

AN ANALYSIS OF DEMAND FOR MONEY IN UGANDA (1986 – 2003)

By

Winnie Nabiddo

REG NO: C/50/8160/03

**A research paper submitted in partial fulfillment of the requirements for the Award
of the Degree of Master of Arts in Economics of the University of Nairobi**

August 2005

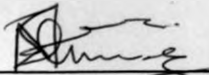
UNIVERSITY OF NAIROBI LIBRARY



0271255 2

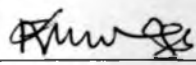
DECLARATION

This research paper is my original work and has not been presented for a degree in any other University.

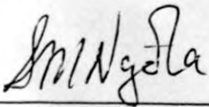
 28/09/05

Winnie Nabiddo

This research paper has been submitted for examination with our approval as University supervisors.



First Supervisor: Prof F. M. Mwega



Second supervisor: Dr. S. Ngola

Dedication

To My Mum (Jessica Kyoyagala) and Ibrahim Mukisa (My Husband).

Acknowledgements

I am deeply indebted to African Economic Research Consortium (AERC) who offered me a full scholarship to undertake a Master of Arts degree course in Economics, of course not forgetting the Faculty of Economics, Makerere University through which I obtained the scholarship.

I owe gratitude and thanks to Prof Mwega and Dr Ngola my first and second supervisor, respectively. I acknowledge generous assistance and constructive criticism from my supervisors. My heartfelt thanks also go to all staff members of Economics Department of the University of Nairobi, who have been an inspiration of my work, especially Prof Mwega, Prof Mwabu, Dr. Kulundu and Dr. Singh

I am also indebted to Mr. Mukisa Ibrahim of Faculty of Economics and Management in Makerere University who encouraged me to undertake a Masters programme in Economics and ensured I was enrolled for the course. I am again very grateful to Mr. Mukisa Ibrahim for constantly, unselfishly, encouraging and advising me through most stages of my course and research work. To you Ibrah I give hearty thanks for your love, trust and understanding. I owe you big time.

I wish to thank all fellow Economics graduate student colleagues at the University of Nairobi. In particular I am thankful to Njuguna Francis who gave me moral and academic support and encouraged me at the University not forgetting the competition that you gave me, it was worthwhile. To Omondi for being a computer wizard during CGE and SAM assignments and being a good discussant, Mwaura for being a good Monetarist and always challenging Me, Mzee Nthenge for being fatherly, Ali for being a good “deskee”, Margaret for being very motherly, Wamboi for being an ambitious and hard working, Kaifa for always being confused and confusing me but obsessed with Chelsea, Wesley for being the best class representative, Paul for being brotherly all the way, Florence the lady for women’s emancipation, Muhu always in favor of polygamy, Molu and Komu

for being unpredictable, Odhiambo for being a good custodian for the computer lab and library, Zacheus always a shirker but obsessed with Manchester United and lastly to Mwangi and Gisheru for always being inseparable.

I can not fail to mention my parents Jessica Kyoyagala (RIP) and Mesach Ssemusinge as well as Aunt Barbrah, Uncle Camillus and Aunt Judith who sacrificed a lot to educate me. Their prayers and encouragement gave me hope and confidence. My sisters (especially Lilliane and Ann), cousins and brothers provided me with the necessary encouragement and support when I sincerely needed them. I owe them heartfelt gratitude for their cooperation and prayers during my course. May the Almighty God bless you.

Although there is an endless list of friends who contributed, either directly or indirectly, to the success in my studies, in particular I would like to sincerely thank Josephine Namukwaya, Shamim Nantege, for all their support towards my educational success.

I finally wish to assert that neither the institutions nor the individuals mentioned above can be held responsible for any kind of errors that may still remain in this paper. I therefore, remain solely responsible for any such errors.

Winnie Nabiddo

TABLE OF CONTENTS

DECLARATION.....	(ii)
DEDICATION.....	(iii)
ACKNOWLEDGEMENTS.....	(iv)
List of Tables.....	(viii)
List of Graphs.....	(viii)
ABSTRACT.....	(ix)
LIST OF ABBREVIATIONS.....	(x)
CHAPTER ONE.....	1
1.0 INTRODUCTION.....	1
1.1 Monetary Policy and Review of the Ugandan Economy.....	1
1.2 Statement of the problem.....	5
1.3 Objectives of the Study.....	6
1.4 Significance of the Study.....	6
1.6 Scope of the Study.....	7
1.4 Organization of the Study.....	7
CHAPTER TWO.....	8
2.0 LITERATURE REVIEW.....	8
2.1 Theories of Money demand.....	8
2.1.1 Classical Theories.....	8
2.1.2 Keynesian Theory.....	8
2.1.3 Post Keynes Theory.....	9
2.1.3 Friedman's Modern Theory of Money.....	10
2.2 Empirical Literature Review.....	11
2.3 Overview of the literature.....	23
CHAPTER THREE.....	24
3.0 METHODOLOGY.....	24
3.1 Selection of Variables.....	24
3.1.1 Money Stock.....	24
3.1.2 Scale variable.....	25
3.1.3 Financial innovation.....	25
3.1.4 Opportunity cost variable.....	25
3.2 Model Specification.....	27

3.2.1 Hypothesis of the study	27
3.3 Estimation Methods.....	28
3.1.1 PAM Models	28
3.1.2 BSM Models.....	28
3.1.3 ECM	29
3.4 Estimation Issues	29
3.5 Unit Root Test	29
3.6 Cointegration Tests.....	30
3.7 Data Sources and sources	31
 CHAPTER FOUR	 32
4.0 Presentation and interpretation of results	32
4.1 Descriptive Analysis of Real Money Demand	32
4.2 Unit Root Test	33
4.3 Cointegration Test	34
4.4 Estimated Models	36
4.5 Stability Tests for Money Demand Functions.....	43
4.5 Overall results interpretation and Uganda's Money Demand function.....	44
 CHAPTER FIVE	 46
5.1 Implications for Monetary Policy.....	46
5.2 Conclusions	47
5.3 Limitations and suggestions for further research	47
 REFERENCES	 49
 APPENDIX	 55

List of Tables

1.0 Monetary Aggregates for Uganda (1986-2003). 4
4.1(a) unit root tests on variables in levels 33
4.1(b) Unit root tests on variables in First Difference. 33
4.2 (a) Bivariate Co-integration results for Real Narrow Money 35
4.2 (b) Bivariate Co-integration results for Real Broad Money 35

List of Graphs

4.1 Descriptive Analysis of Real Money Demand 32

ABSTRACT

A stable money demand function is the essence of planning and implementing monetary policy. The main purpose of this paper is to Estimate Uganda's money demand function and to find out whether there exists a stable money demand function in Uganda. This study presents both a descriptive and empirical analysis of money demand in Uganda over the period 1986:1-2003:4. It also reviews some basic concepts of money demand theory, summarizes the results of developed and developing countries' studies that have used partial adjustment model (PAM), Co-integration and/or error correction techniques and reviews model specification issues. The study makes use of an expanded model incorporating institutional variables in addition to the normally used (traditional) variables. Two definitions of money (M1/P and M2/P) were used and they exhibited a general upward trend for the most of the period under study. In addition, the study tests for the existence of co-integration between monetary aggregates and real money balances.

Following the existence of co-integration, error-correction models were built for the two money demand functions namely real Narrow Money (M1/P) and real Broad money (M2/P) demand. From our results, income (GDP) in the two Money demand functions was found to be positively related to money demand and not significantly different from unity which implied that for the period, increases in income led to an increase in real cash balance. Money demand was also found to be negatively related to exchange rate and interest rate in the two functions, suggesting that there is a degree of substitution from non-interest bearing Ugandan notes into interest bearing financial assets and into holdings of foreign currency. Also inflation was found to be negatively related to the money demand functions. Financial innovation was found to have a negative effect on M1/P and M2/P. The Money demand functions remained stable for the entire period, as confirmed by the chow tests, forecast statistics and the recursive graphics. The empirical findings conclude that the demand for money in Uganda is stable.

LIST OF ABBREVIATIONS

- IMF:** International Monetary Fund
- SAP:** Structural Adjustment Programs
- WB:** World Bank
- FSAP:** Financial Sector Adjustment Program
- BOU:** Bank of Uganda
- LDCs:** Less Developed Countries
- ECM:** Error Correction Model
- EMU:** European Monetary Union
- WAEMU:** West African Economic Monetary Union
- ASEAN:** Association of South East Asian Nations
- GDP:** Gross Domestic Product
- GNP:** Gross Net Product
- M1:** currency in circulation plus demand deposits
- M2:** M1 plus time deposits
- M3:** M2 plus foreign exchange deposits
- PAM:** Partial Adjustment Model
- BSM:** Buffer Stock Method
- DF:** Dickey Fuller test
- ADF:** Augmented Dickey Fuller test
- SBDW:** Sargan Bhargava Durbin Watson test
- ATM:** Automated Teller Machine
- CPI:** Computed Price Index

CHAPTER ONE

1.0 INTRODUCTION

An important issue concerning monetary policy is to identify a stable money demand function [Friedman, (1959), Friedman and Schwartz, (1982), Laidler, (1982)¹]. In turn, a stable money demand function is a necessary condition to establish a direct link between the relevant monetary aggregate and nominal income. The presence of a stable money demand function will thus enhance the ability of monetary authorities to reach pre-determined monetary growth targets if price stability is the main objective².

In the Ugandan context, it is important from a policy point of view to establish whether there exists a stable long-run relationship for money demand. This is because money demand serves as a conduit in the transmission mechanism for monetary policy, so the stability of the money demand function is critical if monetary policy is to have predictable effects on inflation and real output. In most developed and developing countries, policymakers have frequently questioned whether the demand for money is stable.

1.1 Monetary Policy and Review of the Ugandan Economy

Uganda's financial system is still relatively young and undeveloped. As is the case with most developing economies, the system is made up of a formal and an informal sector. In the 1970s and 1980s there were selective and preferential allocation of foreign exchange and credit to sectors in terms of their "priority"³. The formal sector encompasses the central bank, 13 licensed commercial banks, 9 credit institutions, 14 insurance companies, 3 development institutions, 3 building societies and the postal saving bank.

¹ According to Laidler (1982), the demand for money is stable when money holdings can be explained by functional relationships, which have statistical significance, that the same equation can be applied to different countries using different data, without it being necessary to change arguments of the relations to achieve satisfactory results.

² Although empirical support for stable money demand is a necessary condition, for there to be a predictable link between money and prices, it does not necessarily validate the monetarist contention that the money supply is causal in the process of inflation (Kaldor, 1982). However, if price stability is the main policy objective, a stable money demand function is important irrespective of whether the money supply is exogenous or endogenous. When the money supply is endogenous, price stability could be achieved through a discretionary variable such as the interest rate.

³ See Kasekende and Ssemogerere, 1994.

The informal financial sector comprises a wide range of moneylenders, saving circles and similar financial mechanisms.

Uganda's formal financial sector is one of the least developed in Sub Saharan Africa (SSA), with only 70% of the economy monetized. The M2/GDP ratio is just about 9%, compared with 40% for Kenya and 35% for Tanzania⁴. The portfolio of available financial assets is very limited; with nearly all the assets held consisting of liabilities of government, Bank of Uganda and commercial banks. The only diversification worth mentioning is the treasury bill market, which has an active weekly auction, although the commercial banks still hold more than 80% of the bills outstanding.

However in recent times, there has been a considerable attempt to expand the formal financial sector, for example, the expansion of rural banks and micro-credit lending as part of government policy. Post independence Uganda has also been characterized by political and social crisis from around 1966 up to the 1990s. The general result of this has been the disruption of production and destabilization of the wider economy. Inflation became a prominent feature of the Ugandan economy and the reinforced negative real rates of interest created an atmosphere of currency substitution – or more accurately, some movements from domestic to foreign denominated assets.

The 1980s became a period of major economic reforms in Uganda under the auspices of International Monetary Fund/ World Bank (IMF/WB). With respect to the financial sector, the government set specified limits on: net bank credit to government, monetary growth, public spending (PSBR) and overall fiscal stance. But the government could not keep the tight fiscal and monetary stances, as Uganda was yet to recover from the 1979 war effects. Much of its infrastructure was in disrepair and that was worsened by the insurgency that erupted in the Buganda region in 1981 and subsequently disrupting coffee export production (Henstridge, 1996). The government ended up expanding fiscal policy to sustain the war and aggregate demand.

⁴ See Kararach (2001), IFS- (1995,2000 issues)

These events led to a loss of confidence in the economy. Accordingly, substitution of assets within the non – bank private sector appears to have taken place with a flight away from formal financial sector assets. Since 1970, the M2/GDP ratio had exhibited an overall declining trend, from 24% in 1974 to a low of 7.1% in 1989. Time and savings deposit account for just 20% of broad money. This decline could be suggesting that a shift occurred from the holding of formal financial assets to acquisition of inflationary hedges, foreign currency denominated financial assets and informal financial market assets. As a result, the formal financial system shrank as reflected in the relatively higher and rising proportion of financial assets held in the form of cash.

The relationship between the IMF and the Ugandan government broke down and the IMF stand-by arrangement was suspended in 1984. The subsequent financial constraint resulted in a meteoric rise in inflation from 45% in 1984 to almost 200% by 1986, high fiscal deficit and deterioration of the current account balance with the premium on the official exchange rate peaking at 100% in 1988. Indeed the political as well as the economic situation had worsened further by two coups in two years (1985 and 1986). The unstable political situation worsened the balance of payments and foreign exchange constraints and generally budgetary discipline. Equally, the operation of the formal financial sector became inefficient and the informal sector grew considerably (see Atingi-Ego, 1998).

In 1987, the IMF resumed Structural Adjustment Programs (SAP) with the Museveni government – emphasizing reduction of inflation in order to encourage savings and restore sustainable balance of payments. The old currency was replaced with a new one where-by one hundred shillings were exchanged for one shilling; and a conversion tax of 30% imposed on shilling holdings. The exchange rate was also devalued by 76.6%. As export and production did not adjust immediately to these changes, their overall effects were deflationary. Inflation fell to around 37% by September 1987. The government could not maintain its budgetary stance and decided to monetize its deficits.

Table 1: Monetary Aggregates for Uganda 1986 - 2003

Year	Inflation rate (% average for the period)	Change in Domestic credit (%)	Broad money to GDP ratio (%)	Treasury bill rate (%)	Lending rate (%)	Deposit rate (%)	Change in real exchange rate (%)
1986	149.4	84.2	11	30.7	33.3	23.3	5.3
1987	221.3	-	-	30.5	34.7	20	28.2
1988	198.1	-	-	33	35	21.5	-9.8
1989	101.9	-	-	42.2	40	32.2	-15.2
1990	32.1	-	-	41	38.7	31.3	-38.9
1991	27.6	-	-	34.2	34.4	31.2	-23.3
1992	55.5	-	-	39	-	35.8	-8.8
1993	5.1	-8	15	21.3	-	16.3	6
1994	10	-13.8	18	12.5	-	10.0	21.2
1995	6.6	-47.3	13	8.8	20.2	7.6	-2.2
1996	7	34.5	15	11.7	20.3	10.6	9.7
1997	9.5	47.2	9	10.6	21.4	11.8	7.4
1998	4.6	32.5	8	7.8	20.9	11.4	-11.6
1999	10.13	53.3	14	7.4	21.6	4.1	12.97
2000	4.83	38	7	13.2	22.9	4.1	6.7
2001	4.3	43.5	16	6.0	21.7	3.2	2.35
2002	5.06	149.7	21	5.3	17.6	2.2	9.27
2003	6.4	103.8	24	15.5	18.3	3.1	11.22

Source: Uganda Bureau of Statistics, Statistical Abstracts (Various Issues).

From Table 1, it is apparent that the monetary policy environment was generally unstable in Uganda from 1986 to 1998. Following the liberalization of the economy, financial disintermediation, rather than deepening occurred. Domestic credit fell overall in 1993 by 8% and in 1995, by 47.3%, even though claims on the private sector rose and that on central government fell. This contrasts with the early 1990s when a large share of domestic credit went to central government (WB, 1995, 1999). The various nominal rates of interest were institutionally fixed until 1992. Inflation shows a significant jump in the rate during 2003. The 8.7% increase in 2003, compared to -0.3% in 2002 was due to poor food crop harvests caused by prolonged drought in most parts of the country.

In effect the 1990s became the true period of reform in Uganda – designed as it were to remove market rigidities in the economy in general and the financial sector in particular. The Financial Sector Adjustment Program (FSAP) was introduced in 1992 whereby the sector became deregulated and the growth of financial institutions facilitated. The foreign

exchange market was also liberalized and guidelines for indirect monetary policy laid down. In 1991/2, the Bank of Uganda in addition to selling treasury bills and conducting monetary policy was granted greater supervisory powers over commercial financial institutions.

The weakness of the financial sector in Uganda has however been evident by the numerous bank failures. Galbis (1986) argued that such bank failures should not be unexpected because the financial sector in Low Developed Countries (LDCs) are characterized by “bank holding companies” with interest in both financial and non financial markets. Financial liberalization would place excess supply of financial savings in the reach of these companies, which finance questionable ventures in their attempts to maintain market share. Clearly liberalization and other changes to the banking system may well lead to instability in of the demand for money: financial innovation is usually seen as leading to a change in the velocity of circulation (Kaldor, 1983; Arestis and Demetriades, 1993).

