pre-requisite for an effective monetary policy and the extent to which financial innovation affect money demand must be determined to come up with policy that will give the desired outcome. To that end financial innovation has to be taken into account in modelling money demand function. The study therefore delves to make conclusion on how significant financial innovations are as deterministic variables in money demand.

CHAPTER 2

2.0 Literature Review

2.1 Introduction

This chapter reviews existing theoretical and empirical literature on money demand determinants. The literature on the influence of financial innovations on money demand will also be explored with the aim of guiding this particular study which focuses on Zimbabwe.

2.2 Theoretical Literature

2.2.1 The Quantity Theory of Money

This theory is accredited to the classical economists who posits that monetary policy is premised on the quantity theory of money. Most work on quantity theory of money is due to Irvine Fisher (1911) and Friedman (1970). This theory posits that the increase or decrease in the general price level is a consequence of the increase or decrease in the quantity of money. For equilibrium to exists according to this theory, all markets clear and there is a flexible adjustment of relative prices. This entails therefore that the economy is presumed to be always at full employment save for transitory departures resulting from real shocks.

The function of money is simply a medium of exchange in the classical model. It is used as a unit to price goods and services and used as a valuation unit. Money is ideally held for its role as a medium of exchange but has no intrinsic utility (Sriram, 1999). According to this theory money is neutral thus it does not affect relative prices of goods nor does it have an influence on real interest rates neither aggregate real income.

Under the assumption of symmetric information and insignificant transaction costs, the store of value function of money is presumed to be limited. Classicals reasoned that economic agents need some holdings of some quantity of real money in certain circumstances thus leading to the formulation of the quantity theory of money.

According to classical economists, money only affects the general price level and nothing else. They thus hypothesised a direct and proportional relationship between general price level and quantity of money.

Fisher (1911) studied the relationship between money supply (M) and total expenditure on goods and services produced in and economy (P x Y) where Y is aggregate income and P is the general price level. Velocity (V) of money speaks of the circulation of money that is the number of times that money is used to purchase output.

The quantity theory of money can be mathematically expressed as follows:

$MV = PY$ -- (1)

This equation is simply an equilibrium condition where economic agents hold money to transact. Thus, the demand for money under the quantity theory is taken to be transaction demand. The equation according to classical economists is but fixed in the short run because it is assumed that the economy is operating at or close to its natural level of output. Classicals also assumed constant velocity of circulation of money such that they regard it as fixed. Classical economists also believed in a unidirectional causal effect transcending from money to price and not vice versa. Given fixed velocity and income, the classicals contend that any change in money supply will only affect an increase in prices. Monetary changes have no causal effect on the real side of the economy.

Using the simple equation of exchange Fisher analysed the transactions velocity of money circulation. In the analysis there are two parties to a transaction denoted as the buyer and the seller. This means that there is equality between the sales value and aggregate economy receipts. Taken further, it means there is the number of transactions times the average price per transaction must equal the value of sales. Mathematically this can be expressed as follows;

$M_S V_T = PT$--(2)

Where Ms is quantity of money supplied

V_T is money's transaction velocity of circulation

P is the price level

T is the volume of transactions.

Equation 2 above can be changed to mimic the quantity theory of money which is an equation of the determination of the price level. While Vt is assumed to be fixed, it is varies with financial innovations and the nature of monetary arrangement.

$\overline{M_S V_T} = P\overline{T}$ --(3)

The bars on M_S, V_T, and T imply that the variables are constants and the bar or M_S (Money supply) means that it is exogenously determined. The current level of transactions value (P) determines the demand for nominal money balances. In equilibrium, even as money supply (M_S) is exogenously determined it is equal to money demand (M_D). Thus mathematically expressed;

$M_d = k_T P\overline{T}$ --- (4)

Where

$k_T = A\frac{1}{VT}$ ---(5)

$M_d = \overline{M_S}$ --(6)

$Ms\frac{1}{KT} = \overline{M_s V_t} = P\overline{T}$ ---(7)

From equation 7, it can be seen from the equation of exchange that output and prices do have an influence on the demand for money. While Friedman postulates a direct proportional relationship between the level of output and prices with money, Fisher views transactions as fixed such that money demand is a function of the price level.

2.2.2 The Cambridge Cash Balance Form of the Quantity Equation

The cash balance approach expounded by the Cambridge school, is a variant of the transactions approach. The primary proponents of the cash balance approach are Marshall (1923) and in particular Pigou (1917). The Fisher (1911) equation is based on macroeconomic considerations, but the Cambridge school is concerned with the choice-making decision of economic agents (Neewhord, 2019). The transaction approach emphasizes that money functions as a medium of exchange whilst the Cambridge school stresses the store of value role of money. The store of value aspect stems from the embedded satisfaction to the holder by adding convenience and security.

The cash balance theory generally assumes that people hold money as a temporary store of purchasing power and that this demand for cash balances is a function of the real income in the economy.

It is the societal real income that places a constraint on the quantity of probable purchases available to society. Cambridge economists singled out the role of wealth and interest rate is influencing the demand for money (Sriram, 1999).

The demand for money under the cash balance approach can be expressed as

$M_d = \mu Y$ ---(8)

where

Y is real income

μ is the fraction of real income society hold in the form of cash holdings.

Given that the money supply (M) is exogenously determined, equilibrium is achieved by the price system. This transforms equation (8) to

$M = pkY$--(9)

The cash balance approach is similar to the Fisher (1911) equation if it is held that the proportion of income to transactions is constant. Under this assumption, the Cambridge μ is equal to the inverse of V in the transactions approach. Also, the Cambridge k is a transactions demand for money which likewise is inherent in the concept of velocity in the Fisher (1911) equation. The variable *k* might be dependent on other factors in the consumer allocation problem which include the interest rates and wealth, but the main determinant being the level of transactions (Sriram, 1999).

The Cambridge version of the quantity theory affords a satisfactory explanation of monetary equilibrium within the classical group as it focuses on the public's demand for money. More so it dwells on the demand for real money balances, as the vital factor influencing the equilibrium price level in line with a specified quantity of money. The weight the Cambridge model gives on the demand for money is important since it informs both the Keynesian and the Monetarist theories. Of note is the analytical thinking that has channelled attention from the institutional factors and societal needs to the individual behaviour of choice.

2.2.3 Keynesian Theory

According to Sriram (1999), Keynes looked at money demand from the perspective of money 'held' just as in the Cambridge school. This is in stack contrast to the classical economists' 'money in motion' analysis of money demand. Under the classical school of thought money hoarding was an impossibility since all income was spent but Keynes gave emphasis on the motives that motivated economic agents to hold money and the money demand arising from these motives.

Keynes explained that people hold money for three motives that is transaction, precautionary and speculative. The transaction motive follows that postulated in the quantity theory which regarded money as a medium of exchange. Keynes held that the level of transactions by economic agents have a stable correlation with the level of income thus exposing the fact that 'transactions demand' for money is a function of the level of income. The non-harmonisation of receipts and payments also creates the transactions demand for money. There is uncertainty of payments economic agents may want or have to make which creates precautionary demand for money. In that regard, the precautionary demand for money affords an emergency plan for spontaneous expenditures during unpredicted situations. Money is viewed still as a medium of exchange in this motive and is a function of the level of income as well.

Keynes' notable addition to the body of knowledge on money demand was his inclusion of the speculative motive of holding money which he termed the "liquidity preference." Keynes attempted to formalise one of the assertions of Pigou and Marshall that future uncertainty was an influencing factor of the demand for money. Instead of looking at uncertainty in its entirety Keynes narrowed to analysing one variable the future level of interest rate concentrating on the yield on bonds. The store of value role of money is underscored in the speculative motive of the demand for money. Economic agents can hold their wealth in either in money or in bonds. According to Keynes, bonds were the substitute assets to holding money. Money earns zero interest, while bonds earn interest income and capital gain. The interest rate is the main determinant of economic agents' willingness to buy bonds given that potential buyers would expect to earn at the minimum the going rate of interest on the bond part of their portfolio. Keynes posited that there is a range of values or a value of the rate of interest that is viewed as normal and there is an expectation of a fall of interest when the rate is higher than this normal range and rise when the rate is below the normal range.

Given the diversity of view about the expected rate of interest at any given time and that the money and bond holdings of individual economic agents are negligible relative to the aggregate economy holdings, the economy wide speculative demand for money function tends to be a smooth and negative function of the current level of the interest rate.

Keynes' interest rate formalisation in the money demand function can be represented by the following mathematical expression

$M^d = f(y,i)$

Where M^d is demand for real balances

y is real income

i is interest rate

Keynes' demand for money is a demand for real balances (money).

The greatest conclusion arising from the Keynesian analysis is everyone in the economy would prefer to hold money in an economy where the interest rate is critically low. This is triggered by the fact that economic agents will expect the interest rate to increase in the future thus prefers to hold money regardless of whatever is supplied. When this happens, the aggregate demand for money tends to be perfectly elastic with respect to the interest rate putting the economy into "liquidity trap." In this zone the interest elasticity of money demand can be infinite at levels of interest rate close to zero. The involvement by Keynes of the effects income and interest rate on money demand preceded the invention of other theories of money demand which centred on the three motives of holding money.

2.2.4 The Transactions Demand for Cash: An Inventory Theoretic Approach

This model of money demand is due to Baumol (1952) who postulated that cash stock is regarded as an inventory of the medium of exchange in the hands of the holder. Baumol regarded cash as a commodity which can be relinquished at an appropriate time.

In deriving the model, Baumol (1952) examined the transactions demand for cash motivated by rational behaviour meaning economic agents hold cash balances that enable transactions to be carried out at least cost. Baumol assumed that transactions can be predicted with certainty and occur in a steady stream.

Baumol assumed that in any given period of time, an individual will pay out a steady stream, T dollars. The individual obtains cash either by borrowing or by liquidating financial investments and incurs the interest cost (or interest opportunity cost) of *i* dollars per dollar per period. Despite the being other liquid financial assets other than money that paid higher yields, the transactions costs of interchanging between money and these assets validated holding such inventory. The individual withdraws cash in lots of C dollars uniformly distributed through out the year and at each withdrawal instance he incurs a fixed 'brokerage fee' of *b* dollars.
Thus transaction value, T is foreknown while interest cost *i* and brokerage fee *b* are presumed to be constant.

Given that for any value of C is less than or equal to T, the individual is able to fulfil his payments provided he withdraws the money often enough. The individual thus will do $\frac{T}{C}$ withdrawals over the entire period under consideration at a total brokerage cost of $\frac{bT}{C}$. The individual withdraws C dollars and expend it in a steady stream and will only withdraw once it is run down, this implies that his average cash holding will be $\frac{C}{2}$ dollars. The annual interest cost of holding cash will be $\frac{iC}{2}$. The individual will incur a total cost of

$$\frac{bT}{C} + \frac{iC}{2} \quad \text{---(11)}$$

should he finance his total transaction expenditure by borrowing C dollars at intervals uniformly spaced through out the entire period under consideration. This is the total of interest cost and brokerage fees.

