Empirical Analysis of Money Demand in South Africa (1980-2011)

An Autoregressive Distributed Lag Approach

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EMPIRICAL ANALYSIS OF MONEY DEMAND IN SOUTH AFRICA.

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Submitted to the Faculty of Commerce, Administration and Law in Fulfilment of the Requirements for the Master of Commerce (Economics) Degree.

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Supervisor: Doctor I. Kaseeram

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DECLARATION

I the undersigned, hereby acknowledge that this dissertation, except where otherwise specified in the text, is my own work and has not been submitted, in part or full, to any other university for the purpose of obtaining a degree.

Signedõ õ õ õ õ õ õ õ õ õ õ

Isaac Mutsau (April 2013)

ABSTRACT

The estimation of money demand function and determination of its stability is common practice in macroeconomic research due to its significance in the transmission mechanism of monetary policy. This study investigates stability of the long-run money demand for both narrow and broad money in South Africa over the period 1980 to 2011, using expenditure components of Gross Domestic Product (GDP) as scale variables, the real effective exchange rate, inflation and a representative short-term interest rate as opportunity cost variables. The bounds testing procedure, a single equation cointegration technique, is applied to test for cointegration between the endogenous and exogenous variables.

To achieve this objective, the Autoregressive Distributed Lag (ARDL) approach (Pesaran et al., 2001) is employed to estimate the long-run equilibrium relationships between real money balances and disaggregated expenditure components of Gross Domestic Product in addition to the interest rate and inflation as variables reflecting the opportunity cost of holding money. Both short-run and long-run relationships are explored to understand the dynamic adjustments through the error correction mechanisms of the model. The CUSUM and CUSUMQ tests (Brown et al., 1975) are applied to examine the possibility of structural breaks in money demand functions, as well as parameter stability. Results indicate that M2 and M3 money aggregates are cointegrated and are maintaining a stable long-run relationship with their determinants. However, M0 and M1 monetary aggregates are found not cointegrated with their determinants. Different expenditure components have different influence on the demand for broad money. This research also gives evidence that demand for broad money has remained stable despite the external shocks experienced in the previous years due to the global economic meltdown.

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List of Acronyms and Symbols

AEG	Augmented Engle . Granger test
AR(1)	Autoregressive process of the first order
ADF	Augmented . Dickey Fuller test
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
BSM	Buffer Stock Model
CAM	Current Account Monetary model
CCR	Canonical Cointegration Regression
СМА	Common Monetary Area
CPI	Consumer Price Index
CPIX	Consumer Price Index (excluding mortgages and bonds)
CRDW	Cointegrating Regression Durbin Watson test
CUSUM	Cumulative sum of squares test
CUSUMQ	Cumulative recursive sum of squares estimates
DF	Dickey. Fuller tests
DOLS	Dynamic Ordinary Least Squares
ECM	Error Correction Model
EFE	Error Feedback Equation
EG	Engle Granger
EXPGS	Expenditure on goods and services
FCE	Final consumption expenditure
FMOLS	Fully Modified Ordinary Least Squares
GCFC	Gross Fixed Capital Formation
GDP	Gross Domestic Product
GECM	Generalised Error Correction Model
GLS	Generalised Least Squares

GNI	Gross National Income
GNP	Gross National Product
l(d)	Integrated of order d
IID	Identically and Independently Distributed
IMF	International Monetary Fund
JML	Johansen Maximum Likelihood
KAM	Capital account monetary model
KPSS	Kwiatowski, Phillips, Schimidt and Shin test
МО	Notes and coins in circulation outside banks as proxied by M1A(KBP1370J)
M1	M0 plus demand deposits (mostly cheque and transmission deposits).
M2	M1 plus short term deposits (less than 30days such as savings) and medium-term deposits (not exceeding 6 months).
M3	M2 plus long-term deposits whose duration exceeds 6 months.
ML	Maximum Likelihood
NER	Nominal exchange rate
NPISH	Non- profit institutions serving households
NSS	National Statistics System
NPAM	Nominal Partial Adjustment Model
OLS	Ordinary Least Squares
ОМО	Open Market Operations
PAM	Partial Adjustment Models
PEAPC	Price Expectations Augmented Phillips Curve
PP	Phillips . Perron test
RS	Short-term interest rate
RL	Long term interest rate
REER	Real Effective Exchange rate
RPAM	Real Partial Adjustment Model

- SACU Southern African Customs Union
- **SARB** South African Reserve Bank
- **SBC** Schwarz Bayesian Criterion
- **SUR** Seemingly Unrelated Regressions
- VAR Vector Autoregressive model

Glossary of Terms¹

Autoregressive Distributed Lag (ARDL) Model

It is a linear model of two or more time series variables where the lagged dependent variable is a regressor together with independent variables in their present values as well as in their specified lags. The ARDL model assumes the relationship that the dependent variable (endogenous variable) is influenced by its past values and independent variables (exogenous) variables in their current as well as in their past (lagged) values.

Cointegration

Two or more non-stationary time series variables are said to be cointegrated if they exhibit a linear combination that is stationary. For example two or more time series variables that are integrated of order one, I(1) are cointegrated if their combination is integrated of order zero, I(0), as depicted in the stationarity of their residuals in a linear regression model.

Error Correction Model (ECM)

A time series model in (lagged) first differences that also contains an error correction term (that is lagged), whose purpose is to bring I(1) variables back into long run equilibrium. The coefficient on the error correction term measures the speed with which such an adjustment will take place, for the restoration of long-run equilibrium from short-run deviations.

Error Correction Term

The error correction term consists of a linear function of variables that defines their long-run relationship and is specified in such a way that the linear combination of explanatory variables is subtracted from the dependent variable. The error correction term enters the ECM in lagged form so that previous periodos deviations (of the dependent variable in the error correction term) from the long-run equilibrium relationship results in an adjustment in the ECMos dependent variable (this period), the extent of which is captured through the size of the coefficient on the error correction term.

Heteroscedasticity

A regression problem occurs when the variance of the error term is not constant, hence a violation of the OLS assumption. It does not compromise the unbiasedness of parameter

¹ In this section, only technical terms deemed critical to understanding the main thrust of this study are defined.

estimates (coefficients), but it biases the variance of the estimated parameters. As a result, the t-values on the estimated coefficients are not reliable.

Money Demand

It is the desired holding of financial assets in the form of money in cash or bank deposits by economic agents such as households and firms. It can refer to the demand for non-interestbearing holdings such as M1A and M1 monetary aggregates or broader money demand in the sense of M2 and M3 definitions of money. Modern forms of money, such as electronic money are also implied and included in the broadest definition of money in South Africa.

Multicollinearity

A regression problem in which there is a presence of interdependence between exogenous variables, distorting the observation of the true correlation between such exogenous variables and their endogenous variable. As a result, it constitutes a threat to the proper specification of the model and to the effective estimation of structural relationships between the regressend and its regressor(s).

Non-stationary time series

It is a time series process with a constant mean, variance and covariance over time. Such time series processes are integrated of order d, I(d), where $d \ge 1$, in macroeconomic data, usually is d=1, implying that after first differencing, the time series process becomes stationary.

Random Walk

It is a non-stationary time series process, where the estimated value of the next period is obtained by adding the current value to the independent error term. Possibly, a random walk can have a drift where a constant is added to each successive period. It is also referred to as a stochastic process.

Serial correlation

A regression problem in which error terms are exhibiting a pattern, hence violating the OLS assumption that covariance between error terms is zero. Hence, they are not independently distributed across the observations and are not strictly random. Serial correlation is the same as autocorrelation.

Spurious regression

It is the existence of highly significant correlations in a regression model, when in fact no such meaningful correlations are in existence. In a prototypical spurious regression, the fitted coefficients are falsely statistically significant when there is no true relationship between the endogenous variable and its regressor.

Stationary time series

A time series process that is characterised by a constant mean, variance and covariance over time, due to its mean reversion behaviour. Such time series processes are said to be integrated of order zero, I(0). Regression with stationary times series avoids the problem of spurious results.

CHAPTER ONE

Introduction

1.1 Introduction and Background

The primary focus of this research is to re-estimate the money demand function for South Africa, through the Autoregressive Distributed Lag (ARDL) framework. Money demand relationships are examined between various monetary aggregates (M1A, M1, M2 and M3) in the South African Reserve Bank definitions, expenditure components of GDP, the nominal exchange rate, with the interest rate and the inflation rate as the opportunity cost of holding money. Expenditure components identified are final consumption expenditure (both private and government), expenditure on goods and services and gross fixed capital formation used as a proxy for investment. This is an application of a similar research framework adopted to investigate stability of money demand in five Southeast Asian countries by Tang (2007) and in South Africa by Ziramba (2007), yet a different specification is tested.

The search for a theoretically coherent yet empirically robust model of the demand for money is central to the transmission mechanism of monetary policy. Effective monetary policy relies on a system or an economy ability to identify a stable money demand function. In the simple fix-price IS. LM closed economy model the size of the interest elasticity and the stability of the demand for narrow money determine in part the efficacy of monetary policy. The latter applies *a fortiori* if the demand for money depends on wealth as well as income. In most closed economy macro econometric models, the impact of money supply on inflation operates via excess demand and the Price Expectations Augmented Phillips Curve (PEAPC). In such models there is a clear short-run trade-off between the speed at which inflation is reduced and the temporary loss in real output caused by contraction in the money supply (Cuthbertson, 1991).

The South African financial sector has undergone dynamic changes in different monetary policy regimes. There was reliance on direct credit controls in the 1960s and 1970s as key instruments of a liquid asset ratio-based monetary policy system. The adoption of credit liberalisation in 1981 through the recommendations of the De Kock Commission moved the monetary policy stance from direct controls to a more liberal and market-oriented regime. A variety of effective instruments were taken on board to stimulate economic growth while curbing inflation simultaneously. According to Strydom (2000) interest rates were allowed to fluctuate with market signals in a monetary policy framework whose ultimate goal was price stability with monetary aggregates as immediate targets. That led to the announcement of the broad money supply as the money supply target after the second quarter of 1985.

In 1986 monetary policy was characterised through a cost of cash reserves-based system with pre-announced monetary targets. According to Casteleijn (2000) M3 growth targets were announced annually and such targets were to be achieved indirectly by adjusting short-term interest rates. In this regime, the Bank rate featured as the principal operational variable in conducting monetary policy and banks were allowed unlimited access to liquidity through the discount window by discounting paper with the SARB. Various measures such as open-market operations were used to influence overall liquidity and credit extension to the private sector.

Subsequently, the relationship between M3 as the monetary target and other nominal variables collapsed after 1990. It was noticeable that monetary targeting could not be an effective conduit to explain underlying causes of inflation despite excessive and persistent growth in M3. In 1998 a new system of monetary accommodation was introduced and it was characterised by daily tenders of liquidity through repurchase transactions. Monetary policy stance shifted focus from monetary targeting to informal targets of core inflation although money supply guidelines were still announced. An informal inflation target of 1% to 5% was a key aspect of the monetary policy stance after 1998 with intentions to control inflation and through rationing of liquidity. Contractionary and expansionary monetary policy objectives were pursued through short-term interest rate as a conduit to decrease and increase liquidity accordingly.

The year 2000 came with the announcement of formal inflation targets in an attempt to pursue a more prudent monetary policy stance that aimed to bring the inflation rate down to acceptable levels. This decision was influenced by positive results that inflation targeting gave when the inflation rate fall from 15% in 1990 to an average annual rate of 5.2% in 1999. Despite the successes of informal targeting, the need to formalise inflation targets was also due to uncertainties that it was sometimes bringing to the public. Secondly, it was earmarked to align monetary policy with other macroeconomic objectives. In addition, inflation targeting was going to make the SARB accountable and committed to its policy objectives in the broader macroeconomic management framework. Until today, South Africa is regarded as an inflation targeter. As is well known, the necessary condition for effective monetary aggregate targeting is the existence of a stable long-run and a short-run relationship between the monetary aggregate and the final target variables, which in this case is price stability (Halicioglu and Ugur, 2005). A stable money demand function has long been sought after, because it can be very useful in explaining or even predicting the behaviour of the macro economy (Humavindu, 2007). Thus, the history of monetary policy can be summarised as given in the table below.

Table 1.1 Evolution of South Africa's monetary policy

YEARS	MONETARY POLICY FRAMEWORK
1960 - 1981	Liquid asset ratio-based system with quantitative controls over interest and
	credit.
1981 - 1985	Mixed system during transition.
1986 - 1998	Cost of cash reserves-based system with pre-announced monetary targets
	(M3).
1998 - 1999	Daily tenders of liquidity through repurchase transactions (repo system),
	plus pre-announced M3 targets and informal targets for core inflation.
2000	Formal inflation targeting

Source: Casteleijn (2000:5)

Changes in such monetary policy regimes and political dispensations are bound to cause changes in the estimated parameters of the demand for money function and render conventional policy simulations redundant. For example, a money demand function estimated under an inflation targeting monetary policy regime may become obsolete in a new policy. It is notable that changes in governorship at the South African Reserve Bank precipitated dynamic adjustments in monetary policy and supportive instruments targeted. Other things being equal, a stable money demand function estimated over a period when money supply was endogenous may not prove to be stable when new forms of money, such as electronic money, are in existence. Hence, it is traditional in monetary economics for researchers to reflect on the stability of money demand over time. In general, it is envisaged that very useful policy implications can be drawn from this work as money demand represents an important channel of the monetary transmission mechanism.

South Africa is also a member of the world¢ oldest customs union, known as the Southern African Customs Union (SACU), where Botswana, Lesotho, Namibia and Swaziland are members. SACU has been operated under a common customer revenue pool, where South Africa collects the customs revenue accrued to all member countries using a fixed formula, and then redistributes it to the respective members after a certain period. This type of trade arrangement has an impact on price, real and monetary variables, which affect the stability of money demand (Humavindu, 2007).

1.2 Statement of Problem

Previous studies on money demand in South Africa, such as Maxwell (1971), Contogiannis and Shahi (1982), Nell (1999), Moll (1991, 2000), Tavlas (1989), Hurn and Muscatelli (1992), Naude (1992), Johnson (2001), Wesso (2002), Tlelima and Turner (2004), Odhiambo (2005), Todani (2007), Humavindu (2007), Hall, Hondroyiannis, Swamy; Tavlas (2007), and Gupta (2008) except Ziramba (2007) were based on a single aggregated income variable. This approach assumes that various components of real income (as proxied by GDP) have the same effect on money demand. However, Tang (2007) argued that different components of aggregate real income might affect money demand differently. Thus, the use of such a single real income variable is bound to cause aggregation bias. A similar approach has been adopted by Ziramba (2007) with annual data from 1970 to 2005. Six years down the line, the same approach is adopted with a more current data set and a different set of scale variables.

Disaggregating the real income variable (GDP) into components like real final expenditure, real expenditure on investment goods and real expenditure on exports will allow the study to separate out the effects of various income components on money demand. It is hoped that this research will be more robust and it will yield a new model to explain the stability of money demand in South Africa which may be useful from a policy perspective as well, since policy makers can use specific monetary aggregates as conduits for inflation targeting. Different elasticities of GDP components may give rise to different policy lessons.

1.3 Research Objectives

The purpose of this research is to empirically investigate the sectoral money demand function of South Africa using annual data from 1980 to 2011. Its main objective is to reestimate money demand function for South Africa by assessing the short-run and long-run relationships with various macroeconomic components of real income (real GDP), exchange rate and opportunity cost of holding money proxied by the inflation rate and the short-term interest rates. Policy lessons from this study will be presented to the monetary authorities.

There are three key objectives in this study as outlined below.

 To investigate the empirical relationship between M0, M1, M2 and M3 real monetary aggregates, real GDP components, inflation, short-term interest rate, dummy variables and the nominal exchange rate using the autoregressive distributed lag (ARDL) cointegration model.

- To determine the stability of M0, M1, M2 & M3 money demand functions investigated. This is important because as it has been proved, cointegration analysis cannot determine if there is a stable relationship of variables that we examine.
- To investigate the long-run stability of the real money demand function based on the fact that the stability of the money demand function has important implications for the conduct and implementation of monetary policy.

1.4 Hypothesis

The following hypotheses are made.

- A stable money demand function in the South African economy does exist.
- The variables do share a long-run cointegrating relationship.
- Different demand components have different influences on the demand for money.

1.5 Motivation of the Study

This study is motivated by the need for further empirical work and routine analysis in examining South African money demand behaviour to support monetary policy management. It is an attempt to draw messages for monetary policy about the aggregate demand for money. The M3 as the broad monetary aggregate is used as an instrument in the present inflation targeting monetary policy framework by the South African Reserve Bank. This research investigates the stability of M3 among other monetary aggregates in a sectoral approach to see the extent to which various components of Gross Domestic Product (GDP) have an influence on money supply and ultimately on price stability. Hence estimation of the money demand function is done to observe the effectiveness of M3 in sustainable management of inflation in South Africa in a targeting framework of between 3% and 6%.

According to Humavindu (2007) money supply can be used theoretically as a policy tool to target inflation between the stipulated band or a desired level of economic growth and help monetary authorities achieve such targets. South Africa is the leading partner in the Common Monetary Area (CMA) as reflected by the use of the rand as legal tender by countries in this union. In addition, the rand is also used as legal tender in Zimbabwe unofficially after the collapse of the Zimbabwean dollar at the peak of the political crisis in 2008. This is clear signal that the Rand is demanded in South Africa and beyond. Thus its stability has important implications not only in South Africa but in the region.

Firstly, this research presents an unrestricted error correction model (UECM) in the ARDL framework by Ziramba (2007) using a more recent data set and a different set of expenditure components and opportunity cost variables. The research will employ the bounds- testing procedure for cointegration (Pesaran, Shin and Smith, 2001) which depends on Autoregressive Distributed Lag (ARDL) specification. The ARDL approach is adopted, due to its distinct advantages over the Johansen methodology, as extensively applied in on-going money demand estimations in developed and developing countries as applied recently by Sovannroeun (2009) ; Bahmani-Oskooee (2009); Dagher &Kovanen (2011); Achsani (2010); Damarderh and Izadi (2011); Dritsakis (2011) and Tehranchian & Behravesh (2011); Iqbal, Pervaz, Khan & Zubair (2012); and Mousavi, Dogani & Torkamani (2012)².

Available evidence is still limited for money demand function with real GDP components in South Africa due to time lapse. Secondly, the application of the ARDL single equation cointegration framework has an advantage of avoiding the classification of variables in terms of the degree of their integration, unlike the conventional tests where there is a need for unit root or stationary pre-testing. The ARDL approach to cointegration involves a reparameterisation of an unrestricted highly dynamic model to yield long-run relationships. It allows model estimation with variables of different orders of integration which cannot be done in the Johansen methodology. According to Cook (2006), the F-test (ARDL) possesses greater power than both the Engle-Granger and GLS-based cointegration test. The ARDL specification allows separate identification of both long-run and short-run coefficients of explanatory variables (Tang 2007).

1.6 Data and Organisation of the Thesis

The research for money demand in many developing economies is hampered by severe data limitations, including poor quality of economic statistical data, and lack of consistent time series in required frequencies among other reasons. The South African Reserve Bank website and Statistics South Africa will be used to obtain annual data, as primary sources, from 1980 to 2011 on economic variables under investigation. Time series data is downloaded through the online statistical query facility and direct access from responsible personnel from these institutions. The choice of period has also been determined by availability of quality economic statistical data on the SARB statistics data base.

² The main advantage of this testing and estimation strategy lies in the fact that it can be applied irrespective of whether the regressors are I(0) or I(1), and this avoids the pre-testing problems associated with standard cointegration analysis which requires the classification of the variables into I(1) and I(0) (Pesaran H & Pesaran B, 1997).

The remainder of the thesis is organised as follows. Chapter 2 presents an extensive debate on theoretical underpinnings of money demand and related literature. Firstly definitions of money are explained followed by an account of the history of monetary policy in South Africa. After that, classical theories of money demand are presented followed by the Keynesian and Monetarist perspectives. Other theories such as the target threshold model, precautionary models, risk aversion models, asset demands and consumer demand theory and the buffer stock approach to money demand are debated.

Chapter 3 covers empirical considerations on the notion of money demand. It begins with an introduction followed by empirical evidence in a broader perspective. Evidence based on partial and adaptive expectations is reflected based on economic theory of rational expectations that was a popular school of thought in the 80s. Evidence based on the ARDL and Systems approach in a sample of developed and developing countries is then presented. The four approaches to buffer stock models are covered before a discussion of the South African empirical evidence is given.

Chapter 4 covers the statistical estimation methodology and model specification. An introduction is given followed by the concept of stationarity. The problem of spurious regression is presented followed by unit root testing and the concept of cointegration analysis. The ARDL modelling framework to cointegration analysis is discussed together with notions related to the bounds testing procedure and associated hypothesis testing, diagnostic tests for regression pathologies and the CUSUM & CUSUMQ stability tests given by Brown, Durban & Evans (1975). At the end model specification is dealt with supportive practical and theoretical justifications.

Chapter 5 covers model presentation, estimation and discussion of results. The rationale behind choice of variables and data transformation issues are explained in Stage 1 followed by the descriptive statistics and univariate statistical properties of data in stage 2. The long run money demand functions are run and results are discussed. The ARDL is run as an unrestricted error correction model to present results and interpretation. Model fitness is established in the bounds testing approach to hypothesis testing and graphical presentations of the CUSUM and CUSUMQ tests of model stability are given and interpreted. Long run elasticity values are also calculated and interpreted. The speed of adjustment coefficients are also identified and explained.

Chapter 6 presents a summary of research findings and gives conclusive remarks. Policy recommendations are also given as well as an evaluation of strengths and weaknesses of this study.

1.7 Ethical Considerations

This research does not involve any human contact through any survey process. Hence, there is no need to get prior permission from gatekeepers or respective access controllers. Secondary data sources are utilized to obtain statistical information in time series form from databases, although direct contacts may be done with statisticians in the targeted institutions and academic institutions like universities. Sources are directly accessible through on-line downloading facilities or direct enquiry without any special clearance given by the producers and suppliers of such official statistics. Time series data will be obtained from the South African Reserve Bank and Statistics South Africa. Sources of statistical data will be duly acknowledged and indicated in the bibliography section and directly on sub-headings of graphs extracted, as well as on footnotes or general acknowledgement section of the thesis.

CHAPTER TWO

Theoretical Literature Review

2.0 Introduction

This chapter presents a debate on theoretical underpinnings on the notion of money demand. Definitions of money are given in theory and in the South African perspective. The Classical, Keynesian and Monetarist schools of thought regarding the role of money in economic activity are tackled. Classical economists argue that monetary forces do not affect the movements of the real variables such as output and employment in the economy, while Keynesian theory suggests a positive causal relationship between money supply and levels of output via an inverse change in interest rates. The Monetarist school, on the other hand, contends that classical economists rather than Keynesians would have a valid and more authentic argument, as long as money can affect real variables in the short-run with only nominal magnitudes in the long-run. These are among issues debated in different sections of this chapter which is organised as follows.

Section 2.1 gives an account of the theoretical definitions of money and as they are in the monetary system of South Africa. In 2.2, the monetary aggregates in real terms (at constant prices) are identified. Section 2.3 presents the classical theory of money demand followed by an exposition of the Cambridge approach in section 2.3.1. The Keynesian liquidity preference theory is covered in section 2.4. Section 2.5 covers the post-Keynesian transactions money demand theory (inventory . models) and the portfolio theory is debated in section 2.6 including extensions to the inventory model by various scholars in the 70s. The monetarist money demand theory is presented in section 2.7 followed by the target threshold model of Akerlof and Milbourne (1980) in section 2.8.

Section 2.9 presents the precautionary demand for money approach in two perspectives. The first perspective is an account of the model under the assumption that the probability distribution of receipts and payments is known. The second perspective accounts for money, liquid assets and bank advances in precautionary money demand model. Section 2.11 focuses on the asset demand and consumer demand theory on money demand under given restrictions with implications on the demand for narrow money. The buffer stock approach to money demand is given in section 2.12 as a theoretical overview as the empirical framework of it is reserved for chapter 3. Section 2.13 outlines the microeconomic transactions theory of money demand followed by concluding remarks.

2.1 Definitions of Money in Economics

Money is one of the most important institutions in any modernized economy. Money is anything that is generally accepted for payment of goods and services or that is accepted in the settlement of debt (Mohr, Fourie and associates, 2008). In a broader sense, money is understood with respect to its functions as a unit of account, a store of value, a medium of exchange and a standard of deferred payment. According to Friedman (1956), #noney is what money doesq Generally, it is demanded not for its own sake, but for all the functions that it can perform.

The spectrum of money ranges from token money i.e., notes and coins as hard currency to commodity money in which goods and services serve as money in some instances. In fact, commodities were the earliest forms of money in primitive economies. In due course, commodity money paved the way for the more efficient coins, made of various kinds of metal. However, coins became inconvenient as the increasing specialization of production led to a greater dependence on trade and as they were difficult to handle in large transactions. This in turn led to the use of paper money which first appeared in England in the 16th century. The next step in the evolution process was the replacement of paper money, by fiduciary or credit money.

The modern bank note which is in use today bears no relationship to any commodity, and its value is based solely on confidence in the government or monetary authorities to control the supply of notes in such a way that their purchasing power will not fall substantially. This confidence and guarantee of acceptability has been declared by law as legal tender, implying that such notes and coins cannot be rejected by whosoever in the settlement for debts. Finally, the evolution process culminated in money in semi-liquid forms such as cheque accounts. Continuous technological innovation in the monetary sector of the economy has also given other forms such as credit cards, debit cards and various forms of electronic transfers. However, all these additional forms are not legal tender and their acceptability comes when stipulated conditions are met.

2.2 Money in South Africa

The South African reserve bank uses three different measures of the quantity of money. These measures are labelled M1A (a proxy of M0 in this study), M1, M2 and M3 respectively. The monetary aggregate M1A consists of notes and coins circulating outside the monetary sector³ plus cheque and transmission deposits of the domestic private sector

³ The monetary sector is defined as all institutions within the monetary sector, i.e. the now-extinct National Finance Corporation, Corporation for Public Deposits and the so-called pooled+funds of the former Public Debt

with monetary institutions. This constitutes approximately 5% of the total M3 money supply. Cheque and transmission deposits are a subset of demand deposits. This aggregate, in addition to being highly liquid and convenient, also offers substantial benefits to depositors who feel the need to be able to transfer funds virtually immediately to obtain possible arbitrage gains. For example, by transferring idle funds into interest-earning assets if interest rates are expected to decline in the near future(de Jager, 1998:7). Figure 2.1 below shows annual M1A (KBP1370J) money supply statistics, nominally, in millions of Rands. Notably, there has been an increasing trend in M1A especially after 1995 to 2011.



Figure 2.1: M1A (KBP1370J) in millions of Rands, 1979 - 2011⁴

Source: South African Reserve Bank(2012)

M1 is defined solely on the basis of the function of money as a medium of exchange. Hence it constitutes notes and coins in circulation outside the monetary sector as well as demand deposits excluded in M1A of the domestic private sector with monetary institutions. These additional demand deposits of the private sector are determined as the balancing item on the consolidated balance sheet of the banking sector. Figure 2.2 below shows the increase in money supply, with a sharp increase between 2007 and 2008. Possibly, this is attributed to the rise in inflation in South Africa over this period due to the global economic meltdown.

Commissioners, the Land Bank, Post Office Savings bank, private banking institutions (including the former banks, discount houses and equity building societies) and mutual building societies (de Jager, 1998:7).

⁴ Statistics presented for KBP1370, KBP1371, KBP1373 and KBP1374 are downloaded from the SARB research website, <u>http://www.resbank.co.za</u> through the online downloading facility. These are in millions of Rands as shown with numbers on vertical axis of figure 2.1, 2.2, 2.3 and 2.4.





Source: South African Reserve Bank(2012)

M2 is equal to M1 plus all other time deposits in the short-term to the medium term of the domestic private sector with monetary institutions. These time deposits refer to deposits invested for a period of less than 30 days for the medium-term deposits. These can only be withdrawn earlier at considerable cost. They are regarded as quasi-money (near money), since the maturity of these deposits is not very long. Figure 2.3 below is a time series plot of M2 money supply from 1965 to 2011. It shows the same trend as M1.

Figure 2.3: M2(KBP1373J) in millions of Rands, 1965 - 2011



Source: South Africa Reserve Bank(2012)

M3 is equal to M2 plus all time deposits in the long-term of the domestic private sector with monetary institutions, whose maturity is longer than six months. M3 is considered the most

reliable indicator of developments in the monetary sector of the economy. So far, M3 is the measure of very broad money in South Africa and widely used to evaluate the success of monetary policy with monetary growth targets. Hence, it is regarded as the best measure of developments in the monetary sector. Figure 2.4 below is a plot of M3 (KBP1374J) from 1965 to 2011. There is an increasing trend in money supply growth on this aggregate over the period.



Figure 2.4: M3(KBP1374J) in millions of Rands, 1965 -2011

Source: South Africa Reserve Bank(2012)

2.3 Classical Theories of Money Demand.

Through the equation of exchange, Irving Fisher (1911) presented the notion of the classical quantity theory of money. Fisher identity is given as:

Where *M* indicates the average stock of money over a period, *V* its velocity, *P* the price level and *Y* the real income or output of that period. In this identity, the Money stock (*M*) is multiplied by *V* (or the number of times money is used to buy final output) to obtain total expenditure which must be equal to the product of *P* and *Y*. In the equation, Fisher wanted to examine the link between the total quantity of money *M* and the total amount of spending on final goods and services produced in the economy, *PY*, where *P* is the price level and *Y* is aggregate output, *V* is the velocity of money. Velocity is defined more precisely as total spending *PY* divided by the quantity of money *M*.

$$V = \frac{PY}{M}$$
 2.2

The equation of exchange is the derived after multiplying both sides by *M* to give.

This equation relates nominal income to the quantity of money and velocity, stating that the product of quantity of money and its velocity of circulation must be equal to nominal income. Given changes in M, nominal income PY changes with a positive relationship and equiproportionally.

Fisher (1911) believed that velocity is determined by the institution in economy that affects the way individuals conduct their transactions. Fundamentally, he assumed velocity to be reasonably constant in the short-run and that institutional and technological features of the economy would affect velocity slowly over time. His view of short-run constant velocity transforms the equation of exchange into the quantity theory of money demand. In the perspective of classical economists, the quantity theory of money provided an explanation of movements in the price level. The evidence that the quantity theory of money is indeed a theory of money demand can be seen by dividing both sides of the equation by V to give.

$$M = \frac{1}{V} PY$$
 2.4

In this equation, the money market is deemed to be in equilibrium, with quantity of Money *M* that people hold equal to the quantity of money demand M^d . Hence, *M* in the above equation can be replaced by M^d using *k* to represent the quantity $\frac{1}{v}$ so that the above equation can be rewritten as follows:

$$M^{d} = kPY$$
 2.5

Since *k* is a constant, the level of transactions generated by a fixed level of nominal income *PY* determines the quantity of money M^d that people demand. In this regard, Fishers quantity theory of money suggests a money demand function determined by income only, with interest rates having no effect. Fisher assumed that people hold money only to conduct transactions and have no freedom of action in terms of the amount they want to hold. Therefore, it can be concluded that money demand is ideally determined by the level of transactions generated by the level of nominal income *PY* and by institutions in the economy that affect the way people conduct transactions that determine velocity and thus *k*.

However, several criticisms have been levelled against this school of thought. Bain and Howells (2003) argue that the exclusion of financial transaction from consideration undermines much of the logic of the original quantity theory and brought the theory into line with the Cambridge approach and later portfolio models of money demand. Its assumption about money stock M being strictly exogenous has compromised its validity since other circumstances could lead to the growth of endogenous money that could then reverse the causal relationship.

Complications arise from two sources. Firstly, that there are different opinions about the definition of terms such as money, velocity, volume of transactions and the general price level. Secondly, that there are different interpretations about the relationship between the variables in the quantity theory especially with regard to those that are active and those that are passive in causing price changes (Lewis and Mizen, 2000: 61). The definition of money that was used in the development of classical theory is not coherent, compatible and applicable even to different economies that co-existed then with Europe. The idea of constant velocity has also been dismissed by many economists who developed later theories. According to Xueping (1999), Fisher emphasized technological factors and insensitivity of interest rates to money demand.

Later theorists like Walras developed further theories in the form of dichotomized models by focusing on the impact of the causal relationship between money demand and its determinants to the real sector. The Cambridge economists such as Pigou (1917) have reservations on the notion of constant velocity in Fishers identity.

2.3.1 The Cambridge Approach to Money Demand

Alfred Marshall and A.C. Pigou (1917) developed a similar model to the Fishercs identity, known as the Cambridge cash balance approach. This approach changed the focus of interest from a model where velocity is determined by the payments mechanism to one where agents have a desired demand for money (Cuthbertson, 1991:4). It was an attempt to cast the Fishers identity into the form of demand and supply analysis, relaxing some of the earlier underlying assumptions such as exogeneity of money supply and flexibility in money holding portfolios by the general public and consumer sovereignty outside institutional constraints.

Cambridge economists postulated that the levels of people wealth had a direct effect on money demand as given in the following identity.

$$\frac{M^d}{p} = kW$$
 2.6

Where M^d is the demand for money, P is the price level, Md/P represents real money holdings demanded, k is the fraction of income that is held in cash, hence a coefficient of proportionality representing varying relationships between money demand and levels of wealth as given by income and W is representing real resources and indeed a long-run concept. The Fishers identity could essentially be the same as that of the Cambridge economists as long as the assumptions of exogeneity of money supply and constant velocity were holding. Analytically, the effect of changes of money supply on prices will be identical, whether one follows the basic equation of Fisher or Cambridge demand for money theory (Ghatak, 1995:12).

However, it is quite imperative to note that factors influencing velocity in the Fishers version of money demand are a subset of those influencing k in the Cambridge version. Portfolio sovereignty was an influencing factor in the Cambridge k, thus causing it to fluctuate in the short-run because the decisions about using money as a store of wealth largely depended on the yields and expected returns on other assets that also function as stores of wealth, probably bonds etc.

In the long-run equilibrium, savings, rather than being held as money, are invested leading to an increase in the economy resources. The individuals demand for money, then depends on

- (a) The convenience and feeling of security obtained from holding money.
- (b) The expectations and total resources of the individual ; and
- (c) The opportunity costs of holding money (Bain and Howells, 2003:102)

2.4 Keynes's Liquidity Preference Theory

John Maynard Keynes (1936) postulated a theory of money demand which he called the liquidity preference theory. He negated the classical view that velocity was constant and emphasized the importance of interest rates. In general he envisaged that there are three motives behind the demand for money: the transactions motive, the precautionary motive, and the speculative motive. His school of thought was inclined to the views of classical economists such as Marshall, Pigou and other Cambridge theorists, although he went beyond the classical analysis by recognizing individual desires to plan their wealth portfolio considering bonds or liquid money.
The main predictions from Keynesqs theory are, first that individuals do not hold diversified portfolio of assets; they hold either all bonds or all money. Secondly, a downward sloping demand for money function with respect to the interest rate only occurs for the aggregate demand for money. Finally, the theory predicts that in certain circumstances the elasticity of the demand for money with respect to the interest rate may become infinite; this is the so-called liquidity trap. The individual has a fixed holding period and forms expectations about the price of the bond at the end of the holding period with perfect certainty, i.e. they have inelastic expectations. Clearly, if individuals expected the return on the bond to exceed the known interest rate on money r_m and they hold this expectation with perfect certainty, then they will put all their wealth in bonds. The individual does not hold a diversified portfolio, he is a plungerq(Cuthbertson 1988b:5).

Keynes hypothesized that individuals have regressive expectations.

$$g^e = \alpha (r - r_N) > 0$$

Where g^e represents regressive expectations, r_N is the nominal rate of interest and differs between individuals. If people hold different views about what constitutes the nominal rate of interest then (for any given) a rise in the current rate of interest will induce some individuals but not all individuals to move into bonds.

He argues that the transactions motive is an integral component of money demand, determined primarily by the level of peoplecs transactions. The transaction demand for money arises from the lack of synchronization of receipts and disbursements. Keynes believed that the transactions component of money demand was proportional to income since routine transactions were proportional to income.

Under the precautionary motive, people hold money not only to carry out current transactions, but also as cushion against any unexpected need, due to uncertainty about the transactions they might do in the medium term, in case, failure to honour these transactions might suffer them a loss. These precautionary money balances are intended for use in case of arising advantageous circumstances such as clearance sales. Hence, Keynes advocated that such precautionary money balances people may want to hold are determined primarily by the level of transactions that they are expected to make in the future and that these transactions are proportional to income. Therefore demand for precautionary money balances is considered proportional to income.

Unlike the transactions and precautionary motives that put emphasis on the medium of exchange function of money, the speculative motive is inclined to the store of value function.

17

He also considered that wealth is tied closely to income, such that the speculative component of money demand would be related to income. As opposed to his Cambridge predecessors, Keynes believed that the interest rates have an important role to play in influencing the decisions regarding how much money to hold as a store of wealth and that there is a negative relationship between money demand and interest rates.

In the Keynesian model, the rate of interest (*i*) is determined by the demand for money (M_d) and supply of money (M_s). Money supply is fixed in the short-run, exogenous and thus invariant to changes in interest rates. From the three motivates of Keynes, a preliminary money demand equation, based on the income component, ceteris paribus, can be given as

$$M_d = M_t + M_p + M_{sp}$$

Where M_d is money demand, M_t being transaction demand for money, M_p is the precautionary demand for money and M_{sp} is the speculation demand for money. Due to preference between liquid money or bonds, Keynes argued that the speculative demand for money or liquidity preference is an inverse function of the interest rates (Ghatak, 1995:17) and is expressed as follows

$$M_{sp} = f(i) \tag{2.9}$$

A combination of these two functions presents the aggregate and general liquidity preference function, which says that the demand for real money balances (M^d/P) is a function of (related to) *i* and Y.⁵

$$\frac{Md}{P} = f(i, Y)$$
2.10

Where the minus sign below (*i*) in the liquidity preference function means that the demand for real money balances is negatively related to the interest rate, and plus sign below Y means that the demand for real money balances and real income Y are positively related. With such relationships between Md/P, *i* and Y, the demand for real money balances Md/P can be rewritten as:

$$\frac{Md}{P} = L_1(Y) + L_2(i)$$
2.11

⁵ The classical economistsqmoney demand equation can also be written in terms of real money balances by dividing both sides of the above equation (number), by the price level P to obtain: $\frac{Md}{P} = kxy$.

Where L_1 , means the transactions demand for money and L_2 , the speculative demand for money. The derivation of the liquidity preference function for velocity *PY/M* implies that velocity is not constant but instead fluctuates with movements in interest rates. Against that argument, the liquidity preference equation can be rewritten as:

$$\frac{P}{M^d} = \frac{1}{f(i;Y)}$$
2.12

Multiplying both sides of this equation by Y and recognizing that M^d can be replaced by M because they must be equal in money market equilibrium, we solve for velocity.

$$V = \frac{PY}{M} = \frac{Y}{F(i,Y)}$$
2.13

Therefore Keynesos liquidity preference theory of the demand for money indicates that velocity has substantial fluctuations, hence positively related to interest rates (Mishkin, 2002:546). Velocity fluctuations are also attributed to changes in expectations about the nominal level of interest rates by economic agents, which would then cause shifts in money demand. Although the theory has been developed as an extension of the classical Cambridge approach, it casts doubts on the classical quantity theory that nominal income is primarily determined by movements in the quantity of money.

However, Bain and Howells (2003) have presented common criticisms of Keynes¢ liquidity preference theory of money demand. Amongst such arguments are notions that, Keynes¢ theory of portfolio choice is rather incorrect because the implications of speculative demand regarding the choice between all money or all bonds as influenced by expectations on the interest rates regime in future, is not a reality in day to day practices. Its assumption of regressive expectations is unrealistic. In his model, the nominal rate of interest is exogenous and no sound explanation is given of what determines it. The restriction to only two assets . money and bonds - is too limiting, hence an under estimation of portfolio choice. The liquidity trap is a logical impossibility since not everyone can switch from bonds to money as someone must hold the existing stock of bonds. At the same time, savings deposits should not be included as part of the money stock.

2.5 Inventory Models and Transactions Demand For Money

The criticisms of Keynesos theory led post-Keynesian economists to find other ways of justifying some of Keynesos message, in particular the inverse relationship between interest

rates and the demand for money. Baumol (1952), a Keynesian advocate, presents the inventory model based on the transactions demand for money and interest rates. The key assumptions of his model are as follows:

Firstly, the individual receives a known lump sum cash payment of T per period (say per annum) and spends it all evenly over the period. Secondly, the individual may invest in \pm oondsq paying a known rate, r, per period or hold cash (money) paying zero interest. Thirdly, the individual sells bonds to obtain cash in equal amounts K and incurs a (fixed) brokerage fee b per transaction. In the model, all relevant information is known with certainty⁶.

Agents minimize the sum of brokerage costs *bT/K* and interest income foregone *rK/2*. The model yields a square root relationship between the demand for money and the level of income, the brokerage fee and the bond interest rate:

$$\ln\left(\frac{M^{d}}{P}\right) = \left[\ln\left(\frac{b}{2}\right) + \ln T - \ln r\right]$$
2.14

A unit price elasticity is included in the equation 2.14 because a doubling of the price level doubles both b and T therefore double M (T and b must now be considered as real variables rather than nominal variables). Noticeably, individuals will always switch into bonds immediately and will have zero money balances before switching into bonds, since receipts are perfectly foreseen than any other strategy would involve a loss interest. Equation 2.14 determines the mean holdings of money and not holdings at particular point in time, a distinction not always involved in empirical work.

The brokerage fee consists of inconvenience costs (particularly of time) as well as any direst pecuniary costs (for example stockbrokersqor bank charges). The brokerage fee may vary with the real wage rate, or it may decrease owing to changes in payment mechanisms. Baumolog model predicts economies of scale in holding money; a doubling in the level of transactions leads to only a 50 per cent increase in money holdings. It follows that the distribution of transactions/ income influences the demand for money. Hence the simple inventory model can be extended to include interest payments *i* on money to obtain.

$$M^{d} = \frac{K}{2} = \left[\frac{bT}{2(r-i)}\right]^{\frac{1}{2}}$$
 2.15

⁶ Milbourne (1983a) provides an elegant synthesis on target threshold models and demonstrates that inventory models of the Baumol-Tobin type can be viewed as a special case of the more general target threshold models (i.e. Baumol. Tobin models have a fixed lower threshold and a non. stochastic cash inflow). However, for expositional purposes, the destination between the inventory and precautionary models has been made.

The transactions elasticity is again $\frac{1}{2}$ but the interest elasticity is now Er = -r/2(r-i). In principle, equation 2.15 can be estimated in log-linear form with coefficients of $\frac{1}{2}$ expected on *T* and *r-i*: the demand for money now depends on the relative interest rate.

Sprenkle (1969) gave a critique of the inventory model when applied to large firms with his situational analysis mainly focusing on the UK firms. His criticism put the empirical relevance of Baumolog model into question. In his first critique, cash holdings of large firms can be explained by the existence of multiple accounts as much as by optimal inventory behaviour. Secondly he argues that it may not be profitable for firms to undertake optimal cash management if receipts of each branch of the firm are small. Thus, firms can minimize costs by not purchasing any securities at all but keeping all their receipts in cash. Thirdly, Sprenkle (1969) demonstrates that firms hold some optimal and some non-optimal balances. The proportion of non-optimal receipts in total receipts does not have to be very large for non-optimal balances to dominate money holdings.

It has also been argued that possible gains of an individual or firm in Baumolos framework are so small relative to the cost (especially if the value of time is taken into account) that the rational individual would not bother switching into bonds and back again. The relationship between money, interest rates and transactions is more complex than in Baumolos model. Nonetheless, it retains theoretical significance because of its ability to generate an inverse relationship between interest rate and the demand for money despite the assumption of perfect certainty.

2.6 Tobin's Portfolio Model of Money Demand

Tobing model (1958, 1969) can be seen as a response to the common criticisms of the speculative demand model⁷. A wider range of assets, including equities and real assets, is introduced. His model is generally accepted as a Keynesian model as it preserve the possibility of an inverse relationship between the rate of interest and the demand for money, due to its reflection of the indirect transmission link between money and nominal income. To a greater extent, this model is very much centred on microeconomic theory of choice behaviour. However, it produces a demand for money function that is very likely to be stable and hence, removes the third characteristic of the speculative demand model. In this regard,

⁷ Only a descriptive exposition is given in this text for further reading consult Tobin J (1958). Liquidity preference as behaviour towards riskqreview of Economic studies, 25 (i), 65 . 86 and Tobin J (1969). A general equilibrium approach to monetary theoryqJournal of money credit and banking 1 (i) 15 . 29. Also see Bain and Howells (2003). Monetary Economics: Policy and its theoretical basis, Palgrave Macmillan, New York (117 . 121).

it is considered as a misrepresentation of the Keynesian school of thoughts (Chick 1977: 48, Dow and Earl, 1982: 72).

In Tobin¢ model, assumption of portfolio choice between money and bonds is emphasized, which depends on the trade-off between the net income receivable on bonds and the degree of risk associated with the total portfolio of bonds and money (which is assumed to be perfectly liquid and non . interest bearing). One underlying assumption is that, expectations regarding future interest rates are neutral hence uncertainty prevalent in Keynes¢ model disappears. In these circumstances, the risk associated with bond holding is much more manageable than in Keynes.

2.6.1 Extensions to the Inventory Model

Several refinements have been made to the simple inventory model. The Baumol (1952) model neglects integer constraints on the number sales of assets. Tobin (1956a) rectified this and finds that it may be worthwhile for some individuals to hold no earning assets at all. This is referred to as the <u>corner</u> solutionq such that their demand for money is then proportional to lumpy income receipts as in Fisherqs model. Barro and Grossman (1976) aggregated Tobinqs corner solution and square root money holders (assuming a gamma distribution for the cross . sectional distribution of income) and finds that the aggregate income elasticity lies between 0.5 and unity (0,5 from transactions and 0.5 from the brokerage fee).

Santomero (1974) introduce commodities into the choice set of the inventory framework. There are transactions costs in moving into and out of durable goods, the yield on which is the expected rate of inflation (less storage and depreciated costs). The expected rate of inflation enters the determination of the demand for money (and bonds) but its sign remains ambiguous (Grossman and Policano, 1995). Barro (1970) and Santomero (1974) endogenise the period between income receipts in the money . bonds . commodity inventory model. The corner solution now depends upon interest rates and transactions costs and in Barros model (where earnings of assets are excluded) money and expected inflation are negatively related.

2.7 Monetarism and Money Demand

In 1956, Milton Friedman developed a theory of the demand for money in a famous article, %The quantity Theory of Money: A Restatement+. This has been considered to the modern quantity theory of money, similar to the Cambridge theory and even close to the Keynesian school of thought, although built upon the drawbacks of the Keynesian perspective. In Freidmangs monetarist school of thought, money is demanded by two groups.

- (a) Ultimate wealth holders (for whom money is simply one way in which they may hold wealth), and
- (b) Business enterprises (for whom money is a productive resource).

The modern quantity theory states that a change in money supply will change the price level as long as the demand for money is stable; such a change also affects the real value of national and economic activity but in the short-run only. According to Friedman, the stability in the demand for money is just a behavioural fact, proven by empirical evidence (Ghatak, 1995:22). As long as the demand for money is stable it is possible to predict the effects of changes of money supply on total expenditure and income. The monetarists are also of the idea that if the economy operates at less than full employment level, then an increase in money supply will lead to a rise in output and employment because of a rise in expenditure, but only in the short-run. After a time, the economy will return to a less than-full-employment situation which must be caused by other real factors.

The theory dwells much on ultimate wealth holders whose demand for money can be analyzed in the same way as the demand for any asset. The demand for money is considered as a whole than as driven by separate motives for holding money in the Keynesian perspective. Thus the monetarist demand function contains:

- (i) A budget constraint (either permanent income or wealth);
- (ii) The prices of the commodity itself (money) and its substitutes and complements (Freidman sees the counter parts of these as being the rates of return on money and other assets).
- (iii) Other variables determining the utility attached to services rendered by money relative to those provided by other asset (these may include the degree of economic stability, the variability of inflation, and the volume of trading in existing capital assets);
- (iv) Tastes and preference. (Bain and Howells, 2003:122).

The theory of asset demand indicates that the demand for money should be a function of the resources available to individuals (their wealth) and the expected returns on other assets relative to the expected return on money. Like Keynes. Friedman recognized that people want to hold a certain amount of real money balances (the quantity of money in real terms (Mishkin, 2000:552).

From this reasoning, Friedman expressed his formulation of the demand for money as follows.

$$\frac{Md}{P} = f\left(Y_P, W, i_m, i_b, i_e, (1/p).dP^e / d_t, \mu_t\right)$$
2.16

Where

- *P* is the price level. It is included because the demand for money is a demand for real balances and a change in *P* changes the real value of money holdings. Thus, *P* is positively related to *Md*.
- W is non-human wealth/wealth.
- $\frac{M^d}{P}$ is the demand for real balances.
- *Yp* is permanent income, introduced as a proxy for wealth because of the difficulties involved in measuring wealth. As in Friedmancs consumption theory, permanent income was taken as an exponentially weighted average of past and current levels of income.
- *i*_m is the rate of return on money itself.
- *i_b* is the rate of return on bonds, abstracting from the possibility of capital gains or losses.
- *i*_e is the rate of return on equities, abstracting from the effects on equity prices of changes in interest rates and the rate of inflation.
- $(1/p).dP^e/d_t$ is the expected rate of inflation including the rate of return on real assets. Notably the demand for money is positively related to the price level, but negatively related to the expected rate of inflation.
- μ is a portmanteau symbol standing for other variables affecting utility attached to the services of money and also includes tastes and preferences. It may either be negatively or positively related to money demand. (Bain and Howells, 2003:123).

The signs underneath the equation variables indicate whether the demand for money is positively (+) or negatively (-) related to the terms that are immediately above them⁸. The rates of return in equation 2.16 are expected variables. Friedman argues that signs attached to variables should be determined principally by data despite their statement by theory.

⁸ Friedman also added to his formulation a term h that represented the ratio of human to non human wealth. He reasoned that if people had more permanent income coming from labor income and thus from their human capital, they would be less liquid than if they were receiving income from financial assets. In the case, they might want to hold more money because it is a more liquid asset than the alternatives. The term h plays no essential role in Friedman¢ theory and has no important implications for monetary theory. For that reason it has been left out in the above money demand function.

Friedman made use of permanent income in equation 2.16 to explain apparently conflicting long-run and cyclical tendencies. His historical studies of money in the United States economy suggested that in the long. run as income rose, velocity fell but that over the business cycle, there was a tendency for the velocity to increase in booms and fall in slump. The argument rested on the proposition that if the demand for money was a function of permanent income, it would fluctuate less, *ceteris paribus*, than if it were a function of current income. As income rise over a boom of a business cycle, individuals continue to base the demand for money on their permanent income, which is now lower than current income because part of current income is positive transitory income. Money demand falls in relation to current income and velocity rises. In the trough of the business cycle, transitory income is negative, money demand rises in relation to current income and velocity falls.

In Friedman¢ model, the distinction between human and non. human wealth is not relevant for firms. However, his model did not give clarity about money demand of business enterprises as he argued that they were facing a different constraint, since firms can influence the total amount of capital in the form of productive assets by borrowing through capital markets. The rates of return relevant to firms are different from those for ultimate wealth holders, for instance, the bank loan rate may be more important for firms than for households (Bain and Howells, 2003:125). Friedman argues that the ultimate test of theories is their ability to predict accurately, since he believes the money demand function to be stable over a smaller number of variables, the variables to be included in the equation, the form that they take and the relationship between them may be changed in order to produce the desired results. He believes testing should take over from theory, although the aim of testing is to demonstrate that the basic theory is correct.

2.8 Money Demand and Transactions in the Target Threshold Model

Akerlof and Milbourne (1980), developed an alternative approach to the modelling of the transactions demand for money in which money holdings are only actively adjusted when they hit an upper or lower threshold level. The model predicts that in the short-run income elasticity is small (i.e. around zero) and may even take small negative values.

There are two main variants of the Akerlof. Milbourne (AM) model. In the first, there is no uncertainty but in the second the timing of lump sum expenditure plans by agents is uncertain. Thus, the certainty model is an inventory model while the second is more akin to a precautionary demand model. In the AM. model, agents adjust their money balances only when threshold points are reached. Secondly, they include uncertainty in the portfolio choice problem.

In its simplest form the model, given defined net receipts, assumes a lump sum receipt of Y per period and spending of C at a constant rate through the period. Money balances accumulate via savings: S = Y - C when the money balance hits the upper threshold H, it is returned to C, so that money balances are exhausted by the next receipt date. In their model with certain receipts Akerlof and Milbourne (1980) obtain:

$$\frac{\partial M}{\partial Y} = -Sy\frac{Y}{4}$$
2.17

Where *M* is the average money holding and $-Sy = \partial S / \partial y$ is the marginal propensity to save and is assured to be positively related to income, hence, the short-run income elasticity is negative and takes a larger negative value the higher the level of income. This result is contradictory to the Baumol result and the classical Fisheros view (1911). Following the AM approach, Fishersqidentity can be written as $M^d = Y$ where Y equals the constant inflow of receipts and is the average time that each dollar is held. Fishers model gives a short-run income elasticity of unity (is assumed to be constant in the short-run).

Akerlof and Milbourne (1980) generalize the above model to incorporate uncertainty about spending plans in the form of small stochastic lump sum purchases of durable goods. When a durable good is purchased, money balances immediately fall (but not below zero since such purchases are small). After lengthy calculations and assuming that the saving ratio s=S/Y is constant they obtain:

$$\frac{aM}{aY} = \frac{s}{4} \left[1 + p + Yp^{1}(Y) \right]$$
 2.18

Where *p* is the probability of a durable purchase (in any time period). Equation 2.18 reduces to equation 2.17 when p = 0 and $p^{1}(Y) = 0$. If the probability of a durable good purchase increases with income $P^{1}(Y) > 0$, then the income elasticity of money demand is negative. They showed that the latter result also holds when durable purchases are large.

In summary, the essence of the inventory theoretical model of the transaction demand for money and bonds) is the assumption of certainty: certainty concerning the timing of income receipts, the timing of the return on money and bond, and the brokerage fee. In this model, money demand obeys the square root law in simplest cases. Akerlof and Milbourne (1980) have presented a transactions model of the target threshold type with lump sum receipts and payment, and this result in the demand for money having a very low (even negative) income elasticity. They extend the model to include an element of uncertainty in the timing of lump sum durable expenditures, and again low income elasticity is a feature of the model.

2.9 Precautionary Models.

Models of the precautionary demand are based on the transactions motive for holding money, but in contrast with most inventory models, the assumption that receipts and payments are known with certainty is relaxed. Agents minimize the expected cost of undertaking transactions, such as costs aligned with brokerage fees and interest forgone on alternative assets (bonds), and there is uncertainty about the size of net cash inflows. In general, the precautionary demand for money depends on the brokerage fee and the interest rate on bonds (as in the inventory models) but in addition some measure of variability of transaction also influences desired money holdings. Two approaches to the precautionary money demand are considered in this text. Firstly, the individual is assumed not to have access to any liabilities such as bank advances and must meet his uncertain transactions needs by switching between money and a bond with a known yield. The second model allows access to bank overdraft (loans).