Two new financial acts, namely Bank of Uganda Act and Financial Institutions Act, were passed in 1993. These confer on the central bank wide-ranging powers over the financial institutions and as the effective monetary policy enforcer. In July 1990, the parallel market in foreign currency was legalized, with the result that the premium on the official exchange rate narrowed and the precautionary motive for holding foreign exchange decreased though asset motive may have remained due to the prevalent inflation. Institutional reforms included allowing residents to hold foreign exchange accounts and to access foreign exchange bureaus without restriction (Kasekende and Ssemogerere, 1994).

1.2 Statement of the Problem

The importance of the demand for money is grounded in the fact that it describes the link between monetary aggregates and the real economy. Goldfield and Sichel (1993) state that the demand for money is a crucial component in the formulation of monetary policy and a stable demand for money function is a prerequisite for the use of monetary

aggregates in the conduct of monetary policy. Judd and Scadding (1982) further argue that the stability of the money demand function presents a set of necessary conditions for money to exert a predictable influence on the real economy. The knowledge of the money demand function is important if we are to know the impact of monetary changes on the real economy.

This study attempts to provide an empirical analysis of the character of the demand for money function in Uganda and also examines whether there is a stable demand for money function in Uganda, especially in view of the fact that the monetary sector in Uganda has undergone considerable financial deregulation as part of the International Monetary Fund (IMF) imposed Structural Adjustment Program (SAP).

The study seeks to identify the determinants of the demand for money in Uganda by attempting to estimate the income, interest, exchange rate and inflation elasticities as well as testing the stability of the demand function for the period 1986 to 2003. Here stability implies that desired money balances vary in a reasonably predictable way in response to changes in the key variables. We need to know the determinants of the demand for money because in Uganda, as is the case in many developing countries where the level of savings is so low and credit facilities inadequate, monetary expansion constitutes a very important tool of macroeconomic management and an alternative to taxation as a means of financing government expenditure.

1.3 Objectives of the study

The objectives of the study are to:

- (i) Estimate Uganda's money demand function.
- (ii) Examine the stability of the demand function for Uganda.
- (iii) Make policy conclusions.

1.4 Significance of the Study

The study will contribute to policy formulation in Uganda since a money demand function is a component of the LM curve, which is important in macroeconomic analysis.

The existence of a stable money demand function in Uganda would imply that policy actions that alter the money stock could be expected eventually to have predictable effects on the ultimate target variables of macroeconomic policy. The relevance of the study of the demand for money is further emphasized by Laidler (1985)⁵.

1.5 Scope of the Study

We are interested in estimating the determinants and analyzing the stability of demand for money in Uganda over the period 1986 to 2003. This period is particularly important for the study because it includes the period of pre and post liberalization of interest rates, liberalization of foreign exchange market, financial deregulation and innovation.

Ever since the previous studies, the financial sector in Uganda has undergone a lot of changes, such as the liberalization of the interest rates, privatization, liberalization of the exchange rates, which are expected to influence demand for money in Uganda. This study therefore is a follow up of the previous studies and also applies the Error Correction Model (ECM) to the demand for money in Uganda. Some studies have been done on the demand for money in Uganda such as Mbire and Mackinnon (1992), Kateregga (1993), Musinguzi (1994). However, in this study we consider the pre and post liberalization period.

1.6 Organization of the Study

The study is organized in five chapters. Chapter Two reviews the relevant theoretical and empirical literature; it also contains an overview of the literature. Chapter Three presents the methodology i.e. model specification, hypothesis, estimation techniques, data type and sources. In Chapter Four we present and interpret the empirical findings. Chapter Five presents the conclusions and draws the policy implications on the basis of the study's empirical findings. It also contains the limitations of the study and references while appendices follow.

⁵ "... We are mainly interested in the demand for money because we are concerned about the way in which the quantity of nominal money in circulation in an economy interacts with other factors to influence the behavior of interest rates, real income, employment and the price level. ..."

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theories of money demand

2.1.1 Classical theories

According to classical economists, money acts as a numeraire. In other words, it is a commodity whose unit is used in order to express prices and values, but whose own value remains unaffected by this role (Sriram, 1999). However, money is deemed neutral with no real economic consequences since its role as a store of value, is limited under the classical assumption of perfect information and negligible transaction costs (Sriram, 1999). We should note however, that the roots of modern theory of money demand began from the early contributions of Mill (1848), Walras (1900) and Wicksell (1906).

The concept of money demand took formal shape through the quantity theory developed in the classical equilibrium framework by two different but equivalent expressions. Fisher (1911) provided the famous equation of exchange ($M_s V_t = P_t T$, where M_s is quantity of money, V_t is the transactions velocity of circulation, P_t is prices and T the volume of transactions) where money is held simply to facilitate transactions and has no intrinsic value. The alternative paradigm, the so-called Cambridge approach, was primarily associated with the neo – classical economists Pigou (1917) and Marshall (1923). This approach stressed the demand for money as public demand for money holdings, especially the demand for real balances, which was an important factor in determining the equilibrium price level consistent with a given quantity of money (Sriram, 1999).

2.1.2 Keynesian Theory

Keynes (1930, 1936) built upon the Cambridge approach to provide a more rigorous analysis of money demand, focusing on the motives of holding money. Keynes postulated three motives for holding money: transactions, precautionary and speculative purposes. He formally introduced the interest rate as another explanatory variable in influencing the demand for real balances.

The money demand function was then represented as $M^d = f(y, i)$ where the demand for real balances (M^d) is a function of real income (y) and nominal interest rates (i). The main proposition of the Keynesian analysis is that when interest rates are very low, economic agents will expect a future increase in interest rates and a reduction on bond value; thus, preferring to hold money. Therefore, the aggregate demand for money becomes perfectly elastic with respect to the interest rate (liquidity trap), when interest rates are very low.

2.1.3 Post – Keynes

Following Keynes, a number of models were developed to confirm the relationship between the demand for real money, income and interest rates. These models can be classified into three separate frameworks, namely transactions, consumer and asset demand theories of money.

Under the transactions theory of money demand framework, the inventory – theoretical approach (see Baumol, 1952 and Tobin, 1956) and the precautionary demand for money (see inter alia Cuthbertson and Barlow, 1991) models were introduced. These models were derived from the medium of exchange function of money.

The asset function of money led to the asset or portfolio approach where major emphasis is placed on risk and expected returns of assets (see Tobin, 1958). Alternatively, the consumer demand theory approach (see Friedman, 1956 and Barnett, 1980) considers the demand for money as a direct extension of the traditional theory of demand for any durable good (see Feige and Pearce, 1977).

The resulting implication of all the models discussed in the previous sections is that the optimal stock of real money balances is positively related to real income and inversely related to the nominal rate of return on alternative assets. Ultimately, the difference lies in the selection of variables that will enter the model.

2.1.4 Friedman's Modern Quantity Theory of Money

Another important development of theories of demand for money was Friedman's (1956) modern quantity theory of money. He stated that the demand for money must be influenced by the same factors that influence the demand for goods and services. Friedman applied the theory of portfolio choice to money and expressed the formula of the demand for money as follows:

$$M_d/p = f(Y_p; R_b - R_m; R^e - R_m; t t^e - R_m)$$

Where M_d/p – demand for real money balances

Y_p - Friedman's measure of wealth, permanent income

R_m – expected return on money

R_b – expected return on bonds

R^e - expected return on equity

$t t^e$ – expected inflation rate

Including permanent income as one of the determinants in the equation helps to avoid its severe fluctuations with business cycles. Friedman divided assets into three types besides money: bonds, equity and goods. The expected return on money R_m is influenced by two factors:

- The services provided by banks on deposits
- The interest payments on money balances

Therefore in developing countries interest rates have no effect or have little effect on the demand for money and permanent income is the primary determinant of money demand. Friedman also suggested that the demand for money function is stable. Because the relationship between y and Y_p is predictable, a stable money demand function implies that velocity is predictable as well. If we can predict velocity, a change in the money supply is the primary determinant of nominal income. Friedman's money demand formulation also gives an explanation to the procyclical velocity phenomenon. Because much of the increases in income will be transitory, permanent income rises much less than income. Friedman's money demand function then indicates that the demand for

money rises by only a small amount relative to the rise in measured income, so velocity rises.

Friedman made use of the theory of portfolio choice to indicate that the demand for money will be a function of permanent income and the expected returns on alternative assets relative to the expected return on money. Friedman believed that changes in interest rates have little effect on the expected returns on other assets relative to money and stressed that the money demand does not undergo substantial shifts and so is stable. These two aspects also indicate that velocity is predictable; yielding a quantity theory conclusion that money is the primary determinant of aggregate spending.

2.2 Empirical Literature

Empirical evidence on the stability of the demand for money functions in United Kingdom (UK) came initially from studies of the long run functions by Paisn (1958, 1959), Dow (1958), and Kavanagh and Walters (1966) as Artis and Lewis (1984) notes. This was later supported by the short run functions estimated by Goodhart and Crockett (1970) and Laidler and Parkin (1970). By contrast, subsequent evidence of instability has come exclusively from examinations of the short run function (Hacche, 1974; Artis and Lewis, 1974). The principal purpose of the (Artis and Lewis (1984) study was to draw attention to the fact that the long run demand for money seems to display evidence of remarkable stability, with only a handful of outlier observations requiring special explanation⁶.

The ratio of money to income was once described by Klein (1962) as one of the “five great ratios of economics”, and its determinants, the arguments of the demand for money function, were thoroughly investigated in the UK (and elsewhere) in the late 1960s and the early 1970s. The success of these investigations and the associated rise of monetarism

⁶ See Artis and Lewis (1985).

hardly need retelling, except to note that a markedly different attitude exists now, as evidenced by Laidler (1981)⁷.

The empirical results given in the paper “the demand for money in Canada” by Gurcharan et al (1968) provided the following points.

“... It has been clearly demonstrated that there exists a stable demand for money function for the Canadian economy over the period from 1936-1968. The function is stable irrespective of whether the constraint of money balances is current income or permanent income and whether the short-term call money rate or the long-term fifteen years government bond yield is used. All interest variables display proper signs and significant coefficients...”

Akerlof (1973), in his new schema in the “demand for money”, notes that the interest rate plays a Keynesian role, but in addition, by encouraging or discouraging investment, the interest rate helps to influence/balance on the equation for the demand and supply of securities, it influences people’s monetary decisions and the unintended flow into their accounts. Also, there are three folds in consumer decision-making, which include consumption, money and securities, which strengthen the reasons for peakedness of money holdings and therefore, tend to strengthen his conclusions.

Bhattacharya (1974), on his structural analysis for India, concluded that money supply was not an exogenous variable in a monetary system. His study shows that money supply; among other variables depends on the interest rate differentiated between the central bank discount rate and short-term interest, of the organized money market. Since the latter was found to be inversely related to money demand, the stock of money becomes an endogenous variable. On the demand side, his study shows that only demand for “money proper” (M1) is inversely related to interest rate. In conclusion time deposits

⁷ ...Ten years ago it was possible to argue that the characteristic monetarist belief in stable demand for money function was well supported by empirical evidence.... However, the last decade has produced a good deal of evidence to suggest that the relationship has shifted in an unpredicted way in a number of countries....

in the definition of money distort the inverse relationship between money demand and interests rate⁸.

According to Rodney (1974), while estimating the long run demand for money for three countries (U.S., U.K., Norway) using time series, the theoretical model indicated that three common methods of defining the aggregate money demand function- deflating the aggregate by population and prices, deflating by prices only, or using nominal data undeflated by population or prices – are mathematically equivalent when the data are dominated by time trend. Differences in the three aggregation procedures have nothing to do with the degree of homogeneity in prices and population, as often claimed but merely reflects the common time trend of the variables⁹.

Laumas and Mehra (1976), on the stability of the demand for money functions for U.S., using an econometric technique, confirmed the stability of the money demand functions that were “properly specified”. The evidence presented showed that all those quarterly demand for money functions that assumed a complete adjustment on actual to desired money holdings within a given quarter yield unstable econometric relationships. For the quarterly demand for money functions that do allow lags in adjustment, it seemed that stable demand for money functions included short and intermediate interest rates. It does not matter whether permanent or current income is used. Also, the definition of the money stock also remains an open question.

Laumas and Mehra (1977), while testing for the stability of the money function for the U.S. from 1900-1974, used an econometric technique and confirmed the stability of money demand equations that were “properly specified”. They derived estimates of the money demand equation under the general assumption that the parameters would be

⁸ For India, the Keynesian liquidity preference hypothesis seems to hold good for the organized money market but not for the unorganized money market. Also money demand depends on monetized components of national income rather than total income.

⁹ He contends “...There appears to be no justification for estimating the long run demand function in aggregate real or nominal terms. Although these estimates have been shown to be equivalent to the estimates, based on real per capita data, they can be quite misleading if not interpreted properly, since they bias the apparent income elasticity toward s unity and indicate a smaller standard error for the apparent income elasticity...”

subject to permanent shifts over time and all these estimated coefficients had correct and statistically significant signs. The statistical evidence presented showed that only those demand functions that allow an “adjustment mechanism” yielded stable estimates of the parameters.

Mehra (1978), while investigating if money was exogenous in money-demand equations, noted that all the existing empirical work on money demand which used single equation estimation techniques implicitly assumed that there were no feed backs from real money to real income and nominal rates of interest in the conventional formulation of money demand equation. He also concluded that the causal structure between money, income and interest rate inferred from the estimated “real” money demand equations was not indicative of true underlying causal structure because it is derived from the money demand equations estimated under wrong prior restrictions on the shapes of the estimated coefficients on income and the price level¹⁰.

According to Wagner (1981), he noted that the pre-Keynesian quantity theorists were quite correct in assuming that a stable money demand function implied a stable monetary multiplier. However, once the rate of interest is introduced to the money demand function, a stable money demand function no longer implies a stable monetary multiplier¹¹.

Perera Nelson (1984), in his paper on the demand for money in Sri Lanka, estimated the demand for money function based on theoretical developments. He incorporated the Partial Adjustment Mechanism (nominal and real) and adaptive expectations mechanism in order to specify the demand for money function for Sri Lanka. The specified equations were estimated by the Generalized Least Squares (GLS) estimation procedure combined with two dimensional grid searches over the range of the adjustment coefficients. His

¹⁰ On the other hand, the estimation of money demand equations in nominal form doesn't yield any conclusive answers with respect to the underlying causal structure between money, income and interest rates.

¹¹ Indeed one cannot even ascertain a priori if the monetary multiplier is more stable than the fiscal multiplier. It appears that the inclusion of interest rate in the demand for money function does entail some significant implications, at least more than Professor Friedman is willing to concede

major finding was that there existed a stable demand function for Sri Lanka despite the changes in the economy during the past years. The policy implication of this; it had a predictable effect on ultimate economic variables.

Hafer (1985), on his comment on “money demand predictability” concluded that short-run money demand function usefulness meant predicting next quarter’s real money balances and this was less than satisfactory. This does not mean that it had no place in setting monetary policy. Indeed, given the fact that policy is set in terms of money growth and its impact on income growth and inflation, it would seem that the apparent “stability” of the first-differenced money demand function should be of interest to a policy-maker using money growth as an intermediate target. Given the forecasts derived from the first differenced model, the evidence suggests to him that a short-run discretionary monetary policy oriented towards controlling some nominal interest may have no place in the current economic environment.

Yoshida (1990) shows that using an ECM type money demand function for Japan for the period 1968 to 1989, the demand for money stability was not conclusive. First by the use of the conventional method, where real money supply (defined as M2) was regressed on real GNP, results pointed to stability. However, DW ratio and LM test both pointed to a residual auto- correlation, which led him to doubt the overall credibility of the regression.

Studies of Australia's money demand generally define money in real terms and tend to focus on M2 while predominantly applying the Engle – Granger and Johansen procedures (deBrouwer, Ng and Subbaraman, 1993). The results are ambiguous with regards to M1 and M2. Orden and fisher (1993) and de Haan and Zelhorst (1991) find that M3 and GDP are not cointegrated after deregulation. In contrast, Lim and Martin (1991) concluded that M3 and GDP are cointegrated after deregulation. Using alternative definitions of money, income and interest rates and applying different testing procedures, de Brouwer, Ng and Subbaraman (1993) found no evidence of cointegration between M1 and income with only weak evidence of cointegration between money base and broad money.

For New Zealand, Orden and Fisher (1993) found no co-integrating relationship for the full sample (quarterly data between 1965 and 1984). Similarly, applying Canadian data from 1968 to 1999, Tkac (2000) found that money; output, prices and interest rates were co-integrated.

However, in U.K., Drake and Chrystal (1994) found that a cointegrating relationship existed for all the monetary aggregates examined and the ECM indicated a rapid speed of adjustment. The latter results were mirrored in Miller's (1991) study in the US where he found a cointegration relationship for M2 and the ECM for M2 suggested a significant error correction term. Hayo (1998) found a stable money demand for 11 European Monetary Union (EMU) countries. Factoring financial innovation, Scharnagl (1998) still found a stable long run money demand relationship for Germany.

