THE EFFECT OF FINANCIAL INNOVATION ON MONEY DEMAND IN UGANDA: AN EXAMINATION OF NEW PAYMENT TECHNOLOGIES ON DEMAND FOR NARROW MONEY

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2010 HD06/1387U

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A DISSERTATION SUBMITTED TO THE COLLEGE OF BUSINESS AND MANAGEMENT SCIENCE IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF ARTS IN ECONOMICS DEGREE OF MAKERERE UNIVERSITY.

MARCH, 2014

DECLARATION

I Miria Nakamya declare to the best of my knowledge that this dissertation is my original work resulting from my effort and independent investigations, and acknowledgement has been given to the works of others. It has never been presented for any award in this or any other institution before.

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APPROVAL

This is to certify that this dissertation has been submitted in partial fulfillment of the requirements for the award of a Master of Arts in Economics degree with my approval as a University supervisor.

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DEDICATION

I dedicate this work to my beloved parents Mr. and Mrs. Aaron Ngiraebisa for their effort that has made me what I am today but above all, glory and honor to God the Almighty.

ACKNOWLEDGEMENT

It is a pleasure to thank those who made this dissertation possible. I would like to extend my sincere gratitude and appreciation to my supervisors; whose supervision and support from the preliminary enabled me to develop and understand the subject.

I would also like to offer my regards and blessings to all those who supported me in any respect all the way. Special thanks to my friends, colleagues and fellow students for their assistance and moral support.

Special thanks to my Dad, Mom and all family members for their encouragement, and for both the financial and moral support.

God Almighty In You All Things Are Possible. You Are My Rock!!!

LIST OF ACRONYMS

POS	Point of sale
EFTPOS	Electronic Funds Transfer at Point of Sale
ATM	Automated teller machine
EFT	Electronic fund transfer
ECS	Electronic clearing system
ECM	Error Correction Model
RTGS	Real time gross settlement
ADF	Augmented Dickey Fuller
PP	Phillip Perron
KPSS	Kwiatkowski-Phillips-Schmidt-Shin

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Abstract

Since the liberalization of Uganda's financial sector in the early 1990s, both foreign and local investors have been attracted to the sector. Competition and development; particularly technological development resulted in the introduction of new payment technologies such as ATM cards, Electronic Funds Transfers (EFTs), Real Time Gross Settlement (RTGS), Internet Banking, use of visa and debit cards and now mobile money transfers. These would ordinarily lead to either an increase of decrease in demand for money. Their effect on demand for money in Uganda has not been studied. In this regard, it is imperative to investigate the effect that these payment technologies have on demand for narrow money.

In particular, this study assesses the effect of the number of automated teller machines (ATMs) and the volume of Electronic Funds Transfer (EFTs) on demand for narrow money (M1). Monthly aggregated data from June 2003 to March 2011 was used and a Johansen Juselius approach to cointegration was applied. In the longrun model, it is established that income has a positive effect on demand for narrow money. The opportunity cost variables of interest rate on the 90-days Treasury bill and expected inflation indicated a negative effect on demand for money. The Treasury bill rate, however, had a very smaller coefficient suggesting that the interest rate channel is still a weak monetary transmission channel. Proxy variables for payment technology innovations, that is, ATMs and EFTs have positive and significant effects on demand for M1. This emphasizes the need to take into account the effect of financial innovation in money demand estimation and when formulating monetary policies in the economy. The model was well specified basing on the results from the Ramsey Reset test, and the CUSUM and CUSUMSQ did not reveal any sign of model instability. It is recommended that for sound monetary policies, the monetary authority should consider the effect of financial innovation on demand for money.

Key words: Demand for money; financial innovation; monetary policy; Cointegration, Error Correction Model.

CHAPTER ONE

INTRODUCTION

1.1 Background and motivation of the study

The financial sector in Uganda; although still small and underdeveloped has undergone transformation since its liberalization in the early 1990s. The sector has got twenty four (24) commercial banks, three (3) credit institutions, four (4) microfinance deposit taking institutions plus other players in the sector such as; insurance companies, forex bureaus, development banks and mobile money operators. The Central Bank-Bank of Uganda is the overall seer responsible for providing the necessary regulatory, supervisory and advisory functions in the sector (Bank of Uganda, 2013). (date)

The sector has undergone a number of reforms such as privatization of financial institutions, interest rate liberalization, and reduction in direct credit by the central bank among others. These were mainly meant to strengthen the sector and to improve efficiency by promoting efficient resource allocation, access to financial services, and soundness of financial institutions in order to earn depositors' trust. Changes in payment methods have increased efficiency, safety and reliable financial transactions. Bank of Uganda created the Payment and Settlements Department (PSD) in 1998 to develop an effective, efficient and secure national payment system and a lot of effort is put in improving the payment system in Uganda. Although cash remains the dominant payment instrument where retail transactions between 75% and 85% are performed with cash, there is an increase in usage of new payment technologies. New electronic payment forms like the use of Automated Teller Machines (ATMs), Electronic Funds Transfers (EFTs), Real Time Gross Settlement (RTGS), and mobile money services have increased in value and volume over time. Individuals now use visa debit and credit cards to pay for goods at supermarkets or on internet, pay for air tickets, settle hotel bills and effect payments for many other services via Point of Sale (POS) terminals. Commercial banks have also gone ahead to introduce internet and mobile banking to enable customers make balance enquiries, request for mini-statements, transfer funds across accounts, pay utility bills, get alerts, do internet shopping and other services.

In Uganda, the first Automated Teller Machine (ATM) was installed in 1997 by Standard Chartered Bank. Today ATMs have spread out countrywide and the number had risen to 733 in 2012 from 25 in 2001 (J. Opolot, D. Nampewo, C. A. Ntumwa and S. Nyanzi, 2013). ATMs relatively create convenience to users because, apart from the 24 hours- accessibility, they often provide the best possible exchange rate for foreign travelers because they allow individuals to withdraw local currency from foreign currency denominated bank accounts. Bankom Limited implemented a payment switch which enables ATM cardholders to use any ATM of any financial institution that is connected to the network. All this increases the ease with which ATMs are used and the accessibility to cash at any time and at various points.

In August 2003, Bank of Uganda implemented an Electronic Funds Transfer (EFT) system for both direct credit and debit transfers, which allows the transfer of funds from one account to another within a given bank or between banks. Bank of Uganda implemented this system in August 2003 for both credit transfers and direct debits. Users of EFTs include corporate customers and the government who transfer salary payments to employees' or beneficiaries' accounts. The system is also used to settle utility bills, pay school fees, pay off suppliers among others. In July 2007, government started using EFTs and extended it to salaries under the "Straight -Through -Processing (STP) system" in July 2008. Since then, EFTs transactions have increased both in volume and value. Of the three payment systems in the Electronic Clearing System (ECS) that is, EFTs, RTGS, and Cheques; EFTs contributes the highest volume of transactions although RTGS has always had the highest value. It is also clear that there has been a gradual decline in Cheques volume over time indicating a shift to electronic methods of payment (BOU, 2010). Innovations that increase the speed at which transactions are done will have on impact on its velocity by increasing it. Such developments are likely to have an effect on the monetary system and the demand for money. They can lead to misreading the path and speed of policy transmission. It is on this background that the study derives motivation to explore and analyse the possible effect of such financial innovation on demand for narrow money**.**

1.2 Problem Statement of the Study

Since the liberalization and other reforms in the early 1990s, Uganda's financial sector has undergone considerable transformation over the years. These reforms and the advancement in

technology coupled with competition among the banking institutions to provide better services have led to the introduction and proliferation of new financial products and services as well as new means of payment. New payment methods such as EFTs, ATMs, EFTPOS, credit cards, debit cards, Internet banking, and mobile money are increasing in usage. For example; the volume of EFTs transactions increased from 170,000 in July 2010 to 758,000 in June 2011 and these were valued at Ushs. 437.2 billion and Ushs. 962.8 billion respectively. By the end of 2010/2011 financial year, the volumes had grown by over 400 percent and the value of transactions more than doubled (BOU, 2012). Installation of ATMs has also increased from 1 ATM in 1999 to 733 in 2012 (J. Opolot, D. Nampewo, C. A. Ntumwa and S. Nyanzi, 2013).

Innovative means of payments improve efficiency and promote faster and reliable transfers of money. This is likely to affect liquidity in some way depending on a particular payment method hence having an influence on demand for money as well as the working of monetary policy. Arrau, Gregorio, Reinhart and Wickham (1995) gave the importance of proper model specification as well as the necessity to take into account economic changes like financial innovation; as neglect of these may result into unreliable results. Various studies have estimated the money demand function in Uganda such as (Kateregga 1993, Katarikawe and Sebudde 1999, Nachega 2001, Kararach 2002, Opolot 2007) but they failed to take into account the effect of financial innovation. Nabiddo (2007) modeled for financial liberalization and financial innovation but using a dummy variable that indicated a negative effect. The effect of financial innovation on demand for money thus, has not been explicitly modeled. This study therefore, seeks to close this gap by explicitly incorporating EFTs volumes of transactions and the number of ATMs as proxies for financial innovation and estimating their likely effect on demand for narrow money in Uganda.

1.3 Purpose of the study

The purpose of this study is to examine the effect that new payment technologies have had on demand for narrow money. A model with traditional variables as well as EFTs volume of transactions and the number of ATMs is estimated.

1.4 Objectives of the study

The overall objective of the study is to determine the effect of financial innovation on demand for M1 in Uganda.

Specifically the study is:

i. To determine the effect of the number of ATMs and the volume of EFTs transactions on the demand for narrow money, while controlling for its traditional determinants.

1.6 Justification of the study

This study is expected to contribute to the knowledge used in the design of monetary policies. It is well known that a predictable money demand function allows for the working of monetary policy in achieving the goals of financial and economic stability. Although Bank of Uganda uses M0 and M2 as intermediate targets in monetary policy, insight on the behavior of M1 is relevant since these monetary aggregates are not independent of one another.

1.7 Scope of the Study

A period of 2003:6 - 2011:3 is studied using aggregate data on the number of ATMs and EFTs volume of transactions together with other variables. The period is chosen because it is that period over which EFTs and ATMs have been in existence and their usage has increased significantly.

1.8 Organization of the study

The rest of this paper is organized as follows: In chapter two theoretical and empirical literature is reviewed; chapter three details the methodology; chapter four presents results from the analysis, the interpretation, and discussion of results; and chapter five gives the conclusion and recommendations in line with the objectives and the findings.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews related literature on the demand for money and financial innovation in both developed and developing countries. The motivation centers on theories of money demand, prior studies on money demand in Uganda such as; (Kateregga 1993, Katarikawe and Sebudde 1996, Nachega 2001, Kararach 2002, Opolot 2007 etc) and models of money demand elsewhere that put emphasis on financial innovation like (Dotsey 1985, Arrau et al 1991, Rinaldi 2001, Anderson-Reid 2008, Kampusü 2011, AL-Rabbaie et al, 2011 etc).

2.1 Theoretical review of the literature

2.1.1 The demand for money

Demand for money can be defined as the desire to hold wealth in cash form other than in other forms such as; stocks, bonds, consumer durables etc or it is simply the amount of money that people desire to hold in cash. Several factors such as; income level, inflation, interest rate, uncertainty about the future affect the demand for money and details to this are given in the theories discussed below.