2.9.1 Money–Bonds and Precautionary Money Demand

Precautionary money demand models assume that net receipts are uncertain but reduce the uncertainty to a risk i.e. the probability distribution of receipts/ payments is assumed to be known. The assumptions of the model are as follows:

- The firm incurs a brokerage cost *b* if net payments per period *N* (i.e. payments less receipts) are greater than money holdings *M*.
- The brokerage fee involves costs of selling interest bearing assets at short notice (e.g. time, inconvenience and is usually assumed to be constant. Holding a higher level of money balances (which can be assumed to earn zero interest) to reduce brokerage fees involves a loss of interest on bonds.
- The agent will therefore trade off expected brokerage fees against interests forgone in choosing his optimal money (and bond) holdings, in much the same fashion as in the non-stochastic inventory model. (Cuthbertson, 1991 p10),

If the probability distribution of net payments exceeding money holdings (i.e. N>M) is p then total expected brokerage costs are bp. Interest payments forgone are rM (r is the yield on the alternative asset and expected total costs TC are:

Precautionary money demand models give different results depending upon the assumption made about the probability *p* of illiquidity, and the result involves fairly complex derivations. For illustrative purpose consider Whalenqs (1966) precautionary demand model, which assumes very risk averse behaviour. It can be shown that the probability *p* of *N*>*M* takes a maximum value $P < \sigma^2 / M^2$ where σ is the standard deviation of net payments ⁹.

Substituting for *p* in equation 2.19 and maximizing *TC* with respect to *M* gives:

$$M = \left(\frac{2\sigma^2 b}{r}\right)^{\frac{1}{3}}$$
 2.20

And the second derivative $\delta^2 TC / \delta M^2 = \delta \sigma^2 b / M^4 > 0$ indicates a minimum.

As is the case with the inventory models we obtain the result that the individualq mean holding of money over some finite time interval is positively related to the brokerage fee and negatively related to the interest rate on bonds, but with an elasticity of $\frac{1}{3}$. Money demand also increases with the cube roof of the variance on expected net payments.

The precautionary money demand model is heavily centred on the transaction cost component and the opportunity cost on bonds, proxied by the interest rate. However, it does not negate the influence of income as well, provided that some restrictive assumptions are made about the distribution of net receipts which have been so far considered to be normally distributed. If the frequency of receipts and payments increases but the value of each receipts and payments increases but the value of each receipts stays the same, then it can be shown (Whalen, 1966) that $\sigma^2 = K_1 Y$ where K_1 is a constant and Y is the volume of transactions. If the converse holds, then $\sigma^2 = K_2 Y^2$.

$$P(-t\alpha > \chi > t\sigma) \le \frac{1}{t^2}$$

$$p(N > M) \le \frac{1}{t^2} = \frac{\sigma^2}{M^2}$$

⁹ The result is based on Chebyshevos inequality. This states that the probability p that a variable x (net payments) will deviate from its mean by t times its standard deviation σ is equal to or less than 1/t², i.e.

Net payments are assumed to have a zero mean and so the probability of net payments equal M, where M/ σ = t standard deviations from zero, is

Substituting these expressions in equation 2.20, we see that the income elasticity of the demand for money will vary between $\frac{1}{3}$ (increased frequency) and $\frac{2}{3}$ (increased transactions value). If an increase in the value of receipts is accompanied by a proportionate increase in the brokerage fee *b* (with an elasticity of $\frac{1}{3}$, then the price level elasticity is unity (i.e. a transactions value of $\frac{2}{3}$ plus a brokerage value of $\frac{1}{3}$).

An individualog relationship between income and the variance of transactions is likely to be more complex than that described above. For example, as incomes rise the frequency of transactions may fall as people attempt to economise on time, since the opportunity cost of time in terms of income forgone will be higher. Overtime both the transactions value and the frequency of transactions are likely to alter in such a manner that the relationship between money holdings and income is impossible to determine. Another problem prominent in testing the theory is that the actual money balances are likely to compromise inventory balances and precautionary balances simultaneously. However, actual data on money cannot be separated into these two types of money demand.

The Miller. Orr (1966, 1968) precautionary demand model is similar to the one described above but the individual only switches between bonds and money when upper or lower bounds for money are reached. The decision variable is then the amount transferred at these limiting points. This give rise to a demand for money (assuming a binomial distribution for the net cash drain with a zero mean) of the form:

$$M = \frac{4}{3} \left(\frac{3bm^2 t}{4r} \right)^{\frac{1}{3}}$$
 2.21

Where m is the amount by which the cash balance is expected to alter (with a probability of $\frac{1}{2}$) and t is the frequency of transactions. The variance of transactions is proportional to $m^3 t$ and therefore implicitly appears in the above formula. The result is almost identical with Whalen¢ formula with a frequency elasticity $E^m = \frac{1}{3}$, a value elasticity of $E^m_m = \frac{2}{3}$ and an interest elasticity $E^m_r = -\frac{1}{3}$.

The Miller. Orr Model, like the AM model, is also a target threshold model and therefore incorporates the intuitively appealing idea that money balances are assisted only when they reach a ceiling or floor. Temporary or transitory changes in money are voluntarily held¹⁰.

¹⁰More or less the same idea will appear in a changed context in the section on buffer stock models.

2.9.2 Money, Liquid Assets and Bank Advances in a Precautionary Money Demand Model.

Sprenkle and Miller (1980) extended the precautionary model to include the possibility of meeting an unexpected cash drain by automatic overdrafts at an interest cost r_0 as well as by running down liquid assets (with an interest rate r). The model is therefore particularly useful in analyzing the demand for broad money (and bank advances) by large firms who have automatic overdraft facilities.

In the model, money earns no interest and there are no brokerage fees, but there is a trade. off between the probable cost of overdrafts relative to the return *r* from investing in alternative liquid assets. The model predicts (for $r_0 < 2r$) that optimal cash holdings are negative, that is, firms should usually plan to use overdraft facilities. By assuming a normal distribution for the net cash drain it is possible to show that optimal cash holding depends upon the variance of the forecast error of cash balances, but explicit demand functions are difficult to derive. Sprenkle and Miller (1980) are able to show that money demand depends on relative interest rates and demand will rise continuously (in the form of increased overdrafts which appear on the liabilities side of the bankop balance sheet as money) as r rises relative for the overdraft rate r_0 .

This dependence of the demand for broad money on the relative interest rate could account in part for the rapid rise in the broad money supply in the United Kingdom in some periods of the 1970s and highlights the need to use relative interest rates in the demand function for broad money (Cuthbertson, 1991:12).

2.10 Risk Aversion Models

Risk aversion models of money demand deal with the problem of choice among a set of assets which have uncertain capital values. As the name suggests, these models assume that individuals maximize utility by trading off risks and returns subject to a wealth constraint (Markowitz, 1952, 1959, Borch, 1969, Feldeinstein, 1969). Holding more risky assets, such as bonds, increases the return to be obtained on the whole portfolio but may also increase the riskiness of the portfolio because of the possibility of capital gains and losses on the risky assets.Under such circumstances it may be worth while holding a capital . safe asset such as money even if the latter does not earn interest. Risk aversion models allow the individual

to hold a diversified portfolio, including money and bonds, which depends on expected ¹¹returns, initial wealth and the variance . covariance matrix of returns.

The precise functional form for the asset demand functions depends on the particular parameterization for the utility function and the maxim and chosen (the latter is usually assumed to depend either on the expected utility from the return on the total portfolio or endof period) ¹⁹. Most often, utility functions are commonly found as negative exponentials, power functions or in the quadratic form. End. of. period wealth may be nominal or real. If all stochastic returns are regarded as normally distributed, or we disregard moments higher than second order in the distribution of wt+1, then

$$E[U(Wt+1)] = U(W^{e}t+1) + \frac{1}{2}U''(W^{e}t+1)Vt + 1$$
2.22

If m^e is a K x 1 vector of expected (proportionate) returns over the fixed holding period, *m* is the actual return (i.e. the known running yield plus the expected capital gain, *S* is the covariance matrix of returns and *A* is a *K* x 1 vector of desired asset holdings at time *t*, then $W^et+1 = (i+m^e)^1 A$ and Vt+1 = A1 SA, the variance of Wt+1. Maximizing (1.9) subject to a nominal wealth constraint $Wt = i^1 A$ yield asset demand functions of form:

$$A_t = \frac{1}{O} \left(i + m^e \right) t + B W_t$$
 2.23

$$\theta = -\frac{U''(W_{t+1}^e)}{U'(W_{t+1}^e)}$$
2.24

Where *I* is the unit vector, Q and B are functions of the variance . covariance matrix of asset returns S and θ is the coefficient of absolute risk aversion. The set of assets in A may contain at most one capital safe asset, money and the asset demands satisfy the adding up constraint. Results from here depend on the explicit form of the utility function chosen.

For the negative exponential $U(Wt +1)=a-b \exp(-cWt+1)$, which exhibits constant absolute risk aversion, the asset demand functions exhibit characteristics analogous to those from neoclassical consumer demand theory ¹², namely symmetry and homogeneity with respect

¹¹ Aggregation over risky assets is possible for any utility function for which the marginal utility of wealth is isoelastic in a linear function wealth (Cass and Stiglitz, 1972 p 341-3); the quadratic and negative exponential satisfy this property.

¹² Tsiang (1972) argues that all we require for a second order . Taylor expansion around expected wealth to be a valid approximation to an acceptable utility function is that risk should remain small relative to the individual total wealth.

to expected return and concavity $(\partial Ai / \partial M^e > 0)$. In this case, homogeneity implies that asset demands depend on relative expected nominal yields. Symmetry and homogeneity substantially reduce the number of parameters to be estimated ¹³ and is a test of the basic axioms of rational choice (Deaton and Muelbauer, 1980:83).

Courakis (1989:116) contests the result of Freidman and Roley (1987) that for a power utility function (which exhibits constant relative risk aversion) asset demands are linear in expected returns and exhibit homogeneity and symmetry in expected returns. However, the notion that these asset demands are homogeneous in initial wealth is not disregarded. Dalal (1983) also provides some counter intuitive results for the expected utility approach. As such, different assumptions concerning the form of the utility function lead to different functional forms for the demand equations in the mean. variance approach, but the demand for assets (including money) in general depends on expected returns, initial wealth, the variance- covariance matrix and the parameters of the utility function.

Although the mean-variance model has some desirable features, it is not universally applicable to all asset choices. Because assets are only distinguished according to their different variance. covariance characteristics it allows only one safe asset. In a world where a wide array of capital. certain short-term assets with low transaction costs exists, these will dominate the low-interest asset narrow money for speculative purposes. The mean. variance model therefore determines the demand for short-term assets but not the demand for narrow money: the latter is not held at all in a speculative model.

It can be demonstrated that with three assets-money, a short-term asset and a bond. money will be dominated in the portfolio by the short-term asset, if the return on money is less than the return on shorts and the variance on shorts is small (Sprenkle, 1974; Chiang et al., 1983, 1984). However, if a wide group of assets paying competitive interest rates are included in the definition of money, the more likely it is that the mean-variance model will be applicable to explaining the demand for what will be termed broad money or broad liquidity. In addition, it must be recognized that the model ignores the brokerage costs of switching between different assets¹⁴.

A switch between longs and shorts involves two brokerage fees, whereas only one is required if the switch is into narrow money. Although the cost of switching may be small per transaction, nevertheless, if frequent switching takes place, total transactions cost may not

¹³ Courakis (1988) demonstrates the issues involved in extending the mean. variance approach when the maxim and involves expected terminal real wealth. For the negative exponential, asset demands are not independent of the expected rate of price inflation (even though the zero row sum condition holds) but for the power function the converse is the case. Note that the adding up constraint is not contestable.

¹⁴ Buiter and Armstrong (1978) combine the mean variance approach with brokerage costs.

be negligible. If switching costs are included in the mean-variance model, which realism dictates they should be, then this biases the decision away from the domination of narrow money by short-term assets. Hence in a more realistic mean. variance model there may be additional brokerage cost reasons for holding money (Sprenkle, 1974, Chiang et al, 1984). However, the formal model presented above does not explicitly include such brokerage costs.

In the empirical implementation of the mean-variance model it is usually assumed that the variance-covariance matrix of asset returns is constant over time. If the latter assumption is incorrect then coefficient instability will result. Time. varying covariance seem a definite possibility in time series data, particularly if the authorities frequently alter their policy stance in the market for government debt. For example, a move from a policy of fixing interest rates to one of controlling money supply by Open Market Operations (OMO), could alter the variance of returns on government long-term debt and the covariance between government debt and private sector assets.

According to Lucas (1976) more volatile rates of inflation that are expected to effected in more volatile interest movements might also alter the variance-covariance of asset returns. Modelling second moments of returns is as yet largely uncharted territory in asset demand equations. However, under the assumption of market clearing with exogenous asset supplies the demand functions of the mean. variance model can be inverted to give can equation for relative (one-period expected) yields. There has been empirical work on such asset price equations where the time . varying variances and covariances have estimated using the autoregressive conditional heteroscedasticity (ARCH) model (Engle, 1982; Bollerslev, Engle & Wooldridge, 1988, Giovannini and Jorion, 1987, 1988). The general conclusion appears to be that the variance-covariance matrix is time varying.

The informational requirements in using a mean-variance approach to asset holdings might limit the applicability of the model sophisticated financial firms such as banks, insurance companies and pension funds. However, this covers the main agents who operate in risky financial markets, households comprise only a small part of this market. Alternatively, one could assume that agents apply the mean-variance analysis to broad aggregates of homogeneous assets (e.g. gilts, equities, liquid assets).

2.11 Asset Demand and Consumer Demand Theory

Friedman (1956), in his restatement of the quantity theory argues that the demand for assets should be based on axioms of consumer choice. He focuses on money demand function and presents a fairly long list of possible arguments of this function (i.e. a vector of expected

returns, wealth and income) with signs to be determined primarily by the data. He echoes the idea of approaching theory of demand for assets by considering explicit motives for holding money. However, Friedman did not present an explicit model of consumer choice and his model contains few *a priori* and hence potentially refutable restrictions.

a) Separability

For the sake of tractability of the decision problem and to be realistic, usually separability assumptions are invoked. Under these assumptions, agents are viewed as acting as if they undertake some form of multistage budgeting. For example decisions about consumption and saving may be independent of variables affecting the work-leisure choice: choice between real and financial assets may be largely independent. A variety of separability assumptions about either the utility function or cost function can be made, but weak intertemporal substitutability and quasi-separability between blocks of assets (e.g. real assets, liquid capital certain, capital uncertain) are usually assumed when analyzing the demand for financial assets¹⁵.

The demand for a subset of assets then depends on prices within the subset and the total wealth held in the subset. Having isolated a set of *n* separable assets (or liabilities) one can then apply the models of consumer choice to them. Neoclassical demand theory is usually based either on maximization of utility subject to expenditure constraint or the equivalent dual of minimizing cost to achieve a given level of utility¹⁶. The axioms of consumer demand theory (e.g. negativity, transitivity) are met for example provided that we choose a cost function that is quasi-concave and homogeneous of degree zero in prices and expenditure. Different functional forms for cost or (direct and indirect) utility functions yield different functional forms for demand functions.

To motivate the application of consumer demand theory to asset demands suppose that we make the reasonable assumption that there exists a utility function defined over the expected (one-period . ahead)¹⁷ value of real assets, $a_{1t}^{t} + 1$;

¹⁵ Varian (1983) provides formal non-parametric tests of separability, although these have not as yet been widely applied in the asset demand literature.

¹⁶ This also raises the question of aggregation over monetary assets. Consumer theory can be used to construct appropriate division monetary aggregates (rather than simple sum aggregates). Space precludes discussion of the theoretic basis of Division aggregates (Barnett, 1980, Barnett et al, 1984) but we do discuss empirical results using division aggregates later on.

¹⁷ Merton (1973), Diewert (1974) and Barnett (1980) examine the assumptions whereby the inter temporal maximization problem can be reduced to a single period optimization problem.

$$U = U(a^{T} 1t + 1, a^{T} 2t + 1, \dots, a^{T} + 1)$$
2.25

The budget constraint is that real assets sum to real wealth:

$$\sum_{i} P_{it}^T a_{it+1}^T = W_t^T$$

$$P_{it}^{T} = (1 + r_{it})^{-1} (1 + g_{z})$$
2.27

Where r_{it} is the expected proportionate nominal return on asset *i* between *t* and *t* +1(including any capital gains) g_2 is the expected proportionate rate of goods price inflation between t and *t* +1 and P_{it}^T is the real price (i.e. approximately equal to the inverse of 1 plus the real interest rate ($r_{it} - g_2$). Corresponding to (2.25) there is a cost function of the several flexible function forms available, for illustrative purpose, used extensively is the PIGLOG (price-independent generalized logarithmic). Asset share S_i are the given by Barr and Cuthberson, 1989,) as:

$$S_i = \alpha_i + \sum_i y_{ij} \ln p_{jt}^T + \beta_i \ln\left[\left(\frac{WT}{P^*T}\right)_t\right]$$
2.28

Where

$$S_{it} = a_{it} / wt$$
 2.29

$$\ln P_t^{*T} = \sum_{si \ln p_{Pit}^T} = InP_t^* + g_2 = \sum_{si \ln pit} + g_2$$
2.30

And a_{it} are the nominal assets holdings w_t is the nominal wealth and in $p_{it} = In(1 + r_{it})^{-1}$ is the nominal price¹⁸. It can be shown that the share equation 2.26 exhibits symmetry, homogeneity and negativity, all of which are testable restrictions.

b)The Demand For (Non-Interest- bearing) M1

Equation 2.26 represents a system of asset demand equations and does not rule out distinct demand functions for narrow and broad money (unlike the mean-variance model). By simple introspection, the approach tell us about the appropriate form for the demand for narrow money (M1), which is usually estimated as a single equation rather than as part of system. For exposition, assume that the demand for liquid assets is weakly separate from other

¹⁸ In P^{*T} is an approximation in equation 2.28 see Deaton and Muellbauer, 1980.

asset and liability choices (and from consumption and leisure). Equation 2.26 implies that the demand for non-interest-bearing *M1* may depend on a set of real prices (yields), real wealth and a composite real interest rate ($In^{p^{*T}}$).

This appears at variance with single . equation empirical studies where M1 often depends on only a single nominal interest rate, a transactions variable a the rate of inflation. The expected inflation rate appears in 2.26 in two ways: as part of the rate of return and in wealth term. Assuming that asset 1 is non-interest-bearing M1, we have:

$$Si = \alpha + \sum_{J \neq 1} \gamma 1 j InPjt + \left(\sum_{j=1}^{n} \gamma j j\right) g_2 + \beta_1 In \left[\left(\frac{w}{z}\right)_t \right] - \beta_1 \left(InP * t\right) + g_2 \right)$$
2.31

Where W_t is nominal wealth and Z_t is the aggregate goods price level.

The sum of the coefficients on the opportunity cost of narrow money (i.e. InP_{ji}) does not equal the sum of those on the rate of inflation. Hence a 1 percent rise in all nominal yields $(InP_{ji} j \neq 1)$ and the rate of inflation g_{2} , will have a direct impact on the demand for narrow money. This appears to justify the inclusion of nominal rate r_{ji} and the rate of inflation in single . equation studies. However, if homogeneity holds, $\sum \gamma_{ij} = 0$, the separate inflation term disappears and only nominal rates appear to be required ¹⁹. Clearly it is incorrect to test homogeneity by imposing relative nominal interest rates, ie $\sum_{j\neq 1} \gamma_{ij} = 0$ or by running an equation of the form.

$$S_1 = \alpha_1 + \delta_{11}g_2 + \sum_{j \neq 1} \delta_{1j} InP_{jt} + \text{Other terms}$$
2.32

And testing $\delta 11 - \sum_{j} \neq 1 \delta 1 j = 0$, i.e. imposing real prices (interest rates). Hence by considering M1 as part of a system of demand equations that obey the anxious of consumer choice, possible errors in the single equation approach are clearly highlighted. A further reparameterization of equation 2.29 gives

¹⁹ The wealth term is ignored for the moment for later consideration.

$$S_1 = \alpha_1 + \sum_{j \neq 1} \delta_{1j} InPjt + \theta_{1g2} + \theta_2 In\left[\left(\frac{W}{Z}\right)_t\right]$$
2.33

Where

8 - 4

$$\theta = \left(\sum_{j=4}^{n} \gamma_{\underline{4}j}\right) - \beta_1 \theta_2 \beta_{\underline{4}}$$

 $D \subseteq I \rightarrow 1$

If in addition, we assume that real wealth and real income are highly correlated then equation 2.31 looks like a conventional long-run demand function for M1 obtained from a single. equation estimation. The dependent variable could then constitute the money. to-income ratio. If homogeneity holds, then the inflation effect θ_4 comes solely from the wealth coefficient B_1 (Cuthbertson, 1991:18). It is also worth noting that even with homogeneity and $\beta_1 = 0$ (i.e. a wealth elasticity of unity), a 1 percent increase in all nominal interest rates and the rate of inflation would lead to a change in the demand for M1. Courakis (1989) derives a similar conclusion for a version of the mean. variance model²⁰.

Barr and Cuthbertson (1989) argue that transactions can be explicitly introduced into the demand for S_1 via a modification of the cost function which result in:

$$S_{i} = \alpha_{i} + \sum_{j} \gamma_{ij} In P_{jt}^{T} + \beta_{i} \{ In \left[\left(\frac{w}{z} \right) \right] - \phi In \left(\frac{et+1}{zt+1} \right) - In P^{*} g_{2} \}$$

$$2.34$$

Where ${}^{e}t + 1$ is the expected level nominal transactions in period t+1 and $Z_{t} + 1$. Thus if $\phi \neq 1$ we expect the demand for M1 to depend on the level of transactions and the wealth. to income ratio (except when $\beta_{i} = 0, i.eEw = 1$). But if $\phi = 1$ (i.e. the cost function is homogeneous with respect to the level of transactions), the demand for money depends on the current period wealth-to-income ratio $n(W_{t}/e_{t} + 1P^{*}_{t})$ There is vast recent empirical evidence to substantiate the claim that demand for narrow money and broad money may depend on wealth and income.

²⁰ For alternative exposition, see Courakis. A.S. (1989), does constant relative risk aversion imply asset demands? Discussion paper 78, Institute of Economics and statistics, Oxford.

The application of consumer demand theory to the demand for financial assets provides a tractable approach which allows testing of the key anxious of choice theory and should therefore be considered as useful as the motives approaches to the demand for money.

2.12 Buffer Stock Approach to Money Demand

The buffer stock idea derives from the notion that, given risk and uncertainty, not all events are correctly anticipated and so, following a shock, at least one variable wond be equal to its planned value. However, one can arrange one affairs so that the shock will fall on a predetermined variable. the buffer (Bain and Howells, 2003:159). In the buffer stock approach to the demand for money, people accept deviations in money holdings around their equilibrium levels.

Letop assume, for example, that a long. run equilibrium is disturbed by an expansion of the money supply, causing money holdings to be temporarily greater than the demand for money. To return portfolios to equilibrium, agents would seek to move out of money into other financial or real assets. However in the short. run, they might choose instead to absorb the shock by holding excess money balances. There are two clear reasons for behaving in the way:

- (a) It requires both time and information to monitor money balances continuously (money, this become a substitute for information, and)
- (b) Because the adjustment of portfolios is not costless, agents wait until they are convinced that the change is not merely transitory.

When money holdings deviate beyond the tolerance range from the equilibrium level (they heat a ceiling or floor), funds are transferred out of the long-run equilibrium level.

Money is assumed to act as a buffer in the process because it is liquid and the cost of adjusting money balances are less likely to be less than the cost of adjusting holdings of other assets. If it is relatively easy to borrow, credit might also act as a buffer, but if borrowing is inflexible money will be the only buffer and money balances can be expected to fluctuate more. Hence, it can be ascertained that transaction and information costs in the financial sector are relatively low, and thus that adjustment should be quick. However, adjustment may be slowed due to stickiness in both interest rates and goods prices and may be spread over a number of months or even quarters. Buffer stocks are then willingly held during this gradual process of adjustment. Economic agents hold money precisely because it acts as a buffer rather than having to strive for an exact value of their money holdings as

presupposed in the deterministic demand for money models such as the Baumol/Tobin inventory. theoretic model. Instead they wish to keep their money holdings within a band, monitoring them only at intervals.

It follows from the buffer stock argument that observed changes in the real stock of money may reflect either:

(i) a change in one or more of the determinants of the long-term or target demand for money, or

(ii) a stock to the nominal stock of money not accompanied by changes in the conventional money demand variables sufficient to keep the economy on its long term money demand schedule.

This approach also suggests that instability in the demand for money found in most econometric researches need not reflect unstable demand for money but rather time-consuming adjustment processes. There is a particular problem with models that assume equilibrium, which are said to be *backward-looking+* (Bain and Howells, 2003:160. The demand for money function in a *backward.* looking model may be unstable if:

- a) any of the costs of adjustment change or
- b) there is a change in government behaviour leading to a change in income.

At a more theoretical level, models of the precautionary demand for money (Miller and Orr, 1966; Akerlof and Milbourne, 1980; Milbourne, 1983, 1987; Milbourne, Buckholtz & Wason,1983; Smith, 1986) provide a useful framework in which to analyse certain aspects of the buffer stock approach. In these models, buffer stock money, in the short. run, is willingly held at unchanged interest rates. Given an unanticipated increase in the net receipts in the aggregate (consequent on, for example, an increase in government expenditure) some agents will hit their upper threshold and reduce their money balances to their return point holdings while others will accommodate an increase in buffer holdings. The net effect depends on the initial distribution of money balances across agents (since the shock is unanticipated, the upper and lower thresholds will remain unaltered for the moment) but there is a presumption that aggregate buffer holdings increase, particularly if money balances are not continuously monitored²¹. However, in the empirical implementation of the

²¹ Milbourne (1985), utilizing the Miller . Orr models, argues that average quarterly money holdings due to an unanticipated increase in exogenous money are likely to be relatively small for a narrow definition of money (e.g. M1). This provides a strong case for abandoning the Miller-Orr model as the basis for buffer stock ideas for M1. but note that Milbournes results are weakened of (a) point . in . time money stock data is used, (b) different agents receive additional balances sequentially, (c) agents do not continuously monitor M1 balances because of time costs of information gathering and (d) agents face generalized uncertainty and hence not a well-defined

buffer stock notion, the precautionary demand model provides an intuitively appealing framework rather than an explicit equation suitable for estimation there are several other types of Buffer stock models that will be discussed under empirical literature review.

2.13 Microeconomic Transactions Theory of Money Demand

The microeconomic transaction theory of money demand is attributed to the works of McCallum (1989) and Goodfriend (1992) as they made an attempt to establish money demand for transactions purposes by households through the general equilibrium analysis framework. In this theory, money demand is explained in terms of the amount of shopping time saved if money could be used as the medium of exchange, unlike transactions in barter trade. According to Bain and Howells (2003), shopping time saved has value as the opportunity cost of it can be expressed in terms of value forfeited in alternative transactions or forms of exchange that could possibly be accomplished in that time. In McCallumo model, a household faces an optimisation problem as it makes an attempt to maximise present and future utility from the consumption of goods and leisure. Hence the multi-period utility function between the household consumption of goods and services, and the time available for leisure is in a budget constraint (Van der Merwe & Mollentze, 2010: 83). There is a positive relationship between time and energy spent on shopping against volume of consumption. At the same time, at any given volume of consumption, time and energy spent on shopping falls as money holdings in the household increases. Thus, as demand for money rises for transactions purposes, the time and energy spent on shopping declines for any given level of consumption.

Against this background, there is a negative relationship between leisure and consumption. Real money holdings are then positively related to leisure. In this perspective, McCallum (1989) deduced that money demand in a specified period (t) is a function of real money balances (M/P), consumption (C) and the interest rate (r) as the opportunity cost variable.

$$\frac{M_t}{P_t} = f(C_t, r_t)$$
2.35

This identity is established on two assumptions. Firstly, the utility provided from an extra unit of consumption plus the utility provided by an extra unit of leisure multiplied by the loss of leisure necessitated by an extra unit of consumption must equal the marginal utility of

probability distribution. Assumptions (c) and (d) would of course violate the assumptions of the Miller-Orr model. See Laidler (1988) for a discussion of the importance of the precautionary demand for money in analyzing the transmission mechanism and in particular that information costs and interest rates may interact to alter the distribution of cash flows in models of the Miller. Orr type.

consumption (or the utility obtained directly from an extra unit of consumption) minus the cost of leisure sacrificed as a result of consumption. Secondly, the utility from extra leisure that is provided by an incremental unit of money held must be equal to the utility from an extra unit of money multiplied by the interest earnings foregone per unit of money. To achieve optimality, the gain in leisure from holding an additional unit of money must be equal to the interest loss (Van der Merwe & Mollentze, 2010:83).

However, this theoretical framework of money demand at household level receives extensive criticism for assuming that variables are known yet they are based on expectations of the future. As current money holdings are dependent on current and expected future values of interest rates and inflation in a utility maximising strategy, McCallum argues that uncertainty of the future does not have negative impact on the reliability of the model. The indication that velocity of money is cyclically constant is regarded by Van der Merwe & Mollentze (2010) as not important. Although it is similar to the Inventory-theoretic model of Baumol and Tobin, in presuming that money is demanded for transactions motives, McCallum¢ theory places emphasis on the notion of time and energy expended in shopping activities by households as Baumol. Tobin theory postulates that money holdings are a prerequisite for making transactions. This makes these two theories of money demand fundamentally different. It should be noted that the significance of real income in the money demand function has no reference at all in McCallum¢ theory; yet real income is used as a determinant of money demand in their empirical justification.

Conclusion

Key points in this chapter can be summarised as follows. Theoretical developments on money demand have been traced from the classical tradition. In the classical school of thought, money served as a numeraire and held by the public as a medium of exchange for transactions purposes. The writings of Pigou (1917) put forward important insights into the concept of money demand through the quantity theory of money with implications that money demand increases proportionally with positive changes in real incomes. The cash-balance approach of Cambridge economists explicitly stated money demand as a function of real income advocating the demand for money as public demand for money holdings.

The Keynesian school of thought was an extension of the cash balance approach in the liquidity preference theory. It established the three motives of holding money, namely the transactions, precautionary and speculative motive and introduced the interest rate as an explanatory variable in addition to real income as the opportunity cost of holding money. A positive correlation between money demand and real income was postulated while interest

rates are negatively correlated to money demand in general without a clear analysis of different impacts of various interest rates on money demand.

The post. Keynesian era brought other alternative approaches to money demand theory, still focusing on the relationship between real money balances, real income and interest rates. The inventory-theoretic approach gives an indication that money demand for transaction purposes has direct variation with real income, although not so proportionally, and with an inverse relationship with interest rates. The cash-in-advance model further exemplified the medium of exchange function of money and introduced the concept of uncertainty in money demand theory. Tobin (1956b), in his portfolio theory of money dwells on the asset function of money as part of a portfolio of many assets which inherently differed in the yield and risk characteristics. Tobin argues that if the substitution effect neutralises the income effect, an increase in interest rates will reduce the demand for money. He gives an assertion that wealth and expectations have an impact on money demand. The overlapping generations models went to an extreme by completely ignoring moneyq medium-of-exchange role while placing emphasis on the asset role of money.

The monetarist school of thought argues that money demand is driven by the same set of factors as the demand for any other asset. Thus the velocity of circulation is highly predictable and money demand is stable. However, because money demand is insensitive to interest rate changes it can be approximated simply as a function of permanent income. Friedman (1956) saw his theory as a resuscitation of the quantity theory in the sense that he sought to re-establish the importance of controlling money supply as the means of controlling inflation. This required a return to the acceptance of a stable money demand function. Although Friedman¢ initial approach was theoretical, he suggested that the form of money demand function could only be determined by empirical testing.

The consumers demand theory approach retained the characteristics of the portfolio approach but considered money as any other consumer good providing flow of services and analysed the demand for it under the utility maximisation framework. In McCallumos model, money demand is analysed in terms of shopping time saved by the use of money for transactions purposes as part of optimising utility. Against this assertion, McCallum comes to conclude that money demand is a function of consumption and the interest rate, if the specified optimisation conditions exist. In the buffer stock theory, money is regarded as a shock absorber that is held allowing for times of economic shocks and is only adjusted to equilibrium levels over the long-run.

The central issue dealt with in this chapter has been the question of the stability of the money demand function. This has long been seen as crucial in relation to economic policy

because it determines whether authorities can hope to influence the rate of growth of nominal income by controlling the rate of growth of money supply. All theories, except that of Keynes, have advocated for the idea of stability. Although there are fundamental differences between various schools of thought in terms of relevance of theory to economic policy, it is imperative to note the distinction between Keynesianism against the entire theoretical spectrum. Keynes major criticism emanates from its lack of micro-foundations. Microeconomic theories are giving individual money demand functions and negate the crucial aspect of aggregation.

To sum up, theories of money demand present the demand for money concept in different angles and the resulting implications are more or less the same. In all perspectives, the optimal stock of real money balances is inversely related to the long-term interest rate and positively related to real income. The differences are arising out of the specification of a proper transaction (scale) variable and the best opportunity cost variable for a money demand model compatible with economic policy. This has precipitated the shift of focus, in academic work, from theory to econometric testing. Hence, empirical analysis of money demand estimation takes this conclusion as a point of departure.

CHAPTER THREE

Empirical Considerations

3.0 Introduction

Empirical literature on the demand for money is vast. As such, neither is it possible to give an exhaustive account of the empirical evidence nor a detailed econometric evaluation of specific equations. Hence, the major thrust of this chapter is to provide illustrative examples of the different approaches adopted, concentrating on recent empirical work. Early empirical work provides illustrative examples of the partial adjustment and adaptive expectations approach. While recent works are utilizing the error feedback and interdependent asset adjustment framework to model lag responses. There has been a revival of interest in modelling buffer stock money, especially in developed countries, although only one attempt has been made in South Africa so far. The Autoregressive Distributed Lag. Error Correction Model approach has dominated in early money demand investigations for both the United Kingdom and the United States of America and recently in applied research of South East Asian Countries. The Vector Auto. Regression (VAR) approach has dominated in most empirical works of money demand in most developed countries as well as in South Africa up to date. However every approach has its strengths and weakness. This chapter gives an extensive debate on different approaches applied to different countries as well as the history of money demand investigation in South Africa.

3.1 Money Demand Theories and Empirical Estimation Issues

One of the significant contributions of empirical research on money demand are the major advancements made in time series econometrics in the past ten years or so which have motivated the researchers to revisit empirical models built previously (Sriram, 1999a:17). Chapter 2 has covered a diverse spectrum of money demand theories propounding transactions, speculative, precautionary or utility considerations. A broad range of hypotheses are implicitly addressed in these money demand theories. It is fundamental to observe that a common set of important variables is found among most of the models in various empirical works. Notably, they place greater emphasis on the significance of the relationship between the quantity of money demanded and a few set of important economic variables linking money to the real sector of the economy (Judd and Scadding, 1982:993). What sets apart these theories, however, is that although they consider similar variables to explain the demand for money, they frequently differ in the specific role assigned to each (Boorman, 1976:35). Emerging from the empirical landscape is a consensus that drivers of money demand are established through a blend of theories.

The bulk of empirical work begins with the basic money demand relationship stated as m = f(y,r) relating the demand for money (*m*) to a scale variable (*y*) and a representative opportunity cost variable. It is very common to note that a lagged dependent variable is included as an explanatory variable as an endeavour to incorporate short-run dynamics in error-correction models covered in future sections of this chapter. In the history of money demand estimation, the income variable (*y*) has been presented through GDP, GNP or the index of industrial production in aggregate form. However in the last decade, researchers have put forward the importance of disaggregating the real income component to explain sectoral money demand and the significance of expenditure components in money demand modelling. Debate has also not, until today, given the best opportunity cost variable to explain money demand in both closed and open-economy scenarios.

The next sub-section 3.2, presents a discussion on the rationale behind the choice of variables in money demand modelling. Functional forms are covered in section 3.3. Subsection 3.4 thereafter, lists common types of formulations specified in various empirical estimations over time and provides a detailed account of each. In this attempt, a list of papers that have carried surveys of research on money demand over the past four decades in both developed and developing countries are used as conduits to reflect different approaches on variable choice and specification preferences.

A list of selected surveys include Goldfield (1973 and 1987), Boorman (1976), Feige and Pearce (1977), Laidler (1977 and 1993), Judd and Scadding (1982), Gordon (1984b), Roley (1985), Goldfield and Sichel (1990) and Sriram (2001). These surveys trace the developments in money demand research over time and provide an understanding on the empirical work that has been carried out in different countries. These are equally reflecting the changing financial and economic conditions and the development of better econometric techniques over time. No survey of money demand investigation has been identified in the empirical works in South Africa. Hence, various papers are referred to in the choice of variable and model formulation debates in subsequent sections of this chapter.

3.2 Discussion on Choice of Variables

The figure below is an illustration of the overview of determinants of money demand through a scale variable and a vector of opportunity cost variables. The scale variable is a measurement of the economic activity. The vector of opportunity cost variables has an array of variables to measure the asset substitution effect, the currency substitution effect and the impact of foreign factors on money demand.

Figure 3.1: The Determinants of Money Demand Function



Source: AL-Samara (2010)

The possible choices to represent the scale variable and the opportunity cost of holding money vary from study to study and the underlying theories specifically considered. The definition of money employed in the empirical work also differs according to these criteria. In general, the empirical estimations underline the transactions and asset theories. The transaction theories view money functioning as a medium of exchange and is held as an inventory for transaction purposes. Asset theories consider the demand for money in much broader terms as part of a problem of allocating wealth among a portfolio of assets which included money. While the transaction theories bring out the importance of money for transaction purposes, the asset theories emphasise liquidity and safety that money implicitly provides in addition to the explicit income the portfolio generates (Sriram, 1999b:18).

In these two broad theoretical perspectives, there are different variable selection preferences. Transaction theories are advocating the use of narrow money as the dependent variable as a reflection of the actual means of payment. Asset theories are giving preference to broader monetary aggregates such as M3, M4 and M5, since they view money as an asset in a portfolio of wealth holdings. In transaction theories, the opportunity cost of holding money is proxied by short-term interest rates such as the discount rate on 91-day treasury

bills and the repo rate, while asset theories are for longer-term interest rates such as the yield on government bonds (10 years and over).

The foreign interest rate and the exchange rate are considered from an asset theory perspective to capture the asset substitution and currency substitution effect, respectively. Due to poor statistical capacities, high levels of inflation or less developed financial sectors in developing countries, inflation or the expected rate of inflation is used as the opportunity cost variable (see Tang 2002a, 2004, 2007). Until today, the choice between real income and wealth as a scale variable depends on the availability of quality statistical data in both developed and developing countries (Bain and Howells, 2003). In this chapter, each of these variables is discussed below in order to appreciate the need to make a choice of variables by blending theories and to develop empirically acceptable econometric models on money demand.

3.2.1 The Money Stock definition

According to Boughton (1992), definitions of money stock are bound to vary across countries due to either institutional characteristics or arbitrary decisions. Nevertheless, two broad categories are generally acknowledged, that is narrow and broad money, although they have different sub-categories in different countries. For economic agents, whose sole motive of holding money and low interest bearing checkable deposits for transactions purposes, money demand is reflected through narrow definitions of money stock. Money demand by asset holders is measurable through broader definitions above M2. However, it is the onus of empirical researchers to establish the correct definition of money stock in various economic settings (see Laidler, 1993). Hence, there is no clear-cut definition of money stock unanimously agreed in empirical work estimating money demand in both developed and developing countries.

The South African definitions of money stock have been dealt with in section 2.2 of Chapter two. Generally the narrowest definition of money is M0, for example in the United Kingdom, which consists of notes and coins in circulation. M1 would then include demand deposits not included in M0. M2 is made of M1 plus time deposits at commercial banks and other financial institutions. Most developed countries and numerous developing countries (including South Africa) define broad money as M3, M2+ (in Canada) and M4 (in UK). The broadest measure, M5, is found in Argentina²². Most empirical researchers of money

²² See Kumah (1989) for a detailed account of money stock definitions in various countries. Bulletins of central banks provide useful source of definitions of monetary aggregates in respective countries.

demand have not used M1 in favour of M3 because of its instability over time, especially in countries experiencing rapid financial innovation.

Studies on a number of developing countries also indicate that the models using the narrow definition of money work better than those employing broad money reflecting weak banking systems and low levels of financial sector development (see Moosa (1992) and Hossain (1994)). According to Laidler (1966), M3 yields more stable money demand functions than narrow aggregates and considered a preferable measure with which to evaluate the long-run economic impact of the change in monetary policy. Ericsson and Sunil (1996) have indicated that narrower definitions of money are less useful in policy issues because their relationship with nominal income appears subject to considerable variability while broader definitions are more stable relative to nominal income and hence less amenable to control.

In other studies conventional monetary aggregates have been replaced by divisia aggregates due to controversies in definitions (see Bain and Howells (2003) and Alsahafi (2009)). Divisia indices tend to give a better statistical fit than unweighted aggregates and demand for money functions incorporating them appear more stable (Chrystal and MacDonald, (1994); Belongia (1996)). This may well be because they are better able to deal with financial innovation than are the conventional aggregates (Mullineux, 1996)²³.

According to Sriram (1999b), some empirical studies have estimated money demand for the individual components of money against the argument that disaggregation provides more flexibility in the choice of variables and specification of adjustment patterns. From empirical works observed, disaggregation has been done either by type of assets or by type of holder. Among them are Albuquerque and Gouvae (2001), Goldfield (1973), Moore, Porter, and Small (1990), Price and Insukindro (1994), Drake and Christal (1994) and Lim (1993). In a nutshell, the choice of monetary aggregates in empirical studies of money demand varies depending on the objectives of the researcher, institutional arrangements of the central bank of a country in defining money stock and other variables that may be included in the models.

3.2.2 The Scale variable.

According to Sriram (1999), the scale variable is used as a measure of transactions relating to economic activity. Notably transaction theories are considering current income while wealth is considered in asset portfolio models. The most prominent candidate is the real income (real GDP) in empirical works of both developing and developed countries(see Achsani (2010); Atta-Mensah (2004); Calza & Zaghini (2008); Carusso (2006); Capasso &

²³ More studies reflecting the use of divisia indices are Yue and Fluri (1991), Fase and Winder (1994), Ford and Morris (1996), Janssen (1996), and Anderson, Jones, and Nesmith (1997b and 1997c).

Napolitano (2008); Ho, Shek & Tsang (2006); Choi & Cook (2007); Omotor & Omotor (2010); Bahmani-Oskooee (2000, 2001, 2005); Hall et al., (2007); Munoz (2006); Halicioglu & Ugur (2005); Kumar, Webber & Fargher (2011); Todani (2007); Tlelima & Turner (2004); Zuo and Park (2011), Belke & Czudaj (2010); Dagher & Kovanen (2011); Tehranchian & Behravesh (2011); Dahmardeh & Izadi (2011); Dafaalla & Suliman (2011); Tang (2010); Opolot (2007); Hamouri (2008)). Bomberger and Makinen (1980) recommend expenditure-based proxies such as gross national Income (GNI). Laidler (1993) indicates that the substitution of GDP with Gross National Product (GNP) or Net national product (NNP) as scale variables and that their behaviour on money demand models would not pose much of a difference.

Other measures such as personal disposable income, private spending, final sales, and domestic absorption have been used as proxies of the scale variable (see Mankiw and Summers (1986)). Thomas (1993) uses real consumption expenditure, real disposable income, gross real sector wealth, real gross fixed capital formation, real GDP and real gross financial wealth to estimate sectoral money demand models for firms and households (see Roley (1985) on a presentation of other additional choices of the scale variable). Albuquerque and Gouvea (2001) used national consumption of electricity to model money demand for Brazil while Tlelima and Turner (2004) alternatively used total consumption expenditure to estimate money demand for M2 in South Africa.

Empirical studies using high frequency data have chosen the index of industrial production because conventional scale variables have no statistical data over high frequencies such as monthly time series on real income aggregates (see McNown and Wallace (1992a) and Choudhry (1995)). Martinez-Peria (2002) and Sriram (1999a) used the index of industrial production to model broad money demand for Brazil and Malaysia, respectively. Yilmaz, Oskenbayev & Kanat (2010) utilised the industrial index of production as a proxy for GDP in estimating broad money demand in Kazakhstan. Sovannroeun (2009) notes that numerous studies have used either the monthly Manufacturing Production Index (MPI) or Industrial Production Index (IPI) as proxies of real income. Martinez-Peria (2002) empirically investigates the impact of banking crises on money demand and price stability in Chile, Colombia, Denmark, Japan, Kenya, Malaysia and Uruguay using the industrial production index as the proxy of the income variable.

Recent research has also advocated the disaggregation of real income into expenditure components to explain money demand, especially in open economies to reflect the significance of international transactions (see Goldfield and Sichel (1990)). Tang (2002, 2004, and 2007) estimates demand for M2 in South-east Asian countries using

disaggregated expenditure components. Ziramba (2007) disaggregated real income to estimate money demand for all the conventional money stock definitions of South Africa. The same approach is adopted in this study. However, Goldfield and Sichael (1990) argue that there is no evidence to support that categorizing GNP, for instance, will yield better money demand models.

Mankiw and Summers (1986) argue that consumption is more money intensive than other components of GNP. They argue that if permanent income is a proxy for wealth, then consumption should be the natural observable proxy for the unobservable permanent income. Hence, Fujiki and Mulligan (1996) estimated money demand on Japan using consumption as a proxy of real income. Consumption is also considered in cash-in-advance models and microeconomic transactions models as a scale variable suitable for these theoretical frameworks (see Lucas, 1988 and Van der Merwe & Mollentze, 2010).

Wealth is a preferred scale variable in asset portfolio models although it is difficult to measure especially in developing countries and numerous developed countries. Thus, it has not been used extensively in money demand estimations due to lack of suitable statistical data in most countries, including South Africa. Studies utilising wealth as a scale variable have been identified in the United Kingdom and the United States. Aside from theoretical emphasis, income is often justified as a proxy for wealth on the grounds of greater data availability and reliability.

As noted by Gupta and Moazzami (1988) a significant number of studies have used real income as measured by GDP or GNP because of extensive availability of data across both developing and developed countries. These are presumed to satisfy directly or indirectly both the income and wealth criteria (Sriram, 1999b:23). However, choosing a narrow definition of money implies a concentration on the role of money as a medium of exchange. This, in turn, seems to lead to the use of GDP or Total Final Expenditure (TFE) as the scale variable (Bain & Howells, 2003:137). Consequently, difficulties are sometimes encountered with this choice since money is a stock variable against GDP or TFE as flow variables.

3.2.3 Opportunity cost variables

The opportunity cost of holding money involves two ingredients, the own-rate of money and the rate of return on assets alternative to money (Sriram, 1999b:23). This dichotomy is also extended to include the foreign interest rate, expected and actual inflation and the exchange rate. These are discussed in detail in the respective sub-headings given below.

a) Domestic Interest rates

Laidler (1993) indicates that the majority of empirical studies assume the own-rate of money as zero or the interest rates having an unvarying rate, can be conveniently ignored. Researchers have a wide choice of interest rates applicable on assets alternative to money depending on the definition of money stock chosen. If a very narrow definition of money is chosen, then one or more short-term rates like the yields on government securities or savings deposits can be adopted assuming that short-term securities are closer substitutes of money and their yields are relevant among the alternatives that are foregone by holding cash. The short-term interest rates prevailing in major industrial nations are included individually in money demand models (Arize, Spalding, and Umezulike (1991)) or as weighted averages of them (see Arango and Nadiri (1981), Darrat(1985), and Arize (1994)). In broader money demand perspectives, longer. term interest rates are opted for, such as the return on equities, yields on long term government or corporate bonds. Bain & Howells (2003) note that interest rates on financial assets tend to move together over time, hence the difficulty in selecting decisively on the most appropriate one.

In the monetarist school of thought, the whole spectrum of interest rates ought to be included in the money demand equation as depicted in Friedmanc model. However, Sriram (1999b) notes that, many studies use just one measure of interest rate to represent both the own rate and the return on alternative assets for money. However, he includes both the own rate and the return on alternative assets of money as being important in explaining money demand in Malaysia. Some studies apply the difference between interest rate and inflation, which can be interpreted as real interest rate (see Kamin & Ericsson (1993)).

b) Foreign Interest rate

The returns on foreign assets are usually represented by the foreign interest rates and the expected rate of depreciation of the domestic currency. The foreign interest rate is mostly represented by the Eurodollar rates (London Interbank Offered rate (LIBOR)) (see for example, Price and Insukindro (1994) and Chowdhury (1995)). However, Bahmani-Oskooee (1991) omit the foreign interest rates altogether from the equation with an argument that they move along with domestic rates, and hence introduced the real effective exchange rates instead.

c) Inflation

The return on real assets is usually represented by the expected rate of inflation (Sriram, 1999b:24). The inclusion of expected inflation in money demand models is informed through

Friedman (1956 and 1969). The argument stems from the derived demand concept, that money is demanded not for its own sake but for the value of services that it generates. In the view that money is a form of wealth in the asset portfolio approach, money demand ought to be viewed as demand for services that it yields as an asset. An alternative view is that inflation measures the cost of buying a good tomorrow rather than today (see Ericsson (1998). The real value of money falls with inflation whilst that of real assets is maintained, so that there is a strong incentive for economic agents to switch out of money into real assets when inflationary expectations are strong (Arestis, 1988a :421).

Several arguments are presented on the rationale behind the use of expected inflation in modelling money demand (see Sriram, 1999b). However, some studies have used the actual inflation rate instead of expected inflation on the justification that the two are highly correlated (see Honohan (1994), Bahman-Oskooee and Rehman (2005), Tang (2002, 2004, 2007)). Generally, the use of inflation as an opportunity cost variable is attributed to the non-availability of statistical data on domestic interest rates particularly in developing countries or in countries where for religious reasons, payment of interest is prohibited or in countries experiencing hyperinflationary pressures. Choudhry (1995) and Munoz (2006) recommend the inclusion of expected inflation alongside the exchange rate variable in explaining money demand in countries with high inflation.

d) The Exchange rate

The inclusion of the exchange rate in empirical works is precipitated by the sensitivity of money demand to external monetary and financial factors. This is ideally the case with the creation of a synchronised international economic system i.e. globalisation where choice of assets by investors, for portfolio diversification, is between domestic and foreign real or financial assets. Embedded in this idea is the vulnerability of returns on financial assets to currency and asset substitution effects caused by exchange rate movements in floating-exchange-rate regimes. The currency substitution effect can be direct or indirect. The direct currency substitution effect is in place when there are investment portfolio adjustments between domestic and foreign money influenced by anticipated exchange rate changes. Sriram (1999b) notes that the indirect currency substitution effect places emphasis on the foreign interest rate especially if foreign securities provide a relevant investment alternative.

Implicitly, foreign securities are more attractive if the returns on them increase favourably. At the same time a depreciation in the domestic currency induce domestic portfolio holders to shun the domestic currency and the opposite is true, hence the direct currency substitution effect. Thus, while the direct currency substitution literature focuses on the exchange rate variable, the capital mobility or indirect currency substitution literature centres its attention on
foreign interest variable (see McKinnon (1982), Cuddington (1983), Giovannini and Turtleboom (1993), and Leventakis (1993). Therefore, the indirect currency effect is the asset substitution effect. Against this background, the exchange rate becomes an important reflection of opportunity cost in empirical studies of money demand. Empirical works considering the exchange rate as an explanatory variable include Halicioglu and Ugur (2005); Munoz (2006); Kumar, Webber & Fargher (2011), Tang (2007) and Ziramba (2007). Some have adopted the nominal exchange rate in the interest of not wanting to invoke multicollinearity problems with inflation in their models and others have considered the real effective exchange rate.

e) Dummy Variables

In regression analysis the dependent variable, or regressand, is frequently influenced not only by ratio scale variables (e.g. income, output and prices) but also by variables that are essentially qualitative, or nominal scale, in nature such as change in political and economic dispensations (Gujarati and Porter, 2009:277). Such qualitative influences are incorporated in models through dummy or dichotomous variables in a series of zeros and ones. Usually a 0 depicts the absence of such a qualitative influence and a 1 shows otherwise.

Humavindu (2007) incorporates the impact of structural changes in the South African economy, through two dummy variables, in his money demand specification for South Africa. The first dummy (which he named D01) accounts for structural breaks between 1980 and 1990 in the form of financial and credit controls and financial sector liberalisation. Another dummy (D94) captures the possibility of a break caused by the shift in the political regime (the birth of a democratic government) after 1994. He finds that D01 is statistically significant and shows that an increase in credit controls led to a decrease in the demand for money as expected. D94 is found statistically insignificant, and subsequently dropped out, implying that regime change did not have any impact on money demand. Sovannroeun (2009) included a political dummy to represent political turmoil in Cambodia, with DU(t)=1 for the period of 1997:07 to 1998:06 and DU(t)=0 elsewhere. The results indicate that political turmoil had no impact on the stability of money demand since the coefficient of the dummy is statistically insignificant. Opolot (2007) applied a dummy, modelling the money demand function for base money and M2 in Uganda. It is introduced as an exogenous variable, to capture the full liberalisation of interest rates in 1994. In both models, the dummy is statistically significant hence validating the effect of interest rates liberalisation on money demand over the period investigated.

3.3 Functional Forms

Money demand functions are generally specified in real terms on the assumption that the price elasticity of nominal money balances is unity (Sriram, 1999b:28). Some researchers employed the nominal magnitudes instead. However, the specification in real terms is the most common form used in the empirical research and the one suggested by the economic theory (see Goldfield, 1973:624).Hence, economic theory does not provide any rationale as to the correct mathematical form of a money demand function. In equation form, the relationship is sometimes expressed as linear, but more often in exponential form (Boorman 1976:323). Generally, three major functional forms are dominating the empirical landscape of money demand modelling, that is the linear-additive, log-linear, and linear-non additive (see Feige and Pearce (1977)). However, there is some consensus among money demand researchers that the log-linear version is the most appropriate functional form (see Zarembka (1968) and Darrat (1986b)).

3.4 Specification Issues: A Broader Perspective

Laidler (1985) gives a historical overview on money demand research in the United Kingdom and the United States of America, regarding early empirical works, as dominated by the static money demand function of the form:

$$M = \alpha_0 + \alpha_1 X + \alpha_2 r + \alpha_3 P$$
 3.1

Where *M* is nominal money balances, *P* is the price level and *X* is the scale variable, usually taken to be current income, financial wealth or permanent income *r* is the opportunity cost of holding money (either a rate on short-term assets or a rate in interest on long. term bonds), later studies included the own rate of money. The variables are in logarithmic form except for *r* which might appear as its absolute value.

Meltzer (1963) used US data for the period 1900-58 for various definitions of money to test the stability of money demand without imposing untested unit income and price elasticities. Bruner and Meltzer (1963) and Laidler (1966) refined this work for the USA, and Barratt and Walters (1966) and Laidler (1971) repeated this kind of analysis for the UK with broadly similar results. In these studies, money demand appeared to be related to a representative interest rate (invariant to the choice of a short or long rate) and to permanent (expected) income which was usually proxied using the adaptive expectations mechanism. Permanent income performed better than current income but only marginally better than financial wealth despite the fact that there was a paucity of accurate data. The evidence favoured a unit price level elasticity and hence α_3 could be constrained to be unity in annual data.

Some early studies include a wide variety of interest in money demand. Hamburger (1966) and Lee (1967. 1969) find evidence in favour of the inclusion of the return on savings and loan association deposits and the return on equity, as well as the time deposit rate. Klein (1974 a,b) and Barro and Santomero (1972) find evidence that the implicit service return on money (i.e. a form of own rate on demand deposits) is a significant determinant of narrow money holdings.

Evidence supporting the Keynesian liquidity trap is mixed. Studies that test for a higher interest elasticity in period of low interest rates (and vice versa) do not generally find any change in the elasticity (Bronfenbrenner and Meyer, 1960, Laidler, 1966). Direct test of the liquidity trap replace r in equation 2.31 by $r - r_m$, where r_m is the minimum level of interest rates (to be chosen by the data in some way, for example by assuming adaptive expectations or a grid search over alternative values for r_m (e.g. Starleaf and Reimer(1967, Pifer, 1969, 1969). Laidler (1985) in his survey, takes the view that evidence goes against the hypothesis. It is notable that early empirical works on money demand in developing countries suggested well- determined and fairly stable money demand functions. However, stability applies under different definitions of money, for different interest rates and over different data periods. In subsequent sections it appears to be the case that in recent years economists have become more circumspect concerning our knowledge of money demand.