From these few studies, it is evident that the results vary. Much of the variation is dependent on the cointegration tests selected and the combination of money and interest rates (Haug and Lucas, 1966). Nevertheless, existence of cointegration between money and income would not, in itself, necessarily establish a paramount role for monetary aggregates in policy making (de Brouwer, Ng and Subbaraman, 1993). Presently, central banks generally agree that conventional monetary aggregates are of little use as targets or indicators for monetary policy (Woodford, 1997). Woodford (1997) also contends that it is possible to analyze equilibrium inflation determination without reference to money supply or demand.

Black and Dowd (1994), while analyzing the factors that influence both money supply and demand in asset substitution, commented that since the late 1970s, however, the assumptions implicit to the traditional specifications have been called into question by empirical studies [e.g. Moore, 1988; Manchester, 1989; Garfinkel and Thornton, 1991; Gauger and Black, 1991]. Gauger and Black (1991) showed that contrary to the assumptions of the traditional model, variations in the money supply are primarily due to variations in the money multiplier and not the base. Moreover, these studies found that the influence of changes in income and interest rates on the demand currency is different

from their influence on the demand for checkable deposits (see Papedemos and Modiglian, 1991). Black noted that the substitution between the components of money demand changes the money multiplier and hence will change the money supply.

The next paragraphs investigate the results for money demand in developing countries. Since financial markets are less developed and prone to regulation, the findings could be different.

Adekunle (1968), in his study, attempted to examine the degree of uniformity that existed across economic environments in the behavior of monetary relationships. Specifically, his study attempted to see the implications, if any, of structural and other differences that separated developed from less developed economies and if the traditional demand function was appropriate for each environment. The 18 countries studied were grouped into three economic environments; industrial, other developed and less developed; and the data for each group were pooled. He contends that:

“... While there is a wide room for generalizations about desired money holdings, there are difference in the form of the demand for money function that can be appropriately applied to each economic environment. The lagged expectations formation in the monetary sector does seem to be shorter in the less developed group....”.

Chorng – Huey Wong (1977), in his paper on the “demand for money in developing countries”, examines the role of credit restraint variables in the demand for money function for developing countries where interest rates are inoperative. A simultaneous equation model was proposed to allow for the interaction between these variables and the supply of money. Statistical results indicated that credit restraint variables in the demand for money function had stronger explanatory power than either the inflation rate or the real rate of return on money.

A money demand function was estimated for ten developing countries (including India, Mexico and Nigeria) and cointegration was only established in a minority of cases (Arrau

et al, 1991). The instability of the money demand function in the latter study was probably a result of the failure to account for financial innovation (Arrau et al, 1991). However including proxies for financial innovation in the study did not improve the stability of the demand for money in those developing countries. The findings in this study suggest that while it is difficult to forecast the path of financial innovation, it would be beneficial to model the process in some way so as to recover better estimates of the money demand function.

In contrast, a stable relationship for narrow money was found for the West African Economic and Monetary Union (WAEMU) even amidst financial liberalization (Rother, 1998). However, Rother (1998) contends that the stability of the demand for money would only continue in WAEMU as long as the economic agents have confidence in the stability of the financial system.

On the other hand, for the Association of South East Asian Nations (ASEAN) countries, Dekle and Pradhan (1997) found continuing instability in the demand for money as financial liberalization intensified. The results indicated that money growth rates were poor predictors of future inflation and output trends, so policy decisions needed to be based on a wider set of monetary and real sector indicators of inflationary pressures [Dekle and Pradhan, (1997)].

Naho (1985), in his study of the demand for money in developing countries estimated money demand functions for Kenya, Tanzania, Burundi, Rwanda and Uganda using the conventional approach to money demand. The sample period covered was 1967-1981. Real money balances (M2) was regressed on real income, the government deficit ratio to income, the rate of inflation and a credit restraint variable. While the government deficit ratio to income was a proxy for money supply changes, the credit restraint variable was used as proxy for the interest rate. He found out that the demand for money in those countries was unstable

Domowitz and Elbadawi (1987) estimated an ECM type money demand function for Sudan, for the period of 1956 – 1982 using annual data. Nominal money balance was regressed on the price level, income, the exchange rate and inflation rate variables. Results showed an income elasticity which was not only significant but also positive (with the expected sign). Stability tests showed that there existed a stable money demand function for Sudan.

Adam (1992) estimated an ECM – type money demand function for Kenya's narrow money for the period 1973 –1990 using quarterly data. Real money balances was regressed on income, the domestic rate of interest, the rate of return on holdings of foreign exchange (the currency substitution effect) and rate of inflation. In his analysis of the model, he first assumed that the full sample coefficients remained stable for the entire period under investigation. Then he turned on to test the recursive stability of the model. He re-estimated the model using the Recursive Least Squares Estimator method to test whether there had been any significant change in the value of the coefficients throughout the period by estimating the model over the period from 1973 to 1977 and then recursively thereafter quarter by quarter. Except for the inflation term, which showed slight instability, all the other coefficients revealed a strong degree of stability, which showed that there existed a stable money demand function for Kenya.

Chris Adam (1992), in his paper “on the dynamic specification of the demand for money in Kenya”, says that the nature of applied time series econometrics is such that empirical conclusions can, at best, be tentative, most particularly when the focus of attention is on the consequences of structural reforms such as those that have been occurring across Africa in the last decade. His paper suggests that the conclusions drawn from earlier analysis of money demand up to the 1980s should be disqualified. That although there is compelling evidence that the fundamental characteristics of money demand remain broadly unchanged, the relationship between money and its determinants in the short –to medium term has altered, often substantially, in a way that weakens the case for money-based stabilization strategies in Africa.

Kateregga (1993) estimated the demand function for Uganda over the period 1980 – 1992 using quarterly data with the help of the ECM. She estimated the demand function for Uganda while regressing the desired real money holdings on real GDP, real interest rate and expected rate of currency depreciation and expected inflation rate and found that the stability test showed that the demand for M0 and M2 had been stable and that for M1 were unstable over the period.

Henstridge (1999) in his paper “demonetization, inflation and coffee: demand for money in Uganda”, investigated the macroeconomic history of Uganda using a time series model for the demand for the three main monetary aggregates. He says that a collapse of income and high inflation led to de-monetization. The flight from currency and demand deposits was limited by their use for transactions, but demand for time and saving deposits was largely a function of inflation. The role of the exchange rate and the price of coffee in determining an asset demand for money were mixed. Re-monetization since the late 1980s had been slower than de-monetization. The econometric results implied that alternatives to money, such as foreign currency and coffee; have had a mixed role. In the longer run, they are alternative assets; as their relative price goes up, the demand for money goes down. But in the short-run, an increase in their price led to an increase in the demand for money, especially currency, because money was a medium for transactions into and out of both foreign currency and coffee; especially coffee when it was part of a thriving smuggling trade.

Nell (1999) in his study of the stability of money demand in South Africa for the period of 1965 to 1997, estimated the money demand function of (M1, M2, M3) against nominal interest rate, GDP, inflation, exchange rate and this showed that there existed a stable long run demand for money function for M3 in South Africa, while the demand for M1 and M2 display parameter instability following financial reforms since 1980.

Randa (1999) in his paper “Economic reform and the stability of the demand for money in Tanzania” investigated whether there exists a stationary long-run equilibrium relationship between real money balances, real income, inflation and expected

depreciation in Tanzania which can be identified as a money demand function. As the institutional and regulatory framework in Tanzania has undergone a series of changes since economic reforms began in the mid-1980s, shifts in parameters over time have occurred, causing instability in the money demand function. Using Johansen's maximum likelihood and dynamic modeling procedure, the paper finds equilibrium in the long run and a stable money demand function. These findings imply that, even though economic liberalization and relaxation of controls could have induced instability in the money demand function as conjectured in the literature, such instability was not significant enough to inhibit the estimation of short – and long-run demand for money.

Kararach (2001)'s empirical analysis of the demand for money function in Uganda using the ECM showed that treasury bill rate was included as a cointegrating variable primarily because, for a large part of the 1980s and up to 1992, it was institutionally fixed. According to him there was no evidence of stability in the demand for money function in Uganda while estimating real money demand using GDP (real output), inflation and real interest rates and real exchange rate as the explanatory variables.

Katafono (2001), while re-examining the demand for money in Fiji used contemporary empirical methods based on sound theoretical principles estimated real broad money against GDP, real interest rates, rate of inflation and real effective exchange rate and found out that the demand for money was unstable in Fiji.

Beguna et al (2002), in their working paper on demand for money in Latvia using cointegration analysis and ECM, estimated their money demand function against real interest rates, rate of inflation and real exchange rate and the results showed that the financial situation had not been stable all the time, considering the rapid development of the money market and influence of two crises but there was a stable M1.

Alejandro (2004), while analyzing the money demand and monetary disequilibrium in Argentina from 1963 to 2003, used "new" open macro-economic framework provided by

the Redux model (a new open macro-economic framework that includes non-tradables)¹². In a model with non-tradable goods, the fundamentals of money demand appear to be not only domestic product prices and interest rates, but also net foreign asset prices, productivity differential and terms of trade. He introduces the new fundamentals in the standard ECM of money demand in order to deal with Argentina's macro-economic instability. The models showed that past currency crisis could be explained by the disequilibrium in the money market and volatility of money demand to external shocks. Using the Johansen cointegration estimation methodology, there was a stable money demand function.

Muhd et-al (2004), while re examining the money demand in Malaysia covering a period from 1974 to 2001, their results showed evidence of instability in the short run money demand after using the ECM and cointegration technique using real GDP, rate of money measured by monthly fixed deposit rate, treasury bill rate, real effective exchange rate and consumer price index.

Hilde (2004) while investigating the demand for broad money stability of demand in Venezuela over a period of financial crisis and substantial exchange rate fluctuation showed that there existed a long-run relationship between real money, real income, inflation, the exchange rate and an interest rate differential, that remains stable over major policy changes and large shocks. The long-run properties emphasize that both inflation and exchange rate depreciation have negative effects on real money demand where-as a higher interest rate differential has a positive effect. The long-run relationship is finally embedded in a dynamic equilibrium correction model with constant parameters. These results have implication for policy-makers. In particular, they emphasize that with a high degree of currency substitution in Venezuela, monetary aggregates will be very sensitive to changes in the economic environment.

¹² See the extended version of the Obstfeld and Rogoff (1995)

2.3 Overview of the literature

The reviewed empirical literature suggests a relationship between money and some representative measure of opportunity cost such as the treasury bill rate and a scale variable such as wealth or income. The dominant approach to modeling the demand for money in the reviewed empirical literature utilizes both the Partial Adjustment Mechanism (PAM) and the Error Correction Modeling (ECM). Results are mixed on the nature and stability of the demand for money function. Most studies like Beguna (2002), Katafono (2001), Muhd et-al (2004), Kararach (2001), Kateregga (1993), Naho (1985), show that the demand function for money in those respective countries was unstable while a few studies by Kevin S. Nell (1999), Adam (1992), Domowitz and Elbadawi (1987) also using ECM pointed to stability of the money demand function, yet a study by Yoshida (1990), was uncertain about stability. In all cases, income is reported to have a significant influence on the demand for money while results on opportunity cost variables are mixed with regard to influence on the demand for money.

With respect to Uganda, the studies reviewed adopted a similar approach to modeling the demand for money. ECM was the preferred approach by Kararach (2001) and Kateregga (1993). This study will use ECM and time series data on a quarterly basis for the empirical analysis of the demand for money function over the entire sample period. The extended sample will enable us examine the implications of money demand after financial liberalization. Apart from the stability testing, we also intend to find the determinants of money demand.

CHAPTER THREE

3.0 METHODOLOGY

This study examines the determinants and stability of money demand in Uganda, taking into consideration financial innovations (which may be as a result of financial reforms or other factors like advancement in technology). Since financial reforms are known to alter the demand for money function, then models formulated to estimate the demand for money incorporating financial innovations in the analysis were used. A number of studies¹³ have been done on the demand for money following this modification of the general demand model to capture the financial innovations.

3.1 Selection of variables

3.1.1 Money stock

Money stocks are mainly classified into two groups – narrow and broad money. As the names suggest, narrow money consists of those assets readily available for transactions while broad money encompasses a wider range of assets. Laidler (1993) states that the correct definition of money is an empirical matter. As such, several definitions of money have been used in various studies. The measures of money have been selected based on the objectives of the researchers (Sriram, 1999). For purposes of this research, the two widely used measures of money in Uganda (namely, narrow and broad money) were used to explain and analyze the stability of the demand function.

3.1.2 Scale variables

The scale variable is used as a gauge of transactions relating to economic activity. The most commonly used variables are GNP, GDP and NNP. Recent research have focused on other scale variables involving more comprehensive measures of transactions and the segregation of transactions into various components under the idea that all transactions are not equally “money intensive” (see Goldfeld and Sichel, 1990). However, Goldfeld and Sichel (1990) concluded that there is no firm evidence that the categorization of GNP into components yield an improvement in the behavior of money demand.

¹³ Liebermann (1977), Ochs and Rush (1983), Sowa and Antwi-Asare (1995), Arrau et al (1991)

Wealth is also used as a scale variable but usage is constrained to only a few countries such as the UK and US where data is available. This research uses real GDP as a proxy for the scale variable as the data is readily available.

3.1.3 Financial innovation

The degree of monetization as one of the elements of financial innovation is captured by currency – money ratio (C/M) which is expected to be negatively correlated with the money economy. The improved banking service following reforms is expected to make the non-bank public to shift their portfolio from currency to bank deposits and financial holdings¹⁴.

The expansion of financial services and instruments due to financial reforms following Bordo and Jonug (1990) can thus be proxied by the ratio of non-bank deposits to bank deposits. Bordo and Jonug's proxy of the ratio of total non-bank to total bank financial assets was replaced with deposits ratio for the simple reason that it includes idle and non-performing loans that may bias our conclusion. Thus an increase in the ratio reflects the level of expansion of non-bank financial firms into products and services that compete with many bank services. This then implies a decrease in money demand as the expansion of banking and financial services induce the non-bank public to make greater use of banking services making it negatively correlated to money demand. The ratio of non-bank deposit to total bank deposits (TNBD/TBD) thus serves as a proxy for financial development and is expected to be negatively correlated with the demand for money (This of course depends on the definition of money). However, because we were unable to get information on the variable for the period between 1986 to 1994, we substituted it with a dummy variable which takes on the value of zero for the period before 1993 (pre-liberalization) and the period after 1993 (post liberalization) takes on the value of one.

3.1.4 Opportunity cost variable

Typically, the opportunity cost of holding money involves two components, the own rate of return of money and the rate of return on alternative assets. Ericsson (1998) states that

¹⁴ See Bordo and Jonug (1990)

it is important to include both interest rates to avoid the collapse of the estimated money demand function. Considering portfolio choices, agents also consider money as part of real and foreign assets (Sriram, 1999).

The return on goods and services is usually represented by the expected rate of inflation (Sriram, 1999). Theoretically, Friedman (1956, 1969) pioneered the inclusion of the expected rate of inflation, and the relationship between demand for money and expected inflation is well documented by Arestis (1988). Arestis postulated that the real value of money falls with inflation whilst the value of real assets is maintained. Therefore, there is a strong incentive for persons to switch out of money into real assets when there are strong inflationary expectations. In developing countries where the financial sector is not well developed, the expected rate of inflation is usually the only variable used as the opportunity cost of holding money.

Foreign interest rates and the expected rate of depreciation usually represent the returns on foreign assets (Sriram, 1999). The currency substitution literature provides the necessary support in choosing the appropriate variables that account for foreign influence. Direct currency substitution concentrates on the exchange rate variable while the capital mobility or indirect currency substitution literature focuses on foreign interest rate (see inter alia Giovannini and Turtelboom, 1993 and Levenatakis, 1993).

For the purposes of this study, both the own rate of return of money and the rate of return of the alternative asset is included. The nominal rate is used since there are two costs associated with holding money balances – the real interest rate reflects the opportunity cost of holding deposits, while the expected rate of inflation is to compensate depositors for the expected depreciation in the real value of money because of inflation¹⁵. The nominal exchange is used as a proxy for expected depreciation. The foreign interest was disregarded as it is assumed that most economic agents in Uganda do not consider foreign securities as a relevant investment alternative.

¹⁵ Bahmani – Oskooee (1991).

3.2 Model specification ✓

The conventional money demand function takes the form of $(M/P) = f(Y, I)$ as stated by Keynes (1936).

Where: M/P is the real money demand balances

Y = income, I = interest rates

Our specification of the demand for money is as follows:

$$(M/P)_t = f(Y_t, r_t, Px_t, (CM)_t, (\text{dum93}), E_t, U_t) \dots \dots \dots (1)$$

Such that $f_1 > 0$, $f_2 < 0$, $f_3 < 0$, $f_4 < 0$, $f_5 < 0$, $f_6 < 0$ where f_i is the partial derivative of real balances with respect to $Y, R, \pi, E, (CM), (\text{dum93})$ respectively

$(M/P)_t$ is the demand for real balances in year t

✓ Y_t is the real GDP in year t

r_t is the nominal interest rate in year t

Px is the inflation rate in year t

E_t is the exchange rate in year t

$(CM)_t$ is the currency-money ratio

(dum93) is the dummy (0= pre liberalization and 1= post liberalization) and

U_t is the error term, which is normally and independently, distributed with zero mean and constant variance.