Money demand theories begun with the quantity theory of money by the classical economists; and the exposition of this theory is found in the work of Irving Fisher (1911). In his quantity theory of money, Irving fisher emphasizes only the transactions motive for holding money. He argues that velocity is constant, a notion that Keynes refutes and predicts fluctuations in velocity. In his equation of exchange (MV = PY), Fisher believed that velocity of money is only affected by institutional and technological changes slowly over time, thus it was assumed to be constant in the short-run. Furthermore, he assumed flexible prices and wages such that output was guaranteed to be at its full employment level. Hence, both income and velocity are constant in the shortrun implying that a unit increase in money supply will result in an equal increase in

price. When the equation of exchange is modified and divided through by velocity$(M = \frac{1}{V}PY)$, the quantity of money becomes a function of nominal income alone. By assuming equilibrium in the money market, money demand must equal money supply$(Md = Ms)$. According to Fisher, money demand is determined by the level of transactions generated by the level of nominal income and the institutions in an economy that affect the way individuals carry out transactions. They way people conduct transactions affects velocity, for example the introduction of payment technologies quickens transactions process and the number of times money exchanges hands will increase.

The alternative Cambridge money demand equation by the classical economists, A. C. Pigou (1917), Alfred Marshall (1923) is identical to Fisher's only that it emphasized individuals' choice to holding money. To them, people hold money because of its utility as a medium of exchange and the utility as a store of wealth. Because of this, they did not rule out the effect of interest rate on demand for money. The money demand function is then represented by the as $(M^d = kPY)$. They believed in the possibility of k to change in the short run as the choice to used money as store of wealth will depend on the yields and expected returns on alternative assets used to store wealth.

Keynes built on the Cambridge approach in his famous (1936) book "The General Theory of Employment, Interest, and Money". He argued that demand for money is basically for three purposes that include; the transactions, precautionary and speculative purpose. Where both transactions and precautionary demand for money depend on the level of income and speculative money balances depend on the level of interest rate. The assets that Keynes considered as store of value were divided into money and bonds. The expected return on money was assumed to be zero and that on bonds combined both interest payments and the expected capital gains. When individuals expected a negative capital gain on bonds resulting from a fall in their price, they would choose to hold money whose expected return is at least zero other than suffering a negative return on bonds.

Combining the three motives of holding money, Keynes developed the money demand function known as the liquidity preference function where demand for real money balances is a function of both income and interest rates.

$$\frac{M^d}{P} = (Y, r)$$

Where, real money balances are positively related to income and negatively related to interest rates. If we solve for velocity, we obtain the following functions which indicates that velocity in Keynes' model fluctuates.

$$V = \frac{PY}{M} = f\frac{Y}{(Y, r)}$$

If there are changes in technology that increase the speed at which people make transactions, money demand is likely to reduce.

Friedman (1956) in his restatement of the quantity theory of money argued that demand for money is like demand for any other asset. He says money is just one form in which individuals choose to hold their wealth and is analytically no different from any other asset that produces a flow of services to its holders over time. Using the asset demand approach, he presupposes that demand for money is affected by the same factors as demand for any other asset such as wealth which he proxied by permanent income and the returns of other assets relative return on money. However, Friedman emphasized that expected returns on all the assets relative return on money are negatively related to money demand but do not have considerable effect since interest rates on related assets and that on money tend to move together (Mishkin, 2004). Because of this, money demand practically remains as a function of only permanent income; and since permanent income fluctuates less compared to current income, the demand for money here is assumed to be relatively stable.

Baumol (1952) and Tobin (1956) are further developments on the Keynesian theory. Emphasizing the transactions motive, they argued that money demand for transactions purpose is also affected by interest rates. Some money balances that are set aside for transactions are allowed to be invested in securities hence the effect of interest rates on money holdings. To them, the main motive for holding transactions balances is to reduce transactions costs associated with transfers between interest- earning assets and money but an individual also has to minimize

the opportunity cost on holding cash. Thus the determinants for real money balances are the interest rate foregone when one chooses to hold cash instead of securities, the brokerage charges, and the agent's income. Whereas interest rate is negatively related to real money balances, transactions costs and income are positively related to money demand. Money demand is thus a function of the square root of nominal income, transactions costs and interest rates. Because of this, a percent increase in income will only cause increase in money demand by half the increase in income and this is explained as the presence of economies of scale in holding money.

2.2.1 Some empirical studies in Uganda

In any given economy, stable money demand functions allow for proper monetary policies and several studies have been carried out in this area. Previous studies have yielded different but important insights into estimation of money demand in Uganda and some of these are discussed in the literature.

Using quarterly data, Kateregga (1993) estimated money demand in Uganda over the period 1980-1992. She estimated an ECM for M0, M1 and M2 where M0 and M2 were found to be stable and M1 was unstable. The variables in the models included desired real money balances, real GDP, real interest rate, expected inflation rate, and expected currency depreciation rate. A negative income elasticity was established but this was attributed to the high inflation rate in the country over that period.

Katarikawe and Sebudde (1999) used monthly data running from 1990: 1 to 1996:12 to estimate money demand for M0 and M2 in Uganda and found it stable. The income variable used was a weighted average index of industrial production and coffee procurement. This variable was chosen to account for trends in both the industrial and agricultural sector. In both models, the interest rate variable proxied by the 90-days Treasury bill rate carried the correct negative sign; however, nominal exchange rate was positively related to M0 and negatively related to M2. The implication is that depreciation in Uganda currency resulted in increase in demand for M0 but caused currency substitution with reference to M2. In the short run dynamic model, current money holdings and the deposit rate affected demand for M2 with lags thus there was no

contemporaneous policy variable, however, some lags had mixed signs. Upon finding that real M0 was not strongly endogenous, they instead used nominal M0 and the coefficient on the error correction term was higher than that in the M2 model.

Nachega (2001) performed a cointegration analysis using quarterly data on a sample period 1982- 1998 to examine the behaviour of money demand for M2 in Uganda. Coefficients of all variables had the expected signs and thus in line with economic theory. The income elasticity was closer to unity being consistent with the quantity theory of money. LIBOR was negatively related to M2 and the own-rate of return positively related as was expected.

Kararach (2002), used quarterly data from 1981-1998 to estimate the money demand function for Uganda. Using the Cochrane-Orcutt method, he found income and interest rate having the expected signs and significant although the coefficient on the interest rate variable was very low. The inflation rate variable had a positive effect on demand for money and expected inflation proxied by previous inflation had a negative effect. An ECM was estimated and stability tests found the money demand function for Uganda to be unstable over that period, however, among the variables he used, financial innovation was not taken into account.

Nabiddo (2007) using quarterly data estimated the money demand functions for both M1 and M2 in Uganda, using and Error Correction Model. She included a dummy variable as a proxy for financial innovation that took place since the liberalization of the financial sector and the results indicated a negative effect. The implication was that financial innovations on average reduced the amount of money demanded by individuals.

Opolot (2007) used quarterly data for the period 1990 to 2004 to estimate money demand for real base money (M0) and real broad money (M2). The income elasticities for the two monetary aggregates were 1.0 and 1.5 respectively. The interest rate variable proxied by the interest rate spread between 91-day Treasury bill rate and the average annual interest rate offered on time and savings deposit was negatively related to both monetary aggregates with the elasticity on M2 slightly bigger than that on M0. Nominal exchange rate was also negatively related to both monetary aggregates indicating currency substitution in case of a depreciation of the local currency. In the shortrun models, the speed of adjustment to a disequilibrium as reflected in the

size of the coefficient of the error term was quite high for real base money than broad money and both models did not reveal any sign of instability. The implication of these results is that monetary targeting is still an effective policy.

2.2.2 Financial innovation and money demand

As a result of innovations in financial sectors, new payment systems have emerged including automated teller machines (ATMs), Electronic Funds Transfers (EFTs) between bank accounts, Electronic Funds Transfer at point of sale (EFTPOS) systems, automatic bill payer accounts, credit cards, mobile money and so on. Such payment systems could have an effect on the money demand function especially M1 which is used as a medium of exchange through their effect on cash and demand deposits. This is because individuals can either substitute cash with bank deposits; checking deposits with savings deposits, or even increase cash demand and this alters demand for M1. According to Irving Fisher (1911), from the equation of exchange we have $\mathrm{M} = \frac{1}{\mathrm{V}}\mathrm{PY}$ where V is velocity, PY the nominal value of transactions and M the quantity of money. This can be re-written as $M = k\,PY$ where $k = \frac{1}{V}$. Ms is fixed by the monetary authority i.e. Ms= M and assuming equilibrium in the money market such that $Md = Ms$, the money demand function can be written as; $Md = k\,PY$. On the basis of this, any changes in V will affect demand for money. For example new payment technologies changes the way people carry out their transactions by increasing the rate at which transactions are done. If technology increased the number of times a given shilling of money is spent in a year (velocity), money demand for transactions purpose will reduce.

Arrau, et al (1991) used quarterly data to assess the role of financial innovation on demand for money in ten developing countries. They defined financial innovation as technological changes that allow individuals of firms to economize on their money holdings. In a panel cointegration model, they applied a deterministic trend, the ratio of M1 to M2, and a stochastic trend as various proxies for financial innovation. The deterministic trend was itself found significant and the parameters of the other variables in the model were plausible in six out of ten countries

examined. However, there was continuous lack of cointegration and to them; this was an indication that a time trend was not a good proxy for financial innovation. The ratio of M1 to M2 as well, did not give any clear results. The stochastic trend modeled financial innovation in terms of permanent shocks to money demand and when they derived time-invariant parameters of the money demand function, the results were better than those obtained using a deterministic trend. The limitation with a stochastic trend, however, is that it involves everything that affects money demand permanently apart from income or interest rate. In their study, they established that financial innovation was quantitatively important in determining the demand for money and its fluctuations.

Stix (2004), using survey data on Austrian individuals aged 14 and above estimated a cash demand equation and it was revealed that ATM transactions and cashless payments had a significant impact on the demand for cash. Findings indicate that cash held by this group of individuals for transaction purposes accounts for just a relatively small share of the total cash in circulation and this was approximately 10%. Individuals who withdraw cash exclusively from ATMs on average held 42% less cash than those who do not use ATMs. However, despite this increase in cashless payments; the share of cash payments was still high and likely to be above 70% by then hence, cash payments still remaining the most important means of payment in Austria

AL-Rabbaie, Baniata and Al-qalawi (2011) used the structural time series model to allow for a stochastic trend as a proxy for financial innovations and estimated its effect on both narrow money M1 and broad money M2 for USA for a sample period between 1976 and 2007. The results indicated that financial innovations had a negative impact on the demand for narrow money and a positive effect on broad money M2. The positive effect on M2 showed the substitutability between interest earning assets and cash or demand deposits. This is not surprising as USA is among the most developed countries with a well developed financial sector having a variety of financial instruments that can attract individuals to buy them.