The individual is indifferent over the way he meets his transactions as long as he meets these at minimum cost. Thus, he chooses the most economical value of C costs minimising the sum of brokerage costs and interest income forgone.

$$-\frac{bT}{C^2} + \frac{i}{2} = 0 \quad \text{--(12)}$$

Giving

$$C = \sqrt{\frac{2bT}{i}} \quad \text{--(13)}$$

The rational individual will, given the general price level, demand cash equivalent to the square root of the value of his transaction. This equation says that optimal demand for real money balances *(C*) is directly proportional to transactions costs *(b)* and transaction value (T) which is a function of real income (y), and inversely proportional to the interest rate (*i*).

2.2.5 Portfolio Theories of Money Demand

These theories provide a microeconomic analysis of money demand that stresses on the store of value function of money. These theories are associated with the "Yale school" which look at the demand for money in the light of a portfolio choice problem (Sriram, 1999).
The demand for money in these models is regarded as part of the decision problem of allocating wealth among a portfolio of assets that include money with each asset generating some mix of explicit income and implicit (or non-pecuniary) service flows. More weight is given to the risk and expected returns of the assets.

When consideration is given to money, the pecuniary yield encompasses the convenience of transacting in addition to rendering liquidity and safety. These models reveal the relationship between interest rates and the demand for real money. These also show the importance of wealth and liquidity as key determinants of money demand.

Tobin (1958) provided an explanation of Keynes liquidity preference theory postulating a negative relationship between interest rate and money demand. In his explanation Tobin (1958), theorised that the risk avoiding behaviour of individuals explain the liquidity preference and the negative relationship between money demand and interest rate.

Risk-aversion theory is premised on concepts of portfolio management. The risk/reward features of different assets combined with the taste of the agent influence the optimal portfolio structure that is a result of maximizing the utility consistent with the available opportunities. Tobin (1958) opined that an economic agent holds a portion of their wealth in the form of money in the portfolio due to the fact that the rate of return on holding money is more certain than the rate of return on holding earning assets. It is therefore risky to hold other financial assets when compared with holding just money alone.

The difference in riskiness may arise because government bonds and equities are subject to market price volatility, while money is not. In spite, the individual is willing to face this risk because the expected rate of return from the alternative assets exceeds that of money. As a result, the risk-averse economic agents would prefer to incorporate some money in an optimally structured portfolio.

Fischer (1975) however disputed the assertion by Tobin (1958) contending that attributing individual desire to hold money to risk-aversion behaviour of the economic agents alone is not a sufficient argument for holding money. He further argued that it is money is not completely riskless as advanced by Tobin (1958) because it is prone to the risk of price level variability.
It must also be acknowledged that there are other financial assets, such as time deposits, that possess similar risk features as money but harvest higher returns. According to Fischer (1975) the safe asset is, precisely, an indexed bond.
This version of money demand can be illustrated mathematically as

$$\frac{M^d}{P} = f(Y_{p,}\, r_b - r_m, r_e - r_m, л^e - r_m)$$

Where;
M^d/P = demand for real money balances
Y_p = Permanent income, Friedman's measure of wealth
r_m = Expected return on money
r_b = expected return on bonds
r_e = expected return on equity (common stocks)
$л^e$ = expected inflation
W = proportion of human and non-human wealth
Portfolio theories hold that the demand for assets increases as wealth increases, the demand for money should be positively related to permanent income because the higher the wealth the larger the portfolio. Portfolio theory proponents singled out three assets which are bonds, stocks and goods as alternatives to money. They further postulated that the desire to hold money depends on the attractiveness of these assets compared to holding money.

As re, or rb increases, money demand declines as it tends to be less attractive to hold money in contrast to holding stock or bond. Additionally, a surge in expected inflation π^ealso reduces the demand for money because its real value depreciates over time.

2.3 Empirical Literature Review

Alvarez and Lippi (2007) used panel data from Italian households and in particular used Italian households ATM ownership, the diffusion of bank branches and ATM terminals in the provinces of Italy estimate the effect of financial innovation on demand for cash. A Baumol and Tobin (BT) model was used and modified to capture the precautionary demand for money. Using the extension of the BT model Alvarez and Lippi (2007) found out that as the density of bank branches and ATM terminals increases, it reduces cash withdrawal costs and thus lowers the level of demand for money.

Teles and Zhou (2005) using ordinary least squares estimation for United Stats of America time series data from 1900 to 2003 estimated the effect of financial innovation on money demand particularly transaction demand for M1 balances. In the study M1 demand function prior to 1980 was found to be very stable but exhibited instability after 1980, a period coinciding with banking and financial sector deregulation and introduction of new financial products termed near money that were close substitute to M1. Following the period after 1980 new interest earning highly liquid financial assets were introduced (money zero maturity (MZM)).

The effect as estimated by Teles and Zhou (2005) was to reduce the demand for M1 holdings since they constituted noninterest earning cash and demand deposits. It was found in the study that despite falling interest rate M1 growth rate remained low. An estimation of the demand for money then was done by using a new monetary aggregate MZM as the dependent variable. MZM monetary aggregate incorporated M1 and other money market liquid assets including NOW accounts, Money Market Deposit Accounts (MMDA) and Money Market Mutual Funds. These are interest earning liquid financial assets with zero maturity and can easily be used for transaction purposes. When this new depended variable was used, the money demand function was found to be stable for the period 1980 to 2003. Thus, in conclusion from the study financial innovation negatively affected the demand for M1 money balances by economic agents.

In a bid to analyse the cash demand by US consumers in the era of low interest rates and electronic payments, Briglevics and Schuh (2014) used panel data obtained from survey data from Survey of Consumer Payment Choice (SCPC). The study adopted and extended the Baumol-Tobin model thus allowing for investigation of credit card payments and revolving debt.

The study showed that given interest rates close to zero, cash holdings by individuals who utilise credit cards for convenience (no revolving debt) has minute interest rate elasticity even with broader money measures. Cash holdings by consumers who use revolving debt credit card interest rate inelastic. It can then be said that financial innovation gives an opportunity for individuals to benefit from minimising the opportunity cost of holding cash.

In a sample of 10 developing countries, Arrau et al (1991) found out that the traditional money demand function when tested for cointegration produced a stationary linear combination. Thus they were found to be I(1). In addition, using the Dickey Fuller and Augmented Dickey Fuller tests were also done on the differenced variables and they estimated the traditional money demand specifications by applying OLS to a variety of specifications.

However, in some of the countries in the sample the results were found to be spurious evidence for model misspecification. To account for "missing money," financial innovation was incorporated in the model and a time trend as a proxy for financial innovation was used which produced significant results when the model was estimated with this variable.

Arrau et al (1991) using the same sample of 10 developing countries used the ratio of M2 to M1 as a proxy for financial innovation justifying the proxy by explaining that the greater the range of money substitutes the lesser the demand for narrow money. When this proxy was used the results indicated that financial innovation had a negative influence on demand for money in the majority of the countries. A problem of collinearity between the proxy and interest rate was found rendering the results from using M2 to M1 less plausible.

In order to correct for collinearity when ratio of M2 to M1 was used as a variable for financial innovation, Arrau et al (1991) using the same sample of 10 developing countries employed the use of financial innovation stochastic trend. They argued technological transformations in payments can be viewed as stochastic trend processes thus they are permanent shocks to money demand. It was assumed to be a random walk stochastic process and that the permanent shocks are orthogonal to the stationary shocks influencing money demand. Using variance decomposition analysis Arrau et al (1991) found that at least 2/3 of the variance of the total residual in the money demand equation is explained by financial innovation.

Testing for the impact of financial innovation on money demand in Mexico and Chile using quarterly time series data from 1980 -1989 and 1975 -1985 respectively, Arrau and Gregorio (1993) employed generalised Least squares estimation method. Using the traditional money demand specification on the same data they found a case of ‘missing money’ which was corrected by inclusion of a proxy of financial innovation. The financial innovation was proxied by assuming that it follows a random walk. Permanent shocks to money demand were assumed to be caused by financial innovation. The results of the maximum likelihood estimation for the 2 countries show that financial innovation did have permanent shock effects on money demand.

Hye and Khan (2011) investigated the money demand effect of financial liberalisation using Pakistan annual time series data from 1971 to 2009. The study’s main emphasis was on M2 (Broad money) demand. In this investigation, an Auto Regressive Distributed Lag (ARDL) method was used after testing for cointegration using the JJ Cointegration. The study also found their specified money demand function to be stable after using the CUSM and CUSUMSQ tests on parameters. The results revealed that in both the short and long run gross domestic product, financial liberalisation index (financial innovation) and real deposit rate had positive effect on money demand in Pakistan over the period under investigation.

Reddy (2017) in assessing the impact of credit and debit cards on currency demand and seignorage in India used time series data from 2004 to 2017. The ARDL model of estimation was employed in the investigation. The demand specification encompassed credit card and debit card value as proxies for financial innovation. Results from the study gave a negative relationship between credit card usage and currency in circulation which was significant at 1% level. This result according to Reddy (2017) could be because credit cards give owners interest free use of money for transactions within the outstanding limit provided by the bank and as such customers may have a low affinity to use cash for transaction purposes thus demand for currency will plummet. On debit cards the relationship with currency demand was found to be positive and significant at 1% level. This may be as a result of the increase in marginal benefit of money that come with debit cards. Also, Reddy (2017) highlighted that this also is buttressed by the fact that debit cards are chiefly used for cash withdrawals used to make cash payments given that bank penetration is low and also that POS terminals are few in the country.

Huynh et al (2014) carrying out an analysis of the impact of card acceptance on the demand of transaction demand in Austria and Canada adopted and extended the Baumol-Tobin Inventory model to include variability of payment methods in the analysis. A comprehensive payments diary data obtained from a survey, done in November 2009 and 2011 for Austrian and Canadian consumers respectively, was used in the empirical study. The study is similar to the one conducted by Alvarez and Lippi (2007) using Italian household card ownership data.

Reformulating the Baumol-Tobin model and applying ordinary least squares, Huynh et al (2014) found that an increase in card acceptance as a form of payment causes economic agents to reduce their cash demand as they frequently increase card usage for transaction purposes. In the empirical investigation, it was noticed that accounting for card acceptance decreases both the cash demand level and the transaction elasticity of cash demand. The investigation found out also that Austria as compared to Canada has the highest incidences of cash payments.
Where cards are not accepted precautionary motive and infrequent huge purchases tended to increase the demand for cash holdings. The study concluded that while increased usage and acceptance of cards reduces demand for cash, the precautionary motive and consumer preference to use cash tends to keep the demand for cash alive.

Saraswati and Mukhlis (2018) studied the impact of debit card transactions, credit card transactions and e-money transactions on currency demand in Indonesia using time series data from January 2009 to August 2017. The research used Vector Correction Models estimation and found out that debit card transactions had significant negative impact on currency demand credit card transactions had significant positive effect on currency demand in the long term and e-money transactions had significant positive effect on demand for currency in both the short and the long run for Indonesia.

Aliha P.M et al (2018) investigating the effect of financial innovation on money demand in Australia used the Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) together with unit root tests and cointegration to estimate the effect of financial innovations. Time series data from 1995 to 2016 was used in this study. The analysis used the conventional money demand function that was modified to include proxies of financial innovation. The financial innovation proxies used were the sum of the number of cheques, ATM, direct entry payments, charge cards and credit cards represented by TPI (total number of payment instruments).

The results from this investigation show that TPI when using DOLS was positively insignificant but when using FMOLS the effect of financial innovations on money demand were significantly positive. FMOLS results were chosen owing to the superiority when the two methods are evaluated using the RMSE (root mean square error).