In semi-log linear form the equation (1) can be expressed as:

$$\text{Log } (M/P)_t = \alpha_0 + \alpha_1 \log Y_t + \alpha_2 R_t + \alpha_3 Px + \alpha_4 \log E_t + \alpha_5 \log (C/M)_t + a_6 \text{dum93} + U_t \dots (2)$$

3.2.1 Hypotheses of the study

The hypotheses of the study include the following

- a) Income is positively related to money demand
- b) Nominal interest rate is negatively related to money demand
- c) Inflation is negatively related to money demand
- d) Exchange rate is negatively related to money demand
- e) Money demand is negatively related to financial innovation, proxied by currency money ratio and the for the post liberalization period.

3.3 Estimation methods

3.3.1 Partial adjustment models (PAM)

The PAM, a semi-log linear specification extensively used for estimating money demand, was originally introduced by Chow (1966) and later popularized by Goldfeld (1973). This model augments the traditional formulation of money demand by introducing the following two concepts:

- 1) Distinction between desired and actual money holdings; and
- 2) The system by which the actual money holdings adjust to the desired levels (Sriram, 1999)

This model fared well when the post-war to 1973 data was used but it was unable to explain the instability in the demand for money experienced since the early 1970s (Sriram, 1999). The problems associated with this model were both theoretical and empirical in nature. The PAM soon lost favor to the Buffer Stock Models (BSM) and error correction models (ECM). Boughton and Tavlas (1991) found that estimates obtained by the BSM and ECM for money demand significantly out performed those of the PAM.

3.3.2 Buffer stock models (BSMs)

The BSMs were predominant in the 1980s as an alternative paradigm for money demand estimation to over-come the two common problems with the PAM, namely the short run interest overshooting and long implausible lag of adjustment (Sriram, 1999). Proponents of BSM postulated that the reason the PAM did poorly was that they failed to consider the short run impact of monetary shocks (Sriram, 1999). The two main changes in the BSM over the PAM were that money shocks are explicitly modeled as part of the determination of money demand and the lag structure is much more complex (Sriram, 1999).

Despite the improvement made over the PAM, there have been mixed results in the empirical applications of this approach (see Boughton and Tavlas, 1991 and Cuthbertson and Taylor, 1987). Milbourne (1988) concluded from his extensive survey that BSM had

theoretical and empirical shortcomings. Consequently, as criticisms grew, the BSM lost their appeal while ECM moved to the forefront in estimating the demand for money.

3.3.3 Error correction models (ECM)

The ECM has proved to be a successful tool in applied money demand research (Sriram, 1999). It is a dynamic error correction representation where the long run equilibrium is embedded in an equation that captures short-run variation and dynamics (see Kole and Meade, 1995). Granger (1983, 1986) showed that the concept of stable long – term equilibrium is the statistical equivalence of cointegration implying the existence of a dynamic error correction form. Engel and Granger state that the cointegration implies the existence of dynamic error correction forms.

With respect to the estimation techniques, the two widely used approaches are Engle and Granger (1987); and Johansen (1988) and Johansen and Juselius (1991). The latter approach is more prominent as it provides an opportunity to evaluate the presence of multiple cointegration vectors and has shown that it is more efficient than the former (Sriram, 1999).

3.4 Estimation issues

We first tested for the time series properties of the variables before equation (2) was estimated. We used single equation estimation technique and Gilbert (1986)'s general to specific modeling technique, where all variables were lagged three times. The statistical package used was PC GIVE version 10.

3.5 Unit root test

If the equation is estimated with data that are non-stationary, the t-statistics of the estimated coefficients will be unreliable since the underlying time series would have theoretically infinite variance. Thus to test whether each variable is non-stationary, we performed a unit root test on each of the variables or tested the order of integration of each series. Three tests were used i.e.

(i) **The Dickey Fuller (DF) test**

$$\Delta x_t = \alpha + \beta_1 x_{t-1} + \varepsilon_t$$

$H_0: \beta = 1$ against the alternative $H_1: \beta < 1$

(ii) **The “Augmented” Dickey Fuller (ADF) test**

$$\Delta x_t = \alpha + \beta_1 x_{t-1} + \sum_{i=1}^k \gamma_i \Delta x_{t-i} + \varepsilon_t$$

Where k is the number of augmentations necessary to rid the series from autocorrelation and

(iii) **Sargan Bhargava Durbin Watson (SBDW) test**

$$DW(x) = \frac{\sum (x_t - x_{t-1})^2}{\sum (x_t - \bar{x})^2}$$

Unlike the DF tests, the test is against the null that the series is $I(0)$ in which case the value of the DW statistic will tend towards a value of 2. If the statistic is low then this is evidence of an $I(1)$ series¹⁶.

3.6 Cointegration tests

In the event of the non-stationarity of the series, we conducted tests of cointegration. Here, we applied the Augmented Dickey Fuller (ADF) test to the residual of the statistic cointegrating (long run) regression rather than the levels of the series. Following the work of Engle and Granger (1987), we specified the co-integrating regression as:

$$x_t = \alpha_0 + \alpha_1 Z_t + \varepsilon_t$$

The residuals of the equation $\varepsilon_t = (x_t - \alpha_0 - \alpha_1 Z_t)$ is simply the linear difference of the $I(1)$ series. If the residuals from the linear combination of non stationary series are themselves stationary, then we accept that the $I(1)$ series are cointegrated and we shall take the residuals from the cointegrating regression as valid term (ECM) which is then built into an error correction model. In the case of tests for cointegration the critical values for the tests will differ according to the number of variables in the cointegrating regression.

¹⁶ See Adam (1992).

3.7 Data type and sources

Time-series data is used for the analysis. Data sources are Bank of Uganda (Bank of Uganda Quarterly and Annual Economic Reports, Bank of Uganda staff estimates) and Statistical Department of Ministry of Finance and Economic Planning (background to the budget, key economic indicators). IMF and World Bank supplemented these with data from World Tables and International Financial Statistics, respectively.

GDP figures are the GDP at factor cost at constant (1991) prices for calendar years in billions of Uganda shillings from key economic indicators. Exchange rates are the official middle rate (Uganda shillings per US\$) while the interest rate is the 91 days treasury bill rate recorded monthly. The inflation rates are computed from the composite CPI for Uganda and data of money supply on monthly basis is collected from the two definitions M1 and M2 which are the end of month figures in billions of Uganda shillings. M1 is currency in circulation plus demand deposit, M2 is M1 plus time and savings deposits. GDP quarterly data is derived from the annual figures through the Friedman (1962)¹⁷ interpolation method. The rest of the data are in quarterly form so they were not be interpolated.

¹⁷ For details of interpolation methods see appendix (i)

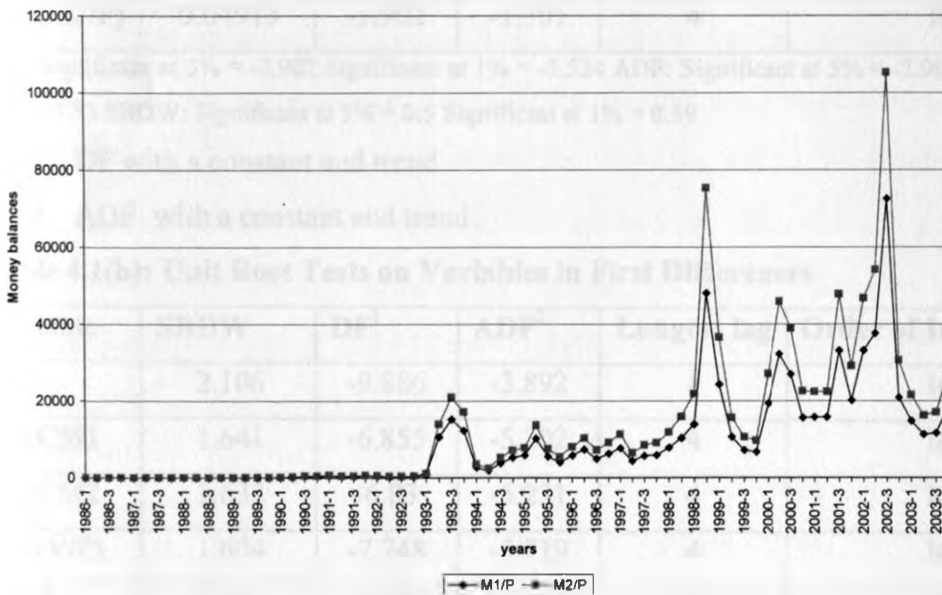
CHAPTER FOUR

4.0 Presentation and Interpretation of Results

In the Ugandan context, it is important from a policy point of view to establish whether there exists a stable long-run relationship for money demand. This is because money demand serves as a conduit in the transmission mechanism for monetary policy, so the stability of the money demand function is critical if monetary policy is to have predictable effects on inflation and real output.

4.1 Descriptive Analysis of Real Money Demand

Graph 4.1: Real Money Demand



Source: Bank of Uganda, Various Issues (see Appendix xi)

From the above graph, it is evident that M2 is growing at higher rate than M1, and this is consistent with empirical literature, especially that, time deposits expand faster than currency in circulation and demand deposits. Also from the above graph, it is evident that from 1993 we have some slight growth in both broad and narrow money and this could be attributed to financial liberalization of the economy and previous political instability that the economy was overcoming. The continued growth of broad and narrow money continues to be manifested sharply in 1998 and 2002.

4.2 Unit Root Tests

Table 4.1(a): Unit Root Tests on Variables in Levels

Variable	SBDW	DF ¹	ADF ²	Longest lag	Order of Integration
r	0.05872	-2.463	-2.2212	4	I(1)
LogCM1	0.1596	-2.717	-1.608	4	I(1)
LogCM2	0.1424	-2.619	-1.528	4	I(1)
Log(Y/P)	0.05651	-1.978	-1.604	4	I(1)
LogE	0.03615	-2.088	-2.317	6	I(1)
Px	0.04929	-2.389	-3.226	4	I(1)
Log(M1/P)	0.0529	-1.975	-1.398	4	I(1)
Log(M2/P)	0.04913	-1.902	-1.301	4	I(1)

DF: Significant at 5% = -2.902 Significant at 1% = -3.524 ADF: Significant at 5% = -2.905 Significant at 1% = -3.53 SBDW: Significant at 5% = 0.5 Significant at 1% = 0.39

1. DF with a constant and trend
2. ADF with a constant and trend

Table 4.1(b): Unit Root Tests on Variables in First Differences

Variable	SBDW	DF ¹	ADF ²	Longest lag	Order of Integration
r	2.106	-9.886	-3.892	4	I(0)
LogCM1	1.641	-6.855	-5.202	4	I(0)
LogCM2	1.633	-6.83	-5.231	4	I(0)
Log(Y/P)	1.604	-7.748	-5.719	4	I(0)
LogE	2.086	-9.495	-5.851	2	I(0)
Px	1.554	-7.341	-3.523	4	I(0)
Log(M1/P)	1.572	-6.780	-5.596	4	I(0)
Log(M2/P)	1.565	-6.756	-5.622	4	I(0)

DF: Significant at 5% = -2.903 Significant at 1% = -3.525

ADF: Significant at 5% = -2.906 Significant at 1% = -3.531

SBDW: Significant at 5% = 0.5 Significant at 1% = 0.39

The Sargan Bhargava Durbin Watson (SBDW) test is against the null hypothesis that the series is I(0), in which case the values of the statistic that are less than the critical value indicate rejection of the null. The critical value of SBDW at 1% and 5% are 0.51 and 0.39

respectively. Unlike the SBDW test, the Dickey-Fuller tests are against the null hypothesis that the series is $I(1)$ in which case when the value of the statistic is less than the critical value in absolute terms we may not reject the null, the critical values of the DF at 1% and 5% are -2.902 and -3.524 respectively while those of the ADF at 1% and 5% are -2.905 and -3.53 respectively. It is however, worthwhile to note that one of the strongest arguments for using the DF tests and SDBW statistics together is that in each case the null hypothesis is the same as the alternative hypothesis of the other, thus providing a cross-check for the test.

Table 4.1 shows the results of the Sargan Bhargava and Dickey-Fuller test statistics for the order of integration of each series. These results can be interpreted as indicating that all the variables are non-stationary for Table 4.1(a)¹⁸, this decision is based on the ADF at 1% since the ADF is more informative and less restricted and the implication is that any specification of the model in levels of the series from this data set is likely to be inappropriate and a problem of spurious regression is likely. However, since all the variables are integrated of order 1, they therefore become stationary after differencing them once as reported in Table 4.1(b).

4.3 Co-integration Tests

Given the non-stationarity of the series, tests of co-integration were conducted; we applied the Augmented Dickey-Fuller (ADF) test to the residuals of the static co-integrating regressions, following the work of Engle and Granger (1987). Stationary residuals from the co-integrating regressions were taken as valid error-correction term (ECM) and built into the error correction model. We tested different static co-integrating regression equations and the results of the bivariate co-integrating regressions are reported in Table 4.2.

¹⁸ See Graphs in Appendix (iii)

Table 4.2(a): Bivariate Co-integration results for real narrow money [Log (M1/P)]

Independent variable	ADF		Conclusion
	Test Statistic	Lag	
Log(Y/P)	-3.381	4	Co-integrating
Log E	-1.685	4	No Co-integration
Log CM1	-3.188	4	Co-integrating
Px	-1.166	4	No Co-integration
r	-3.9	4	Co-integrating

ADF: Significant at 5% = -2.905 significance at 1% = -3.53

Table 4.2(b): Bivariate Co-integration results for real broad money [Log (M2/P)]

Independent variable	ADF		Conclusion
	Test Statistic	Lag	
Log(Y/P)	-4.591	4	Co-integrating
Log E	-1.673	4	No Co-integration
Log CM2	-3.279	4	Co-integrating
Px	-1.193	4	No Co-integration
r	-3.859	4	Co-integrating

ADF: Significant at 5% = -2.906 significance at 1% = -3.531

In testing for co-integration, we tested for the bivariate co-integration between the different real money balances and all the regressors. When we performed co-integration tests on real narrow money, it was found to be co-integrating with Log CM1, r and LogY/P while with respect to broad money it was found to be co-integrating with Log CM2, r and LogY/P [see appendix (viii) and (ix) for the graphs]. However, for the other variables in both models, the tests indicated lack of co-integration.

Therefore, we took the residuals from the co-integrating regression equations indicated in Table 4.3 below as valid error-correction term, which is then built into the error-correction model. (See Appendix (x) and (xi) for ECM of narrow and broad money respectively).

Table 4.3 Co-integrating regression equations for narrow and broad money

ECM1 (Narrow Money)
$\text{Log M1/P} = \alpha_0 + \alpha_1 \text{LogCM1} + \alpha_2 r + \alpha_3 \text{Log(Y/P)} + e_t$
ECM2 (Broad Money)
$\text{Log M2/P} = \beta_0 + \beta_1 \text{LogCM2} + \beta_2 r + \beta_3 \text{Log(Y/P)} + v_t$

4.4 Estimated Models

After establishing co-integration relationships between the variables of the models, we estimated an over parameterized error correction model. Since the Engle-Granger theorem doesn't reveal any information about the nature of the dynamic process around the embedded long-run solution, we initially specified the error correction model by setting the lag length on all variables to three in all the equations. By moving from a general to a specific model, we intended to maximize the goodness of fit with minimum number of variables and consistency with economic theory. The aim being to simplify the model into a more interpretable and parsimonious characterization of the data. We employed the Schwartz information criterion (SC) as a guide to parsimonious reductions along with a number of diagnostic tests¹⁹, parameter stability and economic theory at each stage of reduction. For purposes of checking the stability of the models we estimated the models using recursive least squares. This was completed by the one-step Chow test.

EQ (4.1) Modeling DLog (M1/P) by OLS

In equation 4.1, we report the over parametrized ECM. We reduced the size of the model by imposing zero coefficients on those lags where the t-statistics is low in Equation 4.1. The result is given in Equation 4.2.

¹⁹ See Appendix (ii) for details

EQ (4.1) Modeling DLog (M1/P) by OLS				
	Coefficient	Std.Error	t-value	t-prob
Constant	0.0261440	0.01970	1.33	0.191
Dr	-0.00490265	0.002081	-2.36	0.023
Dr_1	-0.000785450	0.002262	-0.347	0.730
Dr_2	0.000657467	0.002288	0.287	0.775
Dr_3	-0.00308624	0.002190	-1.41	0.166
DPx	-0.000539494	0.0007385	-0.731	0.469
DPx_1	-0.00290683	0.0007336	-3.96	0.000
DPx_2	-0.000291974	0.0007303	-0.400	0.691
DPx_3	0.00263572	0.0007026	3.75	0.001
DLogCM1	-0.190272	0.05455	-3.49	0.001
DLogCM1_1	-0.114176	0.03789	-3.01	0.004
DLogCM1_2	0.0152665	0.03921	0.389	0.699
DLogCM1_3	0.0302163	0.03390	0.891	0.378
DLog(Y/P)	0.788042	0.05761	13.7	0.000
DLog(Y/P)_1	0.143161	0.04070	-3.52	0.001
DLog(Y/P)_2	0.00515399	0.04094	0.126	0.900
DLog(Y/P)_3	0.0510430	0.03628	1.41	0.166
DLogE	0.0138540	0.03537	0.392	0.697
DLogE_1	-0.177921	0.04531	-3.93	0.000
DLogE_2	-0.238659	0.04189	-5.70	0.000
DLogE_3	-0.101289	0.02876	-3.52	0.001
Dum93	-0.0761395	0.01916	-3.974	0.000
ECM1_1	-0.0489141	0.05168	-0.946	0.349
$\sigma = 0.0484967$, $\text{Adj}R^2 = 0.995346$, $F(22, 44) = 427.7 [0.000]**$, $DW = 1.8$				
Schwartz Criterion (SC) = -5.09953				
AR 1-5 test: $F(5, 39) = 1.6111 [0.1800]$				
ARCH 1-4 test: $F(4, 36) = 0.56794 [0.6875]$				
Normality test: $\text{Chi}^2(2) = 8.623 [0.0049]**$				
Hetero test: $\text{Chi}^2(43) = 0.00000 [1.0000]$				
RESET test: $F(1, 43) = 0.039760 [0.8429]$				

After running the regression, adjustments were done in order to eliminate the insignificant variables, based on the insignificance in their *t-statistics*. Therefore we generated the following final Equation 4.2 for M1/P.