Kampusü (2011), estimated the effect of financial innovation on currency demand in Turkey from 2002:01 to 2010:12 using monthly time series data. He employed Polynomial Distributed

lags (PDL) and the Error Correction model (ECM) to estimate the demand for currency. Using the number of ATMs and credit cards as proxies, they found a negative effect of financial innovations on currency demand. The implication is that individuals do not need to carry more cash as it is convenient to withdraw money anytime when need arises.

Rinaldi (2001) studied the effect of payment cards on the demand for cash in Belgium. Using an Error Correction Model on annual data spanning from 1960 to 1999 found ATMs having a strong negative effect on demand for currency. It was asserted that although cash purchases were still about 75 percent, Belgium is among the countries with the most extensive use of cards. This could explain a strong negative relationship between demand for cash and ATMs.

Anderson-Reid (2008) studied the effect of alternative means of payment on currency demand in Jamaica from April 2003 to June 2008 using monthly data. The variables of interest in the model were ATM volume, volume of Point of Sale (POS) transactions, and the number of cards (credit and debit) in circulation. The number of cards and Electronic Funds Transfer at point of sale (EFTPOS) both had a negative influence on cash demand. The volume of transactions through ATMs was positively related to demand for currency and the conclusion was that ATMs were primarily used for accessing cash. However, even with those results, cash still remained the most preferred mode of payment.

Fujiki and Tanaka (2009) investigated the effect of financial innovation on money demand in Japan. Specifically, they examined the effect of electronic money on cash demand using unique household-level survey data from Japan. Using instrumental variable methods, it was established that average cash balances increased with the adoption of electronic money, however, those households at the lower quantiles of the cash balance distribution held more cash after the adoption of electronic money. In this study, such households held cash balances mainly for transactions motives.

Dotsey (1985) investigated cash management practices on the demand for money. He reports that cash management techniques are capable of reducing money balances and failure to account for them in a regression could give misspecified equations for money demand. Particularly

estimating demand for demand deposits, he used variables such as: the number of Electronic funds transfers through the Federal Reserve's wire transfer system; a Trend; Ratchet variable based on long-term interest rates; and Price of office computers and accounting to capture the effect of cash management practices on money demand. The advantage that EFTs has over the rest of the variables is that it recognizes that the rate of innovation depends on both costs and benefits. Investment in such innovations is just like investment in any other business project where costs are weighed against benefits. He noted that a trend variable only considers costs of innovations; the ratchet variable takes into account only the benefits and the price of computers neglects technology already in place, depreciation and benefits from implementation of new cash management practices. For this reason, he believed that EFTs is a good proxy variable in explaining demand for money and from the estimates, its effect was negative and these results were plausible compared to those of other proxies.

The money demand function is essential in understanding macroeconomic activity and making policy prescriptions since it acts as a conduit for the monetary policy, however, inability to predict it makes this hard to achieve. Proper model specification with appropriate scale and opportunity cost variables is a must to avoid misleading results. Instability of money demand functions can in part result from waves of factors such as financial innovations (Arrau et al, 1991), thus a specification that incorporates relevant variables in line with changes in the economic and financial environment is likely to give reliable results. Different studies have different findings in the literature reviewed. It is possible to have different effects of financial innovation on money demand depending on the variables used; the economic and social development under which the study is being carried out and also on the period over which the study is done. The contrasting findings in these reviewed studies have thus motivated an explicit examination of the effect of financial innovation on demand for money in Uganda. This is aimed at contributing to the quest for accurate quantitative estimates of the money demand function as well as to establish the likely effect of new payment technologies. This study therefore, takes a step towards understanding how technological progress in the payment system can affect money demand by choosing the number of ATMs and EFTs volume of transactions as proxies for financial innovation.

CHAPTER THREE

METHODOLOGY

3.0 Methodological Approach

The methodology captures model specification; testing for time series properties using the Augmented Dickey Fuller (ADF) and the Phillip Peron (PP) test; cointegration test using the Johansen Approach to cointegration and finally the Error Correction Model. This is found appropriate basing on the nature of data and the study objective.

3.1 Model Specification

There are a number of theories explaining the demand for money, and almost all of them share common variables although sometimes they could have different hypotheses with regard to some of the variables. In general these theories try to explain the relationship between the quantity of money demanded and its determinants. The traditional formulation of a money demand function based on Keynes (1936) includes the scale and opportunity cost variables. The function is stated as:

$$\left(\frac{M^d}{P}\right) = (Y, r) \tag{3.1}$$

Several studies have been done on demand for money and the general agreement is that the function should contain a scale variable, an opportunity cost variable and other variables that may be relevant to the study being carried out (Laidler, 1977). Modifications have been done on the formulation of the demand function by including relevant variables appropriate for particular investigations. For example besides the income variable, formulations have included different interest rates to measure the own rate and alternative rate of return, expected inflation, the exchange rate variable and so on.

Uganda's financial system is still underdeveloped albeit the increasing number of commercial banks and other financial institutions as well as the advancing technology in the sector. By 2013,

only 20 percent of Ugandan's had access to formal financial services (Kasekende, 2013). Private borrowers mostly make use of commercial banks' to acquire credit and the players in the capital market are majorly commercial banks and a few corporations. The major alternatives to holding cash are real assets, bank deposits and foreign currency to some individuals. With such features of the sector, to estimate the effect of financial innovation on demand for money, a conventional money demand function of a Keynesian type in (3.1) which is commonly used in estimating money demand for developing countries was adopted. The function has been applied in studies by scholars such as Adams (1992), Kateregga (1993), Sriram (2001), Kararach (2002), Suliman and Dafaalla (2010), Rutayisire (2010) among others.

The model in (3.1) is extended to include proxies for financial innovation specifically in the payment system which include the number of ATMs and the volume of EFTs transactions and thus, the long run model is specified as;

$$In\left(\frac{M^d}{P}\right)_t = \beta_0 + \beta_1 LRGDP_t + \beta_2 LEFT_t + \beta_3 LATM_t + \beta_4 TBR_t + \beta_5 EXINF + \varepsilon_t \qquad (3.2)$$

A priori β_0= constant, $\beta_1 > 0$; $\beta_2 \lessgtr 0$, $\beta_3 \lessgtr 0$, $\beta_4 < 0$, $\beta_5 < 0$

Where;

$Ln\left(\frac{M^d}{P}\right)_t$	is the log of real money balances obtained through dividing the monetary aggregate by the CPI
LRGDP	is the log of real Gross Domestic Product
LEFT	is the log of EFTs volume of transactions
LATM	is the log of number of Automated Teller Machines
EXINF	is Expected inflation
TBR	is the 91-day Treasury Bill Rate
P	is the consumer price index (with 2005/6 = 100)
ε	is the random error term
t	is the subscript denoting time

3.2 Choice of variables and justification of their selection

A selection of variables was done basing on the purpose of the study; but this was also dependent on the availability of data on these variables. Monthly data was found appropriate due to a short period that new transaction payment technologies have been in existence. Details to justify the selection of the variables are given as below:

The suitable monetary aggregate

Narrow money (M1) is defined as a combination of both currency in circulation and demand deposits. This monetary aggregate is mostly used as a medium of exchange through making payments of cash or check and other new payment technologies. Financial innovations in form of new payment technologies such as EFTs and ATMs will largely affect this monetary aggregate more than it does affect broad monetary aggregates. For this reason, M1 was chosen as the appropriate monetary aggregate.

Scale variable

We chose real GDP as a scale variable to indicate the volume of transactions on the basis that the level of transactions is proportional to the level of income. Due to absence of monthly data on GDP, the Natural Cubic Spline method of interpolation in Eviews was used to generate monthly GDP series.

Opportunity cost variable

This is a variable that measures the opportunity cost of holding money. This could be the own rate of return on money or the alternative rate of return on other assets other than money (Sriram, 2001). We chose the Treasury Bill Rate and Expected inflation rate. The Treasury Bill Rate is a reference rate of other interest rates such as the interbank rate, rates of bank deposits and thus changes in this rate can affect money demand for M1 either through a fall in M0 or through increase of other interest rates. Because of its importance, it was chosen as a proxy opportunity cost variable for returns on other competing financial assets.

Expected inflation on the one hand was chosen as a proxy for the rate of return on alternative real assets and on the other hand to incorporate inflationary developments failed to be captured by the

return on financial assets especially for a country that has been experiencing moderate inflation like Uganda (Sriram, 2009). Besides, few individuals invest in the financial sector but many invest in real assets such as real estate, animals and so on. Expected inflation was computed from the CPI where actual inflation was first obtained using the CPI and then it was lagged one period back to get expected inflation (Kararach, 2002).

Financial innovation variables

To examine the effect of financial innovation on money demand, emphasis was put on new payment technologies. EFTs volume of transactions and the number of ATMs were incorporated as proxies for financial innovation. The choice of these variables was due to the relative ease to acquire data on them as well as their increasing usage in the payment system.

The motivation of using EFTs derives from the empirical work by Podolski (1986), (Holly (1999) and Dotsey (1985). According to Dotsey's work, EFTs recognizes that the rate of innovation depends on both costs and benefits. Investment in such innovations is just like investment in any other business project where costs are weighed against benefits. He thus concluded that EFTs was a better proxy for financial innovation. EFTs volume of transactions adopted in this study refers to Electronic Funds Transfers through the clearing house; for both credit and direct debits between bank accounts.

The number of ATMs was selected simply because it was not easy to acquire data on the volume of transactions through these machines as this data is confidential. However, this variable was adopted to capture the ease these machines create particularly in accessing cash.

Expected signs of coefficients

In line with theory, income influences money demand positively. An increase in income leads to an increase in transactions and an ultimate increase in money demand for transaction purposes, thus the sign on income is expected to be positive.

On the one hand; increase in the number of ATMs could induce individuals to substitute ATM cards for cash since it could be easy to access cash at any time hence a negative sign. On the other hand, however, individuals could as well use more cash by looking at the view that ATMs

create convenience in withdrawing cash at any point of the day and this increases the rate at which money is withdrawn and thus the amount held in cash. This would then give the variable a positive sign in the model.

The expected sign for EFTs is also either a negative or positive. This is because the ease to transfer money between accounts would mean less need to hold cash hence a negative sign. However, a positive sign could be expected as well when looked at from an angle of facilitating faster and safe payments.

Expected inflation and the Treasury bill rate are hypothesized to have a negative sign. Expected inflation measures the expected rate of return on real assets hence if this return is high relative to the return on money, money demand is likely to reduce. The Treasury bill rate approximates the rate of return on other alternative financial assets hence if it increases; it becomes costly for individuals to demand money other than investing it in these alternative assets.

3.3 Model Estimation Techniques

To estimate the effect of payment technologies on the demand for narrow money, a Vector Autoregressive Model (VAR) was applied. VAR modeling according to C. A. Sims (1980) was found appropriate due to its simplicity when dealing with a system of time series variables. It allows for evolution of more than one variable, and a variable can be predicted basing on its lags and the lags of other variables in the system. When variables are tested for unit root and found to be stationary, then a standard VAR is estimated. However, if they are not and there is proof for cointegration, then the Error Correction term should be added in the VAR and the model turns out to be a Vector Error Correction Model (VECM). These estimation techniques allow obtaining both the shortrun and Longrun models over the period.

