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AN ERROR CORRECTION APPROACH TO THE DEMAND FOR MONEY IN GHANA.

A THESIS submitted to the School of Graduate Studies in partial fulfillment of the requirement of the degree of Master of Science in Economics (Economic Policy Analysis).

BY

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An Error Correction Approach to the Demand for Money in Ghana

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DEDICATION

This work is dedicated to my dear mother, Madam Amma Danso, for her untiring efforts in my education. Although she had no formal education but she envisaged that the best investment she could offer me is educating me. Mother, may your ways be straight.

ABSTRACT

Studies of money demand in Ghana have, more often than not, neglected testing for its stability although a stable money demand function is necessary for the effectiveness of monetary policy. Furthermore, attention has not been paid to the order of integration of the variables in the estimated money demand function. Most of these studies did not use the newly developed error correction techniques to avoid running spurious regressions. This Thesis improves on these limitations. It uses cointegration and error correction models to analyse the determinants of the demand for money. The results indicate that (i) the money demand function in Ghana was stable over the period of study (1969-1995); (ii) the money demand series is an I(1) process; (iii) that both definitions of money (**M1 & M2**) are stable; and (iv) that current income, domestic interest rate, foreign interest rate and financial liberalisation were the main determinants of money demand.

ACKNOWLEDGEMENTS

I wish to render my heartfelt gratitude to the Almighty God for seeing me through. May His name be praised.

Completing this Thesis would have been difficult without the assistance I received from many people. To acknowledge each and everyone is a difficult task. However, some few individuals need special mention. My sincerest thanks goes to my Supervisor, Dr Kambou Gerard, for his untiring efforts. His contributions and suggestions, have really helped me a lot. To Dr Kambou, I say "ayekoo".

The contributions of my friends: Janvier, Mulenga, Wisdom and a host of others, have helped academically, spiritually, materially, or otherwise to bring this work to this far. To them I say may God richly bless you.

Also, I would like to express my joy and appreciation to AERC and its able staff for their sponsorship. I would like them to continue with their good work so that my other unfortunate brothers and sisters in the diaspora can also benefit from their assistance.

Last but not the least, I would like to express my innermost appreciation to my

Heads of department, Ato Mekonnen of Addis Ababa and Dr Afful of Cape Coast, not forgetting Dr Amonoo and his family, for the assistance and encouragement they have given me in one way or another. It is my prayer that the Lord gives them what their hearts desire.

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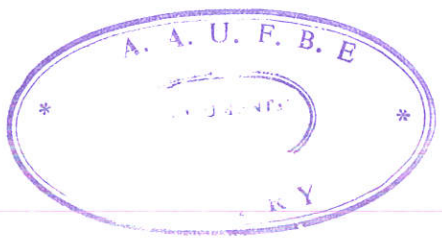

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CHAPTER 1: INTRODUCTION

1.1 STATEMENT OF THE PROBLEM AND OBJECTIVES

The objectives of this Thesis are to empirically analyse the determinants of money demand in Ghana and test for the stability of the money demand function over the 1969-1995 period. The question of whether the money demand function is stable or not is one of the most important recurring issues in the theory and design of macroeconomic policies. In broad terms, a stable money demand function is necessary for the effectiveness of stabilization policies, where stabilization depends on the ability to adjust money supply to its demand in order to prevent undesirable effects of monetary disturbances on real output. The relationship between money supply, prices, income, and balance of payments is determined by the demand for money, and such a relationship plays an important role in macroeconomic policy.

Since the inception of the Economic Recovery Programme (ERP) in April 1983, several major reforms have been introduced into the economy of Ghana with the objectives of restoring macroeconomic stability and moving the economy onto a rapid and sustained growth path. The reforms included the liberalisation of the foreign exchange market, financial sector reforms, and tax and expenditure reforms. The exchange rate reforms helped to correct the overvaluation of the cedi, the domestic currency, which exceeded 1000% in 1982 (Leechor, 1991), led to a market determined exchange rate, and substantially reduced the parallel exchange rate premium. Interest rates have been liberalised, and the security market has expanded with the opening up of the stock exchange market and the weekly auctions of government securities of various maturities. Substantial fiscal adjustments led to the lowering

of the overall budget deficit, thus allowing, together with the increased inflows of net foreign financing, a sharp reduction in the government's recourse to domestic bank financing. The government no longer borrows freely from the Bank of Ghana and monetary policies increasingly emphasise the use of indirect instruments of monetary control.

As a result of these and other reforms, inflation fell, declining from over 270% in 1978 to less than 10% in the early 1990s, real economic growth became positive, averaging 5% for the past decade from -0.8% between 1970 and 1983, real interest rates turned positive, and the exchange rate stabilised. In the light of the wide ranging economic changes that have taken place, especially in the exchange rate market and the financial sector, there is need to examine the demand for money function in Ghana so as to determine what the implications of these reforms have been for the private sector's demand for money. A stable money demand function will be of crucial importance for the conduct of monetary policies in Ghana. A central objective of the Central Bank of Ghana is to maintain low and stable inflation rates. Without a stable money demand, the monetary authorities may not be able to effectively control inflation by means of regulating the growth of monetary stock.

This thesis has three main objectives. Specifically, it will: (a) determine the factors that have an influence on the demand for money in Ghana; (b) test the stability of the money demand function over the stated period; and (c) examine the implications of recent reforms on the private sector's demand for money.

1.2 TESTABLE HYPOTHESES

The following hypotheses will be tested: (1) The money demand function in Ghana is stable; (2) The main determinants of money demand in Ghana are income, expected inflation, and lag of money demand; (3) Financial liberalisation and exchange rate reforms have had a positive impact on money demand function in Ghana.

1.3 SIGNIFICANCE OF THE STUDY

Empirical work on the demand for money in Ghana is very scanty. Even though Amoako (1991), Kallon (1992) and Sowa (1993) estimated a demand for money function in Ghana, with the exception of Kallon, they did not test for the stability of the demand for money function. In addition, these studies did not consider the changes that have taken place since 1990. Furthermore, the studies by Amoako, Kallon and Sowa did not test for the stationarity of the money demand series. The two-stage least square estimation technique used by Sowa is just a typical example of standard estimation procedure that can yield spurious regression results if the data are not stationary. This study will employ cointegration tests to determine whether money demand series in Ghana are stationary and use error correction modelling techniques to examine the behaviour of the demand for money over the 1969-1995 period. Given its objectives and because it uses appropriate techniques of time series econometrics, the study will be important in the following ways: (a) It will contribute to the existing literature on money demand; and (b) perhaps more importantly, its findings could assist the government in Ghana in the formulation of monetary policies.

1.4 LIMITATIONS OF THE STUDY

It should be recognised that this study has its own shortcomings of which the following are of no exception.

The paucity of data on itself is a limiting factor. According to Kholdy (1995), "Data compiled in most developing countries is inaccurate and may therefore bias the empirical results. The time factor as well as financial resources cannot be excluded from the list of constraints to this study. Quarterly data might have been appropriate for this study but could not be compiled due to the above problems. Care should therefore be taken in applying the results of this work.

1.5 ORGANISATION OF THE STUDY

This study is divided into six chapters. Following the introduction, chapter 2 looks at the macroeconomic performance of the Ghanaian economy. Chapter 3 provides a review of the existing literature on money demand. In chapter 4, the model for empirical analysis is specified, and the methodology and data are discussed. Chapter 5 comprises the analysis of data and the interpretation of results. Finally, chapter 6 summarises the main results and makes some policy recommendations.

CHAPTER 2: MACROECONOMIC PERFORMANCE OF THE GHANAIAN ECONOMY

2.0 INTRODUCTION

This chapter is mainly concerned with how the Ghanaian economy has fared in terms of growth and probably development over the period under study. The chapter is sub-divided into five sections: economic structure and performance before the **ERP** (section 2.1), economic structure and performance after the **ERP** (section 2.2), monetary developments and policies (section 2.3), trends on Ghana's financial system (section 2.4) and exchange rate policy and reforms (section 2.5).

2.1 ECONOMIC STRUCTURE AND PERFORMANCE BEFORE THE ERP

Ghana is an agrarian economy just like most African economies. The major cash crop is cocoa. Ghana was the world leader in the production of cocoa until 1978 when it was overtaken by Ivory Coast and Brazil. When Ghana was the world leading producer of cocoa, her per capita income was comparable to that of Mexico and Brazil. Inflation by then was a mere 1 %. Table 2.1 below summarises the performance of the Ghanaian economy between 1969 and 1983. The performance of the economy between 1969 and 1975 was relatively strong. The growth rate of real GDP averaged 3.3%, inflation was 13.4%, and the budget deficit as a ratio of GDP was -5%.

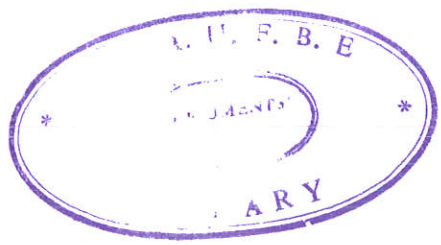

TABLE 2.1 GHANA: SELECTED ECONOMIC INDICATORS (1969-1982).

VARIABLE/ PERIOD	1969-1975	1976-1982
M1G (%)	26.7	43.8
M2G (%)	26.1	41.9
FD	4.81	0.22
DCR	0.3	0.3
GSCR	0.48	0.67
PSCR	0.29	0.11
RGDPG (%)	3.3	-6.1
Xs (%)	14.1	56.0
Ms (%)	16.2	64.9
BDR (%)	-5	-8
INFLATION	13.4	69.8
DI (%)	6.2	11.4

SOURCES: Author's calculation based on data from the International Financial Statistics Year Book (1996), Sowa (1991) and the State of the Ghanaian Economy (1995).

Where,

M1G is the growth in narrow money,

M2G is the growth in broad money,

FD is financial deepening,

DCR is domestic credit as a ratio of GDP,

GSCR is credit to the public sector as a ratio of domestic credit,

PSCR is the share of private sector in total domestic credit,

RGDP is the real gross domestic product,

RGDPG is the growth rate of real gross domestic product,

BDR is the overall budget deficit as a ratio of GDP,

DI is the domestic interest rate proxied by the 90 day treasury bill rate,

Xs is growth rate of exports and

Ms is growth rate of imports.

Between 1976 and 1982, the Ghanaian economy declined. **GDP** growth rates fell, declining from 3.3% between 1969 and 1975 to -6.1%. Inflation also skyrocketed. The average inflation rate rose from 13.4% between 1969 and 1975 to 69.8% between 1976 and 1982. Budget deficit as a ratio of GDP increased from an average of -5% between 1969 and 1975 to -8% between 1976 and 1982. The deterioration in macroeconomic performance was compounded by severe distortions in the system of incentives as the exchange rate and the interest rate remained fixed in the face of rising interest rates. The decline in real **GDP** growth rates was caused by both internal and external factors. The external factors included unfavourable long run terms of trade, the oil price shocks of the mid 70s and early 80s, and adverse weather conditions. For instance, bush fires and drought took Ghana by surprise in 1983 and depressed economic activities further. The internal factors included gross economic mismanagement, corruption and political instability. In 1983, the economy was in deep crisis and in need of economic reforms.

2.2 ECONOMIC STRUCTURE AND PERFORMANCE AFTER THE ERP

The country's economic plight was drawn to the attention of the International community. In 1983, the **IMF** and the World Bank prescribed a Structural Adjustment Programme (SAP). The government of the Provisional National Defence Council (PNDC) accepted the proposed package. It is now more than a decade since Ghana launched its far

reaching but gradualist **ERP** with the following aims: to restore production incentives for food, industrial raw materials and export commodities in order to improve **GDP** growth rates; to increase the availability of essential consumer goods; to remove exchange rate overvaluation and to increase the overall availability of foreign exchange in the country; to lower the rate of inflation; to improve savings mobilisation and investment; and to rehabilitate the physical infrastructure. The **ERP** is still continuing.