EQ 4.2 Modeling DLog (M1/P) by OLS

	Coefficient	Std.Error	t-value	t-prob
Constant	0.0321543	0.01546	2.08	0.042
Dr	-0.00419838	0.001863	-2.25	0.028
DPx_1	-0.00293352	0.0006663	-4.40	0.000
DPx_3	0.00213699	0.0005694	3.75	0.000
DLogCM1	-0.168000	0.04590	-3.66	0.001
DLogCM1_1	-0.109124	0.02662	-4.10	0.000
DLog(Y/P)	0.816009	0.04814	17.0	0.000
DLog(Y/P)_1	0.142358	0.02792	5.10	0.000
DLogE_1	-0.136694	0.02442	-5.60	0.000
DLogE_2	-0.236956	0.03100	-7.64	0.000
DLogE_3	-0.0982541	0.02365	-4.16	0.000
Dum93	-0.100254	0.01608	-6.235	0.000
ECM1_1	-0.0901640	0.03700	-2.44	0.018
$\sigma = 0.0477909$, $\text{AdjR}^2 = 0.994453$, $F(12, 54) = 806.7 [0.000]**$, $DW = 1.9$,				
Schwartz Criterion (SC) = -6.02463				
AR 1-5 test: $F(5, 49) = 0.50108 [0.7739]$				
ARCH 1-4 test: $F(4, 46) = 1.4542 [0.2316]$				
Normality test: $\text{Chi}^2(2) = 5.6733 [0.0586]$				
Hetero test: $F(23, 30) = 0.90808 [0.5893]$				
RESET test: $F(1, 53) = 0.047172 [0.8289]$				

From the model above we obtained the following: Adjusted R^2 is about 99.4%. The income elasticity of demand is not significantly different from unity (i.e. $0.82 + 0.14 = 0.96$ which is close to unity). This seems to imply that for the period, increases in income led to an increase in real cash balances, this could be attributed to the low inflation experienced in the country for most of the years in the sample period.

The dummy is significant at 1% with a coefficient of -0.100254. Significance of the dummy may reflect subsequent doses of financial reforms over the period of study. The ECM is well signed and significant as shown by its *t-statistic*. This is in line with the earlier conclusion reached that there was co-integration between money and some of the monetary aggregates. The third lag of inflation has an unexpected sign unlike for the first

lag. Also interest rate bears the expected sign and therefore suggests that there is a degree of substitution from non-interest bearing Ugandan notes into interest bearing financial assets and into holdings of foreign currency. Notice that exchange rate has the expected sign and significant.

The model passes the normality test and we accept the null that our residuals are normally distributed, a proof for efficiency and consistency of our estimates. The REST test is such that we accept the null that there is no misspecification, with respect to the AR test we accept the null that there is no auto-correlation, for the ARCH test we accept the null that there is no heteroscedasticity, hence indicating that the model is correctly specified²⁰.

As a result of the initial simplification, we have produced a more parsimonious and interpretable model, although the R^2 has fallen slightly from 99.56% to 99.4%, SC has fallen from -5.09953 to -6.02463 hence signifying an improvement in the model parsimony. The model also tracks the data well over the sample period (See Appendix (v) Equation 4.2 actual Vs fitted).

In this study we also estimated the demand for M2/P. Here we employed the general to specific modeling by initially estimating the over parameterized ECM. The over-parameterized model is difficult to interpret in any meaningful way. Its main function is to allow us identify the main dynamics, patterns in the model and to ensure that the dynamics of the model have not been constrained by a short lag length. The over-parameterized model was later reduced to a more interpretable and parsimonious model.

²⁰ See Diagnostic Appendix (ii).

EQ (4.3) Modeling DLog (M2/P) by OLS

EQ 4.3 Modelling DLog (M2/P) by OLS				
	Coefficient	Std.Error	t-value	t-prob
Constant	0.0235533	0.01929	1.22	0.229
Dr	-0.00582766	0.002103	-2.77	0.008
Dr_1	0.000222891	0.002288	0.0974	0.923
Dr_2	0.00316057	0.002338	1.35	0.183
Dr_3	-0.00306795	0.002275	-1.35	0.184
DPx	0.000988111	0.0007477	1.32	0.193
DPx_1	-0.00223731	0.0007452	-3.00	0.004
DPx_2	-0.000356217	0.0007341	-0.485	0.630
DPx_3	0.00173870	0.0007102	2.45	0.018
DLogCM2	-0.237824	0.05183	-4.59	0.000
DLogCM2_1	-0.111200	0.03690	-3.01	0.004
DLogCM2_2	0.0149316	0.03839	0.389	0.699
DLogCM2_3	0.0978903	0.03399	2.88	0.006
DLog(Y/P)	0.757186	0.05588	13.5	0.000
DLog(Y/P)_1	0.126326	0.04027	3.14	0.003
DLog(Y/P)_2	-0.00147457	0.04075	-0.0362	0.971
DLog(Y/P)_3	0.127335	0.03652	3.49	0.001
DLogE	-0.0158307	0.03465	-0.457	0.650
DLogE_1	-0.195628	0.04514	-4.33	0.000
DLogE_2	-0.186175	0.04046	-4.60	0.000
DLogE_3	-0.0819664	0.02863	-2.86	0.006
Dum93	-0.06793091	0.01893	-3.589	0.000
ECM2_1	-0.0574441	0.05172	-1.11	0.273
$\sigma = 0.0491134$, $\text{Adj}R^2 = 0.995206$, $F(22, 44) = 415.2 [0.000]**$, $DW = 1.98$				
Schwartz Criterion (SC) = -7.61528				
AR 1-5 test: $F(5, 39) = 1.6846 [0.1612]$				
ARCH 1-4 test: $F(4, 36) = 0.24678 [0.9097]$				
Normality test: $\text{Chi}^2(2) = 5.4545 [0.0654]$				
Hetero test: $\text{Chi}^2(43) = 0.00000 [1.0000]$				
RESET test: $F(1, 43) = 0.15950 [0.6916]$				

From the above results, it was noticed that some of the *t-statistics* were insignificant and so were eliminated and we re-estimated the final model as seen in Equation 4.4.

EQ (4.4) Modeling DLog (M2/P) by OLS

	Coefficient	Std.Error	t-value	t-prob
Constant	0.0229095	0.01628	1.41	0.165
Dr	-0.00505985	0.001966	-2.57	0.013
DPx_1	-0.00231326	0.0007086	-3.26	0.002
DPx_3	0.00189626	0.0007055	2.69	0.010
DLogCM2	-0.248791	0.04618	-5.39	0.000
DLogCM2_1	-0.119831	0.02780	-4.31	0.000
DLogCM2_3	0.113025	0.03067	3.68	0.001
DLog(Y/P)	1.138847	0.04778	23.8	0.000
DLog(Y/P)_1	0.144077	0.02985	4.83	0.000
DLog(Y/P)_3	0.143535	0.03186	4.51	0.000
DLogE_1	-0.215898	0.03018	-7.15	0.000
DLogE_2	-0.201165	0.03197	-6.29	0.000
DLogE_3	-0.0739371	0.02481	-2.98	0.004
Dum93	-0.04303410	0.01695	-2.561	0.013
ECM2_1	-0.1433582	0.03847	-3.72	0.000
$\sigma = 0.049806$, $\text{AdjR}^2 = 0.994174$, $F(14, 52) = 633.8 [0.000]**$, $DW = 2.13$				
Schwartz Criterion (SC) = -8.44197				
AR 1-5 test: $F(5, 47) = 1.4889 [0.2114]$				
ARCH 1-4 test: $F(4, 44) = 0.10079 [0.9816]$				
Normality test: $\text{Chi}^2(2) = 4.4493 [0.1081]$				
Hetero test: $F(27, 24) = 1.3707 [0.2191]$				
RESET test: $F(1, 51) = 0.0079809 [0.9292]$				

The first feature to notice is the well defined Error correction term, ECM2-1 which indicates a feed back of approximately 14% of the previous quarter's disequilibrium from the long-run income, inflation, interest rate, exchange rate and currency money ratio elasticities. The significance of the coefficient of ECM supports the conclusion that money, currency money ratio, income and interest rate are co-integrated.

All price effects have the expected signs although the third lag of inflation has an offsetting effect. This is consistent with the "buffer stock" models of money holdings popularized by Akerlof and Millbourne (1980) which are characterized by low and zero short-run elasticity of demand and inflation.

The two terms capturing the rate of return on committing assets are correctly signed. They are both suggesting that there is a degree of substitution from non-interest bearing Uganda shillings to interest bearing Uganda financial assets and into holdings of foreign currency.

The dummy is negatively signed likely to suggest that with liberalization, people demand less money because of financial innovations which include use of E-banking and automated teller machines (ATM). Also the other variable CM2 without a lag and lag one are significant and correctly signed except for the third lag of CM2 with an unexpected sign and significant. Thus increased financial innovation leads to decrease in demand for money with respect to CM2 without a lag and lag one.

Although R^2 has slightly fallen from 99.5% to 99.4%, but SC has also decreased from -7.61528 to -8.44197 thus indicating an improvement in model parsimony. We therefore, conclude that for the full sample, the model adequately captures the salient features of the data and is consistent with the main implications of the theory.

The F-statistic is significant looking at its probability hence a good fit indicating that our model fits the Ugandan economy very well for the sample period. The income elasticity of demand for M2/P is 1.14 which is positive and well above unity and consistent with past studies especially for developing countries. The partial interest elasticity of -0.0051 is correctly signed (negative) and inelastic. This confirms to past studies that interest rate may not play a big role in under-developed money and financial market like the Ugandan case.

The exchange rate has an elasticity of -0.22, 0.20 and 0.07, for lag one, two and three respectively, with the expected signs. The partial inflation elasticity is -0.0023 and 0.0019, with the expected sign. The currency money ratio has an elasticity of -0.25, -0.12 and 0.11, as for the dummy variable it is -0.043, lastly is the error correction term which is negatively signed.

The model passes the normality test and we accept the null that our residuals are normally distributed, a proof for efficiency and consistency of our estimates. The REST test is such that we accept the null that there is no misspecification, with respect to the AR test we accept the null that there is no auto-correlation, for the ARCH test we accept the null that there is no heteroscedasticity, hence indicating that the model is correctly specified. The model tracks the data well over the sample period (see appendix (vii), equation 4.4, actual Vs fitted). Also the diagnostic tests indicate that the model is consistent with the data.

4.5 Stability Tests for Money Demand Functions

Classical economic theory perceives money demand as a stable function of income, prices and interests rates. This stability is predicted on unchanging institutional environment. More recently however, changes in institutional environment are widely believed to be responsible for the observed long-run cycles in income velocity of money and ultimately unstable demand for money. However, the issue of whether the money demand function is stable is one of the most outstanding arguments in the practice of macroeconomic policy.

Stability tests were carried out on both M2/P and M1/P, attention was given to both model and parameter stability. Chow tests and recursive tests were used to check for model stability and parameter constancy.

The models were re-estimated using recursive least squares estimator to test whether there has been any significant change in the value of the model throughout the sample period. The resulting series of the recursive estimators were then analyzed for their stability.

In this case we present the recursive graphics of the variables used in the static co-integrating regression and the error correction term. First, for the demand of M1/P, we present recursive graphics of error correction term (ECM1-1), inflation rate (Px), exchange rate (E), interest rate (r) and GDP (Y/P) [see Appendix (iv)].

In the case of ECM1-1 the plot is relatively steady and any movements in the value have not been significant. Almost for the entire period under study the feed back to the long-run did not differ significantly from -0.10. In the same vein movements in the values of the following coefficients; Dr , DPx_{-1} , DPx_{-3} , $DLogCM1$, $DLogCM1-1$, $DLog(Y/P)$, $DLog(Y/P)_{-1}$, $DlogE_{-1}$, $DlogE_{-2}$, $DlogE_{-3}$, $Dum93$ and ECM_{-1} are seen to having been stable and significant. The recursive residuals of the equation indicate that at no point was the one period equation error statistically insignificant. The one step Chow tests for the entire sample also indicate that over the period the model never failed to explain changes in $M1/P$. Therefore, $M1/P$ in Uganda was stable over the sample period.

Finally, for the demand of $M2/P$, recursive graphics of the $ECM2-1$, $CM2$, inflation, Exchange rate, interest and income are presented [see Appendix (vi)]. In this case $ECM2-1$ has a stable coefficient and shows no movements that are significantly different from -0.14 implying that for the entire period the feed-back to the long-run equilibrium did not largely differ from -0.14. Also the values of all the other variables indicated that the coefficients remained fairly stable for the entire sample period.

The recursive residuals of the equation indicate that at no point was the one period equation error statistically insignificant. The one-step Chow tests for the entire sample also indicates that over the period the model never failed to explain changes in the demand for $M2$ in Uganda. Therefore, demand for $M2/P$ and $M1/P$ in Uganda was stable over the sample period [see Appendix (vi)]

4.6 Overall Results Interpretation and Uganda's Money Demand Function

Equation 4.2 which is narrow money has a positive feed back effect with respect to DPx_{-3} which is also smaller than the coefficient of DPx_{-1} . This is also true in Equation 4.4 (broad money) with respect to DPx_{-3} and in relation to the coefficient of DPx_{-1} . The error correction term is statistically significant at 1% level with the feed-back of approximately 14% of the previous quarter's disequilibrium for broad money and 9% for narrow money.

The income elasticity is not only positive but within the expected range for most developing countries with respect to broad money. In narrow money this variable is not significantly different from 1. Ndele (1991) and others do contend with the results for broad money in our estimation. This indicates that real income is an appropriate explanatory variable in the money demand function for Uganda. This improves on Kateregga's (1993) result of negative income elasticity for Uganda which she attributed to high rates of inflation for the period of study.

The exchange rate variable was significant at 1% level with an elasticity of -0.21, -0.20 and -0.07 for broad money, while that of narrow money was significant at 1% level with an elasticity of -0.14, -0.23 and -0.1. The liberalization of the exchange rate seems to have eliminated the parallel market by unifying the official and parallel market rates. This may thus indicate that financial sector reforms have enhanced the demand for foreign currency either to make direct purchases or to hedge against inflation or as a store of wealth which would be liquidated at an appropriate exchange rate.

The inflation elasticity of the demand for money is significant and correctly signed for the first lag. This implies that inflation is a significant variable which affects portfolio decisions of wealth holders in Uganda. Wealth holders prefer to keep their wealth in real goods and services rather than deposit in a bank if they anticipate increase in inflation in the future.

Finally currency money ratio which is a proxy for the spread of banking services is significant at 1% level and has the expected sign. This indicates that the liberalization of the financial sector has resulted into new banks and/or expansion of branches to new areas, thus increasing the spread of banking services. This could imply creation of a competitive environment for the banking sector such that the financial institutions compete for the available potential market. We could thus infer from these results that financial liberalization has generated some significant financial innovation as proxied by the currency money ratio.

CHAPTER FIVE

5.0 Implications for Monetary Policy

A sound understanding of the determinants of money demand is indispensable if policies designed to influence economic growth and conducive price level are to be effective. Desirable monetary policy would be the one which ensures equilibrium in the money market.

As argued in Chapter Four, a critical condition for the effectiveness of monetary policy is a stable money demand function. Since both narrow money and broad money have demonstrated stability, then they could be used. However, broad money is a better function to use in the transmission of monetary policy by the authorities because it clearly captures and explains the long-run feedback effects and the effects of financial sector reforms on the demand for money unlike narrow money.

Although financial liberalization is one of the major vehicles through which the institutional environment is changed, hence, the likely effect on the stability of money demand, demand for money was found to be stable in Uganda. This may indicate that the monetary authorities should emphasize control of money supply rather than switching to interest and exchange rate control since parameter stability tests revealed money demand as being stable.

For a small open economy like Uganda, the impact of monetary policy by way of the external account will be greater in the short-run when using a monetary aggregate as a target. Hence, interest rates have to be raised to high levels to have any significant impact on money demand. The danger associated with high level of interest rates is its contribution to a weakening of the profitability of firms and enlarged size of non-performing loans in banks portfolios.

5.2 Conclusions

The study attempted to empirically model the demand for money using narrow and broad money. Money demand was analyzed both descriptively and econometrically. Descriptively, demand in Uganda for narrow and broad money demonstrated an upward trend for the entire period under study. While econometrically, time series characteristics of the variables were first investigated by carrying out unit root tests, where all the variables turned to be stationary after differencing them once.

In conclusion, this paper supports the view that “monetary aggregates” should be used as a supplementary intermediate target variable in a regime whose principal anchor is an inflation reduction as its main goal.