The interest is to establish the longrun relationship between money demand and the variables for financial innovations and this is obtained if the variables are cointegrated. According to Granger's representation theorem (Engle and Granger, 1987), if there is cointegration among a set of variables then there exists an error correction representation of the data. This implies that for any exogenous shock to the system, there are forces that will restore the longrun equilibrium

among these variables. The error correction mechanism thus represents short term adjustments towards equilibrium; hence it is also possible to estimate the short run relationship.

Using the Eviews (Econometric views software package), unit root tests on the series are performed using the Augmented Dickey-Fuller (ADF), the Phillip-Peron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests to determine the stationarity of variables and their order of integration. Since there is a whole system of variables, the Johansen and Juselius (1990) approach was appropriate to test for cointegration among the variables.

The ADF test consists of estimating the following equations;

$$\Delta Xt = \beta_0 + \beta_1 t + \delta X_{t-1} + \gamma i \sum_{i=1}^{n} \Delta X_{t-i} + \varepsilon_t \quad (3.3)$$

$$\Delta Xt = \beta_0 + \delta X_{t-1} + \gamma i \sum_{i=1}^{n} \Delta X_{t-i} + \varepsilon_t \quad (3.4)$$

Where: Δ is the difference operator; Xt is a matrix of time series; n is the number of lags enough to avoid autocorrelation and t is the time trend. Equation 3.3 contains both an intercept and a trend whereas equation 3.4 consists of only an intercept.

The assumption is that the coefficient on the error term is tested against the null hypothesis of $\delta = 0$ and the alternative of $\delta < 0$ using the McKinnon critical values. If the null is not rejected, then the series has unit root. By further application of the Phillip-Perron and KPSS tests to verify the results from the ADF test, the series' order of integration is established. If the variables in the system are found to be integrated of the same order, a VAR-based Johansen approach is then applied to test for cointegration among them.

A general specification of an unrestricted Vector Autoregressive Estimation (VAR) is stated as below;

$$X_t = A_1 X_{t-1} + \cdots + A_k X_{t-k} + \theta + U_t \quad (3.5)$$

Where;

X_t is a vector of variables ($LRM1, LRGDP, LEFT, LATM, EXINF, TBR$), k is the lag-length, θ represents deterministic terms such as the constant, and U_t is the error term.

In making inferences about the number of cointegrating relations, the trace-statistic and the maximum Eigen value statistic are used.

The trace-test is given as;

$$\lambda_{trace(r)} = -T\sum_{i=r+1}^{n} Ln\left(1 - \hat{\lambda}_i\right)$$

$$r = 0, 1, 2, \ldots, n-1$$

$$H_0: r = 0, H_1: r > 0, H_0: r \leq 1, H_1: r > 1, H_0: r \leq 2, H_1: r > 2,$$

The maximum Eigen value statistic is given by;

$$\lambda_{max} = -TLn\,(1 - \hat{\lambda}_{r+1})$$

$$r = 0, 1, 2, \ldots, n-2, n-1$$

$$H_0: r = 0, H_1: r = 1, H_0: r = 1, H_1: r = 2, \text{etc}$$

Basing on the results from the cointegration tests, if there is some evidence of cointegration given by the established number of cointegrating equations; an error correction (ECM) model is estimated basing on the number of cointegrating equations.

The Error Correction Model is given as;

$$\Delta X_t = \pi X_{t-i} + \sum_{i=1}^{p-1} \Gamma_{t-i} \Delta X_{t-i} + \delta Z_t + U_t \qquad (3.6)$$

Where; $\pi = \alpha\beta'$; α is the vector of adjustment coefficients; β is the vector of cointegrating relations, and Γ is the coefficient matrix of the lagged differenced terms. Z_t represents deterministic variables such as the dummy variables or constant and U_t is the error term.

3.4 Data type and source

All data is secondary and is in monthly series running from 2003:6 to 2011:3. Data on EFTs volume of transactions, number of ATMs, Treasury bill rate, the Consumer price index, and narrow money (M1), were obtained from Bank of Uganda; and data on GDP was obtained from the Uganda bureau of statistics (UBOS). The initial series of GDP was quarterly and that of ATMs was semi-annually. This data on both variables was interpolated into monthly series using the "Natural Cubic spline interpolation" method of the Econometric Views (Eviews) package. The advantages of this method are that it uses all the data while interpolating; it is not so sensitive to minor errors in the data; and its first and second derivatives are continuous.

CHAPTER FOUR

ESTIMATION, INTERPRETATION AND DISCUSSION OF RESULTS

4.0 Introduction

This chapter presents the empirical findings, interprets and gives a discussion of them in line with the objective. The main objective is to estimate the effect of the number of ATMs and the volume of EFTs transactions on demand for narrow money (M1). Thereafter, a longrun and shortrun model is estimated; diagnostic and stability tests are performed to determine the reliability of the findings.

Table 4. 1: Descriptive statistics
(Sample Period 2003:6 – 2011:3)

Variables	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability for normality test
LRM1	7.5	0.17	-0.08	2.04	2.97	0.23
LRGDP	8.18	0.03	-1.17	6.12	48.32	0
TBR	8.53	3.19	1.84	7.04	94.98	0
EXINF	0.58	0.93	0.02	3.6	1.16	0.56
LEFT	10.6	1.63	0.35	1.84	5.81	0.05
LATM	5.46	0.59	-0.92	3.24	10.8	0.004

A low standard deviation relative to the mean implies that most of the numbers are very close to the mean. Variables; LRM1, LRGDP, LEFT, LATM and TBR have low standard deviation with respect to their mean, and the implication is that most data points of these variables are close to their mean. However, for EXINF with a standard deviation greater than the mean, it suggests that some of the observations lie far away from the mean. Normality of variables is based on the Jacque-Bera test and in this case the P-values suggest that only LRM1, LEFT and EXINF are normally distributed.

4.2 Data Characteristics

All variables were first transformed into natural logarithms except for the EXINF and TBR. LRM1 and LRGDP were deflated using the CPI with rebased 2005/2006 = 100. EXINF was calculated as inflation from the CPI and then lagged one period. To get the characteristics of the

variables, a visual inspection of the data by plotting the series in their level form on a line graph was first done (Enders, 1995). The results are given in Figure 1.1 of the appendix. It is evident that EXINF was stationary but the rest of the series showed some trend.

Using the Augmented Dickey Fuller (ADF) and the Phillip-Peron (PP), a unit root test was carried out on the variables. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests was used as a confirmatory test and it was proven that LRM1, LRGDP, LEFT, TBR and LATM were non stationary and integrated of I(1), but EXINF was indeed stationary in levels. Results from the KPSS test are presented in table 1.1of the appendix.

In table 4.2 models of the ADF and PP tests are estimated. Models ADF1 and PP1 are estimated with a constant and a trend; and models ADF2 and PP 2 estimated with only a constant.

Table 4. 2: Unit root tests results from the Augmented Dickey Fuller (ADF) and the Phillip-Peron (PP).

Variables in Levels		**ADF With constant**	**PP With constant**	**Order of Integration**
	LRM1	0.37	-0.75	I(1)
	LRGDP	-1.49	-2.67	I(1)
	LEFT	-0.97	-0.63	I(1)
	LATM	-1.91	-2.07	I(1)
	TBR	-2.65	-2.14	I(1)
	EXINF	-7.78	-7.72	I(0)
Critical values at 5%		**-2.8936**	**-2.89288**	
Variables in first difference				
	LRM1	-5.59	-8.18	I(0)
	LRGP	-8.34	-6.06	I(0)
	LEFT	-7.17	-5.44	I(0)
	LATM	-4.16	-5.7	I(0)
	TBR	-6.25	-6.11	I(0)
	EXINF	-----	----	I(0)
Critical values at 5%		**-2.8936**	**-2.89288**	

4.3 Cointegration test

After performing the unit root test on the variables to establish their properties, a cointegration test was performed using the Johansen and Juselius approach (1990) to establish if a long run relationship exists among the variables.

Although Engle and Granger's (1987) original definition of cointegration referred to only those variables integrated of the same order, it is argued that it is possible to have a system of variables of I(1) and I(0) order of integration. Lütkepohl and Krätzig (2004) stated that occasionally it is convenient to have both *I* (1) and *I* (0) variables in the system. According to Asteriou and Hall (2007), it is possible to have cointegrating relationships within a system of both *I* (0) and *I* (1) variables in the model. Hjalmarsson and Österholm, (2007) pointed out that although Johansen methodology required a system of only *I* (1) variables, having stationary variables in the system is theoretically not a problem. He emphasised it by citing Johansen (1995) who stated that there was little need to test for variables' order of integration before a cointegration test. Stationary variables would simply reveal themselves in form of cointegrating vectors. Johansen (1995) as cited in Ahking F. W. (2002) stated that it was a mistaken belief that all variables in a cointegration test must be of the same order of integration. A combination of both stationary and non-stationary variables would be allowed for as long as there are at least two non-stationary variables with the same order of integration. This is because, there is no linear relationship between a I(1) variable and a I(0) variable but it is possible to have it between I (1) variables.

Empirically, Rutayisire (2010) used quarterly data from 1982:2 – 2005:4 to estimate money demand for M2 in Rwanda and among the variables in his study, the variable representing the anticipated fluctuation of the Rwandan Franc exchange rate was stationary.

On the basis of the above views, the study included EXINF in the model albeit its being stationary in levels.

4.3.1 Cointegration Results

The cointegration test was based on a VAR (6) and this lag length was chosen with respect to the lag selection criteria where criteria; Likelihood Ratio (LR) test statistic, Final prediction error

(FPE), Akaike information criterion (AIC) and Hannan-Quinn information criterion (HQ) chose lag 6 and only the Schwarz information criterion (SC) chose lag 3 (See table 1.2 of the appendix). We estimated a VAR based on lag-length 6 and this was reduced by one lag in the cointegration test.

The cointegration test found 3 cointegrating equations (See table 4.3 below). It was kept in mind that stationary variables will always introduce more cointegrating vectors and in this case –one cointegrating vector since we have one stationary variable. Basing on the argument above, however, there should be at least a relevant cointegrating equation out of the three we obtained. To identify it, normalization was done on the LRM1 variable in order to make it be part of the cointegrating relationship (Hjalmarsson and Österholm, 2007). Indeed the cointegrating vector in relation to this variable gives us a typical money demand function.

Table 4. 3: Cointegration analysis using the Johansen Approach

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.72	218.54	95.75	0.00
At most 1 *	0.69	137.99	69.82	0.00
At most 2 *	0.50	62.56	47.86	0.00
At most 3	0.15	17.79	29.80	0.58
At most 4	0.10	7.45	15.49	0.53
At most 5	0.01	0.52	3.84	0.47

Unrestricted Cointegration Rank Test (Maximum Eigen value)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.72	80.55	40.08	0.00
At most 1 *	0.69	75.43	33.88	0.00
At most 2 *	0.50	44.77	27.58	0.00
At most 3	0.15	10.34	21.13	0.71
At most 4	0.10	6.93	14.26	0.50
At most 5	0.01	0.52	3.84	0.47

****MacKinnon-Haug-Michelis (1999) p-values**

4.4 Estimation of the Long-run money demand model for M1

Upon finding three cointegrating equations and not forgetting that inclusion of a stationary variable leads to an additional cointegrating vector; normalization was done on the LRM1 which is the variable of interest (Hjalmarsson and Österholm, 2007). This was achieved by entering the variables for estimation in an order such that LRM1 came first. So the first coefficient in the cointegrating equations was automatically normalized to 1. In order to determine if the additional cointegrating vectors too correspond to a money demand relationship, we examined their parameters and realized that one could be interpreted as a money demand function although some of its parameters were insignificant. However, the third one did not conform to economic theory of money demand. All the three cointegrating vectors are presented in table 1.3 of appendix 3.