These reforms have transformed the economy and helped improve macroeconomic performance. Cocoa and other exports recovered and real output grew. Ghana is now second to Ivory Coast in terms of world cocoa production and real **GDP** has averaged 5% over the past decade.

TABLE 2.2 GHANA: SELECTED ECONOMIC INDICATORS (1983-1995).

VARIABLE/ PERIOD	1983-1989	1990-1995
M1G (%)	44.1	35.8
M2G (%)	45.1	38.4
FD	0.14	0.16
DCR	0.2	0.2
GSCR	0.70	0.64
PSCR	0.16	0.23
RGDPG (%)	5.3	5.3
Xs (%)	68.7	42.7
Ms (%)	75.7	39.7
BDR (%)	-1	-0.1
INFLATION	42.0	27.1
DI (%)	17.7	25.8

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Ms (%)	75.7	39.7
BDR (%)	-1	-0.1
INFLATION	42.0	27.1
DI (%)	17.7	25.8

SOURCES: Author's calculation based on data from the International Financial Statistics Year Book (1996), Sowa (1991) and the State of the Ghanaian Economy (1995).

As Table 2.2 indicates, inflation fell sharply, declining from 69.8% between 1976 and 1982 to 42% between 1983 and 1989 and to 27% between 1990 and 1995. Budget deficit as a ratio of GDP declined from an average of -8% between 1976 and 1982 to -1% between 1983 and 1989 and to -0.1% between 1990 and 1995. The policy reforms behind the improved economic performance were comprehensive. They encompassed the conduct of monetary policy, the management of the budget, trade and exchange rate policy, and the financial sector. Because they have implications for the private sector's demand for money, we briefly examine the reforms related to monetary policy, exchange rate, and the financial sector.

2.3 MONETARY DEVELOPMENTS AND POLICIES

Prior to the establishment of the Bank of Ghana (BoG) in 1957, money supply in Ghana was tied to the country's external balance of payments, expanding with a surplus on the external account and declining with a deficit. After 1957, the BoG was given the mandate for monetary control under the ordinance which established it. The BoG Act (1963), section 22 provides that:

> **If on any particular day the total amount of media of payment exceeds by 15% or more the total amount of the media of payment in existence during the 12 months immediately preceding that day, the Board shall forthwith make a report to the Minister, specifying the causes which in their opinion**

have led to that situation and their proposals to the Minister as to the steps to be taken in view thereof (Sowa, 1991).

Until 1972, the 15% target was strictly followed. In 1972, after a military coup had toppled Dr Busia's regime and brought General Acheampong to power, money supply increased by 40.6%. The BoG attributed this high monetary expansion "mainly to net credit to the government and public institutions, particularly the Ghana Cocoa Marketing Board and the Ghana Supply Commission"[1]. Since then, increases in money supply has been in leaps and bounds. As Table 2.1 indicates, the average annual growth rate of **M1** which was 26.7% between 1969 and 1975 increased to 43.8% between 1976 and 1982. The growth rate of **M2** followed a similar pattern, rising from 26.1% between 1969 and 1975 to 41.9% between 1976 and 1982. Both the money supply and inflation increased rapidly. Before the **ERP**, the government financed its budget deficits primarily through money printing. Financing as a ratio to deficit by the **BoG** increased from 8% in 1972 to 151% in 1975. This increased the supply of money and subsequently led to inflation. As shown in Table 2.1, inflation, which averaged 13.4% between 1969 and 1975, skyrocketed to 69.8% between 1976 and 1982. Net credit to the government as a ratio of total domestic credit increased from 48% between 1969 and 1975 to 67% between 1976 and 1982.

At the inception of the ERP in 1983, the country's financial system was almost collapsing under strong inflationary pressures and an overvalued exchange rate. The prime objective of monetary policy under the ERP, therefore, was to curb the rate of inflation which was then running at 3-digits, regain control of credit expansion by the Banking system

[1] Bank of Ghana Annual Report of the Board for the Financial year ended 30th June, 1972.

particularly to the government, while supporting the exchange rate policy and achieving the targets for real output and the overall balance of payments. This involved restricting the growth rate of broad money supply (**M2**). A severe credit squeeze was therefore applied and the government's access to domestic credit was sharply curtailed. Between 1990 and 1995, the average rate of growth of **M1** decelerated, falling to 35.8%. **M2** followed the same trend as **M1,** between 1990 and 1995 it averaged 38.4%.

The tight monetary policies have led to a decrease in the net domestic credit growth, which fell from 61% in 1985 to 13% in 1988. After 1988, it further decreased to single digits; it was 9% in 1992 (Sowa, 1993; Kapur et al, 1994). However, it can be observed that the monetary authorities in Ghana have not yet succeeded in bringing money supply under control as expected. Despite some progress in constraining domestic credit, money supply growth has remained relatively high. The government recognises that more work needs to be done to reduce further the money supply growth rate. In his 1996 Budget statement, the Minister of Finance announced that tight monetary policies will be maintained until the desired level of money supply is achieved.

2.4 TRENDS ON GHANA'S FINANCIAL SYSTEM

The financial system in Ghana has operated under duress. Until recently, it has not had the chance to operate freely without any interference. Interest rates were administratively set and credit was allocated to preferred sectors at subsidised rates. In 1982, the **PNDC**

government vetted all bank balances exceeding 50,000 cedis[2]. In addition, the 50 cedi notes that were in the system were withdrawn. As a result, the Ghanaian populace lost interest in the banking system. Savings in the form of real assets or under pillows or on the farms became the order of the day.

After the inception of the **ERP**, the financial sector was revived with the introduction of wide ranging reforms[3]. The interest rates were liberalised. As Tables 2.1 and 2.2 indicate, the domestic interest rate has increased from an average of 6.2% between 1969 and 1975 to 11.4% between 1976 and 1982. The rates have increased further in the 1990s, rising to an average of 25.8% between 1990 and 1995. Moreover, the security market has been enlarged by the sale of government bonds to the private sector. Privatisation is high on the government's agenda and has proceeded fairly rapidly. Privatisation of the Social Security Bank has boosted the private sector's participation in the financial sector. In 1990, a stock exchange market was opened.

By 1995, the number of non-bank financial institutions (NBFIs) operating in the country increased to 23 from 15 in 1989. These included 9 Finance houses, 4 Savings and Loans companies, 3 Leasing companies, 2 Discount houses, 2 Hire purchase companies, 2 Building societies and a Venture Capital Funding company. The banking sector also grew. Several new private banks emerged and, in 1995, the number of banking institutions in Ghana

---

[2] Many people lost their monies in the banking system. This is because they were expected to give account of their monies in the banks supported by documents. Since many of these people did not keep account of their activities, they forfeited whatever monies they had with the various banks.

[3] For more details on the financial sector reforms, refer to Box 1 in the appendix.

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increased to 15 from 10 in 1989. The growth of the financial sector was accompanied with new services and product improvement. There was the introduction of Moneylink and Autocash ATM machines by Standard Chartered Bank and Meridian BIAO (now Trust Bank) in 1994, followed in 1995 by Barclays bank with Barclays cheque card, Ghana Commercial Bank with Bonus fixed deposit account, and National Investment Bank with bearer bonds. It should be noted that the monetisation of the economy was both vertical and horizontal since the banking system was spread throughout the country.

2.5 EXCHANGE RATE POLICY AND REFORMS

Until the ERP was launched in 1983, the cedi was overvalued and foreign exchange was scarce. In 1982, the overvaluation of the cedi exceeded 1,000% of the official exchange rate (Leechor, 1991). The rationing of the foreign exchange in the official banking system for the importation of consumer goods led to the development of parallel markets and a general deterioration of the economy. As noted by Kapur et al (1991, p.34):

> **Shortages of foreign exchange and imported goods and distortions in the structure of relative prices led to a proliferation of parallel markets, an intensification of unrecorded cross border trade, and a marked deterioration in government services, in the basic economic and social infrastructure and in the country's capital stock in general.**

In order to redirect incentives toward productive activities and exports, and to endow Ghana with an efficient exchange rate system, a four-stage reform was implemented

immediately after the inception of the ERP in April 1983. The steps included devaluations under a pegged exchange rate system, floating exchange rate in the framework of an auction market, absorption of the parallel market and a composite exchange rate arrangement. Initially, a series of sizable discrete exchange rate adjustments were undertaken supported by appropriate fiscal and credit policies in order to reverse the overvaluation of the exchange rate. The cedi was devalued from 2.75 cedis to a dollar in April 1983 to 90 cedis to the dollar in January 1986. However, the pegged exchange rate arrangement and the series of devaluations undertaken during this period did not prove sufficient to reach an appropriate real exchange rate. Hence, an auction market was introduced and a dual exchange rate system (auction markets and pegged exchange rate arrangement) was created as a transitory measure to bridge the gap between the official and unofficial rates. Thereafter, the official exchange rates were unified in the context of 'retail' auction for foreign exchange[4]. This system was discontinued in April 1990 after it had provided an institutional framework for the achievement of an appropriate exchange rate and the gradual liberalisation of Ghana's exchange and trade systems.

The sizable parallel market for foreign exchange, which persisted after the unification of the exchange rates undermined the efficiency of the official exchange rate system and continued to distort economic incentives. This led to the establishment of foreign exchange bureaus in the country. The bureaus, established on February 1, 1988, led to the dismantling of the parallel foreign exchange market. The activities of the bureaus also reduced the spread between the average bureau buying rate and the auction rate from a peak of 40% in February

[4] The auction was chosen because it allowed the Central Bank to continue to centralise the nation's foreign exchange receipts which was viewed as crucial in minimising capital flight.Also it was the belief that the auction could prevent the emergence of collusive behaviour on the part of commercial banks.

1989 to 8% in April 1990. A wholesale auction was then put in place in April, 1990. This was followed by the completion of the liberalisation of payments for current international transactions, making the cedi a convertible currency. Thereafter, the foreign exchange auction and the foreign exchange markets were unified into what became known as the inter-bank exchange rate system. Today, Ghana operates a flexible exchange rate system with minimum government intervention. This has restored peoples confidence in the cedi.

CHAPTER 3: LITERATURE REVIEW

3.1 THEORETICAL FRAMEWORK

Economists have long been concerned with a theoretical framework for the demand for money. Starting out from a fairly rudimentary level, these theories have become increasingly comprehensive. Fisher (1911) linked the demand for cash balances to the value of transactions in an economy. He stated that the stock of money times the number of times that money is spent each year (velocity of money in circulation) must equal the annual value of all transactions[5]. Building on this, the Cambridge school, led by Pigou (1917) and Marshall (1923), stressed the importance of income in the demand for money function. Here, the level of income was considered the main constraint on individual cash balances. They also discussed the importance of uncertainty about the future and the rate of interest in influencing the demand for money[6].

Keynes's (1930 & 1936) analysis of the demand for money focused on the motives that prompted people to hold cash balances. He identified three motives for holding money: transactionary, precautionary and speculative. Keynes argued that cash balances are held in

---

[5] This constitutes what is known as Fisher's identity equation:

$$MV = PT,$$

where
M = the stock of money, V = velocity of money in circulation,
P = the average price level, and T = volume of transactions.

[6] However, in formulating the demand for money function, they specified their analysis by holding other influences constant. Hence, the demand for money equation was written as :

$$M = kY,$$

where k = the reciprocal of income velocity.

order to bridge the gap between receipts and payments as well as for precautionary purposes, and specified the precautionary and transactionary demand for cash balances as functions of the level of income. He further stressed that the demand for money could be influenced by the interest rate. In explaining the speculative motive, Keynes built on the ideas of the Cambridge school. He reasoned that the speculative demand for holding cash balances was influenced by the expected interest rate on (and thus the price of) bonds. The higher the interest rate, the lower the cash balances held by individuals. Keynes, therefore, included the interest rate as an explanatory variable in his demand for money function[7]. According to Keynes, individuals compare their normal or expected interest rate with the market interest rate. Whenever the market interest rate is greater than the normal interest rate, the expectation is that the market interest rate will fall leading to an increase in the price of bonds. With the price of bonds expected to rise, people will move away from cash into bonds in order to make capital gains. Conversely, if the market interest rate is lower than the normal interest rate, the expectation is a rise in the market interest rate leading to a fall in the price of bonds. With the price of bonds expected to fall, people will move away from bonds into cash in order to avoid capital losses. The basic conclusion of Keynes' asset demand for money is that individuals hold either cash or bonds but not both at the same time. Tobin (1956) differed on the tenet of Keynes' asset demand for money. According to Tobin, generally, people are uncertain about the future rate of interest. Due to the uncertainty about

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[7] Keynes' demand for money equation was :

$$M^d = [k(Y) + l(r)]P,$$

where
M^d = demand for nominal cash balances, Y = income, r = interest rate, P = price level, k & l represent transactionary and speculative motives respectively.

the future rate of returns on bonds and the accompanying risks, people will hold both cash and bonds.