5.3 Limitations and suggestions for further research

The major limitation is the unavailability of data on the ratio of total non-bank deposits and hence necessitating its omission in the model, prompting the use of the dummy to capture financial innovation. Also we were unable to estimate money demand using M3 because, there are no records for the variable for some years, which is attributed to the political chaos in the country for a period of time that rendered failure of the economy to record the variables. Also for the period 1986 to 1989, inflation for the country is captured by the CPI for Kampala, because no survey was carried out in the country due to political unrest in the country.

Also worth noting is that liberalization is a process and hence implemented in phases, so as a result some data was never recorded because of the transition period. This therefore means that the study may not benefit from longer time series data.

More to the above is that a cross country comparison of results of similar studies with those on Uganda may be difficult due to the definitions and measurements of the variables used. However, for comparisons of similar studies in Uganda, the results are worth while. The study in addition reveals the flexibility that the monetary authorities now have in issuing newly created money without causing inflation. However, there is a

limit within which money can be increased, thus a study which will do simulations so as to exactly determine the extent to which money can be increased and capture total non-banking deposits will enrich further our knowledge on money demand.

The data on other variables that could have been used to capture financial innovation like the ratio of total non-bank deposits to total bank deposits was unavailable for most of the period under study.

REFERENCES

- Adenkunle, J.O. (1968), 'The demand for money: evidence from developing and less developing countries', *IMF staff papers 15.Vol. 5, No.11*.
- Akerlof, George A. (1976), 'The demand for money: a general equilibrium inventory – theoretic approach', *The Review of Economic Studies*, Vol.40, No.1.
- Akerlof, George A. (1977), 'The short run demand for money: a new look at an old problem', *The American Economic Review*, Vol.72, No.2.
- Akerlof, G.A. and R. Millbourne (1980), 'The short-run demand for money', *Economic Journal*, Vol.90, 885-900.
- Alenjandro, Gay (2004), 'Money demand and monetary disequilibrium in Argentina (1963 – 2003)', *Journal of Economic Literature*, Vol.23, No.3
- Alina, Beguna et al (2002), 'Money demand in Latvia', *Euro-faculty working paper in Economics*, no.15.
- Arestis, P. (Ed), (1993), '*Money and banking—issues for the twenty first century*', New York; St. Martin's press.
- Arestis, P. and P.Demetriades (1993), 'Financial liberalization and development: A critical exposition: - in Arestis P. (Ed).
- Atingo-Ego M. (1998), 'Monetary policy rules...', unpublished mimeo, Bank of Uganda.
- Artis, M.J.and M.K. Lewis (1984), 'How unstable is the demand for money in the U.K?', *Economica*, new series, Vol.51.No.204.
- Bahmani – Oskoe, M., M. Martin and F. Niroomand,(1998), "Exchange rate, sensitivity of the demand for money in Spain, *Applied Economics*,30, pp 607-612.
- Bhattacharya, B.B. (1974), 'Demand and supply of money in a developing economy: a structural analysis for India', *The Review of Economics and Statistics*, Vol.56, No.4
- Bjornland, Hilde C. (2004), 'A stable demand for money demand despite financial crisis: the case of Venezuela'. *Journal of Economic Literature Classifications*, E44.
- Black, David and Michael, Dowd (1994), 'Asset substitution: a note on the factors that influence both money supply and demand', *Journal of Economics Education*, vol.25, no.2.
- Bank of Uganda Various Issues.

Bondo, M. and Jonug, H (1990), 'The expansion of financial services and instruments due to their reforms', IMF Working Paper WP/90/14.

Chomg-Huey, Wong, (1977), 'Demand for money in developing countries: some theoretical and empirical results', *Journal of Monetary Economics*, pp 59-86.

Chow, G.C. (1996), 'On the long run and the short run demand for money', *Journal of Political Economy*, 74 (April 1966), 11-31.

Christopher, Adam, S. (1992), 'The dynamic specification of the demand for money in Kenya', *JAE Vol.3*.

Christopher, Adam S. (1992), 'Recent developments in econometric methods: an application to the demand for money in Kenya', *African Economic Research Consortium, special paper fifteen*

Crockett, A.D. and O.J. Evans (1980), 'Demand for money in Middle Eastern Countries.' *IMF staff papers, Vol. 5, No.9*.

Dickey, D.A. and W.A. Fuller (1979), 'Distribution of the estimators for autoregressive time series with a unit root', *Journal of the American statistical Association*, 74, 427-31

De Brouwer, M. Ng, T. and Subbaraman, S.S. (1993), 'An Econometric analysis of demand for M3 in Malaysia': 1973-95, Centre for Economic Research Discussion paper, George Washington University.

Drake, S. Leigh, B. and Chrystal, G. (1994), 'Company- Sector Money Demand: New evidence on the existence of a stable long-run relationship for the UK', *Journal of Money, Credit and Banking*, vol. 26 (August part1) pp 479-94.

Dekle, R. and M.Pradhan (1996), 'Financial liberalization and money demand in ASEAN countries', *International Journal of Financial and Economics*, 4(3), pp 205 -215.

Domowitz, I. and I.E.Elbadawi, (1987), 'An Error Correction Approach to the money demand: the case of Sudan', *Journal of Development Economics*, vol. 26

Engle, R.F. and C.W. Granger (1982), 'Co-integration and economics, representation, estimation and testing'. *Econometrica*, vol.55

Freidman, M. (1959), 'The demand for money: some theoretical and empirical results', *Journal of Political Economics*, Aug, 327-351.

Friedman, M. and A.J. Schwartz A.J. (1982), '*Monetary trends in the U.S. and the U.K.*', Chicago, University of Chicago press.

Galbis, V. (1986), 'Financial sector liberalization under oligopolistic condition and a bank holding Co. ', *Saving and Development*, Vol.10, No.4.

Gauger, J. and Black H. (1991), 'Asset substitution and monetary volatility', *Journal of Money and Banking*, Vol.12. No.8.

Geithman, David T. (1971), 'Money demand, income velocity and monetary policy', *Southern Economic Journal*, Vol.38, No.1.

Gilbert, C.L. (1986), 'Practitioners' corner: Professor Hendry's methodology', *Oxford Bulletin of Economics and statistics*, 48, 283-307.

Goldfeld, S. and D.E. Sichel (1993), 'The demand for money in Benjamin M. Friedman and Frank. H.Haan (Eds), *Handbook of Monetary Economics*, Vol.1 North-Holland, Amsterdam.

Goodhart, C.A.E. (1985), '*Money information and Uncertainty*', 1st edition, London, Macmillan

Hafer, R.W. (1985), 'Money demand predictability', *Journal of Money, Credit and Banking*. Vol.30, No.6.

Haug, Alfred and Lucas, Robert F. (1966), 'Demand and supply functions in the US' *Econometrica*, 32 (Oct 1964), 476-509.

Haug, Alfred A. and Robert F. Lucas, (1996), 'Long-term Money Demand in Canada: In search of stability', *The Review of Economics and Statistics*, vol.78, pp345-48.

Hayo, R. (1998), 'The future of the Euro: A public choice perspective', *JEL*, Vol.17, 7-30.

Henstridge (1999), 'Demonetization, inflation and coffee: demand for money in Uganda' PhD thesis (Unpublished).

IMF and World Bank Statistics Various Issues.

Judd, J. and J.L. Scadding (1982), 'The search for a stable money demand function: a survey of post 1973 literature', *Journal of Economic Literature*, Vol.22, No.11.

Johansen, S. and Juselius, K. (1991), 'Maximum Likelihood Estimation and inference on cointegration with application to the demand for money', *Oxford Bulletin of Economics and Statistics*, 52, pp 169 -210.

John Moore (1988), ' Monetary policy and the emergence of cycles' , The Levy Economics Institute Collections , Vol.1, No. 6.

Joseph, Miller (1991), ' A bank lending channel of monetary policy in U.S.' , JEL Classification: C23, E44, E51,G21.

Kararach, George (2001), 'Evidence on the demand for money function in Uganda', *Journal of Economic Literature* Classification, C1.

Kasekende, Louis A. and Michael Atingi-Ego (2003), 'Financial liberalization and its implications for the domestic financial system: the case of Uganda', *African Economic Research Consortium*, research paper 128.

Kasekende, L.A. and G. Ssemogerere (1994), 'Exchange rate unification and economic development: the case of Uganda', *World Development* (august).

Katafono, Resina (2001), 'A re-examination of the demand for money in Fiji', *Working Paper of Economics Department of the Reserve Bank of Fiji*.

Keynes, J.M. 'The general theory of employment, interest and money', (NY, Macmillan Co, 1936).

Klein, J.J. (1978), '*Money and the economy*', 4th Edition, New York, Harcourt Brace Jovanovich Inc.

Lim, D. and Martin, W. (1991), 'The stability of the demand for money in the European community countries': A survey, Research memorandum WO&E Nr. 9321

Lim, D and Martin, W. (1991), 'The demand for money: theories, evidence and problems'; Harper and Row inc.

Laidler, D.E.W. (1985), '*The demand for money: theories, evidence and problems*', New York: Row

Laumas, G.S. and Y.P. Mehra (1976), 'The stability of the demand for money function: the evidence from quarterly data', *The Review of Economics and Statistics*, Vol.58, No.4

Laumas, G.S. and Y.P. Mehra (1977), 'The stability of the demand for money function 1900-1974', *The Journal of Finance*, Vol.32, No.3

Manchester, J. (1989), ' How money affects real out put', *journal of money, credit and banking*" 21(Feb.): 16-32

Mbire, M. and Mackinnon, J. (1992), '*Modeling money demand in Uganda*', unpublished.

Mehra, Y.P. (1978), 'Is money exogenous in money demand equations', *The Journal of Political Economy*, Vol.86, No.2

Muhd-Zulkhibri and A.Majid (2004), 'Reassessing the stability of broad money demand in Malaysia', *Journal of Economic Literature Classifications*, C21.

Musinguzi, P. (1994), 'Targeting monetary aggregates and the use of the reserve money Programme', paper presented at the 10th East African Central Banking Course, Mukono Uganda.

Naho, A.M. (1985), 'The demand for money in Developing countries: The empirical evidences from Eastern African countries'. *E.R.B. paper 85*

Ndele, S.M. (1995), 'The effects of non bank financial intermediaries on demand for money in Kenya', *African Economic Research Consortium*, Research paper five.

Nell, Kevin S. (1999), 'the stability of money demand in South Africa, (1965-1997)', *Journal of Economic Literature, Classifications*, E21.

Orden, H. and Fisher, T. (1993), 'the interest elasticity of transaction demand for cash review of Economics and statistical', 38(3), pp 241-247.

Paula, A. Tkac (2000), ' The determinants of the flow of funds of managed portfolios' , Working Paper 2000, Federal Reserve Bank of Atlanta.

Rodney, L. Jacobs (1974), 'Estimating the long run demand for money from time series data', *The Journal of Political Economy*, Vol. 82, No.6

Rother, G. (1998), 'Nominal Vs real adjustment in demand for money functions: applied Economics', 22(1), pp 5-12

Sargan , J.D. and A. Bhargava (1983), Testing residuals from least squares regression for being generated by the Gaussian random walk, *Econometrica*, 51, 153-74

Scharnagl, Michael (1998), ' Seasonal co-integration analysis for germany,M3 Money demand, university of Munich, Vol.23, Issue 3.

Sriram, S. S (1999), 'survey of literature on demand for money: theoretical and empirical work with special reference to ECM', IMF Working Paper: WP/99/64.

Sriram, S. S. (2001), 'A survey of recent empirical money demand studies', *IMF staff papers*, Vol.47, No.3.

Statistical Abstracts, Various Issues.

Thornton, J. and Gatrikel, F.(1996), 'Co-integration, error correction and the demand for money in Mexico'. *Journal of Economic Literature Classifications*, C21.

Wagner, John R. (1981), 'Some implications of a stable demand for money function', *southern economic journal*, Vol. 48, No.2.

Yoshida, T. (1990), 'On the stability of the Japanese money demand function, Estimation results using the Error Correction Model', *BOJ monetary and Economic studies*, Vol.8, No.5.

APPENDIX

Appendix (i): Method of interpolating Annual Data to Quarterly Frequency

The method of data interpolation by Friedman (1962) has been used in the present study and below are the steps followed.

First, we define y as the variable available at annual but not quarterly frequency and x as the variable which is available at both annual and quarterly frequency but its not among the explanatory variables to be used in the estimable function. In our case for variable x , we used exports as the interpolator. The method is as follows:

- Using annual observations only compute the mean quarterly growth for y and x . Use this to derive (log) linear interpolations for both y and x . The linear interpolation of y is:

$$y^*_{t+i} = y_t + iT_y, \quad \text{where } i = 1, 2, 3, \quad \text{and } T_y = (Y_{t+1} - Y_t) / 4, \text{ and}$$

$$x_j^*_{t+i} = x_{jt} + iT_{xj}, \quad \text{where } i = 1, 2, 3, \quad j = 1 \dots k \text{ and } T_{xj} = (x_{j,t+1} - x_{j,t}) / 4$$

for the elements of the x vector.

- Again using only the annual observation run the regression.

$$y_{tA} = \beta' x_A + \varepsilon$$

Where the subscript denotes annual observations.

- From the actual quarterly values of the x_j variables and their interpolated values (x^*), compute the actual error in the trend interpolation for the elements of x , expressed as

$$\delta_{j,t+i} = (x_{j,t+i} - x^*_{j,t+i})$$

- This error term is then used to adjust the simple linear trend interpolation for Y by the weighted individual error in trend interpolation for each regressor, where the weights are given by the β_j coefficient on the x_j variable in the annual regression estimated in step 2. Hence the final interpolation for y is:

$$Y^{\wedge}_{t+i} = Y^*_{t+i} + \sum_{j=1}^k \beta_j \delta_{j,t+i}$$

Clearly this method results in every fourth observation being exactly correct (since the error in interpolation of the x variables is identically equal to zero for each variable), so that the interpolated series always returns to the unknown annual observations for the series. Moreover, it provides a robust and transparent way of weighting the error term.

- M. Friedman (1962), "The Interpolation of Time Series By Related series", *The Journal of the American Statistical Association*, Dec. 1962.

Note: The program called linear was also used to cross check for correctness and consistency of the above method

Appendix (ii): Diagnostic and stability tests used

AR(1) is the error autocorrelation diagnostic test which yields a Lagrange-Multiplier (LM) test for serial autocorrelation:

$$u[t] = \sum \alpha_i u[t-i] + \epsilon[t] \text{ for } i = 1, \dots, r \quad [0 \leq s \leq r \leq 12]$$

With $\epsilon[t] \sim IID(0, \sigma^2)$. This test is done through the auxiliary regression of the residuals on the original variables and lagged residuals. The null hypothesis is no autocorrelation which would be rejected if the test statistic is too high (i.e. if the p-value in brackets is below 5%). This LM test is valid for models with lagged dependent variables, whereas neither the DW nor residual correlogram provide a valid test in that case. Thus for serial autocorrelation test we shall use the LM test since we have lagged dependent variables for the three regressions.

The **ARCH** test is the autoregressive conditional heteroscedasticity which tests if the residuals have an ARCH structure at 5% level:

$$E(u[t]^2/u[t-1], \dots, u[t-r]) = \sum \gamma_i u[t-i]^2 + \epsilon(t), \quad i = 1, \dots, r \text{ with } [0 \leq s \leq r \leq 12] \text{ and with } \epsilon[t] \sim IID(0, \sigma^2). \text{ This is done by regressing the squared residuals on a constant and lagged squared residuals (note that some observations are lost at the beginning of the sample).}$$

Normality test used is the Jarque-Bera (JB) test at 5% level which is rejected if the statistic is greater than 5.99. This checks whether the variable $u[t]$ are normally distributed as

$$u[t] \sim IID(0, \sigma^2) \text{ with } E(u[t]^3) = 0 \text{ and } E(u[t]^4) = 3 \sigma^4.$$

This is done by computing for the skewness and kurtosis of OLS residuals and uses the following test statistic:

$$JB = n \left[\frac{S^2}{6} + \frac{(K - 3)^2}{24} \right]$$

Where S represents skewness and K is kurtosis. JB asymptotically follows a chi-square distribution with 2 degrees of freedom.