One type of log-linear specification extensively used for estimating money demand is the partial adjustment model (PAM), originally introduced by Chow (1966) and later popularised by Goldfield. The model augments the conventional formulation of money demand by introducing the following two concepts: (i) distinction between desired and actual money holdings, and (ii) the mechanism by which the actual money holdings adjust to the desired levels. This modelling approach triumphed only with post 1973-data. However, its failure to explain money demand instability in 70s led to its rejection by researchers in favour of the buffer-stock models (BSM). In the 80s the BSM was popular as it addressed some of the weaknesses of the PAMs. In the 90s BSMs lost favour to error-correction models (ECM)s with advancements in econometric methodology. Hence, the next subsection gives an outline of PAMs as they are the departure of all econometric works of money demand followed by BSMs, before ECMs are presented.

3.4.1 Partial Adjustment Models and Adaptive Expectations.

In this framework, actual money balances adjust to the gap between the desired or long-run demand for real money balances and the previous periods holdings, in a conventional specification such as $m_t^* = a_0 + a_1 y_t + a_2 i_t$, such that:

$$m_t - m_{t-1} = d(m_t^* - m_{t-1})$$
 3.2

Where m_i is the actual money balances in real terms demanded in period *t* and *d* is the partial adjustment coefficient with 0 < (1-d) < 1. Al the variables in this formation are in natural logarithms. Fitting equation 3.2 into the conventional specification gives:

$$m_t = da_0 + da_1 y_t + da_2 + i_t + (1 - d)m_{t-1}$$
3.3

Where a_1 and a_2 provide the long-run elasticity of money demand with respect to income and interest rate respectively while da_1 and da_2 give short-run elasticities with 0 < (1-d) < 1. All variables are shown in natural logarithms. The introduction of the lagged dependent variable made PAMs popular as their most significant contribution to empirical work. Hence they display an element of short-run and long-run analysis through the partial adjustment coefficient. Notably, its critics have pointed out that the lagged dependent variable has a dominating explanatory power and yet with a positive sign, statistically significant in most empirical works. This has been its drawback.

However, there are two types of adjustment schemes in this framework of analysis. These are known as the real partial adjustment models (RPAMs) and the nominal partial adjustment models (NPAMs). In RPAMs, the lagged money balance variable takes the form of M_{t-1}/P_{t-1} as derived from the equations above where *M* and *P* are nominal balances and prices respectively. The adjustment is assumed to be in nominal terms in NPAMs in which the lagged dependent variable is in the form of M_{t-1}/P_t (Sriram, 1999b:31). The adjustment scheme is understood as the:

$$\log M_{t} - \log M_{t-1} = \lambda (\log M_{t}^{*} - \log M_{t-1})$$
3.4

Where M_t, M_{t-1} and M_t^* are in nominal instead of in real terms. This framework was applied extensively by researchers through a broader specification of the PAMs as illustrated by Goldfield and Sichel (1990) as

$$\ln m_t = b_0 + b_1 \ln y_t + b_2 \ln i_t + b_3 \ln m_{t-1} + b_4 \pi_t + v_t$$
3.5

In which m_t is real money balances, y_t is a transaction variable, i_t represents one (or more) interest rates, and $\pi_t = \ln(P_t / P_{t-1})$ is the rate of inflation associated with the price index, P_t . The inclusion of π_t in the above equation is meant to encompass the real partial adjustment modelling framework in which b_4 is zero or the nominal partial adjustment framework in which $b_4 = -b_3$.

Prior to Feigeos (1967) study of the demand for narrow money in the USA, researchers had assumed that either partial adjustment or the adaptive expectations hypothesis (usually on income) were responsible for the lags in the demand for money. Fiege (1967) considered both hypotheses simultaneously, with permanent income providing the expectations variable. The equation is estimated on annual data over the period 1915 . 1963. Fiege (1967) found the results satisfactory on *a priori* grounds and, in particular, instantaneous adjustment (on annual data) and adaptive expectations on income are indicated. On quarterly US data Goldfield (1973) finds less than instantaneous adjustment. Meyer and Neri (1975), using annual data for the USA, find that both narrow and broad money depend on a measure of expected income.

Laidler and Parkin (1970) applied Feigec model to UK quarterly per capital data on M2 for 1956 (2) . 1967 (4) and obtain ambiguous results concerning adjustment and expectations lags. They interpret the results in terms of permanent income rather than adjustment lags. The interest rate is statistically insignificant, and Laidler and Parkin (1970) argue that this arises because the Treasury bill rate does not provide a satisfactory proxy variable for the relative return on money: the omitted variable is the own rate on money.

For the United Kingdom, for various definitions of money, Artis and Lewis (1976) look at the stability of coefficient estimates over a sample period begins in 1963 (2) and extended from 1970 (4) to 1973 (1) for broad money. They include the interest rate differential between the own rate on money and the rate on long-term government bond. The variance of bond prices (measures as a moving average) is included in all equations to measure riskiness. Equations are presented with nominal and real balances as the dependent variable and first . order partial adjustment is invoked. In all cases, the equations fail the Chow test for parameter stability over the period 1971 (1) -1973 (1), and for broad money the equation is dynamically unstable over the long data period (as the lagged dependent variables exceeds unity).

According to Cuthbertson (1991), the main candidates for the observed instability in the demand for money in the USA (1960 . 1973) appear to be financial innovation, measurement problems, misspecification dynamics and the role of money as a buffer stock. In contrast, to the above, the demand for narrow money in other industrialized countries does not appear to have been affected by financial innovation variables even though they also experience high interest rates in the 1970s (see Arango and Nadiri (1981), Boughton (1981)). The pace of financial innovation appears to be accelerating in other industrialized nations (see Hall et al., 1989 for further exposition).

The partial adjustment modelling framework is generally acknowledged for its ability to bring the notion of autoregressive mechanisms, through the inclusion of the lagged dependent variable as one of the regressors. However, its failure to account for the ±missing moneyq problem rendered it a less useful estimation instrument. Coefficient signs and their respective elasticities were not conforming to apriori expectations as given by economic theory. For instance, Sriram (1999b) indicated that income elasticities were as poor as 0.1, interest rates at about -0.05 (interest overshooting) and the lagged dependent variable coefficient was close to unity. The partial adjustment modelling approach also over restricted the flexibility of the lag structure, hence limiting its ability to account for short-run disequilibrium.

3.4.2 Buffer Stock Models (BSMs): Four Approaches

The theoretical framework of BSMs has been covered in Chapter two. These models gained favour with researchers in the 80s as they displayed sound ability to curb the weaknesses of PAMs related to interest rate overshooting and long and implausible lags of adjustment .The BSMs are acknowledged for taking money shocks as part of the determination of money demand and bring a more complex lag structure. As a result the short-run interest overshooting problem is avoided. According to buffer-stock proponents, the reason behind the failure of PAMs in explaining the missing money episode is that they did not consider the short-run impact of monetary shocks.

In the BSMs, the positive monetary innovations result in an accumulation of cash balances in the short-run, and hence, the cash balances rather than the interest adjust which help overcoming the interest shooting problem, Secondly, the complicated nature of the monetary transmission mechanism is much more realistically dealt with by modelling the effects on short-run money demand directly. Thirdly, the insertion of the money shock variable in the money demand function addresses the specification bias of the PAMs assuming that the BSMs is the **%**ue+model (Sriram, 1999b:33). There are a number of different approaches that are all classified as buffer stock money. In this study only four of these shall be given as reflection of empirical evidence on money demand investigation, namely the single-equation Disequilibrium Money Models, Complete Disequilibrium Monetary Models, Shock absorber approaches and the Forward. looking Buffer Stock Model.

a) Single – Equation Disequilibrium Money Models.

Estimates of demand for money functions for almost any developed country have a sizeable autoregressive component which has frequently been interpreted as reflecting slow adjustment of short-run to long-run desired money holdings. However, when such equations are inverted to obtain the market clearing level of, say, the interest rate, the latter will grossly over shoot its long-run equilibrium value in response to an exogenous change in current period money supply,. This argument may not be entirely watertight. If we mechanically invert the partial adjustment short. run money demand function.

$$m_t = \beta x_t + \gamma_{mt-1}$$
 3.6

Then we obtain $\partial x / \partial_{mt} = {}^{1} / \beta$ and a long. run effect which is smaller: $\partial x / g_{m}(1-p)\beta, 0 > \gamma > 1$). However, as Laidler (1982) points out if the increase in money M_{t} is exogenous, then agents are forced to hold it at the beginning of period t and hence the money stock at the end of period t-1 should be denoted m_{t} and not m_{t} -1 in equation 3.6. Hence the long-run and short short-run impact on x_{t} is $(1-\gamma)/\beta$. Another argument stresses regime shifts (of which the Lucas critique, 1976) could be viewed as a special case if (a)(contains expectations terms. If (a) is estimated when m_{t} is endogenous and hence agents voluntarily respond to changes in x_{t} , the parameters of such an equation may not remain constant when m_{t} is exogenous (e.g. Walsh, 1984).

This has led various authors (Artis and Lewis, 1976; Laidler, 1982) to interpret this estimated demand for money parameters as representing a slow real balance effect and to advocate inverting the demand for money function prior to estimation. Hendry (1985) for UK $M\underline{1}$ and Mackinnon and Milbourne (1988) for US narrow money clearly demonstrate that investigating conventional short-run money demand function and taking the price level as the dependent variable yields exceedingly poor estimated price equations over the period 1960 - 1985. They conclude that price equations are not simply short. run money demand equations on their heads (Mackinnon and Milbourne, 1988). This does not preclude the

money supplyces causal influence on the price level, but factors other than those embodied in the short-run money demand function may also influence prices (for example, in the complete disequilibrium money models discussed in the next section). A major drawback with the single-equation disequilibrium money approach is that only one argument can be chosen as the dependent variable, whereas on a priori grounds one might expect all arguments of the demand function to adjust simultaneously.

b) Complete Disequilibrium Monetary Models

The second type of buffer stock model remedies the above defect and disequilibrium money holdings are allowed to influence a wide range of real and nominal variables. In the complete disequilibrium model approach, the following type of equations frequently appears

$$\Delta X_t = f(Z_t) + \gamma(L)(M_t^s - M_t^d)$$
3.7

$$M_t^d = \alpha_0 P_t + \alpha_1 R_t + \alpha_2 Y_t$$
3.8

 X_t may be a set of real and nominal variables (e.g. output, prices, exchange rate), Z_t is set of predetermined equilibrium variables, M_t^d is the long-run demand form money and $\gamma(L)$ is a lag polynomial.

As the money disequilibrium term appears in more than one equation, the mode yields cross . equation restrictions on the parameters of the long-run demand for money function. This type of model has performed well for the USA (Laidler and Bentley, 1983), the UK (Hilliard, 1980, Laidler and Oq Shea, 1980, Davidson, 1984; 1987), Australia (Jonson and Trevor, 1979) and Canada (Laidler et al., 1983). By and large, these models have been estimated using systems methods (e.g. three-stages least squares, (3SLS) and full information maximum likelihood, FIML) with a broad definition of money and have perhaps not proved successful in explaining small open economies with flexible exchange rates as they have in the modelling of closed economies such as the USA(see White, 1981).

In some models of this type M_t^d is estimated using cointegration techniques and the residuals are viewed as disequilibrium money. The latter is then included as a additional variable in expenditure equations such as stock building (Ireland and Wren-Lewis, 1988) and non- durable consumption (Cuthbertson and Barlow, 1991).

If the coefficients of long-run money demand are the investigatorop parameters of interest, then the full systems approach has the drawback that any estimates of the latter are conditional on the correct specification of the whole model. For example, if one should want to test whether coefficients in the long-run money demand remained stable over time, the need to estimate the whole model to obtain estimates of these parameters complicates the exercise. However, the complete disequilibrium model approach has the considerable advantage of showing the various routes whereby monetary disequilibrium affects the economy.

c) Shock Absorber Modelling Approaches to Buffer Stock Money.

This model directly estimates the demand for money function, but it is assumed that shocks to money supply are initially voluntarily held in transactions balances. The Carr and Darby (1981) version of this approach invokes the rational expectations hypothesis in that the monetary shock is the difference between actual money in circulation and the expected money supply. Some of these unanticipated balances are voluntarily held in money balances. However, anticipated changes in the money supply are immediately reflected in price expectations, and if prices are perfectly flexible, real money balances remain unchanged.

Carr and Barby (1981) test for the influence of unanticipated money demand using the following two . equation model:

$$(m-p)_{t} = \beta^{1} x_{t} + \alpha (m-m^{d})_{t} + \phi m_{t}^{a} + M_{t}$$
 3.9a

$$M_t = \gamma^1 Z_t - 1 + vt$$
 3.9b

Where α is expected to lie in the closed interval [0,1] and $\phi = 1$ õ co. The first equation is a conventional money demand equation with the addition of an unanticipated and anticipated money term. m_t is the logarithm of the nominal stock at time t, P_t is the logarithm of the price level x_t is a vector of determining exogenous variables observed at time t, β is a suitably dimensioned coefficient vector and m_t is a random disturbance term. m_t^a is the anticipated component of money supply and is determined as the predictions for equation 3.1.7b. z_{t-1} is a vector of variables known to agents at t-1 which are considered to have a systematic influence on supply, γ is a stable coefficient vector and v_t is the non.

Cuthbertson (1986b) using UK data on M1 an AR(4) model for m_t^a and through an ARDL money demand equation, finds that the shock absorber hypothesis is rejected for the Mackinnon. Milbourne formulation. Cuthbertson and Taylor (1988a) used UK data for M1. ARDL model as their conventional demand for money function and use a Kalman filter to generate the m_t^a series. They utilized the Mackinnon-Milbourne formulation of the shock absorber hypothesis, on assumption that money supply was endogenous. Their results were supportive of the Carr. Darby shock absorber hypothesis.

An interesting application of the shock absorber approach which eschews a role for expectations (and its practical problems) is provided by Browne (1989) who adds an exogenous money term to a conventional money demand function for Ireland. He finds that high. powered money in Ireland have a positive initial impact on Irelandqs demand for real broad money balances (M_3) with a zero long. run effect as the price level ultimately fully adjusts to the increase in exogenous money.

d) Forward – Looking Buffer Stock Models.

This modelling approach is based on the notion that economic agents determine their planned money balances by minimizing a multi period quadratic cost function (Cuthbertson, 1991: 52). Sargent (1979) developed a forward. looking model of the form

$$m_{t} = \lambda_{1} m_{t-1} + (1 - \lambda_{1})(1 - \lambda_{1}D) \sum_{0}^{\infty} (\lambda_{1}D)^{s} E_{t-1} m_{t+s}^{*}$$
3.10

Where $E_{t-1}m_{t+s}^*$ are the expected values of future long-run money balances (and λ_{\pm} depends on the adjustment cost parameters and the discount factor *D* in the cost function). The buffer stock element arises because agents make decisions concerning m_t based on information in period t-1 and hence surprise increases in nominal income are partly held as buffer money. Hence, if the long-run demand function is given by

$$m_t^* = C_0 P_t + C_1 Y_t - C_2 r_t = C^1 x_t$$
3.11

According to Cuthbertson (1988c) the estimating equation is considered as follows:

$$m_t = \lambda_1 m_{t-1} + \lambda (p - p^e)_t \beta (y - y^e)_t - \delta (r - r^e)_t$$

+
$$(1 - \lambda_1)(1 - \lambda_1 D)C^1 E_{t-1} \sum_{0}^{\infty} (\lambda_1 D)^s X_{t+s}^e + \mu_t$$
 3.12

where we assume that monetary innovations are at linear combination of innovations in prices, income, and interest rates, plus a catch. all disturbance μ_t . The testable predictions of this money demand function are that the weights on the expected future variable X_{t+s}^e decline geometrically as the time horizon is extended and that these weights are related to the coefficients on the lagged dependent variable. The model subsumes (Hendry, 1983; Mizon, 1984) conventional money demand functions. If the arguments of the demand for money function are generated by a random walk, equation 3.12 is of the ARDL form (Hendry et al. 1984).

The forward. looking buffer stock model counteracts some of the deficiencies in conventional backward. looking formulations of the demand for money function. Conventional models may omit potentially important variables, namely future values of the arguments of the demand for money. It would be paradoxical for the demand for the transactions balances to depend on the past level transactions, unless these are a proxy variable for future transactions (as in the adaptive expectations formulation of conventional functions) (Cuthbertson, 1991). Conventional demand functions that estimate a convolution of expectations and adjustment lags (for example, partial adjustment and error feedback equations), may exhibit instability because of instability in the expectations . generating process.

The forward. looking model is highly credited for its ability to overshoot after an unanticipated independent change in the money supply. If the increase in the money supply is accompanied by an unanticipated increase in nominal income, this leads to a temporary increase in holdings of buffer money. Also, to the extent that an increase in money supply leads to a reappraisal of the expected future path of the price level and real income, money demand increases today, and this reduces any disequilibrium in the money market at given interest rates.

Following Kannianien and Tarkka (1986), Muscatelli (1988) provides a variant of the above model, with the main additional feature being that costs of adjustment apply to non-money asset holdings $(A_{t+s} - A_{t+s-1})^2$ rather than to money. Planned short-run money balances depend not only on expected forcing variables χ_{t+s}^e as in equation 3.12, but also on expected future levels of saving.

Cuthbertson (1988c) uses a two. step procedure to estimate equation 3.12 for UK M1 with alternative auto. regression (AR) and vector auto-regression (VAR) forecasting schemes for the χ variables (i.e. p, y, r). The results confirm stable parameters with long-run unit (expected price) and income elasticities accepted by the data. The addition of savings to the model creates additional estimation problems and does not appear to add value appreciably to the empirical performance and theoretical interpretability of the model (Muscatelli, 1988). Cuthbertson and Taylor (1987c, 1990b) test the implicit cross-equation rationality restrictions by assuming that $y_{t_i} P_{t_i} r_{t_i}$ are generated by a VAR process and their findings are in favour of the rational expectations restrictions for the UK M1 and M3 definitions of money.

Muscatelli (1989) argues that although the forward model of Cuthbertson (1988c) performs well statistically, it is variance encompassed by a backward-looking error feedback equation (EFE). The variables in the ECM provide an additional explanatory power when added to the forward model but the reverse does not apply. Cuthbertson and Taylor (1991) criticize Muscatelliqs implementation of some of the test procedures but accept that, formally the ECM does variances encompass the forward model. They note that the ECM is designed to fit the blips in the data by using complex difference variables, while the forward model has an explicit dynamic structure. For Italian M2, Bagliano (1989) uses the stability tests proposed by Hendry (1988) and non. nested tests to examine the relative performance of feed forward and feedback equation and finds tentative evidence that an expectations model performs better that the feedback model after change in the monetary policy regime which occurred in 1969-70.

In general, despite the improvements BSMs brought over PAMs, they have been subject to the following criticism. Goodfriend (1985) argues that BSMs are justifying the lagged dependent variable as a regressor more than focusing on the economic justification in the first place. Although the short-run dynamic structure of the model is complex and sophisticated as compared to the PAMs, it still remains restrictive and hence inadequate. Its assumption of money stock exogeneity has been dismissed by Laidler (1993). As noted by Milbourne (1988), empirical performance of the BSMs has been weak. Consequently, the era of cointegration analysis and ECMs brought improvements in quality empirical estimation of money demand against the above weaknesses of BSMs and PAMs.

3.5 The Era of Cointegration Analysis and Error-correction Models (ECMs)

This section presents a discussion on the beginning of the application of cointegration analysis and error-correction models. It dwells more on the history of the application of these techniques in money demand modelling than their theoretical underpinnings. Theory of cointegration analysis and error-correction models is extensively covered in Chapter four. To the present, ECMs have been applied as methodology of estimating money demand in both developing and developed countries. They have been able to cover the short falls that PAMs and BSMs had in terms of failure to give a flexible dynamic structure and ignoring the importance of scrutinizing the underlying data generation processes before running regressions.

Although early critics of ECMs such as Hafer and Hein (1980), Fackler and McMillin (1983) and Gordon (1984a) argue that the transformation of variables in levels to their first differences to make them stationary to avoid spurious regression result in loss of information pertaining to the long-run relationship that economic variables in levels convey, the cointegration and ECM framework does provide a solution to this challenge. With cointegration analysis, empirically acceptable inferences on the long-run relationships are made simultaneously establishing short-run dynamics.

Empirical work has applied both single equation and multivariate cointegration techniques in modelling money demand. Notably, advocates of single equation cointegration techniques have applied either the Engle. Granger methodology (see Granger (1983, 1986) and Engle and Granger (1987) or the Autoregressive Distributed Lag (ARDL) approach of Pesaran & Pesaran (1997) and Pesaran & Shin (1999). The Johansen (1988) and Johansen. Juselius (1990) approach have recently been used extensively in multivariate cointegration techniques. There are few other cointegration techniques such as Phillips and Ouliaris (1990), Johansen (1991) to estimate I(2) series, and Johansen (see Hoffman and Tahiri (1994)). Additionally, the dynamic OLS and cointegration regression Durbin-Watson (CRDW) test procedures are also used in some studies (Sriram, 1999b:40).

Theory of cointegration analysis is covered at depth in Chapter four. Empirical issues around the multivariate approach are not covered in this study. However only theoretical aspects of multivariate cointegration analysis are covered in chapter four and partially in the survey of money demand studies covered in section 3.4. The speed of adjustment coefficient in error-correction models should carry a negative sign. As noted by Tlelima and Turner (2004), the negative sign on the speed of adjustment coefficient confirms the presence of a long-run relationship between variables and hence cointegration. The Chow test was applied to test for structurally stability in studies before 1990. However, the CUSUM and CUSUMQ

proposed by Brown et al., (1975) have been applied extensively in recent studies to confirm structural stability of money demand models (see Dafaalla and Suliman (2010).

3.5.1 The Autoregressive Distributed Lag–Error Correction Modeling (ARDL-ECM) Approach.

The aim of this approach is to obtain a well. fitting equation that has good statistical properties; forecasts well outside its sample period of estimation and conform to the *a priori* notions given the static equilibrium model. According to Mah (2000), the conventional cointegration tests like Engle and Granger (1987), Johansen (1988) or Johansen and Juselius (1990) lack reliability in small sample studies. Hence the ARDL modelling framework of Pesaran and Shin (1999) is robust and gives reliable cointegration results regardless of sample size. In the class of error correction models, it covers the weaknesses of other approaches although its critics have attacked its assumption of a single cointegrating vector in a model. However, its preference over the Johansen Maximum Likelihood (JML) is argued extensively in money demand literature. For instance, Kramers, Ericsson and Dolado (1992) argues that with small sample sizes, no cointegration relationship can be made among variables that are integrated of order one. Cheung and Lai (1993 :316) asserts that finite-sample analyses can bias the likelihood ration (LR) tests in Johansen**Ģ** approach towards finding cointegration either too often or too infrequently.

To a greater extent, the ADRL. ECM approach is credited for its ability to co-opt stationary and non. stationary time series data into a data coherent equation with valid parameter estimates. Thus, there is no need for unit root testing or stationarity pre-testing as is the case with other conventional approaches to cointegration analysis. According to Cook (2006), the F-test in the ARDL framework possesses greater power than both the Engle-Granger and the GLS-based cointegration tests. Tang (2007:477) notes that an ARDL specification allows separate identification of both long-run and short-run coefficients of explanatory variables.

Coghlan (1978) uses an unrestricted ARDL model for narrow money. Hendry (1979, 1985) also provides an econometric study of the demand in the United Kingdom for transactions balances (M1). In the long, run equilibrium, the real demand for M1 is assumed to depend upon real income γ (i.e GNP), and the expected yield is assumed to depend on alternative asset r (i.e. local authority three month rate) and the rate of inflation π . A long-run unit income elasticity is proposed. In obvious notation, the static long-run equilibrium is.

$$\frac{M}{PY} = Kr^{\alpha} \quad \beta \quad \alpha, \beta < 0$$
3.13

Hence, the estimated long . run equation is

$$(m-p-y) = 4.2 - 5.6 In(1+R) - 1.9 In(1+\pi)$$
3.14

Of great significance is the fact that, the equation exhibits parameter constancy when the data period is extended to 1982 (4) and when estimated recursively over the period 1965 (3) . 1982 (4).

The inflation effect should probably not be interpreted as a switch from money into goods but rather as a lag response to a change in the price level (Milbourne, 1983; Cuthbertson, 1986a). In the spirit of the bounds model of Miller and Orr (1966) agents adjust money balances only when they hit an upper (or lower) threshold and this occurs after a lag.

The demand for M1 in the UK appears to be undergoing some structural change in the second half of the 1980s Cuthbertson and Taylor (1991) note that over the period 1968 (4). 1983 (4) there appears to be some instability in the long-run income elasticity, and Hall et al., (1989) find evidence that the conventional variables in the demand for M1 do not form a co-integrating vector (although the addition of real financial wealth and a measure of stock market turnover tends to improve matters here).

Hendry and Ericsson (1983, 1988) examine the demand for broad money in the United Kingdom using the annual data over the period 1867. 1975. In their conclusion, they are disproving statistical procedure and claims of a stable demand for money function made by Friedman and Schwartz (1982) using the same data set. They used a general to specific modelling strategy to yield a preferred ECM equation:

$$\Delta_{1}(m - p - g)_{t} = 0.48 \Delta_{1}^{2} P_{t} + 0.44 \Delta_{1}^{2} (m - p)_{t-1} - 1.27 RS_{t}$$
$$-0.26(m - p - y)_{t-4} + 0.013(D_{1}) + 0.051(D_{2})_{t}$$
3.15

Gordon (1984b) applies the ARDL. ECM approach to the demand for narrow money in the USA but finds considerable instability in the equations estimated. Rose (1985) directly confronts the missing money problem for narrow money in terms of the restrictive (partial adjustment) lag structure used by previous investigators. By allowing the data to determine the appropriate lag structure within the ARDL. ECM format, Rose finds a stable demand function for the missing money period (on seasonally adjusted data).

Within the ARDL. ECM frame Baba, Hendry & Starr (1988) provide the definitive empirical account of the behaviour of narrow money M1B in the USA between 1960(2) and 1984(2)

and the great velocity decline (1982(1) . 1983(2). In the missing money episode previous models had over. predicted the demand for money by some 8-12 percent, while similar models had in the main substantially under-predicted the growth in narrow money. Building on the basic ECM of Rose (1985), Baba et al.,(1988) find that both the increase in the volatility of bond yields and use of the appropriate learning . adjusted after tax own yield on M1 instruments provide an empirical explanation for the rapid decline in velocity in the early 1980s.

The policy implications of the Baba et al.,(1988) demand function are that the change in the Federal Reserve Bankos operating procedures in the late 1979 in USA caused an increase in the volatility of interest rates, which then led to a rise in the demand for *M1* in the early 1980s (i.e. great velocity decline). The increase in monetary growth was therefore not indicative of excess money which might lead one to advocate a tightening of monetary policy, but merely a change in desired money holdings by agents.

One cannot avoid the inference that the ARDL. ECM approach tells us more about the demand for narrow money in the USA than would be obtained by working within the partial adjustment framework: Roley (1985) restricts himself to partial adjustment (and first. difference) equations for *M1*, and although he introduces a wide variety of other variables he is unable to make any positive inroads into the missing money and great velocity decline episodes.

Taylor (1986) applies the ARDL. ECM methodology to a consistent set of data for M2 (den Batter and Fase, 1981) for three European countries (Germany, the Netherlands and France) over the period 1960 (1) . 1976(4). The equations pass most of the diagnostic tests although there is some evidence of parameter instability over the post. sample period 1977(1) -1978(4). The long-run solutions yield unit income elasticities for Netherlands and Germany, while that for France is 1.6, and the interest rate effects are correctly signed. Milbourne (1985) provides a useful summary of empirical results for Australia. Muscatelli and Papi (1989) examine the demand for M2 for Italy, (1963(1) . 1987(4), using the Engle-Granger two . step procedure and a learning. adjusted (logistic) curve on the interest rate on new financial assets (as in Baba et al., 1988). The resulting ECMs give reasonable statistical and economic results. Thus, overall, error feedback approach yielded reasonable results for the demand for M2 in European countries.

Akinlo (2005) used the Auto-Regressive distributed Lang (ARDL) approach combined with CUSUM and CUSUMSQ tests to examine the cointegrating property and stability of M2 money demand over the period 1970(1)-2002(4) in Nigeria. The results show that the estimated relation is somewhat stable most especially with CUSUM test. All parameter

estimates are data coherent and statistically significant despite the observation that the interest elasticity estimate is small in absolute magnitude, hence inelastic and a lesser cause of concern to policy makers.

3.6 Analysis of Recent Empirical Evidence outside South Africa

This section presents a survey of a selected number of studies that evaluated money demand using the ECM approach from a randomly selected list of developing and developed countries. The objective is to present estimated long-run income elasticities, in aggregate form, and interest rate elasticities or semi-elasticities in a comparable framework. This kind of analysis gives an opportunity to reflect on the findings of other researchers specifically focusing on the coefficient sizes of parameter estimates as well as their mathematical signs. Research papers from 2000 to the present have been sampled randomly and the results are presented in the table below. Table 3.1 summarises information for a cross section of randomly selected developing, transitional and developed countries, on monetary aggregates (nominal or real), scale variables, opportunity cost variables and the major findings presented.

Table 3.1: A Survey on Money Demand Studies and their findings outside South Africa								
Author	Period/	Country	Method	Income	Interest	Main Findings		
	Monetary		OT	Elasticity	rate			
	Aggregates		study		Elasticit			
Akinlo (2005) Herve and Shen(2011)	1970:1 to 2004:4 M2 1980 to 2007 M1	Nigeria Cote dqvoire	ARDL CUSUM ECM	1.094 (43.8)* 5.312 (6.164)	-0.097 (1.91)* -0.191 (0.243)	Stable M2 money demand The effect of aggregate (M2) is not so stable.		
Singh and Kumar(2009)	1974 to 2004 M1	Papua New Guinea	GETS JML	1.399** S.E(0.0466)	-0.087** S.E(0.00 4)	Parameter estimates have correct signs and both GETS and JML confirms cointegration. CUSUM confirms structural stability of the function.		
Manap (2009)	1976:1 to 2009:4	Malaysia	FMOLS Hansen	(M1)1.26** (0.03) (M2)1.58** (0.026)	-0.032** (0.011) -0.031** (0.009)	Johansen ¢ test finds cointegration on M1 & M2 against their		

	M1 & M2					determinants. Hansenos test for parameter stability confirms stability on M1 and not M2.
Ho, Shek & Tsang (2006)	1984:4 to 2005:1 (M2 & M3)	Hong Kong	ECM	(M1)0.6116 (4.83)*** (M31.3992 (16.01)***	- 0.072*** (-2.57) - 0.026*** (-11.1)	M1 & M3 are stable over the period.
Tang. C.F (2010)	1960:1 to 2007:2 M2	Japan	ARDL	M2(1.786)***	-0.014	M2 money demand is stable
Capasso & Napolitano (20008)	1977:1 to 2007:3 (M2& M3)	Italy	ARDL CUSUM	(M2)1.123* (2.661) (M3)0.87** (3.4)	-0.192** (- 13.587) -0.002** (-3.3)	M2 is instable and there is remarkable stability with M3
Tehranchian & Behravesh (2011)	1975 to 2008 M2	Iran	ARDL CUSUM	3.26 (3.24)	-0.026 (-2.69)	A long-run relationship is confirmed between M2 and its determinants
Achsani(2010)	1990:1 to 2008:3 M2	Indonesia	ARDL VECM CUSUM	3.204 (3.064)*	0.082 (1.27)	The ARDL confirmed long- run stability of estimates on and the VECM did not, on M2.
Abdullah, Ali & Matahir (2010)	M1 & M2	Indonesia	ARDL	(M1)-0.24 (-0.773) (M2)-9.61*** (-2.134)	-0.196** (-2.766) 1.92* (3.603)	M1 and M2 re stable and regressors have correct signs.
Abdullah, Ali & Matahir (2010)	M1 & M2	Malaysia	ĀRDL	(M1)-0.362 (-1.052) (M2)-6.087** (-2.157)	-0.005 (-0.726) 2.547* (3.252)	M2 is cointegrated with its determinants and a stable long run relationship is confirmed. However M1 is not.
Abdullah, Ali & Matahir (2010)	M1 & M2	Philippines	ARDL	(M1)0.225 (0.873) (M2)-9.738** (-2 384)	0.063** (2.55) 0.435 (1.102)	There is a long- run and stable relationship on both M2 and M1.
				(2.004)	(

(2010)				(M2)8.091* (3.693)	0.638*** (1.937)	interest rate has a positive sign. M1 has statistically insignificant coefficients.
Abdullah, Ali & Matahir (2010)	M1 & M2	Thailand	ARDL	(M1)-0.770 (-1.257) (M2)-4.099** (-2.194)	-0.037 (-1.173) -0.227 (-0.201)	Cointegrating relationships are confirmed in both M1 & M2. However the negative signs on real income are a cause for concern.
Owoye and Onafowora (2007)	1986:1 to 2001:4 M2	Nigeria	VECM	2.067* (5.33)	0.306* (8.191)	The interest rate has a positive sign and stability of long-run money demand is confirmed.
Nachega (2001)	1963/64 to 1993/94 M2	Cameroon	ECM	0.7* (2.0)	0.9 (1.3)	The stability of the short-run dynamics of the broad money demand function is confirmed.
Opolot (2007)	1990:1 to 2004:4 Base Money (LRBMON) & M2	Uganda	ECM VAR	LRBMON 1.516*** (2.97) (M2) 1.02***	-0.018** (-2.1) -0.199**	Cointegration analysis indicates that there is a long run relationship for both base money and M2. Stability of money demand is confirmed in both cases.
Halicioglu and Ugur (2005)	1950 to 2002 M1	Turkey	ARDL	0.939*** (10.84)	-0.01*** (5.99)	There is a stable long run relationship between M1 and its determinants.
Bahmani- Oskooee and Bohl(2000)	1965:1 to 1991:4 M3	German	ECM	1.38	-0.21	M3 money demand is not stable.
Bahmani- Oskooee and Chi Wing	1985:1 to 1999:4	Hong Kong	ARDL CUSUM	1.64*** (16.63)	-0.045** (2.26)	M2 as the broad money aggregate is

Ng(2002)	M2					stable and cointegrated with its determinants.
Munoz (2006)	1980 to 2004 M3	Zimbabwe	VECM	0.413*** S.E(0.106)	- 0.0007** * S.E(0.00	Except for 2004, a stable money demand function for M3 exists.
Kallon (1992)	1986:4 to 1996:1	Ghana	TSLS	0.667* (2.03)	-0.005* (4.53)	No significant effect of foreign interest rates on M1 demand
Bashier and Dahlan (2011)	1975 to 2009 M2	Jordan	JML CUSUM	1.05* S.E(0.152)	-0.233** S.E(0.05)	Stability tests reveal that M2 is stable and parameter estimates are theoretically consistent.
Belke and Czudaj (2010)	1995 to 2009:2	Euro Area	ARDL CCR FM-OLS DOLS	1.11*** 1.15*** 1.35***	1.82*** 2.4*** 1.74***	A statistically reliable money demand function is established using different regression techniques. The financial crisis does not have an impact on stability of money demand

Notes: In parentheses are the t-ratios and where these were not identified, the respective standard errors are indicated. The asterisks *, ** and *** denote significance levels at 10%, 5% and 1% respectively. Acronyms ARDL, CCR, CUSUM, DOLS, ECM, FM-OLS, JML, TSLS, VAR and VECM mean Auto Regressive Distributed Lag, Canonical Cointegration Regression, Cumulative Sum of Squares, Dynamic Ordinary Least Squares, Error Correction Models, Fully Modified Ordinary Least Squares, Johansen Maximum Likelihood, Two Stage Least Squares, Vector Auto Regression and Vector Error Correction Model, respectively

The presentation of the Jarque-Bera test is valid and more reliable in larger samples. However, the decision rule can be viewed as approximations in smaller samples. For the interest elasticity(E(I)), evidence from the p-value leads to the rejection of the null hypothesis that it is normally distributed. The skewness coefficient dictates that the distribution is positively skewed, as shown by outliers that are positive coefficients.

 Table 3.2: Descriptive Statistics for Income and Interest rate
 elasticities for a sample

 excluding South Africa.
 excluding South Africa.

	Interest Elasticity	Income Elasticity
Mean	-0.004	1.152
Median	-0.029	1.108
Maximum	0.900	2.067
Minimum	-0.233	0.413
Std. Dev.	0.240	0.448
Skewness	2.813	0.152
Kurtosis	11.190	2.242
Jarque . Bera	82.240	0.556
Probability	0.000000	0.757
Sum	-0.077	23.034
Sum Sq. Dev.	1.106	3.814
Observations	20	20

Source: Authors' own calculations

Notably, most of the observations lie between 0 and -0.1 in the frequency distribution depicted in Figure 3.2 below. The maximum value it has in the sample is a positive value of 0.9 (which is not supported by Keynesian or Monetarist theory) against a minimum of -0.23. The average coefficient of the interest elasticity is -0.004 and -0.03 as the median.

The income elasticity (E(Y)) is approximately normally distributed as evidenced by the distribution depicted in Figure 3.2 below and confirmed through the p-value of the normality test which does not lead to the rejection of the null hypothesis. The average income elasticity is 1.15 and its median is 1.108. The maximum income elasticity coefficient is 2.067 and the minimum is 0.413. The distribution depicts weak positive skewness. Thus, the results of this survey confirm the unit income elasticity hypothesis since averages are closer to 1.

Figure 3.2: Frequency Distribution of Estimated Interest Elasticities²⁴



Figure 3.3: Frequency Distribution of Estimated Income Elasticities



As short-run dynamics have no theoretical justification, the survey has been restricted to the long-run parameter estimates. Again, only results from studies confirming the presence of cointegration have been considered without necessarily dwelling on the controversies of

²⁴ Figure 3.2 and 3.3 are generated using Eviews 6 using statistics in Table 3.2

coefficient signs and apriori expectations. For instance, the interest rate is expected to be negative in classical and post-Keynesian economics. However, there is theoretical justification of positive signs from theories such as the McKinnon and Show complementarity hypothesis (see Ansari, 2002:81). There is no clear guidance from the theory or empirical studies regarding the acceptable magnitude on elasticities or semi-elasticities of the opportunity cost variables (Sriram, 2001:338). Notably, there is a host of other opportunity cost variables included in other studies excluded in this survey to cater for foreign influences on money demand in open economies. So far aggregated scale variables have been examined. Literature on disaggregated components of scale variables is not extensively available. Hence their empirical justification is covered in the first section of Chapter 5.

3.7 South African Empirical Evidence with Aggregated Scale variable

Many empirical studies are available in the monetary literature dealing with the estimations of money demand in South Africa. This area has received substantial attention, as in other countries, because of its significance to monetary policy formulation and transmission mechanism in the history of monetary policy management in South Africa. The tradition of money demand investigation in South Africa is dated as far back as 1966.

Heller (1966) used the conventional single equation approach to investigate stability of money demand for South Africa for the period 1918 to 1955. Different money demand functions of the linear form were estimated to site relevant constraints and the specific roles of each exogenous variables identified namely price level, interest rate and income proxied by GNP. Ordinary least squares (OLS) regression analysis was applied and out of the 21 parameters of the component equations, 19 passed the 95% significance tests, and all equations had satisfactory explanatory power. A long-run stability was confirmed as components making up the total demand for money were statistically significant. However, he failed to specify a stable short-run demand for money function that is equally crucial for the management of effective monetary policy regimes.

Maxwell (1971) adopted a lagged stock adjustment mechanism of the form:

$$InM_{t} = \alpha_{0} + \alpha_{1}InM_{t-1} + \alpha_{2}Inr_{t} + \alpha_{3}InA_{t}$$
3.16

Where *Mt* is the real stock of money demanded at time *t*, M_{t-1} is the stock of money at time $t-1, r_t$ is a representative interest rate with A_t as the constraint factor at time *t*. The time

frame is split into two, the pre-war period (1918. 1939) and the post-war period (1945-60). Examination of all results, over the whole period (1918. 60) and both sub-periods reveal that an interest elastic permanent income model gave the best results, followed by a current income model and last the wealth model. Examination of all results, over the whole period and both sub-periods, reveals that an interest rate in the various equations tested indicated that whenever a reasonable fit was obtained (say R^2 greater than 0.3) the interest coefficient had the predicted sign and was significant. This may be taken as fairly conclusive evidence that the demand for money is interest elastic, contrary to Friedman¢ assertion. However the absence of quarterly data precluded any analysis of the short-run function as the research utilized annual data. Heller¢ assertion of a stable long-run money demand function was not confirmed.

Stadler (1981) investigated money demand within a dual framework of a single. equation approach of the conventional form compared against one model of the autoregressive (AR) form with a mechanism of partial. adjustment of the form.

$$M_{t} = gb_{0} + gb_{1}Y_{t} + gb_{2}P_{t} + (1 - g)M_{t-1} + g\mu_{t}$$
3.17

Real income (Proxied by GDP), interest rates and exchange rate were chosen as scale variables among others to model the demand function. Ordinary least squares regression analysis was applied on quarterly data, from 1965 to 1979. However, stability of money demand was not established. Classical economic theory was found inapplicable to reality. Perhaps if factors such as monetary policy regime changes and socio-economic patterns were taken into account, results might have confirmed a priori theory. The study does not claim to have determined the demand for money function for South Africa. Contrary to previous studies, no discernible relationship between the demand for money and the rate of rate interest could be found. Parameter estimates were found to be statistically insignificant and continued research was emphasized.

Contogiannis and Shahi (1982) examined money demand in South Africa for the period 1965 to 1980 using SARB quarterly data. The Price Expectations Model, Adaptive and Partial Adjustment models together with the Koyck transformation were used as core-methodology. It was more of an exploratory research where stability of money demand is not ascertained and inflation is found to be a self-generating character. Further research was called for.

Courakis (1984) used a system of multivariate equations to investigate money demand function in an attempt to give a more accurate perspective. Expectations and Partial Adjustment modelling techniques together with Koyck transformation were used as a refinement of past research done by Contogiannis and Shahi (1982). Quarterly data from SARB from 1966 to 1980 was used to explain the nature of money demand relationship in existence then. However, this was more of a methodological exposition than a decisive determination of a money demand relationship and its stability status.

Whittaker (1985) used Koyck transformation modelling as key methodology to challenge previous works of Stadler (1981), Contogiannis and Shahi (1982) and Courakis (1984). However, the maximum likelihood approach was used to give parameter estimates using SARB quarterly data from 1965 to 1980. Again the outcome was a robust methodological evaluation of previous research approaches, giving a closer picture of the South African money demand function and its numerical parameters for M2 and M3. Findings included that money demand for M1 was unstable over that period of study. Overally, Whittaker did not convincingly verify or reject any of the behavioural relationships from which the money demand function is built.

Tavlas (1989) tested the demand for money in South Africa through a buffer stock model, together with conventional partial adjustment models, of the form;

$$m_t - p_t = a_0 + a_1 Y_t + a_2 \gamma_t + a_3 (m_{t-1} - P_{t-1}) + \alpha_4 (m_t - m_t^a) + \mu_t^a$$
3.18

Where $m_t^a = g^1 z_t$ and $mt = g^1 z_t + v_t$. Hence z_t is a set of variables agents assume have an important influence on the money supply, $m_t^a = \log M_{t_i}^a$ M_t^a is the anticipated money supply, g is a vector of coefficients to be estimated, and v_t is a white noise error term.

He used quarterly data from the International Financial Statistics (IMF) from 1977 (1) to (1987) 4, with M3 as focus. Parameter estimates were marginally significant. In his work, it is concluded that a stable specification for M3 does exist, supporting the targeting of that aggregate by monetary authorities. Inflationary pressures are derived by regressing the then current inflation rate on a polynomial distributed lag (second point with no end point restrictions) on the past values of the inflation rate beginning with observation t-1 and ending with observation t-19. However, his major drawback is that there are specification problems in his model, although in some instances the monetary base is used in lieu of the money supply in order to generate a series on the anticipated monetary base.

However methodological deficiencies make it difficult to assess the robustness of his model, in that there are no tests for cointegration. Secondly, the test of stability went no further than a Chow (1960) test of the first half of the sample against the second half. Thirdly, the sample was only 10 years (1977:4-1987:3); and the data were deseasonalised before estimation (Moll, 2000:192).

Barr and Kantora (1990) vector autoregression explored links among income, money and prices and confirmed the independent importance of money supply growth for the growth in real incomes and inflation in South Africa. The money demand relation, however, does not emerge clearly, because the estimation is done in changes, so that information on the relations among the levels of variables (e.g. real money balances and real income) is lost.

Hurn and Muscatelli (1992) found the following cointegrating relationship, using the Johansen (1988) maximum likelihood procedure, from 1965 (1) to 1990 (4),

 $(no \min alM3)_{t} = 1.92^{*}(realGDP)_{t} + 0.85^{*}(GDPdeflator) + 0.032^{*}(deposit rate)_{t} - 0.038^{*}$ (interest rate on 3 -year government Stock) 3.19

This specification is non-homogeneous in prices. It is not clear, what this could mean in practice. The specification with price homogeneity did not satisfy the cointegration tests, possibly owing to the omission of an inflation variable and to the use of the average deposit rate (instead of using a weighted return to the components of M3). Doyle (1996) reports a cointegrating relationship among real currency, real personal consumption, and the cumulated Treasury Bill rate and suggests that currency be a candidate for use on . nominal anchor.

De Jager (1998) presents the framework of the monetary block¢ equations in the South African Reserve Bank econometric model money demand equations to depict the demand for various balances against aggregate income, the interest rate differential, long term interest rate and the price level. All coefficients of the aggregate real income have *a priori* expected signs. Equations are also showing that there is a negative relationship between the long-term interest rate, inflation and narrow and broad money in South Africa over the period under investigation. He establishes that more restrictive measures are needed to ensure the maintenance of macroeconomic stability. Excessive monetary growth would invoke inflationary pressures and the bank rate was among key instruments that could be used to contain domestic monetary demand. The M3 money demand function illustrates near-unity elasticity is estimated at 0.05 and the elasticity of the yield on possible substitute assets is estimated at -0.22. However, his analysis does not show the nature of short-run dynamics and cointegration of M3 and its determinants. Structural stability of parameters is not confirmed decisively.

Moll (1999a, 199b) explored relations among money aggregates, interest rates, income and prices for the period 1966 (4) to 1998(3), splitting the sample into periods before and after economic liberalization policies of the early 1980s. The money demand relationships examined did not cointegrate, probably owing to the omission of an inflation variable, the periodisation adopted, and the selection of cointegration tests. There was, however, considerable evidence of interest rates impacts on income and other measures of real activity.

Moll (2000) uses a general to specific specification search approach pioneered by Hendry (1985) to find a money demand against the same period and produced an equation estimate.

$$(m-p)_{t} = 1.27(m-p)_{t-1} - 0.39(m-p)_{Pt-2} + 0.14(y-p)_{t} + 0.0012r_{m3} - 0.0028r_{10t} - 0.90$$

$$\Delta_{pt} + 0.34\Delta p_{t-1} + seasonals.$$

3.20

In this autoregressive distributed lag model, he finds that there is a stable money demand relationship and indeed no evidence of structural change in the money demand relationship despite real M3 surge. Real M3 surged in the period 1993. 1998, growing by a total of 39 percent when real GDP grew by total of 11 percent, hence leading to suggestions of a structural change in money demand. Parameter estimates as given in the equation above indicate that there is no structural change and the surge can be explained on the basis of income growth and the decline of inflation.

Nell (1999, 2001) empirically tests the existence of a stable long-run demand for money function over the period 1965 to 1997 using a vector autoregressive system of a short. run dynamic model of the error correction form to give the result that

$$\Delta Lm3/pt = -8.12 - 0.88EC_{t-1} + 0.39\Delta Lm3/p_{t-1} + 0.87\Delta Lyt + \varepsilon_t$$
3.21

Results provide evidence that Lm3/p is the only money demand function that yields a longrun demand relationship. The estimation results for the long-run and short-run models showed that Lm3/p displays parameter constancy over the entire period, while the interest rate, although having the correct theoretical sign, is insignificantly different from zero. The real demand for broad money is solely explained by real income (*Ly*) which provides some support for the monetaristor theoretical proposition that there exists a direct link between the *M3* money stock and money income. The long-run income elasticity indicates that the results are robust. The absence of a long-run cointegrating relationship for *M1* and *M2* intuitively suggests that financial reforms since 1980 and/or the debt standstill of 1985 could have induced a change in the long-run relationships of both monetary aggregates. Jonsson (1999,) conduct an investigation of inflation, money demand and purchasing power parity in South Africa using a structural vector auto regression and error correction model, from 1971 (1) to 1998 (2). Specifically following Johansen and Juselius (1990) and Johansen (1991) methodology, a vector of endogenous variable, χ , that are integrated of order 1, is analyzed using the vector error. correction representation,

$$\Delta X_{t} = \mu + \sum_{\nu=1}^{k} T_{i} \Delta X_{t-i} + \pi X_{t-1} + \varepsilon_{t}$$
3.22

The results indicate that a stable money demand type of relationship exists among domestic prices, broad money, real income and nominal interest rates, with plausible estimates of the long-run coefficients, as well as a long-run relationship among domestic prices, foreign prices, and the nominal effective exchange rate. In the short-run, shocks to the exchange rate affect domestic prices but have virtually no impact on real output, and shocks to broad money have a temporary impact on real output before inflation picks up. Both types of shocks seem to trigger a monetary policy response, as the short-term interest rate adjusts quickly and substantially.

Wesso (2002) gives a critique on why earlier models of money demand in South Africa (Stadler 1981; Contogiannis and Shahi, 1982; Courakis, 1984; Whittaker, 1985; Tavlas, 1989) are failing to ascertain a data coherent and theoretically meaningful money demand relationship. He follows Boughton (1992), who attribute the failure by Wessoqs predecessor to give robust models to the fact that they are found imposing untested constraints on lag patterns which are typically rejected by the data. He cites methodological and pedagogical factors as the cause of failure in earlier models in money demand in South Africa. Hence he suggests a more superior methodology of the fixed. coefficient error-correction representation of the form.

$$\Delta (n-p)_{t} = c + \alpha [(m-p)_{t-1} + \beta_{1}Y_{t-2} + B_{2}i_{t-2}B_{3}(s-own)]_{t-1} + \gamma_{11}\Delta (s-own)_{t} + \gamma_{12}\Delta p_{t} + \gamma_{13}\Delta P_{t-1} + \gamma_{14}\Delta (m-p)_{t-1}$$
3.23

Where *m*, *p*, and *Y* denote, respectively, nominal M3, the consumer price index excluding mortgage interest rates and real GDP. The variables *s*, *I* and own denote a short. term market interest rate, a long-term market inter rate, and an own rate of M3 respectively. It is worth noting that, in line with recent results for the euro area (see Dedola et al., 2001), the long-run specification does not include inflation as a measure of opportunity cost of holding money. The fact that inflation does not enter the long-run relationship could be interpreted in

the sense that this variable is regarded as not having additional explanatory content for money demand compared with the nominal long-term interest rate.

All these variables except interest rates are in natural logarithms and time differences are denoted by Δ . The variables in brackets represent the long-run equation in the error correction methodology. The money demand model is estimated using quarterly data from 1971 (1) to 2000(4) and excludes data from 2001:1 to 2002:2 for ex-post forecasting evaluations. A stable money demand function is not confirmed with arguments that such instability is likely caused by technological changes and financial liberalization. However, the single. equation proves inadequate. Hence superior modelling strategies that allow parameter variations over time were recommended for future research.

Tlelima and Turner (2004) estimated the demand for broad money using quarterly data from 1970:1 to 2002:3 with the real GDP, GDP deflator, household consumption expenditure and the treasury bill rate as regressors by applying five different cointegration tests and two error correction tests to establish short-run dynamics. When real GDP is used as the scale variable, the income elasticity is 1.2 and the inflation elasticity of money demand is -0.449 and the semi-interest elasticity on the interest rate differential is 0.163. A long-term drift upwards in the value of the income elasticity is reported from a value of about 0.5 in 1981 to 1.2 in 2002. However, recursive estimates of the steady-state elasticities with respect to income, the interest rate and the inflation rate indicate that these important parameters are not stable in the period investigated. Evidence is found that the income elasticity of demand increased significantly through the period as has the sensitivity of money demand to the opportunity cost of holding money balances. Step changes associated with economic and political disturbances were observed.

Odhiambo (2005) investigates the authenticity of the McKinnon¢ complementarily hypothesis and money demand through a dynamic specification model of the error correction form. It is an attempt to establish the link between money and physical capital in the finance motive for economic development, as postulated by McKinnon (1973). This study uses a model associated with Thornton (1990) and Khan and Hasan (1998) to test the relevance of McKinnon¢ complementarity hypothesis in South Africa given as follows

$$Log(\frac{M}{P_{t}}) = \alpha_{0} + \alpha_{1}\log Y_{t} + \alpha_{2}(\frac{M}{P})_{t-1} + \alpha_{3}(\frac{Sd}{Y})_{t} - \alpha_{4}\log(d - p^{e})_{t} + \pi_{t} + \mu_{t}$$
$$Log(\frac{Sd}{Y})_{t} = \beta_{0} + \beta_{1}\log Y_{t} + \beta_{2}\log yR_{t} + \beta_{3}\log(\frac{M}{P})_{t-1} + \beta_{4}\log DR_{t} + \beta_{5}\log(\frac{S_{d}}{Y})_{t} + \nu_{t}$$
3.24

Where: M/P is real money demand, *Sd/Y* is ratio of domestic savings to GDP (savings rate), y is real income; YR is growth rate of real income, *Sf/Y* is foreign savings to GDP ratio, DR is

dependency ratio, $d-p^e$ is real rate of interest μ_t, V_t are random error terms and π_t is the expected inflation.

In this model, demand for money is made a function of the savings ratio and, simultaneously, savings is made a function of real money balances in order to incorporate the reversibility aspect of the complementarily relationship. The rationale for estimating real money balances and savings simultaneously is based on the argument that complementarily work both ways. The conditions of money supply are pre-supposed to have first order impact on decisions to save and invest. Therefore the long-run real money demand function is defined as a function of real income, savings ratio, expected inflation and real deposit rate. The Johansen. Juselius cointegration procedure multivariate error. correction mechanism is used to test the existence of cointegration and the number of cointegrating vectors. Results are found pro-Mackinnon¢ complementarily hypothesis. However results on money demand function are statistically insignificant.

Todani (2007) presents a system cointegration analysis of a long. run demand for money (M3) through a cointegrated vector auto- regression model, consisting of real money, income and the opportunity cost of holding money. In his VAR model, he argues that for an *n*-vector of time series { X_{t} }, it is assumed that a k^{th} order VAR representation of { X_{t} } exists and is of the following error correction form:

$$\Delta X_{t} = \alpha \beta' \chi_{t-1} + \sum_{i=1}^{k-1} \Gamma_{i} \Delta X_{t-i} + \alpha \beta_{0t}' + \Theta D_{t} + \delta_{0} + \varepsilon_{t}$$
3.24

 $X_{k+1}...X_0$ are assumed fixed, Δ is the first difference operator and ε_t are independent and identically distributed innovations, with mean of zero and positive definite covariance matrix Ω . Hence a VAR money demand model is specified as:

$$X_{t} = [(m - p_{t}), y_{t} \Delta p_{t}, Rs_{t}, Rl_{t}]'$$
3.25

Where m_t is the log of nominal money balances, P_t is the log of consumer price and y_t is the log of a real scale variable. R_{st} represents the rate of return on component included in the stock of money and R_t^1 is rate of return on alternatives to money. The results give a preferred long-run money demand function for South Africa re-written in a conventional way as:

$$m_t - P_t = 3.200y_t - 6,297(R_{tt} - R_{st}) - 0.006_t$$
 3.26

In the above expression his income elasticity is higher than envisaged by theory and the interest elasticity is statistically significant. He concludes that a stable long-run cointegrated money demand relation does exist despite all economic developments that have taken place in South Africa in the past such as financial liberalization, integration into the world economic and opening up of the economy. Of all the variables used, only income and real money are error. correcting to the money demand relation, meaning that they adjust to disequilibrium in the money as reflected by significant adjustment coefficients. Inflation, however, seems exogenous to the money demand relation implying that the link between money and inflation is rather weak.