In addition to the level of income, Baumol (1952) & Tobin (1956) explicitly introduced the interest rate as one of the explanatory variables in the transactions demand for money[8]. The underlying assumption of their analysis is that money is a form of inventory. Hence, maximising behaviour with respect to inventories of goods could also apply to inventories of money. The analysis of the demand for money couched in these terms obeyed the same kind of principle as the optimum inventory approach. The money required for transaction purposes is inversely related to the interest rate and would not change proportionately with the volume of transactions, but rather with the square root of the volume of transactions[9].

Whereas the Keynesian analysis of the demand for money was based on the motives that prompt people to hold money, the modern quantity theory, which is fully elaborated in the works of Friedman (1956), considers money as an asset which provides a flow of services to the holder. Thus, the modern quantity theory of money views money as one of many alternative forms of asset. According to Friedman, there are 5 forms of assets including money, bonds, equities, physical non-human assets and human capital. The most important

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[8] Before then, Hansen (1949) suggested that at sufficiently high interest rates, cash balances become interest elastic, i.e. people will economise on their transaction balances as the interest rate rises beyond a certain minimum.

[9] In the inventory theoretic approach, the demand for money becomes:

$$M^d = 0.5(2bY/r)^{0.5}P,$$

where b = brokerage fee associated with converting bonds into cash.

implication of this approach is that money is regarded as a substitute, not only for bonds but also for equities, physical capital, durable consumer goods and human capital.

3.2 EMPIRICAL WORK

This section is sub-divided into two parts. Section 3.2.1 is an introduction which considers the main empirical issues that have confronted economists and how they have been dealt with. Section 3.2.2 gives a brief overview of empirical money demand studies in Sub Saharan Africa.

3.2.1 INTRODUCTION

In recent years, the number of empirical work on the demand for money in LDCs has grown as more reliable and consistent data have become available. These studies basically attempt to resolve the following issues: (a) the most appropriate definition of money; (b) the arguments that enter into the demand for money function; and (c) the statistical stability of the money demand function over time. Owing mainly to lack of consistent time series data over a sufficient span of time, researchers have found it extremely difficult to examine the third issue. Attention has therefore been focused on the first two issues.

In most empirical work on the demand for money, two principal definitions of money stock, often referred to as **M1** & **M2**, are used. **M1**, commonly referred to as the narrow definition of money, comprises currency (notes and coins) held by the public plus demand

deposits; while **M2** (broad definition) constitutes **M1** plus time and saving deposits with commercial banks.

Regarding the determinants of money, empirical studies show that real income is the most important determinant of the demand for real cash balances (Adekunle, 1968; Sowa, 1993), although available evidence is rather conflicting on the magnitude of the real income elasticity of the demand for money. The interest rate has served as a measure of the opportunity cost of holding money in many studies. However, there is no conclusive evidence as to whether long or short term interest rate influences the demand for money. Studies by Biswas (1965), Gujarati (1968), Singh and Adekunle (1968) show that the demand for money is insensitive to both long and short term interest rates. Sastry, Imam and Gupta (1970), on the other hand, find that the interest elasticity of the demand for money is statistically significant. It has been advocated by some that in an open economy, foreign interest rate is an important determinant of demand for money. Finally, in most studies, the expected rate of inflation is included as an explanatory variable to measure the opportunity cost of holding cash balances in terms of real assets. The expected rate of inflation should be taken into account especially during periods of rapid inflation. This has been shown in studies conducted on Argentina, Brazil, Chile and Korea[10].

3.2.2: OVERVIEW

In this section, a selective number of empirical studies in Sub-Saharan Africa (SSA) will be reviewed. Money demand studies in the region include those by Oladeji (1974) for

[10] For more details, see studies of Cagan (1956), Vogel (1973), Goldfeld (1973), Shapiro (1973) and Khan (1977).

Nigeria; Pathak (1981), Darrat (1985), Mwega (1990) and Adam (1992) for Kenya; and Domowitz & Elbadawi (1987) for Sudan.

Domowitz & Elbadawi (1987) used a dynamic error correction model (ECM) in their study of demand for money in Sudan in the period between 1956 and 1982. Using annual data, an ECM was estimated around the long run proportionality between money and income. The short-run domestic inflation and the U.S. dollar exchange rate variables were significant at the 5 percent level.

Pathak modelled money demand in Kenya using annual data (1968-1978) in a static regression in which the income variable was proxied by GDP and the rate of return on financial assets was proxied by the short-term treasury bill rate. These variables were statistically significant at the 5 percent level.

Darrat (1985), on the other hand, used quarterly data to estimate the demand for money in Kenya for the period 1969-1978. His dependent variables were both M1 and M2 and he used GNP as his income variable. He also argued for a foreign interest rate variable since domestic financial markets were weak. In addition, he admitted the absence of a short-term dynamic effect of money itself. His income elasticities seemed high and heterogenous.

Mwega's model of the demand for money in Kenya was also based on quarterly data. The variables that entered his model were GNP, a short-term treasury bill rate, and a partial adjustment structure for the lagged dependent variable. The study covered the perioble carried the wrong sign. Before Sowa's study, Amoako (1991) used broad money (M2) as his

dependent variable. His work focused on three time periods: 1956 to 1971, 1972 to 1986 and 1956 to 1986. For the income variable, he used the GDP. In all his estimations, he found that income and inflation were very important determinants of the money demand function in Ghana. The long run income elasticities were all greater than one. The 1956-71 period showed that 59 percent of the adjustment took place within a year while the 1956-86 period indicated that 26 percent of the adjustment took place within a year. Amoako's model excluded the exchange rate variable because it was not significant. The results in terms of periods of adjustment have an important implication for monetary policy. The adjustment period is a signal to policy makers that monetary policies take some time before its impact is felt in the economy. Following Amoako but before Sowa was Kallon's (1992) empirical work. He used quarterly data from 1966:1 to 1986:4 to empirically study the demand for money function in Ghana using both M1 and M2 as his regressands. He concluded that income, proxied by gross national product (GNP), and adjusted inflation (i.e., interest rate plus inflation plus the middleman's mark up) were statistically significant. He also found out that the income elasticity of money was greater than two and that the money demand function in Ghana was stable.

CHAPTER 4: EMPIRICAL MODEL, METHODOLOGY AND DATA

4.0 INTRODUCTION

The model that we will use to empirically analyse the demand for money in Ghana is a variant of the ECM developed by Domowitz and Elbadawi (1987). In their study of the demand for money in Sudan, they used a long run equilibrium relationship of the form:

$$m^* = k + \alpha_0 p + \alpha_1 y + \alpha_2 e + \alpha_3 \Delta p \ldots (4.1)$$

where m^*=desired nominal balances; p=price level; y=income; e=exchange rate; and Δp=inflation rate.

In empirical works, an often used one-period loss function is:

$$\theta_1 (m_t - m^*_t)^2 + \theta_2 (m_t - m_{t-1})^2 \ldots (4.2)$$

where,

m_t = planned nominal balances, and $\theta_2(m_t - m_{t-1})$ = the adjustment cost. However, Domowitz and Elbadawi proposed an alternative adjustment cost:

$$\lambda_2 [m_t - m_{t-1} - \phi_t \Delta h_t]^2 \ldots (4.3)$$

where h_t is a vector of variables assumed to influence nominal balances, and θ_t is a row vector that weights each of the elements of Δh_t. Based on equation 4.1, $\mathbf{h}_t$ was taken as $(p_t, y_t, e_t, \Delta p_t)'$. Hence, their loss function became as follows:

$$I_t=\lambda_1(m_t-m^*_t)^2+\lambda_2[(m_t-m_{t-1})^2+(\phi_t\Delta h_t)^2]+\lambda_3\Delta h_t(m_t-m_{t-1})...(4.4)$$

where $\lambda_3 = -2\lambda_2\phi_t$, a row vector of order four.

Thereafter, they minimised equation (4.4) and placed on the outcome certain restrictions. This led them to equation (4.5) below, which they termed the "error correction rule" for cash balances[11].

$$m_t-m_{t-1}=\beta_0+(\beta_1+\beta_7)\Delta p_t+(\beta_2+\beta_6)\Delta y_t+(\beta_3+\beta_8)\Delta e_t+(\beta_4+\beta_9)\Delta^2 p_t+$$

$$(\beta_5-1)[m_{t-1}-p_{t-1}-y_{t-1}]+\beta_3 e_{t-1}+\beta_4\Delta p_{t-1}...(4.5)$$

The equation they estimated for Sudan took the following form:

$$\Delta mt=\gamma_0+\gamma_1\Delta p_t+\gamma_2\Delta y_t+\gamma_3\Delta e_t+\gamma_4(m-p-y)_{t-1}+\gamma_5 e_{t-1}+$$

$$\gamma_6\Delta p_{t-1}+\sigma_1 p_{t-1}+\sigma_2 y_{t-1}+\epsilon_t...(4.6)$$

where ϵ_t is a white noise, homoscedastic error term, uncorrelated with the regressors.

[11] For more details on the derivation, see the work of Domowitz and Elbadawi (1987).

4.1 MODEL OUTLINE

4.1.1 THE LONG RUN RELATIONSHIP

To empirically investigate the determinants of demand for money in Ghana, we postulate the following long run relationship:

$$RM=\alpha_0+\alpha_1 RGDP+\alpha_2 FI+\alpha_3 DI+\alpha_4 ER+\alpha_5 P^e+\alpha_6 DER+\alpha_7 MiL+\alpha_8 Z+Ui \ldots (4.7).$$

where,

RM = RM1 or RM2 = real money aggregate = M1/cpi or M2/cpi,

RGDP = real gross domestic product as a proxy for real income at 1987 prices,

FI = nominal foreign interest rate represented by the U.S. treasury bill rate (90 day),

DI = nominal domestic treasury bill rate (90 days),

CPI= consumer price index,

P^e = expected inflation,

ER = exchange rate (nominal),

DER = dummy for the exchange rate,

MiL = the lag of RM1 or RM2,

Z = financial liberalisation, and

Ui= the disturbance term.

N.B.: α's = estimated coefficients.

It is a common practice in literature to take the logarithm of equation (4.7)[12]. Following this practice, the log of equation (4.7) yields:

$$LRM=\alpha_0+\alpha_1 LRGDP+\alpha_2 LFI+\alpha_3 LDI+\alpha_4 LER+\alpha_5 P^e+\alpha_6 DER+\alpha_7 MiL+\alpha_8 LZ+Ui..(4.8)$$

N.B.:α's now become the various elasticities.

Economic theory requires that the partial derivatives of the explanatory variables of money demand satisfy certain conditions. Income, interest rates, exchange rate, lag of money and expected inflation, a priori, are expected to be positive, negative, negative, positive and negative, respectively. The sign for the financial liberalisation variable cannot be determined a priori. This is because during the process of monetisation and financial development characterised by the growth of the banking system, the level of money holding is expected to rise. As the process of monetisation gathers momentum and financial sophistication[13] increases, the demand for money is expected to decline.

4.1.2 MODEL'S VARIABLES

That real income is one of the most important determinants of the demand for real cash balances has been well documented in the literature. In a seminal study conducted in the United States in 1960, Chow proved that the most significant determinant of the demand for real cash balances is income. Subsequent studies supported this finding. Examples of such

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12 This is done in order to avoid the problem of heteroscedasticity. Not only this but also it helps in arriving at the elasticities of the variables (see Maddala, 1992).