Reset is Ramsey (1969)'s regression specification test; it tests for functional form mis-specification. It checks if $y[t]$ depends on $y^*[t]^n$, $n = 2, \dots, 4$. The null hypothesis is no functional mis-specification which would be rejected if the computed F value is significant at 5% level. This is computed by including the estimated dependent variable as an additional regressor(s). This amounts to adding powers of the fitted values of the original regression. Obtain the R^2 from the new regression and compute the F-statistic from the formula:

$$F = \frac{(R_{new}^2 - R_{old}^2) / \text{number of new regressors}}{(1 - R^2) / (n - \text{number of parameters of the new model})}$$

Forecast test, this follows a chi-square distribution with a 1-step analysis, comparing within and post-sample residual variances. The statistic is calculated as follows;

$$\xi = \sum_{t=T+1}^{T+H} \frac{e_t^2}{\sigma_u^2} = \chi^2(H)$$

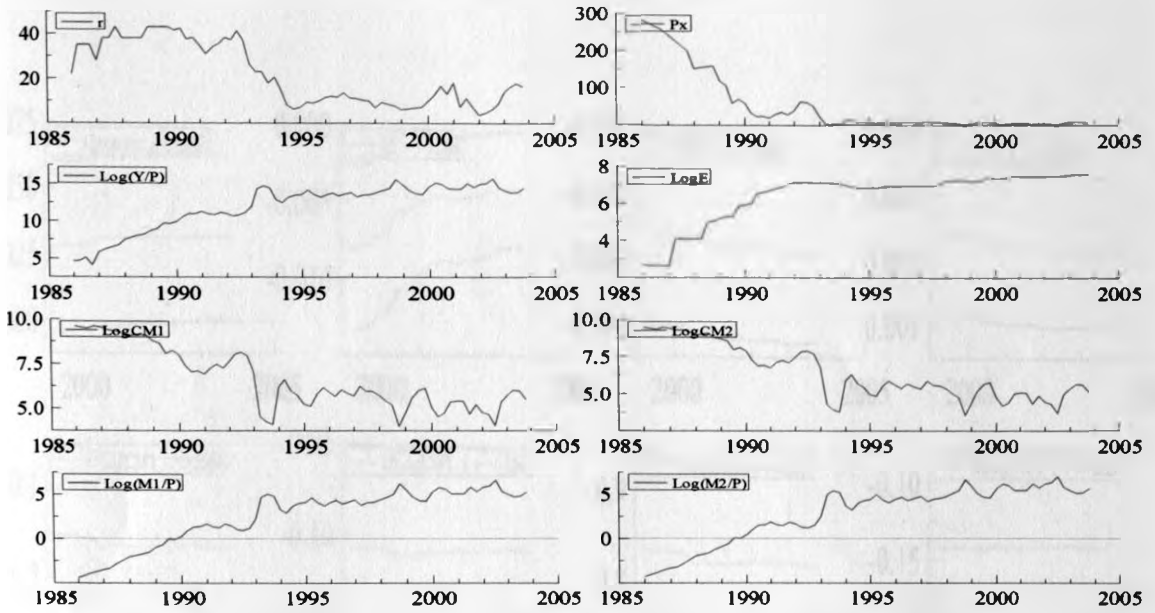
On $H_0: \beta_1 = \beta_2; \sigma_1^2 = \sigma_2^2$ (Periods 1 and 2 for sample and forecast periods). T is sample size and H is number of observations retained for forecasting. The null is no structural change in any parameter between the sample and forecast periods 1 and 2.

Chow test is the main test for parameter constancy and is of the following form;

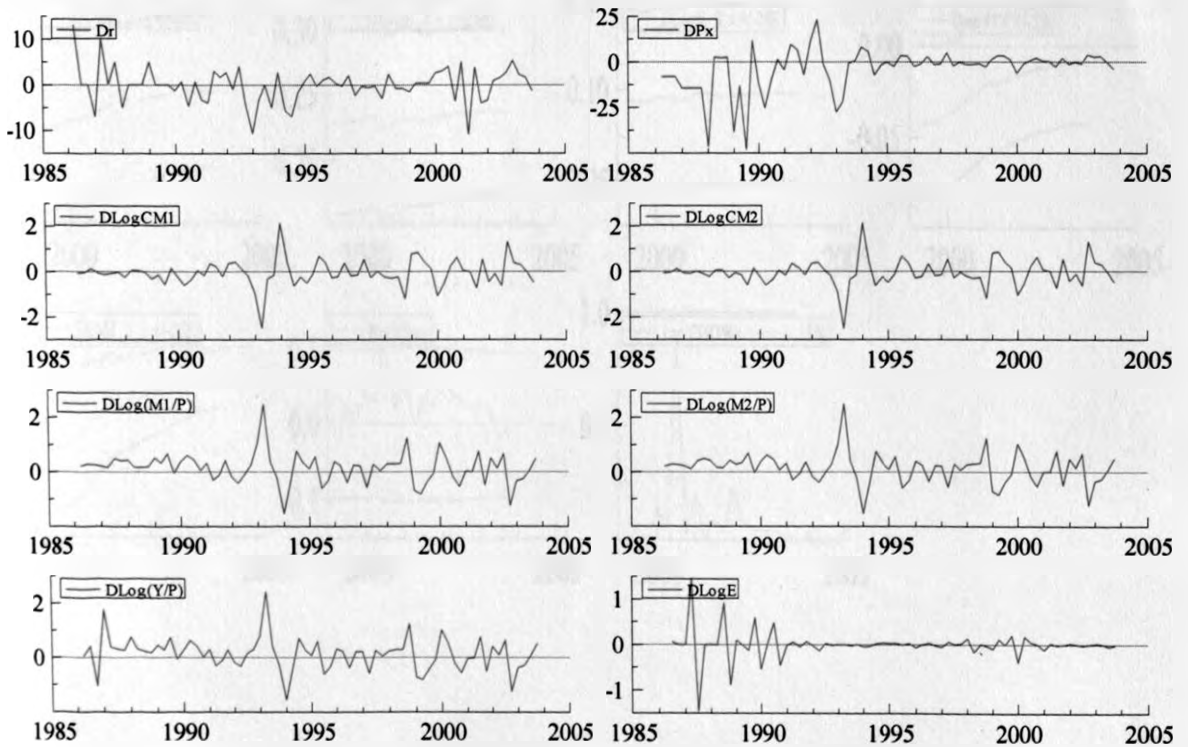
$$\eta = \frac{(RSS_{T+H} - RSS_T) / H}{RSS_T / (T - k)} = F(H, T - k)$$

On H_0 , where H_0 is as for the Forecast test.

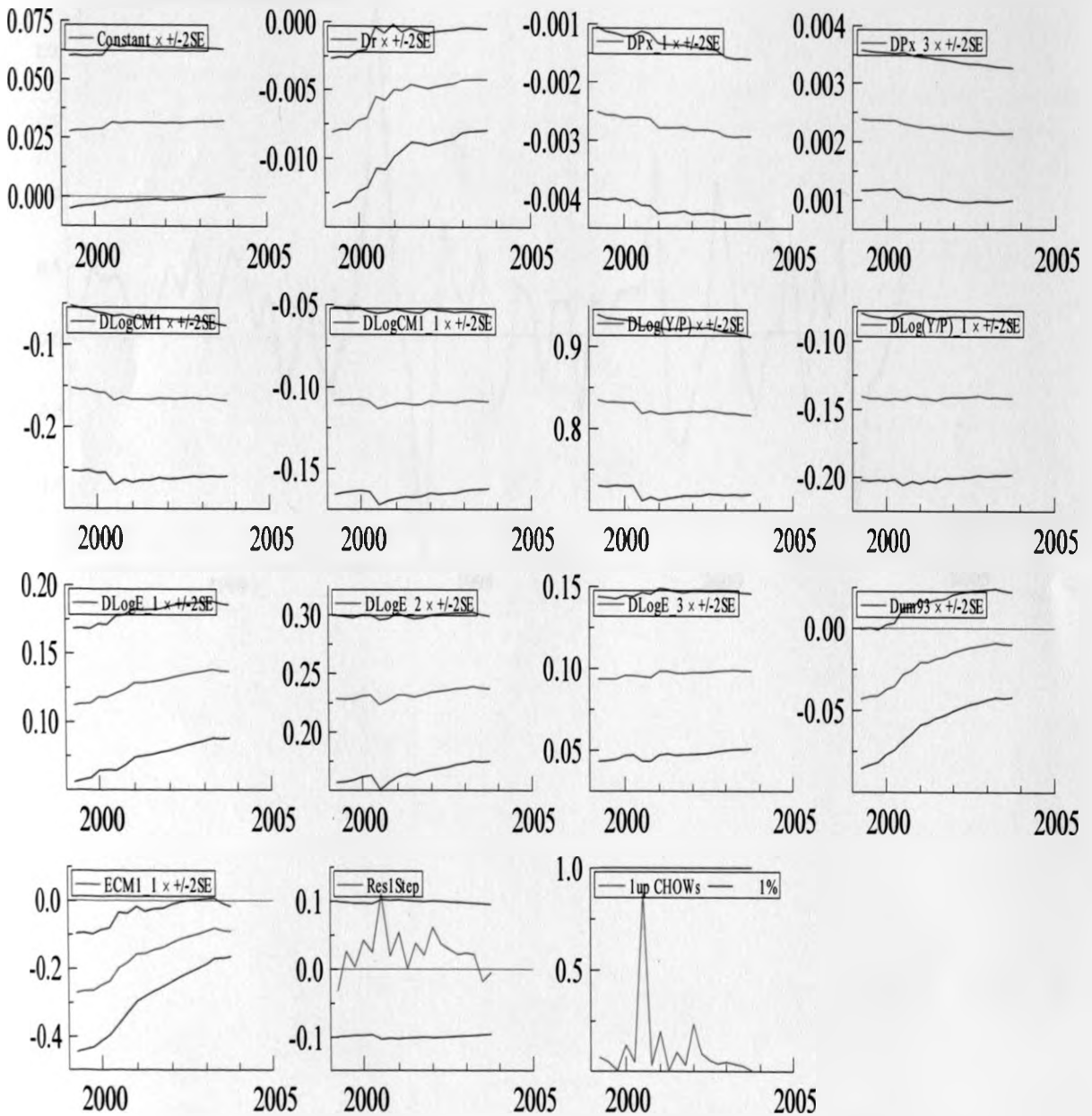
Appendix (iii) a: Variables in their levels



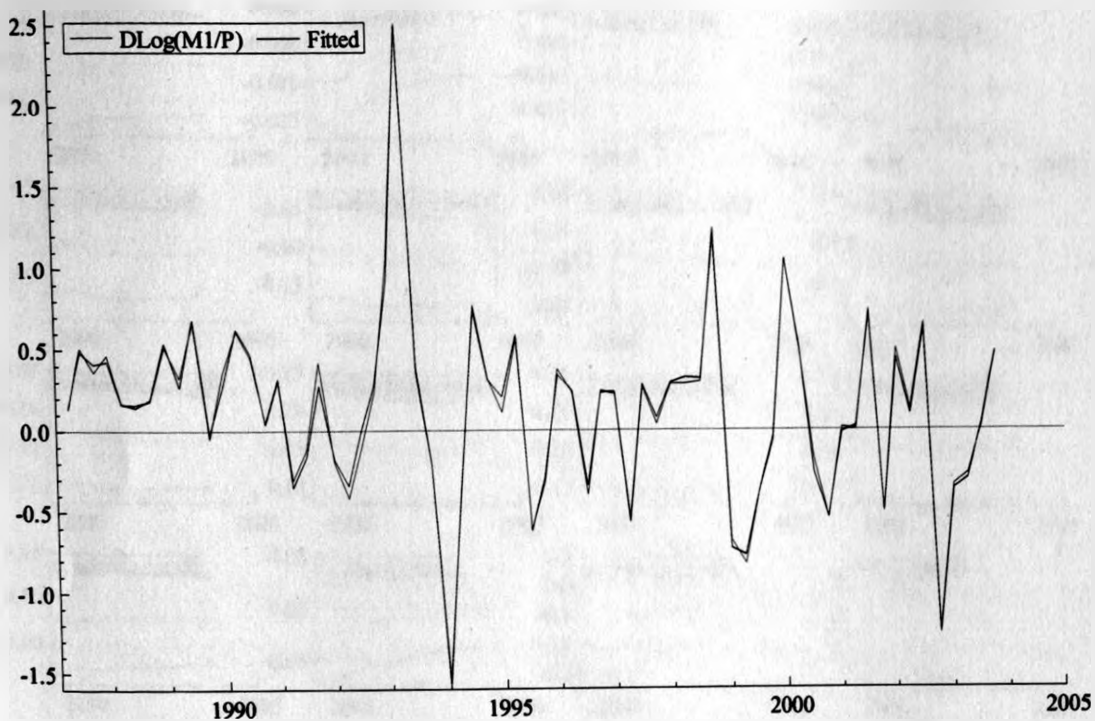
Appendix (iii) b: Variables in their first difference



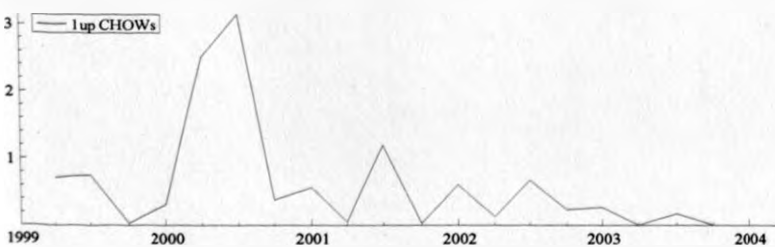
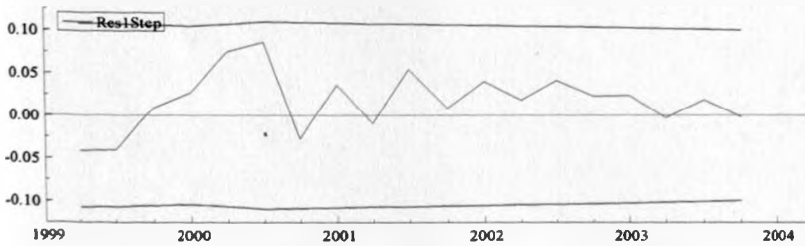
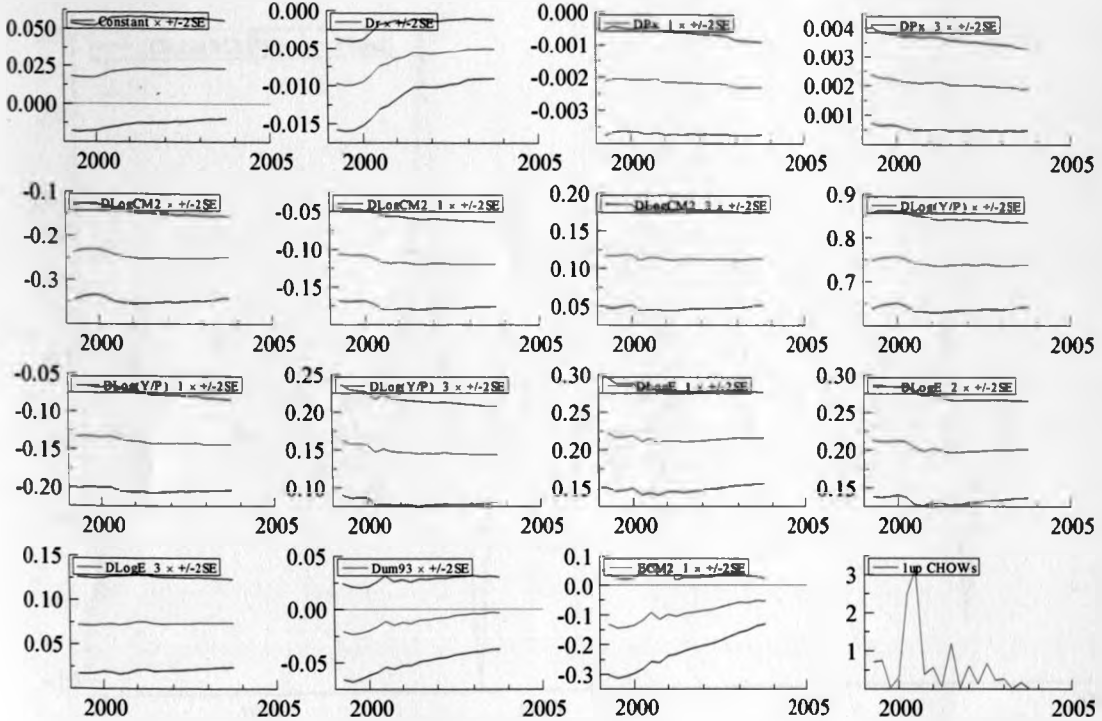
Appendix (iv) Recursive graphics for parameter constancy and model stability for demand for M1/P (Model 1)



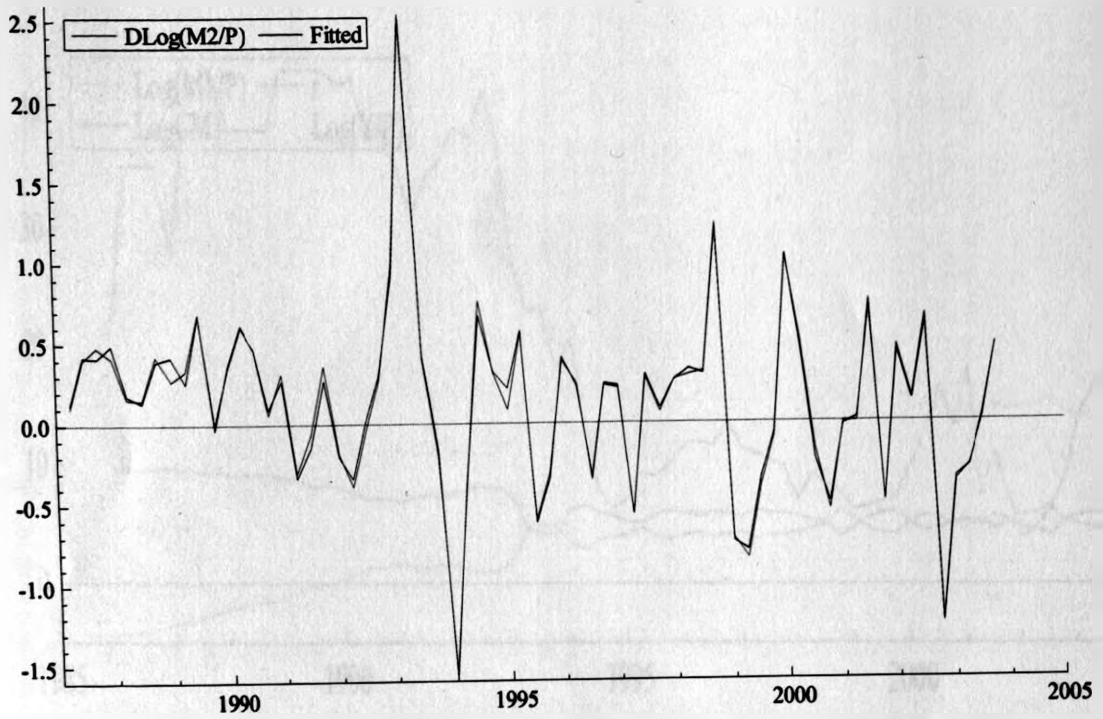
Appendix (v) Equation 4.2: Actual Vs Fitted