In a related study to find the impact of ATMs on money demand on a world at large, Aliha P.M et al (2017), adopted the use of Blundell and Bond (1998) system of GMM panel data estimation technique using World Bank sourced data of 215 countries for the years 2004 to 2013. This is the first of its kind estimation of this magnitude covering the whole world. In the money demand specification by Aliha P.M et al (2017), ATMs are a proxy for financial innovation while the dependent/explained variable is real monetary aggregate M2.

According to Aliha P.M et al (2017), the estimated parameter on ATM numbers is the most crucial in the study and was found to be negative and inversely related to the demand for money (M2 Balances). From the findings a percentage rise in ATM leads to a 0.01% drop in currency holdings. Given that the study made use of obtained by the whole economy and survey data, it tells the correct relationship existing between the number of ATM and the demand for currency in the worldwide economy. While the estimated parameter on ATMs is negligible, its total effect as advanced by Aliha et al (2017) is channelled through income effect (GDP).

Applying the Blundell and Bond (1998) system of GMM the following conclusions where reached, that is the expected interest variable had a positive effect on money demand, a finding that is in stark contrast with theory. The study found the estimate to be significant at 5% level but had a negligible positive effect which led the authors to conclude that money demand was not sensitive to interest rate at a world scale.

Looking at the financial innovations and demand for money in Ukraine, Bilyk (2006) employed the use of VECM technique on data ranging from 1997 to 2005 to estimate the effect. The study sought to check on how financial innovation would impact on both real narrow money (M1) and real broad money (M2) aggregates. A financial innovation index was compiled from the weighting of the various financial innovation products and technologies used in Ukraine to come up with a composite index.

The index is a representation of the banking experts' view on the past and current position in the development of the selected financial products and instruments generally used in retail and wholesale banking. These included automated credit cards, teller machines, wire transfers, collateralized mortgages, debit cards, corporate bonds, forward contracts, automated clearing houses, electronic banking, and treasury bills.

Impulse response functions (IRFs) were also constructed to assess the response of money demand to financial innovations shock. The study established that financial innovations do exert a positive influence on demand for real money balances in the long run while it affects negatively in the short run. The IRF analysis revealed that the effect of financial innovations is more pronounced when looked at in the context of the narrow demand for money specifications. Analysed within the broad money specification context, the shock to the money demand induced by the financial innovations is more persistent. Thus, in Ukraine financial innovations have a long run positive effect on the demand for money.

Tehranchian A.M et al (2012) using seasonal data for Iran from 2001 to 2008 analysed the impact of modern technology on money demand. The ARDL estimation method was used where in credit cards, ATM, electronic funds transfer at the POS and a dummy variable for Shetab banking system were used as proxies for financial innovation. The depended variable in this study was currency (volume of bank notes and coins). The results from the investigation revealed that, contrary to theoretical expectations, among the electronic payment systems the number of ATMs, bank cards and Shetab system have a positive relationship with the demand for money.

POS terminals aligning with theory are negatively related to money demand. Given that the definition of money in this study is M1 (cash and coins only), the POS result is expected as paying using electronic funds transfer through POS would reduce cash demand for transaction purposes. ATMs in Iran have been installed more to facilitate receiving money in banks than as a payment system such that the effect on money demand is positive. Tehranchian A.M et al (2012) highlights in the study that while the parameter estimates on electronic payments were statistically significant, their influence is not significant owing to lack of general acceptance of the payment instruments by the people in Iran coupled with insufficient infrastructure development to enable the use of the payment instruments in electronic exchange.

Safdar and Khann (2014) checking and analysing the financial innovation impact on money demand employed the ADF technique to test for stationarity of variables and the made use of the cointegration method to estimate the model. The following money demand function specification was estimated

$(m_i - p_i)_t = Y_0 + Y_1\Delta P + Y_2 RS + Y_3 Yi + Y_4 ATM + Y_5 CCA + e_{it}$

where m = broad money, p = price level, y = real GDP production, RS = short run interest rate of money itself, ATM = number of ATM machines and CCA = credit card amount.

A VAR was estimated on the model to choose the appropriate lag length which was found to be 2 and the long run relationship was established the employing the Trace statistic and Max-Engen Value. Results from cointegration estimation showed that ATMs were confirmed to be the substitute to cash in Pakistan as a negative relationship was found to exist with the demand revealing that when in possession of ATM card people prefer to abstain from holding cash. Credit cards were also found to have a negative effect on the demand for money.

Neewhord A.T (2019) analysing using ARDL the financial innovation effect on Sierra Leone demand for money found out, using time series data from 1966 to 2016, that the proxy M2/M1 had a significant positive long run relationship with money demand (real broad money, M2). The short run relationship however was found to be negative and significant at 5% level.
This entails that advances in novel means of payment encompassing debit cards, internet banking, credit banking and EFTS among other developments, will in the short run, cause individuals to substitute more liquid assets with illiquid ones.

Mujuri et al (2018) in a bid to investigate the effect of the volume of M-Pesa and ATM transaction volume on money demand in Kenya employed VECM on time series data from 2008-2016 in the study. The results from the study revealed that a positive correlation between financial innovation and money demand in Kenya. In addition, M-Pesa volume transaction and money demand had a negative relationship with estimated parameter of -0.213 on M-Pesa. This signifies a negative influence on the demand for money. Thus, an increase in M-Pesa transactions decrease in money demand in Kenya. M-Pesa props people’s affinity to keep their funds in M-Pesa accounts for longer periods of time due to perceived enhanced safety. Mobile money usage is justified owing to easiness of use and its lower cost advantage in moving money.

Mujuri et al (2018) proffers the above as a reason for a decline in money demand in every instance where there is an increase in volume of M-pesa transactions. M-Pesa transactions results in a surge in cash in circulation (velocity of cash) such that economic agents trend away from keeping money stock in the form of liquid assets (M1) into to less liquid assets (M2 or M3) thus resulting in falling demand for money. Volume of ATM transactions positively impact on the demand for money thus entailing that they are directly proportional. Increase in ATMs significantly causes a rise in the frequency of money demand. ATM transactions have an effect on optimal cash holding in that they reduce waiting and time cost. Thus, individuals with ATM cards have a high propensity to spend money given they can readily access it. The effect will be to increase the demand for money in cash balances hence economy wide aggregate demand for money.

In studying the impact of financial innovation on money demand in Nigeria, Apere (2017) using VAR model on data from 1981 to 2016 and employing treasury bill rate proxied by 4-6 months commercial paper rate as an indicator variable for financial innovation found out that while this has little effect on money demand, financial innovation is not only vital variable in the estimation of money demand but that as financial innovation adoption increases, it negatively affects the demand for money. This is so according to Apere (2017) because economic agents shift away from more liquid financial assets (currency and demand deposits, M1) to lesser liquid assets.

In studying the demand for money (Real M1) effects of financial innovation in Sub Saharan Africa, Dunne and Kasekende (2016), used dynamic panel data estimation methods on annual data of 34 countries spanning 34 years from 1980 to 2013. Both unbalanced and balanced panel methods were employed with unbalanced technique being used on all 34 countries while balanced panel was used on 17 countries. The dynamic panel data estimation techniques used included Dynamic Fixed Effects (DFE), Mean Group (MG) and the Pooled Mean Group (PMG). In the investigation proxies for financial innovation M2/M1 and Bank and ATM concentration variable were used. Employing all the estimation techniques with M2/M1 as a proxy, the results revealed that financial innovation does have a significant role in determining both the long run and short run demand for money.

It was found to have a significant (1% level) negative relationship with money demand. The results coincide with theory and suggest that given a rise in financial innovation, economic agents are more motivated to demand more of less liquid assets than highly liquid financial assets leading to a decrease in the demand for money.

When Bank and ATM concentration proxy for financial innovation was used in the estimation of money demand using the DFE, MG and PMG estimation techniques, this proxy was found to have a positive relationship with money demand though significant in the short run than in the long run. However, the results according to Dunne and Kasekende (2016) are not as per theoretical expectation which is attributed to inconsistency arising from the use of small time series.

Mwangi (2014) empirically sought to find out the effect of financial innovation of money demand in Kenya used the ECM estimation procedure on time series data over the period 2000 to 2012. As proxies for financial innovation, value of mobile transfers and value of transactions done through ATM cards were used as variables for analysis. These are justified for use because their introduction in Kenya increased access to financial products and services, lowered transaction costs and enhanced resource allocation. The results from study showed that mobile transfer and ATM card usage had positive influence on money demand in Kenya.

The Johansen Cointegration procedure was also utilised to establish the long run relationship of the variables with money demand and again there existed a positive long run relationship between the variables of financial innovation (Mobile transfer usage and ATM card usage) with money demand. The results were consistent with economic theory. The results also agree with the findings of Dunne and Kasekende (2016), Reddy (2017) finding on debit card usage but contrary to Mlambo and Msosa (2020) whose findings on mobile subscriptions and ATM exhibited a negative relationship with money demand.

Modelling the impact of financial innovation on the demand for money (broad money, M2) in Nigeria, Odularu and Okunrinboye (2009) looked at the impact of innovations post the Structural Adjustment Programme (SAP) of 1986. The Engle and Granger two-step cointegration technique was employed on data from 1970 to 2004 in the investigation of the impact. The results came out confirming economic theory on income and interest rate affecting demand for money positively and negatively respectively.

In the model, treasury bill interest rate was used as a proxy for financial innovation and also a dummy variable was used for post SAP reforms. Treasury Bill interest rate was found to negatively but insignificantly affect the demand for money in Nigeria thus resulting in the study concluding that financial innovation does not have any significant impact on money demand. However, this conclusion may be justified by the fact that the money market in Nigeria at the time of study was poorly developed as evidence by lack of data on 6-month commercial paper interest rate and that the market is ruled by treasury bills.

Odularu and Okunrinboye (2009) also found out the dummy on financial liberalisation in Nigeria post SAP had an insignificant negative coefficient implying that sweeping reforms of the SAP have not caused to the development of some financial innovations that indirectly or directly affect money demand.

Kayongo A et al (2020) while investigating the determinants and stability of money demand function in Uganda during the period 1994Q1 to 2018Q4 after financial liberalisation used ARDL technique to assess the impact of financial innovation. The dependent variable being tested in the study was real narrow money balance (M1) and a proxy for financial innovation employed in the analysis was the currency to deposits ratio. After all the diagnostic tests were performed, the estimated results showed that financial innovation significant at 1% level had positive relationship with real base money in the short run.
The result was contrary to Ndirangu and Nyamongo (2013) who estimated a negative relationship. Kayongo A et al (2019) attributes this difference to the dependent variables which were different.

In the study by Ndirangu and Nyamongo (2013) broad money was used while Kayongo A et al used narrow money. The study also concluded that the fast growing financial innovations during the aftermath of financial liberalisation period 1994 -2018 has not resulted in structural divergencies in the long run demand for money in Uganda.

Mbazima-Lando and Manuel (2020) sort to find out the impact of financial innovation on money demand specifically M2 in Namibia and utilised the Engel-Granger two step cointegration methodology coupled with CUSUM and CUSMSQ tests of money demand stability.