13 The financial sophistication is characterised by the emergence of money substitutes such as stocks, bonds, securities, and use of credit cards as well as telegraphic transfers of money.

studies can be found in Table 4.1 in the appendix. As income grows, more money is required to make transactions, hence, the positive relationship between income and money demand.

The interest rate variables are included to account for the opportunity cost of holding money. Friedman (1959) suggested that the rates of interest on all alternative assets are important. However, since interest rates tend to move together, researchers have often tried one rate (either long- or short-term interest rate) at a time in order to avoid the multicollinearity problem. The domestic interest rate (**DI**), proxied by the 90-day treasury bill rate, is chosen to represent the opportunity cost of holding money.

Foreign interest rate (**FI**), proxied by the 90-Day US treasury bill rate, is included in the demand for money function in Ghana to capture the fact that since the United States is one of the main trading partners of Ghana, its interest rate serves as a measuring rod for money holding in Ghana. If it increases, it is expected to have a negative impact on the demand for money in Ghana since Ghanaians will rather invest their monies in US treasury bills and vice versa.

It can be seen that the focus is on short term interest rates. This is consistent with both Baumol and Tobin's analysis of the relation between the transaction demand for money and interest rates as well as the quantity theory of money where the demand for money is significantly influenced by the interest rates on the closest substitutes. Using short term interest rate as a measure of opportunity cost is also recommended by Heller (1965). According to Heller:

The short term interest rate is of greater importance (than the long term interest rate) in the money function. The closest substitute for money available, a 60 to 90 day commercial paper, is most influential in deciding whether to hold assets in the form of money or not. Long term interest rates do not influence the quantity of money demanded...(1965).

In a number of studies including those of Blejer (1978), Blejer and Leiderman (1980) and Peterman and Zilberfarb (1983), some measure of the return to foreign currency has been included in the demand function for real balances. Domowitz and Elbadawi (1987) argue that "during periods in which foreign currency is considered an important alternative to domestic money in the wealth portfolio, omission of such a variable may bias a model towards overstating the influence of inflation, in the context of domestic currency devaluation". From the latter part of the 1970s until the ERP, foreign exchange was scarce. This led to the rationing of foreign exchange. As a result, major foreign currencies became accepted by traders and businessmen as a means of exchange and as a superior store of value. This negatively affected the demand for money in Ghana. The implication is that the exchange rate affects the demand for money in Ghana, hence, its inclusion as an explanatory variable in the money demand function.

As a result of the flexible exchange rate system which was adopted after 1983, the parallel exchange rate markets disappeared and the exchange rate has depreciated in response to changes in market conditions. This has reduced the overvaluation of the cedi. Since the exchange rate is now reasonable, many people have reverted to holding the local currency.

This state of affairs suggests that the effects of different exchange rate regimes should be tested. This will be done with a dummy of 0 from 1969 to 1982 and 1 afterwards.

"Money as a store of wealth, competes with other assets such as real estates, cattle and so on. It is assumed that the rate of inflation is the opportunity cost of most of these durable items" (Sowa, 1993). Theory suggests that an increase in the expected rate of inflation would reduce the attractiveness of money balances. "This effect should be more pronounced for narrow money, which conventionally has a zero nominal yield, than for broad money, which includes time and savings deposits, whose yield can be adjusted to offset inflationary expectations" (Jamil, 1994). The inflation rate in Ghana was high, especially in the 1970s when it entered three digits. It is expected that inflation will have a negative and significant impact on the demand for money in Ghana. It should be noted that a simplified version of the adaptive expectation hypothesis is used to generate the inflation rate. This is stated mathematically as follows:

$$P_t^2/p_{t-1}\ldots(4.9)$$

It is argued that the demand for money depends on its lag. If money holding in the previous period was high, it is expected that more money will be held in the next period so that the two are positively related. The lag of the dependent variable is therefore included as an argument in the demand for money function in Ghana.

As pointed out in the preceding discussion, financial liberalisation may have affected the demand for money in Ghana. The increasing use of money as a means of payment taking

place concurrently with the growth of markets and the decline of subsistence production, in conjunction with the growth of the banking system, may have led to a more rapid increase in the demand for money than income. Since developments in the financial sector may run parallel to the rate of income growth, it is useful to consider the separate influence of institutional factors on the demand for money in order to avoid a bias in the income elasticity estimates. A number of indicators such as currency money ratio, number of bank branches and deposit currency ratio have been suggested in order to measure the effects of financial liberalisation on the demand for money[14]. We will use currency income ratio as a proxy for financial liberalisation because data on these variables is readily available and also because it explains better the behaviour of the public towards financial liberalisation. Given that people save with informal money lenders, which is not officially recorded, the deposit currency ratio might not be a good proxy for financial innovations. In a study conducted in Tanzania by Hage (1993), she concluded, using currency money ratio, that institutional factors were negatively related to the demand for money.

4.1.3 THE ERROR CORRECTION MODEL

Given our long run relationship and assuming that individuals minimise a loss function as specified by Domowitz and Elbadawi, but taking into consideration the variables that enter into the model for this study, the error correction model can be specified as follows:

$$\Delta LRM=\beta_0+\beta_1\Delta LRGDP+\beta_2\Delta LFI+\beta_3\Delta LDI+\beta_4\Delta LER+$$

[14] For an elaboration on this, see the works of Chandavarkar (1977), Ezekiel & Adekunle (1969), Short (1980), Melitz & Correa (1970), Bordo & Jonung (1987).

$$\beta_5 \Delta P^e + \beta_6 \Delta DER + \beta_7 \Delta MiL + \beta_8 \Delta LZ + \beta 9 K_{t-1} + \epsilon_t \ldots (4.10)$$

where K = Ui and Ui is as follows:

$$Ui = LRM - [\alpha_0 + \alpha_1 LRGDP + \alpha_2 LFI + \alpha_3 LDI +$$

$$\alpha_4 LER + \alpha_5 P^e + \alpha_6 DER + \alpha_7 MiL + \alpha_8 LZ] \ldots (4.11)$$

This is based on the assumption that the error terms- Ui and ϵ_t- are all white noise processes. This model will explicitly test the effect of interest rates, financial liberalisation and exchange rate reforms.

4.3 METHODOLOGY

The study covers the period between 1969 and 1995. Annual data are used. As noted by Ott et al (1975), it is important to consider the question about the definition of money because the money concept employed may make a considerable difference as to which variables are significant in the money demand function. Although, Amoako (1991) argues that M2 is the appropriate money definition for Ghana, M1 will also be tested or used as a dependent variable.

4.3.1 TIME SERIES CHARACTERISTICS

Before employing any estimation technique, it is pertinent to examine the time series characteristics of the economic variables. The issue of stationarity[15] is important because a priori theory suggests that most economic variables are non-stationary (see Adam, 1992 & 1993b; Kennedy, 1992). The first step in our empirical analysis is therefore to analyse the long run or stationarity properties of the monetary aggregates and time series variables used in this study. This step will help us to avoid spurious regressions arising from using non-stationary series which are not cointegrated. To achieve the above stated objectives, time series regression analysis and an error correction model developed with the aid of the Engle-Granger (1987) procedure are employed to test for cointegration. The presence of cointegration implies that even if the dependent and the independent variables are non-stationary, the deviations (i.e. the residuals from the estimation of the equation) are stationary (Engle & Granger, 1987). According to Engle and Granger, if there is cointegration, the equation with non-stationary variables is best estimated by the error correction model (ECM) for long run equilibrium and short run dynamics[16].

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[15] Any series which has a constant mean, finite variance, transitory innovations and a coefficient (its absolute value) of less than one in the following equation is said to be stationary and the opposite is the case for non-stationarity:

$$\Delta Y_t = \beta Y_{t-1} + U$$

where
Y = the series under consideration,
t = time, and
U = the error term (see Adam, 1993 & Maddala, 1992).

The null hypothesis (Ho) is that $\beta = 1$ (if there is unit root). If the calculated value is less than the critical value, we accept Ho. The result is obtainable from Microfit 286 (version 3) at 95% confidence interval.

The result described so far is the Dickey Fuller (DF) test. It assumes that the data generating process follows the auto regressive process of order 1; Therein the test is biased in the presence of serial correlation. To avoid this limitation, the Augmented Dickey Fuller (ADF) test comes in handy. The equation for the ADF is:

$$\Delta Y_t = \beta Y_{t-1} + \Sigma b_j \Delta Y_{t-j} + Ui.$$

[16] According to the Engle-Granger representation theorem, if a set of variables are cointegrated of order 1,1 [i.e., CI(1,1)], then, there exists a valid error correction representation of the data. In order for the ECM to be immune from the "spurious regression" problems, it must contain a set of levels terms which cointegrate to give a stationary error term (For more details, see Engle & Granger, 1987).

The Engle-Granger procedure has two steps. Exploration of the equilibrium part of the ECM in order to establish whether the variables are cointegrated is the first step. One can be sure of cointegration if the following results are obtained: high R^2 (close to unity), significant coefficients, a significantly non-zero cointegrating regression DW statistic and significant DF and ADF tests of residuals from the levels' regression. The coefficient estimates from the levels or static regressions can be interpreted as the long run effects.

A series with no deterministic component which has a stationary invertible ARMA representation after differencing d times is said to be integrated, denoted by $Y_t \sim I(d)$. If it is true that two series are integrated, we can try to analyse if they are cointegrated. Granger and Engle (1987) consider that the components of the vector Y_t are cointegrated of order (d,b), denoted by $Y_t \sim CI(d,b)$ if: (i) all the components of Y_t are I(d) ; and (ii) there exists a vector α given that $\alpha \neq 0$ such that:

$$Z_t = \alpha' Y_t \sim I(d,b),\ b > 0.$$

The vector α is called the cointegration vector. The second step in the Engle-Granger two stage-procedure is the process of adding the lag of the residual from the levels' regression to the differenced variables to re-run the regression. This second step gives the ECM or the short run model.

The assumption of regression invariance of the coefficients needs to hold if the predictions based on the results are to hold. Given the Ghanaian case of political instability (5 coup d'etats since independence in 1957) and drought (1978 & 1983), this assumption

may not hold. The Chow[17] test statistic (1960) will therefore be used to test for the stability of the cointegrating regressions. A common means of testing for parameter stability in the absence of prior information about the exact timing of a structural break is to use tests developed by Brown, Durbin and Evans (1975). These tests are based on the cumulative sum of recursive residuals (CUSUM) for systematic changes and cumulative sum of squares for recursive residuals (CUSUMSQ)[18] for sudden changes' tests. The CUSUM and CUSUMSQ tests will therefore be employed to enhance the stability test. Version 3 of Microfit 286 will provide the facility at 5% level of significance for CUSUM & CUSUMSQ tests. All dummies in the equation (if any) would be removed in order to maintain the non-singularity or linear independence of the matrix of the regressors in the case of the CUSUM & CUSUMSQ tests because they are run recursively. It should be noted that the bounds are not strictly valid for models with lagged dependent variables but the test may still provide some informal evidence about parameter stability.

While we can read off the relevant elasticities from the coefficient estimates of the various equations, the relative importance of each variable as a determinant of money demand

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[17] The Chow test being referred to here is also called analysis of variance test. Mathematically, it is specified as follows:

$$F=\frac{(RRSS-URSS)/(k+1)}{URSS/(n1+n2-2k-2)}$$

where
F-statistic follows the F-distribution with degrees of freedom (k + 1) and (n_1 + n_2 -2k-2),
RRSS = Residual sum of squares from pooled data,
URSS = Residual sum of squares from the two separate regressions,
n_1 = number of observations from the first data set,
n_2 = number of observations from the second data set,
k = number of parameters in the regression.
The hypothesis of stability is rejected when the calculated value from the regression of the first sample period is greater than the critical value.