Hall et al., (2007) estimated the M3 money demand function with real GDP, the GDP deflator, the three-month treasury bill rate and share prices as explanatory variables through a vector error correction (VEC) specification and the time varying coefficient (TVC) approach. Analysis is made in the context of the portfolio-balanced framework proposed by Brainard and Tobin (1968) and Tobin (1969). Quarterly data over the period 1970:1 to 2006:3 are used. In the TVC estimation of long-run money demand, regarding total coefficients, the average elasticity of income is 1.323 and statistically significant at 1%. The coefficient on the wealth-to-income ratio is positive at 0.137 and statistically different from zero. The TB-rate is statistically significant and estimated at -0.007. Regarding the bias free coefficients, the income elasticity is statistically significant at 1.236 and it leads to the rejection of the null hypothesis that the coefficient on income should be equal to unity. The wealth to income ratio and the TB rate are statistically significant at 0.09 and -0.009 respectively. In the VEC model, the coefficients on income, TB-rate and wealth-to-income ratio are 1.457, -0.015 and 0.311, respectively and are in correct sign. Wealth is stated as an important determinant of money demand and that stability may not be confirmed if it is excluded in a testable money demand equation. Through recursive estimates, CUSUM and CUSUMQ tests, stability of M3 money demand function is confirmed.

Humavindu (2007) employs the ARDL in a two equation technique involving the bounds testing procedure for cointegration and the ECM to present the short-run dynamics. Yearly data is used from 1965 to 2003. The real GDP is the scale variable and CPI and the TB rate is used as opportunity cost variables. A dummy is also incorporated to capture the impact of financial liberalisation in South Africa after 1989. Another dummy is also taken to capture possible shocks on the advent of a new political dispensation in South Africa, although it is subsequently dropped after not showing any statistical significance. The bounds testing procedure confirms cointegration between M3 and its determinants. That is also superseded

by the negative sign on the error correction term, as the speed of adjustment coefficient. The income elasticity of money demand is 1.11 and nearly confirms the unit elasticity hypothesis. The interest elasticities and inflation elasticities are -0.049 and -0.038 respectively. The dummy variable depicts an inverse relationship money demand and the impact of economic forms after 1989 and is statistically significant. The results of CUSUM and CUSUMQ tests do not indicate any structural instability in the model; hence stability of money demand is confirmed.

3.8 Empirical Evidence with Disaggregated Income Components in South Africa and beyond

This section endeavours to discuss empirical studies on money demand using disaggregated expenditure components in South Africa and beyond, since this is also the focus of this study. To what is known, only one study has been conducted with disaggregated expenditure components in South Africa (see Ziramba, 2007). Outside South African empirical landscape, are studies by Tang (2002, 2004, and 2007) on South-east Asian countries. Notably, expenditure components adopted are similar but different opportunity cost variables have been advocated in different money demand equations.

In an assessment from unrestricted error correction models, Ziramba (2007) examine empirically the long-run relationship of money demand and its determinants using annual data from 1970 to 2005. He uses disaggregated components of real income as scale variables, the domestic interest rate, yield on government bonds and the exchange rate. M1, M2 and M3 are tested using the bounds testing approach to cointegration analysis proposed by Pesaran, Shin & Smith (2001). Final consumption expenditure, expenditure on investment goods, expenditure on exports, a proxy of own rate of return, the exchange rate and the government bond yield rate as a proxy for a rate of return on alternative assets were used as regressors. The long-run estimates on each money stock are reported in the Table 3.3 below.

For the case of narrow money (M1), interest rate, exports and investment expenditure are found significant. In the short-run, only final consumption expenditure and the interest rate explain the demand for narrow money in South Africa. Investment expenditure and exports are found elastic while the interest rate is inelastic. For M2 and M3 all long-run coefficients for expenditure components are statistically significant, except exports. However, the bounds testing procedure confirms the existence of a long-run relationship between M1, M2 and M3 and their determinants. Structural stability is confirmed by the CUSUM and CUSUMQ tests for M1, M2 and M3.

Table 3.3: Long-run elasticities on disaggregated income components							
	FCE	EIG	EX	RE	R	BR	
M1	0.45	1.011	1.6	-0.05	0.11	-0.03	
M2	0.5	0.83	-0.007	-0.17	0.03	-0.01	
М3	-0.28	1.14	-0.13	0.39	0.02	-0.02	
Notes: FCE, EIG, EX, RE, R and BR represent final consumption expenditure, real expenditure on investment goods, real expenditure on exports, the exchange rate, short-term interest rate and the long-term interest rate.							

Source: Authors own extraction from Ziramba (2007)

Tang (2007) advocate the ARDL modelling approach as one of the most reputable and best because of its ability to incorporate stationary and non-stationary regressors. This technique is applied in the re-estimation of money demand functions for South East Asian countries by studying the long-run relationship among *M2* aggregate, various macroeconomic components of real income (real Gross Domestic Product, GDP), exchange rate, and opportunity cost of holding money (inflation rate). Five countries considered are Malaysia, Thailand, Singapore, the Philippines and Indonesia, based on annual data from 1960 to 2005. The results in Table 3.4 below reveal that real M2 aggregate, real expenditure components, exchange rate, and inflation rate are cointegrated for Malaysia, the Philippines and Singapore which is an indication of a stable M2 demand function in these countries.

However M2 is not cointegrated with its determinants in Thailand and Indonesia. The study shows the bias of using single real income variable as scale variable in estimating money demand function, in particular, M2 aggregate. This bias is mainly demonstrated by the differences in statistical significance of the real income components. The CUSUM and CUSUMSQ tests show that the estimated parameters are stable for five Southeast Asian economies except for Indonesia¢ short run money demand equation (Tang, 2007:492).

The inflation elasticity of money demand is negative in all countries although only statistically significant in the Philippines. The semi-elasticities on exports are positive in Malaysia, Singapore and the Philippines (but statistically significant in Malaysia and Philippines) and negative with statistically insignificant coefficients in Thailand and Indonesia. Final consumption expenditure is elastic, having the correct sign as dictated by theory and statistically significant in the Philippines, inelastic and statistically significant in Singapore. In all countries, the semi-elasticities on investment expenditure are statistically insignificant, with positive signs in Thailand and Indonesia and negative in sign in Malaysia and the Philippines. The influence of the exchange rate is questionable in explaining M2 money

demand since parameter estimates are not significantly different from zero in all South East Asian countries.

						Stability &			
						cointegration			
	FCE	EIG	EX	RE	Inf	status			
	0.48	-0.106	0.695**	-1.56	-0.0002	Stable with			
Malaysia	(0.376)	(0.969)	(0.036)	(0.355)	(0.988)	cointegration			
	0.789	0.016	-0.26	-0.859	-0.118	Stable and no			
Thailand	(0.536)	(0.953)	(0.79)	(0.604)	(0.201)	cointegration			
	0.77**		0.28	0.048	-0.005	Stable with			
Singapore	(0.04)		(0.214)	(0.829)	(0.563)	cointegration			
	1.355**	-0.018	0.445**	-0.014	-0.05**	Stable with			
Philippines	(0.02)	(0.903)	(0.042)	(0.297)	(0.018)	cointegration			
	5.389	0.382	-0.44	-0.007	-0.068	Instable and no			
<i>Indonesia</i> (0.508) (0.49) (0.823) (0.618) (0.671) cointegration									
Notes: FCE,	EIG, EX, F	RE and In	f represen	t final co	nsumption	expenditure, real			
expenditure o	n investmer	nt goods, r	eal expend	iture on ex	ports, the	exchange rate and			
the inflation	rate. In pa	renthesis	are p-value	es and ast	erisks *, *	** and *** depict			
statistical signi	ificance at 1	0% 5% and	d 1% rospor	tivolv					

Source: Authors' own extraction from Tang (2007)

Conclusion

This Chapter has presented empirical considerations that are guiding the scope of this study. Theoretical underpinnings behind the choice of variables in money demand analysis have been debated at length in section 3.2 after a brief overview of the link between money demand theories and empirical estimation issues in section 3.1. These are subsequently considered in the model specification and final selection of variables for estimation in Chapter 5.

Specification considerations have been presented, through the history of methodology and developments in the supremacy of econometric techniques from as early as the 1960s to the present day. The beginning of money demand modelling has been explained from the era of partial adjustment and adaptive expectations models (PAMs) before the introduction of Buffer Stock Models (BSMs). These techniques were developed before the discovery of cointegration analysis which brought the Error Correction Modelling (ECM) approach which

is a more superior methodology than its predecessors. Developments in this framework have been discussed to give the justification of applying the ARDL-ECM framework in this study. A few cases are cited to observe how the ARDL framework was applied since the 80s till today.

Section 3.7 presents a survey of a selected number of studies that evaluated money demand using the ECM approach from a randomly selected list of developing and developed countries. A meta-analysis is done with a sample size of 20 cases studies, whose models are including any interest rate and real income as determinants of money demand. Magnitudes and signs of coefficients are observed to check the extent to which they were theoretically consistent. Descriptive statistics of the interest rate elasticities and the income elasticities are presented (though in aggregate form). The respective distributions of elasticities in the sample are plotted and analysed. Generally the findings are that the interest rate takes a negative sign although is a few cases it is positive. The income elasticity of money demand is positive though not necessarily confirming the unit-elasticity hypothesis. This gives guidance to empirical work of this study in Chapter 5 and results will be compared against this meta-analysis.

Empirical literature review in South Africa has been covered in section 3.8 with aggregated income variables. A meta-analysis has been difficult to conduct on this because most of the studies conducted outside the framework of cointegration analysis have methodological deficiencies or have inconclusive results. As a result their findings are debated and the respective elasticities or semi-elasticities of parameter estimates are checked in terms of their magnitude or theoretical consistencies. Empirical evidence with disaggregated income components in South Africa and beyond has been presented also in 3.9. Semi-elasticities on expenditure components are presented in tables to check for coefficient signs and the extent to which they meet apriori expectations. Unfortunately, not much is found other than the case of South East Asian countries and only one case in South Africa. Observations are meant to guide empirical work in Chapter 5.

CHAPTER FOUR

Statistical Estimation Methodology

Introduction

This chapter discusses all the relevant statistical estimation concepts and techniques as well as the specification of the models to be employed in the estimation procedure of Chapter 5 and is divided into five sections.

Section 4.1 dwells on the concept of stationarity in various data generating processes and the behaviour of economic relationships in time series data. Different forms of stationarity are identified and explained; namely, weak stationarity, wide-sense stationarity and covariance stationarity or second-order stationarity.

Section 4.2 gives an exposition to various pre-testing strategies for unit roots as a mitigation measure against the problem of spurious regression such as the Dickey-Fuller tests, Augmented Dickey-Fuller tests and the Dickey Fuller-GLS tests. The visual inspection method, Correlograms and the Phillips-Peron test are discussed as alternative approaches to unit root testing. An evaluation of different approaches is given and lastly hypothesis testing in univariate statistics.

Section 4.3 discusses the concept of cointegration and its formal definition, the single equation tests for cointegration, residual-based tests for cointegration, the superconsistency advantages of cointegration analysis and error correction mechanisms. Section 4.4 presents the ARDL modelling approach and its advantages, mathematical relationships in ARDL models, error correction modelling in ARDL frameworks and the revival of this approach in cointegration analysis. Key model selection criteria applied to this study are indicated and their theoretical backgrounds are briefly discussed.

Section 4.5 gives a discussion on short-run and long-run relationships in ARDL-ECM mechanisms. The relationship between the error correction term and cointegration is formally defined. Section 4.6 presents various model diagnostic inspection techniques such as descriptive analysis of residuals, examination of residuals through formal tests and model stability analysis strategies such as the Chow test, recursive analysis, CUSUM and CUSUM-SQ.
4.1 Time Series Processes

A time series process generates data observable over time on a specific variable. Unlike cross-sectional data, time series observations are not independent of time. Current observations depend on past observations, thus displaying time trends over time (Wooldridge, 2013). Hence, prior to their analysis, univariate statistical properties underlying the data generating process, such as stationarity have to be explored to avoid spurious regression.

4.1.1 The Concept of Stationarity

A time series, whose statistical properties such as mean, variance, autocorrelation are all constant over time is said to be stationary. Most statistical methods are based on the assumption that the time series can be rendered approximately stationary through the use of mathematical transformations. A stationarized series is relatively easy to predict since its statistical properties will be the same in the future as they have been in the past. The predictions for the stationarized series can then be changed by reversing whatever mathematical transformations previously used, to obtain predictions for the original series. Thus, finding the sequence of transformations needed to stationarize a time series often provides important clues in the search for an appropriate forecasting model.

Notably, it is important to stationarize a time series in order to obtain meaningful sample statistics such as means, variances, and correlations with other variables. Such statistics give a useful description of future behaviour of the time series only if the series is stationary. For example, if the series are consistently increasing over time, the sample mean and variance will grow with the size of the sample, and they will always underestimate the mean and variance in future periods. If the mean and variance of a series are not well-defined, then its correlation with other variables is not defined as well. For this reason, one should be cautious about trying for extrapolate regression models fitted to non stationary data.

Since the contributions by Granger and Newbold (1974, 1986) Dickey and Fuller (1979), Nelson and Plosser (1982) it is known that estimation of time series equations may be subject to spurious regression results. Spurious results arise due to the existence of common trends (stochastic or deterministic) running through the data and not due to the strength of the regressorsq explanatory power reflecting the fundamental economic relationship between variables suggested by theory.

Cointegration analysis helps us discover if there is indeed a tendency for a linear relationship to hold between variables over long time periods. If no linear relationship exists between variables then they are regarded as not being cointegrated thus casting doubts on the usefulness of the underlying theory

4.1.2 Stationary and Non-Stationary Time Series

In addition to the question of whether the model should be estimated using a single equation approach (e.g. OLS) or a systems estimator, it is necessary also to consider the underlying properties of the processes that generate time series variables. Models containing non-stationary variables will often lead to the problem of spurious regression, whereby the results obtained suggest that there are statistical significant relationships between the variables in the regression model when in fact all that is obtained is evidence of contemporaneous correlations rather than meaningful causal relationship (Harris, 1995:14).

In a basic data generating process, suppose that a variable Y_t is generated by the following (first-order autoregressive) process.

$$y_t = \rho y_{t-1} + \mu_t \tag{4.1}$$

In the above relationship, current values of y_t , depend on their preceding value, y_{t-1} plus a white noise disturbance term, μ_t . The white noise error term satisfies all the classical conditions and hence is normally distributed with mean of 0 and an infinite variance. As such, a time series whose generating process is stochastic is strictly stationary if the joint distribution of any set of *n* observations y_{t1} , y_{t2} y_{tn} is the same as the joint distribution of $y_{(1+k)}$, $y_{(t2+k)}$ $y_{(n+k)}$ for all *n* and *k*.

The above definition of strict stationarity holds for all values of n. Substituting n = 1, we get $\mu_{(t)} = \mu$ a constant and $\sigma_{(t)}^{2} = \sigma^{2}$ a constant for all t. Furthermore if we substitute n= 2, we obtain the result that the joint distribution of X_{t1} and X_{t2} is the same as that of X_{t1+1} and X_{t1+2} . Writing $t_{1} + k = t_{2}$, we see that this is the same as that of X_{t1+k} and X_{t2+k} . Therefore, it just depends on the difference on $(t_{1} - t_{2})$, which is called the lag. The autocovariance function $\alpha(t_{1}t_{2})$ can be written as $\alpha(k)$ where $k = t_{2} - t_{1}$, the lag. Hence $\alpha(k) = cov(Y_{t}Y_{t(t+k)})$ is the autocovariance coefficient at lag k.

A time series can be said to be weakly stationary, wide-sense stationary, covariance stationary or second. order stationary if its mean is constant and its autocovariance function

depends only on the lag, that is $E[Y_{(t)}] = \mu$ and $\operatorname{cov}[Y_{(t)}, Y_{(t+k)}] = \alpha(k)$. However if $Y_{(t1)}, Y_{(t2)}, \dots, Y_{(m)}$ follow a multivariate normal distribution, the two concept of strict stationarity and weak stationary are equivalent (Maddala, 2001:516). Visually strict trend stationarity or weak trend stationarity can be observed when the dataqs graphical plot is observed. In a broader perspective, a stochastic process is said to be very stationary if its mean and variance are constant over time and the value of the covariance between two time periods depends on the distance or lag between the two time periods and not on the actual time at which the covariance is computed. Any time series data can be thought of as being generated by a stochastic, or random, process, and a concrete set of data can be regarded as a (particular) realization (i.e. a sample) of the underlying stochastic process.

In a stationary time series Y_t stationary is present if the following conditions are met

Mean
$$E(Y_t) = \mu$$
 4.2

Variance
$$E(Y_t - \mu)^2 = \sigma^2$$
 4.3

Covariance:
$$\alpha(k) = E[(Y_{t-u})(Y_{t+k-u})]$$
 4.4

The above data generating process has a history in the sense that every value of Y_t is connected to all its past values. In equation $Y_t = Y_{t-1} + \mu_t$, there is no parameter attached to Y_{t-1} , meaning that the parameter is 1. This gives evidence that it is emanating from a random walk process in which the series Y is said to have a unit root (non-stationary). The variance of μt is not constant. It becomes larger as time passes and in actual fact, it tends to infinity.

Taking the first difference of Y_t can make time series stationary: $\Delta Y_t = Y_t - Y_{t-1}$. This series will be stationary as it is equal to the classical disturbance term. Therefore, it has a mean of zero (mean stationary) and a constant variance (variance stationary) and covariance stationary as covariance between values of the series and those at other time periods $(\operatorname{cov} Y_t, Y_{t-1})$ is constant. Thus the first difference of a random-walk, process is stationary and is integrated of order 1, 1(1). If stationarity is attained after differencing the series *p* times, then the series is integrated of order *p*, 1(*p*).

4.2 Avoiding Spurious Regression

Spurious regression is misleading due to its ability to reflect false relationships between variables. Before any empirical estimation is conducted it is necessary to conduct pre-unit root tests to understand the underlying data generating process for application of suitable methodology. Various parametric and non-parametric pre-testing methods are discussed in this subsection before their pros and cons are highlighted.

4.2.1 Pre–Testing (Unit Roots and Other tests)

Pre-testing unit roots is essential before the models are estimated in order to best arrive at accurate specifications, estimations and evading the spurious regression problem. Tests for the stationarity of variables are known as unit root tests as they are involving the checking for statistically significant differences of the parameter on Y_{t-1} from 1 in equation $Y_t = Y_{t-1} + \mu_t$. Unit root tests are carried out on individual variables in isolation. At this stage any relationships between variables being tested are not taken into account and any other variables selected to be in the model. In this section the following are suggested unit root tests that will be used in this research.

4.2.2 Dickey-Fuller Tests (DF –Tests)

To discuss the Dickey-Fuller tests, consider the model: $Y_t = \beta_0 + \beta_1 X + \mu_t$, such that $\mu_t = \alpha \mu_{t-1} + \varepsilon_t$, where ε_t is a covariance stationary process with zero mean. The reduced form for this model is $Y_t = \gamma + \delta_t + \alpha y_{t-1} + \varepsilon_t$, where $\gamma = \beta_0(1-\alpha) + \beta_1\alpha$ and $\delta = \beta_1(1-\alpha)$. This equation is said to have a unit root if $\alpha = 1$ (in which case $\delta = 0$). The Dickey. Fuller Tests are based on testing the hypothesis $\alpha = 1$ in the above equation under the assumption that ε_t are white noise errors. There are three test statistics:

$$k(1) = T(\alpha^{-1}), \ t(1) = \frac{\alpha^{-1}}{SE(\alpha^{-})}, \ \mathsf{F}(0,1).$$
 4.5

Where α^{\uparrow} is the OLS estimate of a α from equation $Y_t = \gamma + \delta_t + \alpha y_{t-1} + \varepsilon_t$, $SE(\alpha^{\uparrow})$ is the standard error of α^{\uparrow} , and F (0,1) is the usual F-statistics for testing the joint hypothesis if $\delta = 0$ and $\alpha = 1$ in this equation. These statistics do not have the standard normal, student-t, and F distributions. The critical value for K (1) and t (1) are tabulated for $\delta = 0$ in Fuller

(1976) and the critical value for the F (0, 1) statistics are tabulated in Dickey and Fuller (1981).

4.2.3 Augmented Dickey- Fuller Tests (ADF)

Dickey and Fuller (1981), Said and Dickey (1984), Phillips (1987), Phillips and Perron (1988) and others developed modifications of the DF tests when ε_t is not white noise. If a simple autoregressive, AR (1) model is used when in fact Y_t follows an AR(p) process, then the error term will be autocorrelated to compensate for the misspecification of the dynamic structure of Y_t . Autocorrelated errors will invalidate the use of DF distributions which are based on the assumption that μ_t is **%** hite-noise+. Thus, assuming that Y_t follows a *pth* order autoregressive process:

$$Y_{t} = \lambda_{1}Y_{t-1} + \lambda_{2}Y_{t-2} + \dots + \lambda_{n}Y_{t-p} + \mu_{t}$$
4.7

Or

$$\Delta Y_{t} = \lambda_{0}^{*} Y_{t-1} + \lambda_{1}^{*} \Delta Y_{t-1} + \lambda_{2}^{*} \Delta Y_{t-2} + \dots \lambda_{p-1}^{*} \Delta Y_{t-p+1} + \mu_{t}$$

$$4.8$$

given that, $\mu_t \approx IID(0, \sigma^2)$

Where $\lambda^* = (\lambda_1 + \lambda_2 + \dots + \lambda_p) - 1$. If $\lambda^* = 0$ against the alternative that $\lambda^* < 0$, then Y_t contains a unit root. To test the null hypothesis, we again calculate the DF t-statistics $[\lambda^{**} / Se(\lambda^{**})]$, which can be compared against the critical values. This however, is only valid in large samples, since in small samples percentage points of the augmented Dickey-Fuller Distribution (ADF) are generally not the same as those applicable under strong assumptions of the simple Dickey-Fuller model (Banerjee, Dolado, Galbraith & Hendry, 1993:106).

Thus, the ADF test is comparable to the simple DF test but it involves adding an unknown number of lagged first differences of the dependent variable to capture autocorrelated omitted variables that would otherwise, by default, enter the error term, μ_t (Harris, 1995:34). In this way, unit root tests can be applied if the data generating process is quite general. However it is important to choose the appropriate lag-length since too few lags may result in over-rejecting the null when it is true, while too many lags may reduce the power of the test.

4.2.4 THE Dickey Fuller-GLS TEST

4.2.5 Complementary (Informal) Unit Root Testing

There are other alternative approaches to unit root testing in time series. These are as follows:

a) Visual Inspection

This is a non- parametric approach involving observing the tabulated date series without further inference on it. By simply looking at the flow of the series, a reasonable indication as to whether a variable is stationary or not can be observed. This is much easier with graphical plots of the series.

b) Correlograms

This is a more visual inspection method and is derived from ancient time series analysis. It involves plotting the autocorrelation coefficients over time. The autocorrelation coefficient (Pk) is calculated computing the covariance between a variable and its *kth* lagged value and dividing this value by the variance of the series. This will be between 0 and 1. This diagram is to be inspected in terms of how rapidly the autocorrelation function declines as we increase the lag length. If the series rapidly declines without subsequent % piking+, then the series is deemed stationary. If there are regular spikes this may suggest seasonality. A correlogram of the differenced series can also be inspected to get further information on it. If the first differenced series has an autocorrelation function which damps rapidly then it would

seem to be stationary. If there are regular spikes, then a difference equal to the spike order for this process must be chosen (Cameron 2005:371).

4.2.6 The Phillips–Perron Test (PP test)

Phillips (1987), Perron (1989) and Phillips and Perron (1988) argued that the ADF tests were inadequate for unit root testing in time series. They suggested nonparametric alternatives to the ADF test. These tests are the Z_{α} and Z_t tests (also known as the PP tests). The non-parametric procedure in unit root testing was postulated in order to take account of the serial correlation in the model. Hence, these are nothing but modified DF type statistics. Their greatest advantage is that the Z-statistics eliminate asymptotically the nuisance parameters that are present in the DF-statistics when the errors are not independently and identically distributed (IID). However, the main drawback in computing these Z-statistics is that the researcher has to decide *a priori* the number of residual autocovariances which are to be used in implementing the corrections suggested by Phillips and Perron (Muscatelli and Hurn 1995:175)

4.2.7 Power and Level of Unit Root Tests

Choosing the correct form of the ADF model is problematic and using different lag lengths often results in different outcomes with respect to rejecting the null hypothesis of non-stationarity. These problems are compounded by the fact that there are several issues related to the size and power of unit root tests, especially concerning the small sample properties of these tests (Harris, 1995:39)

Schwert (1989) first presented evidence to point out size distortion problems of the commonly used unit root tests: the ADF and PP tests. Dejong, Nankervis, Savin and Whiteman (1992) argued about low power of unit root tests. They cited that the PP tests have very low power (generally less than 0,10) against trend alternatives. The ADF has power between 0,30 and 0,35 and thus, becomes more useful in practice although it is equally weak. In their analysis Dejong et al.,(1992) recommended the DF-GLS test as more superior to ADF and PP tests.

4.2.8 Hypothesis Testing in Unit Root Tests

The null hypothesis considered in the unit root test is H_0 : Y_t is difference stationary and H_1 : Y_t (trend) stationary, that is H_0 : Y_t is stationary and H_1 : Y_t is nonstationary. In classical theory of hypothesis testing, the null hypothesis and the alternative are not on the same

footing. The null hypothesis is on a pedestal and is rejected only when there is overwhelming evidence against it. That is why the 5% and 1% levels of significance are commonly used together with the 10% level is some instances.

However, if on the other hand, the null and alternative were to be H_0 : Y_t is stationary and H_1 : Y_t is nonstationary the conclusion would be quite different (Maddala, 2001: 552). In the Bayesian approach, H_0 and H_1 , are on the same footing and hence this asymmetry does not rise (Dejong and Whiteman, 1991:334). Tests for unit roots with the null hypothesis being stationary (no unit root) have also been developed and they often give results contrary to those of the unit tests with the unit root as a null.

Other tests with stationarity as the null hypothesis are the KPSS tests of Kwiatowski, Phillips, Schmidt and Shin (1992) and the Leybourne-McCabe (1994) tests. However, these are analogous to the Phillips . Perron tests and the ADF test respectively. Hence, this study shall make use of the PP and the ADF tests among others.

4.2.9 Confirmatory Analysis

Results of the usual unit root tests can be confirmed using tests with stationarity as null hypothesis. These tests can be in the form as given in the table below:

Test 1 (Usual test)	Test 2
Ho: Y_t non-stationarity (unit root)	Ho: Y_t stationary
H1: Y_t stationary	H1: Y_t non-stationary (unit root)

Table 4.1 Confirmatory unit root testing with stationarity as null

If test 1 and Test 2 are conducted in either order and both reject their null hypothesis, then the presence of unit roots cannot be confirmed. Burke (1994) conducted a study to determine the usefulness of confirmatory data analysis using the ADF unit root test and the KPSS stationarity test. In his conclusion, he deduced that the 5% level of significance gives better results than the 10% significance level. Joint non-rejections are far more common than joint rejections. However false confirmations are equally likely. If the true model is trend stationary, chances are between 50-60% that confirmatory results are congruent with other

Source: Maddala and Kim (1998)

pre-test results and half of these are correct, when the true model is difference stationary, the proportion of confirmation is 60-65% of which about 82% are correct (Maddala, 2001:553). Overall, many scholars are of the notion that unit root tests are of some substance than using confirmatory analysis due to its defectiveness.

4.3 The Concept of Cointegration

A priori theory of econometrics explains that non-stationary in time series is a short run phenomenon; hence non-stationary series are in disequilibria in the short run and show no inter-relationships. However, in the long-run, there is need to integrate short-run dynamics with long-run equilibrium. Cointegration implies that if two (or more) series are linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends, they will nevertheless more closely together over time and their differences ultimately stabilize.

The literature on cointegration is vast and quite technical, and therefore discussion of this concept in this research is heuristic. A commonly cited example of cointegration by Murray (1994) is the drunkard and her dog, leaving the bar, the drunkard meanders higgledy-piggledy. Her dog wonders about in his merry ways. However, the dog still guides his owner and the drunkard is quite cogniscent of the security provided by the dog. In this regard, the behaviour of variables in this bivariate case is said to be cointegrated. Smith and Harrison (1995) extended the illustration by Murray (1994) to depict multiple cointegration by adding the boyfriend as a third variable and how error correction is manifested to demonstrate the possibility of having more than one cointegrating vector among variables.

The method of cointegration in econometric research solves the challenges encountered in spurious regression. In other words, the establishment of a cointegrating relationship between two or more time series variables enables researchers to find sense in regressing non-stationary variables. In actual fact, the discovery of a cointegrating relationship among time series variables implies the existence of a standing, long-run relationship which is thus presumed, prior to empirical testing. In essence, researchers may simply examine the integration orders of their respective variables before conducting any regressions and make use of cointegration methodology to come up with economically meaningful results. At this point, the problem of spurious regression is not a serious wary anymore.

The process of differencing for the purpose of achieving stationarity results in loss of longrun information which is contained in the levels but not in the differences of the variables (Hendry, 1986:20). The method of cointegration, developed in a series of papers by Granger (1981, 1986), Granger and Weiss (1983) and Engle and Granger (1987), conveniently gives a solution to this challenge. Granger (1981:128-130) developed the concept of cointegration, which reconciled non-stationary processes with the notion of long-run equilibrium. In his discovery, regressing non-stationary variables integrated of the same order (d), in their level form, did not produce spurious results. This was justified by the presence of common trends between those variables and that such trends are ultimately cancelled out during the regression process. Hence, such convergence reveals equilibrium or a long-run relationship between endogenous variables against their independent (exogenous) variables.

However, other research findings have demonstrated the possibility of getting unbalanced cointegration regressions, which involve regression variables with different orders or integrations on both sides of the equation, which must meet specific criteria for them to be valid. According to Maddala and Kim (1998:251), and Charemza and Deadman (1992:148) the endogenous variable should be of a lower order than all exogenous variables. Contrary to the above, Banerjee et al., (1993:166) reports Monte Carlo studies on unbalanced regressions involving I (1) and I (0) as well as I (1) and I (2) variables and concludes that % a regression may be unbalanced may not be a matter of concern+and that they are % alid tools of inference as long as the correct critical values are used+. Maddala and Kim (1998:252) on the other hand suggest that this view by Banerjee et.al is quite % ptimistic+. It shall therefore be emphasized at this point that the scope of this research study shall be limited to I (1) macroeconomic variables from which cointegrating relationships are then to be investigated.

According to Harris (1995:22), the economic interpretation of cointegration is that if two (or more) series are linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends, they will nevertheless move closely together over time and the difference between them will be stable. Thus the concept of cointegration mimics the existence of a long-run equilibrium to which an economic system converges over time and the error term accounts for the disequilibrium. Therefore, the disequilibrium error term explains the extent to which the system itself is deviating from its equilibrium position at time *t*. Engle and Granger (1987:251-252) regard this equilibrium as a stationary point characterized by forces that tend to push the economy back towards equilibrium whenever it moves away.

4.3.1 Cointegration Formally Defined

The formal definition of cointegration for two or more variables developed by Engle and Granger (1987:253) is outlined by Cuthbertson, Hall and Taylor (1995:132) as follows. The

cointegration of two or more variables, as given by Engle and Granger (1987) in Cuthbertson et.al (1995:132), may be defined through the vector X_t and that they are said to be cointegrated of the order *d*,*b* where $d \ge b \ge 0$ [denoted $X_t \approx CI(d,b)$] if:

- i) all components of X_t are I(d), and
- ii) there exists a vector, α' (not equal to zero) such that $Z_t = \alpha' X_t \approx I(d-b), b > 0$.

The components of vector X_t are assumed to be a *k* time series $(X_{1t}, X_{2t}, \dots, X_{kt})$. In this vector, time series variables are cointegrated of the order (d, b), where $d \ge b \ge 0$. Given that the time series are integrated of order *d*, a linear combination of these *k* time series exists, say $a_1X_{1t} + a_2X_{2t} + \dots + a_kX_{kt}$ which is integrated of the order (d, b). Hence, mathematically, this can be expressed as follows.

$$X_{1t} \approx I(d), X_{2t} \approx I(d), X_{kt} \approx I(d)$$
 then $X_{1t}, X_{2t}, \dots, X_{kt} \approx CI(d,b)$

If $a_1X_{1t} + a_2X_{2t} + \dots + a_kX_{kt} \approx (d-b)$ then the vector $\alpha' = [a_1, a_2, \dots, a_k]$ is the cointegrating vector i.e., it contains the coefficients that constitute the linear combination of the *k* time series.

Therefore if a set of I (d) variables yields a linear combination that has a lower order of integration (d-b<d, for b>0), then the vector α' is termed the cointegrating vector. This implies that two variables with different orders of integration cannot be cointegrated. This is plausible since two series with different orders of integration possess different means, trends, structural and seasonal breaks thus the errors between them, i.e. $(Y_t - \alpha' X_t)$ are expected to become infinitely large with lapsing of time.

However it is possible to have a mixture of different orders of integration in time series when there are three or more series under investigation. Under these circumstances, a subset of the higher order series must cointegrate to the order of the lower-order series. Let a take an example, where $Y_t \approx I(1), X \approx I(2)$ and $W \approx I(2)$. If X_t and W_t cointegrate then $V_t = \lambda_0 X_t + \lambda_1 W_t \approx I(1)$. At this point, V_t is a good candidate to cointegrate with the remaining I (1) series Y_t . If they happen to cointegrate then $Z_t = eV_t + fY_t$ will be I (0). This process may be summarized as: 1) $X_t, W_t \approx CI(2,1)$, 2) $V_t, Y_t \approx (1,1)$ and thus 3) $Z_t \approx I(0)$ (Cuthbertson et al., 1955:133), Charemza and Deadman (1992:147-148).

4.3.2 The Single-Equation Test for Cointegration

The Cointegrating Regression Durbin-Watson (CRDW), the Engle-Granger (EG), Augmented Engle-Granger (AEG) and the bounds of Pesaran and Shin (1999) are widely used tests for single equation cointegration. The CRDW test was proposed by Bhargava and Sargan (1983). In this test, the cointegrating regression**s** Durbin-Watson *d* statistics, is employed, where the null-hypothesis of no cointegration is $H_0: d = 0$. For cointegration to occur the *d* statistic should be closer to 2, implying an absence of autocorrelated residuals. However if d = 0, the error terms are autocorrelated and hence no cointegration between the time series observations exists. The CRDW test is useful when disturbances follow a first order autoregressive (AR (1)) process, but its critical values are different for higher order schemes. Although considered the most powerful invariant test, there are limitations to this test in that it depends on strong assumptions about the data generating process. Hence the Engle-Granger tests and the augmented Engle-Granger (AEG) tests whose critical values hardly change are preferred.

Once the order of integration of the relevant time series variables has been established, the hypothesized equilibrium relation involving variables sharing the same order of integration (or permissible mixed integration combination) is then estimated via OLS and the estimated residuals (i.e. $z_t = Y_t - \hat{\beta}_1 - \hat{\beta}_2 X$) are retained for purposes of completing the Engle Granger and Augmented-Engle Granger cointegration tests (Engle and Granger (1987:267-269); Thomas (1993:163-166)). Essentially, the Engle-Granger and Augmented Engle-Granger tests (which are similar to the DF and ADF tests) entail performing stationarity test on the residuals (e_t). The null hypothesis for these tests is: $H_0: \lambda = 0$ implying absence of cointegration as opposed to the alternative hypothesis of cointegration, i.e. $H_1: \lambda < 0$. The following regression are used to conduct cointegration tests: Engle Granger Regression: $\Delta \varepsilon_t = \lambda \varepsilon_{t-1} + v_t$, Augmented-Engle Granger regression: $\Delta \varepsilon_t = \lambda \varepsilon_{t-1} + \sum_{i=1}^{p-1} \lambda i \Delta \varepsilon_{t-i} + w_t$ where Δ represents the first difference operator, ε_r is the residual from the cointegrating regression. v_t and w_t represents the random error terms. Augmented Engle Granger tests accommodate for autocorrelation hence higher lag order of the first differenced residuals is used. Notably, no intercept and trend variables are included. These hypotheses are tested by comparing the t-statistic on the regression coefficient λ , to a special set of critical values - which depend on *m* number of explanatory variables in the cointegrating regressioncomputed by Engle and Granger (1987:269).

4.3.3 Residual-Based Test for Cointegration

regression $y_t = \beta' X_t + \mu_t$, t=1,õ ...,T, Let consider us the multiple where $X_t = (x_{1t}, x_{2t}, \dots, x_{kt})'$ is the k-dimensional *l(1)* regressors. It is noticeable that for y_t and X_t to be cointegrated, μ must be stationary, that is I(0). If this condition is not observed, the regression is otherwise spurious. Therefore, it is imperative to test whether the error term, μ_{e} , is I(0) or I(1). The Engle and Granger cointegration test is carried out in two steps. The individual variables should be pretested for unit roots. The concept of cointegration entails that all involved variables should be I(1). Firstly, the equation $y_t = \beta' X_t + \mu_t$ should be run through OLS regression to obtain the residuals by $\hat{\mu}_t = y_t - \hat{\beta}' X_t, t = 1, ..., T$, where $\hat{\beta}$ are the OLS of β .Secondly, the unit root test should be conducted to $\stackrel{^{\wedge}}{\mu_t}$ by constructing an AR(1) for the error term $\hat{\mu}_t$ given by $\hat{\mu}_t = \psi \hat{\mu}_{t-1} + \varepsilon_t$ on the null-hypotheses that, $H_0: \psi = 1$ against the alternative that $H_1: \psi < 1$. Since $\hat{\mu}_t$ is a zero-mean residual process, there is no need to include an intercept term here

In essence, this is the residual-based Engle-Granger-Dickey Fuller cointegration test. This ought to be carefully treated as a test for no cointegration due to the implication of the null of the unit root in the error term that **y** and **X** are not cointegrated. The rejection of the null hypotheses leads to the conclusion that there is no cointegration and the opposite is true. The asymptotic distribution of the t-statistic for $\psi = 1$ in the regression equation of the error term is also non-standard, but fundamentally different from that of the univariate Dickey-Fuller test. The key difference emanates from the fact that one needs to allow estimation of uncertainty through $\hat{\beta}$ in the first place. The resulting test distribution ultimately depends on the dimension of the regressors, **k**.

There are three specifications with different deterministic components, as is the case with other univariate unit root tests. These are;

$$y_t = \beta' X_t + v_t \tag{4.9}$$

$$y_t = a_0 + \beta' X_t + v_t$$
 4.10

$$y_t = a_0 + a_1 t + \beta' X_t + v_t$$
4.11

where a_0 is an intercept and a_1 is a linear trend coefficient. The three sets of critical values of the Engle-Granger-Dickey Fuller tests have been provided by Engle and Yoo (1987) and Phillips and Ouliaris (1990) for different values of *k*. Since the serial correlation is a problem often in practice, it is common to use an augmented version of the Engle Granger-Dickey

Fuller test that is extended on equation $\hat{\mu}_t = \psi \hat{\mu}_{t-1} + \varepsilon_t$ to give $\Delta \hat{\mu}_t = \phi \hat{\mu}_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta \hat{\mu}_{t-1} + \varepsilon_t$.

It should always be noted that all the problems that afflict the unit root tests also afflict the residual-based cointegration tests. In particular, the asymptotic critical values may be seriously misleading in small samples and that the distribution of the test statistics will, in general be slightly different in any particular application. Hence, the critical values given by Engle and Granger can be taken as a rough guide. The method has no systematic procedure for the separate estimation of the multiple cointegrating vectors. An error made in the first step in the Engle-Granger two step procedure is carried on to the second step. Unfortunately, these cointegration tests are often severely lacking power especially because of the imprecision or uncertainty of estimating β . Hence, failure to reject the null of no-cointegration is common in practice, which may provide only weak evidence that two or more variables are not cointegrated.

Despite the aforementioned drawbacks, the Engle-Granger approach is relatively simple. Where there is a unique cointegrating vector, it allows the use of the superconsistency property of OLS to obtain consistent estimates of the cointegrating vector. It gives adequate information about the speed of adjustment to equilibrium.

4.3.4 Asymptotically Efficient Single- Equation Methods

The argument that the simple two-step estimator of Engle and Granger is not asymptotically efficient is a key drawback levelled against it in the literature of cointegration analysis. However, there are several asymptotically efficient single equation methods that have been proposed. For instance, Phillips (1991b) suggests a regression in the spectral domain, Phillips and Loretan (1991) suggest a non-linear error-correction estimation, Phillips and Hansen (1990) suggest an instrumental regression with a correction, Saikkonen (1991) suggests a simple trick of including leads as well as lags in the lag-polynomials of the error correction model in order to achieve asymptotic efficiency. Saikkonen (1992) suggests a

simple GLS type estimator, whereas Parko (1991) CCR estimator transforms the data so that OLS afterwards gives asymptotically efficient estimators. Engle and Yoo (1991) suggest a three-step estimator starting from the static Engle-Granger estimation. From all these estimators, it is possible to obtain simple t-values for the short-term adjustment parameters. According to Sorensen (2005), what is estimated in these frameworks may not be obvious if the system contains more than one cointegrating relation. Therefore, the Johansen maximum likelihood estimator is advocated in cases of higher dimensional systems due to high possibilities of having more than one cointegrating vector *a priori*.

4.3.5 The Johansen Methodology

There is a possibility that if there are more than two variables in a model and that a long-run relationship stands among them, then there are cointegrated through more than one cointegrating vectors. Variables in the model might form several equilibrium cointegrating relationships governing their joint evolution. Asteriou and Hall (2007) argue that if there is more than one cointegrating vector and assuming that only one cointegrating relationship exists, where there are actually more than one, is a very serious problem that cannot be resolved by the Engle-Granger single-equation approach. Hence a systems approach to cointegration, such as Johansen (1988) and improved by Johansen and Juselius (1990,1992 and 1994) becomes more relevant than single equation strategies.

Unlike the Engle-Granger statistic procedure, the Johansen Vector Autoregressive (VAR) procedure allows the simultaneous evaluation of multiple relationships and imposes no prior restrictions on the cointegration space. The Johansen cointegration approach tests for the cointegration rank for a VAR process, estimate the lambda trace and lambda maximal statistics, eigen values, and the eigenvectors. Both the Trace test and the maximal eigenvalue test are used to determine the number of cointegrating vectors present, although they donq always indicate the same number of cointegrating vectors. The long-run equilibrium coefficients are also computed. Thus, the approach consists of full information maximum likelihood estimation (FIML) of a system characterised by *r* cointegrating vectors (Babatunde and Adefabi, 2005:10).

Using the Johansen Maximum Likelihood (JML) procedure, it is possible to obtain more than a single cointegrating relationship. A dilemma is faced if there is evidence of more than one cointegrating relationship, as to which one should be used. There are two separate tests for cointegration, which can give different results. Since this multivariate approach is based on the maximum likelihood based test, unlike the Engle-Granger OLS based test, it requires large samples. Hargreaves (1994) compares the Johansen¢ approach to five other methods of estimating long-run relationships and concludes that the Johansen¢ method is the best if the sample size is fairly large with at least 100 observations or more, assuming that the model is well specified and the residuals are not highly correlated.

The Johansen methodology assumes that variables are endogenous, although it is possible to incorporate exogenous variables in the system. Tests are relying more on the relationship between the rank of a matrix and its eigenvalues or characteristic roots. The Vector Error Correction Model (VECM) is the basic VAR, with an error correction term incorporated into the model and as with bivariate cointegration; multivariate cointegration implies an appropriate VECM can be formed. The rationale behind the error correction term is essentially the same as with the standard error correction model, in its ability to measure divergence from long-run equilibrium.

Studies comparing Johansen¢ methodology to other approaches in cointegration analysis have generally concluded favourably for the Johansen, although that is not regarded as a universal consideration. Gonzalo (1994) advocates that the JML performs better when the errors are not normally distributed, or when the dynamics of the vector error correction model are unknown and additional lags are included in the VECM. However, criticisms around the Johansen methodology are that it is a large sample test and its results can be sensitive to the number of lags included in the tests and the presence of autocorrelation. If the two test statistics are giving contradicting evidence, which one is regarded as better? If there are more than two cointegrating vectors present, how do we find the most appropriate vector for the subsequent tests? The Wickens critique suggests we often find evidence of cointegration when none exists.

4.3.6 The Bounds Testing Approach to Cointegration Analysis

Before the year 2000, cointegration analysis was driven by either the two- step residualbased procedure for testing the null of cointegration (see Engle and Granger (1987) and Phillips and Ouliaris (1990)) or the systems-based approach developed by Johansen (1991,1995). Other approaches such as the variable addition approach of Park(1990), the residual-based procedure by Shin (1994) and the stochastic common trends (system) approach of Stock and Watson (1988) have been used, although less extensively. This spectrum of analysis is centred on the notion that the underlying variables are integrated of order one. According to Pesaran et al., (2001), these approaches have exacerbated the degree of uncertainty into the analysis of level relationships due to the need for pre-testing. Feridun (2010) argues that in the case where the presence of structural breaks introduces uncertainty as to the true order of integration of the variables, the bounds testing procedure introduced by Pesaran (1997), Pesaran and Shin (1999) and Pesaran et.al (2001) should be preferred.

The bounds testing approach to cointegration analysis is developed by Pesaran et al.,(2001) to test the existence of a level relationship between the endogenous variable and its explanatory variables, when it is known that regressors are trend stationary or difference stationary. Hence, this approach is applicable whether the underlying regressors are I(1), purely I(0, fractionally integrated or mutually cointegrated. The statistic underlying the bounds testing procedure is the familiar Wald or F-statistic in a generalised Dickey-Fuller type of regression used to test the significance of lagged levels of the variables under consideration in a conditional unrestricted equilibrium correction model (ECM). It is given in this procedure that the asymptotic distributions of both statistics are non-standard under the null hypothesis that there exists no relationship in levels between the included variables, irrespective of whether the regressors are I(1) , purely I(0) or mutually cointegrated They established that the proposed test is consistent and drive its asymptotic distribution under the null and suitably defined local alternatives, again for a set of regressors which are a mixture of I(0) and I(1) variables (Pesaran et al., 2001:1).

In this framework of analysis, two sets of critical values are provided for the two polar cases (see Pesaran and Pesaran, 1997:478-479). Since these two sets of critical values provide critical value bounds for all classifications of the regressors into purely I(0) or I(1), the bounds testing procedure is proposed. If the computed F-statistic is below the lower critical bound, the null of no cointegration cannot be rejected. If it falls above the upper limit, evidence to reject the null of no cointegration is found, thus confirming the presence of a long-run relationship between the dependent variable and its regressors. However if the computed F-statistic falls within the bounds, inference is inconclusive and integration properties of the variables may be checked before further inference is made.

As demonstrated by Pesaran and Shin (1999), the small sample properties of the bounds testing approach are superior to that of the traditional Johansen cointegration approach, which typically requires a large sample size for the results to be valid. According to Feridun (2010), the ARDL(Bounds testing approach) is likely to have better statistical properties than the traditional cointegration techniques because of its ability to draw on the unrestricted error correction model (see section 4.4.0 for a more mathematical exposition of this phenomena). In particular, Pesaran and Shin (1999) show that the ARDL approach has better properties in small sample sizes up to 150 observations. However, Narayan and Smith (2005) have provided exact critical values for up to 80 observations. The bounds testing approach is a

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more superior test for cointegration analysis if structural breaks are present in the time series data (Feridun, 2010:18)

4.3.7 The Principle of Superconsistency

According to the % uperconsistency+property of OLS, if *Yt* and *Xt* are both non-stationary; integrated of order one variables, and ε_t is integrated of order zero (i.e. stationary), then as sample size, T, becomes larger the OLS estimator of β converges to its true value at a much faster rate than the usual OLS estimator with stationary, integrated of order zero, variables (Stock 1987:1041). In this case I(1) variables asymptotically dominate the I(0) variables, Δx_t , Δy_t and ε_t . Omitted dynamic terms (and any bias due to endogeneity) are captured in the residual, ε_t , which will consequently be serially correlated. If there is a simultaneity problem, then $E(X_t \mu_t) \neq 0$ is also true. However, this problem cannot be attributed to the notion of superconsistency.

From an intuitive perspective, letts recall that OLS minimizes the sum of squared residuals $(\sum \varepsilon_t^2)$. If X and Y enjoy the same order of integration say I(1) then a linear combination of the two will also be I(1), except for the long run relationship which is I(0) and a selection of values for $\hat{\beta}_1$ and $\hat{\beta}_2$ via OLS that differ from the true β_1 and β_2 will result in the error terms displaying non-stationarity thus exhibiting trends. Thus, as the sample size increases, $\sum \varepsilon_t^2$ increases rapidly. However if OLS selects the correct values for β_1 and β_2 , then the error term will be stationary and $\sum \varepsilon_t^2$ will not increase so quickly. Since OLS searches for the minimum $\sum \varepsilon_t^2$ it is able to choose the correct estimates for β_1 and β_2 conditional upon the sample size being large enough. Banerjee, Dolado, Hendry and Smith., (1986:255-257) confirmed this large sample property.

4.3.8 Cointegration and Error Correction

So far the drawback of the cointegration regression that has been examined so far is that only the long run properties of a model are considered and the short-run dynamics of models are not dealt with. These long-run relationships measure any relation between the level of the variables under consideration while short run dynamics give a measure of the dynamic adjustments between the first-differences of the variables. A principal feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium. After all, if the system is to return to long-run equilibrium, the movements of at least some of the variables must respond to the magnitude of the disequilibrium (Enders, 2010:365). However, a good time series model should account for both the short-run dynamics and long run equilibrium simultaneously. The error correction model closes this gap in cointegration analysis.

The error correction model (ECM) has a long tradition in time series econometrics. In a simple model, with an endogenous variable **y** and a single explanatory variable **x**, the error correction term can be established as $\varepsilon_t = y_t - \beta x_t$ where β is a cointegrating coefficient. As such, ε_t is the error that is present from regressing y_t on x_t . Hence, an ECM can be defined from the above bivariate relationship as $\Delta y_t = \alpha \varepsilon_{t-1} + \phi \Delta x_t + \mu_t$, where μ_t is identically and independently distributed with a mean of zero and infinite variance i.e. $\mu_t \approx IID(0, \sigma^2)$.

The ECM equation, $\Delta y_t = \alpha \varepsilon_{t-1} + \phi \Delta x_t + \mu_t$, is stating that Δy_t can be explained by the lagged ε_{t-1} and Δx_t . It equally implies that ε_{t-1} , the lagged error term, is an equilibrium or disequilibrium term that would have occurred in the previous period. If the value of the error term is equal to zero then the model is presumed to be in equilibrium and the opposite is true. Let us assume that $\Delta x_t = 0$ and that $\varepsilon_{t-1} > 0$, implying that y_{t-1} is above its equilibrium value. Hence, for equilibrium to be restored Δy_t must be negative. The intuitive implication is that the error correction coefficient α must be negative such that $\Delta y_t = \alpha \varepsilon_{t-1} + \phi \Delta x_t + \mu_t$ has dynamic stability. Alternatively, disequilibrium due to the excess of y_{t-1} above its equilibrium, forces y_{t-1} to fall in the successive periods and the equilibrium error will be corrected in the model, hence the term error correction model.

Notably, β is called the long-run parameter, while α and ϕ are short-run parameters. Therefore, the ECM has in built long-run and short-run properties. The long-run property is embedded in the error correction term ε_{t-1} and the short run behaviour is partially captured by the error correction coefficient, α . Of utmost significance is that all the variables in the ECM are stationary and that makes it free from the spurious regression problem. Generally, the error correction term is unknown *apriori* and it should be estimated through the EngleGranger two-step procedure. Firstly, one has to run a regression of **y** on **x** and save the residuals, $\hat{\varepsilon}_t = y_t - \hat{\beta} x_t$ before running an ECM regression of Δy on $\hat{\varepsilon}_t$ and Δx through equation $\Delta y_t = \alpha \hat{\varepsilon}_t + \phi \Delta x_t + \mu_t$.

As given by Cottrell (2004), the mathematical derivation of the ECM can be done by beginning with a bivariate relationship where $Y_t = KX_t$. This relationship can be re-written in logarithmic form as $y_t = k + x_t$ following the convention of letting a lower-case letter designate the natural log of the variable represented by the corresponding upper case letter. Taking logs reduces the burdensome multiplicative relationship to an additive one, which is a helpful mathematical simplification Thus a dynamic relationship between y and x can be expressed as:

$$y_{t} = \beta_{0} + \beta_{1}x_{t} + \beta_{2}x_{t-1} + \alpha_{1}y_{t-1} + \mu_{t}$$

$$4.12$$

The inclusion of the lagged values of both x and y in the above specification enables the realization of a wide variety of dynamic patterns in the data. To assess the extent to which the conditions under which the generic dynamic equation are consistent with the long-run equilibrium relationship, the factors that could cause divergence should be \pm eroed outq Precisely, these are factors which cause divergence from equilibrium such as changes in x_t and stochastic fluctuations, μ_t . Hence, it is necessary to set $y_t = y^*$ and $x_t = x^*$ for all t, and set $\mu_t = 0$. By so doing, we obtain

$$y^{*} = \beta_{0} + \beta_{1}x^{*} + \beta_{2}x^{*} + \alpha_{1}y^{*}$$

$$\Rightarrow (1-\alpha)y^{*} = \beta_{0} + (\beta_{1} + \beta_{2})x^{*}$$

$$\Rightarrow y^{*} = \frac{\beta_{0}}{1-\alpha_{1}} + \frac{\beta_{1} + \beta_{2}}{1-\alpha_{1}}x^{*}$$
4.13

If the above corresponds to the equation, $y_t = k + x_t$ then it should follow that $k = \frac{\beta_0}{1 - \alpha_1}$ and

 $\frac{\beta_1 + \beta_2}{1 - \alpha_1} = 1$. The second implication in this relationship is that $\beta_1 + \beta_2 = 1 - \alpha_1$. Let π denote

the common value of these two terms. Then β_2 can be expressed as $\pi - \beta_1$ and α_1 can be written as $1 - \pi$. Thus, equation $y_t = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \alpha_1 y_{t-1} + \mu_t$ becomes:

$$y_{t} = \beta_{0} + \beta_{1}x_{t} + (\pi - \beta_{1})x_{t-1} + (1 - \pi)y_{t-1} + \mu_{t}$$

$$4.14$$

$$\Rightarrow y_t = \beta_0 + \beta_1 x_t - \beta_1 x_{t-1} + \pi x_{t-1} - \pi y_{t-1} + y_{t-1} + \mu_t$$
4.15

$$\Rightarrow y_t - y_{t-1} = \beta_0 + \beta_1 (x_t - x_{t-1}) + \pi (x_{t-1} - y_{t-1}) + \mu_t$$
4.16

As a result, $\Delta y_t = \beta_0 + \beta_1 \Delta x_t + \pi (x_{t-1} - y_{t-1}) + \mu_t$ where $\Delta x_t \equiv x_t - x_{t-1}$ is a triple equality condition. Therefore, this is the characteristic % error correction+ specification, where the change in one variable is related to the change in another variable, as well as the gap between the variables in the previous period.

4.4 ARDL Modelling Approach to Cointegration Analysis

The Autoregressive Distributed Lag (ARDL) modelling approach to cointegration analysis is the adopted framework for analysis in Chapter 5. This approach is adopted because of its ability to incorporate both stationary and non-stationary regressors. The ARDL model has been chosen in the scope of this research because of its simplicity and suitability to fairly small samples. Unlike other conventional cointegration tests, it may not be necessary to conduct unit root or stationarity pre-testing. The ARDL specification allows separate identification of both long-run and short-run coefficients of explanatory variables (Tang, 2007). According to Cook (2006), the F-test (ARDL) possesses greater power than both the Engle-Granger and the GLS-based cointegration tests. Bahmani-Oskooee and Rehman (2005:775) have indicated that the ARDL approach is very suitable to the formulation of the demand for money function specified in Chapter 5 because there may be a stationary variable along with non-stationary variables such as money or income.