We thus obtained a long run model for M1 demand for money in table 4.4 on the next page; where the figures in parentheses are t-values.

Table 4. 4: The Longrun model for M1

VARIABLES	Constant	$LRGDP_t$	TBR_t	$EXINF$	$LEFT_t$	$LATM_t$
Coefficient	4.993528	1.651734	-0.008672	-0.068647	0.062520	0.260017
T-Value		(6.94784)	(-2.19585)	(-3.86230)	(5.20330)	(5.00694)

Diagnostic tests

Vector Portmanteau (12) = 189.05[0.080]
Vector AR 1-3 test = 50.12 [0.059]
Vector Normality test= Chi2 (12) = 75.59 [0.000]
Vector hetero test = 168.07= 0.97[0.064]

All the coefficients carry the expected signs and are statistically significant. Several diagnostic tests were performed on the residuals to examine the performance of the model. The LM serial correlation test, the portmanteau test and the Heteroskedasticity test did not reveal any problem with the model. However, the model did not pass the test of normality of errors but we carried on with it. Gonzalo (1994) compared five alternative methods for estimating longrun relationships and he established that the Johansen maximum likelihood method in an ECM performs better

even when the errors are not normally distributed. The values of the loading matrix are presented in table 1.3 of the appendix. These are adjustment coefficients which measure the speed at which the variables adjust to longrun equilibrium.

4.5.1 Interpretation and Discussion of Results from the Longrun Equilibrium Relationship

From the estimated model in table 4.4, we can conclude that most of the variation in the longrun is explained by LRGDP since this variable has the highest coefficient than the rest of the variables. The income elasticity of money demand is 1.65 and the test for unit elasticity was carried out. The null hypothesis that the income elasticity was equal to unity was rejected at the 5 per cent level of significance with a Chi-square (1) = 5.24 and probability of 0.0222.

These results conform to theory which postulates that increase in income will lead to increase in transactions and thus an ultimate increase in demand for money. It is also in line with other empirical evidence found in Uganda such as; Nabiddo (2007), Opolot (2007), Kararach (2002), and Nachega (2001) and Katarikawe and Sebudde (1996) where some got income elasticity less than unity and in excess of unity.

According to the quantity theory of money, the value is bound to be equal to unity and some empirical work especially in developing countries have found income elasticities far greater than one. This has been attributed to different factors in such countries which include; high monetization of economies, underdevelopment of the financial sector, use of M1 mostly for transactions purposes etc; but sometimes it results from failure to account for the effect of financial innovation (Arrau et al 1991).

In this study, income elasticity is greater than unity although financial innovation is accounted for. On the one hand, by looking at the semi-elasticity of -0.01 on the interest rate variable, the value indicates that money demand in Uganda is still inelastic to changes in interest rates. This is not so different from what other studies established (See Kararach (2002) and Opolot (2007)). On the other hand, financial innovation in this study increases demand for narrow money. Considering the small coefficient on the Treasury bill rate and the positive effect of financial innovations variables on money demand, it is not surprisingly to have such high income elasticity.

Proxies for financial innovations tend to increase demand for narrow money. The elasticity of electronic funds transfers with respect to demand for M1 is 0.06. This indicates that with a 1% increase in EFTs volume of transaction; on average money demand increases by about 6%.

To our knowledge, there is little literature on the use of EFTs between bank accounts in money demand estimation. However, Holly (1999) applied a cointegration approach to analyse the significance of innovations in the payments system on money demand and supply and on their determinants in the United States. He used EFTs volume of transactions but this consisted of ATM transactions and electronic transfers between bank accounts and we only applied the latter in our study. In his analysis, although there was little evidence for a positive effect on the variables and their co-movement like he had hypothesized; he concluded that there was some evidence that the hypothesis was not completely inaccurate.

As already mentioned, EFTs considered in this study involve only transfer of money between bank accounts. These just change the mode of payment from using cheques or cash to making electronic transfers. Since the implementation of the EFT system by Bank of Uganda in 2003, payments through this system have increased over the years. Specifically, in 2007 the government of Uganda shifted from issuing cheques to effecting payments through electronic transfers; and in July 2008 the system was extended to payment of salaries (Semakula and Muwanga, 2012).

Apart from government, EFTs is also used by corporate and other customers to pay salaries, bills, school fees and to meet other financial obligations. This system is safe, faster and reliable as it only takes 24 hours to credit a beneficiary's account compared to using cheques that could take over 5 days to clear. As a country's resources and budget grow, private and government expenditure increase too. With the advancement in technology, increasingly large volume of this expenditure is done through EFTs. For example; the volume of EFTs transactions increased from 170,000 in July 2010 to 758,000 in June 2011 and these were valued at Ushs. 437.2 billion and Ushs. 962.8 billion respectively.

When the system was extended to payment of salaries under the 'Straight Through Processing' (STP) scheme, it reduced manual steps in processing salaries (Semakula and Muwanga, 2012).

This speeds up the payment process and when these payments are made they are deposited into accounts such as current accounts or savings accounts. Nevertheless, although savings accounts belong to M2, they involve less restriction. They allow usage of ATM cards and withdrawals are done more or less at any time as individuals choose hence increasing demand for M1.

Basing on individuals' earnings in Uganda, for majority average income is not that much for them to make high savings with banks. In most cases, salary earners' accounts run dry and they wait until the next payment is made to make withdrawals. According to table 1.4 in the appendix, Per capita GDP in Uganda has averaged at around USD. 431.84 Per year and the trend in the annual national savings as a percentage of GDP shows a decline from 18.11% in 2006 to 13.33% in 2011 (World Economic Outlook Database, 2013). Putting the above into consideration, demand for narrow money is bound to increase.

ATM was hypothesized to have either negative or positive sign. Results indicate a positive and significant effect on M1 of 0.26. These results are consistent with findings by Columba (2009) who found a positive relationship between the number of ATMs and M1 although the effect on cash demand was negative. Other studies have found similar results but on demand for currency (See Valverde and Fernandez, 2009; Karen. A.R, 2008). Karen. A.R, 2008 used the volume of ATMs transactions and found a positive effect in excess of unity on demand for currency in Jamaica, and this gives an insight that ATMs are majorly used to access cash.

The positive coefficient of 0.26 indicates that for a 1 percent increase in the number of ATMs, on average demand for M1 increases by about 26%. The implication here is that ATMs enable individuals to hold more money either in cash or in form of demand deposits. By looking at the view that ATMs create easy access to cash, it is likely that individuals make withdrawals at any time hence increasing the amount of cash held which is a component of M1. Although the number of ATMs in Uganda is not yet that very high, from the results it is worth noting that the rate at which it is growing could considerably have an effect on money holding. There is a considerable growing number of bank-branches as well as the number of ATMs installed in Uganda. By December 2011, the total number of ATMs installed in Uganda had increased to 668 from 629 of June 2011 (BoU, 2011).

These findings can also be discussed along the following lines: First; restrictions on most savings accounts are not so binding due to competition in the banking sector hence individuals can at least withdraw more money from these accounts at anytime using ATM cards. This increases cash holdings which is a component of narrow money. Secondly; some individuals open up accounts for security purposes and to make withdrawals at their own convenience. On the one hand it is possible to expect a negative effect on demand for currency since ATMs reduce costs in form of time spent in banks' long queues, shoe- leather costs and other transactions costs involved (Baumol and Tobin, 1956). However, on the other hand it is also important to note that ATMs increase demand deposits which are a component of M1 (See Paroush and Ruthenberg, 1986).

It is also worth noting the fact that cash is needed to fill ATMs and it could be possible that any given reduction in cash demand, if any; could be offset by the increase in demand for idle cash to fill the machines. Even when this cash is not withdrawn at that very moment, it is part of M1 hence increasing it. Amromin and Chakravorti (2007), argued that an increase in demand for cash in relation to the increase in the number of ATMs could partly be attributed to the fact that ATM operators fill them with cash; hence an increase in demand for idle cash, especially if those machines are not serviced daily.

Lastly; income of economic agents is still low such that most of the funds on bank accounts will be withdrawn at any point in time to meet any cash demands that may arise. Although some people save, a substantial of individuals will make withdrawals when need arises and many account holders use these accounts to receive salary payments because employers demand so; and given the above mentioned factors it is probable that whenever these accounts are credited withdrawals are made and individuals wait for the next crediting.

Expected inflation is negatively signed as hypothesized with a coefficient of -0.07 implying a reduction in money demand by about 7% on average resulting from its increase by 1%. Higher rates of inflation entail erosion of the value of money hence economic agents will instead invest in alternative real assets to hedge against the rising prices (Sriram, 2001). It also pays to invest

in real assets since as the general price level rises, prices of these real assets will rise too. In his empirical analysis on the demand for money in Uganda over the period 1981- 1998, Kararach (2002) too obtained similar results.

The Treasury bill rate is negatively signed as expected, however, with a very small magnitude of -0.01. The implication here is that an increase in interest rate has less effect on demand for M1. When we compared this effect with that of expected inflation, it is likely that when it comes to alternative ways of investing money, investing in real assets say real estate, animals among other assets is preferable to investing in other alternative financial assets. This could be caused by the less developed financial market and the unwillingness to participate in the market by individuals due to various reasons such as lack of trust in financial institutions as well as the limited knowledge about the available investment opportunities in the financial sector

4.6 Estimation of the Short-run dynamic model for M1

The existence of a cointegrating vector among the variables and basing on the results from the weak exogeneity test given in table 1.3 of the appendix, an error correction model was estimated. Weak exogeneity results revealed that for all the variables, the null hypothesis of weak exogeneity was rejected at the 5% level of significance except for the EFTs for which it was rejected at the 10%. The implication is that the error term enters into the models of the all the variables including our variable of interest (M1) except for the Treasury bill rate variable.

The general shortrun dynamic model containing first differences of the long run model variables was estimated using the Ordinary Least Squares (OLS) method since the first differences of I (I) variables are stationary.