[18] Using the CUSUM & CUSUMSQ tests, the hypothesis of stability is rejected when the plot of recursive residuals from the regression crosses, at least, one of the critical bands at 5 percent level of significance (see Pesaran & Pesaran, 1991).

is not obvious because of differences in the units of measurement of the explanatory variables. We thus compute standardised beta[19] (Theil, 1980) for each of the coefficients to indicate the relative importance of each variable in determining money demand. The beta coefficient test can be expressed mathematically as follows:

$$BC = \beta_x(\sigma_x/\sigma_y)$$

where

BC = beta coefficient,

X = regressor,

Y = regressand,

β = the coefficient, and

σ = the standard deviation.

4.4 DATA DESCRIPTION AND SOURCES

The monetary aggregates include narrow money (M1), quasi-money (QM) and broad money (M2). They are obtained from World bank year book (1995). The Bank of Ghana defines narrow money (M1) as the sum of currency outside banks and private sector demand deposits while Quasi money is the sum of time, savings and foreign currency deposits of residents. The exchange rate variable is obtained from IFS (various issues) and Quarterly Digest of Statistics of Ghana (June 1994, Vol.12, No.2). The exchange rate is the official rate

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[19] The Beta coefficient is the coefficient estimate from the regression in which the variables have been standardised (Kennedy, 1992). For comparative analyses, the variables under consideration need to be in the same unit of measurement (Maddala, 1977). This is satisfied by the beta coefficient estimate because it is expressed in terms of its standard deviation.

expressed as the annual average of the official market exchange rate in national currency per U.S. dollar.

The interest rates are compiled from IFS year book (various issues). The domestic and foreign interest rates are the 90 day treasury bill rates and they can be found in line 60C of the IFS year book (various issues).

The income variable is obtained from IFS (various issues). GDP (1987 base year) is considered the best income variable due to the nature of the economy and also lack of data on other proxies like gross national expenditure (GNE).

Finally, the CPI has been obtained from the World bank year book (various issues) and African Development Indicators (various issues). These are compiled using the Laspeyres formula: goods in the consumption basket are selected according to the pattern of consumption in the base year, derived from household expenditure surveys, and weighted by their relative prices in the base year. The CPI for this study is based on the 1974-75 household budget survey covering nine urban centres and thirty rural centres. It covers 250 items including rent.

Other sources of information were reviewed to augment the data requirement when those provided in the IFS, World Bank year books and African Economic Indicators were not up to date. These included the state of the Ghanaian economy published by the Institute of Statistical, Social and Economic Research (Legon), various Development plans of Ghana by

the Ministry of Planning and Development, and Economic surveys of Ghana by The Statistical Service.

CHAPTER 5: DATA ANALYSES AND INTERPRETATION OF RESULTS

5.0 INTRODUCTION

In the preceding chapters, we have drawn attention to the factors which may influence the demand for money in Ghana. This chapter provides an econometric analysis of the demand for money. Equations are estimated in log-linear or semi-log-linear form to allow for an immediate interpretation of the coefficients in terms of elasticities.

5.1 TIME SERIES CHARACTERISTICS

In this section, we begin by testing the order of integration and then proceed to test for cointegration.

5.1.1 TESTS FOR THE ORDER OF INTEGRATION

Before testing for cointegration, the order of integration of the individual time series must be determined[20]. Tests for unit roots are performed on all the data using the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) tests. The null hypothesis is that the variable under investigation has a unit root against the alternative that it does not. The hypothesis can be restated as follows:

Ho: $\alpha = 1$, Ha: $\alpha < 1$.

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[20] It should be noted that in a one variable case, the order of integration of the regressor and the regressand must be the same before they can cointegrate. On the other hand, if the explanatory variables are greater than two, then, "the order of integration of the dependent variable cannot be higher than the order of integration of any of the explanatory variables". This implies that if the dependent variable is integrated of say order 1, the explanatory variables should, individually, be integrated of order 1 and above (Wojciench & Derek, 1992).

The DF and the ADF equations are stated below.

$$Y_t=\gamma+\delta_t+\alpha Y_{t-1}+\varepsilon_t...(DF)$$

$$Y_t=\gamma+\delta_t+\alpha Y_{t-1}+\sum_{j=1}^{k}\theta_j\Delta Y_{t-j}+\varepsilon_t...(ADF)$$

The Y_{t-j} in the ADF test is to allow for ARMA processes. If the α in the two tests has a coefficient equal to one (1), then, there is unit root. This also implies that the variable is non-stationary and that it is a random walk without drift. These tests were carried out using the Microfit facility. The results are summarised in Table 5.1 below. The critical values are in parentheses. The calculated values are compared with the critical values and if the critical values are larger than the calculated ones, then, the null hypothesis of unit root is validated. If the null hypothesis is accepted, then, the variable has to be differenced until it becomes stationary. The number of times that the variable will be differenced before it becomes stationary gives its order of integration.

NB: The following abbreviations have been used throughout the study.

a = Significant at the 5% level, **A** = Adjusted,

b = Significant at the 10% level, **DW** = Durbin Watson test,

SC = Serial Correlation test, **F** = F-Statistic,

S = Stationary, **N** = Normality test, **NS** = Not Stationary,

H = Heteroscedasticity test, () = T-ratios or critical values & **FF** = Functional form test.

From Table 5.1, it can be seen that **Lrm2**, **Lrgdp**, and **Fi** are not integrated of order zero because their levels have unit roots. This means that, at their levels, the critical values are greater than their coefficients. However, when they were differenced once, they became stationary. This means that they are integrated of order one, (ie I{1}).

TABLE 5.1 ORDER OF INTEGRATION TESTS USING THE ADF FACILITY

VARIABLES	LEVELS				FIRST DIFFERENCE			
	DF		ADF		DF		ADF	
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND
LRM2	-0.56 (-2.98)	0.30 (-3.59)	-0.75 (-2.99)	0.33 (-3.60)	13.5 (-2.99)	8.61 (-3.60)	8.07 (-2.99)	7.48 (-3.61)
M2L	1.33 (-2.99)	-3.82 (-3.60)	0.667 (-2.99)	-3.37 (-3.61)	-4.44 (--2.99)	-4.47 (--3.61)	-4.11 (-2.99)	-3.96 (-3.62)
LRGDP	0.61 (-2.98)	-0.59 (-3.59)	0.55 (-2.99)	-0.99 (-3.60)	-4.02 (-2.99)	-4.48 (-3.60)	-3.44 (-2.99)	-4.31 (-3.61)
FI	-1.69 (-2.98)	-1.71 (-3.59)	-2.62 (-2.99)	-2.61 (-3.60)	-3.49 (-2.99)	-3.41 (-3.60)	-4.21 (-2.99)	-4.35 (-3.61)
LFI	-1.78 (-2.98)	-1.81 (-3.59)	-3.05 (-2.99)	-3.03 (-3.60)	-3.23 (-2.99)	-3.15 (-3.60)	-5.33 (-2.99)	-5.74 (-3.61)
P∝	-5.54 (-2.98)	-5.43 (-3.59)	-3.02 (-2.99)	-2.97 (-3.60)	-9.96 (-2.99)	-9.73 (-3.60)	-5.36 (-2.99)	-5.23 (-3.61)
DI	-0.27 (-2.98)	-4.39 (-3.59)	1.03 (-2.99)	-1.64 (-3.60)	-10.8 (-2.99)	-11.2 (-3.60)	-4.47 (-2.99)	-4.99 (-3.61)
LDI	-0.87 (-2.98)	-4.40 (-3.59)	-0.77 (-2.99)	-3.41 (-3.60)	-7.40 (-2.99)	-7.24 (-3.60)	-5.20 (-2.99)	-5.07 (-3.61)
LER	1.14 (-2.98)	-1.94 (-3.59)	0.15 (-2.99)	-2.31 (-3.60)	-2.81 (-2.99)	-2.93 (-3.60)	-3.09 (-2.99)	-3.29 (-3.61)
Z	-1.48 (-2.98)	-1.11 (-3.59)	-1.45 (-2.99)	-1.35 (-3.60)	-3.57 (-2.99)	-3.51 (-3.60)	-2.47 (-2.99)	-2.37 (-3.61)
LZ	-1.57 (-2.98)	-1.25 (-3.59)	-1.50 (-2.99)	-1.43 (-3.60)	-3.92 (-2.99)	-3.87 (-3.60)	-2.70 (-2.99)	-2.64 (-3.61)

As regards **Lfi**, the ADF test without trend indicates stationarity. This is however, a borderline case as can be seen from the critical and coefficient values of 2.99 and 3.05

respectively. Since it is a borderline case, we will take it that it is not integrated of order zero and for that matter difference it. When it was differenced once, the null hypothesis of unit root was rejected. Hence, **Lfi** is integrated of order one.

Although the DF test of $\mathbf{P^e}$ indicates that it is integrated of order zero, the ADF with trend test shows that it is not. The ADF test without trend also has a borderline case but as argued above, we proceeded to difference it. When this variable was differenced once it became stationary, implying that it is integrated of order one.

The DF test with trend for **M2L, Di** and **Ldi** indicates that these variables are integrated of order zero. However, the ADF test, both with and without trend, indicates unit root of the variables at their levels. Based on this result we proceeded to difference the variables. After the first difference, as can be seen from Table 5.1, the variables became stationary. This indicates that they are integrated of order one.

The levels of **Ler**, **Z** and **Lz** indicate that they have unit roots. This means that they are non-stationary. With the exception of the ADF test without trend (a borderline case), the first difference of **Ler** also indicates that it has unit root. Its second difference which is not reported in Table 5.1 indicates that it is integrated of order two. This has been shown in Table 5.3 below. The DF test with and without trend accepts that Lz is integrated of order one but the ADF test does not. Finally, while the ADF test, with and without trend, as well as the DF with trend show that Z is not integrated of order one, the DF test without trend suggests that Z is I(1).

TABLE 5.3 SECOND DIFFERENCE.

VARIABLE	SECOND DIFFERENCE			
	DF		ADF	
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND
LER	-4.96 (-2.99)	-4.85 (-3.61)	-5.27 (-2.99)	-5.14 (-3.62)
Z	-6.52 (-2.99)	-6.41 (-3.61)	-5.42 (-2.99)	-5.64 (-3.62)
LZ	-6.91 (-2.99)	-6.79 (-3.61)	-5.79 (-2.99)	-6.04 (-3.62)

In short, we can say that, with the exception of **Ler**, **Z** and **Lz**, the variables under consideration in this study are integrated of order one. The variables which are integrated of order two can cointegrate with the error term to produce an I(1) series which can combine effectively with the other I(1) series in the model. From the above discussion, it can be concluded that running a regression on the variables under consideration at their levels will provide spurious results. It should be noted that **Lrm1** is also integrated of order one as shown in Table 5.2 in the appendix. The unit root tests on the independent variables yield results similar to those summarised in Table 5.1.