4.4.1 ARDL Relationships

An autoregressive distributed lag (ARDL) relationship exists when a regression equation where regressors are including lagged values of the dependent variable and current and lagged values of one or more explanatory variables. In time series analysis the explanatory variable may influence the dependent variable with a time lag and this often necessitates the inclusion of lags of the explanatory variable in the regression. The dependent variable maybe correlated with lags of itself, suggesting that lags of the dependent variable should be included in the regression as well. The theoretical properties of the ARDL scheme can be explored through an equation.

$$y_{t} = m + \alpha_{1} y_{t-1} + \beta_{0} x_{t} + \beta_{1} x_{t-1} + \varepsilon_{t}$$

$$4.17$$

This is duly called an ARDL (1, 1) since the dependent variable and the single explanatory variable are each lagged once. The residual error term, ε_i is presumed to satisfy all the OLS classical assumptions, hence a white noise process. The inversion of the lag polynomial in **y** gives:

$$y_t = (1 + \alpha_1 + \alpha_1^2 + \dots)m + (1 + \alpha_1 L + \alpha_1^2 L^2 + \dots)(\beta_0 x_t + \beta_1 x_{t-1} + \varepsilon_t)$$
4.18

Thus the current value of **y** depends on the current and all previous values of **x** and ε_t . Alternatively, this relation shows that the current value of **x** has an effect on the current and future values of **y** (Johnston and DiNardo, 1997:244). The partial derivatives taken from equation $y_t = m + \alpha_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + \varepsilon_t$ can be written as;

$$\frac{\partial y_t}{\partial x_t} = \beta_0 \tag{4.19}$$

$$\frac{\partial y_{t+1}}{\partial x_t} = \beta_1 + \alpha_1 \beta_0$$
4.20

$$\frac{\partial y_{t+1}}{\partial x_t} = \alpha_1 \beta_1 + \alpha_1^2 \beta_0$$
4.21

The inclusion of lags implies the likelihood of a set of dynamic responses in **y** to any given change in **x**. There is an immediate response, followed by short-run, medium run and long-run responses. The long-run effect of a unit change in x_t is obtained by summing the partial derivatives; provided the stability condition is satisfied, the sum is $(\beta_0 + \beta_1)/(1-\alpha_1)$. If **x** is held constant at some level \overline{x} indefinitely. It follows that the foregoing relation shows that **y** will tend to a constant value \overline{y} given by , $\overline{y} = \frac{m}{1-\alpha_1} + \frac{\beta_0 + \beta_1}{1-\alpha_1}\overline{x}$, given that the stability condition and innovations are set at their expected value of zero. This is a static equilibrium

equation. If y and x are the natural logarithms of Y and X, equation $\overline{y} = \frac{m}{1-\alpha_1} + \frac{\beta_0 + \beta_1}{1-\alpha_1}\overline{x}$

implies a constant elasticity equilibrium relation: $Y = AX^{\gamma}$ or in log form, $y = a + \gamma x$ where

$$a = \frac{m}{1 - \alpha_1}$$
 and $\gamma = \frac{\beta_0 + \beta_1}{1 - \alpha_1}$

In cases where the variables of interest are trend stationary, the general practice has been to de-trend the series and to model the de-trended series and to model the series and to model the de-trended series as stationary distributed lag or autoregressive distributed lag (ARDL) models. Estimation and inference concerning the properties of the model are then carried out using standard asymptotic normal theory. However, the analysis becomes more complicated when the variables are difference-stationary, or I(1). Literature on cointegration is concerned with the analysis of the long run relations between I(1) variables, and its basic premise is, at least implicitly, that in the presence of I(1) variables the traditional ARDL approach seems no longer applicable. Consequently, a large number of alternative estimation and hypothesis testing procedures have been specifically developed for the analysis of I (1) variables (see Phillips and Hansen (1990) and Phillips and Loretan (1990)).

4.4.2 Error Correction Modelling in ARDL Frameworks

As indicated earlier on, an error correction model is a dynamic system with the characteristics that the deviation of the current state from its long-run relationship will be fed into its short run dynamics. Hence, error correction models are based on the behavioural assumption that two or more time series exhibit an equilibrium relationship that determines both short-run and long-run behaviour. This long-run equilibrium is assumed in virtually all dynamic models involving data in levels but is trivial in the stationary case. The equilibrium can be modelled in many ways when the data are stationary, including autoregressive distributed lag models, generalised error correction models, and other dynamic regressions. (See Beck (1991) and Banerjee et al., (1993)).

Equilibrium relationships in turn have implications for short-run behaviour as one or more series move to restore equilibrium. In each case, short-run change is necessary to maintain the long-run relationship. In some cases the changes will come exclusively from changes in one process. A variable change in response to exogenous conditions, for example. In other cases, both processes may respond to disequilibrium. Depending on the nature of error correction, different estimators of the relationship must be used. The error correction model tells the degree to which the equilibrium behaviour drives short-run dynamics (De Boef, 2001:82). However, it should be noted that an error correction model is not a model that corrects error in another model.

a) The Generalized One-Step Error Correction Method

The generalized one-step error correction model is a transformation of an autoregressive distributed lag (ARDL) model (Banerjee et.al. 1993). As such, the model may the used to estimate relationships among stationary processes as well as unit root processes. It requires no restrictions on the ARDL so that the same information is available from the ARDL as from the ECM representation (Banerjee et al., 1993). The ECM representation is thus used when information about reequilibration is the focus of inquiry and when weak exogeneity is an appropriate assumption (De Boef, 2001:84). The one-step error correction model was popularised in economics by Davidson, Hendry, Srba & Yeo(1978). They advocated the general error correction model for theoretical and empirical reasons. In particular, they wished to estimate the error correction coefficient directly, rather than deriving it from alternative specifications. As for all ARDL models, weak exogeneity is an important assumption for the ECM representation.

The generalized error correction model (GECM) is estimated in one step. From the ARDL framework, it can be derived and written as given below. Assuming an ARDL (1,1) model established as:

$$y_{t} = \alpha_{0} + \gamma_{0} x_{t} + \gamma_{1} x_{t-1} + \alpha_{1} y_{t-1} + \mu_{t}$$
4.22

$$y_{t} - y_{t-1} = \alpha_{0} + \gamma_{0} x_{t} + \gamma_{1} x_{t-1} + \alpha_{1} y_{t-1} - y_{t-1} + \mu_{t}$$

$$4.23$$

$$\Delta y_{t} = \alpha_{0} + \gamma_{0} x_{t} + \gamma_{1} x_{t-1} - (1 - \alpha_{1}) y_{t-1} + \mu_{t}$$

$$4.24$$

$$\Delta y_t - \gamma_0 x_{t-1} = \alpha_0 + \gamma_0 x_t - \gamma_0 x_{t-1} + \gamma_1 x_{t-1} - (1 - \alpha_1) y_{t-1} + \mu_t$$
4.25

$$\Delta y_{t} = \alpha_{0} + \gamma_{0} \Delta x_{t} + \gamma_{0} x_{t-1} + \gamma_{1} x_{t-1} - (1 - \alpha_{1}) y_{t-1} + \mu_{t}$$

$$4.26$$

$$\Delta y_{t} = \alpha_{0} + \gamma_{0} \Delta x_{t} + (\gamma_{0} - \gamma_{1}) x_{t-1} - (1 - \alpha_{1}) y_{t-1} + \mu_{t}$$

$$4.27$$

$$\Delta y_{t} = \gamma_{0} \Delta x_{t} - (1 - \alpha_{1}) [y_{t-1} - \alpha_{0} / (1 - \alpha_{1}) - (\gamma_{0} - \gamma_{1}) / (1 - \alpha_{1}) x_{t-1}] + \mu_{t}$$

$$4.28$$

$$\Delta y_t = \gamma_0 \Delta x_t - (1 - \alpha_1) [y_{t-1} - \beta_0 - \beta_1 x_{t-1}] + \mu_t$$
4.29

Hence, the equation $\Delta y_t = \gamma_0 \Delta x_t - (1 - \alpha_1)[y_{t-1} - \beta_0 - \beta_1 x_{t-1}] + \mu_t$ is the general error correction model where $-(1 - \alpha_1)$ the speed of adjustment is and $[y_{t-1} - \beta_0 - \beta_1 x_{t-1}]$ is the error correction mechanism. The current change in **y** is seen to be the sum of two components. The speed of adjustment coefficient is proportional to the current change in **x**, and the second is a partial correction for the extent to which y_{t-1} deviated from the equilibrium value corresponding to x_{t-1} . This deviation or equilibrium error is shown by the error correction mechanism in the squared brackets. If it is positive, then there is a downward correction in the current period, given the stability condition on α_1 . Conversely, a negative error produces an upward correction. In a static equilibrium Δx and Δy will each be zero (Johnston and DiNardo, 1997:246).

In an alternative given by De Boef (2001) the GECM can be given in its simplest form as:

$$\Delta y_{t} = \lambda_{1} + \lambda_{2} \Delta x_{t} - \gamma (y_{t-1} - x_{t-1}) + \pi x_{t-1} + \eta_{t}$$

$$4.30$$

The error correction term in the GECM is given by $(y_{t-1} - x_{t-1})$. The (implied) coefficient on x_{t-1} of one in this term suggests a proportional (or one-to-one) long-run relationship between **y** and **x**. The validity of this assumption does not affect the estimated error correction rate, γ (Banerjee et al., 1993). However, to estimate the long-run relationship accurately, a second x_{t-1} term is included in the GECM to **%** reak homogeneity+, in a bid to allow the equilibrium relationship to deviate from one-to-one.

The true long run relationship is then 1 - (#/ ?). The standard error for the long-run effect cannot be calculated analytically, as it involves the ratio of estimated parameters. One solution is to use simulations from the estimated data to calculate the correct standard errors or to reformulate the regression so that the long-run relationship is estimated directly (Banerjee et al., 1993). Alternatively, the standard error can be approximated by $J'_f \operatorname{var}(\#, ?)J_f$, where J_f is the Jacobian of the transformation given by f. Here 1 - (#/ ?), and $\operatorname{var}(\#, ?)$ are the variance-covariance matrix of the component parameters. The tradeoff with other dynamic regressions is that the error correction coefficient will not be directly estimated. All other variables in the GECM are defined and may be interpreted as for the second-stage ECM above. Unlike the two-step method, using the dynamic single-equation GECM, the analyst simultaneously estimates the long-run relationship, the disequilibrium, and the short-run dynamics.

The single-equation GECM is both theoretically appealing and also statistically superior to the two-step estimator in many cases. Banerjee et al., (1993) show that dynamic regressions will be asymptotically equivalent to more complex full-information maximum-likelihood and fully modified estimators when the processes are weakly exogenous. Thus the single-equation GECM will be efficient and unbiased, as well as consistent. Importantly, if weak exogeneity is not a reasonable assumption, the single-equation GECM will be both biased and inefficient and t-tests based on the model parameters will be highly misleading.

b) One-Versus Two-Step ECMs Problem under Near-Integration

Two time series processes x and y are said to be near-integrated if their underlying data generating processes and found in between the state of being stationary or cointegrated. In practice, many models of equilibrium relationships are premised on cointegration and hence, rely on the Engle-Granger two-step method (Ostrom and Smith 1992; Clarke and Stewart 1994; Rajmaira and Ward 1990; Wlezien 1995). Others are estimating generalized error correction models in one step (Durr 1993; Green, Palmquist & Schickler, 1998; MacKuen, Erikson & Stimson, 1998), while some are adopting alternative (general systems) estimators such as Johansenœ (1988) vector ECM, but the theoretical is the same in all cases that the time series processes move together over time in the long-run, and short run behaviour is determined by how far out of equilibrium the processes currently are. The choice of estimator rides on the characterization of the persistence of the individual time series (and in the case of integrated series, on the persistence in the linear combination as well) and assumptions about exogeneity. The understanding of the properties of these estimators when data is stationary or cointegrated is adequate. However, the costs of using these estimators when the data are near-integrated remain unclear (De Boef, 2001:83).

Let \mathfrak{q} assume that the error correction is a reasonable behavioural assumption. If theory and statistical evidence regarding the memory of the processes we care about is mixed so that the modulus of ρ maybe 1 or less than 1, what happens if we use either of these methods to estimate an error correction model? Evidence from econometrics suggests that inferences from either static or dynamic regressions will be systematically biased. The work of Elliot (1995, 1998) is particularly relevant. In a similar analysis of FMVAR, Kauppi (1998) shows

114

that FMVAR is also vulnerable to the problems raised by Elliot when roots are close to but not exactly 1.

He investigated the properties of alternative estimators of long-run relationships under nearintegration of \mathbf{x} . He assumed a static data generating process identical to the static regression estimated in the first step of the Engle-Granger estimator and allowed for a very general error structure in the data generating processes, including both serial correlation and cross-equation residual correlations. Elliot gave a summary of his analytical findings and evidence in two main results.

 Efficient estimators such as those used by Saikkonen (1992) or Johansen (1988) or full-information maximum-likelihood estimators and fully modified estimators will be biased (but consistent) under general conditions when the *x* data generating process is near-integrated. While Elliot did not consider single-equation GECMs, he argues that these results are likely to generalize to the class of efficient estimators.

Further, Banerjee et al., (1993) notes that the generalized ECM is asymptotically equivalent to FIML, provided that weak exogeneity is an accurate assumption. This bias increases as the covariance of the data generating process increases (as simultaneity increases).

The coverage of the confidence intervals on the estimate of the long-run relationship will be very poor; the confidence intervals will not include the true value at acceptable rates. Specifically, analytical results suggest that the size of the test will tend to 0 asymptotically but in a sample will tend to 1 as simultaneity increases if the data are near-integrated. Bias is smaller as the variance of *y* increases. The mean bias is nonnegative, leading to overrejection of the null hypothesis that the data contain no long-run relationships.

Elliot identifies two key parameters in the distributions of the estimated long-run relationship and its *t* statistic: σ_{12} (the covariance) and *c*. If either σ_{12} or *c* are to zero, the nonstandard part of the distributions disappears, but when either that processes are near-integrated $(c \neq 0)$ or there is simultaneity ($\sigma_{12} \neq 0$), the distribution of the *t* statistic estimating the longrun relationship is a mixture of normalcy with random mean. The distribution for the estimate of the long-run relationship is also non-standard in this case.

The key to the problem is that we need to α usi-difference+near-integrated data rather than including first differences or additional lagged levels in our models. The problem is that we do not know the true value of ρ needed to quasi-difference appropriately, and it cannot be consistently estimated. This is the reason why the estimators that take into account contemporaneous correlations, like SUR, and correlations at leads and lags, like dynamic regressions such as DOLS (Saikkonen, 1991), ECMs, or systems estimators like Johansen (1988) will not solve the problem; the properties of these estimators depend critically on a known value of ρ . If we assume that $\rho = 1$ and we are right, these procedures will provide unbiased estimates. If the assumption is incorrect and we have simultaneity (in addition to serial correlation), then our estimates will be biased and inefficient. Weak exogeneity will fail and conditioning on the marginal process will be invalid (De Boef, 2001).

It is important to note that there is no simultaneity in the long-run and the problems cited disappear, even under near-integration. The problems associated with imposing unit roots on the data generating process occur only if the errors in the **x** and **y** data generating process are correlated, that is, $\sigma_{12} \neq 0$. The lower the correlation, the smaller the bias and efficiency problems introduced by departures from unit root. Combinations of high correlations and large departures from unit roots increase the likelihood of both problems and thus of incorrect inference. Therefore, it can be deduced that near-roots are a cause for concern and may be problematic when using cointegration methodology or when using methods for short memory processes to estimate long-run relationships, even when using efficient estimators.

4.4.3 Revival of the ARDL Approach to Cointegration Analysis

This section gives literature on the relevance and applicability of the ARDL framework as an alternative superior methodology in cointegration analysis. It provides the foundation from which the model to be tested is specified in the next section. To some extent, it gives the motivation on why the ARDL has been adopted in the class of other cointegration methodologies. Pesaran and Shin (1999) re-examined the use of the traditional ARDL approach for analysis of long run relations when the underlying variables are I(1), despite earlier claims that it was no longer applicable. In their analysis, the following general ARDL (p, q) is considered;

$$y_{t} = \alpha_{0} + \alpha_{1}t + \sum_{i=1}^{p} \phi_{i}y_{t-i} + \beta'x_{t} + \sum_{i=0}^{q-1} \beta_{i}^{*'}\Delta x_{t-i} + \mu_{t}$$
4.31

$$\Delta x_{t} = P_{1} \Delta x_{t-1} + P_{2} \Delta x_{t-2} + \dots + P_{s} \Delta x_{t-s} + \varepsilon_{t}$$
4.32

Where x_t is the k-dimensional I(1) variables that are not cointegrated among themselves, μ_t and ε_t are serially uncorrelated terms with zero means and constant variance-covariance, and P_i are $k \times k$ coefficient matrices such that the vector autoregressive process in Δx_t is stable. It is assumed that the roots of $1 - \sum_{i=1}^{p} \phi_i z^i = 0$ all fall outside the unit circle and there exists a stable unique long-run relationship between y_t and x_t .

The problem of consistent estimation of the parameters of the ARDL model both when μ_i and ε_i are uncorrelated and correlated was examined. In circumstances where these error terms are uncorrelated, it is proven that the OLS estimators of the short-run parameters, α_0 , α_1 , β , β_1^* , $\tilde{o} ..., \beta_{q-1}^*$ and $\phi = (\phi_1, ..., \phi_p)$ are \sqrt{T} -consistent, and the covariance matrix of these estimators has a well-defined limit which is asymptotically singular such that the estimators of α_1 and β are asymptotically perfect collinear with the estimator of ϕ . These results have an interesting implication that the OLS estimators of the long-run coefficient, defined by the ratios $\delta = \alpha_1 / \phi(1)$ and $\theta = \beta / \phi(1)$, where $\phi(1) = 1 - \sum_{i=1}^{p} \phi_i$, converge to their true values faster than the estimators of the short run parameters α_1 and β . The ARDL-based estimators of δ and θ , are $T^{\frac{3}{2}}$ -consistent and **T**-consistent, respectively. Despite the singularity of the covariance structure of the OLS estimators of the short-run parameters, valid inferences on δ and θ , as well as on individual short-run parameters, can be made using standard normal asymptotic theory. Therefore the, traditional ARDL approach justified in the case of trend-stationary regressors, is in fact equally valid even if the regressors are first -difference stationary (Pesaran et al., 2001:2).

If μ_t and ε_t are correlated the ARDL specification needs to be augmented with an adequate number of lagged changes in the regressors before estimation and inference are carried out. The degree of augmentation that is required depends on whether q>s+1 or not. Denoting the contemporaneous correlation between μ_t and ε_t by the $k \times 1$ vector **d**, the augmentation of

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^p \phi_i y_{t-i} + \beta' x_t + \sum_{i=0}^{q-1} \beta_i^{*'} \Delta x_{t-i} + \mu_t \text{ can be written as;}$$

$$y_{t} = \alpha_{0} + \alpha_{1}t + \sum_{i=1}^{p} \phi_{i}y_{t-i} + \beta'x_{t} + \sum_{i=0}^{m-1} \pi'_{i}\Delta x_{t-i} + \eta_{t}$$
4.33

Where $m = \max(q, s+1)$, $\pi_i = \beta_i^* - P_i'd$, i = 0, 1, 2, ..., m-1, $P_0 = I_k$, where I_k is a $k \times k$ identity matrix, $\beta_i^* = 0$ for $i \ge q$, and $P_i = 0$ for $i \ge s$. In this augmented specification, η_i and ε_i are uncorrelated and the results stated above will be directly applicable to the OLS estimators of the short-run and long-run parameters of the above equation. Hence, traditional methods of estimation and inference, originally developed for trend-stationary variables are applicable to first-difference stationary variables.

The estimation of the short-run effects still requires an explicit modelling of the contemporaneous dependence between μ_t and ε_t . In practice, an appropriate choice of the order of the ARDL model is crucial for valid inference. Once, this is done, estimation of the long-run parameters and computation of valid standard errors for the resultant estimators can be carried out either by the OLS method, using the delta method (Δ -*method*) to compute the standard errors, or by the Bewelyc (1979) regression approach. These two procedures yield identical results and a choice between them is only a matter of computational convenience.

The use of the ARDL estimation procedure is directly comparable to the semi-parametric, fully-modified OLS approach of Phillips and Hansen (1990) to estimation of cointegrating relations. In the static formulation of the cointegrating regression,

$$y_t = \mu + \delta t + \theta' x_t + v_t \tag{4.34}$$

Where $\Delta x_t = e_t$, and $\xi_t = (v_t, e_t')'$ follows a general linear stationary process, the OLS estimators of δ and θ are $T^{\frac{3}{2}}$ - and *T*-consistent, but in general the asymptotic distribution of the OLS estimator of θ involves the unit-root distribution as well as the second-order bias in the presence of the contemporaneous correlations that may exist between v_t and e_t . Therefore, the finite sample performance of the OLS estimator is poor and in addition, due to the nuisance parameter dependencies, inference on θ using the usual t-tests in the OLS regression of the above equation is invalid. To overcome these problems Phillips and Hansen (1990) have suggested the fully-modified OLS estimation procedure that asymptotically takes account of these correlations in a semi-parametric manner, in the sense that the fully-modified estimators have the Gaussian mixture normal distribution asymptotically, and inferences on the long run parameters using the *t*-test based on the limiting distribution of the fully-modified estimator is valid.

4.4.4 Model Selection Criteria in ARDL Models

Model selection in econometric analysis involves both statistical and non-statistical considerations. It depends on the objectives of the analysis, the nature and extent of economic theory used, and the statistical adequacy of the model under consideration compared with other econometric models (Pesaran & Pesaran, 1997:352). Gujarati and Porter (2009) note that the basis of model selection emanates from its ability to be data admissible, theoretical consistency, have weakly exogenous regressors, exhibit parameter constancy, exhibit data coherency and be encompassing. A good model should have insample and out-of-sample forecasting capacity. Hence various statistical model selection criteria are applied to choose the best model in different circumstances.

In the subsection only four criteria are discussed as used by Pesaran et.al in developing the ARDL methodology, namely the adjusted R-squared, Akaike¢ Information Criterion (AIC), the Schwarz¢ Bayesian Criterion (SBC) and the Hannan-Quinn Criterion (HQN).

a) The Adjusted- R-Squared Criterion (R^{-2})

As a penalty for adding regressors to increase the R^2 , Theil (1971) developed the adjusted R^2 . It only increases in absolute value if the absolute *t*-value of the added variable is greater than 1. However, the rule of thumb normally applied is that the model that gives the highest R^{-2} has more explanatory power. Notably, maximising R^{-2} is equivalent to minimizing the unbiased estimator of the disturbance variance (Dufour, 2008:3). Further, if two regression models (which satisfy the assumptions of the classical linear model) are compared, and if one of these is the ±rueqmodel, then the variance associated with the true model is smaller on average than the one of the other model (Theil, 1961:543). On the other hand, in large samples, the rule which consists in maximising R^{-2} does not select the true model with a probability converging to one: that is it is not consistent (see Gourieroux and Monfort, 1995).

b) Akaike's Information Criterion (AIC)

In single-equation regression models (linear or non-linear), the AIC is defined as

$$AIC_{\ell} = \log(\sigma^{-2}) + \frac{2p}{n}$$

$$4.35$$

Where sigma squared is the ML estimator of the variance of regression disturbances. Against this criterion, a model is chosen based on the lowest value obtainable from the AIC. Minimising the value of the AIC implies that each estimated parameter entails a benefit and a cost. Clearly, a benefit of adding another parameter is that the value of the sum of squared residuals. The cost is that degrees of freedom are reduced and there is added parameter uncertainty.

The AIC allows the addition of parameters until the marginal cost of doing so is equal to the marginal benefit (Enders, 2010:119).Conveniently; the AIC can be applied to both linear and non-linear models alike. It is also a criteria based on an estimate of the final prediction error, which try to estimate the mean square prediction error taking into account estimation uncertainty (Akaike, 1969; 1970; Amemiya, 1980). Shibata (1976) argues that the AIC is not consistent, in the sense that it does not select the most parsimonious (simple) true model with probability converging to one as sample size increases. According to Gujarati and Porter (2009), the AIC is useful for in-sample as well as out-of-sample forecasting performance of a regression model; useful for both nested and non-nested models and is extensively used for the determination of lag lengths in autoregressive models.

c) The Schwarz Bayesian Criterion (SBC)

In the SBC, the penalty for adding more regressors is even larger than the AIC. Asteriou and Hall (2007), note that the SBC penalise for model complexity than all other criteria. In logarithmic form it can be written as:

$$\ln SBC = \frac{k}{n} \ln n + \ln(\frac{RSS}{n})$$
4.36

Where $[(k/n)\ln n]$ is the penalty factor. Hence, the SBC will select a more parsimonious model (a model with the least number of freely estimated parameters) than the AIC and its other advantage over the AIC is that of its superior large sample properties. Enders (2010) notes that it is possible to prove that the SBC is asymptotically consistent while the AIC is biased towards selecting an overparameterised model.

Through Monte Carlo experiments, Pesaran and Shin (1999) conducted an examination on the suitability of the ARDL-based approach to estimation and inference, and the fully-modified OLS procedure to small samples. They deduced that both AIC and SBC are statistically sound and that the choice between them has to be made on the basis of their small sample properties and computational convenience. They have postulated that the two approaches are both asymptotically valid when regressors are I(1). They have recommended the two-step strategy where selection of p and m in an ARDL (p, m) is done

first before the long-run coefficients and their standard errors are estimated using the ARDL model. The Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SC) were taken to develop estimators named ARDL-AIC and ARDL-SC. Below is a list of their summarized findings.

- The ARDL-AIC and the ARDL-SBC estimators have similar small- sample performances, with the ARDL-SBC performing slightly better in a majority of the experiments. This may reflect the fact that the Schwartz criterion is a consistent model selection criterion while the Akaike is not.
- The ARDL test statistics that are computed using the Δ-method (or equivalently by the means of the so-called Bewleyœ regression), generally perform much better in small samples than the test statistics computed using the asymptotic formula that explicitly takes account of the fact that the regressors are I (1).
- The ARDL-SBC procedure when combined with the Δ-method of computing the standard errors of the long-run parameters generally dominates the Phillips-Hansen estimator in small samples. This is in particular true of the size-power performance of the tests on the long run parameter (Pesaran and Shin, 1999:3). The Monte Carlo results point strongly in favour of the two-step estimation procedure, and this strategy seems to work even when the model under consideration has endogenous regressors, irrespective of whether the regressors are I(1) or I(0).

The case where the regressors are I(1) and cointegrated among themselves presents additional identification problems and is best analysed in the context of a system of long-run structural equations (see Pesaran and Shin (1995)).

d) The Hannan – Quinn Criterion (HQC)

The HQC has been primarily proposed for selection of the order of autoregressive moving average or vector autoregressive models (Pesaran and Pesaran, 1997:354). In regression models, it is given as:

$$HQC_{\sigma} = \log \tilde{\sigma} + (\frac{2\log \log n}{n})$$

$$4.37$$

The strength of the HQC lies between the AIC and the SBC. Under certain regularity conditions it can be shown that the HQC is as consistent as the SBC, especially in large samples.

4.5 Short-run and Long-run Relationships in ARDL-ECMs

Short-run and long-run relationships are shown through the ARDL-ECM mechanism. Let us consider a simple dynamic ARDL model describing behaviour of Y in terms of X given as:

$$Y_{t} = a_{0} + a_{1}Y_{t-1} + \gamma_{0}X_{t} + \gamma_{1}X_{t-1} + \mu_{t}$$

$$4.38$$

where the residual is identically and independently distributed with a mean of 0 and variance σ^2 . The long-run effect is given when the model is in equilibrium where:

$$Y_{t}^{*} = \beta_{0} + \beta_{1} X_{t}^{*}$$
4.39

and for the sake of simplicity, let us assume that in the long-run:

$$X_{t}^{*} = X_{t} = X_{t-1} = \dots = X_{t-p}$$
4.40

thus, it is given by

$$Y_{t}^{*} = a_{0} + a_{1}Y_{t}^{*} + \gamma_{0}X_{t}^{*} + \gamma_{1}X_{t}^{*} + \mu_{t}$$

$$Y_{t}^{*}(1-a_{1}) = a_{0} + (\gamma_{0} + \gamma_{1})X_{t}^{*} + \mu_{t}$$

$$Y_{t}^{*} = \frac{a_{0}}{1-a_{1}} + \frac{\gamma_{0} + \gamma_{1}}{1-a_{1}}X_{t}^{*} + \mu_{t}$$

$$Y_{t}^{*} = \beta_{0} + \beta_{1}X_{t}^{*} + \mu_{t}$$
4.41

so that the long-run elasticity between Y and X is captured by $\beta_1 = (\gamma_0 + \gamma_1)/(1-a_1)$. It is necessary to make the assumption that $a_1 < 1$ in order that short-run model 4.35 converges to a long-run solution. An ECM is derivable as a reparameterisation of the original ARDL in the model 4.35 to give:

$$\Delta Y_t = \gamma_0 \Delta X_t - (1-a)[Y_{t-1} - \beta_0 - \beta_1 X_{t-1}] + \mu_t$$
4.42

$$\Delta Y_{t} = \gamma_{0} \Delta X_{t} - \pi [Y_{t-1} - \beta_{0} - \beta_{1} X_{t-1}] + \mu_{t}$$
4.43

Through the ECM above (equation 4.43), variables Y and X are cointegrated and both shortrun and long-run effects are shown. This is precisely because the long-run equilibrium $Y_{t-1} - \beta_0 - \beta_1 X_{t-1}$ is included in the model together with the short-run dynamics captured by the differenced terms (Asteriou and Hall, 2007:312).

4.5.1 The Error Correction Term and Cointegration

In a two . variable Y_t and X_t , ARDL model of the form:

$$Y_{t} = \mu + \sum_{i=1}^{n} a_{i} Y_{t-i} + \sum_{i=0}^{m} \gamma_{i} X_{t-i} + \mu_{t}$$
4.44

Equation 4.41 can be reparameterised to give:

$$\Delta Y_{t} = \mu + \sum_{i=1}^{n-1} a_{i} \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_{i} \Delta X_{t-i} + \theta_{1} Y_{t-1} + \theta_{2} X_{t-1} + \mu_{t}$$

$$4.45$$

From equation 4.45, if n=1 and after mathematical derivations beyond the scope of this study, it can be deduced that:

$$\theta_2 = \sum_{i=1}^m \gamma_i \tag{4.46}$$

which is the numerator of the long-run parameter, $\beta_{\rm l}$; and that:

$$\theta_1 = -\left(1 - \sum_{i=1}^n a_i\right) \tag{4.47}$$

Hence, the long-run parameter β_0 is given by $\beta_0 = 1/\theta_1$ and the long-run parameter $\beta_1 = -\theta_2/\theta_1$. Therefore the level terms of Y_t and X_t in the ECM tell us exclusively about the long-run parameters and the short-run adjustment to the long-run relationship. Against this background, the most informative way to write the ECM is as follows:

$$Y_{t} = \mu + \sum_{i=1}^{n-1} a_{i} \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_{i} \Delta X_{t-i} + \theta_{1} \left(Y_{t-1} - \frac{1}{\theta_{1}} - \frac{\theta_{2}}{\theta_{1}} X_{t-1} \right) + \mu_{t}$$

$$4.48$$

$$Y_{t} = \mu + \sum_{i=1}^{n-1} a_{i} \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_{i} \Delta X_{t-i} - \pi \left(Y_{t-1} - \beta_{0}^{*} - \beta_{1}^{*} x_{t-1} \right) + \mu_{t}$$

$$4.49$$

where $\pi = 0$. Given that $Y_{t-1} - \ddot{\beta}_0 - \ddot{\beta}_1 x_{t-1} = e_t$, the equilibrium error can be rewritten as:

$$Y_{t} = \mu + \sum_{i=1}^{n-1} a_{i} \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma_{i} \Delta X_{t-i} - \pi \mathcal{E}_{t-1} + \mathcal{E}_{t}$$

$$4.50$$

Therefore, π is the error correction term or the speed of adjustment coefficient. This is a measurement of the extent to which deviation from equilibrium from a standing long-term relationship in the long-run can be corrected in the short-run, or how much equilibrium error is corrected. If π is 1, the implication is that 100% of the short-run imbalance will be adjusted towards the long-run balance within the period, or rather the correction is instantaneous and full. If π is 0.5, then 50% of the error correction adjustment is taking place within that period. If π is 0, then there is no adjustment and it would not make sense to say that Y_t^* is the long run part of Y_t . The negative sign of the error correction term confirms cointegration between Y_t and X_t .

However, the error correction term can be greater than 1 implying a much expedited adjustment is a very short space of time within the reference period. The short-run ARDL model enables the study of the behaviour of each variable in the estimated system in response to the residual from the cointegrating equation, through the error correction term. Literature postulates that the coefficient of the lagged error correction term should be negative and statistically significant to further confirm the existence of a long-run relationship (Bathalomew, 2011:18). Kramer et al., (1992), Sovannroeun (2009) and Haghighat (2012) have shown that the significant lagged error term is a more efficient way of establishing cointegration.

4.6 Model Diagnostic Inspection

After model specification, a battery of diagnostic instruments is applied to check if the model is statistically adequate. Most of them are more focused on diagnosing regression pathologies through regression residuals. The presence of regression pathologies such as serial correlation, multicollinearity and heteroscedasticity violates the classical assumptions of the OLS and hence invalidate statistical validity of parameter estimates. In this section, graphical tools as well as conventional tests to check the properties of residuals are discussed. Tests for structural and parameter instability are also discussed to check for model stability and robustness.

4.6.1 Descriptive Analysis of the Residuals

The deficiency of a model can be detected by plotting the residuals. Outliers, in homogeneous variances or structural breaks can be detected in the residual series. They
are standardised before plotting them to spot unusual residuals. To standardise them, their mean is calculated and divided by their standard deviation to obtain the standardised residuals. If the residuals are normally distributed with a mean of zero, roughly 95% of the standardised residuals should deviate by a factor of 2 along the zero line. According to Lutkepohl and Kratzig (2004), autocorrelations and partial autocorrelations of the residuals maybe worth looking at because these quantities contain information on possibly remaining serial dependence in the residuals. The presence of serial autocorrelation in the squared residuals is indicative of conditional heteroscedasticity in the model. A rough impression of the main features of the residual distribution can sometimes be obtained from a plot of the estimated density through the Kernel density estimator. However, this technique is beyond the scope of this study and shall not be done in model estimation procedures of chapter 5.

4.6.2 Examination of Residuals through Formal Tests

There are numerous diagnostic tests that can be applied to measure statistical adequacy of models. It is common tradition to report tests of general mis-specification, autocorrelation, nonnormality and both first order and higher order serial correlation in econometric models. Unlike graphical techniques, these tests are more reliable diagnostic instruments.

First order serial correlation. One of the assumptions of the classical linear regression, OLS, is that residuals are not serially correlated. If they become serially correlated, parameter estimates are still linearly unbiased and consistent, but they are no longer having minimum variance as expected. Hence they are not efficient, therefore rendering OLS statistics invalid for testing purposes. The Durbin-Watson *d*-statistic is the most celebrated measure of serial correlation in empirical modelling. Gujarati (1988) defines it as the ratio of the sum of squared differences in successive residuals to the residual sum of squares:

$$d = \frac{\sum_{t=2}^{t=N} (e_t - e_{t-1})^2}{\sum_{t=1}^{t=N} e_t^2}$$
4.51

As a rule of thumb, if d if found to be 2 in an application, one may assume that there is no first-order serial correlation (Gujarati, 1988:377). Hence the null hypothesis of either positive or negative serial autocorrelation ought to be rejected. If d is 0, there is perfect positive correlation in the residuals. The more it deviates from 2 towards 4, evidence to support for negative serial correlation accrues. When d is exactly 4 there is perfect negative serial correlation in the residuals.

Higher order serial correlation. The Breusch-Godfrey (1978) test is used extensively to detect for higher order serial correlation in the residuals. There is a Lagrange Multiplier (LM) version as well as the F-statistic version. Notably, the two versions are asymptotically equivalent. Lutkepohl and Kratzig (2004) notes that the LM statistic for the null of interest can be obtained easily from the coefficient of determination R^2 of the auxiliary regression model as:

$$LM_{\mu} = TR^2$$

$$4.52$$

where T is the sample size. The null hypothesis of no serial correlation is rejected, both in the LM and F- version testing approaches, if the probability value (p-value) is smaller than the level of significance which can be at most 0.1 and at least 0.01 or 0.05 if testing is done by moderate researchers. The F-version is given by:

$$F_{sc}(p) = \left(\frac{n-k-p}{p}\right) \left(\frac{\chi_{sc}^2(p)}{n-\chi_{sc}^2(p)}\right)$$

$$4.53$$

This test is a better test for serial correlation than the Durbin Watson test. The *d*-statistic gives inconclusive results under certain circumstances. The *d*-statistic is not applicable when a lagged dependent variable is used and it canq take into account higher orders of serial correlation (Asteriou and Hall, 2007:143).

Non-normality tests. The Jarque-Bera (JB)(1990) test of the normality of is used to detect violation of the OLS assumption of normally distributed residuals in a model. This is against the assumption of the classical regression model that residuals ought to be normally distributed with a mean of 0 and constant variance. The implication of violations of this assumption is that inferential statistics of a model, such as the t-test and the F-test, are rendered invalid. The JB test is based on the skewness and kurtosis of a distribution. According to Ziramba (2007), the kurtosis of a normal distribution is 3 and its respective skewness is 0. Lutkepohl and Kratzig (2004) notes that the test checks whether the third and fourth moments of the standardized residuals are consistent with a standard normal distribution through the LM formula:

$$LJB = \frac{T}{6} \left[T^{-1} \sum_{t=1}^{T} (\tilde{\mu}_{t}^{s})^{3} \right]^{2} + \frac{T}{24} \left[T^{-1} \sum_{t=1}^{T} (\tilde{\mu}_{t}^{s})^{4} - 3 \right]^{2}$$

$$4.54$$

where $T^{-1}\sum_{t=1}^{T} (\mu_t^s)^3$ is a measure of skewness of the distribution and $T^{-1}\sum_{t=1}^{T} (\mu_t^s)^4$ is a measurement of kurtosis. The null hypothesis of normality of a distribution is rejected if the p-value of the JB-statistic is greater than the chosen level of significance.

Functional form. The RESET (Regression Specification Error test) was proposed by Ramsey (1969). It is applied to test possibilities of mis-specification errors in the model that can be attributed to the inclusion of irrelevant explanatory variables or omission of fundamental regressors. It has a F-version as well as a LM. version. The null hypothesis that there is no mis-specification bias in the model it tested by the test statistic:

$$RESET_{h} = \frac{\left(\sum_{t=1}^{T} \mathcal{U}_{t}^{2} - \sum_{t=1}^{T} \mathcal{O}_{t}^{2}\right) / (h-1)}{\sum_{t=1}^{T} \mathcal{O}_{t}^{2} / (T-K-h+1)}$$

$$4.55$$

where the RESET-statistic has an approximate F(h-1, T)-distribution (see Granger and Terasvirta (1993) for greater mathematical expositions of this test). In diagnostic analysis of Microfit 4, the null hypothesis of no mis-specification is rejected if the *p*-value of the RESET-statistic is smaller than the chosen significance level.

Heteroscedasticity. The statistical implication of heteroscedasticity is that the variance of residuals is no longer constant. Although coefficients of estimated parameters are still unbiased and consistent, their efficiency is lost. In fact the presence of heteroscedasticity causes the OLS method to underestimate variances and standard errors, hence leading to overestimated and misleading *t*-statistics and *F*-statistics (Asteriou and Hall, 2007:104). The Breusch-Pagan (1979) and the White (1980) tests are extensively applied to check for heteroscedasticity in models. In this study, only the Breusch- Pagan test in Microfit 4 is applied without confirmatory tests through the White test or other tests. The LM and F-versions are complementary and the null hypothesis of no heteroscedasticity cannot be rejected if the p-value of the Breusch . Pagan statistic is greater than the specified levels of significance.

4.6.3 Stability Analysis

It is tradition in modern empirical analysis to check for model stability over time. As such parameter instability and structural change are inspected if there is a reason to suspect structural breaks in the underlying data generating process. This is deemed important in econometric modelling due to the weaknesses of the assumptions of the Box-Jenkins methodology that coefficients of parameter estimates are constant in different periods. In South Africa, for instance, there are various reasons to suspect for structural changes in money demand due to so many important turn around in economic and political spheres of the nation. Changes in monetary policy stances by the SARB might have induced unknown changes in money supply. Financial liberalisation and other deregulations might have

impacted on expenditure components of money demand. Thus, there are different diagnostic instruments to examine structural and parameter stability in models, depending on whether the breaking points in the time series are known or not. In this subsection, the Chow test, Recursive analysis, CUSUM and CUSUMQ tests are discussed as alternative diagnostic strategies in line with their pros and cons. However, only the CUSUM and CUSUMQ tests are employed in chapter 5, a common practice in empirical literature of money demand analysis. These are equally applicable in the ARDL modelling framework.

Chow test. If there is a reason to suspect a structural break at a particular date, it is straightforward to use a Chow test (Enders, 2010:104). Chow test (Chow, 1960) offers a classical possibility for testing for structural change. In this testing procedure, different variants are often reported, that is the sample-split, break point and forecast tests (see Doornick & Hendry (1994) or Kramer & Sonnberger (1986)). For instance, if the structural break may have occurred in period T, the sample-split and break-point tests compare the estimates from the observations associated with the period before T and after period T. Residuals are generated and compared within each split and compared against each other to see if there are significant changes in variances, autoregressive coefficients and deterministic terms. The constancy of the white noise variance is also checked. Bothe test statistics are derived from likelihood ration principles based on their respective null hypotheses (Lutkepohl and Kratzig, 2004:48). The parameter constancy hypothesis is rejected if the values of the test statistics are large. This study is not utilising this approach for model stability tests due to its weaknesses over the CUSUM and the CUSUMQ tests.

Recursive analysis. Many recursive statistics are often computed and plotted to get an impression of the stability of a model through time. For this purpose, the model is estimated using only data from t=1, δ ., τ and letting τ run from some small value T_1 to T. The estimates and their estimated confidence intervals are then plotted for different τ values (Lutkepohl and Kratzig, 2004:50). Additional data points on X and Y can be added and running a regression as each addition is made tom observe changes in β_1 and β_2 . Changes on estimated parameters are observed against each iteration. According to Gujarati and Porter (2009) the model is structurally stable if the changes in the estimated values of parameters are small and essentially random. Ideally if there are notable and significant changes on the values of estimated parameters, then the model is structurally unstable and there is an indication of a structural break.

CUSUM tests. The cumulative sum of recursive residuals (CUSUM) tests are proposed by Brown, Durbin & Evans (1975). The CUSUM and CUSUMQ are quite general tests of

structural change in that they do not require prior determination of where the structural break takes place. If this is known, the Chow test would be more powerful. But, if this break is not known, the CUSUM and CUSUMQ are more appropriate (Baltagi, 2008:53). The CUSUM is computed through the formula:

$$CUSUM_{\tau} = \sum_{t=k+1}^{\tau} \mu_{t}^{(r)} / \mathcal{O}_{u}$$

$$4.56$$

These are plotted at 5% level of significance and the null hypothesis of stability is rejected if the CUSUM crosses the lines $\pm 0.948 \left[\sqrt{T-K} + 2(\tau-K) / \sqrt{T-K} \right]$ (see Kramer & Sonnberger (1986), Kramer, Ploberger & Alt (1988), or Granger & Terasvirta (1993:85)). This test is designed to detect a nonzero mean of the recursive residuals due to shifts in the model parameters. The test may not have much power if there is not only one parameter shift but various shifts that may have compensated their impacts on the means of the recursive residuals (Lutkepohl and Kratzig, 2004:53). To check for impacts from suspected simultaneous or synchronous shifts in parameters of the model, the CUSUM-of-squares (CUSUM-SQ)plots are observed based on the formula 4.54 below may be more informative.

$$CUSUM - SQ_{\tau} = \sum_{t=K+1}^{\tau} \left(\dot{u}_{t}^{(r)} \right)^{2} / \sum_{t=K+1}^{T} \left(\dot{u}_{t}^{(r)} \right)^{2}$$

$$4.57$$

The null hypothesis of structural stability is rejected if the plots cross the critical lines at 5% significance level. Baltagi (2008) notes that the CUSUM and CUSUM-SQ should be regarded as data analytic techniques, such that the value of the plots lie in the information to be gained by inspecting them.

Conclusion

The major objective of chapter four was to give a discussion of statistical techniques under which the data shall be manipulated, in an attempt to establish the long-run and short-run relationships between money demand and its determinants. The chapter has presented the statistical significance of checking for stationarity in analysing the underlying data generation process of time series data before running regressions. The problem of spurious regression is discussed and the appropriate univariate statistical methods to guard against it are also presented. These include unit root tests such as the Dickey-Fuller test, Augmented Dickey-Fuller test, the Dickey-Fuller GLS test and the Phillips-Peron test. Other alternative univariate statistical tests such as the visual inspection method and correlograms are discussed.

The concept of cointegration analysis has been discussed and its potential to give superconsistent parameter estimates in this study. The single equation cointegration analysis has been chosen considering its suitability and simplicity even though other superior techniques such as the vector autoregression analysis have not been chosen. Error correction mechanisms and their ability to give short run dynamics have been dealt with. The superiority of the ARDL approach to cointegration analysis has been presented and its ability to give both short run and long run relationship between money demand and its determinants. The fact that this model has an inbuilt error correction mechanism has, thus been put forward. The theoretical framework of econometric modelling justifying the estimation procedure applied in Chapter 5 has been presented.

CHAPTER FIVE

Model Specification, Estimation and Interpretation of Results²⁵

This chapter gives a detailed account of the empirical estimation procedure that was undertaken, together with a presentation and interpretation of the results. As mentioned previously the primary focus of the empirical investigation is to derive the long-run cointegration relationships between money demand and its determinants and ultimately exploit these relationships to derive the short-run models, which include error correction models that explain the adjustment necessary to return the money demand function of South Africa from disequilibrium to equilibrium. Hence, through error correction mechanisms of the ARDL, the adjustment process to equilibrium between money demand (through the key money supply aggregates), GDP expenditure components, the real effective exchange rate, inflation and short-term interest rate is established.

Model specification is covered in section 5.1. Section 5.2 gives an outline of the final choice of the variables included in the model as well as issues around the sample size. Data sources are explained. The estimation procedure is guided by methodology outlined in chapter four. Section 5.3 outlines the pre-estimation step of the estimation procedures involving transformation of data and descriptive statistics. At this stage all the variables in levels are transformed to logarithmic form and first differences are generated except for interest rates.

Section 5.3 presents stage one of empirical analysis. Univariate statistical investigations are done through the Augmented Dickey Fuller (ADF) and the Phillips-Peron (PP) tests for stationarity in order to separate out the I(1) variables from the I(0) variables. This section also presents and discusses the results concerning stationarity.

Section 5.4 takes the estimation process to stage two where the bounds testing procedure to cointegration analysis is applied. ARDL estimates are established, diagnostic tests are conducted and results presented. Long-run elasticities are computed in the Bardsen (1989) framework and interpreted. The ARDL-ECMs for M2 and M3 are estimated to explore short-run dynamics and encapsulating them into the long-run relationships in an attempt to measure the speed of adjustment of deviations from equilibrium. Section 5.5 dwells on model stability testing to check for structural as well as parameter instability, specifically focusing on M3, before the overall conclusion of the chapter.

²⁵ All tables and figures in this analysis are of the author, unless indicated otherwise. They are a summarized version of output from Microfit and Eviews 6.

5.1 Model Specification

The baseline money demand function, in most empirical works, is written as

$$M_t^d = f(S, Oc) \tag{5.1}$$

The money demand equation 5.1 shows that real money demand over a period of time, M_t^d (nominal value of money demand converted through a suitable price deflator) is a function of S, a scale variable reflecting the level of transactions in the economy and *Oc*, a single or vector of opportunity cost variables. The scale variable can be real income or wealth (see section 3.2 of chapter 3). *Oc* can be a single opportunity cost variable such as inflation or a representative interest rate or both. The exchange rate is also a suitable opportunity cost variable to capture foreign influences on the money demand function for an open economy.

Hence, from equation 5.1, the empirical money demand equation can be extended to incorporate a host of explanatory variables to capture the effect of a variety of factors. For instance, the model developed by Mundell (1963) is an extension of the principle shown in equation 5.1 and its assumptions are that money demand is a function of a real income, a representative interest rate on alternative assets as an opportunity cost of holding money and the exchange rate.

$$M_t^d = f(Y, r, Ex)$$
 5.2

It is important to highlight that economists continue to search for a specification of the money demand function that gives a reliable relationship with other macro variables (Huang, Lin and Cheng, 2001:1727). However, equations 5.1 and 5.2 are vulnerable to the aggregation bias, that expenditure components of aggregate real income have a uniform influence on money demand.

This study brings the argument as given by Tang (2002; 2004) and Ziramba (2007) that disaggregated expenditure components of real income have different influences on money demand. Secondly, unlike the specification estimated by Ziramba (2007) in the same belief, inflation is introduced as the opportunity cost variable to capture the opportunity cost of holding money in the long-term and the short-term interest rate as the opportunity cost of holding money in the short-term. The short-term interest rate is included as a proxy for the own rate of return on money. The exchange rate (real or nominal) captures the impact of the South African rand fluctuations on the foreign exchange market. Against this framework, an

augmented money demand function is developed as an extension of Mundellop model and re-specified in semi-log linear form as:

$$\ln M_{t}^{d} = a_{0} + a_{1} \ln FCE_{t} + a_{2} \ln GFCF_{t} + a_{3} \ln Ex_{t} + a_{4} \ln RE_{t} + a_{5}RSD_{t} + a_{6} \inf_{t} + \varepsilon_{t}$$
 5.3

where

 M_t^d = demand for real money,

FCE= is real final consumption expenditure,

GFCF = real gross fixed capital formation (a proxy for expenditure on investment goods),

Ex = real expenditure on exports,

RE = an applicable exchange rate,

RSD = short-term interest rate (a proxy for own rate of return on money) to represent the opportunity cost of holding cash balances in the short-run,

inf = rate of inflation, in percentage to reflect the opportunity cost of holding money as an asset in

the long-run and

 μ_{t} = a stochastic disturbance term, satisfying all the classical assumptions and a white noise process.

The justification of variables is presented in the next subsection. *Ln* is the logarithmic transformation to enable the interpretation of coefficients as elasticities and to smoothen the time series on the respective variables. Thus, equation 5.3 is the long-run money demand equation. In this equation, *a priori* economic theoretical expectations are such that a_1 , a_2 and a_3 are positive (see Tang, 2007: 481). However, a_4 can be positive or negative as debated in chapter three (see Halicioglu and Ugur, 2005: 4). Monetarists, as given by Milton Friedmang money demand equation indicate that a_5 should be positive if it is an explanatory variable together with the long-run interest rate and negative if the long-run interest rate has been excluded as an exogenous variable (see Bain and Howells, 2003:123). Contrary to the postulations of the Monetarists is the argument in the McKinnon-Shaw framework that the standard money demand function seems to break down with interest rate having a positive

effect on money demand rather than negative. This is caused by financial repression in developing countries.

At higher interest rates cash balances in bank accounts with the general public tend to increase and banks will then accumulate these deposits for lending. According to the complementarity hypothesis of McKinnon (1973) in Ansari (2002), there is complementarity between money and investment in physical assets. Ansari (2002) notes that the implication of this hypothesis is that the relationship between interest rate and income is no longer negative, but it is rather positive. Against different theoretical considerations, the coefficient sign on the interest rate can be positive or negative without any paradoxical connotations of empirical findings. According to Bain and Howells (2003) selecting a representative rate of interest from the interest rate regime of an economy depends on the available knowledge of institutional factors and that for testing purposes in money demand functions any can be adopted in the model because they are highly correlated. The coefficient sign on inflation, a_6 , is negative in all money demand theories.

For equation 5.3, an ARDL specification for money demand can be shown to display both short-run dynamics and the long-run relationships between real money demand and its determinants in levels. Hence the ARDL representation of 5.3 can be expressed as:

$$D \ln M_{t}^{d} = b_{0} + \sum_{i=0}^{n} b_{1i} D \ln FCE_{t-i} + \sum_{i=0}^{n} b_{2i} D \ln GFCF_{t-i} + \sum_{i=0}^{n} b_{3i} D \ln Ex_{t-i} + \sum_{i=0}^{n} b_{4i} DRSD_{t-i} + \sum_{i=0}^{n} b_{5i} D \ln RE_{t-i} + \sum_{i=0}^{n} b_{6i} D \inf_{t-i} + \sum_{i=0}^{n} b_{7i} D \ln (M_{t}^{d})_{t-i} + b_{8} \ln (M_{t}^{d})_{t-1} + b_{9} \ln FCE_{t-1} + b_{10} \ln GFCF_{t-1} + b_{11} \ln Ex_{t-1} + b_{12}RSD_{t-1} + b_{13} \ln RE_{t-1} + b_{14} \inf_{t-1} + \varepsilon_{t}$$
5.4

where *D* is a first difference operator and ε_t is identically and independently distributed and a random white noise error term. Following the propositions of Pesaran et al.,(2001) a bounds testing procedure is followed to test the existence of any meaningful long-run relationship by establishing whether variables are cointegrated or not.

Notably, the test statistics are calculated in the Wald test version to give the F-statistic which is asymptotically distributed and non-standard under the null hypothesis of no cointegration relationship between the variables of interest, irrespective of whether the explanatory variables are purely I(0), I(1) or mutually cointegrated. In other words, the F-statistic can be derived by imposing exclusion restrictions on the lagged variables in levels from the estimation of equation 5.4 (see Tang, 2007:481).

It should be noted that equation 5.4 as an ARDL is a reparameterisation of the error correction model as shown by Asteriou and Hall (2007:312) and presented by Ziramba (2007) as an unrestricted error correction model (UECM). Therefore, a general error-correction representation of equation 5.4 is formulated as:

$$D\ln M_{t}^{d} = b_{0} + \sum_{i=0}^{n} b_{1i} D\ln FCE_{t-i} + \sum_{i=0}^{n} b_{2i} D\ln GFCF_{t-i} + \sum_{i=0}^{n} b_{3i} D\ln Ex_{t-i} + \sum_{i=0}^{n} b_{4i} DRSD_{t-i} + \sum_{i=0}^{n} b_{5i} D\ln RE_{t-i} + \sum_{i=0}^{n} b_{6i} D\inf_{t-i} + \sum_{i=0}^{n} b_{7i} D\ln(M_{t}^{d})_{t-i} + \lambda EC_{t-1} + \upsilon_{t}$$
5.5

where λ is the speed of adjustment coefficient and *EC* are the residuals that are obtained from the estimated cointegrated ARDL as specified in equation 5.3. The sign of the speed of adjustment coefficient is expected to be negative and its size gives a measurement of the deviation from the long-run equilibrium relationship corrected in the short-run as discussed in the previous chapter. A negative sign of the speed of adjustment parameter is a more powerful indication of the presence of cointegration between variables (see Bahmani-Oskooee and Brooks (1999), Kanioura and Turner (2005) and Kremers, Ericsson, Schimdt and Shin (1992b)).