The estimated model is given as:

$$\Delta LRM1_t = \gamma_0 + \sum_{i=0}^{\rho-1} \gamma_{1i} \Delta LRM1_{t-i} + \sum_{i=0}^{\rho-1} \gamma_{2i} \Delta LRGDP_{t-i} + \sum_{i=0}^{\rho-1} \gamma_{6i} \Delta TBR_{t-i} + \sum_{i=0}^{\rho-1} \gamma_{5i} \Delta EXINF_{t-i} \sum_{i=0}^{\rho-1} \gamma_{3i} \Delta LEFT_{t-i} + \sum_{i=0}^{\rho-1} \gamma_{4i} \Delta LATM_{t-i} + +\gamma_7 ECM_{t-1} + DUM2009$$

(4.1)

We estimated a model with 5 lags as the long-run model, and using the General – to – Specific method according to Ericsson and Hendry (2005), insignificant lags were sequentially eliminated basing on the Student's t- statistic in order to end up with a parsimonious model given in equation 4.2 below:

$$\Delta LRM1_t = 0.03 - 0.43\Delta \mathrm{LRM1}_{t-1} - 0.41\Delta \mathrm{LRM1}_{t-2} - 0.29\Delta \mathrm{LRM1}_{t-3} + 0.79\,\Delta LRGDP_t + 0.01\Delta \mathrm{TBR}_{t-4} - 0.02\Delta \mathrm{TBR}_{t-5} - 0.02\,\Delta \mathrm{LATM}_{t-3} + 0.15\,\mathrm{ECM}_{t-1} \quad (4.2)$$

We performed diagnostic tests on the model and it seemed to be satisfactory basing on the results from the different tests as presented in Table 4.5 below:

Table 4. 5: The estimated parsimonious ECM for M1

Dependent Variable: D(LRM1)
Method: Least Squares
Sample (adjusted): 2003M12 2010M07
Included observations: 73 after adjustments

Variables	Coefficient	Std. error	t-value	P-value
Intercept	0.025879	0.007268	3.560677	0.0014
$\Delta LRM1_{t-1}$	-0.428493	0.098510	-4.349730	0.0000
$\Delta LRM1_{t-2}$	-0.414709	0.112865	-3.674381	0.0005
$\Delta LRM1_{t-3}$	-0.285122	0.104928	-2.717304	0.0085
$\Delta LRGDP_t$	0.792223	0.243394	3.254897	0.0018
ΔTBR_{t-4}	0.011146	0.004219	2.641806	0.0104
ΔTBR_{t-5}	-0.020902	0.004750	-4.400243	0.0000
$\Delta LATM_{t-3}$	0.484989	0.219242	2.212122	0.0305
ECM_{t-1}	-0.154752	0.049525	-3.124733	0.0027

Diagnostic tests

R2	= 0.57
F(8.64)	= Prob[0.000]
DW	= 2.10
BG-LM test (2): F (1.21)	= 2.75[0.25]
ARCH (1): F (0.21)	= 0.22 [0.64]
Hetero: F(30.58)	= 0.44 [0.14]
Hetero X: F(4.13)	= 0.37[0.36]
RESET: F (1.15)	= 0.70 [0.68]
Chow test: F (1.18)	= 0.31[0.04]
Normality: Chi^2(2)	= 3.27 [0.20]

4.9 Discussion of Results from the Dynamic Model

The parsimony of the shortrun model seemed satisfactory basing on the results from the diagnostic and stability tests presented above. The coefficient of multiple determination of 0.57 is relatively small but this is expected when the dependent variable is differenced (Keele and De Boef, 2004). Results indicate that the model was free from; Serial correlation, Autoregressive Conditional Heteroskedasticity and Whites Heteroskedasticity. The null hypothesis of residual normality could not be rejected at all levels of significance and as indicated by the F-test, all the coefficients of the variables in the model were jointly significant.

The Chow Forecast test does not reject the null of no structural break for the period before and after 2009:4 and the Reset test did not reveal any misspecification problem. The two tests for stability too, that is, both the Cumulative sum (CUSUM) and Cumulative sum of square (CUSUMSQ) test did not show any sign of instability in the money demand function (See figure 1.3 of appendix 7).

The negatively signed coefficient on the error correction term which is also significant provides evidence for a longrun relationship or longrun causality between the variables. Considering the size of the coefficient, it tells us the speed of adjustment of the variables to longrun equilibrium. The value of -0.155 is relatively small; an indication that narrow-money responds slowly to the error in the previous period. This implies that any imbalance in money demand in one month can be corrected in the next month at a rate of 15%. These results are comparable to those of Nabiddo (2007) who used quarterly data and obtained an error correction term of -0.09 for M1 in Uganda. Although most studies used a broader monetary aggregate, their results can still be comparable with what we obtained. For example Opolot (2007) got an error correction term of 0.132 for M2 in Uganda; Rutayisire (2010) obtained 0.082 for Rwanda and both of these studies applied quarterly data. It would thus take long for the monetary authority in Uganda to clear any surplus cash in the hands of the public through its restrictive monetary policies. This can be partly explained by the less developed financial sector in Uganda and probably the high costs involved in financial transactions.

The coefficient on the income variables LRGDP carries a positive sign and this is in line with economic theory as well as consistent with the longrun income elasticity. Even in the short term, growth in income positively affects money demand and this model it had only a contemporaneous influence of about 0.79.

ATMs influence money demand positively but with the third lag with a magnitude of 0.48. It is logical that ATMs increase money holdings in the shortrun just as it does in the long run through easy access to cash and convenience in making withdrawals. EFTs and expected inflation on the contrary to what was obtained in the longrun relationship do not adjust in the shortrun.

The Treasury bill rate has a positive effect with a magnitude of 0.01 with the fourth lag but the effect became negative of -0.02 with the fifth lag. The net effect, however, was negative when we added the coefficients of the two lags, that is, (-0.02 + 0.01 = - 0.01) and this coincides with the semi-elasticity obtained in the longrun.

CHAPTER FIVE

SUMMARY AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the conclusion and recommendations made in line with the findings of this study; and it also highlights areas of further research related.

5.1 Summary

Use of new payment technologies has been steadily increasing and this has implications on money demand, nevertheless, cash still remains the dominant payment instrument where retail transactions between 75% and 85% are performed with cash. This study was intended to examine the effect of financial innovation on demand for narrow money in Uganda over the period 2003:06 – 2011:03. It contributes to the literature by specifically estimating the effect of new payment technologies, that is, EFTs and ATMs on the demand for money. In combination with the standard variables of the money demand theory, the volume of transactions through EFTs and the number of ATMs were estimated in a cointegration model using the Johansen Juselius approach and it was established that there existed a long run relationship among these variables.

In the longrun model, both EFTs volume of transactions and the number of ATMs had a positive and significant effect on demand for narrow money, with ATMs having a larger effect compared to that of EFTs. Many individuals have access to ATMs compared to those that use EFTs hence that difference; besides payments through EFTs are also withdrawn from ATM. The shortrun model also gives plausible results as the coefficient on the error correction term is significant. The positive effect of payment innovations on demand for M1 to some extent can be supported by the "Baumol-Tobin theory", of transactions demand for money where individuals' wealth is held in form of money that yields no return and in bonds that yield return. However, for M1, individuals distribute their wealth between cash and demand deposits. It is generally evident that there is still high transaction costs associated with keeping money in bank accounts. These costs can be in terms of time spent lining up in banks, shoe leather costs from making trips to the bank,

bank charges and some other factors. Given the fact that these costs involved will increase demand for money and on the other hand payment innovations create convenience and easy access to cash; money demand for M1 inevitably increases. By looking at the standard variables of the money demand model, the income elasticity was in excess of unity and the effect on the opportunity cost variables was negative and statistically significant. It was also established that expected inflation has got more influence than interest rate when it comes to alternative investments of money. The implication is that when it comes to investing money, individuals prefer real assets to financial assets.

5.2 Recommendations

Results provide insights into the effect of payment innovations in Uganda's financial sector on demand for narrow money and this has an implication for monetary policy. Although M1 is no longer a targeted aggregate, it is worth noting that all the analyses and results got using M1 definition of money, by the same token can apply to M2 definition as well. Ignoring financial innovation in money demand estimation may lead to wrong ideas about the path and speed of policy transmission and incorrect parameter estimates. Deriving from the money multiplier, Payment technologies such as ATMs that allow for easy transfers between cash and deposits will definitely cause changes in the cash ratio. This to some extent can create instability in M1 since some withdrawals are from savings accounts which are a component of M2. Besides, innovations that either increase demand for money or allow individuals to economize on money holdings will cause shifts in the velocity of money. It is therefore imperative that forecasts for money demand should account for financial innovations when it comes to formulation of monetary policies.

In line with the standard variables, the interest rate variable was significant but with a small magnitude and the implication is that the interest rate channel is still weak for monetary policy transmission. In comparison with the coefficient on expected inflation, it is evident that economic agents prefer investing in real assets as an alternative means of holding their wealth. This reveals that not many people commit their wealth in financial assets. The stability of the money demand function, however, suggests that growth in the monetary aggregate (M1) can still be used as a good indicator of the general price level and output growth.

5.3 Limitations and Suggestions for further research

There was a limitation in terms of data on the right variables to use as proxies for financial innovation. New payment technologies have not been in place for a longer period and monthly data was appropriate to have a reasonable sample period. It was not easy to obtain data in monthly series on these variables and some was only generated through interpolation. However, the results are generally conceivable and encouraging to carry out future research on money demand and transactions technology by considering the increasing diffusion of the various new payment technologies. First, many payment technologies such EFTPOS, Visa Credit and debit cards, internet banking and mobile money payments are increasing but these were left out because of limitations of data on them. Secondly, a comparison of cash demand and demand deposits functions as well as a comparison between monetary aggregates such as M1 and M2 could be done to establish the difference in the impact that these innovations could have on each. Thirdly, disaggregated data on individual households could also be used to determine the effect that payment innovations have on demand for money on an individual level. Lastly, the effect of these variables could also be examined in other countries in the East African region for comparison and clarity purpose.

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APPENDICES

Appendix 1

Table 1.1 KPSS Unit root tests results

	Variables in levels			**Variables in first difference**		
Variables	With constant and trend	With constant	**Order of Integration**	With constant and trend	With constant	**Order of Integration**
LRM1	0.27	1.25	I(1)	0.11	0.32	I(0)
LRGP	0.33	0.71	I(1)	0.03	0.13	I(0)
LEFT	0.17	1.18	I(1)	0.02	0.02	I(0)
LATM	0.27	1.13	I(1)	0.13	0.34	I(0)
TBR	0.15	0.9	I(1)	0.04	0.14	I(0)
EXINF	0.09	0.19	I(0)	---	---	I(0)
Critical value at 5%	**0.146**	**0.463**		**0.146**	**0.463**	

Appendix 2

Table 1.2: Lag selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-63.78671	NA	3.57E-07	2.180835	2.38323	2.260569
1	374.7244	781.0979	1.24E-12	-10.3976	-8.98087	-9.839502
2	497.6037	195.8388	8.42E-14	-13.1126	-10.4815	-12.07608
3	604.434	150.2301	9.93E-15	-15.3261	-11.48055*	-13.81112
4	665.3111	74.19401	5.32E-15	-16.1035	-11.0436	-14.11013
5	719.7896	56.18094	3.91E-15	-16.6809	-10.4067	-14.20918
6	783.9269	54.11581*	2.53e-15*	-17.56021*	-10.0716	-14.61007*

* 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 3:

Table 1.3: Cointegration analysis for M1and tests of significance

Standardized coefficients						
	LRM1	LRGDP	TBR	EXINF	LEFT	LATM
	1.00	-1.65	0.01	0.07	-0.06	-0.26
	1.00	0.06	0.05	-0.05	-0.14	-0.01
	1.00	-28.85	-10.77	0.60	-17.33	27.91
Standardized adjustment coefficients						
	LRM1	LRGDP	TBR	EXINF	LEFT	LATM
	-0.44	0.13	-0.68	-0.10	0.12	0.33
Significance test on variables						
	LRM1	LRGDP	LEFT	LATM	EXINF	TBR
chi2(1)	11.45	15.14	10.06	12.35	10.07	8.15
p-value	0.000	0.012	0.021	0.042	0.041	0.01
Weak exogeneity test on the variables						
	LRM1	LRGDP	LEFT	LATM	EXINF	TBR
chi2(1)	11.45	15.14	10.06	12.35	8.15	10.07
p-value	0.000	0.012	0.070	0.042	0.010	0.021

Appendix 4

Table 1.4: Estimates of the Longrun model for M1

Vector Error Correction Estimates
Date: 16/02/13 Time: 18:02
Sample (adjusted): 2004M02 2010M06
Included observations: 64 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LRM1(-1)	1.000000
LRGDP1(-1)	-1.651734 (0.23773) [-6.94784]
TBR(-1)	0.008672 (0.00395) [2.19585]
EXINF(-1)	0.068647 (0.01777) [3.86230]
LATM(-1)	-0.260017 (0.05193) [-5.00694]
LEFT(-1)	-0.062520 (0.01202) [-5.20330]
C	4.993528

Error Correction:	D(LRM1)	D(LRGDP1)	D(TBR)	D(EXINF)	D(LATM)	D(LEFT)
CointEq1	-0.443548 (0.15219) [-2.91444]	0.131019 (0.02429) [5.39395]	-0.678052 (0.76160) [-0.89030]	-0.100079 (0.50759) [-0.197165]	0.329296 (0.05994) [5.49376]	0.136591 (0.40371) [0.33834]
D(LRM1(-1))	-0.050737 (0.14423) [-0.35178]	0.025657 (0.07040) [0.36442]	-1.513943 (5.46015) [-0.27727]	0.867740 (2.37639) [0.36515]	-0.004965 (0.00567) [-0.87517]	0.750896 (2.27795) [0.32964]
D(LRM1(-2))	-0.317034 (0.13449) [-2.35728]	0.042802 (0.06565) [0.65196]	4.713681 (5.09154) [0.92579]	1.879943 (2.21596) [0.84836]	-0.009579 (0.00529) [-1.81075]	-1.260758 (2.12417) [-0.59353]

D(LRM1(-3))	-0.273413	0.095127	-0.132034	4.863117	-0.000195	-1.210173
	(0.14519)	(0.07088)	(5.49671)	(2.39230)	(0.00571)	(2.29320)
	[-1.88309]	[1.34217]	[-0.02402]	[2.03282]	[-0.03414]	[-0.52772]
D(LRM1(-4))	-0.171698	0.096841	1.419751	3.916701	-0.002774	0.822183
	(0.13696)	(0.06686)	(5.18510)	(2.25669)	(0.00539)	(2.16320)
	[-1.25361]	[1.44847]	[0.27381]	[1.73560]	[-0.51495]	[0.38008]
D(LRM1(-5))	0.220243	0.144011	-1.783343	3.357547	0.003498	0.683879
	(0.10942)	(0.05341)	(4.14254)	(1.80294)	(0.00430)	(1.72825)
	[2.01275]	[2.69610]	[-0.43049]	[1.86227]	[0.81280]	[0.39571]
D(LRGDP1(-1))	-0.088550	0.494038	-3.612302	-75.42064	-0.001181	-9.064149
	(0.37544)	(0.18327)	(14.2134)	(6.18600)	(0.01477)	(5.92974)
	[-0.23586]	[2.69569]	[-0.25415]	[-12.1921]	[-0.07997]	[-1.52859]
D(LRGDP1(-2))	0.426233	0.699359	-20.79340	118.2465	0.143160	20.33609
	(1.28479)	(0.62716)	(48.6391)	(21.1689)	(0.05053)	(20.2920)
	[0.33175]	[1.11512]	[-0.42750]	[5.58585]	[2.83295]	[1.00217]
D(LRGDP1(-3))	-5.139788	-1.937622	34.43781	-83.98337	-0.192304	-22.52881
	(2.01759)	(0.98487)	(76.3814)	(33.2431)	(0.07936)	(31.8659)
	[-2.54749]	[-1.96738]	[0.45087]	[-2.52634]	[-2.42328]	[-0.70699]
D(LRGDP1(-4))	5.666012	1.286954	-38.31460	11.26990	0.162653	15.88168
	(1.86206)	(0.90895)	(70.4932)	(30.6804)	(0.07324)	(29.4094)
	[3.04288]	[1.41587]	[-0.54352]	[0.36733]	[2.22084]	[0.54002]
D(LRGDP1(-5))	-3.640542	-0.375937	22.87659	20.21173	-0.072600	4.441537
	(0.97523)	(0.47606)	(36.9202)	(16.0686)	(0.03836)	(15.4029)
	[-3.73299]	[-0.78969]	[0.61962]	[1.25784]	[-1.89266]	[0.28836]
D(TBR(-1))	0.018854	-0.000638	0.360893	-0.085454	-0.000366	-0.036935
	(0.00522)	(0.00255)	(0.19748)	(0.08595)	(0.00021)	(0.08239)
	[3.61440]	[-0.25075]	[1.82749]	[-0.99425]	[-1.78145]	[-0.44830]
D(TBR(-2))	0.016012	0.001495	-0.126393	-0.072278	0.000194	-0.284493
	(0.00573)	(0.00280)	(0.21687)	(0.09439)	(0.00023)	(0.09048)
	[2.79511]	[0.53459]	[-0.58280]	[-0.76575]	[0.86155]	[-3.14433]
D(TBR(-3))	0.004135	-0.004793	-0.195481	-0.182425	-0.000140	0.019729
	(0.00620)	(0.00303)	(0.23490)	(0.10223)	(0.00024)	(0.09800)
	[0.66637]	[-1.58256]	[-0.83220]	[-1.78442]	[-0.57363]	[0.20132]
D(TBR(-4))	0.042195	0.003770	-0.141948	0.159695	-0.000131	0.132267
	(0.00715)	(0.00349)	(0.27063)	(0.11779)	(0.00028)	(0.11291)
	[5.90245]	[1.08033]	[-0.52451]	[1.35581]	[-0.46578]	[1.17148]
D(TBR(-5))	-0.000554	0.002910	0.226274	0.010086	-0.001213	-0.116653

	(0.00827)	(0.00404)	(0.31307)	(0.13626)	(0.00033)	(0.13061)
	[-0.06695]	[0.72096]	[0.72275]	[0.07402]	[-3.72928]	[-0.89312]
D(EXINF(-1))	0.047888	0.006002	0.140182	0.161714	9.85E-05	0.041217
	(0.01461)	(0.00713)	(0.55323)	(0.24078)	(0.00057)	(0.23080)
	[3.27702]	[0.84144]	[0.25339]	[0.67163]	[0.17143]	[0.17858]
D(EXINF(-2))	-0.014561	-0.012503	0.434393	-0.582154	-0.001767	-0.254094
	(0.01308)	(0.00639)	(0.49532)	(0.21558)	(0.00051)	(0.20664)
	[-1.11290]	[-1.95759]	[0.87700]	[-2.70047]	[-3.43440]	[-1.22962]
D(EXINF(-3))	0.032132	0.001444	0.007636	-0.385937	-6.39E-05	-0.070332
	(0.01195)	(0.00584)	(0.45254)	(0.19696)	(0.00047)	(0.18880)
	[2.68800]	[0.24741]	[0.01687]	[-1.95950]	[-0.13588]	[-0.37253]
D(EXINF(-4))	0.002622	0.001178	0.141484	-0.045505	-0.000359	0.013320
	(0.00546)	(0.00266)	(0.20667)	(0.08995)	(0.00021)	(0.08622)
	[0.48027]	[0.44190]	[0.68457]	[-0.50589]	[-1.67096]	[0.15448]
D(EXINF(-5))	-0.002916	0.000805	0.101867	-0.032189	-0.000219	-0.051073
	(0.00404)	(0.00197)	(0.15298)	(0.06658)	(0.00016)	(0.06382)
	[-0.72172]	[0.40791]	[0.66587]	[-0.48345]	[-1.37740]	[-0.80023]
D(LATM(-1))	6.135327	-0.314919	-128.9804	-53.23544	1.580584	16.22897
	(3.09465)	(1.51063)	(117.156)	(50.9893)	(0.12172)	(48.8771)
	[1.98256]	[-0.20847]	[-1.10093]	[-1.04405]	[12.9854]	[0.33204]
D(LATM(-2))	-9.174371	-0.199302	407.2992	49.72340	-0.575314	-50.11800
	(5.43383)	(2.65249)	(205.712)	(89.5312)	(0.21373)	(85.8223)
	[-1.68838]	[-0.07514]	[1.97994]	[0.55538]	[-2.69182]	[-0.58397]
D(LATM(-3))	4.824272	2.698304	-401.8219	65.07554	-0.047493	65.91315
	(5.23075)	(2.55336)	(198.024)	(86.1852)	(0.20574)	(82.6149)
	[0.92229]	[1.05677]	[-2.02915]	[0.75507]	[-0.23084]	[0.79784]
D(LATM(-4))	-6.213685	-2.880453	94.57756	-87.11405	-0.140283	-18.71717
	(5.41026)	(2.64099)	(204.820)	(89.1429)	(0.21280)	(85.4501)
	[-1.14850]	[-1.09067]	[0.46176]	[-0.97724]	[-0.65923]	[-0.21904]
D(LATM(-5))	6.902250	0.608464	11.51566	12.39234	0.109775	-27.50908
	(3.19464)	(1.55944)	(120.942)	(52.6368)	(0.12565)	(50.4563)
	[2.16057]	[0.39018]	[0.09522]	[0.23543]	[0.87363]	[-0.54521]
D(LEFT(-1))	-0.034169	-0.003640	-0.437404	0.045848	0.000927	-0.601347
	(0.01353)	(0.00660)	(0.51204)	(0.22285)	(0.00053)	(0.21362)
	[-2.52625]	[-0.55138]	[-0.85423]	[0.20573]	[1.74340]	[-2.81501]
D(LEFT(-2))	0.021666	-0.000429	-0.412383	0.079809	0.000605	-0.295579
	(0.01417)	(0.00692)	(0.53650)	(0.23350)	(0.00056)	(0.22383)
	[1.52881]	[-0.06196]	[-0.76865]	[0.34180]	[1.08533]	[-1.32058]