Using time series data from 2002Q1 to 2019Q4 and financial innovation proxies (stock market capitalisation + domestic credit) /GDP, M2/M1, PSCE/GDP and Bank Assets/GDP a money demand equation was formulated and estimated.

The results show that financial innovation proxied by (stock market capitalisation and domestic credit)/GDP had a negative and significant impact on money demand. Mbazima-Lando and Manuel (2020) attributed the development to developments in the financial sector which led to a fall in the demand for money given that part of it would be channeled through stock market investments, especially by large corporations.

When consideration was given to ratio of M2/M1, this proxy of financial innovation was found to influence positively the demand for money in Namibia. Thus, despite developments in innovations by the banking sector, economic agents still persistently increased their demand for money. Mbazima-Lando and Manuel (2020) suggested that this could be due to the rise in transaction demand propelled by the demand of innovative financial sector products such as ewallets, cellphone banking and MobiPay investments. This however is contrary to theory which predicts a negative and significant relationship on the ground that individuals will move away from more liquid assets (M1) to lesser liquid assets (M2).

Mlambo and Msosa (2020) analysed the impact of financial technology focusing on the effect of mobile subscriptions and ATMs on the demand for money. Panel quarterly time series data from 1995 to 2014 was used in the analysis. The empirical analysis centred on 5 African countries believed to have sophisticated financial markets South Africa, Kenya, Botswana, Nigeria and Mauritius. Panel GMM was used to estimate the parameters and the results showed that both mobile subscriptions and ATM exhibited a negative relationship with money demand. In interpretation, Mlambo and Msosa (2020) citing studies by Shiva and Durai (2017) advanced that should banking system be technical advanced with wider adoption of bank cards in a country, the quantum of money in circulation will be negatively affected by debit card usage.

2.4 Literature Gap

Many studies on financial innovation especially in the industrialised countries, given their sophisticated financial system and stable economic environments characterised by low inflation, real positive interest rates and economic growth, haver focused much on financial innovations in bank-based payment systems and interest bearing illiquid assets in their studies.

Bank infrastructure in these countries is well developed and the financial institution's geographical spread allows for use of many of the varied bank-based payment systems.

Financial literacy and inclusion are high in these countries such that economic agents can make optimal decisions pertaining to the how to allocate their financial holdings between liquid and illiquid financial assets. None of the studies on financial innovation in developed countries have dwelt on how mobile money innovation impacts on money demand. This is unlike developing and least developed countries to which Zimbabwe falls. Financial deepening, inclusion and literacy are still scant such that use of bank based-payment systems is limited to cities, towns and growth points. Many of the unbanked rural folk rely on mobile money to carry out gay to day transactions. Studies have been done in Kenya (Mwangi 2014, Mujuri et al 2018, Mlambo and Msosa 2020) to assess how mobile money affect money demand. There is still need to further studies in this area because the mobile money financial services have become the panacea to financial inclusivity in less developed and developing countries.

These countries faced with negative real interest rates, high inflation, unstable financial sector and sluggish economic growth, witnessed astronomic adoption and use of mobile money where banking infrastructure is non existent. Banks also have ridden on the phenomenal growth of the mobile money transaction adoption to reach out to the unbanked and the financially excluded. Mobile phone money especially, the transactions value must therefore be incorporated in money demand models in order to inform policy.

Therefore, this study seeks to fill the literature gap that is yawning in analysing how financial innovation in particular inclusion of mobile money to the generally accepted proxies of innovation including ATM, POS and ratio of M2 to M1 impact on money demand. Worse still not many studies have been done in Southern Africa on how financial innovation affect money demand which leaves room for further empirical studies whose results will be of phenomenal vitality in the conduct of monetary policy for welfare maximisation.

2.5 Conclusion

Most empirical literature build on the theoretical models as expounded by the classical, monetary and Keynesian economics have came with varied conclusion on the effect of financial innovation on money demand. There is, however, general agreement amount economists that developments in the financial sector post 1980 and 1990 have had an impact on the stability of the money demand function. The different results are due to the assortment of financial innovation proxies being used in the empirical investigation and also the cocktail of monetary aggregates being used as the depended variable. The effect in some cases was found to be in the positive while in others it was negative and, in some cases, insignificant. However, there is concerted efforts being made by economists and policy makers alike to continue to monitor the impact that financial innovation has on money demand to guide formulation and implementation of optimal policy.

CHAPTER 3

3.0 Data Description and Methodology

3.0.1 Introduction

This chapter looks at the methodological issues related to the study. It describes and analyses the procedures adopted in analysing the data. It also describes how the estimation method used in the study.

3.1 Research Design

The major objective of this study is to establish the relationship existing between money demand and financial innovation in Zimbabwe. A historical study methodology was preferred in this research. Historical study according to Wiersma (1986) deals with a critical analysis of past events this aiding in production of precise description, presentation and interpretation of those events. Choice of data and methodology was informed by the general practice prevalently applied in the field of money demand study (e.g., Sriram, 1999)

3.2 Data Analysis and Presentation

The data employed in this research is time series quantitative data such that descriptive and inferential statistical analysis was adopted. As is always the case in econometric data analysis, diagnostic tests including Unit Root test and Cointegration will be done as well as post-diagnostic tests. Pre-estimation tests are crucial to ensure that the variables employed in the study are reliable for estimating money demand. Vector Error Correction Model (VECM) has been chosen to analyse the data. The results from the analysis will be presented in tabular format. Tables and figures allow for an easy summarised presentation of results.

3.3 Model Specification

The model is derived from the theoretical Keynesian money demand equation discussed in chapter 2. The Keynesian demand equation is stated as follows:

$$\boldsymbol{Md} = \boldsymbol{k}(\boldsymbol{Y}) + \boldsymbol{L}(\boldsymbol{r}) \quad \text{----------------------} \qquad \textbf{(3.1)}$$

Where;

Md = demand for money,

k (Y) = transaction and precautionary motive, that is dependent income (Y*)* levels.

L (r*)* = speculative motive that hinges on interest rate (r).

3.4 Vector Error Correction Model

The impact of financial innovation on money demand in Zimbabwe is explored in this research with the assistance of the vector error correction term. The vector error correction term is chosen for its distinct advantage in functionality and use as compared to other econometric methods. The vector error correction model (VECM) has also proven to be an efficient technique for measuring money demand (Sriram, 1999).

The error correction model (ECM) connects the long-term equilibrium association inferred by cointegration with the short-run dynamic correction mechanism that explains how the explanatory variables respond when they deviate from long-run equilibrium (Ouliaris, 2016). The vector error correction model therefore allows for a concurrent analysis of short run dynamics for variables of interest instead of concentrating more on long run association between money demand and the exogenous variables projected by theory (Bilyk, 2006).

The ECM illustration of a cointegrated structure has the following parameters:

$$\Delta y_t = c + a(y_{t-1} - \beta x_{t-1}) + \sum_{j=1}^{p} \varphi_j \Delta y_{t-j} + \sum_{j=1}^{p} \gamma_j \Delta x_{t-j} + \varepsilon_t \text{ ------------- } \mathbf{3.2}$$

Where *B* represents the long-term equilibrium relationship, it is the coefficient of cointegration. *a* shows the speed of adjustment or how strongly the past disequilibrium affects changes in the dependent variable y. It can also be termed own factor loading.

p is the order of the auto regressive (AR) process in y and x

φ and γ are 'own' dynamic parameters of x and y (not showing disequilibrium conditions)

Following the Keynesian specification above, the money demand function to be applied in this research can therefore be specified as follows:

$$M_t^d = \alpha + \beta_y \text{MINDEX} + \beta_r R_t + \beta_\pi CPI_t + \beta_{POS} POS_t + \beta_{MOB} MOB_t + \beta_m M_2/M_3 + \mathcal{E}_{tt} \text{ --------3.3)}$$

Where M^d_t = natural log of demand for money represented by M_3

Y_t = natural log of national income which is proxied by manufacturing volume index

Rt= natural log of Interest rates

CPI = natural log of Consumer Price Index proxy for Inflation

POS = natural log of value of pos transactions

MOB = natural Log of value of Mobile phone monetary transactions

M_2/M_1 = ratio of m2/m1

Ɛ = disturbance term (error term)

The following assumptions as stated by Dzingirai (2015) will be adopted as the basis of this research which include: households are held to be in equilibrium such that they are unrestricted in quantities of goods and services they can procure nor the amount of labour they can supply which allows money to be expressed in log linear form in the model.

The ECM representation of the money demand function (3.3) is as follows which is a multivariate representation:

$$\Delta LnM_t^d = a_0 + a_1\Delta LnM_{t-i}^d + a_2 Ln\Delta MINDEX_{t-i} + a_3 Ln\Delta R_{t-i} + a_4 Ln\Delta ICPI_{t-i} + a_5 Ln\Delta POS_{t-i} + a_6\Delta MOB_{t-i} + a_7 Ln\Delta \frac{m_2}{m_1}_{t-i} + ECT_{t-i} + \mu_{it} \text{ -----------------------(3.4)}$$

Equation (3.4) shows the ECM wherein each variable is explained by itself and other variables of interest in the model.

ECT_{t-i} is the lagged error correction term deviation from long term cointegrating relations, μ_{it} is the error term and i = 1,2,3….n)

3.5.0 Diagnostic Tests

3.5.1 Unit Root Test

A stochastic process is stationary when its mean and variance do not vary with time. When they are time invariant. It is covariance stationary if the covariance between the two time periods is dependent only on the lapsed time j and not on the reference time t (Marone, 2016). Stationarity is associated with long run equilibrium and when a series is non-stationary, there is no long-run mean reversion (Marone, 2016). The stationarity or otherwise of a series has a significant implication on its behaviour and characteristics. As an example, for any nonstationary series, persistence of shocks is infinite. To evade spurious and inconsistent results, stationarity test is key in modelling time series data. Unit root is a generally applied test of stationarity or non-stationarity of time series data. The unit root procedure tests the following hypothesis which will be tested:

H_0: $\delta = 0$, is used in this research to indicate that unit root is prevalent in the time series (time series is not stationary.

H_1: $\delta < 0$, to indicate that time series is stationary.

This research adopted Augmented Dickey Fuller test (ADF) to determine the existence of unit root in the time series. In instances where the data is found to be non-stationary, it will be detrended by differencing.

3.5.2 Johansen Cointegration Test

Cointegration is a term used to describe the linear long-run co-movement of two time series variables of same order of integration. Cointegration occurs when two or more-unit root time series datasets have a long run equilibrium, co-move such that their linear combination is a stationary series and have a common underlying trend. Cointegration test therefore expose if non-stationary time series data co-move in the long run. The Johansen cointegration test was adopted in this study. The Johansen methodology derives cointegrated variables straight from the maximum likelihood estimation rather than from OLS estimators and has the ability to identify more than one cointegrating relationship should it be present. The Trace statistic and the maximum eigenvalue are the two likelihood tests that the Johansen method use to detect the number of cointegrating vectors. The two tests rely on the understanding that in the VECM, the rank of the long-run effect matrix, decides if the VAR(p) variables are cointegrated. The Johansen test was used because it reveals the number of cointegrating equations in the system.

The Johansen test begins with the VECM model of order p which is specified by

$Y_t = \mu + A_1 Y_{t-1} \dots \dots + A_p Y_{t-p} + \varepsilon_t$ ……………………………(3.5)

Where Y_t is an (n x 1) vector of variables integrated of order one I(1). ε_t is a vector of innovations.