5.2 Sample size and Final Selection of Variables

The study utilises annual data on variables finally selected in 5.2.1 from 1980 to 2011. Attempts to make use of quarterly data to have an extended sample size were not fruitful. In preliminary experiments whose results are not reported in this chapter, it became evident that quarterly data is noisy and consequently annual data was resorted to. Hence, the sample size has 32 observations. Final real money demand is represented by M0 (as notes and coins in circulation without transmission deposits or demand deposits with the public). M1 is also a narrow definition tested. Broader definitions of money supply are M2 and M3. Average annual inflation is adopted as an opportunity cost variable although it is CPI itself that is considered a suitable price deflator. The interest rate on notice deposits is chosen as a representative interest rate and the real effective exchange rate is taken to capture foreign influences in the model. Inclusion of dummy variables was hampered by software constraints as Microfit 4 could not accommodate more than 10 variables in the ARDL model. Therefore, they were excluded from this analysis.

5.2.1 Justification of Variables Selected

The choice of the money supply variables (M0, M1, M2 and M3) was influenced by *a priori* economic expectations that when the economy is in equilibrium money demand is equal to

money supply. Hence, these money supply aggregates by the South Africa Reserve Bank are a reflection of money demand in the economy. According to Hamori and Tokihisa (2001:305), stability of the money demand function is an important premise behind the hypothesis that monetary policy matters, that is, the money supply will have a certain amount of expected influence on real variables. Thus, money supply controlled by the South African Reserve Bank is an effective monetary policy instrument and fundamental to the monetary policy transmission mechanism.

It is traditional and theoretically consistent to choose an income variable, such as the Gross Domestic variable (GDP), as a scale variable in money demand equations than a proxy variable for wealth. This is done despite suppositions that such a variable choice is biased towards the transactions motives for holding money balances than the precautionary or speculative motives. According to Coenen and Vega (2001:729), the choice of real GDP and the GDP deflator as the scale and price variables in the money demand function is common practice in existing empirical work, though alternative measures such as total final expenditure, consumption or wealth are also frequently found. In this research, GDP is a scale variable can have different influences on money demand stability. Hence major components of final expenditure (GDP). final consumption expenditures (private and government sectors), expenditures on investment goods and exports are considered as autonomous scale variables in line with empirical works of Tang (2000, 2004, 2007). This approach is adopted to avoid aggregation bias, as was with the case with all the previous money demand functions of South Africa except in the analysis by Ziramba (2007).

The inflation rate is a scale variable as an opportunity cost of holding money. In the inflation targeting monetary policy framework of South Africa, money supply is an instrument for demand management. Thus, its influence on money demand cannot be taken for granted. Monetarists have advocated for inflation as a scale variable in money demand functions due to the link between the price level and the transactions and speculative motives for holding money by the general public. In his money demand equation Friedman (1956) included both interest rates and inflation as opportunity cost variables. Inflation, as a reflection of the price level, is included because the demand for money is a demand for real balances and changes in the price level are bound to change the real value of money holdings. Bain and Howells (2003) suggest the inclusion of an available rate of interest on the closest substitute for money, since this should best represent the opportunity cost of holding money. However, researchers have provide various schools of thought on the ideal interest rate to be included in a money demand model as highlighted earlier on in chapter three. Against this background, inflation and a short-term interest rate (interest rate on notice deposits, 1-32

days) are chosen as opportunity cost variables. This makes selection of variables in this study different from Ziramba (2007) specification.

However, efforts to include the long term interest rate did not prove to give statistically plausible results. The introduction of the long-term interest rate into the model had indications of multicollinearity, in the form of statistically insignificant estimates, incorrect signs of coefficients and low coefficient of determination. Hence it was removed and indeed serial correlation was solved. Three short-term interest rates were identified and due to insufficient guidance from theory or empirical underpinnings the interest rate on notice deposits was finally chosen as a proxy of own rate of return on money. The justification of that choice was driven by the outcome of the correlation matrix that was drawn to seek evidence that indeed these interest rates are moving together over time and is highly positively correlated. Table 5.1 below is a pair wise correlation matrix of the four interest rates chosen in the South African monetary policy regime and an identified foreign interest rate.

Table 5.1: Correlation Matrix for domestic interest rates and the
foreign interest rate ²⁶

	LS	FR	RS	RSD	ТВ
LS	1.00	0.44	0.78	0.79	0.78
FR	0.44	1.00	0.32	0.32	0.39
RS	0.78	0.32	1.00	0.96	0.98
RSD	0.79	0.32	0.96	1.00	0.98
ТВ	0.78	0.39	0.98	0.98	1.00

Interest rate on notice deposits, 1-32 days (*RSD*) is weakly positively correlated to the foreign interest rate at 32% and strongly related to all domestic interest rates identified. Its strong linear association at 79% with the long-term interest rate (yield on government bond 10 years and over) could be the potential source of multicollinearity. Hence it justifies the exclusion of the long-term interest rate and its role is observed through inflation as reflected through Milton Friedmance argument on the role of inflation in explaining money demand. RSD is highly positively correlated with the bank rate (repo rate) and the Treasury bill rate (TB) at 96 % and 98% respectively. This strong linear association makes *RSD* a good representative interest rate in the model. However the foreign interest rate was eventually removed to solve mis-specification bias in the model, as reflected through the Ramseyce RESET in preliminary results. Focus was ultimately placed on the domestic economy since

²⁶ It should be noted the USLIBOR rate was used as a representative foreign interest rate in preliminary experiments of the study and subsequently dropped in the interest of parsimony.

South Africa has maintained a positive interest differential with industrialised economies over the period of study. Hence, in the interest of parsimony, the foreign interest rate was taken out the model.

Mundell (1963) and Fleming (1962) postulated in their empirical work that money demand is likely to depend upon the exchange rate in addition to the interest rate and the level of income. The Mundell . Fleming model provided the basic framework which explains the interaction between the money supply, prices and the exchange rate, and yields neutrality in the long run (Cuthbertson, 1991:2). In the current account monetary (CAM) model of a small open economy, the demand for money function provides the main transmission mechanism between the money supply and the exchange. Capital account monetary (KAM) models by Dornbusch (1976) and Frankel (1979) demonstrate how a contraction in money supply might cause exchange rate overshooting in a model with smart speculators and sticky goods prices (Buiter and Miller, 1982). The selection of the real or nominal exchange rate as an independent variable in money demand functions is in line with these economic foundations. It is also empirically consistent with similar research undertaken by Pesaran et al., (2001), Civcir (2003), Arize, Malindretos & Shwiff (1999), Bahmani-Oskooee and Rehman (2005) and Tang (2007) among others.

5.2.2 Data Sources.

Statistical data on variables were downloaded from the South African Reserve bank web site (http://www.resbank.co.za) through access to their online downloading facility. These statistical data are also available in the various publications of South African Reserve bank, Quarterly Bulletin or through Statistics South Africa online access to economic time series data. All money value variables are in local currency (the South African Rand). The money value variables are then converted into real terms by an appropriate price deflator (the Consumer Price Index (CPI). Annual data is taken from 1980 to 2011. The following variables were included in this research:

Final Consumption Expenditure (FCE) (6007Y+6008Y). The definition of final consumption expenditure in national income accounting is extensively covered in the United Nations Handbook of National Accounts (series F, No. 85, Chapter 12:93-95). This is a summation of final consumption by households, general government and NPISH at purchasersq prices excluding total intermediate consumption. Government consumption expenditure is precisely current expenditure on salaries and wages and on goods and other services of a non-capital nature by the services departments (not business enterprises) of general government. General government includes central government, provincial governments and local governments (SARB Quarterly Bulletin, June 2011). Hence, this

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variable is an aggregate of the two quarterly series. The series are deflated by the CPI (2008=100) to obtain real values.

Expenditure on Investment goods (6009Y). It is the sum of gross fixed capital formation by the private and public sectors (net) in 2005 prices. This covers the total value of producersquet acquisitions of new or existing produced capital assets (including dwellings of households) plus major improvements to land and sub-soil assets plus cost of ownership transfer of such assets²⁷. The series are deflated by the GDP deflator (2005=100).

Export expenditures on goods and services (6013Y). The series are measured in real terms and measurable in volumes against 2005 base year prices. The series are deflated by the implicit deflator for exports.

Money supply aggregates. These have been estimated on a monthly basis since March 1965 in millions of rands, and are seasonally adjusted. The quarterly series have been averaged out of the monthly data over three months and they include: **M0**-notes and coins (**NC**) in circulation with the general public (outside the banking system) excluding demand deposits. M1-notes and coins (**NC**) outside the banking system plus demand deposits, checking deposits or sight deposits. **M0** and **M1** are the narrow definitions of money and are the media that one would expect to be used primarily for transactions purposes. **M2** is M1 plus short and medium term deposits.**M3** is a broader measurement of money in the sense that it includes sight and long term time deposits, including certificates of deposit. M0 reflects notes and coins in circulation (**NC**) in this study. It should be noted that M1A was excluded.

Short term interest rate(RSD). Interest rate on notice deposits, 1-32 days (*RSD*) is used as a proxy for the own rate of return on money. Monthly figures are averaged to give the annual estimates. It is obtainable from the SARB data base since 1960 and is used as a possible leading indicator of inflation. It is considered a short run opportunity cost of holding money.

Long term interest rate (RL). This is regarded as an opportunity cost of holding a diversified portfolio of monetary assets, liquid and illiquid, in the long term. It is a percentage yield on ten-years and over government bonds, an alternative leading indicator of inflation and also used to calculate yield spreads between the long and short bond rates.

Real effective exchange rate (NER). The nominal exchange rates are measured in R (rands) per US \$ (dollar). The SARB data base contains this monthly series going as far back as 1978. The series represents a supply shock variable, since devaluations causes increases in prices of imported intermediate and capital inputs, which tend to influence the

²⁷ It is notable that changes in inventories are not included in this definition

inflation rate. Hence the nominal exchange rate is the key driver of imported inflation. However, with inflation adjustments of the nominal rate, the real rate is computed and used for empirical analysis in this study.

The Consumer Price Index (CPI). This is a measurement of the change in the general price level of the basket of consumable goods and services by the general public in metropolitan areas. It is a current social and economic indicator that is constructed to measure changes over time in the general level of prices of consumer goods and services that households acquire, use, or pay for (see Statistics South Africa (2009): The South African CPI Sources and Methods manual). Thus, it is used to calculate the inflation rate on a monthly basis. In this research, it is used as a price deflator to convert money value variables into real terms. It is found on the economic time series of Statistics South Africa and is dated as far back as 1971. The CPIX (CPI excluding interest rates on mortgage bonds) was introduced for the first time in January 1997. Therefore the availability of CPIX is limited and it shall not be used in this study.

5.3 Data transformation and Descriptive statistics

There is need to transform statistical data by converting it from nominal variables to real variables if aggregates are not obtained at constant prices. In this study monetary aggregates are deflated by CPI as a suitable price deflator. Thereafter log-transformations are done in Eviews 7 and Microfit as preparations for empirical analysis.

5.3.1 Conversion of variables

Firstly, data on monetary aggregates, the short. term interest rate, CPI and the exchange rate are downloaded from the SARB data base as monthly time series. Hence the monthly series are converted to a annual series by deriving averages. Inflation is calculated from the CPI, although there are also annual inflation series obtained in percentage form. The real rate of interest is calculated by subtracting the inflation component from the nominal short-term interest rate. However, GDP and its expenditure components are downloaded as annual series at constant prices series.

Secondly, since monetary aggregates (M0, M1, M2 & M3) are extracted from the SARB website as nominal variables, there is need to convert them to real variables. They are converted to real variables by using CPI as the price deflator so that the effect of price changes (inflation) can be removed to observe real changes in money supply over time without distortions caused by such changes. Appendix A is the final data set analysed in this research.

5.3.2 Natural Log Transformation

All variables are transformed to logarithmic form. The rationale behind the transformation is that coefficients are easily interpreted as elasticity values. The log transformation is used if a variable takes only positive values, to stabilise the variance of a variable if the variance tends to increase over time. By transforming to logarithmic form the dependent variable is normalised, if the distribution of its residuals is positively skewed (Kleinbaum, Kupper, Muller & Nizam, 1998). To some extent, transformation has an effect of smoothing a time series, thus removing seasonal trends for the effect of other influences on the data generating process to be observed. The relationship between the dependent variable and regressors is made linear in a regression model by transforming variables to logarithmic form, particularly if the relationship of the dependent variable to explanatory variable suggests a model with consistently increasing slope. However all variables are transformed in this manner except the short term interest rate. The short term interest rate is already given in percentage form. Hence, there is no need to transform it since its coefficient is automatically interpreted as an elasticity value.

5.3.3 Descriptive Statistics

In its natural logarithmic form, the Kurtosis of a normal distribution is 3. If the Kurtosis is less than 3, the distribution is flat relative to the normal. The skewness of a normal distribution is zero. Positive skewness means that the distribution has a long right tail and a negative skewness implies that the distribution has a long left tail (Ziramba, 2007). A lag length of 6 is chosen as the limit for hypothesis testing to investigate the presence of autocorrelation in the variables. The null hypothesis of no autocorrelation is rejected if the probability value for the Q . statistics is less than 0.05 (5% level of significance). The respective Q-statistics were performed (results are not reported and can be availed by the author upon request) shows that variables are free from autocorrelation from the correlograms.

The Jarque. Bera statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. Under the null hypothesis of a normal distribution, the Jarque-Bera statistics is distributed as with 2 degrees of freedom. The reported p-value against each variable is the probability that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis. In this case, for all variables, we fail to reject the null hypothesis of a normal distribution. Hence, it shows that there is no adverse impact induced by outliers in our time series.

	INF	LEX	LFCE	LGFCF	LM0	LM1	LM2	LM3	LREER	RSD
Mean	9.74	12.58	13.79	12.17	9.76	11.70	12.43	12.63	4.73	11.44
Median	9.15	12.62	13.75	12.09	9.96	11.80	12.50	12.63	4.72	10.80
Maximum	19.20	13.12	14.31	12.85	11.53	13.76	14.40	14.63	5.05	20.56
Minimum	1.40	12.09	13.36	11.75	7.62	9.07	9.99	10.45	4.41	4.25
Std. Dev.	4.44	0.34	0.27	0.34	1.18	1.44	1.35	1.28	0.13	4.44
Skewness	0.13	0.01	0.41	0.86	-0.30	-0.19	-0.18	-0.03	0.19	0.24
Kurtosis	2.06	1.52	2.05	2.59	1.87	1.78	1.87	1.85	3.28	2.15
Jarque-Bera	1.28	2.94	2.09	4.20	2.16	2.17	1.89	1.77	0.30	1.28
Probability	0.53	0.23	0.35	0.12	0.34	0.34	0.39	0.41	0.86	0.53
Sum	311.60	402.59	441.37	389.42	312.34	374.38	397.80	404.25	151.34	366.04
Sum Sq. Dev.	609.98	3.67	2.32	3.61	42.90	64.23	56.58	50.69	0.56	610.78
Observations	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00	32.00

All variables are reflecting that they not significantly skewed, hence normally distributed. All monetary aggregates are positively skewed. All variables are showing evidence that their skewness coefficients are not significantly different from zero and platykurtic as given by their respective kurtosis values, except LNEER that tends to mesokurticness. Overall, there is evidence that there are no outliers in these respective time series causing the data sets to become relatively symmetrical.

INF	1.00												
LEX	-0.82	1.00											
LFCE	-0.74	0.95	1.00										
LGFCF	-0.59	0.75	0.84	1.00									
LMO	-0.78	0.97	0.96	0.69	1.00								
LM1	-0.79	0.97	0.97	0.72	1.00	1.00							
LM2	-0.77	0.97	0.98	0.72	1.00	1.00	1.00						
LM3	-0.77	0.97	0.99	0.76	0.99	1.00	1.00	1.00					
LREER	0.33	-0.66	-0.58	-0.29	-0.66	-0.66	-0.65	-0.64	1.00				
LS	0.65	-0.71	-0.74	-0.87	-0.61	-0.64	-0.64	-0.67	0.22	1.00			
RS	0.45	-0.46	-0.50	-0.57	-0.39	-0.40	-0.40	-0.44	0.19	0.78	1.00		
RSD	0.52	-0.51	-0.50	-0.56	-0.42	-0.42	-0.42	-0.45	0.19	0.79	0.96	1.00	
ТВ	0.51	-0.52	-0.54	-0.55	-0.46	-0.47	-0.46	-0.49	0.24	0.78	0.98	0.98	1.00
	INF	LEX	LFCE	LGFCF	LMO	LM1	LM2	LM3	LREER	LS	RS	RSD	ТВ

Table 5.3: Correlation matrix

The results of pair-wise correlations displayed in the correlation matrix indicate positive correlations between velocity of money and expenditure components of real income and significant negative correlations with opportunity cost variables (Short-term interest rate, inflation and the exchange rate). Expenditure components are also negatively correlated to opportunity cost variables. There are positive correlations between the expenditure components themselves. However, LFCE and LEx are highly positively correlated which is a

partial reflection of potential multicollinearity between these variables. According to Asteriou and Hall (2007), if a correlation coefficient between variables exceeds 0.9, problems related to multicollinearity are bound to emerge. The impact of such a regression pathology is that signs of estimated coefficients can be opposite of those expected or loss of statistical significance on affected coefficients. Opportunity cost variables are positively correlated and hence the selection of the interest rate on call deposits as a representative opportunity cost variable is justified. Overall, the depiction of correct signs on correlation coefficients confirms the economic relationships between these variables as envisaged by theory.

5.3.4 Graphical Descriptions of Data

The time series of variables are displayed graphically in Figure 5.1. It is evident from the graphical displays that dependent variables M0, M1, M2 and M3 are nonstationary. At the same time, exogenous variables, notably LEx, LFCE and LGFCF are nonstationary. These series exhibit a distinctive upward trend in levels. Hence, they have no constant mean and have a long memory in their increasing trend. Such tendencies are however less apparent with the real effective exchange rate, inflation and the short-term interest rate. These display evidence that they could be trend stationary or fractionally integrated.

Contrary to the level series, the graphs of differenced series in Figure 5.2 are showing evidence of stationarity. They are displaying the tendency to fluctuate about zero displaying both a finite variance and constant time, independent of time. Such mean reversion tendencies are consistent with behaviour of stationary series. The overall implication at this elementary stage is that all variables might be integrated of order one, since they appear in their first differences.

The graphs of variables in levels are confirming correlations between variables as given in the correlation matrix (Table 5.2). From Figure 5.1, it can be deduced that endogenous (M0, M1, M2 and M3) versus expenditure on exported goods and services (LEx) and LFCE exhibit very similar stochastic trends over the referenced period. Hence positive correlations between variables are indicative of stochastic trends. Notably, inflation is showing a negative relationship with monetary aggregates in Figure 5.1, hence confirming relatively strong negative correlations indicated in Table 5.2.

The behaviour of the real exchange rate is not clear, but it confirms the weak correlations against monetary aggregates shown in Table 5.2. In an attempt to examine the velocities of M0, M1, M2 and M3 against the opportunity cost variables, inflation, short-term interest rate and the real effective exchange rate, we can conclude that the inflation rate displays a



Figure 5.1: Graphic Plots of Variables in Levels

Figure 5.2: Graphic Plots of Variables in First Differences.



decreasing trend. The relationship between velocity and short-term interest rate is not very clear. Pair wise correlations depict weak negative correlation between money supply

aggregates and the short-term interest rates. Gross fixed capital formation depicts a decreasing trend prior to 1993 and displays an increasing trend thereafter. Hence its graphical display confirms mediocre positive correlations against endogenous variables. Therefore, the visual effect of time series plots in Figure 5.1 endorses a better understanding of the correlation coefficients given in table 5.2. The opposite is also true that correlations difficult to comprehend are better understood alongside with graphical displays of variables in levels.

5.4 Empirical Analysis

This subsection examines integration properties of data through univariate statistical estimations of variables before the application of bounds test integration tests. The ADF tests and PP-tests are conducted to establish the order of stationarity of data. The bounds test procedure is then implemented to establish long run relationships and short-run dynamics through an unrestricted error correction model of the ARDL form. Model diagnostic inspection is ultimately followed by CUSUM tests to examine structural as well as parameter stability of the model. It should be noted that other informal unit root tests such as correlograms were plotted and observed simply as confirmatory evidence in unit roots tests. Hence, these results are not reported but are available from the author on request.

5.4.1 Integration Properties of Data

The ADF test and the PP-test are used in this study to analyse the integration properties of data. Although Pesaran et al., (2001) give the allowance to implement the bounds testing procedure irrespective of whether regressors are I(0) or I(1), it is nevertheless important to conduct unit root tests. Establishing the stationarity status of data is important before bounds cointegration test to ensure that variables are integrated of order one and not beyond. If some variables are integrated on an order higher than one, regressors may lead to spurious cointegration results as there is no provision for I(2) in the critical values for bounds testing. However, I(2) processes are hardly found in economic time series. Thus, the bounds testing applies and works with a mixture of I(0) and (1) or when all variables are I(1).

Tables 5.3a and 5.3b present the formal unit root test results using the ADF tests and the PP-is regarded a confirmatory test. These stationarity tests are conducted on the null hypothesis that the data generating process has a unit root. Notably, all variables are stationary in levels. There is evidence that they become stationary in their first differences. Hence, they are integrated of order 1. The bounds testing procedure can be applied taking integration properties of data into cognisance. The results of these formal tests are also

VariableModel·································	Table 5.4a : Augmented Dickey Fuller and Philips-Peron Unit root tests									
VariableModelLag $\tau_r, \tau_{\mu'}, \tau$ Φ_3, Φ_1 BWConclusionLM0Trend & Intercept0-1.4562.7953-1.35Non-stationary: integrated of order 1LM0None09.143-37.554Non-stationary: integrated of order 1Intercept0-5.124***13.55***3-5.08***-5.08***DLM0Intercept0-4.817***23.21***3-4.795***DLM0None4-0.654-3-1.458Mone1-1.7653.7933-1.311Intercept0-2.715*7.373***3-2.736*None12.526-33.076**None0-3.513**12.39***3-3.3776**DLM1Intercept0-3.513**12.39***3-3.3776**Intercept0-2.715*7.734***3-3.776**None0-1.586-3-1.44DLM2None12.526-38.065None0-2.715*7.734***3-3.776**Intercept0-2.715*7.734***3-3.776**None12.526-38.065Mone23.355*3-3.44DLM2Intercept0-2.715*7.734***3-3.275*ILM2None12.526-3-3.44				ADF	-		PP			
LM0 Trend & Intercept 0 -1.456 2.795 3 -1.35 Non-stationary: Integrated of order 1 LM0 None 0 9.143 - 3 7.554 Intercept 0 order 1 Trend & Intercept 0 -5.124*** 13.35*** 3 -5.08*** Intercept 0 order 1 DLM0 None 4 -0.654 - 3 -1.458 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - <td< th=""><th>Variable</th><th>Model</th><th>Lag</th><th>$\boldsymbol{\tau}_{\tau},\boldsymbol{\tau}_{\mu},\boldsymbol{\tau}$</th><th>$\Phi_3, \Phi_1$</th><th>вw</th><th></th><th>Conclusion</th></td<>	Variable	Model	Lag	$\boldsymbol{\tau}_{\tau},\boldsymbol{\tau}_{\mu},\boldsymbol{\tau}$	Φ_3, Φ_1	вw		Conclusion		
LM0 Intercept None 0 -2.011 4.044 3 -2.463 Integrated of order 1 Mone 0 9.143 - 3 7.554 integrated of order 1 DLM0 Trend & Intercept 0 -5.124**** 13.35*** 3 -5.08*** DLM0 None 4 -0.654 - 3 -1.458 LM1 Trend & Intercept 0 -2.715* 7.373*** 3 -2.735* None 1 2.526 - 3 8.065 Intercept DLM1 Intercept 0 -3.933** 7.734*** 3 -3.776** None 0 -1.586 - 3 -1.44 Intercept DLM2 None 1 2.526 - 3 -3.3776** Intercept 0 -2.715* 7.373*** 3 -2.735* DLM2 None 1 2.526 - 3 8.065 Intercept 0		Trend & Intercept	0	-1.456	2.795	3	-1.35	Non-		
None 0 9.143 - 3 7.554 order 1 Intercept 0 -5.124*** 13.35*** 3 -5.08*** Intercept 0 -4.817*** 23.21*** 3 -4.795*** DLM0 None 4 -0.654 - 3 -1.458 Intercept 0 -2.715* 7.373*** 3 -2.735* Non-stationary: LM1 Intercept 0 -2.715* 7.373*** 3 -3.776** Non-stationary: DLM1 Intercept 0 -3.513** 12.339*** 3 -3.387** Integrated of order 1 DLM1 Intercept 0 -3.513** 12.339*** 3 -3.387** Integrated of order 1 DLM2 None 0 -1.765 3.793 3 -1.414 Integrated of order 1 Intercept 0 -3.737** 3 -2.735* LM2 None 1 2.526 - 3 8.065 Non-stationary: integrated of order 1	LM0	Intercept	0	-2.011	4.044	3	-2.463	Integrated of		
Trend & Intercept 0 -5.124*** 13.35*** 3 -5.08*** DLM0 None 4 -0.654 - 3 -4.795*** LM1 Trend & Intercept 1 -1.765 3.793 3 -1.458 LM1 Intercept 0 -2.715* 7.373*** 3 -2.735* None 1 2.526 - 3 8.065 stationary: DLM1 Intercept 0 -3.513** 12.339*** 3 -3.776** DLM1 Intercept 0 -3.513** 12.339*** 3 -3.387** DLM1 Intercept 0 -3.513** 12.339*** 3 -3.387** DLM2 None 0 -1.765 3.793 3 -1.44 Intercept 0 -2.715* 7.37*** 3 -3.776** Intercept 0 -3.513** 12.34*** 3 -3.776** DLM2 Intercept 0 -3.513** 1		None	0	9.143	-	3	7.554	order 1		
Intercept 0 -4.817*** 23.21*** 3 -4.795*** DLM0 None 4 -0.654 - 3 -1.458 LM1 Trend & Intercept 0 -2.715* 7.373*** 3 -2.735* None 1 2.526 - 3 8.065 stationary: stationary: Integrated of order 1 DLM1 Intercept 0 -3.933** 7.734*** 3 -3.376** DLM1 Intercept 0 -3.513** 12.339*** 3 -3.776** Intercept 0 -3.513** 12.339*** 3 -3.776** Intercept 0 -2.715* 7.734*** 3 -3.776** Intercept 0 -2.715* 7.373*** 3 -2.735* LM2 None 1 2.526 - 3 -3.87** DLM2 Intercept 0 -3.513** 12.34*** 3 -3.3776** Intercept 0 -3.513** 12.34***		Trend & Intercept	0	-5.124***	13.35***	3	-5.08***			
DLM0None4-0.654-3-1.458LM1Trend & Intercept0-2.715*7.373***3-2.735*Non- stationary: Integrated of order 1LM1Intercept0-2.715*7.373***3-2.735*Non- stationary: Integrated of order 1DLM1Trend & Intercept0-3.933**7.734***3-3.776**Non- stationary: Integrated of order 1DLM1Intercept0-3.513**12.339***3-1.311Integrated of 		Intercept	0	-4.817***	23.21***	3	-4.795***			
None 4 -0.654 - 3 -1.458 LM1 Trend & Intercept 0 -2.715* 7.373*** 3 -2.735* Non-stationary: Integrated of order 1 DLM1 Intercept 0 -3.933** 7.734*** 3 -3.776** Integrated of order 1 DLM1 Intercept 0 -3.513** 12.339*** 3 -3.387** Integrated of order 1 DLM1 Intercept 0 -1.586 - 3 -1.44 Integrated of order 1 Intercept 0 -2.715* 7.734*** 3 -3.387** Integrated of order 1 Intercept 0 -2.715* 7.733*** 3 -1.44 Integrated of order 1 Intercept 0 -2.715* 7.373*** 3 -2.735* Integrated of order 1 DLM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 Intercept 0 -3.513** 12.34*** 3 -3.387** <	DLM0									
LM1 Trend & Intercept 1 -1.765 3.793 3 -1.311 Intercept 0 -2.715* 7.373*** 3 -2.735* Non-stationary: Integrated of order 1 DLM1 Trend & Intercept 0 -3.933** 7.734*** 3 -3.776** Integrated of order 1 DLM1 Intercept 0 -3.513** 12.339*** 3 -1.311 None 0 -1.586 - 3 -1.44 Trend & Intercept 1 -1.765 3.793 3 -1.311 Intercept 0 -2.715* 7.373*** 3 -2.735* LM2 None 1 2.526 - 3 8.065 DLM2 Trend & Intercept 0 -3.933** 7.734*** 3 -3.76** DLM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 None 1 4.178** 10.936*** 3 -3.241 N		None	4	-0.654	-	3	-1.458			
Intercept 0 -2.715* 7.373*** 3 -2.735* Non-stationary: None 1 2.526 - 3 8.065 stationary: Integrated of order 1 DLM1 Intercept 0 -3.933** 7.734*** 3 -3.776** integrated of order 1 None 0 -1.586 - 3 -1.44 - Trend & Intercept 0 -2.715* 7.373*** 3 -2.735* Integrated of order 1 Intercept 0 -1.586 - 3 -1.44 - Intercept 0 -2.715* 7.373*** 3 -2.735* Non-stationary: Integrated of order 1 LM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 Intercept 0 -3.513** 12.34*** 3 -3.776** Stationary: Integrated of order 1 DLM3 Intercept 2 -1.033 6.946 3 -1.44 Non-stationary: Integrated o	LM1	Trend & Intercept	1	-1.765	3.793	3	-1.311			
None 1 2.526 - 3 8.065 stationary: Integrated of order 1 DLM1 Intercept 0 -3.933** 7.734*** 3 -3.776** Integrated of order 1 None 0 -1.586 - 3 -1.44 - Trend & Intercept 1 -1.765 3.793 3 -1.311 Intercept 0 -2.715* 7.373*** 3 -2.735* Non- LM2 None 1 2.526 - 3 8.065 Non- DLM2 Intercept 0 -3.933*** 7.734*** 3 -3.776** Non- Intercept 0 -3.933*** 7.734*** 3 -3.76** Non- DLM2 Intercept 0 -3.513** 12.34*** 3 -3.76** Non- LM3 Intercept 1 -4.178** 10.936*** 3 -2.241 Non- LM3 Intercept 1 -4.327*** 6.587***	2	Intercept	0	-2.715*	7.373***	3	-2.735*	Non-		
DLM1 Trend & Intercept 0 -3.933** 7.734*** 3 -3.776** Integrated of order 1 DLM1 Intercept 0 -3.513** 12.339*** 3 -3.387** order 1 None 0 -1.586 - 3 -1.44 - Intercept 0 -2.715* 7.373*** 3 -2.735* - LM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 Trend & Intercept 0 -3.933*** 7.734*** 3 -3.776** Non-stationary: Integrated of order 1 DLM2 Intercept 0 -3.513** 12.34*** 3 -3.776** Integrated of order 1 DLM3 Intercept 0 -1.586 - 3 -1.44		None	1	2.526	-	3	8.065	stationary:		
DLM1 Intercept 0 -3.513** 12.339*** 3 -3.387** Order 1 None 0 -1.586 - 3 -1.44 - Trend & Intercept 1 -1.765 3.793 3 -1.311 - Intercept 0 -2.715* 7.373*** 3 -2.735* Non- LM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 Intercept 0 -3.933*** 7.734*** 3 -3.387** Non- stationary: Integrated of order 1 DLM2 Intercept 0 -3.513** 10.936*** 3 -2.241 Non- stationary: Integrated of order 1 LM3 Intercept 1 -4.178** 10.936*** 3 -2.933 Integrated of order 1 DLM3 Intercept 1 -4.377*** 6.587*** 3 -2.933 Integrated of order 1 DLM3 Intercept 1 -4.302*** 9.495*** 3 -3		Trend & Intercept	0	-3.933**	7.734***	3	-3.776**	Integrated of		
None 0 -1.586 - 3 -1.44 Trend & Intercept 1 -1.765 3.793 3 -1.311 Intercept 0 -2.715* 7.373*** 3 -2.735* LM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 Intercept 0 -3.933*** 7.734*** 3 -3.776** None 0 -3.513** 12.34*** 3 -3.877** None 0 -1.586 - 3 -1.44 Mone 0 -1.586 - 3 -1.44 LM3 Intercept 1 -4.178** 10.936*** 3 -2.241 LM3 Intercept 1 -4.377*** 6.587*** 3 -2.933 Non-stationary: Integrated of order 1 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.9* Non-stationary: Integrated of order 1 RSD Intercept <td< td=""><td>DLM1</td><td>Intercept</td><td>0</td><td>-3.513**</td><td>12.339***</td><td>3</td><td>-3.387**</td><td>order i</td></td<>	DLM1	Intercept	0	-3.513**	12.339***	3	-3.387**	order i		
Trend & Intercept 1 -1.765 3.793 3 -1.311 Intercept 0 -2.715* 7.373*** 3 -2.735* LM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 Intercept 0 -3.933*** 7.734*** 3 -3.776** stationary: Integrated of order 1 DLM2 Intercept 0 -3.513** 12.34*** 3 -3.387** stationary: Integrated of order 1 DLM2 Intercept 0 -1.786 - 3 -1.44 stationary: Integrated of order 1 LM3 Intercept 1 -4.178** 10.936*** 3 -2.241 Non- stationary: Integrated of order 1 DLM3 Intercept 1 -4.377*** 6.587*** 3 -2.933 -1.144 None 0 -1.198 - 3 -2.93 -1.162 DLM3 Intercept 1 -4.958*** 10.126*** 3 -3.556* RSD Intercept 3 -0.619 - 3 -0.688 <td></td> <td>None</td> <td>0</td> <td>-1.586</td> <td>-</td> <td>3</td> <td>-1.44</td> <td></td>		None	0	-1.586	-	3	-1.44			
Intercept 0 -2.715* 7.373*** 3 -2.735* LM2 None 1 2.526 - 3 8.065 Non-stationary: Integrated of order 1 DLM2 Intercept 0 -3.933*** 7.734*** 3 -3.776** Integrated of order 1 DLM2 Intercept 0 -1.586 - 3 -1.44 Mone 0 -1.586 - 3 -1.44 Non-stationary: Integrated of order 1 LM3 Intercept 1 -4.178** 10.936*** 3 -2.241 LM3 Intercept 2 -1.033 6.946 3 -1.144 None 2 3.355 - 3 10.61 Non-stationary: Integrated of order 1 DLM3 Intercept 1 -4.377*** 6.587*** 3 -2.933 Integrated of order 1 RSD Intercept 1 -4.302*** 9.495*** 3 -2.355 Non- stationary: Integrated of order 1 RSD Intercept		Trend & Intercept	1	-1.765	3.793	3	-1.311			
LM2 None 1 2.526 - 3 8.065 Non-stationary: integrated of order 1 DLM2 Intercept 0 -3.933*** 7.734*** 3 -3.776** integrated of order 1 DLM2 Intercept 0 -3.513** 12.34*** 3 -3.387** integrated of order 1 None 0 -1.586 - 3 -1.44 Non-stationary: integrated of order 1 LM3 Intercept 2 -1.033 6.946 3 -1.144 LM3 Intercept 2 3.355 - 3 10.61 DLM3 Intercept 1 -4.377*** 6.587*** 3 -2.933 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.93 DLM3 Intercept 1 -4.928*** 10.126*** 3 -3.556* RSD Intercept 3 -0.619 - 3 -3.688 None 3 -0.619 - 3 <td></td> <td>Intercept</td> <td>0</td> <td>-2.715*</td> <td>7.373***</td> <td>3</td> <td>-2.735*</td> <td></td>		Intercept	0	-2.715*	7.373***	3	-2.735*			
DLM2 Trend & Intercept 0 -3.933*** 7.734*** 3 -3.776** stationary: Integrated of order 1 DLM2 Intercept 0 -3.513** 12.34*** 3 -3.87** integrated of order 1 None 0 -1.586 - 3 -1.44 integrated of order 1 LM3 Trend & Intercept 1 -4.178** 10.936*** 3 -2.241 None 2 3.355 - 3 10.61 Non- stationary: Integrated of order 1 DLM3 Trend & Intercept 1 -4.377*** 6.587*** 3 -2.933 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.9* None 0 -1.198 - 3 -1.112 Integrated of order 1 RSD Intercept 3 -1.135 2.654 3 -3.556* None 3 -0.619 - 3 -0.688 integrated of order 1 DRSD Intercept 2	LM2	None	1	2.526	-	3	8.065	Non-		
DLM2 Intercept 0 -3.513** 12.34*** 3 -3.387** Integrated of order 1 None 0 -1.586 - 3 -1.44 - LM3 Intercept 1 -4.178** 10.936*** 3 -2.241 None LM3 Intercept 2 -1.033 6.946 3 -1.144 Non-stationary: None 2 3.355 - 3 10.61 Non-stationary: DLM3 Intercept 1 -4.377*** 6.587*** 3 -2.933 order 1 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.933 order 1 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.933 order 1 RSD Intercept 3 -1.198 - 3 -3.556* Non-stationary: None 3 -0.619 - 3 -2.355 Non-stationary: None 3		Trend & Intercept	0	-3.933***	7.734***	3	-3.776**	stationary:		
None 0 -1.586 - 3 -1.44 LM3 Trend & Intercept 1 -4.178** 10.936*** 3 -2.241		Intercept	0	-3.513**	12.34***	3	-3.387**	Integrated of		
LM3 Trend & Intercept 1 -4.178** 10.936*** 3 -2.241 Intercept 2 -1.033 6.946 3 -1.144 Non-stationary: Integrated of order 1 DLM3 Trend & Intercept 1 -4.377*** 6.587*** 3 -2.933 Integrated of order 1 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.933 Integrated of order 1 None 0 -1.198 - 3 -1.112 Integrated of order 1 RSD Intercept 1 -4.958*** 10.126*** 3 -3.556* None 3 -1.135 2.654 3 -2.355 Non-stationary: Integrated of order 1 RSD Intercept 3 -1.135 2.654 3 -2.355 Non-stationary: Integrated of order 1 DRSD Intercept 2 -4.979*** 6.96*** 3 -3.921** Non-stationary: Integrated of order 1 DRSD Intercept 2 -4.877*** 3 -3.972*** <td>DLIVIZ</td> <td>None</td> <td>0</td> <td>-1.586</td> <td>-</td> <td>3</td> <td>-1.44</td> <td>order i</td>	DLIVIZ	None	0	-1.586	-	3	-1.44	order i		
LM3 Intercept 2 -1.033 6.946 3 -1.144 Non-stationary: integrated of order 1 DLM3 Trend & Intercept 1 -4.377*** 6.587*** 3 -2.933 integrated of order 1 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.933 integrated of order 1 None 0 -1.198 - 3 -1.112 - - RSD Intercept 1 -4.958*** 10.126*** 3 -3.556* Non-stationary: integrated of order 1 None 0 -1.198 - 3 -1.112 - - - RSD Intercept 1 -4.958*** 10.126*** 3 -3.556* Non-stationary: integrated of order 1 DRSD Intercept 2 -4.979*** 6.96*** 3 -3.921** Non-stationary: integrated of order 1 DRSD Intercept 2 -4.979*** 6.96*** 3 -3.921** Non-stationary: integrated of order 1		Trend & Intercept	1	-4.178**	10.936***	3	-2.241			
None 2 3.355 - 3 10.61 stationary: stationary: Integrated of order 1 DLM3 Trend & Intercept 1 -4.377*** 6.587*** 3 -2.933 Integrated of order 1 DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.933 Integrated of order 1 None 0 -1.198 - 3 -1.112 - RSD Trend & Intercept 1 -4.958*** 10.126*** 3 -3.556* None 3 -0.619 - 3 -0.688 . DRSD Intercept 2 -4.979*** 6.96*** 3 -3.921** None 2 -4.979*** 8.68*** 3 -3.921** .	LM3	Intercept	2	-1.033	6.946	3	-1.144	Non-		
DLM3 Trend & Intercept Intercept 1 -4.377*** -4.302*** 6.587*** 9.495*** 3 -2.933 -2.93 Integrated of order 1 None 0 -1.198 - 3 -1.112 - RSD Trend & Intercept 1 -4.958*** 10.126*** 3 -3.556* Non- stationary: None 3 -1.135 2.654 3 -2.355 Non- stationary: None 3 -0.619 - 3 -0.688 -0.688 None 2 -4.979*** 6.96*** 3 -3.921** -3.921** DRSD Intercept 2 -4.979*** 6.96*** 3 -3.921**	2.110	None	2	3.355	-	3	10.61	stationary:		
DLM3 Intercept 1 -4.302*** 9.495*** 3 -2.9* order 1 None 0 -1.198 - 3 -1.112 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - <t< td=""><td></td><td>Trend & Intercept</td><td>1</td><td>-4.377***</td><td>6.587***</td><td>3</td><td>-2.933</td><td>Integrated of</td></t<>		Trend & Intercept	1	-4.377***	6.587***	3	-2.933	Integrated of		
None 0 -1.198 - 3 -1.112 RSD Trend & Intercept 1 -4.958*** 10.126*** 3 -3.556* Intercept 3 -1.135 2.654 3 -2.355 Non-stationary: None 3 -0.619 - 3 -0.688 Integrated of order 1 DRSD Intercept 2 -4.979*** 6.96*** 3 -3.921** Integrated of order 1		Intercept	1	-4.302***	9.495***	3	-2.9*	order 1		
RSD Trend & Intercept 1 -4.958*** 10.126*** 3 -3.556* Intercept 3 -1.135 2.654 3 -2.355 Non-stationary: stationary: Integrated of order 1 None 3 -0.619 - 3 -0.688 stationary: Integrated of order 1 DRSD Intercept 2 -4.979*** 8.68*** 3 -3.881***	DEINO	None	0	-1.198	-	3	-1.112			
RSD Intercept 3 -1.135 2.654 3 -2.355 Non-stationary: stationary: None 3 -0.619 - 3 -0.688 stationary: Integrated of order 1 DRSD Intercept 2 -4.979*** 6.96*** 3 -3.921** Integrated of order 1 None 2 -4.798*** 8.68*** 3 -3.881*** Integrated of order 1		Trend & Intercept	1	-4.958***	10.126***	3	-3.556*			
None 3 -0.619 - 3 -0.688 stationary: Trend & Intercept 2 -4.979*** 6.96*** 3 -3.921** Integrated of order 1 DRSD Intercept 2 -4.798*** 8.68*** 3 -3.881***	RSD	Intercept	3	-1.135	2.654	3	-2.355	Non-		
DRSD Trend & Intercept 2 -4.979*** 6.96*** 3 -3.921** Integrated of order 1 None 2 -4.798*** 8.68*** 3 -3.881*** Integrated of order 1	ROD	None	3	-0.619	-	3	-0.688	stationary:		
DRSD Intercept 2 -4.798*** 8.68*** 3 -3.881***		Trend & Intercept	2	-4.979***	6.96***	3	-3.921**	Integrated of		
None 2 -4 877*** - 3 -3 072***	DRSD	Intercept	2	-4.798***	8.68***	3	-3.881***	order 1		
		None	2	-4.877***	-	3	-3.972***			

Tables 5.4 (a and b): Formal Unit Root Testing

Notes: Asterisks ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. The optimal lag lengths for the ADF tests are selected using the Akaike Information Criterion. The bandwidths for the PP-tests are fixed at 3 without using the Newey-West Bartlett Kernel selection as in other empirical works. The critical values for both the ADF and PP-tests are obtained from MacKinnon (1996) tables.

Table 5.4	Table 5.4b : Augmented Dickey Fuller and Philips-Peron Unit root tests								
			ADF			PP			
Variable	Model	Lag	$\boldsymbol{\tau}_{\tau},\boldsymbol{\tau}_{\mu},\boldsymbol{\tau}$	Φ_3, Φ_1	BW		Conclusion		
	Trend & Intercept	6	-1.378	3.804	3	-0.845	Non-stationary:		
LFCE	Intercept	7	2.024	3.868	3	1.056	order 1		
	None	2	3.065	-	3	6.943			
	Trend & Intercept	6	-2.37	3.285	3	-3.935**			
DLFCE	Intercept	5	-0.671	3.45	3	-3.611**			
	None	5	0.367	-	3	-1.728*			
	Trend & Intercept	0	-2.513	3.176	3	-2.69	Non-stationary:		
LEX	Intercept	0	-0.359	0.129	3	-0.341	Integrated of order 1		
	None	0	2.412	-	3	2.49			
	Trend & Intercept	0	-4.884***	11.963***	3	- 4.885*** -			
DLEx	Intercept	0	-4.969***	24.69***	3	4.978*** -			
	None	0	-4.171***	-	3	4.175***			
	Trend & Intercept	2	-1.542	7.23*	3	-1.225	Non-stationary:		
LGFCF	Intercept	2	0.573	5.531	3	0.398	Integrated of order 1		
	None	2	1.302	-	3	1.305			
	Trend & Intercept	1	-4.377***	6.41***	3	-3.547*			
DLGFCF	Intercept	0	-2.962*	8.773***	3	-2.975** -			
	None	0	-2.884***	-	3	2.903***			
	Trend & Intercept	0	-2.449	3.136	3	-2.511	Non-stationan/:		
LREER	Intercept	0	-2.17	4.71	3	-2.143	Integrated of		
	None	0	-0.442	-	3	-0.481	order 1		
	Trend & Intercept	0	-5.051***	12.774***	3	- 5.082*** -			
	Intercept	0	-5.034***	25.338***	3	5.038*** -			
DEREER	None	0	-5.077	-	3	5.078***			
	Trend & Intercept	5	-1.779	3.643	3	-2.783			
Inf	Intercept	5	-1.275	3.719	3	-1.243	Non-stationary:		
	None	5	-1.561	-	3	-1.027	Integrated of		
	Trend & Intercept	4	-2.275	9.721**	3	- 4.961*** -	order 1		
Dinfl	Intercept	4	-2.309	11.865**	3	5.094*** -			
	None	4	-2.051**	-	3	5.114***			

Notes: Asterisks ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively. The optimal lag lengths for the ADF tests are selected using the Akaike Information Criterion. The bandwidths for the PP-tests are fixed at 3 without using the Newey-West Bartlett Kernel selection as in other empirical works. The critical values for both the ADF and PP-tests are obtained from MacKinnon (1996) tables.

5.4.2 Bounds Testing for Cointegration

The first step of the ARDL-bounds testing procedure is to determine the lag lengths on the first differenced variables from the unrestricted models using the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC). The results of the AIC and SBC tests (not reported here) show that the optimal lag length is 2. This is equally in line with the rule of thumb that if annual data is used in a model, the maximum number of lags may not exceed three (see Charemza and Deadman, 1992). Attempts to fix the lags at 3 did not work as software rejected indicating inadequate sample size. The F-statistics of the bounds tests are given in Table 5.4.

In order to ascertain the presence of a long-run equilibrium relationship between monetary aggregates and determinants, a joint significance Wald-test (F-test) is conducted.. The estimated coefficients of lagged level variables in equation 5.4 are tested to establish whether they are zero under the null hypothesis of no long-run relationship. Specifically, the joint significant test is performed on $H_0: b_8 = b_9 = b_{10} = b_{11} = b_{12} = b_{13} = b_{14} = 0$ against the alternative hypothesis $H_1: b_8 \neq 0, b_9 \neq 0, b_{10} \neq 0, b_{11} \neq 0, b_{12} \neq 0, b_{13} \neq 0, b_{14} \neq 0$. Critical values of Narayan (2005:1987-90) are considered for this hypothesis test since the sample size in this study has 32 observations.

From these results presented in Table 5.4, it is shown that there is evidence of cointegration between regressors and broader definitions of money (M2 and M3). This is the case because the Wald-tests give F-statistics greater than upper bounds at 1% significance level. Narrower aggregates (M0 and M1) are not cointegrated with determinants, hence no further inference is considered for these models.

5.4.3 The ARDL Long-run Results

The ARDL long-run results from equation 5.4 for M2 and M3, based on several lag selection criteria are reported on Panel A of Table 5.5 and 5.6 respectively along with their model selection criteria. The diagnostic test results of equation 5.4 are also displayed in the respective columns of each model selection criteria in Panel B of Tables 5.5 and 5.6. In Panel A of Table 5.6, the results of the adjusted R-squared, AIC and HQN are exactly the same. Long run results are similar and statistically significant except for the long-run coefficient of final consumption expenditure. It has the expected magnitude and sign but statistically insignificant. In Panel B of 5.6, the M2 money demand model passes three out of four in the battery of diagnostic tests. All model selection criteria are reflecting that the model has a correct functional form, with residuals normally distributed and homoskedastic.

Monetary Aggregate	F-Statis	stic	Conc	lusion					
LMO	F(26,2)=	0.73	F(LM(below Hence	F(LM0/LFCE,LGFCF,LEx,LREER,Inf,RSD) is found below the lower bounds at all levels of significance. Hence no cointegration.					
LM1	F(26,2)=	(2)= 0.702 F(LM1/LFCE,LGFCF,LEx,LREER,Inf,RSD) is four below the lower bounds at all levels of significant Hence no cointegration.					RSD) is found f significance.		
LM2	F(26,2)=	4.48**	F(LM (the lor determ	F(LM2/LFCE,LGFCF,LEx,LREER,Inf,RSD) >4.148 (the lower bound) at 5%. M2 is cointegration with determinants.					
LM3	F(26,2)=	7.23**	F(LM2 (the lor determ	F(LM2/LFCE,LGFCF,LEx,LREER,Inf,RSD) >4.148 (the lower bound) at 5%. M2 is cointegration with its determinants.					
	Panel	B: Criti	cal Value (Naray	es for sn /an, 200	nall samp 5)	le sizes			
Critical valu	les for	10	%	C.	5%		1%		
Narayan		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)		
(2005p.1987	()	2.334	3.515	2.794	4.148	3.976	5.691		
Notes: The Asterisks ***, ** and * are depicting 1%, 5% and 10% significance respectively. Panel B displays applicable critical values of these tests									

Table 5.5: Results from the bounds tests for Cointegration Analysis

However M2 model fails against higher order serial correlation tests. This makes it a poor model and further inference on it is invalidated. Its error correction model results, for short-run estimates ought to be treated with a dose of scepticism. Higher order serial correlation can be attributed to multicollinearity detected earlier on in the correlation matrix presented in Table 5.2.

Table 5.6: M2 ARDL model and Diagnostic Tests.

Table 5.6: ARDL estim	ates and diagnostic test	ting (M2 is the	depend	ent variable)	
PANEL A: ARDL estim	ates				
	М	odel Selection	n Criteria	1	
Regressors	R^{-2}	AIC	SB	C HQN	
LM2(-1)	-0.214 (-1.32)	-0.214 (-1.32)	•	-0.214 (-1.32)	
LFCE	0.632	0.632	0.48	0.632	
LFCE(-1)	2.997***	2.997***	2.76***	2.997***	
LFCE(-2)	(4.697) 1.907*** (2.454)	(4.697) 1.907*** (2.454)	(5.465) 1.33***	(4.697) 1.907*** (2.454)	
LEx	0.279*	0.279*	0.266*	0.279*	
LEx(-1)	(1.807) 0.526***	(1.807) 0.526***	(1.92) 0.43***	(1.807) 0.526***	
LEx(-2)	(3.65) 0.535***	(3.65) 0.535***	(3.217) 0.382*	(3.65) ** 0.535***	
LGFCF	(3.93) -0.518**	<u>(3.93)</u> -0.518**	<u>(3.724)</u> -0.483	(3.93) *** -0.518**	
LGFCF(-1)	(-2.785) -0.59**	(-2.785) -0.59**	(-3.42) -0.467	(-2.785) ** -0.59**	
LGFCF(-2)	(-2.979) -0.278** (-2.251)	(-2.979) (-2.604) -0.278** -0.199*		(-2.979) -0.278** (-2.254)	
Inf	-0.013***	-0.013***	-0.012	*** -0.013***	
Inf(-1)	(-3.99) -0.016*** (-3.94)	(-3.99) (-4.287) -0.016*** -0.013) (-3.99) *** -0.016***	
LREER	0.226**	0.226**	0.209*	0.226**	
LREER(-1)	-0.096 (-1.1)	-0.096 (-1.1)	-0.131 (-1.613	-0.096	
RSD	0.013*** (4.65)	0.013*** (4.65)	0.014*	** 0.013*** (4.65)	
RSD(-1)	0.004 (1.383)	0.004 (1.383)		0.004 (1.383)	
Constants	-61.58*** (-7.256)	-61.58*** (-7.256)	-50.34 (-58.49	*** -61.58***) (-7.256)	
PANEL B: Diagnostic	Tests				
R^{-2}	AIC	SBC		HQN	
χ^2_{sc} (1)=5.372 (0.020)	χ^2_{sc} (1)=5.372 (0.020)	χ^2_{sc} (1)=5.803	8(0.016)	χ^2_{sc} (1)=5.372 (0.020)	
χ^2_{FF} (1)=0.346(0.556)	χ^2_{FF} (1)=0.346(0.556)	χ^2_{FF} (1)=0.346(0.556) χ^2_{FF} (1)=1.951(0.162) χ^2_{FF} (1)		χ^2_{FF} (1)=0.346(0.556)	
χ^2_N (2)=2.008(0.366)	χ^2_N (2)=2.008(0.366)	χ^2_N (2)=0.108(0.948) χ^2_N (2)=2.008		χ^2_N (2)=2.008(0.366)	
χ^2_H (1)=0.017(0.896)	χ^2_H (1)=0.017(0.896)	χ^2_H (1)=0.142(0.706) χ^2_H (1)=0.017(0)		χ^2_H (1)=0.017(0.896)	

The asterisks ***, ** and * denote the significance level at 1%, 5% and 10%. The absolute values of the t-ratios are in parenthesis. The original results can be viewed in Appendix C where the F-version of diagnostic tests can be seen as confirmatory evidence.

Table 5.7: M3 ARDL	estimates and diagnos	tic testing			
PANEL A: ARDL esti	mates				
	M	lodel Selectio	n Criteri	а	
Regressors	R^{-2}	AIC	SBC	HON	
LM3(-1)	-0.174	-0.063	020	-0.174	
	(-1.124)	(-0.307)		(-1.124)	
		-0.128			
LM3(-2)	0 514	(-0.839)	1.005	*** 0 54 4	
LECE	0.514	0.402	1.095	0.514	
	(1.452) 2 27***	2 33***	1 8/13	5) (1.452) *** 2.27***	
	(4.54)	(4 56)	(5 17	(4.54)	
LECE(-2)	2 156***	2.3***	1 305	*** 2 156***	
	(3.92)	(3.943)	(4 53	3) (3.92)	
I Fx	0.384***	0.358**	0.234	L** 0.384***	
	(3,499)	(3.098)	(2.43	9) (3.499)	
LEx(-1)	0.44***	0.45***	0.318	*** 0.44***	
(')	(3.635)	(3.652)	(3.35	5) (3.635)	
LEx(-2)	0.321***	0.331***	0.419	*** 0.321***	
()	(3.324)	(3.358)	(6.61	3) (3.324)	
LGFCF	-0.5***	-0.524***	-0.318	-0.5***	
	(-3.808)	(-3.849)	(-3.24	(-3.808)	
LGFCF(-1)	-0.255*	-0.281*	-0.284	4** -0.255*	
	(-1.828)	(-1.944)	(-2.2	3) (-1.828)	
LGFCF(-2)	-1.187**	-0.16 [*] -0.224 [*]		-1.187**	
	(-2.372)	(-1.856)	(-3.12	22) (-2.372)	
Inf	-0.006**	-0.007**	-0.006	6** -0.006**	
	(-2.64)	(-2.73)	(-2.84	18) (-2.64)	
Inf(-1)	-0.01***	-0.012*** -0.007		-0.01***	
	(-3.612)	(-3.594)	(-2.87	(-3.612)	
LREER	0.199*	0.205**	0.083	3* 0.199*	
	(3.1)	(3.135)	(2.00	5) (3.1)	
LREER(-1)	-0.043	-0.03		-0.043	
	(-0.656)	(-0.43)		(-0.656)	
LREER(-2)	-0.117	-0.128*		-0.117	
DOD	(-1.723)	(-1.823)	0.000	(-1.723)	
RSD	0.008	0.008	0.006	5) (1.122)	
	(4.432)	(4.106)	(4.95	5) (4.432) 0.0007	
K3D(-1)	-0.0007	-0.001		-0.0007	
	-0.004*	-0.013)		-0.004*	
RSD(-2)	(-1 844)	(-1 78)		(-1 844)	
100(2)	-56 1***	-56 88***	-48 23	6*** -56 1***	
Constants	(-7.455)	(-7.401)	(-92.5	58) (-7.455)	
PANEL B: Diagnosti	c Tests		X	, , , , ,	
R^{-2}	AIC	SBC		HQN	
χ^2_{sc} (1)=0.356 (0.551)	χ^2_{sc} (1)=0.187(0.665)	χ^2_{sc} (1)=0.038((0.846)	χ^2_{sc} (1)=0.356 (0.551)	
χ^2_{FF} (1)=5.599(0.018)	χ^2_{FF} (1)=5.286(0.021)	χ^2_{FF} (1) =0.042	2(0.837)	χ^2_{FF} (1)=5.599(0.018)	
$\chi^2_{\scriptscriptstyle N}$ (2)=2.59(0.274)	χ^2_N (2)=0.636(0.728)	χ^2_N (2)=1.779(0.411)	$\chi^2_{\scriptscriptstyle N}$ (2)=2.59(0.274)	
χ^2_H (1)=0.015(0.902)	χ^2_H (1)=0.013(0.910)	χ^2_H (1)=0.322((0.570)	χ^2_H (1)=0.015(0.902)	

Table 5.7: M3 APDL estimates and diagnostic testing

 χ_{sc}^2 , χ_{FF}^2 , χ_N^2 and χ_H^2 are Lagrange Multiplier (LM) statistics are the Breusch-Godfrey test for higher order serial correlation, the Ramsey RESET statistic for mis-specification bias, The Jarque-Bera statistic for normality and the Breusch. Pagan statistic for heteroskedasticity respectively. These statistics are distributed as Chi-square variates with degrees of freedom in parenthesis.