5.1.2 TESTS FOR COINTEGRATION

These tests are based on the unit root tests for the stationarity of the residuals. Tables 5.4 and 5.5 present the results of the DF and the ADF tests with **Lrm2** as the dependent variable while the results reported in Tables 5.6 and 5.7 are the DF and the ADF tests where **Lrm1** is the dependent variable. Seven equations are considered in each case. These are:

$$Lrm2 = Lrgdp + Ler + P^e + Der + Fi + M2l + Z + K \quad \ldots\ldots(1)$$

$$Lrm2 = Lrgdp + Ler + P^e + Fi + Di + Lz + K \quad \ldots\ldots(2)$$

$$Lrm2 + Lrgdp + Ler + P^e + Fi + Di + Z + K \quad \ldots\ldots(3)$$

$Lrm2 = Lrgdp + Ler + Fi + Di + Z + K$.....(4)

$Lrm2 = Lrgdp + Lfi + Ldi + M2l + Lz + K$.....(5)

$Lrm2 = Lrgdp + Lfi + Ldi + Lz + K$.....(6)

$Lrm2 = Lrgdp + Fi + Di + Z + K$.....(7)

$Lrm1 = Lrgdp + Ler + Fi + Der + M1l + Z + P^e + K$.....(8)

$Lrm1 = Lrgdp + Ler + Fi + Di + Der + M1l + Z + P^e + K$...(9)

$Lrm1 = Lrgdp + Ler + Fi + Di + Z + K$.....(10)

$Lrm1 = Lrgdp + Ler + Fi + Lz + P^e + K$.....(11)

$Lrm1 = Lrgdp + Lfi + Ldi + Lz + K$.....(12)

$Lrm1 = Lrgdp + Fi + Di + Z + K$.....(13)

$Lrm1 = Lrgdp + Fi + M1l + P^e + K$.....(14)

TABLE 5.4 UNIT ROOT TESTS FOR RESIDUALS (LRM2)

EQUATIONS	VALUE		COMMENT
	DF	ADF	
1	-4.3847 (None)	-3.8347 (None)	Both indicate stationarity (S)
2	-5.1314 (None)	-3.4091 (None)	Both indicate stationarity (S)
3	-5.3230 (None)	-3.3076 (None)	Both indicate stationarity (S)
4	-5.5613 (-5.3798)	-3.5868 (-5.4075)	DF = S but ADF = NS
5	-5.8349 (-5.4075)	-4.0686 (-5.4375)	DF = S but ADF = NS
6	-5.1004 (-4.9745)	-3.1422 (-4.9980)	DF = S but ADF = NS
7	-6.3334 (-4.9745)	-3.6441 (-4.9980)	DF = S but ADF = NS

From Table 5.4 above, it is clear that the residuals from the first three equations are stationary. This is because their calculated values are larger than the critical values in brackets. The word "**none**" which appears in the brackets indicates that there is no unit root or that there is stationarity. This also means that there is cointegration among the variables. For equations 4 through 7, the results from Table 5.4 indicate that while the DF test accepts stationarity of the residuals, the ADF test rejects it.

From Table 5.5 below, it is also clear that only the residuals from equations 8 and 9 are cointegrated. While the DF test indicates stationarity for equations 10, 13 and 14, the ADF test suggests non-stationarity. On the other hand, the results in Table 5.5 show that we cannot accept cointegration for equations 11 and 12 (i.e., they are non-stationary).

TABLE 5.5 UNIT ROOT TESTS FOR RESIDUALS (LRM1)

EQUATION	VALUE	
	DF	ADF
8	-6.1866 (NONE)S	-3.8108 (NONE)S
9	-7.3299 (NONE)S	-3.7830 (NONE)S
10	-5.9364 (-5.3798)S	-3.6466 (-5.4075)NS
11	-4.2285 (-5.4075)NS	-3.0653 (-5.4375)NS
12	-4.4703 (-4.9745)NS	-2.5897(-4.9980)NS
13	-6.2816 (-4.9745)S	-3.7636 (-4.9980)NS
14	-7.1105 (-4.9980)S	-4.6350 (-5.0236)NS

From the above, it can be observed that certain equations, with the exception of the lag dependent variables, contain the same explanatory variables. These equations are 1 and 8, 4 and 10, 6 and 12 as well as 7 and 13. No matter the dependent variable, equations 1 and 8, 4 and 10 as well as 7 and 13 indicate no differences in the stationarity tests. However, while the DF test indicates stationarity for equation (6), equation (12) is the reverse. In both equations 6 and 12, the ADF test indicates non stationarity. Overall, we can say that, with the exception of equations 6 and 12, the stationarity results are the same no matter the regressand.

TABLE 5.6 STATIONARITY TEST (LRM2).

EQUATION/RESIDUAL NAME	TEST			
	DF		ADF	
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND
1/R1	-4.2940 (-2.985)S	-4.1963 (-3.602)S	-3.7475 (-2.990)S	-3.6541 (-3.611)S
2/R2	-5.0255 (-2.985)S	-4.9041 (-3.602)S	-3.3308 (-2.990)S	-3.2520 (-3.61)NS
3/R3	-5.2159 (-2.985)S	-5.0805 (-3.602)S	-3.2368 (-2.990)S	-3.1520 (-3.61)NS
4/R4	-5.4646 (-2.979)S	-5.3042 (-3.594)S	-3.5473 (-2.985)S	-3.4303 (-3.60)NS
5/R5	-5.7113 (-2.985)S	-5.5867 (-3.602)S	-3.9752 (-2.990)S	-3.8779 (-3.611)S
6/R6	-4.9968 (-2.979)S	-4.8935 (-3.594)S	-3.0745 (-2.985)S	-2.9980 (3.602)NS
7/R7	-6.2177 (-2.979)S	-6.1300 (-3.594)S	-3.6028 (-2.985)S	-3.4762 (-3.60)NS

The mixed results obtained above required that we take a closer look at the stationarity (cointegration) of the residuals. This aspect is shown in Tables 5.6 and 5.7. Here, the residuals were saved and the DF and the ADF tests both with and without trend were applied to them.

TABLE 5.7 STATIONARITY TEST (LRM1)

EQUATION/ RESIDUAL NAME	DF		ADF	
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND
8/B8	-6.0609 (-2.99)S	-5.9262 (-3.60)S	-3.7259 (-2.99)S	-3.6517 (-3.61)S
9/B9	-7.1804 (-2.99)S	-7.0210 (-3.60)S	-3.7037 (-2.99)S	-3.6108 (-3.61)S
10/B10	-5.8260 (-2.98)S	-5.6848 (-3.59)S	-3.5978 (-2.99)S	-3.4901 (-3.60)NS
11/B11	-4.1404 (-2.99)S	-4.0463 (-3.60)S	-2.9944 (-2.99)S	-2.9492 (-3.61)NS
12/B12	-4.3780 (-2.98)S	-4.2793 (-3.59)S	-2.5318 (-2.99)NS	-2.4509 (-3.60)NS
13/B13	-6.1636 (-2.98)S	-6.0318 (-3.59)S	-3.7136 (-2.99)S	-3.5945 (-3.61)NS
14/B14	-6.9768 (-2.99)S	-6.9538 (-3.60)S	-4.5788 (-2.99)S	-4.6691 (-3.61)S

The difference between the results presented in Tables 5.4 and 5.5 and those in Tables 5.6 and 5.7 is that while the results in Tables 5.4 and 5.5 look at stationarity in whole, the results in Tables 5.6 and 5.7 decompose stationarity into timeless and time elements[21].

Equations 1 and 5 in Table 5.6 indicate cointegration of the residuals in terms of the DF and the ADF tests with and without trend. On the other hand, the results show that, with regards to the ADF test with trend, the residuals from equations 2, 3, 4, 6 and 7 are not cointegrated.

From Table 5.7 above, we can see that the stationarity of equations 8 and 9 is accepted. In addition to these two equations, equations 10 and 14 are also cointegrated, although the ADF test with trend did not accept cointegration on similar equations (4 and 7)

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[21] For more details, see C.R.Nelson and C.I.Plosser, "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications", Journal of Monetary Economics, Vol.10, pp.139-162.

when Lrm2 was the regressand. While the DF test accepts cointegration of the residuals of equations 11 through 13, the ADF test provides mixed results. Considering equations 11 and 12, the ADF test with trend suggests that they are non-stationary. The ADF test without trend for equation 13 indicates stationarity. Finally, the ADF test without trend for equation (11) indicates a borderline case. For now, we shall accept stationarity for the two.

Overall, the cointegration results are mixed. According to Maddala (1992), when cointegration is accepted by the use of "with trend" criteria, the results are biased towards the trend. However, since both tests also accept cointegration without trend, the evidence of cointegration will be tested further through the ECM approach. If the ECM is applied to the long run equations and the cointegration relationship is genuinely present, the coefficient of the error terms will be negative and significant. This ultimate proof will be done in section 5.5 of chapter 5.

5.2 LONG RUN REGRESSION RESULTS

Tables 5.8 and 5.9 below give the various long run regression results for **Lrm2** and **Lrm1** respectively. In all, seven equations were run in each case. The variables used in the various regressions are **Lrm2**, **Lrm1**, **Lrgdp**, **Ldi**, **Lfi**, **Lz**, **M2l**, **M1l**, **Ler**, **Der**, and $\mathbf{P^e}$. These are, respectively, real broad money, real narrow money, real gross domestic product, domestic interest rate, foreign interest rate, financial changes, lag of real **M2**, lag of real **M1**, exchange rate, a dummy for exchange rate, and expected inflation.

TABLE 5.8 LONG RUN REGRESSION RESULTS (OLS) WITH LRM2 AS THE DEPENDENT VARIABLE.

VARIABLES	EQUATIONS						
	1	2	3	4	5	6	7
LRGDP	3.10 (5.2)a	2.99 (8.6)a	3.04 (8.9)a	3.12 (9.3)a	2.93 (7.2)a	2.43 (9.3)a	2.98 (9.0)a
LER	-0.19 (-6.0)a	-0.07 (-1.7)	-0.07 (-1.8)b	-0.06 (-1.6)	...	...	...
P^e	-0.28 (-1.1)	-0.18 (-0.9)	-0.24 (-1.2)	...	...	...	...
DER	0.00 (1.9)b	...	...	...	...	...	...
FI	-0.08 (-6.7)a	-0.08 (-6.7)a	-0.07 (-6.3)a	-0.07 (-6.3)a	...	...	-0.07 (-5.9)a
LFI	...	...	...	...	-0.45 (-5.5)a	-0.43 (-5.2)a	...
DI	...	-0.03 (-3.0)a	-0.03 (-3.1)a	-0.04 (-3.5)a	...	...	-0.05 (-7.7)a
LDI	...	...	...	...	-0.58 (-7.2)a	-0.63 (-8.4)a	...
M2L	-0.26 (-1.9)b	...	...	...	-0.45 (-1.6)	...	...
Z	5.42 (2.4)a	...	8.83 (5.0)a	9.12 (4.9)a	...	...	11.2 (8.9)a
LZ	...	0.57 (4.9)a	...	...	0.69 (7.9)a	0.62(8.0)a	...
K	-33.7 (-4.2)	-30.2 (-6.4)	-33.2 (-7.3)	-34.2 (-7.7)	-28.0 (-5.2)	-21.4 (-6.1)	-32.4 (-7.3)
R^2	0.936	0.948	0.949	0.939	0.947	0.940	0.932
$A.R^2$	0.911	0.931	0.932	0.924	0.933	0.930	0.919
F	37.57	57.49	58.37	64.24	70.84	86.70	74.88
DW	1.738	2.072	2.119	2.022	2.343	2.039	2.327
SC	0.422	0.066	0.214	0.136	0.847	0.017	1.465
FF	2.450	1.051	0.858	3.996	2.158	4.569	3.11
N	2.164	1.839	1.053	0.435	0.806	1.282	0.188
H	3.645	3.192	4.151	3.683	2.569	0.811	2.402

TABLE 5.9 LONG RUN REGRESSION RESULTS (OLS) WITH LRM1 AS THE DEPENDENT VARIABLE.