The Maximum Eigen value and the Trace tests under the Johansen method as represented as;

$J_{trace} = -T \sum_{i-r+1}^{n} Ln(1 - \Lambda i)$ ………………………(3.6)

$J_{max} = -T(Ln - \Lambda i)$--(3.7)

T is the sample size and Λi is the *ith* biggest canonical correlation. The null hypothesis of the Trace test is *r* co-integrating vectors which is pitched against the alternative hypothesis that there are *n* co-integrating vectors. While on the other hand, the maximum eigenvalue test has the null hypothesis of *r* co-integrating vectors against the alternative hypothesis of r + 1 co-integrating vectors (Hjalmarsson and Osterholm, 2007). The statistic follows a nonstandard

3.6.0 Variable Selection and Description of Data

This research employs the use of secondary monthly data spanning from January 2016 to September 2020. The Data was sourced from the monthly publications of the Reserve Bank of Zimbabwe (RBZ) and Zimbabwe Statistical Agency (ZIMSTAT) data base. The following series data was accessed.

3.6.1 Money Demand (M^d)

In this research M_3 taken to be the proxy for money demand after assuming equilibrium condition and it was chosen due to its liquidity nature given that it is comprised of notes and coins, demand deposits,time deposits. Increases in income propels money demand and a rise in interest rates consequently results in the fall of the money for demand. M3 was preferred as a measure of money demand for a broader measure of money is more appropriate for modelling purposes. M_3 is also less prone to distortion by financial deregulation and innovations and has a more dependable relationship with income.

3.6.2 Value of Mobile Money Transactions

Due to the fast adoption of mobile money transactions in Zimbabwe, it is only reasonable to analyse how this has affected money demand. Zimbabwe has a vibrant mobile financial services market, with 3.2 million active mobile money subscribers (22% of the total adult population, double Sub-Saharan Africa's rate of 11%) (Willis, 2016). Due to the inclusivity and geographical reach of mobile financial services, it is prudent that the impact of mobile money financial services transactions on money demand be assessed.

3.6.3 Value of POS transactions

POS transactions by end of 2018 accounted for 95% of all retail transactions and POS terminals increased from 56,000 in 2017 to 70,000 by May 2018 (RBZ, 2018). He wide adoption and use of POS terminals in the payment system warrants that its impact of money demand be studied. The advent of cash crisis culminating in the general use of POS terminals for transaction purposes makes it even more appropriate to study how this has impacted on money demand. T

3.6.4 Income proxied by Manufacturing Index

This variable measure real sector activity and is a major determinant of transaction demand for money. Income is taken to be a scalable variable in the specification of money demand function. As real output grows, transaction demand for money is expected to increase. The coefficient of this variable is expected to be positive. In this research however because of the unavailability of GDP statistics on a monthly basis, manufacturing index was used as a proxy for the variable.

3.6.5 Inflation (CPI_t)

Inflation represents the return on real sector assets as substitutes to holding money. This according to Tobin (1958) impacts on individuals' preferences of portfolio holdings. Inflation can influence savings through several channels. First, economic theory posits that increased uncertainty should cause a surge in savings as risk-averse consumers set resources aside as a precaution against possible adverse changes in income and other factors. Therefore, inflation may increase precautionary savings by individuals. Second, inflation can influence saving through its effect on real wealth. If consumers attempt to maintain a certain targeted level of wealth or liquid assets relative to income, saving will rise with inflation. It should be noted however that inflationary expectations play a critical role in the supply of and demand for loanable funds. It is expected that inflation will have a negative effect on savings. Zimbabwe has suffered from persistent inflation problems entering into hyperinflation episodes thus diminishing the return on monetary holdings. Past inflationary periods have rendered savings worthless. Economic agents in Zimbabwe have witnessed life time pension savings being eroded by inflation. As a result, inflation was included as an opportunity cost for real assets in Zimbabwe. Monthly CPI statistics sourced from the RBZ and ZIMSTAT were used in this research.

3.6.6 Interest Rate (Rt)

This represents the opportunity cost of holding money. The own rate of return is represented by the three months commercial savings deposit rate. The higher the rate of interest, then the more money is presumed to be saved. Economists believe that at higher rates of interest economic agents will be more induced to postpone current consumption. According to utility maximization, the rate of interest is at the heart of contemporary theories of consumer behaviour, given the present stock of wealth (Ansong et al, 2011). This is the rate that determine the incentive to substitute monetary holdings to investing in savings deposits with commercial banks. In this research three months commercial bank savings rate shall be used as the opportunity cost of holding money.

The results associated with a change in the rate of return are theoretically unclear due to the strength offsetting effects of the substitution and income effects. Net savers are confronted with two partial effects following an increase in interest rates: an income effect promulgating a surge in current consumption and a substitution effect resulting in a reduction in current consumption. Because net savers (net lenders) get more in investment income than they expend to service debt, high interest rates increase net investment income, thus increasing present consumption and reducing the need to save to finance future consumption.

Should the substitution effect is pronounced, an increase in the rate of return tends to incentivise consumers to postpone consumption and increase savings in the present period in order to achieve higher consumption levels later (Ansong et al, 2011). This variable is used to validate the existence of smoothing consumption theory and the life-cycle model where individuals will keep their monies during working years for usage during their retirement period.

3.6.7 Ratio of broad to narrow money ($\frac{m_2}{m_1}$)

The introduction and growth of interest-bearing liquid money market instruments has had a tremendous effect on money demand. These instruments include highly liquid money market interest bearing assets such as the NOW (Negotiable Orders of Withdrawal) accounts in England introduced in the 1970s. It has become cheap for firms to invest excess demand deposit balances in the money market and it has also become faster to liquidate such money market investments in the event of emergency need of cash. Thus, introduction of money market instruments has made it easy for economic agents to optimise their returns on their money holdings. Enhanced information systems and forecasting procedures have significantly reduced risks regarding near-term cash flows thus allowing for profitable reductions in M1 balances. The traditional theory of money demand hinges upon the idea that changes in the yield on an interest-bearing asset or changes in the cost of converting interest-bearing assets into money will affect money holdings. Money market instruments have lower transactions costs than many other assets of comparable yields and their introduction and inclusion to cash-management strategies might be expected to reduce the volume of demand deposits held at any given interest rate. Therefore, to inclusion of $\frac{m_2}{m_1}$ in the model is justified on the above grounds to capture how introduction of new interest-bearing liquid assets have affected money demand in Zimbabwe.

CHAPTER 4

4.0 Results Presentation and Analysis

4.1 Introduction

The chapter presents the results of the investigative analysis and results of stationarity tests of the variables in the model. The Augmented Dickey Fuller test methodology was employed in determining the stationarity of the variables. The chapter also presents the findings of the Johansen Cointegration tests that were carried out on the variables to determine their long run association. Also results of the various postestimation tests including multicollinearity, autocorrelation, model stability and error correction model estimation will be presented in this chapter.

4.2 Results

4.3 Econometric Tests

4.3.1 Unit Root Tests

The ADF unit root test procedure was employed in analysing the stationarity of the model variables. The results of the test are presented below. All the explanatory variables in the model equation were found to have a unit root at their level that is they were not stationary. The variables in this model, though the 5% level was chosen are such that they must be stationary at all level of significance that is at 1%, 5% and 10%. The variables were not stationary at all levels thus necessitating that first difference stationarity test be carried out.

Table 4.1: The ADF I(0) Stationarity Test Results

variable	T-Statistic	Critical Value (5%)	P-Value
M3	-1.3193	-2.890623	0.6181
LNMINDEX	-2.7737	-2.890623	0.0262
LNM2/M1	-0.5497	-2.890155	0.9387
LNCPI	-0.5534	-2.890623	0.2458
MOB	-0.5608	-2.890926	0.8728
LNPOS	-1.7073	-2.890926	0.9968
LNINT	-1.1037	-2.890122	0.8344

Table 4.2: The ADF First Difference Unit Root Test Results

variable	T-Statistic	Critical Value (5%)	P-Value	Order of Integration
D(M3)	-7.3979	-2.891871	0.0000	I(1)
D(LNMINDEX)	-10.1764	-2.890926	0.0000	I(1)
D(LNM2/M1)	-11.4435	-2.891550	0.0000	I(1)
D(LNCPI)	-10.7147	-2.890926	0.0000	I(1)
D(MOB)	-3.1552	-3.461686	0.0259	I(1)
D(LNPOS)	-7.6702	-2.890926	0.0000	1(1)
D(LNINT)	-11.2733	-2.892200	0.0067	I(1)

From the table 4.1 above all variables were found to have unit roots at 5% significance level except for LNMINDEX which was stationary at 5% and 10 % while nonstationary at 1% significant level. At all other levels of significance (1% and 10%) the variables were non stationary. Given that the variables were nonstationary at their level, they were tested for stationary at first difference and thus were all first difference stationary (Table 4.2). They were all I(1) series. This justifies the investigation of long run money demand relationship.

4.4 Cointegration Analysis

4.4.1 Optimal Lag Selection

The optimal maximum lag selection was conducted serially using the five information criteria provided for in Eviews which are the Final Prediction Error (FPE), Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC), The Hanna-Quinn Information Criterion (HQ) and the Sequential Likelihood Ratio (LR). The below table 4.3 presents the results of the VAR lag order selection test. The lowest value for each of the criterion was chosen to be the criterion's VAR lag length.

Table 4.3 Optimal VAR Lag Length Selection Test Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	366.2705	NA	1.04e-12	-7.726248	-7.535622	-7.649279
1	997.0303	1153.002	3.85e-18	-20.23721	-18.71220*	-19.62146
2	1064.348	112.9194	2.64e-18	-20.63113	-17.77174	-19.47659
3	1114.656	76.81512	2.68e-18	-20.65927	-16.46550	-18.96595
4	1184.106	95.58757	1.88e-18	-21.09906	-15.57092	-18.86696
5	1282.427	120.5222	7.56e-19	-22.15972	-15.29720	-19.38883
6	1366.216	90.09520	4.52e-19	-22.90787	-14.71096	-19.59819
7	1426.327	55.58643	5.06e-19	-23.14681	-13.61552	-19.29835
8	1519.743	72.32209*	3.29e-19*	-24.10199*	-13.23632	-19.71475*

* indicates lag order selected by the criterion

From the table above, the lag length of 1 (one) was chosen to be the optimal lag for each variable in the model. The optimal lag length which is the maximum optimal lag for the variables according to the tests results is lag 1(one). This was chosen based on the criterion with the lowest value which in this case is the SC criterion. This therefore entails that the long run relationship between money demand and the independent variables has been analysed using the lag length of 1 (one).