In Table 5.6, panels A and B are displaying the ARDL results and outcomes on the battery of diagnostic tests on residuals of M3 money demand model. The adjusted R-squared, AIC and HQN are showing that the model is a poor fit due to the prevalence of regression pathologies in it as given in Panel B. This is despite the evidence given in Panel A that long-run estimates are having *a priori* expected signs and are statistically significant. This is evidence that there are serial correlation problems and mis-specification errors in the model. However, as indicated in chapter four, these three model selection criteria cannot be relied on in small sample sizes.

However, the SBC reflects contradictory results. It shows that the model is a good fit. This is supported by Pesaran et al., (2001) that the SBC is parsimonious and gives better results in small sample sizes. Under this model selection criterion, long run estimates are all statistically significant except the proxy of investment (LGFCF) which is significant but comes with an unexpected negative sign. This could be attributed to multicollinearity problems detected earlier on in the correlation matrix in Table 5.2. There is high positive correlation between LGFCF and LFCE of 0.84, although it is less than the critical 0.9 mark. Positive correlation between LFCE and LEX of 0.95 might have introduced multicollinearity problems affecting the sign of LGFCF. Despite these shortcomings, the results of the SBC are satisfactory and hence the results of its subsequently presented auxiliary error correction model are equally valid.

5.4.4 Computation of Long-run Elasticities

This study employs the Bardsen (1989) procedure to derive the log-run elasticities from the ARDL as the variables are cointegrated. These are derived from the coefficient of one lagged level exogenous variable divided by the coefficient of the lagged level endogenous variable multiplied by a negative sign. For instance, in equation 5.4, the long-run coefficient

of final consumption is $-\begin{pmatrix} b_9 \\ b_8 \end{pmatrix}$. The coefficients for export expenditure, investment, short-

term interest rate, exchange rate and inflation are $-\begin{pmatrix}b_{11}\\b_8\end{pmatrix}, -\begin{pmatrix}b_{10}\\b_8\end{pmatrix}, -\begin{pmatrix}b_{12}\\b_8\end{pmatrix}, -\begin{pmatrix}b_{13}\\b_8\end{pmatrix}$ and $-\begin{pmatrix}b_{14}\\b_8\end{pmatrix}$ respectively.

Table 5.8: Long-run	elasticities	for M2	and M3
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Table 5.8: Estimated Long Run Coefficients based on the Schwarz Bayesian Criterion								
PANEL A : M2 as dependent variable								
Regressor	Coefficient	Standard Error	T-ratio	p-value				
LFCE	4.572	0.099	46.073	0.000				
LEx	1.079	0.093	11.603	0.000				
LGFCF	-1.149	0.05	-22.895	0.000				
Inf	-0.025	0.003	-7.994	0.000				
LREER	0.078	0.071	1.089	0.293				
RSD	0.014	0.002	7.836	0.000				
С	-50.34	0.861	-58.49	0.000				
PANEL B: M3 as	s dependent v	ariable						
Regressor	Coefficient	Standard Error	T-ratio	p-value				
LFCE	4.243	0.07	60.589	0.000				
LEx	0.971	0.062	15.749	0.000				
LGFCF	-0.827	0.03	-27.832	0.000				
Inf	-0.012	0.002	-6.262	0.000				
LREER	0.083	0.042	2.005	0.062				
RSD	0.006	0.001	4.955	0.000				
С	-48.236	0.521	-92.579	0.000				

In Panel A, the long-run elasticities for M2 are displayed. The long-run elasticity for final consumption expenditure is 4.57. It is a positive elasticity, statistically significant at 1% and conforms to *a priori* expectations, but its magnitude is relatively too high. It shows that it is a major determinant of M3 money demand in South Africa over the period under investigation. The implication is that the demand for money in South Africa is influenced more by private consumption expenditure and government consumption expenditure. This is contrary to Ziramba (2007) whose long-run elasticity on final consumption expenditure on M2 was -0.17 and paradoxical to theoretical expectations. The long-run elasticities on other determinants: exports expenditure, investment expenditure, inflation, real effective exchange rate and short-term interest rate are 1.08, -1.15, -0.02, 0.78 and 0.014, respectively. In Panel B, the long-run elasticities for final consumption expenditure, investment expenditure, exports expenditure, investment expenditure, inflation, the real effective exchange rate and short-term interest rate are 4.23, 0.97, -0.83, -0.01, 0.08 and 0.006, respectively.

For both M2 and M3, the long-run elasticities for final consumption are highly elastic and statistically significant. Their magnitudes can be benchmarked by the long-run elasticity for Indonesia that was estimated at 5.39 (see Tang, 2007). The export elasticity of money demand is elastic for M2 but seemingly inelastic for M3. For both models, the long-run coefficient for exports expenditure is positive and conforms to *a priori* expectations. The investment elasticities for M2 and M3 are negative, elastic for M2 and inelastic for M3. These findings support the arguments of Tang (2002, 2004) and Ziramba (2007) that there is bias in using a single, aggregated, income variable as a scale variable in money demand investigations.

The inflation elasticity of money demand is negative at -0.03 and -0.01 for M2 and M3 respectively. The inelastic or insignificant relation of inflation on money demand is supported by Pinga and Nelson (2001:1280-1) in similar studies in Indonesia, Malaysia, the Philippines, Thailand and Singapore. The semi-elasticity with respect to the short-term interest rate is positive for both M2 and M3. This is supported by the McKinnon-Shaw complementary hypothesis; hence meet apriori expectations (see Ansari, 2002:81). The parameter estimates with respect to the real effective exchange rate are 0.078 and 0.083 for M2 and M3 respectively. These exchange rate semi-elasticities points to the currency substitution effect as explained by Al-Samara (2009), an indication of the propensity to hold more of the Rand by households with lesser expectations of its depreciation (see Sriram, 2009:15) and Al-Samara (2010:12).

5.4.5 The ARDL-ECM for Short-run Estimates

At this stage, given that M2 and M3 are cointegrated with their determinants, the unrestricted error correction model, expressed through 5.4, is estimated. The objective is to capture the short-run dynamics into the long-run relationship. According to Dritsakis (2011), short-run deviations can occur due to shocks in any of the variables of the model. Hence, the dynamics governing the short-run behaviour of broad money demand are different from those in the long-run. More focus is given to the SBC criterion due to its advantages discussed in Chapter 4. Short-run estimates are statistically significant and are in correct sign, except *LGFCF*, in Table 5.8 for M2. The same is true with short-run estimates for M3 in Table 5.9. The SBC gives statistically significant estimates, except *DLFCE*.

SBC HQ 1,1,1) (0,2,2,2,1,1,0) (1,2,2,2,1,1,1
<u>1,1,1) (0,2,2,2,1,1,0) (1,2,2,2,1,1,1</u>
0.48 0.632
(1.362) (1.514)
-1.333 ^{***} -1.907 ^{***}
(-3.254) (-3.154)
0.266* 0.279*
(1.921) (1.807)
-0.382*** -0.535***
(-3.724) (-3.933)
-0.483*** -0.518**
(-3.42) (-2.785)
0.199* 0.278**
(1.968) (2.351)
-0.012*** -0.013***
(-4.287) (-3.99)
0.209*** 0.226***
(2.934) (2.829)
0.014*** 0.013***
(7.835) (4.652)
-50.34*** -61.58***
(-58.49) (-7.705)
-1 -1.21
0.89 0.89
4 0.0066332 0.0054564
2.78 2.64
00) 25.08(0.000) 26.71(0.000)
6 0

Table 5.9: M2 ARDL-ECM Short-run Estimates

The speed of adjustment coefficients are negative for both M2 and M3. In both models the SBC indicates that the error term coefficient is -1. This is an indication that there is total adjustment (100%) of deviations from long-run equilibrium in the short-run. In other words, there is full adjustment of disequilibrium effects in the short-run over a period of a year. The signs of the speed of adjustment coefficient are consistent with *a priori* expectations.

Table 5.10: Error Correction Representation of ARDL					
Model Selection Criteria					
	\overline{R}^2	AIC	SBC	HQ	
Regressors	(1,2,2,2,1,2,2)	(2,2,2,2,1,2,2)	(0,2,2,2,1,0,0)	(1,2,2,2,1,2,2)	
DLM3(-1)		0.128			
		(0.839)			
DLFCE	0.514	0.402	1.095***	0.514	
	(1.452)	(1.048)	(4.725)	(1.452)	
DLFCE(-1)	-2.156***	-2.3***	-1.305***	-2.156***	
	(-3.921)	(-3.942)	(-4.533)	(-3.921)	
DLEx	0.384***	0.358***	0.234**	0.384***	
	(3.499)	(3.098)	(2.44)	(3.499)	
DLEx(-1)	-0.321***	-0.331***	-0.419***	-0.321***	
	(-3.324)	(-3.358)	(-6.613)	(-3.324)	
DLGFCF	-0.5***	-0.524***	-0.319***	-0.5***	
	(-3.808)	(-3.849)	(-3.245)	(-3.808)	
DLGFCF(-1)	0.187**	0.16*	0.224***	0.187**	
	(2.372)	(1.856)	(3.122)	(2.372)	
DInf	-0.006**	-0.007**	-0.006*	-0.006**	
	(-2.636)	(-2.73)	(-2.848)	(-2.636)	
DLREER	0.199***	0.205***	0.083*	0.199***	
	(3.105)	(3.134)	(2.005)	(3.105)	
DLREER(-1)	0.117	0.128*		0.117	
	(1.723)	(1.822)	0 000+++	(1.723)	
DRSD	0.009***	0.008***	0.006***	0.009***	
	(4.432)	(4.106)	(4.955)	(4.432)	
DRSD(-1)	0.004^	0.004^		0.004^	
	(1.844)	(1.781)	40.000	(1.844)	
	-56.1^^^	-56.88^^^	-48.236	-56.1^^^	
C	(-7.455)	(-7.401)	(-92.58)	(-7.455)	
ECM(-1)	-1.17	-1.19	-1	-1.17	
\overline{R}^2	0.92	0.92	0.91	0.92	
RSS	0.0020729	0.0019367	0.0035731	0.0020729	
DW-statistic	2.13	2.08	1.97	2.13	
F-statistic	31.033(0.000)	27.93(0.000)	30.75(0.000)	31.033(0.000)	
Notes: The absolute values of t-ratios are in parenthesis. RSS stands for the residual sum of					
squares. The asterisks ****, ** and * denote 1, 5 and 10 percent statistical significance.					
Notably, the results from \overline{R}^2 , AIC and HQN are the same. Complete results can be viewed from appendices, which is the researchersqown output from Microfit 4.					

Table 5.10: M3 ARDL-ECM Short-run Estimates

The error correction term is statistically significant in both M2 and M3. It is a more powerful indication that M2 and M3 are cointegrated with their determinants as indicated in a variety of applied econometrics literature. The DW-statistics is 1.97 in M3 model which confirms that the model is free from first-order serial correlation. The DW-statistic on M2 is 2.78, which is still within the rejection region of the null hypothesis of first order serial correlation. For M3, the adjusted R-squared is 0.92 implying that 92% of the variation is explained in the model and is an indication that the model is a good fit. For M2, the adjusted R-squared is 0.89

against the SBC, which shows that the model is also a good fit. However, its fitness has been compromised by the detection of higher order serial correlation.

5.5 Results for Structural and Parameter Stability Tests

In the final analysis M3 money demand is considered for stability tests in this study due to the consistency in the behaviour of the model from the previous analysis. In order to conduct the stability tests, the estimations of equation 5.4 are focused as the auxiliary model for the M3 money demand. Once again, the SBC is selected as a more parsimonious model due to its relative ability to give better statistical fitness than others. Although the CUSUM and CUSUM-SQ stability tests were performed across all model selection criteria, only the SBC graphical presentations are shown. Tests for M2 are also not shown, but were also done. They are not reported, but are available from the researcher on request.



Figure 5.3: Plot of Cumulative Sum of Recursive Residuals

Figure 5.4: Plot of Cumulative Sum of Squares of Recursive Residuals



It can be seen in Figure 5.3, where the plots of the CUSUM are within the critical bounds at 5 percent significance level. The CUSUM are plotted for the first set of *n* observations. The plot deviates with reversion to the zero line, hence confirming structural stability. The CUSUM-SQ confirms both structural stability and parameter stability, by plotting the cumulative sum of squares of recursive residuals. The plot is also within the critical bounds as depicted in Figure 5.4. Hence, M3 money demand is structurally stable and parameters are also stable over the period under investigation. M2 was also found stable, although the CUSUM and CUSUM-SQ have not been reported. It is imperative to note that the global financial crisis did not have any adverse impact on the demand for money in South Africa.

Conclusion

Empirical analysis has been conducted successfully in Eviews 7 and Microfit 4. Analysis has been accomplished in three phases. In the first phase, preliminary tests to establish integration properties of data have been accomplished. The intermediate phase was seen with the implementation of the bounds testing procedure, determination of long-run estimates and diagnostic inspection for regression pathologies. Long-run elasticities have been computed and interpreted while short-run estimates have been determined to explore dynamic relationships. In the final phase, structural stability as well as parameter stability has been checked for.

In a nutshell, broader definitions of money, M2 and M3 have been found cointegrated with their determinants. Narrower definitions, M0 and M1 have been found not cointegrated with their determinants. There is also evidence for the study to support the notion that disaggregated components of income could give a better reflection of money demand, thereby avoiding the aggregation bias of using aggregated real income variables such as GDP or GNP. However, M3 has been found to be a better model than M2. Since M3 is the targeted definition of money supply for monetary policy formulation, stability tests were focused on it. Apparently, M3 is found stable over the reference period despite the global financial crisis and other internal sources of shocks.

CHAPTER SIX

Conclusion – Summary, Policy Recommendations and Evaluation

Introduction

This chapter consists of four sections. A summary of empirical findings is given in Section 6.1 before policy recommendations are discussed in Section 6.2. A general critique is presented in Section 6.3 to appreciate the strengths and weaknesses of the study. Section 6.4 provides implications for future research before a conclusion is given for the chapter.

6.1 Summary of Empirical Findings

The study finds that broad money demand is a stable function of disaggregated income expenditure components, with focus on M2 and M3 in South Africa between 1980 and 2011. This is despite the impact of the global financial crisis since 2007. Narrow definitions, M0 and M1 have been found not cointegrated with their determinants. Hence interest to confirm their long-run stability has been thwarted at that point. For M2 and M3, exogenous variables do share a long-run cointegrating relationship. Of significance, is the confirmation that disaggregated expenditure components have different influences on money demand. This is in line with findings by Ziramba (2007) although this study brings signal with a variation. In Ziramba (2007), final consumption expenditure, exports expenditure and investment expenditure have a positive influence for M1 and M2. The M3 model has negative coefficients for exports and final consumption. However, results have a different signal and it is established that final consumption expenditure and exports are positively related to money demand while investment exerts a negative influence. The results of this study, in this regard, are empirically consistent with Tang (2002, 2007) for Malaysia and Tang (2007) for the Philippines.

The Keynesian school of thought advocates that the interest rate is a key variable in the money demand model. In the Keynesian model, economic agents are expected to hold money for transactions purposes and for speculative motives. Such motives are to some extent driven by the rate of interest as an opportunity cost variable. In this regard, the relationship between money demand is expected to be negative. However, this study finds a positive interest rate semi-elasticity of money demand which is a contradictory phenomenon to both Keynesian and Monetarist perspectives. Other previous researchers have found positive interest semi-elasticity (see Nell (1999)) and considered their findings paradoxical.

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From the findings of this study, it can be deduced that the unexpected sign of the short-term interest rate is attributed to the nature of money demand, where the transactions motive is the core-driver of this relationship. This is evidenced and confirmed by highly elastic coefficients of final consumption expenditure for both M2 and M3. Therefore, it can be argued that this sign is not paradoxical, but empirically consistent with Nell (1999) although this comparison is made on different specifications. To say the positive sign on the short-term interest rate is not conforming to *a priori* expectations can be an inaccurate assertion. Ansari (2002), supports the positive sign by arguing that it is plausible in developing countries to have such a relationship between money demand and the short-term interest rate. Instead the response by economic agents to higher interest rates by holding money in the form of longer-term fixed deposits (which are part of M3) perpetrates the positive short-term interest semi-elasticity of money demand. The South African money demand model estimated in this study concurs with such a school of thought and hence justified.

6.2 Policy recommendations

The findings of this study have important policy implications on the management of monetary policy in South Africa. Conduct of monetary policy by focusing on broader monetary aggregate (M3) as an intermediate target has been instrumental in the inflation targeting framework of South Africa. Hence reliable quantitative estimates are pivotal towards achieving a better understanding, by monetary authorities of relationships underpinning money demand. Stability of long-run money demand for broad money is confirmed, particularly M3, which is an indication that the M3 definition of money supply remains an appropriate instrument of monetary policy for the South African Reserve Bank (SARB) authorities. However, absence of a stable long-run relationship and is of lesser concern to monetary policy formulation and inflation-targeting in South Africa.

For policy design, the primary indication of the findings of this study is that M3 money supply is a more preferable intermediate target than the interest rate. At the same time, they are notable policy implications observed on disaggregated expenditure components. Effective management of M2 and M3 growth is recommended with fiscal policies focused on consumption expenditure by both households and government in South Africa. This is motivated by highly elastic log-run coefficients on final consumption expenditure for both M2 and M3 as the major driver of money demand in South Africa. Thus, a prudent and complementary fiscal policy on consumption by government and households is critical for a successful inflation-targeting monetary policy.

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Other things being equal, the exchange rate semi-elasticity of money demand has a bearing on the effectiveness of monetary policy. The positive long-run coefficient, seemingly, is an incentive to good conduct of monetary policy by SARB. In a flexible exchange rate regime, if the demand for money indeed depends upon the exchange rate apart from the levels of interest rates and income, the monetary policy effects on income and employment may be compromised (Tang, 2007:9). Monetary policy would lose its effectiveness if the impact of depreciation is negative on money demand (Bahmani-Oskooee and Pourheydcrian, 1990). However, broad money is exchange rate inelastic implying that the probability of realising destabilised money balances by the exchange rate turbulence is not a source of worry, *ceteris paribus*.

The negative and positive feedback by inflation and the short-term interest rate, respectively is an issue of lesser concern. This is because of the semi-elasticities of inflation and the short-term interest rates that are significantly inelastic. This is evidence that any monetary policy adjustments that have an effect on inflation or interest-rates may not have an adverse impact on broad monetary aggregates.

6.3 Evaluation of Study

Econometric time series software that automatically and conveniently selects an optimal ARDL lag structure for each of the several model selection criteria after the researcher has set the maximum lag length is Microfit (Pesaran and Pesaran, 1997). The advantages of Pesaran et al.,(2001) framework of cointegration analysis have been discussed at length in Chapter four. Methodologically, the adoption of this bounds testing approach in this study brings all the advantages as incentives. According to Chigusiwa, Bindu, Mudavanhu, Muchabaiwa & Muzambi (2011), this framework is less tedious as there is no need to classify variables according to their integration properties. Hence, this circumvents the inaccuracies of standard unit root tests in cases where there is a structural break thereby increasing the stability of the model (Chigusiwa et al., 2011:119). Therefore the researcher takes the methodology employed in this study as superior in the class of other cointegration techniques. However, the limited data handling capacity of Microfit 4 made it impossible to include more than 10 variables, hence exclusion of dummy variables. The assumption of the existence of a single cointegrating vector in a linear cointegrating relationship ought to be viewed with caution.

The study brings an alternative money demand specification to Ziramba (2007). The same expenditure components are incorporated, but the vector of opportunity cost variables is different. Inflation is introduced into the model while the long-term interest rate is excluded. The exchange rate is maintained. This specification gives a contribution to the empirical

literature gap. Furthermore, a new data set is utilised. Ziramba (2007) findings were from an analysis before the impact of the global financial crisis. Hence, there is a recognisable time lapse that makes the findings outdated. The time gap has precipitated a re-estimation of the money demand function to check for its stability against macroeconomic developments.

Notably, the drawbacks are also present with identified strengths. The model has been built and tested on assumption that money supply is weakly exogenous. Hence, it suffers marginally from endogeneity problems and issues related to ergodicity. The exclusion of dummy variables to investigate the impact of structural breaks is a disincentive to the study. There are also suspected spurious correlations in the model. Misspecification bias might not have been totally eradicated. The exclusion of the long term interest rate and the nominal exchange rate in solving multicollinearity in preliminary experiments in the study, are still a bone of contention.

For instance, the inclusion of both inflation and the real effective exchange rate in the vector of opportunity cost variables is a definite source of multicollinearity. Tang (2007) suggests that there is a bias of incorporating the real exchange rate and inflation jointly. The reasoning behind this is that there is an inflation component in the formula used to convert the nominal exchange rate to a real variable. However, efforts to try and eradicate this bias from the model did not give positive results. Under these circumstances, it becomes difficult to separate the correlation between inflation and the real exchange rate, in a co-linear relationship, from their respective correlations with money supply as the endogenous variable.

Empirical modelling is an art. The choice of variables to explain an economic relationship is influenced by a host of factors ranging from the availability of economic statistical data and ability to select the best proxy variables. The selection of the most representative interest rate in any money demand model has been a controversial issue in empirical studies of the subject (see Bain and Howells, 2003 Hence, the choice of the interest rate on notice deposits (1-32 day) as a representative short-term interest rate was a result of availability considerations and computational convenience. Therefore, this choice might have introduced some bias and compromised the quality of results from this analysis.

Economic research relies on secondary data sources from databases in the National Statistics System (NSS) of South Africa and beyond. The study has utilised economic statistics from Statistics South Africa and the South African Reserve Bank. Inflation rates and CPI time series have been sourced from the Price statistics division of StatsSA, hence a primary source. All other variables are from the SARBop statistical databases. However, there are quality issues around the time series against the arguments that the quality of

economic statistics in South Africa is not to the expected standards as yet. Efforts to improve quality of economic statistics have introduced distortions in the time series and compromised their quality to some extent. For example, the consumer price index crisis of 2003 at Statistics South Africa caused discrepancies in the CPI data (South African Statistics Council, 2006:14). The GDP estimates and expenditure component series are influenced by the quality of business surveys at StatsSA and SARB in terms of response rates and quality of imputation strategies they employ to cater for non-response. Economic indicators such as GDP and its expenditure components are collected from secondary administrative data from businesses and organs of the state. Hence, such estimates are subject to error and may bias the money demand equation in one direction or the other. As a result, the negative impact of inadequate quality of economic time series data cannot be taken for granted in this research, given that it is beyond the researchers control.

The sample size considered for empirical estimations in this study is relatively small. Earlier intentions to utilise quarterly data to widen the sample size did not give statistically plausible results. Results from preliminary experiments (not reported in chapter five) proved that quarterly data was noisy. Thus, the alternative to use annual data solved the challenge and results reflected statistical adequacy. Therefore, the effect of the sample size on loss of degrees of freedom is a methodological weakness of this study.

6.4 Implications for Future Research

The positive sign on the short-term interest rate has been suspected to have been influenced by the rate of inflation. The impact of inflation and short-term interest rate on money demand, in the absence of the long-term interest rate has not been found in theory nor empirical literature. It would be a worthy cause to investigate such relationships in future research. On the methodological front, as far as is known, not much has been done in South Africa in terms of estimating money demand using non-linear cointegration techniques. Thus, there is need for a departure from the culture of assuming linear money demand relationships that are routinely estimated via single equation cointegration techniques or systems approaches.

It is imperative that more effort be invested on investigating the characteristic features of interest rates in South Africa before any is chosen to be a representative rate in any money demand model. There is a need to explore money demand relationships by trying alternative variables representing the level of transactions in the economy and alternative combinations of opportunity cost variables. For instance, very little has been done to model money demand using short-term indicators (high frequency data) on proxies of scale variables such as the index of industrial production in South Africa. Available empirical literature on the

history on money demand investigations in South Africa, to date, reflect that not much has been done to investigate the impact of financial innovation on money demand. Effects of financial innovation can be captured by varying the definition or measurement of the dependent variables with the use of divisia indexes as measures of money supply and interest rates (Bain and Howells, 2003:155).

Conclusion

It is crucial that monetary authorities shift focus to sectoral implications of money demand for effective monetary and fiscal policies in South Africa. In order for them to achieve desired policy objectives, policy makers ought to consider the influence of disaggregated components of real income to identify specific input and feedback on these against their policy instruments. This avoids the aggregate bias. Researchers may also take the same direction and investigated sectoral money demand functions to back up policy design and management.

To sum up, research on money demand has been extensively conducted in South Africa, yet there are still gaps in empirical literature. Most of the results presented prior to the era of error correction models are statistically deficient and their results ought to be treated with caution. In this study, stability of money demand has been empirically tested and satisfactory evidence confirms a long-run equilibrium relationship between broader monetary aggregates, M2 and M3, in South Africa from 1980 to 2011. The global economic meltdown, so far, has not induced structural instabilities in this crucial relationship. Thus in line with Poolec analysis (1970), the key lesson is that money supply is a relevant monetary policy instrument and a crucial intermediate target by South African Reserve Bank. Turning a blind eye on this assertion may give rise to unprecedented turbulence in the aggregate output level of the economy and have adverse impacts on other macroeconomic fundamentals.

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Appendix A: Critical values for the ADF stationarity tests and critical values for the standard normal distribution.

Depending on the model selected to test for the presence of a unit root in a time series, the augmented Dickey Fuller test is based on the Mackinnon critical values. These follow a phidistribution which is nonstandard and asymptotic. Statistical significance is based on the computed F-statistic against critical values matching the closest sample size. The rejecting of the null hypothesis ultimately depends on the twin test of the ADF statistic against the critical values of the standard normal distribution if the F-statistic has been found statistically significant.

Sample	Proba	Probability of a smaller value						
Size(T)	0.01	0.025	0.05	0.10	0.90	0.95	0.975	0.99
25	074	0.90	1.08	1.33	5.91	7.24	8.65	10.61
50	0.76	0.93	1.11	1.37	5.61	6.73	7.81	9.31
100	0.76	0.94	1.12	1.38	5.47	6.49	7.44	8.73
250	0.76	0.94	1.13	1.39	5.39	6.34	7.25	8.43
500	0.76	0.94	1.13	1.39	5.36	6.30	7.20	8.34
∞	0.77	0.94	1.13	1.39	5.34	6.25		7.16
8.27								

Empirical Distribution of ϕ_3

Source : Dickey and Fuller (1981)

Empirical Distribution of ϕ_1										
Sample			Proba	Probability of a smaller value						
Size(T)	0.01	0.025	0.05	0.10	0.90	0.95	0.975	0.99		
25	0.29	0.38	0.49	0.65	4.12	5.18	6.30	7.88		
50	0.29	0.39	0.50	0.66	3.94	4.86	5.80	7.06		
100	0.29	0.39	0.50	0.67	3.86	4.71	5.57	6.70		
250	0.30	0.39	0.51	0.67	3.81	4.63	5.45	6.52		
500	0.30	0.39	0.51	0.67	3.79	4.61	5.41	6.47		
∞	0.30	0.40	0.51	0.67	3.78	4.59		5.38		
6.43										

Source : Dickey and Fuller (1981)

Critical Valu	es for the	Standard Normal	l Distribution – n	(0,1)
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					())	
0.01	0.025	0.05	0.10	0.90	0.95	0.975
0). <u>99</u>					
-2.33	-1.96	-1.65	-1.28	1.28	1.65	1.96
2	2.33					

Appendix B1: M0 Bounds	Test Cointegration	Results
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* * * * * * * * * * * * * * * * * *	*******	******	*****	* * * * * * * * * * * * * * * * * * * *	*
	Dep	endent va	riable is DLMO		
29 ob	servations u	used for e	stimation from 3	1983 to 2011	
* * * * * * * * * * * * * * * * * *	*******	* * * * * * * * *	* * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*
Regressor	Coeffi	cient	Standard Erro	or T-Ratio[Prob]	
С	-87.	5435	48.3988	-1.8088[.212]	
DLM0(-1)	.8	87513	.64082	1.3656[.305]	
DLM0(-2)	4	9552	.55455	89356[.466]	
DLFCE	2.	7130	3.0450	.89097[.467]	
DLFCE(-1)	-2.	3177	3.5740	64848[.583]	
DLFCE(-2)	-2.	4953	3.3247	75054[.531]	
DLGFCF	-1.	8906	1.6042	-1.1785[.360]	
DLGFCF(-1)	2.	9387	1.7218	1.7068[.230]	
DLGFCF(-2)	1.	4968	1.1943	1.2533[.337]	
DLEX	.2	9273	1.0084	.29030[.799]	
DLEX(-1)	-2.	1748	1.5994	-1.3598[.307]	
DLEX(-2)	-3.	3165	1.9425	-1.7074[.230]	
DLREER	1.	1142	.66397	1.6781[.235]	
DLREER(-1)	4	2649	.72046	59197[.614]	
DLREER(-2)	-1.	2654	.82597	-1.5321[.265]	
DINF	.03	81959	.030947	1.0327[.410]	
DINF(-1)	01	4874	.024032	61893[.599]	
DINF(-2)	.002	9386	.019854	.14801[.896]	
DRSD	.02	2786	.014916	1.5276[.266]	
DRSD(-1)	03	34777	.034745	-1.0009[.422]	
DRSD(-2)	05	52938	.035569	-1.4883[.275]	
LMO(-1)	-1.	8750	1.0210	-1.8364[.208]	
LFCE (-1)	6.	0749	3.6022	1.6865[.234]	
LGFCF(-1)	-2.	4476	1.6346	-1.4974[.273]	
LEX(-1)	3.	6700	2.1578	1.7008[.231]	
LREER(-1)	1.	0969	.73271	1.4970[.273]	
RSD(-1)	.05	9478	.044759	1.3289[.315]	
* * * * * * * * * * * * * * * * * * *	**********	********	* * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*
R-Squared		.90435	R-Bar-Squared	33913	
S.E. of Regressio	n	.080090	F-stat. F(2	26, 2) .72727[.729]	
Mean of Dependent	Variable	.12546	S.D. of Depende	ent Variable .069210	
Residual Sum of S	quares	.012829	Equation Log-1:	ikelihood 70.8393	
Akaike Info. Crit	erion	43.8393	Schwarz Bayesia	an Criterion 25.3808	
	DW-stati	stic	3.2	257	
* * * * * * * * * * * * * * * * * *	**********	********	* * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*

Ordinary Least Squares Estimation

Diagnostic Tests

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*	Test Statistics	*	LM Ve	rsion	*	1	F Versi	on	*
* * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * *	* * * * * *	* * * * * * * * * * * *	* * * * * * *	* * * * *	* * * * * * *	*******	* * *
*		*			*				*
* 2	A:Serial Correlation	n*CHSQ(1)=	*NONE *	*F(1,	1)=	*NONE*	*
*		*			*				*
* E	B:Functional Form	*CHSQ (1)=	*NONE*	*F(1,	1)=	*NONE*	*
*		*			*				*
* (C:Normality	*CHSQ(2)=	*NONE *	*	Not	t appli	cable	*
*		*			*				*
* I	D:Heteroscedasticit	y*CHSQ(1)=	.28483[.594]*F(1, 2	27) =	.26782[.60	9]*
* * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * *	* * * * * *	********	******	* * * * * *	* * * * * * *	**********	* * *

A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values

Appendix B2: M1 Bound	s Test	Cointegration	Results
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	Ordinary Least	Squares Estimation	
* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *
	Dependent v	ariable is DLM1	
2	9 observations used for	estimation from 198	3 to 2011
* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*******
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
С	-24.5725	79.4727	30919[.786]
DLM1 (-1)	60920	1.3078	46583[.687]
DLM1 (-2)	85391	1.1949	71461[.549]
DLFCE	52510	5.3939	097351[.931]
DLFCE(-1)	2.5235	5.0520	.49950[.667]
DLFCE(-2)	3.5094	7.0771	.49588[.669]
DLGFCF	63393	2.3877	26550[.815]
DLGFCF(-1)	59700	1.8501	32268[.778]
DLGFCF(-2)	.46469	1.2880	.36079[.753]
DLEX	1.0367	1.6150	.64190[.587]
DLEX(-1)	.63469	3.1687	.20030[.860]
DLEX(-2)	57273	1.5828	36185[.752]
DLREER	.35196	.83292	.42256[.714]
DLREER(-1)	61193	1.1749	52084[.654]
DLREER(-2)	46966	.88040	53346[.647]
DINF	035321	.046145	76543[.524]
DINF(-1)	038661	.053544	72204[.545]
DINF(-2)	0050160	.036976	13566[.905]
DRSD	.039492	.029205	1.3523[.309]
DRSD(-1)	015877	.039044	40664[.724]
DRSD(-2)	016707	.040928	40820[.723]
LM1(-1)	47072	1.4986	31410[.783]
LFCE(-1)	.39956	4.9304	.081040[.943]
LGFCF(-1)	.0086394	1.8259	.0047315[.997]
LEX(-1)	1.7714	4.0736	.43484[.706]
LREER(-1)	.40858	.74210	.55057[.637]
RSD(-1)	.036808	.074528	.49388[.670]
* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *
R-Squared	.90123	R-Bar-Squared	38282
S.E. of Regre	ssion .10978	F-stat. F(26,	2) .70186[.741]
Mean of Depend	dent Variable .14749	S.D. of Dependent	Variable .093357
Residual Sum (of Squares .024104	Equation Log-like	lihood 61.6946
Akaike Info. (Criterion 34.6946	Schwarz Bayesian	Criterion 16.2361
	DW-statistic	2.9641	L
* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *
	Diagno	stic Tests	

*	* * * * * * * * * * * * * * * * * * * *	*********	******	***********	* * * * * * *	* * * * * *	******	*******	* * *
*	Test Statistics	*	LM Ver	sion	*	E	Versi	on	*
*	* * * * * * * * * * * * * * * * * * * *	********	******	**********	* * * * * * *	* * * * *	* * * * * *	*******	* * *
*		*			*				*
*	A:Serial Correlation	n*CHSQ(1)=	*NONE *	*F(1,	1)=	*NONE*	*
*		*			*				*
*	B:Functional Form	*CHSQ(1)=	*NONE *	*F(1,	1)=	*NONE*	*
*		*			*				*
*	C:Normality	*CHSQ(2)=	*NONE *	*	Not	: appli	cable	*
*		*			*				*
*	D:Heteroscedasticity	/*CHSQ(1)=	.33805[.561]]*F(1, 2	27) =	.31845[.57	7]*
÷.,		+++++++++			+ + + + + + +				+++

A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values

Appendix B3: M2 Bounds Test Cointegration Results

	Ordina	ry Least	Squares	Estimati	on			
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * *	* * * * * * * *	********	*******	****	* * * * * * *	* * * * * * *	* * * * * * * *
	Dep	endent '	variable	is DLM2				
29 obser	vations	used for	estimati	lon from	1983	to 201	1	
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * *	* * * * * * * *	********	*******	****	* * * * * * *	*****	* * * * * * * *
Regressor	Coeff	icient	Star	ndard Err	or		T-Ratio	o[Prob]
C	-50	.1116		44.3212			-1.130	6[.376]
DLM2 (-1)		47317		.49100			9636	91.4371
DLM2(-2)		41274		26972			-1.530	3[266]
DLECE	• 2	6378		1 2685			2 079	6[173]
DIFCE(-1)	_ 0	80264		2 0758		_	03866	6 0731
DIFCE(-1)	.0	200204		1 7620			.03000	0[.973]
DLFCE (-2)	1			1.7039			. / 0 / / 1	9[.JIJ]
DLGFCF		22044		.698/8			3154	/[./82]
DLGFCF(-1)	•	31300		.65521			.4///0	0[.680]
DLGFCF(-2)	0	23876		.349/6		-	.06826.	3[.952]
DLEX	•	35935		.49248			.7296	9[.541]
DLEX(-1)	'	72693		1.0731			67740	0[.568]
DLEX(-2)		19425		.68695			28278	8[.804]
DLREER		13209		.18789			.70304	4[.555]
DLREER(-1)		16660		.32208			5172	5[.657]
DLREER (-2)		10218		.28012			.3647	7[.750]
DINF	00	93176		.011308			82400	0[.497]
DINF(-1)	00	98582		.0091884			-1.072	91.3961
DINF(-2)	- 00	60877		0097015			- 62750	0[594]
DRSD		12119		0055923			2 167	1 [163]
	- 00	69130		011019			- 6273	6 [594]
	- 00	36567		013047			- 2802	6[806]
DR3D(-2)	.00	06202		013047			_1 1002	0[.000]
LMZ (-1)		90292		.00375			1 1 200	0[.334]
LFCE (-1)	3	.9199		3.4666			1.1300	8[.3/6]
LGFCF(-I)		9/482		1.0841			8991	/[.463]
LEX(-1)	T	.5220		1.4419			1.055	5[.402]
LREER(-1)	•	10532		.44056			.2390	5[.833]
RSD(-1)	.0	33728		.014923			2.260	1[.152]
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * *	* * * * * * * *	********	********	****	******	*****	* * * * * * * *
R-Squared		.98311	. R-Bar-	Squared				.76356
S.E. of Regression		.031480) F-stat	:. F(26,	2)	4.4778	8[.199]
Mean of Dependent Va	riable	.13961	S.D. (of Depend	lent '	Variabl	e	.064741
Residual Sum of Squa	res	.0019820) Equati	lon Log-l	ikel	ihood		97.9193
Akaike Info. Criteri	on	70.9193	Schwai	rz Bayesi	an C	riterio	n !	52.4608
	DW-stati	stic		3.	2210			
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * *	* * * * * * * *	********	*******	****	* * * * * * *	* * * * * *	* * * * * * * *
		Diagn	ostic Tes	ts				
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * *	*******	*******	*******	****	******	*****	* * * * * * * *
* Test Statistics	*	I.M. Ver	sion	*		F Vers	ion	*
***************	* * * * * * * * *	*******	*********	*******	****	******	******	* * * * * * * *
*	*			*				*
* A.Corial Corrolatio	~ * CUSO (1) —	*NONE *	* 🖓 (1	1) -	*NONE:	* *
* A.Seriai Correlatio	ц.сцэд(*	1)-	"NONE"	т. Т. (±,	1)-	NONE	
	******	1.	4.37.0.37E.4		1	1.	+ 110117	
* B:Functional Form	*CHSQ(1)=	*NONE*	× F. (1,	⊥)=	*NONE	* *
*	*			*				*
* C:Normality	*CHSQ(2)=	*NONE*	*	No	ot appl	lcable	*
*	*			*				*
* D:Heteroscedasticit	y*CHSQ(1)=	.42321[.5	515]*F(1,	27)=	.3998	6[.532]*
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * *	* * * * * * * *	********	*******	****	* * * * * * *	*****	* * * * * * * *
A:Lagrange multiplier test	of resi	dual se	rial corr	elation				
B:Ramsey's RESET test usir	ng the so	uare of	the fitt	ed value	S			
C:Based on a test of skewr	less and	kurtosi	s of resi	duals				
D:Based on the regression	of squar	ed resi	duals on	squared	fitte	d value	es	

Ordinary Least Squares Estimation								
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*****					
Dependent variable is DLM3								
29 obser	vations used for	estimation from 1983 t	0 2011					
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *					
Regressor	Coefficient	Standard Error	T-Ratio[Prob]					
С	-79.9979	67.4004	-1.1869[.357]					
DLM3(-1)	.010322	.54552	.018921[.987]					
DLM3(-2)	53109	.29888	-1.7770[.218]					
DLFCE	1.9237	1.1495	1.6736[.236]					
DLFCE(-1)	-2.0825	3.2351	64374[.586]					
DLFCE(-2)	.060747	1.8526	.032790[.977]					
DLGFCF	54542	.50874	-1.0721[.396]					
DLGFCF(-1)	.45203	.56783	.79606[.509]					
DLGFCF(-2)	.21884	.22839	.95818[.439]					
DLEX	.53814	.35580	1.5125[.270]					
DLEX(-1)	91537	1.2090	75714[.528]					
DLEX(-2)	36952	.67118	55056[.637]					
DLREER	.13608	.11696	1.1634[.365]					
DLREER(-1)	092737	.21356	43424[.706]					
DLREER(-2)	0082003	.21031	038992[.972]					
DINF	0082875	.0080574	-1.0286[.412]					
DINF(-1)	0088810	.0061847	-1.4360[.288]					
DINF(-2)	0045344	.0084389	53732[.645]					
DRSD	.0074273	.0037826	1.9635[.189]					
DRSD(-1)	0012052	.0076518	15751[.889]					
DRSD(-2)	.6703E-3	.0094517	.070916[.950]					
LM3(-1)	-1.6156	1.3268	-1.2177[.348]					
LFCE (-1)	6.4569	5.3683	1.2028[.352]					
LGFCF(-1)	-1.2680	1.1564	-1.0965[.387]					
LEX(-1)	2.0659	1.8097	1.1416[.372]					
LREER(-1)	.17331	.36635	.47307[.683]					
RSD(-1)	.016312	.011929	1.3673[.305]					
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*****					
R-Squared	.98947	R-Bar-Squared	.85261					
S.E. of Regression	.019492	F-stat. F(26,	2) 7.2298[.129]					
Mean of Dependent Va	riable .13344	S.D. of Dependent Va	riable .050772					
Residual Sum of Squa	res .7599E-3	Equation Log-likelih	lood 111.8207					
Akaike Info. Criteri	on 84.8207	Schwarz Bayesian Cri	terion 66.3622					
	DW-statistic	2.9924						
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*****					

Appendix B4: M3 Bounds Test Cointegration Results

Diagnostic Tests

* * * * * * * * * * * * *	******	* * * * * * * * *	* * * * * *	********	*******	*****	* * * * * *	******	****
* Test Sta	tistics	*	LM Ve	rsion	*		F Vers	ion	*
* * * * * * * * * * * * *	* * * * * * * *	* * * * * * * * *	* * * * * *	* * * * * * * * * *	* * * * * * * *	*****	*****	* * * * * * * * *	* * * * *
*		*			*				*
* A:Serial Co	rrelatio	n*CHSQ(1)=	*NONE*	*F(1,	1)=	*NONE*	*
*		*			*				*
* B:Functiona	l Form	*CHSQ (1)=	*NONE*	*F(1,	1)=	*NONE*	*
*		*			*				*
* C:Normality		*CHSQ (2)=	*NONE*	*	Nc	ot appl	icable	*
*		*			*				*
* D:Heterosce	dasticit	y*CHSQ(1)=	.95261[.3	329]*F(1,	27)=	.91704[.	347]*
+++++++++++++++++++++++++++++++++++++++	* * * * * * * *	* * * * * * * * *	*****	********	*******	*****	* * * * * *	*******	* * * * *

A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values

Au ARDL(1,2,2,2	toregres: ,1,1,1) s	sive Di elected	stribute d based o	d Lag Est on R-BAR \$	imate Squar	es ed Crit	cerion	
* * * * * * * * * * * * * * * * * * * *	*******	*****	*******	********	****	*****	*****	*
20	Dep	endent	variable r octimat	e is LMZ	1000	to 201	1	
10 USet	valions u	******	L ESLIMAN	.TOU TLOU	1902 ****	LO ZUI	_⊥ : * * * * * * * * * * * * * *	*
Begressor	Coeffi	cient	S+ :	ndard Fr	ror		T-Patio[Prob]	
IM2(-1)	- 1	Q/12	500	1599/	LOI		-1 2137 [246]	
LECE	• 1	3756		10912			1 31/0[212]	
LFCE(-1)	• 3	0579		65234			4 6876[000]	
LFCE(-2)	2	0102		63308			3 1753[007]	
LEX	.2	9187		.15750			1.8531[.087]	
LEX(-1)		4007		15204			3 5522[004]	
LEX(-2)	.5	1430		.14407			3.5699[.003]	
LGECE	5	5676		.19767			-2.8166[.015]	
LGFCF(-1)	5	6654		20635			-2.7456[.017]	
LGFCF (-2)	3	0972		.12172			-2.5444[.024]	
INF	01	1898		.0032374			-3.6751[.003]	
INF (-1)	01	6677		.0042028			-3.9680[.002]	
LNEER	.2	1429		.077352			2.7704[.016]	
LNEER(-1)	1	4494		.077529			-1.8695[.084]	
RSD	.01	3212		.0026855			4.9197[.000]	
RSD(-1)	.003	3319		.0030196			1.1034[.290]	
C	-62.	0225		9.0655			-6.8416[.000]	
* * * * * * * * * * * * * * * * * * * *	********	*****	*******	*******	****	******	**********	*
R-Squared		.9998	7 R-Bai	-Squared			.99972	
S.E. of Regression		.020778	3 F-sta	at. F(16,	13)	6497.5[.000]	
Mean of Dependent Va	riable	12.5871	1 S.D.	of Depend	dent	Variabl	le 1.2441	
Residual Sum of Squa	res .	0056124	4 Equat	ion Log-i	likel	ihood	86.1915	
Akaike Info. Criteri	on	69.1915	5 Schwa	arz Baves:	ian C	riteric	on 57.2813	
DW-statistic		2.6250	6 Durbi	.n's h-sta	atist	ic	-3.5527[.000]	
* * * * * * * * * * * * * * * * * * * *	******	*****	*******	* * * * * * * * *	****	******	********	*
		Diagn	ostic Te	sts				
* * * * * * * * * * * * * * * * * * * *	******	*****	* * * * * * * * * *	*******	****	******	**********	*
* Test Statistics	*	LM Ver	rsion	*		F Vers	sion	*
* * * * * * * * * * * * * * * * * * * *	******	*****	* * * * * * * * * *	* * * * * * * * * *	* * * * *	******	*****	*
*	*			*				*
* A:Serial Correlatio	n*CHSQ(1)=	5.3328[.021]*F(1,	12)=	2.5943[.133]	*
*	*			*				*
* B:Functional Form	*CHSQ(1)=	.92915[.335]*F(1,	12)=	.38354[.547]	*
*	*			*				*
* C:Normality	*CHSQ(2)=	2.2635[.322]*	Ν	ot appl	icable	*
*	*			*				*
* D:Heteroscedasticit ********	y*CHSQ(*******	1)=	.068832[*******	.793]*F(1, *****	28)= ******	.064391[.802]	*
A:Lagrange multiplie:	r test of	residu	ual seria	l correla	ation			
B:Ramsey's RESET tes	t using t	he squa	are of th	e fitted	value	es		
C:Based on a test of	skewness	and ku	urtosis c	f residua	als			
D:Based on the regre	ssion of	squared	d residua	ls on squ	lared	fitted	values	

Appendix C1: Adjusted- R-squared – ARDL model and diagnostic test results for M2

Appendix C2: AIC – ARDL model and diagnostic test results for M2

Au ARDL(1,2,2,2,1, ******	toregres 2,1) sel	sive Dia ected ba	stribu ased on	ed La 1 Akai	ıg Esti .ke Inf	mate: ormat	s tion Cr *****	riterior *******	l ******
30 observ	Dep	endent sed for	variab	le is ation	LM2 from	1982	to 201	1	
**********************	********	******	******	*****	******	*****	*****	_ * * * * * * *	******
Regressor LM2 (-1) LFCE LFCE (-1) LFCE (-2)	Coeffi 2 .3 .3 .2	cient 28876 32901 1835 3684	S	tanda:	rd Erro 18771 46308 66659 73429	or		T-Ratio -1.5383 .71047 4.7759 3.2254	[Prob] [.150] [.491] [.000] [.007]
LEX LEX(-1) LEX(-2)	. 3	37188 51565 18959		•	17814 17118 14663			2.0875 3.5965 3.3389	[.059] [.004] [.006]
LGFCF LGFCF(-1) LGFCF(-2)	6 5 3	50683 54635 32387			20475 20787 12288			-2.9637 -2.6283 -2.6357	[.012] [.022] [.022]
INF INF(-1) LNEER	01 01	.0889 .8030 24786		.00.	34078 44380 84914			-3.1953 -4.0627 2.9190	[.008] [.002] [.013]
LNEER(-1) LNEER(-2) RSD	1 07 .01	2960 7915 3941		.0. .0: .00:	79304 80379 27948			-1.6342 96934 4.9881	[.128] [.352] [.000]
RSD(-1) C **************************	.003 -65.	33877 5866 *******	*****	.00 9 *****	30272 .8024 ******	* * * * *	****	1.1191 -6.6909 ******	[.285] [.000] ******
R-Squared S.E. of Regression Mean of Dependent Var Residual Sum of Squar Akaike Info. Criterio DW-statistic	ciable ces . on	.99988 .020826 12.5871 .0052048 69.3223 2.7385	R-B F-s S.D Equ Sch Dur	ar-Squ tat. . of 1 ation warz 1 bin's	uared F(Depende Log-l: Bayesia h-sta	17, ent V ikeli an Cr tisti *****	12) ariable hood iterior c ******	6087.0 e n 5	.99972 [.000] 1.2441 7.3223 6.7116 *NONE* *******
		Diagn	ostic :	lests					
* * * * * * * * * * * * * * * * * * * *	*******	******	*****	* * * * *	* * * * * *	* * * * *	*****	******	******
 * Test Statistics 	*	LM Ver	sion		*		F Vers	ion	*
* * * * * * * * * * * * * * * * * * * *	*	******	*****	*****	* * * * * *	****	*****	******	*******
* A:Serial Correlation *	n*CHSQ(*	1)=	7.4465	[.006]]*F(*	1,	11)=	3.6319	[.083]* *
* B:Functional Form *	*CHSQ(*	1)=	1.4504	[.228]]*F(*	1,	11)=	.55882	[.470]* *
* C:Normality *	*CHSQ(*	2)=	2.7796	[.249]* *	No	t appl	icable	*
* D:Heteroscedasticity *****	/*CHSQ(********	1)=.1	961E-3	[.989 *****]*F(******	1, *****	28)= . *****	1831E-3 ******	[.989]* ******
A:Lagrange multiplier B:Ramsey's RESET test C:Based on a test of D:Based on the regres	test of using t skewness sion of	residu he squa and ku squared	al ser re of rtosis resid	ial co the fi of re uals c	orrelat itted v esidual on squa	ion value s ared	s fitted	values	

Appendix C3: SBC – ARDL model and diagnostic test results for M2

ARDL(0,2,2,2,1,1,0) selected based on Schwarz Bayesian Criterion	
* * * * * * * * * * * * * * * * * * * *	
	* * * * *
Dependent variable is LM2	
30 observations used for estimation from 1982 to 2011	
***************************************	* * * * *
Regressor Coefficient Standard Error T-Ratio[P	rob]
LFCE .48040 .35273 1.3620[.	193]
LFCE(-1) 2.7586 .50474 5.4654[.	000]
LFCE(-2) 1.3331 .40973 3.2536[.	005]
LEX .26620 .13855 1.9213[.	074]
LEX(-1) .43157 .13417 3.2167[.	006]
LEX(-2) .38152 .10244 3.7242[.	002]
LGFCF48283 .14118 -3.4199[.	004]
LGFCF(-1)46661 .17918 -2.6041[.	020]
LGFCF(-2)19917 .10122 -1.9677[.	068]
INF011757 .0027422 -4.2874[.	001]
INF(-1)012950 .0034695 -3.7326[.	002]
LREER .20895 .071218 2.9340[.	010]
LREER(-1)13134 .081414 -1.6133[.	128]
RSD .013693 .0017475 7.8359[.	000]
C -50.3362 .86056 -58.4924[.	000]
* * * * * * * * * * * * * * * * * * * *	* * * * *
R-Squared .99985 R-Bar-Squared .9	9971
S.E. of Regression .021029 F-stat. F(14, 15) 7249.4[.	[000
Mean of Dependent Variable 12.5871 S.D. of Dependent Variable 1.	2441
Residual Sum of Squares .0066332 Equation Log-likelihood 83.	6849
Akaike Info. Criterion 68.6849 Schwarz Bayesian Criterion 58.	1759
DW-statistic 2.7829	
* * * * * * * * * * * * * * * * * * * *	* * * * *
Diagnostic Tests	
* * * * * * * * * * * * * * * * * * * *	* * * * *
* Test Statistics * LM Version * F Version	*
* * * * * * * * * * * * * * * * * * * *	* * * * *
* * * *	*
* A:Serial Correlation*CHSQ(1)= 5.8037[.016]*F(1, 14)= 3.3580[.	88]*
* * *	*
* B:Functional Form *CHSQ(1)= 1.9510[.162]*F(1, 14)= .97380[.	340]*
* * *	*
* C:Normality *CHSQ(2)= .10771[.948]* Not applicable	*
* * *	*
* D:Heteroscedasticity*CHSQ(1)= .14225[.706]*F(1, 28)= .13340[.	718]*
* * * * * * * * * * * * * * * * * * * *	