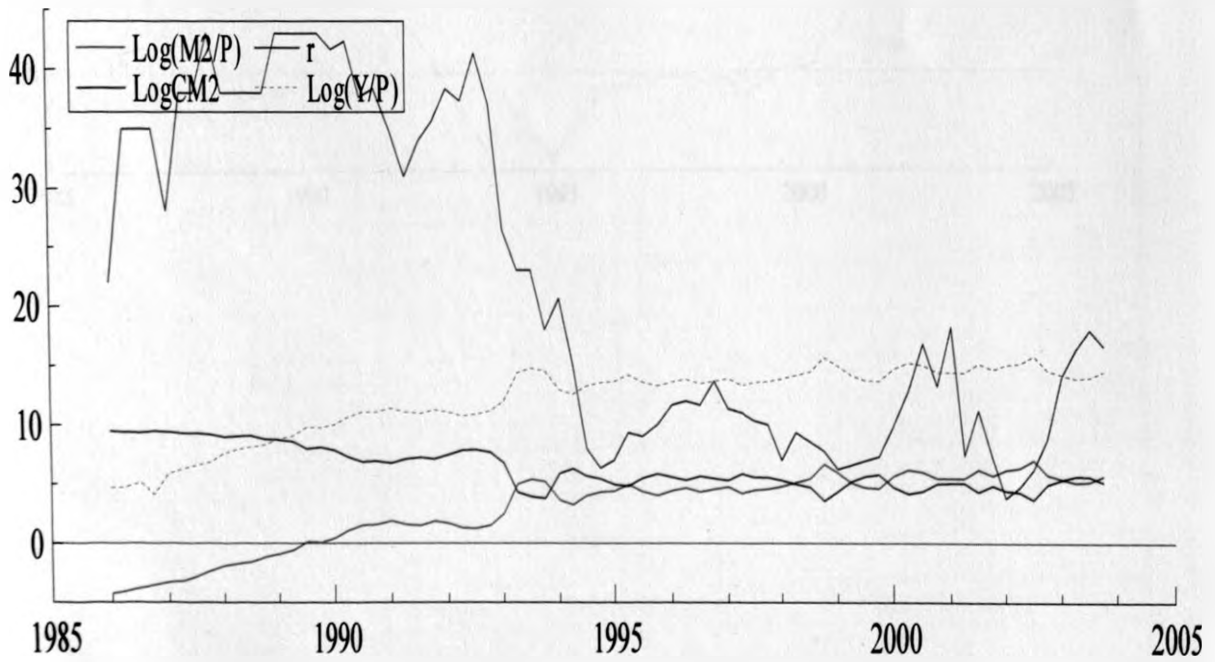
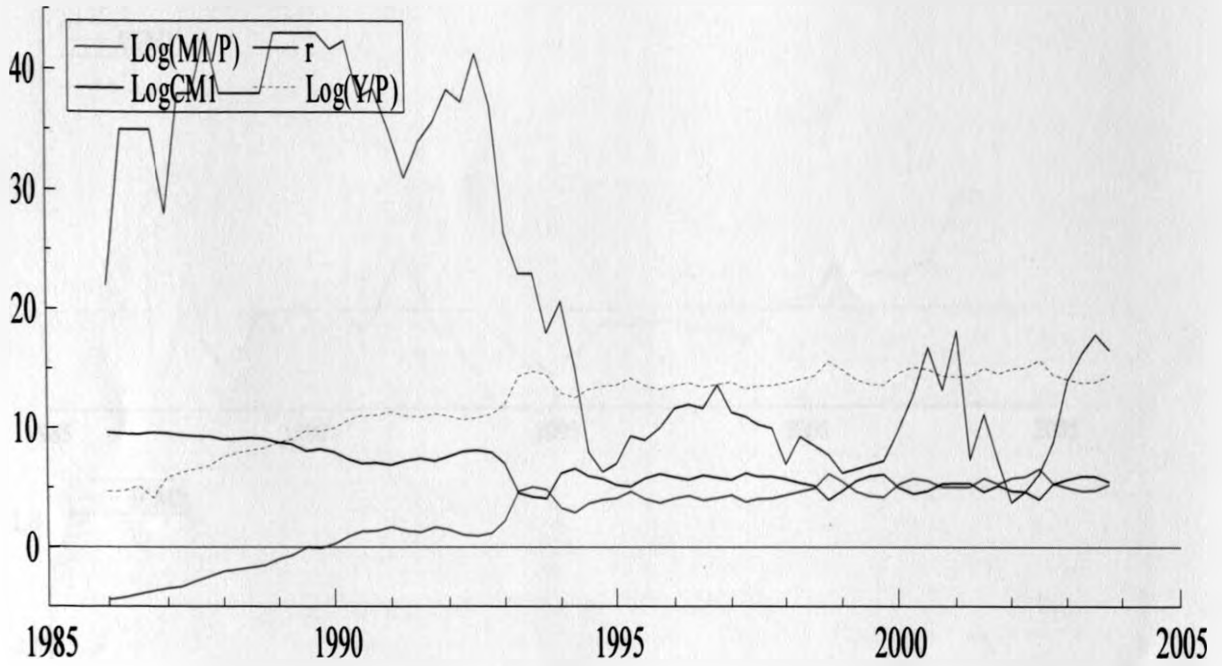
Appendix (vi): Recursive graphics for parameter constancy and model stability for demand for M2/P (Model 2)



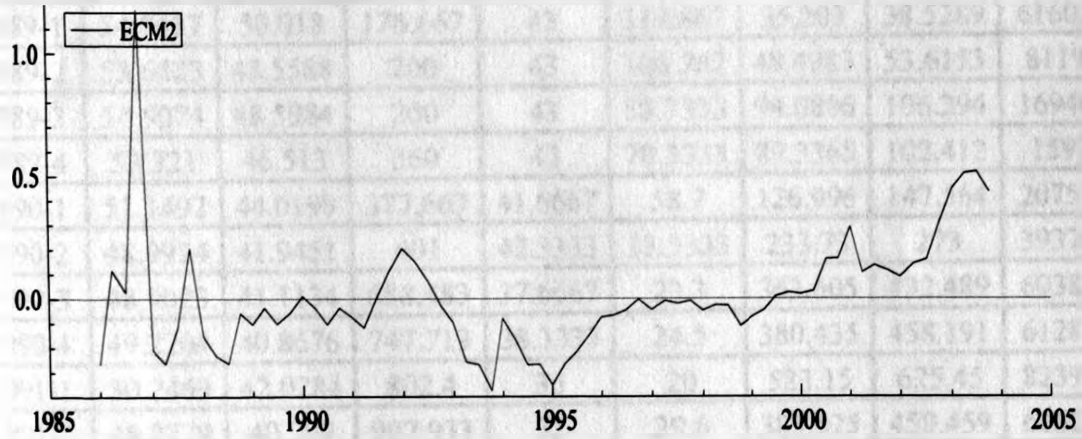
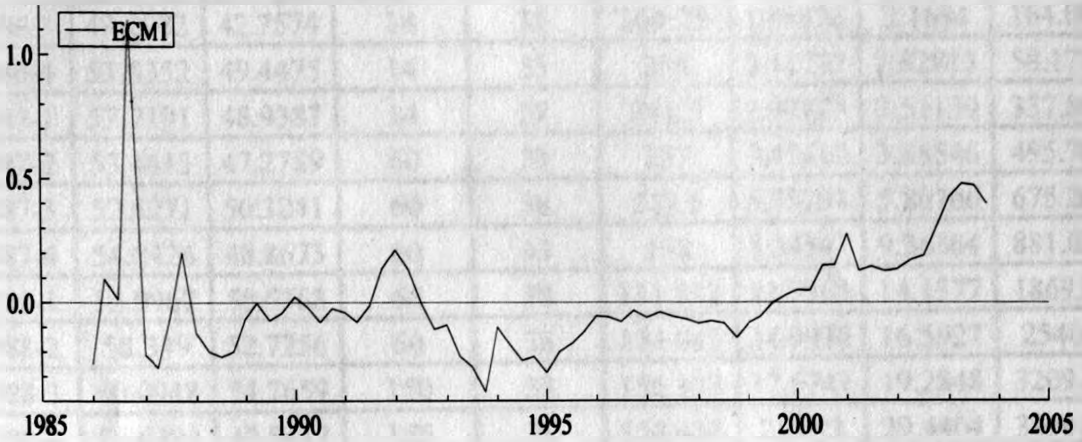
Appendix (vii) equation 4.4: Actual vs. fitted



Appendix (viii): Co-integrating Variables for model One (M1/P) and model Two (M2/P)



Appendix (x): Error Correction Term for Narrow Money and Broad Money



Appendix (xi): Data of Monetary Aggregates used for Analysis from 1986:1 to 2003:4

Year	CM1	CM2	E	r	Px	M1/P	M2/P	Y/P
1986-1	52.7439	45.7672	14.8	22	280.75	1.1683	1.34639	102.538
1986-2	50.5102	43.9024	14	35	272.5	1.43853	1.65505	108.121
1986-3	49.0982	42.7574	14	35	264.25	1.88836	2.1684	164.081
1986-4	57.8352	49.4475	14	35	256	2.41797	2.82813	58.1719
1987-1	57.7191	48.9387	14	28	241.5	2.97723	3.51139	337.862
1987-2	53.4615	47.2789	60	38	227	3.43612	3.88546	495.786
1987-3	52.6271	50.3241	60	38	212.5	5.55294	5.80706	675.262
1987-4	54.8426	48.8673	60	43	198	8.34343	9.36364	881.025
1988-1	56.0967	50.5368	60	38	151.533	12.7365	14.1377	1869.88
1988-2	58.349	52.7256	60	38	154.043	14.9936	16.5927	2546.4
1988-3	60.0948	54.7659	150	38	156.133	17.5747	19.2848	3209.84
1988-4	56.6394	40.5417	155	38	158.433	21.073	29.4404	3850.64
1989-1	54.7437	50.018	176.667	43	119.867	35.203	38.5289	6160.85
1989-2	53.6823	48.5588	200	43	106.767	48.4983	53.6153	8119.5
1989-3	54.9074	48.5984	200	43	58.7333	94.0806	106.294	16946.1
1989-4	53.321	46.513	360	43	70.3333	89.3365	102.412	15977
1990-1	51.1492	44.0199	377.667	41.6667	58.7	126.996	147.564	20751.9
1990-2	48.9924	41.9451	401	42.3333	33.3333	233.73	273	39376.8
1990-3	48.9023	41.1134	688.483	37.6667	23.3	363.605	432.489	60385.5
1990-4	49.2204	40.8676	747.713	38.3333	24.5	380.435	458.191	61281.9
1991-1	50.2469	42.0284	802.4	35	20	523.15	625.45	82399.3
1991-2	48.2779	40.299	907.933	31	29.6	383.525	459.459	60627.2
1991-3	48.918	38.7469	976.367	34	35.9667	339.184	428.221	53970.7
1991-4	49.2489	41.3738	1122.93	35.6667	28.7667	515.272	613.349	72574.5
1992-1	50.6881	42.0236	1253.93	38.3333	40.3	423.11	510.347	60507
1992-2	48.9667	39.4408	1230.33	37.3333	63.3667	278.217	345.413	44015.8
1992-3	55.8346	42.1789	1245.47	41.3333	61.9	249.689	330.528	50724.4
1992-4	55.7558	40.9372	1241.57	37	51.7	316.615	431.225	67515.4
1993-1	47.2538	36.7191	1241.42	26.3333	24.0333	888.641	1143.59	147754
1993-2	43.5503	33.0591	1238.62	23	2.16667	10561.1	13912.6	1666839
1993-3	46.9549	33.9332	1205.84	23	1.46667	15169.3	20990.5	2503605
1993-4	30.092	21.5161	1183.37	18	1.96667	12201	17064.1	1897843
1994-1	49.5964	35.7198	1116.11	20.6667	9.96667	2631	3653.11	401140

1994-2	47.3697	34.2667	1016.74	15	15.6667	1775.53	2454.47	272146
1994-3	48.0948	35.0853	952.47	8	8.16667	3824.08	5242.04	554599
1994-4	46.4993	34.0901	928.29	6.33333	6.6	5251.52	7163.13	726489
1995-1	29.5247	22.1686	930.663	7	6.3	5843.92	7783.07	788365
1995-2	46.0197	34.4494	956.51	9.33333	3.6	10247.2	13688.9	1427381
1995-3	47.5596	35.174	981.747	9	6.83333	5546.83	7500	777138
1995-4	48.4548	35.4805	1037.94	10	9.83333	4003.73	5467.8	557523
1996-1	50.3342	36.4134	1032.01	11.6667	7.2	5817.59	8041.67	777896
1996-2	49.4862	35.1429	1033.03	12	5.86667	7298.86	10277.8	974896
1996-3	48.5112	32.8795	1068.05	11.6667	8.66667	4882.3	7203.46	673607
1996-4	48.7104	33.2404	1079	13.6667	7.1	6207.04	9095.77	838938
1997-1	50.3049	34.4574	1037.21	11.3333	5.86667	7732.39	11288.6	1040994
1997-2	47.3114	32.1151	1059.28	11	10.7333	4360.56	6423.91	583032
1997-3	45.6869	30.4951	1091.87	10.3333	8.5	5678.04	8506.67	753950
1997-4	46.7405	30.2492	1147.02	10	8.3	5871.08	9071.89	790275
1998-1	45.4528	29.8842	1376.33	6.98133	6.76667	7778.32	11830.5	1006658
1998-2	43.0781	27.9122	1400.83	9.31	5.25	10305.4	15904.8	1345553
1998-3	43.6151	27.7448	1443.33	8.53333	4.06667	13858.2	21785.2	1799161
1998-4	43.9441	28.0198	1449.83	7.76	1.21667	48000	75279.4	6221115
1999-1	44.8622	29.7084	1326.33	6.23333	2.56667	24215.6	36567.5	3025625
1999-2	45.0327	30.3306	1365.83	6.58333	5.9	10543.5	15654.2	1349579
1999-3	43.8976	29.8162	1405.33	6.93333	9.16667	7174.55	10562.9	890102
1999-4	45.075	31.2889	1772.45	7.27667	10.1333	6712.5	9670.07	824607
2000-1	42.3018	30.2427	1521.18	9.86667	3.7	19373.9	27099.1	2274809
2000-2	41.7581	29.2995	1561.43	12.8333	2.2	32162.1	45837.9	3853442
2000-3	42.0751	29.0746	1680.61	16.8333	2.73333	26845.1	38848.8	3123788
2000-4	44.4741	30.6966	1823.28	13.2333	4.83333	15525.5	22493.8	1779131
2001-1	43.7188	30.6924	1772.45	18.2667	5.1	15712.4	22381	1716971
2001-2	41.5584	29.2834	1773.47	7.36667	5.3	15739	22336.5	1681882
2001-3	42.2532	29.2542	1748.63	11.2	2.53333	33052.6	47739.5	3580815
2001-4	42.6281	29.4795	1723.06	7.2	4.3	20063.6	29012.4	2146237
2002-1	39.927	28.2786	1749.88	3.76667	2.9	33080.5	46706.9	3230938
2002-2	39.4556	27.3586	1794.31	4.66667	2.66667	37520	54110	3566484
2002-3	39.2842	27.035	1807.18	6.16667	1.43333	72453.5	105281	6733623
2002-4	41.3322	28.1663	1835.06	8.83333	5.06667	20850	30596.1	1932716
2003-1	39.7774	27.3395	1897.66	14.1	7.63333	14795.2	21526.2	1343179
2003-2	38.2268	26.4103	1990.17	16.3333	10.6	11222.3	16243.4	1010701

2003-3	38.7292	26.3943	1995.87	17.9333	10.3	11567.3	16973.1	1084848
2003-4	38.9105	26.4384	1968.99	16.6	6.4	18643.2	27438	1817881

Source: Bank of Uganda (Various Issues)

Key:

M1/P is the real narrow money

M2/P is the real broad money

CM1 is a ratio of currency in circulation to M1

CM2 is a ratio of currency in circulation to M2

Y/P is the real Gross Domestic Product in billions of Uganda Shillings

E is the official middle rate (Uganda shillings per US dollar)

Px is the inflation rate computed from CPI

r is the 91 days of treasury bill rate