4.4.2 Johansen Cointegration Test

The study employed the Johansen Cointegration test because of its inherent advantage of allowing for the prospect of analysing more than one cointegrating vector which is not available in single equation estimation methods. The method uses the maximum likelihood tests premised on Trace and Maximum Eigenvalue statistics. Johansen cointegration method allows for the investigation of the short run dynamic analysis separately from the long run relationships. The variables considered in this study were found to be unit root variables at their level which then warranted that the variables be exposed to cointegration test. The test results of the Johansen Cointegration test are presented in table 4.4 and 4.5 below,

Table 4.4: Johansen Cointegration Trace Test Results

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.469448	177.6137	125.6154	0.0000
At most 1 *	0.333413	114.8639	95.75366	0.0013
At most 2 *	0.251566	74.71100	69.81889	0.0193
At most 3	0.199827	46.02357	47.85613	0.0736
At most 4	0.118531	23.95379	29.79707	0.2024
At most 5	0.103303	11.46335	15.49471	0.1845
At most 6	0.006732	0.668696	3.841465	0.4135

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

Table 4.5: Johansen Cointegration Maximum Eigenvalue Test Results

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.469448	62.74982	46.23142	0.0004
At most 1 *	0.333413	40.15289	40.07757	0.0490
At most 2	0.251566	28.68744	33.87687	0.1836
At most 3	0.199827	22.06978	27.58434	0.2168
At most 4	0.118531	12.49043	21.13162	0.5001
At most 5	0.103303	10.79466	14.26460	0.1648
At most 6	0.006732	0.668696	3.841465	0.4135

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level

The results cointegration test results displayed above were obtained under the underlying condition that trends are deterministic. Both the Trace statistic indicates 3 cointegrating equations and the Maximum Eigenvalue test identified 2 cointegrating equations for the model. Because cointegration exists, this implies that a vector error correction model (VECM) has to be estimated for the model and the results are displayed below.

4.4.3 Estimated Long Run Demand Function

It has been established by the Johansen cointegration technique that the variables incorporated in the money demand model have a long run association and it is trite to estimate how the demand for money will react to variations in its determinants in the long run. The cointegration results are as shown in table 4.6.

Table 4.6 VECM Results for Long Run Money Demand

Variable	coefficient	Std. Error	T-statistics
LNPOS	0.6989	0.1776	3.9362
MOB	0.4065	0.6788	0.5989
LNMINDEX	-1.1331	0.2791	-4.0592
LNM2_M1	5.7300	0.7406	7.7372
LNINT	-0.0778	0.2935	-0.2651
LNCPI	-5.5648	0.8322	-6.6872
CONSTANT	9.009		

R squared	0.515641	F-Statistic	11.97657
Adj. R squared	0.472587	Log likelihood	193.3730
Sum sq. reduals	0.116568	Akaike AIC	-3.724707
S.E. equation	0.035989	Schwarz SC	-3.488787
Mean dependent	0.028974	S.D. dependent	0.049556

The long run money demand relationship from the VECM is:

M_3 = 0.0778LNINT + 5.5648LNCPI -0.6989LNPOS – 0.4065 LNMOB + 1.1331 $LNMINDEX_{t-1}$ -5.7300LNM_2/M_1 – 9.009

The long run estimated coefficients for manufacturing index, LNMINDEX (proxy for national income), interest rate (LNINT) and inflation proxied by consumer price index (CPI) have the expected signs predicted by theory.

The results indicates that a percentage increase in manufacturing index will result in a 1.133% increase in the demand for money. That only supports the theoretical argument that increase in income consequently result in an increase in transactional demand for money. Transactional demand for money is a function of income. There is a direct positive relationship between the two given that expenditure in the real sector is a consequent of income.
Again, precautionary demand for money is also reliant on income. The more the income the more is the precautionary demand for real money balances. Thus, the transaction and precautionary demand for money in Zimbabwe hold in the long run.

Interest rate has a surprising positive sign in the estimated equation. A percentage increase in interest rate ceteris paribus results in the increase in the demand for money by 0.08%. An increase in interest rate increases the opportunity cost of holding money through loss of potential income that could be earned from holding interest bearing assets which include bonds. The decimation of an active money market may be the reason for the unexpected positive sign. In fact, lending increased as opposed to investment prompting and increase in demand for money. Banks thrived by increasing their lending portfolio especially consumer lending which is highly consumptive thus further spurring transaction demand.

As for inflation proxied herein by CPI, the results also are consistent with economic theory which posits a positive relationship between money demand and inflation. An increase in inflation causes a surge in money demand because inflation results in the loss of value in terms of what money can buy. Inflation especially hyperinflation causes economic agents to prefer to invest in the real sector. Inflation also increases the transaction and precautionary amounts that individuals hold to carry out their transactions even as the quantity of goods and services procured has not risen.

Point of sale transactions have tended to decrease the demand for money as estimated in this model. This is as expected from theory. POS leads to a 0.69% decrease in money demand following a 1% increase in value of POS transaction. POS enables ease of transactions and comes with reduced transaction costs. In Zimbabwe transactions on POS have tended to be bullish mainly because of cash shortages and a significant promotion by the RBZ for the transacting public to resort to the use of electronic money to evade circumvent cash shortages. This is despite the fact the cost to the transacting public following the introduction of the 2% electronic transaction tax is increased as income increases, bank balances increase thus triggering the increase in POS transactions as a substitute for cash. Thus, as POS transactions increase transaction and precautionary demand decrease.

A 1% increase in mobile money transaction value will ceteris paribus result in a 0.41% decrease in the demand for money. Mobile money has proved to be a cost friendly and convenient means of transferring money. The increase in the use of mobile monetary transactions results in the decrease in money demand for transaction and precautionary purposes. Mobile money transactions result in the rise in cash circulating in the economy, that is it causes an increase in velocity of cash which lead to individuals substituting monetary holdings in the form of liquid assets (M1) for less liquid financial assets (M2 or M3). This substitution apparently results in the decrease in the demand for money. This finding concurs with the findings of Mujuri et al (2018), Mlambo and Msosa (2018).

This also is in line with the Keynesian postulation on the transaction demand for money in that demand for money is ignited by the medium of exchange role of money in carrying out regular purchases of goods and services. Mobile money in Zimbabwe has enabled for a faster of settling personal and business transactions just as fast as it were if cash was used. Mobile money usage in Zimbabwe has indeed influenced the pricing structure and system in the economy with prices being quoted in mobile money terms as if it were a currency. There is talk of Ecocash, One money or Telecash price of goods and services. It therefore means that as long as the mobile wallet has a positive balance, an individual has cash for transaction and precautionary purposes. It is the increased velocity of money orchestrated by mobile money transactions that inevitably leads to the decrease in the demand for money.

Turning to the ratio of broad money (M2) to narrow money (M1), the research found a negative relationship for Zimbabwe. A 1% increase in the ratio results in a 5.73% decrease in the demand for money. However, studies on money demand in Zimbabwe have not included this variable to enable country specific comparison with this finding. This result however diverges from that by Mbazima-Lando and Manuel (2020) who found a positive relationship in Namibia. This finding also agrees with the finding of Arau et al (1991) who found a negative relationship. The result is coming against a background of lack of depth in the development of the financial markets including both the capital and money market. With well-developed financial markets the demand for money decrease following the increase in the ratio. In developing countries like

Zimbabwe with poor financial markets and sustained high inflation transaction and precautionary demand for money supersede speculative demand. Institutional investors still invest in such riskless financial assets as treasury bills despite a collapsing money market thus explaining the negative relationship between interest rates and money demand..

4.4.4 Short Run Model Analysis and Interpretation

Given that there is cointegration of the variables, the error correction model was estimated. The error correction model synthesises the short and long run behaviour of the variables under study. The short run model shows the adjustment process and reversion to long run equilibrium following an exogenous shock that causes deviation from long run equilibrium. It shows how fast this adjustment process to long run equilibrium is following short run changes in the explanatory variables. The estimated error correction model is given below

$ECM = M_{3(t-1)} - 0.0778LNINT_{(t-1)} + 5.5648LNCPI_{(t-1)} -0.6989LNPOS_{(t-1)} – 0.4065\ LNMOB_{(t-1)} + 1.1331\ LNMINDEX_{(t-1)} -5.7300LNM_2/M_{1(t-1)} – 9.009$

The short run model results are as presented in the table 4.7 below:

Table4.7 Short Run VECM Regression Results of Money Demand

Variable	coefficient	Std. Error	T-statistics	P-Value
ECM	-0.033	0.010	-3.134	0.0023
$\Delta M_{3(t-1)}$	0.537	0.088	6.105	0.0000
$\Delta LNPOS_{(t-1)}$	0.012	0.023	0.526	0.600
$\Delta MOB_{(t-1)}$	0.001	0.091	0.014	0.989
$\Delta LNMINDEX_{(t-1)}$	-0.012	0.043	-2.274	0.7851
$\Delta LNM2\_M1_{(t-1)}$	0.051	0.048	1.065	0.2895
$\Delta LNINT_{(t-1)}$	0.017	0.068	0.242	0.8097
$\Delta LNCPI_{(t-1)}$	-0.881	0.175	-5.034	0.0000
CONSTANT	0.016	0.004	3.585	0.0005

R-squared	0.515641	Mean dependent var	0.028974
Adjusted R-squared	0.472587	S.D. dependent var	0.049556
S.E. of regression	0.035989	Akaike info criterion	-3.724707
Sum squared resid	0.116568	Schwarz criterion	-3.488787
Log likelihood	193.3730	Hannan-Quinn criter.	-3.629253
F-statistic	11.97657	Durbin-Watson stat	2.386783
Prob(F-statistic)	0.000000		

The ECM also signifies the variables' speed of adjustment to restoration of long run equilibrium. The larger the coefficient of the ECM, the greater is the speed of adjustment from short run to long run equilibrium. A negative sign tells of the subsequent monthly adjustment to equilibrium in response to a shock. In addition, a negative sign also means that there is a long run relationship between money demand and the explanatory variables point of sale values, mobile money transaction values, manufacturing index, interest rate, CPI and ratio of M2 to M1.

From the estimated equation above, the coefficient of the ECM is negative at -0.033. The adjustment speed to lung run equilibrium is at 3.3% and this serves to buttress the fact that the previous month's deviation of money demand from long run equilibrium is corrected at the speed of 3.3% in the current month.

The results show that there is a short run negative relationship that exist between all the variables with the exception on manufacturing volume index and CPI. The variables used as proxies of financial innovation have a negative sign which implies that in the short run, an increase in their use as payment methods and money substitutes results in the decrease in money demand.

4.5 Post Estimation Residual Tests

4.5.1 Serial Correlation Tests

The results for serial correlation tests are as presented in table below.

Table 4.8 Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

F-statistic	2.716286	Prob. F(1,89)	0.1029
Obs*R-squared	2.932002	Prob. Chi-Square(1)	0.0868

From the results presented in the table above, there null hypothesis of no serial correlation is accepted given that the P-Value of the Chi-Square is greater than the 5% level which entails that it is statistically significant. There is therefore no evidence of serial correlation in the estimated residuals.