VARIABLES	EQUATIONS						
	8	9	10	11	12	13	14
LRGDP	0.96 (1.35)	1.59a (2.46)	2.58a (8.34)	2.09a (5.32)	2.05a (7.81)	2.55a(8.70)	0.42a (2.21)
LER	-.066b (-1.8)	-.006 (-.16)	-.016 (-.43)	-.128a (-4.3)	...	...	...
FI	-.041a (-2.6)	-.044a (-3.2)	-.064a (-5.9)	-.076a (-5.9)	...	-.063a (-6.1)	-.024b (-1.9)
LFI	...	...	...	...	-.385a (-4.6)	...	...
DI	...	-.029a (-2.8)	-.041a (-4.1)	...	...	-.044a (-7.6)	...
LDI	...	...	...	...	-.534a (-7.1)	...	...
DER	.149 (.569)	.149 (.668)	...	...	...	...	...
M1L	.474a (2.7)	.298b (1.8)	...	...	...	...	.77a (11.9)
Z	2.25 (.78)	6.15b (2.2)	10.4a (6.2)	...	...	10.96a (9.9)	...
LZ	...	...	...	.473a (3.97)	.621a (7.95)	...	...
P^e	-.63a (-2.5)	-.45b (-1.9)	...	-.35 (-1.5)	...	...	-.687a (-3.3)
K	-6.129 (-.65)	-14.4 (-1.7)	-27.4 (-6.7)	-18.9 (-3.5)	-16.8 (-4.8)	-26.9 (-6.9)	.694 (.27)
R^2	.934	.955	.936	.907	.927	.935	.916
A.R^2	.909	.934	.921	.884	.913	.924	.900
F	36.52	44.89	61.36	38.94	69.40	79.62	57.14
DW	2.42	2.73	2.19	1.68	1.78	2.31	2.61
SC	2.59	6.69	.61	.66	.28	1.15	3.88
FF	.33	1.35	4.65	.89	4.22	4.57	.26
N	1.19	.39	.13	.89	.94	.14	.57
H	.79	2.78	3.44	1.08	1.18	3.54	3.45

In all the 14 equations, **Lrgdp** was significant at the 5% level except in equation (8). It also carried the right sign. This result is as expected[22] and consistent with established money demand theory.

The exchange rate variable, on the other hand, did not fair well in this study. Out of the 14 equations run, the exchange rate variable (**Ler**) appeared in 8 equations. It was significant at 5% in equations 1 and 11. It also appeared significant at the 10% level in equations 3 and 8. Although **Ler** was not significant in some of the equations in which it appeared as an explanatory variable, it carried the right sign throughout.

The dummy variable for the exchange rate (**Der**) appeared only in equations 1, 8 and 9 and was dropped from all other equations which means that its role in explaining the demand for money in Ghana was statistically weak. Although it was statistically significant at the 10% level in equation (1), it was insignificant in the others. It also carried the wrong sign. This led to its exclusion from the other equations. This means that although Ghana moved from a fixed exchange rate regime to a flexible one after the inception of the ERP in 1983, this did not seem to affect the demand for money.

Expected inflation ($\mathbf{P^e}$) has been found in most previous studies to be significant. In contrast, our results in Table 5.8, where **Lrm2** is the dependent variable, indicate that inflation is not a significant determinant of money demand in Ghana. On the other hand, results in Table 5.9, where **Lrm1** is the regressand, indicate that $\mathbf{P^e}$ has mixed results. Expected inflation, as indicated in Table 5.9, appeared in equations 8, 9, 11 and 14. It was

[22] For more examples on the significance of income, refer to Table 4.1 in the appendix.

insignificant in equation (11). However, it was significant at the 5% level in equations 8 and 14 and at the 10% level in equation (9). $\mathbf{P^e}$ carried the right sign in all seven equations. That $\mathbf{P^e}$ is not significant in some equations may be because the change in the value of real assets as a result of inflation was not significantly large so as to induce people to hold more real assets. Furthermore, from the mid 70s to early 80s, all kinds of commodities were rationed. This made people go around with cash so that they can purchase any needed commodity that suddenly became available. This situation prevented people from investing their cash balances in real assets although the value of the cedi kept on depreciating. The insignificance of $\mathbf{p^e}$ in Table 5.8 might also be due to the fact that **M2** is the dependent variable. According to Jamil (1994), "Expected inflation is more pronounced in **M1** than **M2** because **M1** has a zero nominal yield but the yield of **M2** can be adjusted to offset the inflationary expectations". In addition to the above, price controls, which were prevalent in Ghana at a point in time, might have depressed inflation.

Foreign interest rate (**Fi** or **Lfi**), represented by the U.S. treasury bill rate (90-day), was statistically significant at the 5% level throughout the equations except in equation (14) where it was significant at 10%. It also carried the expected sign (negatively related to real money demand). Domestic interest rate (**Di** or **Ldi**) also appeared in 11 equations. It was statistically significant at the 5% level throughout and carried the right sign (negative) in all the equations. It should be noted that foreign interest rate was found by Hoffman and Tahiri (1994) to be significant in the Moroccan money demand function. Kallon (1992) also found that the domestic interest rate was significant with respect to the Ghanaian economy. This study therefore, confirms their findings.

One thing outstanding in this study is the fact that interest rate is statistically significant. This has not been so in the previous studies in Ghana. The reason for the significance of the interest rate variable might be that the ERP has really restored the confidence of the public in the financial sector. Interest rates in Ghana have been increased on a number of occasions. For instance, while it was within 20% in the 1980s, it is now between 48% and 51% (Daily Graphic, Feb., 1997). The reason for such increases was to offset the inflationary effect of government policies. These increases might have removed the negative effect of inflation leading to positive real interest rates, which helped to restore peoples' confidence in the financial sector. The significance of the interest rate variable might also be due to the growing range of financial assets which have been made available to the public. For instance, government treasury bills of different maturity dates have been made available to the public; this was not the case in the past. Hence, interest rate may have become an important variable in the public's decision as to whether to hold cash balances or alternative financial assets.

The lag of real broad money (**M2l**) appeared in only equations 1 and 5. It was significant at the 10% level in equation (1) but insignificant in equation (5). It also carried the wrong sign in both equations. It was expected to be positively related to the demand for real money balances but the reverse was the case. On the other hand, its counterpart in Table 5.9 (**M1l**) was significant in all equations in which it appeared. It was statistically significant at the 5% and 10% levels in equations 8 & 14 and 9 respectively. The sign of **M1l** was the right one (i.e., positive) unlike its counterpart in Table 5.8 above.

The last variable to be considered is **Z**-the financial liberalisation variable. **Z** appeared in all the equations either as **Z** or **Lz**. With the exception of equation (8), it was statistically significant at the 10% level in equation (9) and at the 5% level of significance in all the other equations.

In all the equations, the explanatory variables explained over 87% of the variations in the dependent variables (i.e., **Lrm2** & **Lrm1**) as shown by the magnitude of the R^2 and the adjusted R^2 in Tables 5.8 and 5.9. This shows that the regressions have a good fit. The explanatory power of the equations, as indicated by the F statistic, was not bad. It ranged between 36.52 and 86.70. Hence, the null hypothesis that all the explanatory variables in the equations, except the constant, do not explain any variation in the dependent variable is rejected.

The diagnostic tests indicate that there are no diagnostic problems in all the equations summarised in Table 5.8. The only slight problem detected was heteroscedasticity in the first four equations. This was corrected using adjusted White's heteroscedasticity consistent S.E.'s. These results appear in Table 5.10. With the exception of $\mathbf{P^e}$ and **Ler** which were still insignificant in some of the equations, all the other variables became significant at the 5% level after correcting for heteroscedasticity.

TABLE 5.10 ORDINARY LEAST SQUARES ESTIMATION: ADJUSTED WHITE'S HETEROSCEDASTICITY-CONSISTENT S.E.'S

VARIABLES	EQUATIONS			
	1	2	3	4
LRGDP	3.0988 (6.3571)a	2.9850 (9.6378)a	3.0478 (10.2288)a	3.1229 (10.4969)a
LER	-0.1894 (-5.8707)a	-0.0689 (-1.4584)	-0.0731 (-1.9188)b	-0.0646 (-1.6224)
P^e	-0.2827E-3 (-2.0557)b	-0.1811E-3 (-1.5217)	-0.2422E-3 (-2.0028)b	...
DER	0.00171 (2.8595)a	...	...	...
FI	-0.0827 (-7.5719)a	-0.07534 (-6.8886)a	-0.0703 (-7.1053)a	-0.0726 (-7.1703)a
DI	...	-0.03217 (-2.7415)a	-0.0329 (-3.2364)a	-0.0372 (-3.4866)a
M2L	-0.2578E-5 (-2.7302)a	...	...	...
Z	5.4226 (2.1222)a	...	8.8281 (4.8413)a	9.1048 (4.6946)a
LZ	...	0.56756 (4.0817)a	...	...
K	-33.7437 (-5.1369)	-30.1802 (-6.8862)	-33.2018 (-8.4203)	-34.1854 (-8.6764)

As can be seen from Table 5.9, equations 11 and 12 had either autocorrelation or omitted variable problems as indicated by the low DW statistic (i.e., below 2). The same problems may also explain the relatively high DW statistic in equations 9 and 14. The only equations which were free of these problems were equations 8 and 13.

TABLE 5.11 COCHRANE-ORCUTT METHOD (CO) AND ADJUSTED WHITE'S HETEROSCEDASTICITY-CONSISTENT S.E.'s (AWHCSEs)

VARIABLES	EQUATIONS				
	9	11	12	13	14
	CO.AR3.14	CO.AR2.4	CO.AR2.3	AWHCSEs	CO.AR1.3
LRGDP	1.706a (2.46)	2.229a (4.54)	2.022a (6.63)	2.545a (9.141)	.413a (2.83)
LER	.0498 (1.13)	-.143a (-3.54)	...	...	...
P^e	-.500 (-1.51)	-.272 (-1.21)	...	...	-.726a (-3.49)
DER	.143 (.74)	...	...	...	...
FI	-.037a (-2.66)	-.075a (-4.24)	-.063a (-6.56)	-.022a (-2.31)	...
LFI	...	...	-.362a (-4.12)	...	...
DI	-.047a (-3.11)	...	...	-.044a (-7.93)	...
LDI	...	...	-.534a (-5.04)	...	...
Z	7.088a (2.26)	...	...	10.956a (10.33)	...
LZ	...	.411a (2.79)	.609a (6.46)	...	...
M1L	.323b (1.83)	...	...	...	.789a (16.78)
K	-16.018 (-1.75)	-20.969 (-3.10)	-16.513 (-4.12)	-26.940 (-7.32)	.707 (.35)
R^2	.971	.911	.929	...	.929
A.R^2	.942	.871	.905	...	.910
F	33.606	23.257	39.111	...	49.589
DW	2.105	2.058	1.995	...	2.104

The Cochrane Orcutt method was therefore employed to correct the anomaly in equations 9, 11, 12 and 14. The results are presented in Table 5.11 below. Although the problem was corrected leading to a DW of two in all cases, it only improved the results of equations 12 and 14. On the other hand, the results, as can be seen from Table 5.11, indicate

in terms of equation (9) that while Z became significant at the 5% level from the previous 10% level, $\mathbf{P^e}$ became insignificant, although it was significant at the 10% level before the anomaly was corrected. Since the problem of heteroscedasticity was detected in equation (13), the adjusted White's heteroscedasticity-consistent standard error's remedy was adopted to rectify the situation. The results is as presented in column 5 of Table 5.11 above. In fact, this correction method led to an increase in the significance of the variables (i.e., they became highly significant than before).

5.3 OTHER TESTS

Based on Tables 5.8 and 5.10, equations 1 to 3 were done away with. This is because some of the variables which appeared in them were either insignificant or carried the wrong sign. Using the same criteria and based on Tables 5.9 and 5.11, equations 8 through 11 became redundant. Further tests were performed on equations 4 through 7 and 12 through 14 for **Lrm2** and **Lrm1**, respectively, to determine the most appropriate long run models upon which the short run models or the ECMs will be derived. The tests which were performed included the variable deletion test and the alternative tests for non-nested regression models.

The variable deletion test was applied to equation (4) versus equation (7) and equation (5) versus equation (6) because they contained the same variables except **Ler** and **M2l**, respectively. The results are presented in Boxes 2 and 3 respectively. Looking at Box 2 critically, it can be noticed that the F statistic rejects the inclusion of **Ler** as an explanatory variable in the money demand equation. This is because at both 1% and 5% level of significance, the variable (**Ler**) is insignificant. Based on this result, equation (7) is taken

between the two. Similarly, equation (6) is preferred to equation (5) as reported in Box 3 below.

BOX 2 VARIABLE DELETION TEST (OLS CASE)-4 VRS 7.