D(LEFT(-3))	0.033825	-0.005025	-0.022237	-0.106017	-0.000563	0.118979
	(0.01442)	(0.00704)	(0.54577)	(0.23753)	(0.00057)	(0.22769)
	[2.34634]	[-0.71404]	[-0.04075]	[-0.44633]	[-0.99253]	[0.52255]
D(LEFT(-4))	0.005137	-0.007178	0.119273	-0.307547	-0.000774	-0.048676
	(0.01403)	(0.00685)	(0.53111)	(0.23115)	(0.00055)	(0.22158)
	[0.36614]	[-1.04811]	[0.22457]	[-1.33049]	[-1.40270]	[-0.21968]
D(LEFT(-5))	-0.007027	-0.006401	-0.180965	-0.144908	-0.000407	0.099705
	(0.01054)	(0.00515)	(0.39909)	(0.17369)	(0.00041)	(0.16650)
	[-0.66662]	[-1.24389]	[-0.45345]	[-0.83428]	[-0.98227]	[0.59883]
C	-0.041381	9.10E-05	0.316790	0.165301	0.001545	0.408054
	(0.01423)	(0.00695)	(0.53869)	(0.23445)	(0.00056)	(0.22474)
	[-2.90817]	[0.01311]	[0.58808]	[0.70506]	[2.76018]	[1.81570]
R-squared	0.830163	0.781566	0.724801	0.936746	0.997586	0.710644
Adj. R-squared	0.665633	0.569957	0.458201	0.875468	0.995248	0.430331
Sum sq. resids	0.018874	0.004498	27.05107	5.124029	2.92E-05	4.708287
S.E. equation	0.024286	0.011855	0.919427	0.400157	0.000955	0.383580
F-statistic	5.045675	3.693452	2.718688	15.28692	426.6230	2.535176
Log likelihood	169.3104	215.2076	-63.25505	-10.01392	376.3954	-7.306180
Akaike AIC	-4.290951	-5.725239	2.976720	1.312935	-10.76236	1.228318
Schwarz SC	-3.211510	-4.645797	4.056162	2.392377	-9.682914	2.307760
Mean dependent	0.007433	0.000326	-0.277969	0.009793	0.023944	0.064829
S.D. dependent	0.042000	0.018078	1.249103	1.133941	0.013857	0.508212

Determinant resid covariance (dof adj.)	3.82E-16
Determinant resid covariance	5.97E-18
Log likelihood	724.2225
Akaike information criterion	-16.44445
Schwarz criterion	-9.765409

Appendix 5

Table: 1.5 Estimates of the Shortrun model for M1

Dependent Variable: D(LRM1)

Method: Least Squares

Date: 22/02/14 Time: 00:40
Sample (adjusted): 2003M12 2010M07
Included observations: 73 after adjustments
D(LRM1) = C(1)*(LRM1(-1) - 1.651734057*LRGDP1(-1) + 0.008672174285*TBR(-1) - 0.06251966554*LEFT(-1) - 0.2600165725*LATM(-1) + 0.06864744373*EXINF(-1) + 4.993527791) + C(2)*D(LRM1(-1)) + C(3)*D(LRM1(-2)) + C(4) *D(LRM1(-3)) + C(15)*D(TBR(-4)) + C(16)*D(TBR(-5)) + C(24)*D(LATM(-3)) + C(32) + C(33)*D(LRGDP1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.154752	0.049525	-3.124733	0.0027
C(2)	-0.428493	0.098510	-4.349730	0.0000
C(3)	-0.414709	0.112865	-3.674381	0.0005
C(4)	-0.285122	0.104928	-2.717304	0.0085
C(15)	0.011146	0.004219	2.641806	0.0104
C(16)	-0.020902	0.004750	-4.400243	0.0000
C(24)	0.484989	0.219242	2.212122	0.0305
C(32)	0.025879	0.007268	3.560677	0.0014
C(33)	0.792223	0.243394	3.254897	0.0018

R-squared	0.568261	Mean dependent var	0.007921
Adjusted R-squared	0.514293	S.D. dependent var	0.050249
S.E. of regression	0.035020	Akaike info criterion	-3.750790
Sum squared resid	0.078490	Schwarz criterion	-3.468404
Log likelihood	145.9038	Durbin-Watson stat	2.103444

Appendix 6

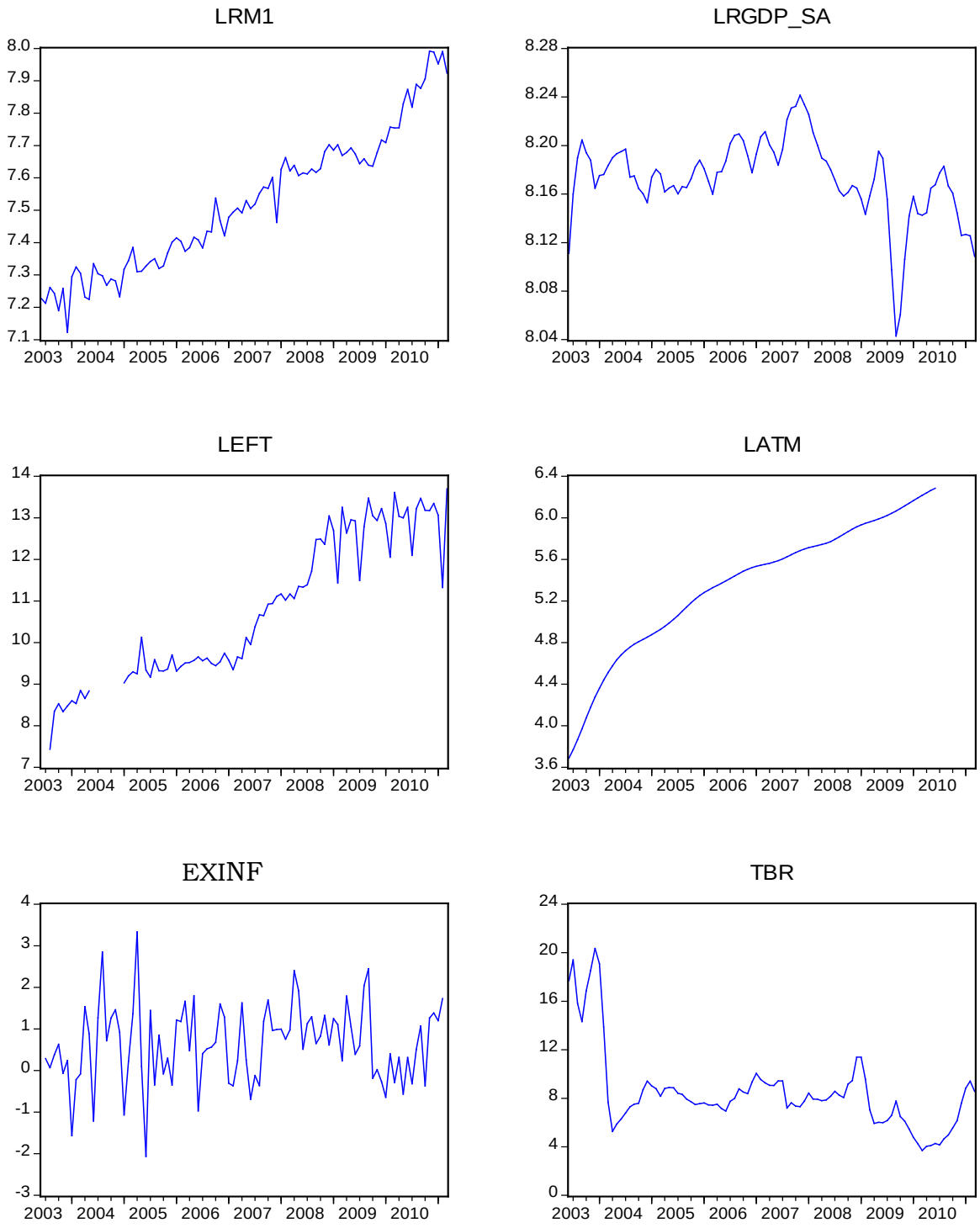
Table 1.6 GDP per capita, savings and inflations examinations in the three countries

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GDP per capita U.S dollars										
Burundi	108.98	124.63	149.15	166.63	174.00	201.95	212.89	242.21	274.90	282.09
Kenya	456.01	478.44	546.57	637.23	748.70	813.05	792.75	809.75	832.53	976.55
Rwanda	210.80	236.33	286.57	337.91	398.82	489.34	536.40	562.58	624.31	693.03
Tanzania	313.64	337.50	364.19	358.97	409.70	489.74	490.94	510.70	516.05	599.19
Uganda	277.11	294.76	346.38	367.57	423.80	506.32	494.58	508.28	510.43	589.16
Gross national savings percent of GDP										
Burundi	16.82	13.68	15.09	-1.47	14.64	19.03	21.75	7.77	6.29	4.37
Kenya	17.23	17.24	17.24	16.82	15.42	12.84	13.81	14.97	10.47	12.51
Rwanda	15.93	21.76	21.94	15.39	17.98	18.63	15.01	15.77	14.81	12.07
Tanzania	16.82	19.16	18.35	16.85	15.63	19.19	19.95	24.14	20.44	23.60
Uganda	16.31	18.92	17.80	18.11	17.64	14.72	13.32	14.07	13.33	11.45
Inflation, average consumer prices										
Burundi	10.69	11.77	1.20	9.09	14.42	25.97	4.62	4.09	14.89	11.76
Kenya	9.81	11.79	9.87	6.04	4.27	15.10	10.55	4.09	14.00	9.40
Rwanda	7.45	11.95	9.12	8.83	9.08	15.44	10.35	2.31	5.67	6.29
Tanzania	4.43	4.14	4.36	7.25	7.03	10.28	12.14	7.19	12.69	16.00
Uganda	8.71	3.67	8.60	7.21	6.07	12.04	13.07	3.97	18.68	14.13

Source: International Monetary Fund, World Economic Outlook Database, April 2013

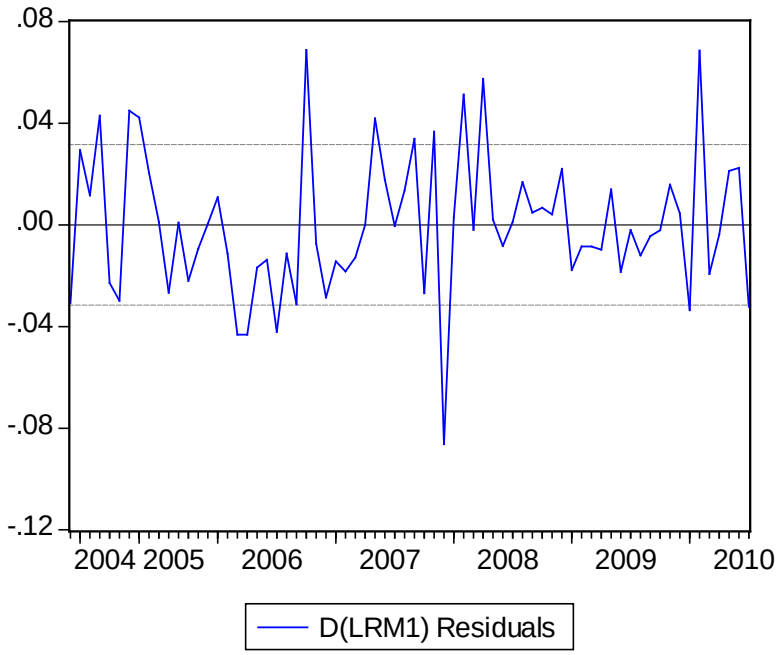
Appendix 7

Figure1.1 Trends in variables used.



Appendix 8

Figure 1.2 Residual graph from the error correction model



Appendix 9

Figure 1.3 Residual tests for parameter constancy