4.5.2 Multicollinearity Tests

The Variance Inflation Factor (VIF) was employed in the model as a test for multicollinearity. The VIF tells how much the variance of the regression coefficient is inflated due to multicollinearity. The VIF score of the explanatory variable signifies how well it is explained by other independent variables in model. The rule of thumb is that the VIF of any explanatory variable should not be more than 3 otherwise the variable is highly correlated with other independent variables. The results of the VIF test are presented below;

Table 4.9. Multicollinearity Test Results

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C(1)	0.000109	2.051842	2.051842
C(2)	0.007724	1.853157	1.379152
C(3)	0.000526	1.197001	1.182164
C(4)	0.001882	1.125572	1.122211
C(5)	0.002309	1.423766	1.421122
C(6)	0.004683	1.239238	1.238564
C(7)	0.030659	1.393083	1.379846
C(8)	0.008241	1.160791	1.152874
C(9)	1.96E-05	1.496066	NA

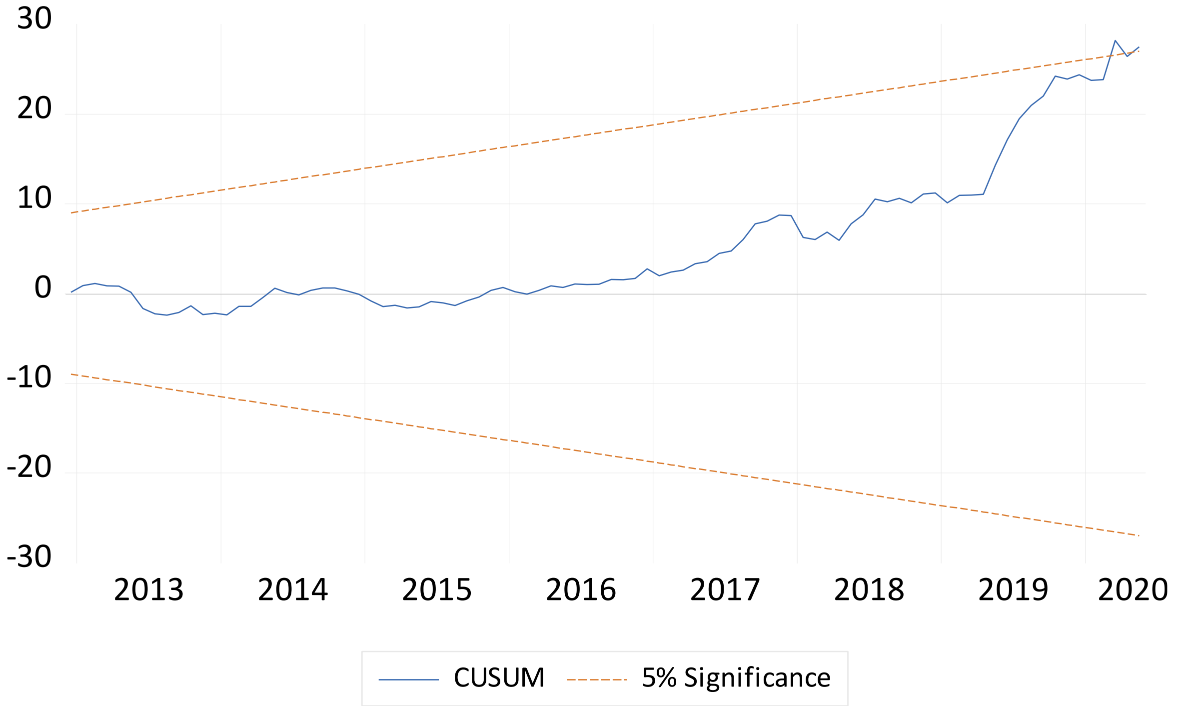
From the table above all the VIFs for the coefficients are below 3, which therefore entails that the model does not suffer from multicollinearity.

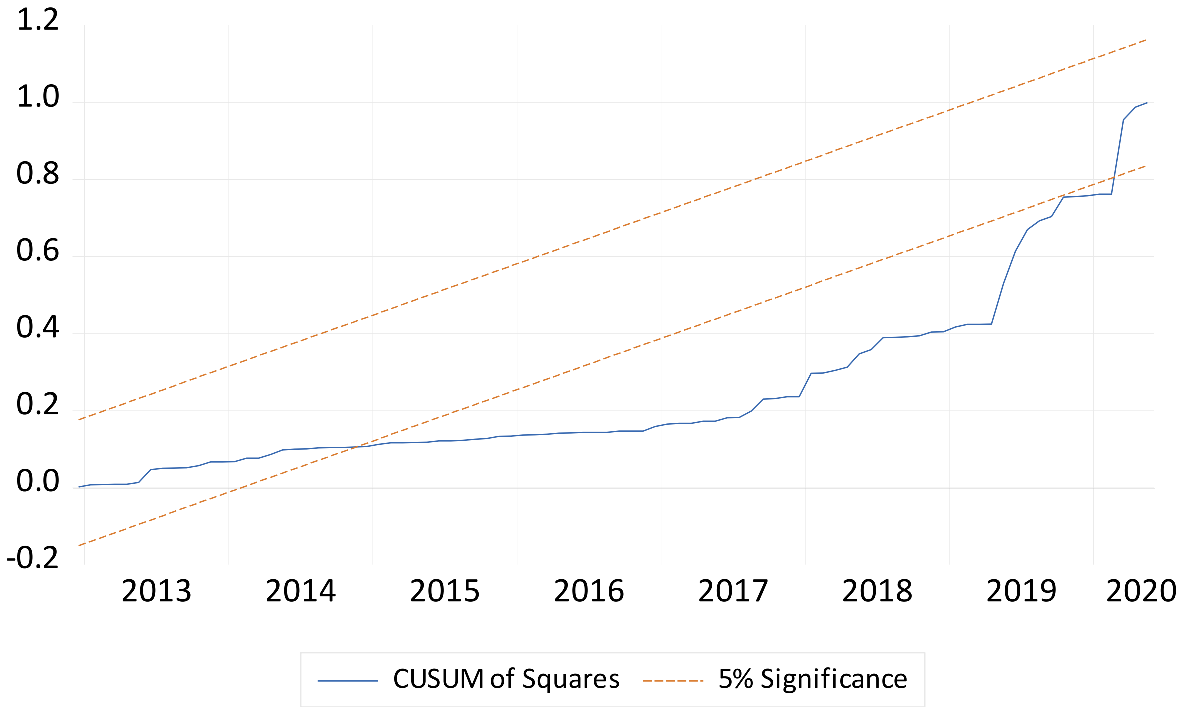
4.5.3 Stability Test

The conduct of monetary policy successfully hinges on the stability of the money demand function such that stability tests are crucial. Stability tests allows for identification of structural breakpoint over the estimation timeframe under consideration. Such structural break point may be due to policy shifts or financial sector innovations. For Zimbabwe, the period being considered in this research witnessed abundant changes in the financial landscape with increased adoption of new payment technologies and systems. To that end the CUSUM and CUSUMQ were used to test for structural stability of the money demand function. Even as long run relationship was confirmed by cointegration, short run prediction of the economy may have been constrained by short run deviations of money demand from long run equilibrium.

CUSUM test vitally detects systematic deviations in the regression coefficient, while CUSUMQ test hinges on consistency of regression coefficients. The test is based on the cumulative sum of recursive residuals and plots the cumulative sum incorporating the 5% critical lines. There is parameter instability should the cumulative sum goes beyond the borders of the 5% critical lines. The results of the test are presented as shown in figures below.

Figure 4.1 CUSUM Stability Test (Recursive Stability Test)





From above the CUSM plot shows that the specified money demand function was a bit unsstable for the period under review with the CUSUM lying within the confines of the 5% bounds but breaking out towards end of 2019.

However, for the CUSUMQ, the recursive residuals are found to break the bounds of the 5% plot bounds from the period June 2014s to March 2020. The CUSUMQ indicates general instability in the money demand function. During this period, there has been consistent and increased adoption of mobile money and point of sale payment systems. Mobile money usage experienced phenomenal growth during this period.

Chapter 5

5.0 Summary, Conclusion and Policy Implications

5.1 Introduction

The study intended to extract the effect of financial innovation on money demand in Zimbabwe, especially its effect on M3 balances. As proxies for financial innovation the study utilised as variables ratio of M2 to M1, transaction value for mobile money and point of Sale transactions. There is growing demand for technology-based payments systems that encompass mobile money and point of sale such that their influence on demand for money in Zimbabwe ought to be examined. This chapter provides a synopsis of the results from the study leading to conclusion. Policy implications are also highlighted, and recommendations proffered in this chapter.

5.2 Summary

The study sought to investigate the financial innovation effect on money demand in Zimbabwe. The study also aimed at establishing cointegration relationship in the demand function specified and also assessing the stability of the demand function. It used the VECM estimation technique to analyse the monthly data sourced mainly from the RBZ and ZIMSTAT from 2012 to 2020.This period is characterised by increased adoption of mobile money and POS usage triggered by cash shortages. This saw the soaring of transactions carried out through these payment channels. The unbanked in Zimbabwe were allowed access to financial services and products through mobile money platforms. These also came with ease and low cost of transaction. Solid understanding of the stability and strong factors of money demand are at the centre of monetary policy conduct.

A VECM estimation technique was used in the study because of its advantage of enabling the concurrent analysis of both the short run and long run effects of the variables on the dependent variable. Also having established from unit root test that the variables in the model were non-stationary on level, a Johansen Cointegration procedure was carried out which established that the variables were indeed cointegrated.

Grounded on theory variables such as inflation (CPI), GDP (manufacturing index) and interest rates were selected in the specification of the money demand function. Financial innovation proxies of value of mobile money transactions and value of POS transactions were targeted owing to wide adoption of these in Zimbabwe. M2/M1 was chosen on the basis that this is generally accepted internationally as a measure of financial innovation.

It can be established from the results that in the long run the variables used to capture financial innovation in particular value of mobile money transaction (MOB), value of POS transactions and ratio of M2 to M1 (M2/M1) all had a negative influence on money demand. The ratio of M2 to M1 in this study exerted a huge positive influence on money demand. Studies on money demand in Zimbabwe have not incorporated this variable to enable comparison specific to Zimbabwe.

The short run results indicated that all variables impact negatively on the demand for money save for CPI and volume of manufacturing index which are positive. The ECM also shows an adjustment speed of 3.3% to long run equilibrium after a divergence.

Post estimation test done indicated that the residuals are devoid of serial correlation and from the VIF test no evidence of multicollinearity was established. Stability test carried out using the CUSUMQ showed that the money demand function was unstable. This is attributed to the growing cash crisis over the period prompting a switch to mobile money and POS transaction. This instability resulted in the Reserve Bank of Zimbabwe intervening in the market to regulate mobile money transaction in 2020.

5.3 Conclusion

The research has managed to ascertain the determinants of money demand in Zimbabwe include inflation herein proxied by CPI and positively impacts on the demand for money. In the long run inflation is a major driver on money demand. Interest rates are also a negative determinant of money demand and this conforms to widely held economic view of its relationship with money demand. This only confirms economic agents' wealth maximising behaviour which dissuades them from holding money when interest go up. Income proxied with manufacturing index is also a positive determinant. Financial innovations which were a major focus of this research also are determinants of money demand.

On financial innovations herein proxied by ratio of broad money (M2) to narrow money (M1), value of mobile money transactions and value of point of sale transactions were also identified to be determinants of money demand in Zimbabwe. In addition, POS and Mobile money negatively affect money demand which only proves that these have tended to be money substitutes in transactions. As long as the wallets are funded with positive balances demand for transaction balances plumets. Mobile money and POS have become shadow currencies carrying a different value normally higher than cash price for the same commodity. These instruments have been used as conduits for arbitrage as they were trading with cash especially on the underground market aiding in inflating the economy. Transaction charges and service provider charges are cited as the scape goat for the premium when using these modes of payments. Left unchecked, these surrogate currencies in Zimbabwe have caused a wild run-in exchange rate and inflation. It is only when the value of mobile money transactions where capped that there was stability to prices in Zimbabwe with money on month inflation retreating.