Au Ardi. (0, 2, 2, 2	toregress	ive Dis	tributed I	Lag Est Hannan	imate	es un Crite	arion		
***************************************	*********	******	********	******	⊻u⊥ı. *****	******	******	******	**
	Depe	ndent. v	variable i	s LM2					
30 observ	ations us	sed for	estimatio	n from	1982	to 201	1		
* * * * * * * * * * * * * * * * * * * *	****	******	******	******	*****	******	*****	* * * * * *	**
Regressor	Coeffic	ient	Stand	ard Eri	for		T-Ratio	o[Prob	1
LFCE	.48	3545		.34092			1.424	0[.175	1
LFCE(-1)	2.7	634		.50162			5.508	9.000	1
LFCE (-2)	1.4	275		.41061			3.476	6[.003	1
LEX	.26	5480		.13770			1.923	1[.074]]
LEX(-1)	.46	5272		.14159			3.268	0[.005]
LEX(-2)	.38	829		.11700			3.318	8[.005]
LGFCF	51	208		.14701			-3.483	2[.003]
LGFCF(-1)	46	531		.18329			-2.538	7[.023]
LGFCF(-2)	22	2545		098694			-2.284	3[.037]
INF	010	289	.0	027803			-3.700	5[.002]
INF(-1)	013	8613	.0	034484			-3.947	7[.001]
LNEER	.19	232		067808			2.836	3[.013]]
LNEER(-1)	14	396		070524			-2.041	3[.059]
RSD	.013	3475	.0	016880			7.983	2[.000]]
С	-51.4	428		2.9739		-	17.298	3[.000]]
* * * * * * * * * * * * * * * * * * * *	******	******	********	******	****	******	*****	* * * * * *	**
R-Squared		.99985	R-Bar-S	quared				.99972	2
S.E. of Regression		020914	F-stat.	F (14,	15)	7329.	5[.000]]
Mean of Dependent Var	iable 1	2.5871	S.D. of	Depend	dent '	Variabl	е	1.2443	1
Residual Sum of Squar	es .C	065607	Equatio	n Log-l	Likel	ihood	:	83.849	7
Akaike Info. Criteric	in 6	58.8497	Schwarz	Bayesi	lan C	riterio	n .	58.340	7
I	DW-statis	tic		2.	7927				
* * * * * * * * * * * * * * * * * * * *	******	******	*******	******	*****	******	*****	*****	**
		Diagno	stic Tests	5					
* * * * * * * * * * * * * * * * * * * *	*******	******	*********	******	****	*****	******	* * * * * * *	**
* Test Statistics	*	LM Vers	sion	*		F Vers	ion		*
* * * * * * * * * * * * * * * * * * * *	*******	******	******	******	****	*****	*****	* * * * * * *	**
*	*			*					*
* A:Serial Correlation	.*CHSQ((1) = 0	5.3092[.01	2]*F(1,	14)=	3.728	4[.074]*
*	*			*					*
* B:Functional Form	*CHSQ((1) = 2	2.2891[.13	0]*F(1,	14)=	1.156	5[.300]*
*	*	~		*					*
* C:Normality	*CHSQ(∠)= .(148093[.97	ю]* 	N	ot appl	icable		*
* D. II.+	*	1 \	270001 54	× ⊃1≁⊡/	1	201	2504		*
 D:Heteroscedasticity 	~~CHSQ(⊥)= . 	.3/088[.54	2] _ F. (, L	∠8)= *******	.3504	91.229	1×
	*********	*******	· · · · · · · · · · · · · · · · · · ·	******	*****	* * * * * * *	* * * * * *	* * * * * * *	**
A:Lagrange multiplier	lest oI	restang	i serial (correla	LLION				

Appendix C4: HQN – ARDL model and diagnostic test results for M2

A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values

Ap	pendix	D1: A	diusted-R-So	uared – ARDL	model and dia	anostic test	t results for M3

Autoreo	gressive Distr	ibuted Lag Estimates	3							
ARDL(1,2,2,2,1,2,2) selected based on R-BAR Squared Criterion										
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *							
	Dependent va	riable is LM3								
30 observatio	ns used for e	stimation from 1982	to 2011							
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *							
Regressor Co	efficient	Standard Error	T-Ratio[Prob]							
LM3(-1)	20130	.17883	-1.1257[.284]							
LFCE	.59374	.33181	1.7894[.101]							
LFCE(-1)	2.2409	.52839	4.2409[.001]							
LFCE(-2)	2.1795	.60681	3.5917[.004]							
LEX	.38752	.11711	3.3089[.007]							
LEX(-1)	.44825	.13761	3.2574[.008]							
LEX(-2)	.32663	.10192	3.2049[.008]							
LGFCF	51603	.14916	-3.4595[.005]							
LGFCF(-1)	24335	.15182	-1.6029[.137]							
LGFCF(-2)	19288	.083630	-2.3063[.042]							
INF -	.0049939	.0025056	-1.9931[.072]							
INF(-1)	010180	.0030441	-3.3444[.007]							
LNEER	.16449	.062235	2.6430[.023]							
LNEER(-1)	082122	.061764	-1.3296[.211]							
LNEER(-2)	092821	.059918	-1.5491[.150]							
RSD	.0089475	.0020431	4.3795[.001]							
RSD(-1) -	.0011824	.0023847	49583[.630]							
RSD(-2) -	.0038574	.0023642	-1.6316[.131]							
С	-56.6525	8.5005	-6.6646[.000]							
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	****							
R-Squared	.99994	R-Bar-Squared	.99985							
S.E. of Regression	.014575	F-stat. F(18,	11) 10796.9[.000]							
Mean of Dependent Variabl	e 12.7727	S.D. of Dependent V	ariable 1.1932							
Residual Sum of Squares	.0023367	Equation Log-likeli	hood 99.3351							
Akaike Info. Criterion	80.3351	Schwarz Bayesian Cr	iterion 67.0237							
DW-statistic	2.0430	Durbin's h-statisti	c58419[.559]							
* * * * * * * * * * * * * * * * * * * *	****	* * * * * * * * * * * * * * * * * * * *	*****							

Di	aq	ynd	S	t:	ic	2]	[€	95	s t	::	3
 		1.1							1		1	

* :	* * * * * * * * * * * * * * * * * * * *	********	****	*****	* * * * * * *	****	******	***********	k	
*	Test Statistics	*	LM V	ersion	*		F Vers	ion '	k	
* :	* * * * * * * * * * * * * * * * * * * *	********	****	*****	******	****	*****	******	k	
*		*			*			,	k	
* *	A:Serial Correlation	n*CHSQ(*	1)=	.049249[.824]*F(*	1,	10)=	.016443[.901]	* *	
* *	B:Functional Form	*CHSQ(*	1)=	7.8549[.005]*F(*	1,	10)=	3.5470[.089]	* *	
* *	C:Normality	*CHSQ(*	2)=	2.1214[.346]* *	No	ot appl	icable ,	k k	
*	* D:Heteroscedasticity*CHSQ(1)= .3940E-8[1.00]*F(1, 28)= .3677E-8[1.00]*									
P	A:Lagrange multiplier test of residual serial correlation									

B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values

Appendix D2: AIC – ARDL model and diagnostic test results for M3

Dependent variable is IM3 30 observations used for estimation from 1982 to 2011 ***********************************	Aut ARDL (1,2,2,2,1,2	coregressiv 2,2) select ********	ve Distr ted base	ibuted La d on Akai	ag Estim .ke Info ******	nates ermation (********	Criterion *********	* * *
30 observations used for estimation from 1982 to 2011 Regressor Coefficient Standard Error T-Ratio[Prob LMS(-1) 20130 .17883 -1.1257[.284 LFCE .59374 .33181 1.7894[.101 LFCE(-1) 2.2409 .52839 4.2409[.001 LFCE(-2) 2.1795 .60681 3.5917[.004 LEX .33752 .11711 3.3089[.007 LEX(-2) .22663 .10192 3.2049[.008 LGFCF 51603 .14916 -3.4595[.005 LGFCF(-2) 19288 .083630 -2.3063[.042 INF 0049939 .0025056 -1.9391[.072 INF(-1) 010180 .003041 -3.3444[.007 INFER .16449 .062235 .26430[.023 INEER(-1) 082122 .061764 -1.3296[.211 INEER(-2) 0038574 .0023847 45838[.630 RSD(-2) 0038574 .0023842 -1.6316[.131 C -56.6525 8.5005 -6.664		Depen	ident vai	riable is	LM3			
Regressor Coefficient Standard Error T-Ratio[Prob LM3(-1) 20130 .17883 -1.1257[.284] LFCE .59374 .33181 1.7894[.101] LFCE (-1) 2.2409 .52839 4.2409[.001] LFCE (-2) 2.1795 .60681 3.5917[.004] LEX .38752 .11711 3.089[.007] LEX(-1) .44825 .13761 3.2574[.008] LEGCF 51603 .14916 -3.4595[.005] LGFCF (-1) 24335 .15182 -1.6029[.137] LGFCF(-2) 19288 .003630 -2.3063[.042] INF (-1) 010180 .0030441 -3.3444[.007] LMEER (-1) 082122 .061764 -1.3296[.211] INEER (-1) 082821 .059918 -1.5491[.510] RSD (-2) 0038574 .0023642 -1.6316[.131] C -56.6525 8.5005 -6.6464[.000] Residual Sum of Squares .0023367 Equation Log-likelihood 99.33	30 observ	ations use	d for es	stimation	from 1	982 to 20	11	
Regressor Coefficient Standard Effor T-Ratio[PF00 LM3(-1) 20130 .17883 -1.1257].284 LFCE .59374 .33181 1.7894[.101 LFCE(-1) 2.2409 .52839 4.2409[.001 LFCE(-2) 2.1795 .60681 .3.5917[.004 LEX .38752 .11711 3.3089[.007 LEX(-1) .44825 .13761 3.2574[.008 LEX(-2) .32663 .10192 3.2049[.008 LGFCF(-2) 16235 .16023[.042 .16029[.137 LGFCF(-2) 19288 .083630 -2.3063[.042 INF 0049939 .0025056 -1.9931[.072 INF(-1) 01180 .0030441 -3.3444[.007 INEER(-1) 082122 .061764 -1.3296[.211 NEER(-1) 0038574 .0023487 49583[.630 RSD(-1) 0011824 .0023847 49583[.630 RSD(-2) 0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 Masical Sum of Squares .	******	*********	******	*******	******	******	*****	***
LMS(-1)2013017883 -1.125/[.284 LFCE5937433181 1.7894[.101 LFCE(-1) 2.240952839 4.2409[.001 LFCE(-2) 2.179560681 3.5917[.004 LEX3875211711 3.3089[.007 LEX(-1)4482513761 3.2574[.008 LEX(-2)3266310192 3.2049[.008 LGFCF51603149163.4595[.005 LGFCF(-1)2433515182 -1.6029[.137 LGFCF(-2)19288083630 -2.3063[.042 INF00499390025056 -1.9931[.072 INF(-1)0011800030441 -3.3444[.007 INEER16449062235 2.6430[.023 LMEER(-1)082122061764 -1.3296[.211 LMEER(-1)001824002384749583[.630 RSD00894750020431 4.3795[.001 RSD(-1)0011824002384749583[.630 RSD(-2)00385740023642 -1.6316[.131 C56.6525 8.50056.6646[.000 ***Squared99994 R-Bar-Squared9998 R-Saquared99994 R-Bar-Squared9998 R-Saquared9023611991	Regressor	Coeffici	ent	Standa	rd Erro:	r	T-Ratio[Pro	bj
LFCE	LM3 (-1)	201	.30	•	17883		-1.1257[.28	4]
LFCE(-1) 2.2409 .52839 4.2409[.001 LFCE(-2) 2.1795 .60681 3.597[.004 LEX(-1) .44825 .13761 3.2574[.008 LEX(-2) .32663 .10192 3.2049[.008 LGFCF51603 .14916 -3.4595[.005 LGFCF(-1)24335 .15182 -1.6029[.137 LGFCF(-2)19288 .083630 -2.3063[.042 INF0049393 .0025056 -1.9931[.072 INF(-1)010180 .0030441 -3.3444[.007 LNEER .16449 .062235 2.6430[.023 LNEER(-1)082122 .061764 -1.3296[.211 LNEER(-1)082421 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 **** * * * * * * * * * * * * * * * * *	LFCE	.593	574	•	33181		1.7894[.10	1]
LFCE (-2) 2.1795 .60681 3.5917[.004 LEX .38752 .11711 3.3089[.007 LEX(-1) .44825 .13761 3.2574[.008 LEX(-2) .32663 .10192 3.2049[.008 LGFCF -51603 .14916 -3.4595[.005 LGFCF(-1)24335 .15182 -1.6029[.137 LGFCF(-2)19288 .083630 -2.3063[.042 INF -0.0049939 .0025056 -1.9931[.072 INF(-1)010180 .0030441 -3.3444[.007 LNEER .16449 .062235 2.6430[.023 LNEER(-1)082122 .061764 -1.3296[.211 LNEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 **********************************	LFCE (-1)	2.24	.09	•	52839		4.2409[.00	1]
LEX	LFCE(-2)	2.17	95	•	60681		3.5917[.00	4]
LEX(-1) .44825 .13761 3.2574[.008 LEX(-2) .32663 .10192 3.2049[.008 LGFCF -51603 .14916 -3.4595[.005 LGFCF(-1)24335 .15182 -1.6029[.137 LGFCF(-2)19288 .083630 -2.3063[.042 INF -0049939 .0025056 -1.9931[.072 INF(-1)010180 .0030441 -3.3444[.007 LNEER .16449 .062235 2.6430[.023 LNEER(-1)082122 .061764 -1.3296[.211 LNEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 **********************************	LEX	.387	52	•	11711		3.3089[.00	7]
LEX(-2) .32663 .10192 3.2049[.008 LGFCF51603 .14916 -3.4595[.005 LGFCF(-1)24335 .15182 -1.6029[.137 LGFCF(-2)19288 .083630 -2.3063[.042 INF0049939 .0025056 -1.9931[.072 INF(-1)010180 .0030441 -3.3444[.007 LNEER .16449 .062235 2.6430[.023 LNEER(-1)082122 .061764 -1.3296[.211 LNEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646(.000 **********************************	LEX(-1)	.448	25	•	13761		3.2574[.00	8]
LGFCF	LEX(-2)	.326	63	•	10192		3.2049[.00	8]
LGFCF(-1)24335 .15182 -1.6029[.137 LGFCF(-2)19288 .083630 -2.3063[.042 INF0049939 .0025056 -1.9931[.072 INF(-1)010180 .0030441 -3.3444[.007 INEER .16449 .062235 2.6430[.023 INEER(-1)082122 .061764 -1.3296[.211 INEER(-2)092821 .059918 -1.549[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 **********************************	LGFCF	516	03		14916		-3.4595[.00	5]
LGFCF(-2)19288 .083630 -2.3063[.042 INF0049939 .0025056 -1.9931[.072 INF(-1)010180 .0030441 -3.3444[.007 LNEER .16449 .062235 2.6430[.023 LNEER(-1)082122 .061764 -1.3296[.211 LNEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 **********************************	LGFCF(-1)	243	35		15182		-1.6029[.13	7]
INF0049939 .0025056 -1.9931[.072 INF (-1)010180 .0030441 -3.3444[.007 LNEER 1.6449 .062235 2.6430[.023 LNEER(-1)082122 .061764 -1.3296[.211 LNEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002364749583[.630 C -56.6525 8.5005 -6.6646[.000 **********************************	LGFCF(-2)	192	88	.0	83630		-2.3063[.04	2]
<pre>INF(-1)010180 .0030441 -3.3444[.007 INEER16449 .062235 2.6430[.023 INEER(-1)082122 .061764 -1.3296[.211 INEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 Mean of Dependent Variable 12.7727 S.D. of Dependent Variable 1.193 Residual Sum of Squares .0023367 Equation Log-likelihood 99.335 Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic58419[.559 ***********************************</pre>	INF	00499	39	.00	25056		-1.9931[.07	2]
LNEER16449062235 2.6430[.023 LNEER(-1)082122061764 -1.3296[.21] LNEER(-2)092821059918 -1.5491[.150 RSD00894750020431 4.3795[.00] RSD(-1)0011824002384749583[.630 RSD(-2)00385740023642 -1.6316[.131 C	INF(-1)	0101	80	.00	30441		-3.3444[.00	7]
LNEER(-1)082122 .061764 -1.3296[.211 LNEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 **********************************	LNEER	.164	49	.0	62235		2.6430[.02	3]
LNEER(-2)092821 .059918 -1.5491[.150 RSD .0089475 .0020431 4.3795[.001 RSD(-1)0011824 .002384749583[.630 RSD(-2)0038574 .0020642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 **********************************	LNEER(-1)	0821	.22	.0	61764		-1.3296[.21	1]
RSD .0089475 .0020431 4.3795[.001 RSD(-1) 0011824 .0023847 49583[.630 RSD(-2) 0038574 .0023642 -1.6316[.131 c -56.6525 8.5005 -6.6646[.000 Mean of Dependent Variable 1.99994 R-Bar-Squared .9998 S.E. of Regression .014575 F-stat. F(18, 11) 10796.9[.000 Mean of Dependent Variable 12.7727 S.D. of Dependent Variable 1.193 Residual Sum of Squares .0023367 Equation Log-likelihood 99.335 Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic 58419[.559 * * * * * * * * * * * * * * *	LNEER(-2)	0928	21	.0	59918		-1.5491[.15	0]
RSD(-1) 0011824 .0023847 49583[.630 RSD(-2) 0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 ************************************	RSD	.00894	75	.00	20431		4.3795[.00	1]
RSD(-2) 0038574 .0023642 -1.6316[.131 C -56.6525 8.5005 -6.6646[.000 ************************************	RSD(-1)	00118	24	.00	23847		49583[.63	01
C -56.6525 8.5005 -6.6646[.000 ************************************	RSD(-2)	00385	74	.00	23642		-1.6316[.13	11
<pre>R-Squared .99994 R-Bar-Squared .9998 S.E. of Regression .014575 F-stat. F(18, 11) 10796.9[.000 Mean of Dependent Variable 12.7727 S.D. of Dependent Variable 1.193 Residual Sum of Squares .0023367 Equation Log-likelihood 99.335 Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic58419[.559 ***********************************</pre>	C	-56.65	2.5	8	.5005		-6.6646[.00	01
R-Squared .99994 R-Bar-Squared .9998 S.E. of Regression .014575 F-stat. F(18, 11) 10796.9[.000 Mean of Dependent Variable 12.7727 S.D. of Dependent Variable 1.193 Residual Sum of Squares .0023367 Equation Log-likelihood 99.335 Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic 58419[.559 ***********************************	· * * * * * * * * * * * * * * * * * * *	********	******	*******	******	******	****	***
S.E. of Regression .014575 F-stat. F(18, 11) 10796.9[.000 Mean of Dependent Variable 12.7727 S.D. of Dependent Variable 1.193 Residual Sum of Squares .0023367 Equation Log-likelihood 99.335 Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic 58419[.559 ***********************************	R-Squared		99994	R-Bar-So	uared		.999	85
<pre>Mean of Dependent Variable 12.7727 S.D. of Dependent Variable 1.193 Residual Sum of Squares .0023367 Equation Log-likelihood 99.335 Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic58419[.559 ***********************************</pre>	S.E. of Regression	. 0	14575	F-stat.	F(1)	8, 11)	10796.91.00	01
Residual Sum of Squares .0023367 Equation Log-likelihood 99.335 Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic 58419[.559 ************************************	Mean of Dependent Var	iable 12	.7727	S.D. of	Dependei	nt Variab	le 1.19	32
Akaike Info. Criterion 80.3351 Schwarz Bayesian Criterion 67.023 DW-statistic 2.0430 Durbin's h-statistic 58419[.559 ************************************	Residual Sum of Squar	es .00	23367	Equation	Log-lil	kelihood	99.33	51
Diagnostic Tests	Akaike Info. Criterio	n 80	. 3351	Schwarz	Bavesia	n Criteri	on 67.02	37
Diagnostic Tests ***********************************	DW-statistic	2	.0430	Durbin's	h-stat	istic	58419[.55	91
Diagnostic Tests * Test Statistics * LM Version * F Version * A:Serial Correlation*CHSQ(1)= .049249[.824]*F(1, 10)= .016443[.901 * * * * * * * * * * * * * * * * * * *	****	*********	*******	********	******	********	**********	***
Diagnostic Tests * Test Statistics * LM Version * F Version * A:Serial Correlation*CHSQ(1)= .049249[.824]*F(1, 10)= .016443[.901 * * * * * * * * * * * * * * * * * * *								
Diagnostic Tests * Test Statistics * LM Version * F Version * A:Serial Correlation*CHSQ(1)= .049249[.824]*F(1, 10)= .016443[.901 * * * * * * * * * * * * * * * * * * *								
<pre>************************************</pre>		Ι	Diagnost	ic Tests				
<pre>* Test Statistics * LM Version * F Version ************************************</pre>	* * * * * * * * * * * * * * * * * * * *	*******	******	* * * * * * * * *	* * * * * * *	******	*****	* * *
<pre>* ***********************************</pre>	* Test Statistics	* L	M Versio	on	*	F Ver	sion	*
<pre>* * * * * * * * * * * * * * * * * * *</pre>	*****************	********	*******	******	******	******	****	***
<pre>* A:Serial Correlation*CHSQ(1)= .049249[.824]*F(1, 10)= .016443[.901 * * * * * * * * * * * * * * * * * * *</pre>	*	*			*			*
* * * * * * * * * * * * * * * * * * *	* A:Serial Correlation	*CHSQ(1) = .049	9249[.824]*F(1, 10)=	.016443[.90	1]*
* B:Functional Form *CHSQ(1)= 7.8549[.005]*F(1, 10)= 3.5470[.089 * * * * * * * * * * * * *	*	*			*			*
* (Normality $*(\text{HSO}(2)) = 2.121/(2.2461) \times \text{Not appliable}$	* B:Functional Form	*CHSQ(1)= 7.8	3549[.005]*F(1, 10)=	3.5470[.08	9]*
$X(\cdot N \cap rmality)$ $X(HS()) = 2 + 2 + 2 + 4 + 3 + 5 + 5 + 5 + 5 + 5 + 5 + 5 + 5 + 5$	*	*		0145 046	*			*
* * * * * *	* C:Normality	*CHSQ(2	2.1	L214[.346]* *	Not app	licable	*
* D:Heteroscedasticity*CHSQ(1)= .3940E-8[1.00]*F(1, 28)= .3677E-8[1.00	* D:Heteroscedasticity	*CHSQ(1)= .3940)E-8[1.00]*F(1, 28)= ********	.3677E-8[1.0	0]*
A:Lagrange multiplier test of residual serial correlation B:Ramsey's RESET test using the square of the fitted values C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values	A:Lagrange multiplier B:Ramsey's RESET test C:Based on a test of D:Based on the regres	test of re using the skewness as sion of so	esidual square nd kurtc uared re	serial co of the fi osis of ro esiduals of	orrelati itted va esiduals	ion alues s red fitte	d values	

Autoregre	essive Dist	ributed Lag Estimates								
ARDL(0,2,2,2,1,1,0)	ARDL(0,2,2,2,1,1,0) selected based on Schwarz Bayesian Criterion									
* * * * * * * * * * * * * * * * * * * *	*********	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *							
D	ependent va	riable is LM3	0.014							
30 observations	used for e	stimation from 1982 t	to 2011							
****	******	***********************	****							
Regressor Coet	ficient	Standard Error	T-Ratio[Prob]							
LFCE	.96826	.24879	3.8919[.001]							
LFCE(-1)	1.8774	.36607	5.1286[.000]							
LFCE(-2)	1.3816	.29965	4.6108[.000]							
LEX	.26138	.10049	2.6011[.020]							
LEX(-1)	.29558	.10333	2.8606[.012]							
LEX(-2)	.35904	.085383	4.2050[.001]							
LGFCF -	.28744	.10729	-2.6792[.017]							
LGFCF(-1) -	.26899	.13376	-2.0110[.063]							
LGFCF(-2) -	.23674	.072025	-3.2869[.005]							
INF0	054467	.0020290	-2.6844[.017]							
INF(-1)0	078666	.0025165	-3.1260[.007]							
LNEER .	086856	.049485	1.7552[.100]							
LNEER(-1)	087813	.051467	-1.7062[.109]							
RSD .0	061476	.0012318	4.9906[.000]							
C –4	7.3241	2.1703	-21.8057[.000]							
* * * * * * * * * * * * * * * * * * * *	******	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *							
R-Squared	.99992	R-Bar-Squared	.99984							
S.E. of Regression	.015262	F-stat. F(14, 1	15) 12659.1[.000]							
Mean of Dependent Variable	12.7727	S.D. of Dependent Va	ariable 1.1932							
Residual Sum of Squares	.0034940	Equation Log-likelik	nood 93.3002							
Akaike Info. Criterion	78.3002	Schwarz Bayesian Cri	iterion 67.7913							
DW-sta	tistic	2.0069								
* * * * * * * * * * * * * * * * * * * *	*******	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *							

Appendix D3: SBC – ARDL model and diagnostic test results for M3

			Diag	nostic Tes	ts					
* * *	* * * * * * * * * * * * * * * * * * *	*******	****	*********	****	*****	****	******	********	****
*	Test Statistics	*	LM V	ersion		*		F Vers	sion	*
* * *	* * * * * * * * * * * * * * * * * * *	*******	*****	*********	****	*****	****	******	*******	****
*		*				*				*
* A *	:Serial Correlation	n*CHSQ(*	1)=	.061574[.8	304]	*F(*	1,	14)=	.028794[.8	*[68
* B *	:Functional Form	*CHSQ(*	1)=	.091258[.7	763]	*F(*	1,	14)=	.042717[.8	39]* *
* C *	:Normality	*CHSQ(*	2)=	1.7644[.4	114]	*	No	ot appl	icable	*
* D ***	:Heteroscedasticit	y*CHSQ(*******	1)= ****	.82500[.3	364] ****	*E(*****	1, ****	28)= ******	.79177[.3	81]* ****
A: B:1	Lagrange multiplie Ramsey's RESET test	test of using th	resio ne squ	dual serial uare of the	co: fi	rrelat tted v	ion alue	S		

C:Based on a test of skewness and kurtosis of residuals D:Based on the regression of squared residuals on squared fitted values

Au ARDL (1,2,2,2,2 ******************************	toregres ,1,2,2)	sive D select	istr ed b	ibuted La ased on H	ag Est Hannan	imate -Quin	es nn Crit	erion *****	* * * * * *	****
	Dei	pendent	vai	riable is	T.M.3					
30 observ	vations	used fo	or es	stimation	from	1982	to 20	11		
****	******	* * * * * * * *	****	******	*****	****	*****	*****	*****	****
Regressor	Coeff	icient		Standa	rd Eri	or		T-Rat	io[Pro	obl
LM3(-1)	:	20130			17883			-1.12	57[.2	84]
LFCE		59374			33181			1.78	94[.1	011
LFCE(-1)	2	.2409			52839			4.24	09[.0	011
LFCE (-2)	2	.1795			60681			3.59	17[.0	041
LEX		38752			11711			3.30	.01989	071
LEX(-1)		44825			13761			3.25	74[.0	08]
LEX (-2)		32663			10192			3.20	49[.0	081
LGFCF		51603			14916			-3.45	95[.0	05]
LGFCF(-1)	:	24335			15182			-1.60	29[.1]	37]
LGFCF(-2)		19288		.0	83630			-2.30	63[.0	42]
INF	00	49939		.00	25056			-1.99	31[.0	72]
INF(-1)	0	10180		.00	30441			-3.34	44[.0	07]
LNEER	•	16449		.0	62235			2.64	30[.0	23]
LNEER(-1)	0	82122		.0	61764			-1.32	96[.2	11]
LNEER(-2)	0	92821		.0	59918			-1.54	91[.1	50]
RSD	.00	89475		.00	20431			4.37	95[.0	01]
RSD(-1)	00	11824		.00	23847			495	83[.6	30]
RSD(-2)	00	38574		.00	23642			-1.63	316[.1	31]
С	-56	.6525		8	.5005			-6.66	646[.0	00]
* * * * * * * * * * * * * * * * * * * *	*******	******	****	******	*****	****	*****	*****	*****	****
R-Squared		.9999	94	R-Bar-Sq	uared				.99	985
S.E. of Regression		.01457	75	F-stat.	F (18,	11)	10796	5.9[.0	00]
Mean of Dependent Var	riable	12.772	27	S.D. of	Depend	lent	Variab	le	1.1	932
Residual Sum of Squar	res	.002336	57	Equation	Log-l	likel	ihood		99.3	351
Akaike Info. Criterio	on	80.335	51	Schwarz	Bayesi	lan C	Criteri	on	67.03	237
DW-statistic		2.043	30	Durbin's	h-sta	atist	ic	584	19[.5	59]
* * * * * * * * * * * * * * * * * * * *	*******	* * * * * * *	****	******	*****	****	*****	*****	*****	****
		Diag	nost	ic Tests						
* * * * * * * * * * * * * * * * * * * *	*******	* * * * * * *	****	*******	*****	****	*****	*****	*****	****
* Test Statistics ************************************	*	LM Ve	ersic	on ********	*	****	F Ver:	sion ******	*****	* ****
*	*				*					*
* A:Serial Correlation	n*CHSQ(*	1)=	.049	9249[.824]*F(*	1,	10)=	.0164	43[.9	01]* *
* B:Functional Form *	*CHSQ(*	1)=	7.8	3549[.005)*F(*	1,	10)=	3.54	70[.0	89]* *

^		~			~				^
*	B:Functional Form	*CHSQ(1)=	7.8549[.00	05]*F(1,	10)=	3.5470[.	089]*
*		*			*				*
*	C:Normality	*CHSQ(2)=	2.1214[.34	46]*	No	ot appl	icable	*
*	_	*			*				*
*	D:Heteroscedasticity	/*CHSQ(1)= .	3940E-8[1.	00]*F(1,	28)= .	3677E-8[1	.00]*
* *	*****	********	*****	* * * * * * * * * * *	*******	****	******	* * * * * * * * *	*****
А	:Lagrange multiplier	test of	residu	ual serial	correlat	ion			
В	:Ramsey's RESET test	using th	le squa	are of the	fitted v	alue	s		
С	:Based on a test of	skewness	and ku	urtosis of	residual	S			
-	D 1 11			1 1 1		1	C 1 1 1	7	

 $\ensuremath{\texttt{D:Based}}$ on the regression of squared residuals on squared fitted values

Appendix E1a: The Adj-R-Squared and AIC Estimated ARDL Long-run coefficients for M2

Estimated Long Run ARDL(1,2	n Coefficients using t ,2,2,1,1,1) selected b	he ARDL Approach based on R-BAR Squared	Criterion	
Dependent variab 30 observations	le is LM2 used for estimation fr *******	com 1982 to 2011	*****	
Regressor	Coefficient	Standard Error	T-Ratio[Prob]	
LFCE	4.6944	.17135	27.3959[.000]	
LEX	1.1274	.10900	10.3432[.000]	
LGFCF	-1.2001	.096109	-12.4865[.000]	
INF	023929	.0022375	-10.6948[.000]	
LNEER	.058079	.061807	.93968[.365]	
RSD	.013854	.0017391	7.9664[.000]	
С	-51.9401	2.4903	-20.8572[.000]	

Appendix E1b: The HQN and SBC Estimated ARDL Long-run coefficients for M2

Estimated Long Run Coefficients using the ARDL Approach ARDL(0,2,2,2,1,1,0) selected based on Hannan-Quinn Criterion				
Dependent variabl 30 observations u ********	e is LM2 sed for estimation fr ********	om 1982 to 2011 ********	* * * * * * * * * * * * * * * * * * * *	
Regressor	Coefficient	Standard Error	T-Ratio[Prob]	
LFCE	4.6764	.20555	22.7509[.000]	
LEX	1.1158	.13077	8.5327[.000]	
LGFCF	-1.2028	.11539	-10.4241[.000]	
INF	023902	.0026615	-8.9805[.000]	
LNEER	.048360	.073909	.65432[.523]	
RSD	.013475	.0016880	7.9832[.000]	
С	-51.4428	2.9739	-17.2983[.000]	

Estimated Long Ru ARDL(0,2,2 ************	n Coefficients using th ,2,1,1,0) selected base *******	ne ARDL Approach ed on Schwarz Bayesia *********	n Criterion ******
Dependent variab 30 observations ******	le is LM2 used for estimation fro ******	om 1982 to 2011	*****
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LFCE	4.5721	.099236	46.0734[.000]
LEX	1.0793	.093022	11.6026[.000]
LGFCF	-1.1486	.050169	-22.8949[.000]
INF	024707	.0030907	-7.9939[.000]
LREER	.077606	.071276	1.0888[.293]
RSD	.013693	.0017475	7.8359[.000]
С	-50.3362	.86056	-58.4924[.000]
* * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	****	* * * * * * * * * * * * * * * * * * * *

Appendix E2a: The Adj-R-Squared and AIC Estimated ARDL Long-run coefficients for M3

Estimated Long Run Coefficients using the ARDL Approach ARDL(1,2,2,2,1,2,2) selected based on R-BAR Squared Criterion					
	Dependent var	iable is LM3			
30 c	30 observations used for estimation from 1982 to 2011				
* * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	****		
Regressor	Coefficient	Standard Error	T-Ratio[Prob]		
LFCE	4.1739	.15718	26.5555[.000]		
LEX	.96762	.083524	11.5849[.000]		
LGFCF	79268	.085650	-9.2549[.000]		
INF	012632	.0019188	-6.5830[.000]		
LNEER	0087025	.049733	17498[.864]		
RSD	.0032528	.0015535	2.0938[.060]		
С	-47.1591	2.0092	-23.4721[.000]		
* * * * * * * * * * * * * * * * * * * *					

Estimated Long Run Coefficients using the ARDL Approach ARDL(1,2,2,2,1,2,2) selected based on Akaike Information Criterion

Dependent variable is LM3 30 observations used for estimation from 1982 to 2011

50 0	DSELVACIONS USED IOI (ESCIMACIÓN IIÓM I902 C	0 2011
* * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	** * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LFCE	4.1739	.15718	26.5555[.000]
LEX	.96762	.083524	11.5849[.000]
LGFCF	79268	.085650	-9.2549[.000]
INF	012632	.0019188	-6.5830[.000]
LNEER	0087025	.049733	17498[.864]
RSD	.0032528	.0015535	2.0938[.060]
С	-47.1591	2.0092	-23.4721[.000]
* * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * *

Appendix E2b: The SBC and HQN Estimated ARDL Long-run coefficients for M3

Estimated Long Run Coefficients using the ARDL Approach ARDL(0,2,2,2,1,1,0) selected based on Schwarz Bayesian Criterion				
* * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	******	
	Dependent va	riable is LM3		
30 c	bservations used for e	stimation from 1982 t	2011	
****	****	* * * * * * * * * * * * * * * * * * * *	****	
Regressor	Coefficient	Standard Error	T-Ratio[Prob]	
LFCE	4.2273	.15000	28.1818[.000]	
LEX	.91601	.095432	9.5985[.000]	
LGFCF	79317	.084209	-9.4190[.000]	
INF	013313	.0019423	-6.8543[.000]	
LNEER	9571E-3	.053937	017744[.986]	
RSD	.0061476	.0012318	4.9906[.000]	
С	-47.3241	2.1703	-21.8057[.000]	
* * * * * * * * * * * * * * * * * * * *				

Estim	ated Long Run Coeffici	ents using the ARDL A.	pproach		
ARDL (1, 1	ARDL(1,2,2,2,1,2,2) selected based on Hannan-Quinn Criterion				
* * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * *		
	Dependent va	riable is LM3			
30 0	bservations used for e	stimation from 1982 t	0 2011		
* * * * * * * * * * * * * * * * * *	****	****	****		
Regressor	Coefficient	Standard Error	T-Ratio[Prob]		
LFCE	4.1739	.15718	26.5555[.000]		
LEX	.96762	.083524	11.5849[.000]		
LGFCF	79268	.085650	-9.2549[.000]		
INF	012632	.0019188	-6.5830[.000]		
LNEER	0087025	.049733	17498[.864]		
RSD	.0032528	.0015535	2.0938[.060]		
С	-47.1591	2.0092	-23.4721[.000]		
* * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	*******	* * * * * * * * * * * * * * * * * * * *		

Appendix F1: The Adjusted-R-Squared ARDL-ECM short-run estimates for M2

Error Correction Representation for the Selected ARDL Model ARDL(1,2,2,2,1,1,1) selected based on R-BAR Squared Criterion ***** Dependent variable is dLM2 30 observations used for estimation from 1982 to 2011 Coefficient Standard Error T-Ratio[Prob] Regressor .40912 .53756 difce 1.3140[.205] dlfCE1 -2.0102 .63308 -3.1753[.005] 1.8531[.079] dlex .29187 .15750 .14407 -.51430 dLEX1 -3.5699[.002] .19767 -.55676 -2.8166[.011] dLGFCF .12172 .30972 2.5444[.020] dLGFCF1 .12172 .0032374 .077352 .0026855 -.011898 -3.6751[.002] dinf 2.7704[.012] 4.9197[.000] dlneer .21429 .013212 drsd 9.0655 -6.8416[.000] .15994 -7.4659[.000] dC -62.0225 -1.1941 ecm(-1) List of additional temporary variables created: dLM2 = LM2 - LM2(-1)dLFCE = LFCE - LFCE(-1)dLFCE1 = LFCE(-1) - LFCE(-2)dLEX = LEX - LEX(-1)dLEX1 = LEX(-1) - LEX(-2)dLGFCF = LGFCF - LGFCF(-1)dLGFCF1 = LGFCF(-1) - LGFCF(-2)dINF = INF - INF(-1)dLNEER = LNEER-LNEER(-1)dRSD = RSD - RSD(-1)dC = C - C (-1)ecm = LM2 -4.6944*LFCE -1.1274*LEX + 1.2001*LGFCF + .023929*INF -.058 079*LNEER -.013854*RSD + 51.9401*C R-Squared.95226R-Bar-Squared.89349S.E. of Regression.020778F-stat.F(10, 19)25.9282[.000]Mean of Dependent Variable.14008S.D. of Dependent Variable.063667 .89349 Residual Sum of Squares.0056124Equation Log-likelihoodAkaike Info. Criterion69.1915Schwarz Bayesian Criterion 86.1915 57.2813 DW-statistic 2.6256 R-Squared and R-Bar-Squared measures refer to the dependent variable $d\ensuremath{\text{LM2}}$ and in cases where the error correction model is highly restricted, these measures could become negative.

Appendix F2: The AIC ARDL-ECM short-run estimates for M2

Error Correction	Representation for	the Selected ARDL Mo	on Criterion
****	****	****	*****
Dependent variable	is dLM2		
30 observations use	d for estimation fro	om 1982 to 2011	
* * * * * * * * * * * * * * * * * * * *	****	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dlfCE	.32901	.46308	.71047[.487]
dlfCE1	-2.3684	.73429	-3.2254[.005]
dlex	.37188	.17814	2.0875[.051]
dlex1	48959	.14663	-3.3389[.004]
dlgfcf	60683	.20475	-2.9637[.008]
dLGFCF1	.32387	.12288	2.6357[.017]
dINF	010889	.0034078	-3.1953[.005]
dlneer	.24786	.084914	2.9190[.009]
dlneer1	.077915	.080379	.96934[.345]
dRSD	.013941	.0027948	4.9881[.000]
dC	-65.5866	9.8024	-6.6909[.000]
ecm(-1)	-1.2888	.18771	-6.8658[.000]
* * * * * * * * * * * * * * * * * * * *	****	* * * * * * * * * * * * * * * * * * * *	******
List of additional	temporary variables	created:	
dLM2 = LM2 - LM2(-1)			
dLFCE = LFCE-LFCE(-	-1)		
dLFCE1 = LFCE(-1) - I	FCE (-2)		
dLEX = LEX-LEX(-1)			
dLEX1 = LEX(-1) - LEX	L (−2)		
dLGFCF = LGFCF-LGFC	EF(-1)		
dLGFCF1 = LGFCF(-1)	-LGFCF(-2)		
dINF = INF - INF(-1)			
dlneer = lneer-lnee	ER(-1)		
dLNEER1 = LNEER(-1)	-LNEER(-2)		
dRSD = RSD - RSD(-1)			
dC = C - C (-1)			
ecm = LM2 - 4.5633	*LFCE -1.1462*LEX	+ 1.1461*LGFCF +	.022439*INF031
305*LNEER013446*	RSD + 50.8913*C		
* * * * * * * * * * * * * * * * * * * *	****	* * * * * * * * * * * * * * * * * * * *	******
R-Squared	.95572	R-Bar-Squared	.89300
S.E. of Regression	.020826	F-stat. F(11, 1	.8) 23.5470[.000]
Mean of Dependent V	ariable .14008	S.D. of Dependent Va	riable .063667
Residual Sum of Squ	ares .0052048	Equation Log-likelih	nood 87.3223
Akaike Info. Criter	cion 69.3223	Schwarz Bayesian Cri	terion 56.7116
DW-statistic	2.7385		
******************	· * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *	******
K-Squared and R-Bar	-squared measures re	erer to the dependent	z variable
dLM2 and in cases w	here the error corre	ection model is highl	-У
re	stricted, these meas	sures cou⊥d become ne	gative.

Appendix F3: The SBC ARDL-ECM short-run estimates for M2

Error Correction	Representatio	on for the Selected AF	RDL Model
ARDL(U, Z, Z, Z, I, I, U) ************************************	selected base	ed on Schwarz Bayesian ******	1 Criterion
Dependent variable is dLM2			
30 observations used for e	stimation fro	om 1982 to 2011	
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	****
Regressor Coe	fficient	Standard Error	T-Ratio[Prob]
dlfCE	.48040	.35273	1.3620[.189]
dlfCE1	-1.3331	.40973	-3.2536[.004]
dlex	.26620	.13855	1.9213[.070]
dlex1	38152	.10244	-3.7242[.001]
dlgfCf	48283	.14118	-3.4199[.003]
dLGFCF1	.19917	.10122	1.9677[.064]
dINF -	.011757	.0027422	-4.2874[.000]
dlreer	.20895	.071218	2.9340[.009]
dRSD	.013693	.0017475	7.8359[.000]
dC –	50.3362	.86056	-58.4924[.000]
ecm(-1)	-1.0000	0.00	*NONE *
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *
List of additional tempora	ry variables	created:	
dLM2 = LM2 - LM2(-1)			
dLFCE = LFCE - LFCE (-1)			
dLFCE1 = LFCE(-1) - LFCE(-2)			
dLEX = LEX-LEX(-1)			
dLEX1 = LEX(-1) - LEX(-2)			
dLGFCF = LGFCF - LGFCF(-1)			
dLGFCF1 = LGFCF(-1) - LGFCF(-2)		
dINF = INF - INF(-1)			
dLREER = LREER-LREER(-1)			
dRSD = RSD - RSD(-1)			
dC = C - C (-1)			
ecm = LM2 - 4.5721 * LFCE	-1.0793*LEX	+ 1.1486*LGFCF + .	024707*INF077
606*LREER013693*RSD +	50.3362*C		
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	*****
R-Squared	.94357	R-Bar-Squared	.89090
S.E. of Regression	.021029	F-stat. F(10, 19	9) 25.0822[.000]
Mean of Dependent Variable	.14008	S.D. of Dependent Var	iable .063667
Residual Sum of Squares	.0066332	Equation Log-likeliho	od 83.6849
Akaike Info. Criterion	68.6849	Schwarz Bayesian Crit	erion 58.1759
DW-statistic	2.7829		
* * * * * * * * * * * * * * * * * * * *	****	* * * * * * * * * * * * * * * * * * * *	*****
R-Squared and R-Bar-Square	d measures re	efer to the dependent	variable
dLM2 and in cases where th	e error corre	ection model is highly	7

restricted, these measures could become negative.

Appendix F4: The HQN, ARDL-ECM short-run estimates for M2

Error Correction Representation for the Selected ARDL Model						
ARDL(0,2,2,2,1,1	1,0) selected b	ased on Hannan-Quinn	Criterion			
* * * * * * * * * * * * * * * * * * * *	************	* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *			
Dependent variable is dI	LM2					
30 observations used for	r estimation fr	om 1982 to 2011				

Regressor (Coefficient	Standard Error	T-Ratio[Prob]			
dlfCE	.48545	.34092	1.4240[.171]			
dlfCE1	-1.4275	.41061	-3.4766[.003]			
dlex	.26480	.13770	1.9231[.070]			
dLEX1	38829	.11700	-3.3188[.004]			
dlgfcf	51208	.14701	-3.4832[.002]			
dLGFCF1	.22545	.098694	2.2843[.034]			
dINF	010289	.0027803	-3.7005[.002]			
dlneer	.19232	.067808	2.8363[.011]			
dRSD	.013475	.0016880	7.9832[.000]			
dC	-51.4428	2.9739	-17.2983[.000]			
ecm(-1)	-1.0000	0.00	*NONE *			
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	******			
List of additional tempo	orary variables	created:				
dLM2 = LM2 - LM2(-1)						
dLFCE = LFCE-LFCE(-1)						
dLFCE1 = LFCE(-1) - LFCE(-1)	-2)					
dlex = lex-lex(-1)						
dLEX1 = LEX(-1) - LEX(-2)						
dLGFCF = LGFCF-LGFCF(-1)						
dLGFCF1 = LGFCF(-1) - LGFC	CF(-2)					
dINF = INF-INF(-1)						
dLNEER = LNEER-LNEER(-1)						
dRSD = RSD - RSD(-1)						
dC = C - C (-1)						
ecm = LM2 - 4.6764 * LFCH	E -1.1158*LEX	+ 1.2028*LGFCF +	.023902*INF048			
360*LNEER013475*RSD +	+ 51.4428*C					
* * * * * * * * * * * * * * * * * * * *	*****	* * * * * * * * * * * * * * * * * * * *	******			
R-Squared	.94419	R-Bar-Squared	.89210			
S.E. of Regression	.020914	F-stat. F(10, 1	L9) 25.3760[.000]			
Mean of Dependent Variak	ole .14008	S.D. of Dependent Va	ariable .063667			
Residual Sum of Squares	.0065607	Equation Log-likelih	nood 83.8497			
Akaike Info. Criterion	68.8497	Schwarz Bayesian Cri	iterion 58.3407			
DW-statistic	2.7927	4				

	1	C				

R-Squared and R-Bar-Squared measures refer to the dependent variable dLM2 and in cases where the error correction model is highly restricted, these measures could become negative.

Appendix G1: The Adjusted-R-Squared, ARDL-ECM short-run estimates for M3

Error Correction Representation for the Selected ARDL Model						
ARDL(1,2,2,2,1,2,	2) selected ba	ased on R-BAR Squar	ed Criterion			
* * * * * * * * * * * * * * * * * * * *	***********	* * * * * * * * * * * * * * * * * * * *	*****			
Dependent variable is dLM	3					
30 observations used for	estimation fro	om 1982 to 2011				
* * * * * * * * * * * * * * * * * * * *	*******	* * * * * * * * * * * * * * * * * * * *	****			
Regressor Co	efficient	Standard Error	T-Ratio[Prob]			
dlfCE	.59374	.33181	1.7894[.091]			
dlfCE1	-2.1795	.60681	-3.5917[.002]			
dlex	.38752	.11711	3.3089[.004]			
dlex1	32663	.10192	-3.2049[.005]			
dlgfCf	51603	.14916	-3.4595[.003]			
dLGFCF1	.19288	.083630	2.3063[.034]			
dINF -	.0049939	.0025056	-1.9931[.063]			
dlneer	.16449	.062235	2.6430[.017]			
dlneer1	.092821	.059918	1.5491[.140]			
dRSD	.0089475	.0020431	4.3795[.000]			
dRSD1	.0038574	.0023642	1.6316[.121]			
dC	-56.6525	8.5005	-6.6646[.000]			
ecm(-1)	-1.2013	.17883	-6.7176[.000]			
* * * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * *	* * * * * * * * * * * * * * * * * * * *			
LIST OF Additional tempor dLM3 = LM3-LM3(-1) dLFCE = LFCE-LFCE(-1) dLFCE1 = LFCE(-1)-LFCE(-2) dLEX1 = LEX(-1)-LEX(-2) dLGFCF = LGFCF-LGFCF(-1) dLGFCF1 = LGFCF(-1)-LGFCF dINF = INF-INF(-1) dLNEER = LNEER-LNEER(-1) dLNEER1 = LNEER(-1)-LNEER dRSD = RSD-RSD(-1) dRSD1 = RSD(-1)-RSD(-2) dC = C-C(-1) ecm = LM3 - 4.1739*LFCE 7025*LNEER0032528*RSD +	<pre>(-2) (-2)96762*LEX 47.1591*C</pre>	+ .79268*LGFCF +	.012632*INF + .008			
****	*****	* * * * * * * * * * * * * * * * * * *	****			
R-Squared	.96766	R-Bar-Squared	.91473			
S.E. of Regression	.014575	F-stat. F(12.	17) 27.4262[.000]			
Mean of Dependent Variable	e .13372	S.D. of Dependent	Variable .049913			
Residual Sum of Squares	.0023367	Equation Log-likel	ihood 99.3351			
Akaike Info. Criterion	80.3351	Schwarz Bavesian C	riterion 67.0237			
DW-statistic	2.0430	contail bayobtail o				
· · · · · · · · · · · · · · · · · · ·						
D. Conversed and D. Dam. Convers	od	for to the depende	nt monichle			

R-Squared and R-Bar-Squared measures refer to the dependent variable dLM3 and in cases where the error correction model is highly restricted, these measures could become negative.

Appendix G2: The AIC, ARDL-ECM short-run estimates for M3

```
Error Correction Representation for the Selected ARDL Model
 ARDL(1,2,2,2,1,2,2) selected based on Akaike Information Criterion
Dependent variable is dLM3
30 observations used for estimation from 1982 to 2011
Coefficient
.59374
Regressor
                                Standard Error
                                                   T-Ratio[Prob]
                                 .33181
dlfCE
                                                    1.7894[.091]
                                     .60681
dlfCE1
                     -2.1795
                                                   -3.5917[.002]
                                 .00001
.11711
.10192
.14916
.083630
.0025056
                     .38752
dlex
                                                    3.3089[.004]
dlex1
                     -.32663
                                                    -3.2049[.005]
                                                   -3.4595[.003]
dlgfcf
                     -.51603
                      .19288
                                                    2.3063[.034]
dLGFCF1
dINF
                   -.0049939
                                                   -1.9931[.063]
                                 .062235
.059918
.0020431
.0023642
                     .16449
                                                    2.6430[.017]
dlneer
                                                    1.5491[.140]
dlneer1
                     .092821
                                                     4.3795[.000]
dRSD
                    .0089475
                                                    1.6316[.121]
                    .0038574
dRSD1
                             8.5005 -6.6646[.000]
.17883 -6.7176[.000]
dC
                    -56.6525
ecm(-1)
                     -1.2013
List of additional temporary variables created:
dLM3 = LM3 - LM3(-1)
dLFCE = LFCE - LFCE(-1)
dLFCE1 = LFCE(-1) - LFCE(-2)
dLEX = LEX-LEX(-1)
dLEX1 = LEX(-1) - LEX(-2)
dLGFCF = LGFCF - LGFCF(-1)
dLGFCF1 = LGFCF(-1) - LGFCF(-2)
dINF = INF - INF(-1)
dLNEER = LNEER-LNEER(-1)
dLNEER1 = LNEER(-1) - LNEER(-2)
dRSD = RSD - RSD(-1)
dRSD1 = RSD(-1) - RSD(-2)
dC = C - C(-1)
ecm = LM3 -4.1739*LFCE -.96762*LEX + .79268*LGFCF + .012632*INF + .008
7025*LNEER -.0032528*RSD + 47.1591*C
k-squared .96766 R-Bar-Squared
S.E. of Regression .014575 F ct
Mean of Der

                                                          .91473
                       .014575 F-stat. F(12, 17) 27.4262[.000]
Mean of Dependent Variable .13372 S.D. of Dependent Variable .049913
Residual Sum of Squares .0023367 Equation Log-likelihood
                                                        99.3351
Akaike Info. Criterion
                      80.3351 Schwarz Bayesian Criterion 67.0237
DW-statistic
                        2.0430
R-Squared and R-Bar-Squared measures refer to the dependent variable
dLM3 and in cases where the error correction model is highly
restricted, these measures could become negative.
```

Appendix G3: The SBC, ARDL-ECM short-run estimates for M3

Error Correction Representation for the Selected ARDL Model ARDL(0,2,2,2,1,1,0) selected based on Schwarz Bayesian Criterion Dependent variable is dLM3 30 observations used for estimation from 1982 to 2011 Regressor Coefficient Standard Error T-Ratio[Prob] .24879 dlfCE .96826 3.8919[.001] .29965 .10049 .085383 -4.6108[.000] 2.6011[.018] -4.2050[.000] -2.6792[.015] 3.2869[.004] -2.6844[.015] 1.7552[.095] -1.3816 dlfCE1 dlex .26138 -.35904 dLEX1 .10729 -.28744 dlgfcf
 -.28744
 .10729
 -2.6792[.015]

 .23674
 .072025
 3.2869[.004]

 -.0054467
 .0020290
 -2.6844[.015]

 .086856
 .049485
 1.7552[.095]

 .0061476
 .0012318
 4.9906[.000]

 -47.3241
 2.1703
 -21.8057[.000]

 -1.0000
 0.00
 NONE
 dLGFCF1 -.0054467 dinf dlneer dRSD dC ecm(-1) List of additional temporary variables created: dLM3 = LM3 - LM3(-1)dLFCE = LFCE - LFCE(-1)dLFCE1 = LFCE(-1) - LFCE(-2)dLEX = LEX - LEX(-1)dLEX1 = LEX(-1) - LEX(-2)dLGFCF = LGFCF - LGFCF(-1)dLGFCF1 = LGFCF(-1) - LGFCF(-2)dINF = INF-INF(-1) dLNEER = LNEER-LNEER(-1)dRSD = RSD - RSD(-1)dC = C - C(-1)ecm = LM3 -4.2273*LFCE -.91601*LEX + .79317*LGFCF + .013313*INF + .957 1E-3*LNEER -.0061476*RSD + 47.3241*C R-Squared .95164 R-Bar-Squared .015262 Forth .90650 S.E. of Regression.015262F-stat. F(10, 19)29.5167[.000]Mean of Dependent Variable.13372S.D. of Dependent Variable.049913Residual Sum of Squares.0034940Equation Log-likelihood93.3002Akaike Info. Criterion78.3002Schwarz Bayesian Criterion67.7913DW-statistic2.00602.00602.0060 DW-statistic 2.0069 **** R-Squared and R-Bar-Squared measures refer to the dependent variable dLM3 and in cases where the error correction model is highly

restricted, these measures could become negative.

Appendix G4: The HQN, ARDL-ECM short-run estimates for M3

Error Correction Representat	tion for the	Selected ARDL Mode	el
ARDL(1,2,2,2,1,2,2)	selected ba	ised on Hannan-Quir	nn Criterion
****	***********	*****	* * * * * * * * * * * * * * * * * * * *
Dependent variable is dLM3	timotion fue	$m = 1000 \pm n = 2011$	
50 ODServations used for es	SLIMALION IIC)	* * * * * * * * * * * * * * * * * * * *
Regressor Coet	ficient	Standard Error	T-Batio[Prob]
difce	59374	331.81	1 7894[091]
dLFCE1 -	-2.1795	.60681	-3.5917[.002]
dlex	.38752	.11711	3.3089[.004]
dLEX1 -	32663	.10192	-3.2049[.005]
dlgfcf -	51603	.14916	-3.4595[.003]
dLGFCF1	.19288	.083630	2.3063[.034]
dINF(049939	.0025056	-1.9931[.063]
dlneer	.16449	.062235	2.6430[.017]
dlneer1 .	.092821	.059918	1.5491[.140]
dRSD .(089475	.0020431	4.3795[.000]
dRSD1 .(038574	.0023642	1.6316[.121]
dC -5	56.6525	8.5005	-6.6646[.000]
ecm(-1) -	-1.2013	.17883	-6.7176[.000]
dLM3 = LM3-LM3(-1) $dLFCE = LFCE-LFCE(-1)$ $dLFCE1 = LFCE(-1) - LFCE(-2)$ $dLEX1 = LEX(-1) - LEX(-2)$ $dLGFCF = LGFCF-LGFCF(-1)$ $dLGFCF1 = LGFCF(-1) - LGFCF(-1)$ $dLNEER = LNEER-LNEER(-1)$ $dLNEER1 = LNEER(-1) - LNEER(-1)$ $dLNEER1 = LNEER(-1) - LNEER(-1)$ $dRSD1 = RSD-RSD(-1)$ $dC = C-C(-1)$	-2) -2)		
ecm = LM3 -4.1739*LFCE 7025*LNEER0032528*RSD +	96762*LEX 47.1591*C	+ .79268*LGFCF -	+ .012632*INF + .008
* * * * * * * * * * * * * * * * * * * *	***********	*****	*****
R-Squared S.E. of Regression Mean of Dependent Variable Residual Sum of Squares Akaike Info. Criterion DW-statistic	.96766 .014575 .13372 .0023367 80.3351 2.0430	R-Bar-Squared F-stat. F(12, S.D. of Dependent Equation Log-like Schwarz Bayesian (.91473 17) 27.4262[.000] Variable .049913 lihood 99.3351 Criterion 67.0237

R-Squared and R-Bar-Squared measures refer to the dependent variable dLM3 and in cases where the error correction model is highly restricted, these measures could become negative.