5.4 Policy Implications

From the results it can be shown that financial innovation plays a key part in money demand in Zimbabwe such that it will be fatal to ignore its implication in policy formulation. Mobile money transaction must therefore be monitored given that it has allowed financial inclusion of the previously unbanked population in Zimbabwe and also that it has led to parallel pricing regime in the country. It has acted as a currency on its own thus in order monetary authorities to effectively implement monetary targeting policy regime for price stabilisation control of the monetary transaction occurring in mobile money platforms becomes paramount.

The government should also continue to advocate for the use of technology-based payment systems that ride on banking platforms especially POS in the informal sector. Given that this sector remains unbanked and is a major sector sustaining livelihoods in Zimbabwe, it is critical that banking products be adopted in this sector. The sector has continued to be a cash-based sector and where mobile money is used, a premium price is charged over and above the cash-based price.

5.5 Limitation of the Study

The major limitation of the study was the unavailability of data on major variables determining money demand which is gross domestic product (GDP) which was proxied by manufacturing index, which is not a true reflection of GDP in Zimbabwe. Data on CPI was not readily available from ZIMSTAT as well as data on manufacturing index. The data was also sourced from private players in the industry which might not be accurate.

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APPENDICES

Appendix 1: Optimal Lag Selection

VAR Lag Order Selection Criteria
Endogenous variables: LNM3_1_ LNPOS MOB LNMINDEX LNM2_M1 LNCPI LNINT
Exogenous variables: C
Date: 03/14/21 Time: 14:05
Sample: 2012M01 2020M05
Included observations: 93

Lag	LogL	LR	FPE	AIC	SC	HQ
0	366.2705	NA	1.04e-12	-7.726248	-7.535622	-7.649279
1	997.0303	1153.002	3.85e-18	-20.23721	-18.71220*	-19.62146
2	1064.348	112.9194	2.64e-18	-20.63113	-17.77174	-19.47659
3	1114.656	76.81512	2.68e-18	-20.65927	-16.46550	-18.96595
4	1184.106	95.58757	1.88e-18	-21.09906	-15.57092	-18.86696
5	1282.427	120.5222	7.56e-19	-22.15972	-15.29720	-19.38883
6	1366.216	90.09520	4.52e-19	-22.90787	-14.71096	-19.59819
7	1426.327	55.58643	5.06e-19	-23.14681	-13.61552	-19.29835
8	1519.743	72.32209*	3.29e-19*	-24.10199*	-13.23632	-19.71475*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 2: Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.469448	177.6137	125.6154	0.0000
At most 1 *	0.333413	114.8639	95.75366	0.0013
At most 2 *	0.251566	74.71100	69.81889	0.0193
At most 3	0.199827	46.02357	47.85613	0.0736
At most 4	0.118531	23.95379	29.79707	0.2024
At most 5	0.103303	11.46335	15.49471	0.1845
At most 6	0.006732	0.668696	3.841465	0.4135

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.469448	62.74982	46.23142	0.0004
At most 1 *	0.333413	40.15289	40.07757	0.0490
At most 2	0.251566	28.68744	33.87687	0.1836
At most 3	0.199827	22.06978	27.58434	0.2168
At most 4	0.118531	12.49043	21.13162	0.5001
At most 5	0.103303	10.79466	14.26460	0.1648
At most 6	0.006732	0.668696	3.841465	0.4135

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

1 Cointegrating Equation(s): Log likelihood 1066.831

Normalized cointegrating coefficients (standard error in parentheses)

LNM3_1_	LNPOS	LNMINDEX	LNM2_M1	LNINT	LNCPI	MOB
1.000000	0.698922	-1.133070	5.730001	-0.077808	-5.564797	0.406516
	(0.17756)	(0.27914)	(0.74058)	(0.29353)	(0.83216)	(0.67880)

Appendix 3: VECM Results

Vector Error Correction Estimates
Date: 03/14/21 Time: 14:10
Sample (adjusted): 2012M03 2020M05
Included observations: 99 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LNM3_1_(-1)	1.000000
MOB(-1)	0.406516
	(0.67880)
	[0.59887]
LNPOS(-1)	0.698922
	(0.17756)
	[3.93619]
LNMINDEX(-1)	-1.133070
	(0.27914)
	[-4.05916]
LNM2_M1(-1)	5.730001
	(0.74058)
	[7.73720]
LNINT(-1)	-0.077808
	(0.29353)
	[-0.26508]
LNCPI(-1)	-5.564797
	(0.83216)
	[-6.68718]
C	9.009011

Error Correction:	D(LNM3_1_)	D(MOB)	D(LNPOS)	D(LNMINDEX)	D(LNM2_M1)	D(LNINT)	D(LNCPI)
CointEq1	-0.032756	-0.018595	-0.130384	0.045843	-0.075316	-0.039239	-0.005745
	(0.01045)	(0.01147)	(0.04725)	(0.02508)	(0.02126)	(0.01626)	(0.00686)
	[-3.13449]	[-1.62111]	[-2.75953]	[1.82782]	[-3.54303]	[-2.41327]	[-0.83806]
D(LNM3_1_(-1))	0.536558	-0.215155	-0.892249	0.014849	-0.278039	0.296845	-0.016708
	(0.08789)	(0.09647)	(0.39737)	(0.21093)	(0.17878)	(0.13675)	(0.05766)
	[6.10511]	[-2.23033]	[-2.24539]	[0.07040]	[-1.55520]	[2.17074]	[-0.28978]
D(MOB(-1))	0.001277	-0.040667	-0.189942	-0.070328	-0.178198	0.285590	-0.064192
	(0.09078)	(0.09964)	(0.41044)	(0.21787)	(0.18466)	(0.14125)	(0.05955)
	[0.01406]	[-0.40814]	[-0.46278]	[-0.32280]	[-0.96500]	[2.02194]	[-1.07791]
D(LNPOS(-1))	0.012055	-0.030599	-0.246026	-0.024568	0.006308	-0.007820	0.016820
	(0.02293)	(0.02517)	(0.10367)	(0.05503)	(0.04664)	(0.03568)	(0.01504)
	[0.52578]	[-1.21582]	[-2.37321]	[-0.44645]	[0.13524]	[-0.21919]	[1.11822]
D(LNMINDEX(-1))	-0.011866	0.026466	-0.107939	0.110013	-0.070124	-0.011778	0.004221
	(0.04338)	(0.04761)	(0.19613)	(0.10411)	(0.08824)	(0.06750)	(0.02846)
	[-0.27355]	[0.55584]	[-0.55034]	[1.05669]	[-0.79468]	[-0.17450]	[0.14832]
D(LNM2_M1(-1))	0.051198	0.001781	0.555650	-0.188577	-0.293186	0.111037	-0.060871
	(0.04805)	(0.05274)	(0.21726)	(0.11533)	(0.09775)	(0.07477)	(0.03152)
	[1.06548]	[0.03376]	[2.55753]	[-1.63516]	[-2.99943]	[1.48512]	[-1.93099]
D(LNINT(-1))	0.016532	-0.010636	0.058750	-0.093911	-0.077494	-0.193095	-0.078260
	(0.06843)	(0.07512)	(0.30941)	(0.16424)	(0.13921)	(0.10648)	(0.04489)
	[0.24157]	[-0.14160]	[0.18987]	[-0.57178]	[-0.55668]	[-1.81343]	[-1.74321]
D(LNCPI(-1))	-0.881481	-0.786947	-1.785143	0.424378	0.231812	-0.516157	-0.144291
	(0.17510)	(0.19219)	(0.79168)	(0.42024)	(0.35618)	(0.27244)	(0.11487)
	[-5.03423]	[-4.09455]	[-2.25488]	[1.00985]	[0.65082]	[-1.89454]	[-1.25614]
C	0.015862	0.012802	0.060821	0.000399	0.003344	-0.005803	0.002969
	(0.00442)	(0.00486)	(0.02000)	(0.01062)	(0.00900)	(0.00688)	(0.00290)
	[3.58538]	[2.63626]	[3.04059]	[0.03754]	[0.37153]	[-0.84296]	[1.02293]
R-squared	0.515641	0.240963	0.229665	0.070110	0.394905	0.174124	0.139587
Adj. R-squared	0.472587	0.173493	0.161191	-0.012547	0.341119	0.100713	0.063106
Sum sq. resids	0.116568	0.140442	2.382977	0.671451	0.482359	0.282212	0.050167
S.E. equation	0.035989	0.039503	0.162719	0.086375	0.073209	0.055997	0.023610
F-statistic	11.97657	3.571415	3.354039	0.848209	7.342131	2.371906	1.825114
Log likelihood	193.3730	184.1500	44.00017	106.7001	123.0724	149.6058	235.1067
Akaike AIC	-3.724707	-3.538383	-0.707074	-1.973738	-2.304492	-2.840522	-4.567813
Schwarz SC	-3.488787	-3.302463	-0.471154	-1.737818	-2.068572	-2.604602	-4.331893
Mean dependent	0.028974	0.004210	0.023304	0.002239	-0.003805	0.001492	0.002397
S.D. dependent	0.049556	0.043451	0.177667	0.085838	0.090190	0.059050	0.024392

Determinant resid covariance (dof adj.)	2.01E-18
Determinant resid covariance	1.03E-18
Log likelihood	1066.831
Akaike information criterion	-20.13799
Schwarz criterion	-18.30306
Number of coefficients	70

Appendix 4: Short Run Results

Dependent Variable: D(LNM3_1_)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 03/14/21 Time: 14:11
Sample (adjusted): 2012M03 2020M05
Included observations: 99 after adjustments
D(LNM3_1_) = C(1)*(LNM3_1_(-1) + 0.406515853767*MOB(-1) +
0.698921913964*LNPOS(-1) - 1.13306963181*LNMINDEX(-1) +
5.73000147338*LNM2_M1(-1) - 0.0778079791536*LNINT(-1) -
5.56479664934*LNCPI(-1) + 9.00901097491) + C(2)*D(LNM3_1_(-1))
+ C(3)*D(MOB(-1)) + C(4)*D(LNPOS(-1)) + C(5)*D(LNMINDEX(-1)) +
C(6)*D(LNM2_M1(-1)) + C(7)*D(LNINT(-1)) + C(8)*D(LNCPI(-1)) + C(9)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.032756	0.010450	-3.134488	0.0023
C(2)	0.536558	0.087887	6.105114	0.0000
C(3)	0.001277	0.090777	0.014064	0.9888
C(4)	0.012055	0.022928	0.525783	0.6003
C(5)	-0.011866	0.043379	-0.273552	0.7851
C(6)	0.051198	0.048052	1.065477	0.2895
C(7)	0.016532	0.068434	0.241575	0.8097
C(8)	-0.881481	0.175097	-5.034232	0.0000
C(9)	0.015862	0.004424	3.585378	0.0005

R-squared	0.515641	Mean dependent var	0.028974
Adjusted R-squared	0.472587	S.D. dependent var	0.049556
S.E. of regression	0.035989	Akaike info criterion	-3.724707
Sum squared resid	0.116568	Schwarz criterion	-3.488787
Log likelihood	193.3730	Hannan-Quinn criter.	-3.629253
F-statistic	11.97657	Durbin-Watson stat	2.386783
Prob(F-statistic)	0.000000		