Dependent variable is LRM2
List of the variables deleted from the regression:
LER
27 observations used for estimation from 1969 to 1995

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LRGDP	2.9837	.33215	8.9829[.000]
FI	-.069615	.011756	-5.9216[.000]
DI	-.050704	.0065494	-7.7418[.000]
Z	11.2208	1.2585	8.9161[.000]
K	-32.4360	4.4363	-7.3116[.000]

Joint test of zero restrictions on the coefficient of deleted variables:
Lagrange Multiplier Statistic CHI-SQ(1)= 2.7834[.095]
Likelihood Ratio Statistic CHI-SQ(1)= 2.9375[.087]
F Statistic F(1, 21)= 2.4137[.135]

BOX 3 VARIABLE DELETION TEST (OLS CASE)-5 VRS 6.

Dependent variable is LRM2
List of the variables deleted from the regression:
M2L
26 observations used for estimation from 1970 to 1995

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
LRGDP	2.4335	.26707	9.1118[.000]
LFI	-.43008	.084507	-5.0893[.000]
LDI	-.63071	.078609	-8.0234[.000]
LZ	.62262	.079588	7.8231[.000]
K	-21.3651	3.5793	-5.9690[.000]

Joint test of zero restrictions on the coefficient of deleted variables:
Lagrange Multiplier Statistic CHI-SQ(1)= 2.9450[.086]
Likelihood Ratio Statistic CHI-SQ(1)= 3.1256[.077]
F Statistic F(1, 20)= 2.5548[.126]

The next test used in this study is the alternative tests for non-nested regression models. A model **A** may be said to encompass another model **B** if it can explain the results of model **B** (Hall et al, 1992). Also,model **A** will have a lower standard error. Equations 4, 6 and 7 were used in this test to determine the most appropriate long run model for **Lrm2**. While equation (4) was alternated against equation (6) in Box 4, equation (6) was alternated against equation (7) in Box 5.

BOX 4 ALTERNATIVE TESTS FOR NON-NESTED REGRESSION MODELS-4 VRS 6.

```
Dependent variable is LRM2      27 observations used from 1969 to 1995      J Regressors for model M1=4:      LRGDP      LER
   FI
   DI          Z          K
Regressors for model M2=6:    LRGDP      LFI      LDI
                              LZ         K
Test Statistic              M1 against M2              M2 against M1
   N-Test                  -2.4878[.013]              -2.3331[.020]
  NT-Test                  -2.1198[.034]              -1.7988[.072]
   W-Test                  -1.7233[.085]              -1.4981[.134]
   J-Test                   1.9188[.055]               1.8495[.064]
  JA-Test                   1.6877[.091]               1.7672[.077]
Encompassing     F( 3,  18)  2.5543[.088]     F( 4,  18)  1.7358[.186]
Model M1:    DW   2.0224 ;R-Bar-Squared    .92402 ;Log-likelihood    20.1560
Model M2:    DW   2.0386 ;R-Bar-Squared    .92950 ;Log-likelihood    20.5400
Model M1+M2: DW   2.2537 ;R-Bar-Squared    .93782 ;Log-likelihood    24.9441
Akaike's Information Criterion of M1 versus M2=  -1.3840 favours M2
Schwarz's Bayesian Information Criterion of M1 versus M2=  -2.0319 favours M2
```

BOX 5 ALTERNATIVE TESTS FOR NON-NESTED REGRESSION MODELS-6 VRS 7.

```
Dependent variable is LRM2      27 observations used from 1969 to 1995
Regressors for model M1=6:    LRGDP      LFI      LDI
LZ          K
Regressors for model M2=7:    LRGDP      FI       DI
Z           K
Test Statistic              M1 against M2              M2 against M1
   N-Test                  -2.1364[.033]              -3.2740[.001]
  NT-Test                  -1.8691[.062]              -2.8714[.004]
   W-Test                  -1.5543[.120]              -2.1837[.029]
   J-Test                   1.6862[.092]               2.4838[.013]
  JA-Test                   1.6243[.104]               2.2611[.024]
Encompassing     F( 3,  19)  1.9249[.160]     F( 3,  19)  3.1398[.049]
Model M1:    DW   2.0386 ;R-Bar-Squared    .92950 ;Log-likelihood    20.5400
Model M2:    DW   2.3266 ;R-Bar-Squared    .91913 ;Log-likelihood    18.6872
Model M1+M2: DW   2.3831 ;R-Bar-Squared    .93740 ;Log-likelihood    24.1227
Akaike's Information Criterion of M1 versus M2=  1.8528 favours M1
Schwarz's Bayesian Information Criterion of M1 versus M2=  1.8528 favours M1
```

From Box 4 above, both the Akaike's information criterion (AIC) and the Schwarz's Bayesian Information criterion (SIC) favour equation (6) against equation (4). Box 5 also indicates that equation (6) is favoured against equation (7).

BOX 6 EQUATION 12 VRS 14: ALTERNATIVE TESTS FOR NON-NESTED REGRESSION MODELS

Dependent variable is LRM1 26 observations used from 1970 to 1995
Regressors for model M1=12: LRGDP LFI LDI
LZ K
Regressors for model M2=14: LRGDP P^e FI
M1L K

Test Statistic	M1 against M2	M2 against M1
N-Test	-3.9401[.000]	-5.0048[.000]
NT-Test	-3.2921[.001]	-4.1874[.000]
W-Test	-2.3810[.017]	-2.8001[.005]
J-Test	2.9723[.003]	3.6264[.000]
JA-Test	2.6409[.008]	3.4395[.001]

Encompassing F(3, 18) 4.6065[.015] F(3, 18) 6.0003[.005]
Model M1: DW 1.7749 ;R-Bar-Squared .90909 ;Log-likelihood 19.1449
Model M2: DW 2.6115 ;R-Bar-Squared .89714 ;Log-likelihood 17.5398
Model M1+M2: DW 2.8201 ;R-Bar-Squared .94000 ;Log-likelihood 26.5511
Akaike's Information Criterion of M1 versus M2= 1.6050 favours M1
Schwarz's Bayesian Information Criterion of M1 versus M2= 1.6050 favours M1

From the discussions based on Tables 11 and 12, three equations were maintained for further scrutiny. These are equations 12, 13 and 14. This was to help determine the most appropriate long run model for **Lrm1** upon which the ECM will be derived. The test which was applied to the three equations (i.e., 12, 13 & 14) was the alternative tests for non-nested regression models. The results are as presented in Boxes 6, 7 and 8. When equation (12) was non-nested with equation (14), the AIC and the SIC tests favoured equation (12), as can be seen from Box 6. This led to the pitching of equation (13) against equation (14). The results, as presented in Box 7, indicate that equation 13 encompasses equation 14 (i.e., 13 is favoured). The two favoured equations, 12 and 13 by the non-nested tests, were also non-nested. The results in Box 8 indicate that equation (13) is favoured. The non-nested tests, therefore, suggest that equation (13) is the most appropriate long run model when **Lrm1** is the regressand. Based on these results, equation (6), which contains **Lrgdp**, **Lfi**, **Ldi**, and **Lz** as explanatory variables of **Lrm2** and equation (13) which contains **Lrgdp**, **Fi**, **Di**, and **Z** as explanatory variables of **Lrm1** are chosen as the long run models for this study.

BOX 7 EQUATION 13 VRS 14: ALTERNATIVE TESTS FOR NON-NESTED REGRESSION MODELS

```
Dependent variable is LRM1      26 observations used from 1970 to 1995
Regressors for model M1=13:   LRGDP        FI          DI
Z          K
Regressors for model M2=14:   LRGDP        P*          FI
M1L        K
Test Statistic          M1 against M2          M2 against M1
   N-Test               -3.0123[.003]          -5.6968[.000]
  NT-Test               -2.5125[.012]          -4.7776[.000]
   W-Test               -1.9638[.050]          -3.0348[.002]
   J-Test               2.3088[.021]           4.0308[.000]
  JA-Test               2.0634[.039]           3.9495[.000]
Encompassing     F( 2, 19)  2.8632[.082]   F( 2, 19)  7.7234[.004]
Model M1:   DW  2.4611 ;R-Bar-Squared  .92617 ;Log-likelihood  21.8499
Model M2:   DW  2.6115 ;R-Bar-Squared  .89714 ;Log-likelihood  17.5398
Model M1+M2: DW  2.6942 ;R-Bar-Squared  .93729 ;Log-likelihood  25.2746
Akaike's Information Criterion of M1 versus M2=  4.3101 favours M1
Schwarz's Bayesian Information Criterion of M1 versus M2=  4.3101 favours M1
```

BOX 8 EQUATION 12 VRS 13: ALTERNATIVE TESTS FOR NON-NESTED REGRESSION MODELS

```
Dependent variable is LRM1      27 observations used from 1969 to 1995
Regressors for model M1=12:   LRGDP        LFI         LDI
LZ         K
Regressors for model M2=13:   LRGDP        FI          DI
Z          K
Test Statistic          M1 against M2          M2 against M1
   N-Test               -3.1571[.002]          -1.8469[.065]
  NT-Test               -2.7651[.006]          -1.6060[.108]
   W-Test               -2.1276[.033]          -1.3719[.170]
   J-Test               2.4349[.015]           1.5179[.129]
  JA-Test               2.3362[.019]           1.2964[.195]
Encompassing     F( 3, 19)  3.7798[.028]   F( 3, 19)  2.5656[.085]
Model M1:   DW  1.7812 ;R-Bar-Squared  .91322 ;Log-likelihood  20.3906
Model M2:   DW  2.3093 ;R-Bar-Squared  .92364 ;Log-likelihood  22.1173
Model M1+M2: DW  2.4285 ;R-Bar-Squared  .93707 ;Log-likelihood  26.7088
Akaike's Information Criterion of M1 versus M2=  -1.7267 favours M2
Schwarz's Bayesian Information Criterion of M1 versus M2=  -1.7267 favours M2
```

A word of caution is in order before we proceed: In principle, the long run equation must contain " either none or at least two explanatory variables integrated to an identical order higher than the order of integration of the dependent variable" (Wojciench & Derek, 1992). This is not the case for equations 6 and 13. Both equations contain the variable Z

which is integrated of order 1 or 2. However, since the cointegration tests showed mixed results with the DF test without trend showing that Z is integrated of order one as the dependent variable, we proceeded to use the two equations as our long run equations. Hence, equations 6 and 13 are recalled for further analysis.

Lrm2 = - 21.3697 + 2.4336Lrgdp - 0.42989Lfi - 0.62926Ldi +

(-6.1[.000]) (9.3[.000]) (-5.21[.000]) (-8.37[.000])

0.62303Lz.....(6)

(8.02[.000]).

DW = 2.0386 R-bar^2 = 0.92950 F=86.7037

Lrm1 = -26.9403 + 2.5453Lrgdp - 0.062836fi - 0.043956Di +

(-6.8954) (8.7013) (-6.0690) (-7.6206)

10.9560Z.....(13)

(9.8851)

DW = 2.3093 R-Bar^2 = 0.92364 F = 79.6205

T-ratios are in parenthesis.

Equations 6 and 13 have a good fit. The independent variables explain about 93% of the variations in the dependent variables. As said earlier, the chosen equations have no diagnostic problems. The F-statistic also indicates that equation (6) has the highest explanatory power (i.e., 86.70) among the first seven equations just as equation (13) (i.e., 79.62) among the last seven equations. In addition, all the variables are statistically significant at the 1% level and carry the right signs.

The income elasticity of money is greater than two as can be seen from equations 6 and 13 above. This confirms the results obtained by Amoako (1991) and Kallon (1992). This might be so because of the high transactions costs incurred in swapping money for bonds and vice versa. It also suggests that money is a luxury commodity. With regards to equation (6), the coefficients of the explanatory variables imply that a 10% increase in **Lrgdp** and **Lz** will lead to a 24.3% and 6.2% increase in Lrm2, respectively. On the other hand, a similar increase in **Lfi** and **Ldi** will lead to a reduction in **Lrm2** by 4.3% and 6.3% respectively. Equation (13) also indicates that a 10% increase in the **Lrgdp** and **Z** will increase **Lrm1** by 25% and 110% respectively. On the other hand, if there is a 10% increase in **Fi** and **Di**, **Lrm1** will be reduced by 0.6% and 0.4% respectively. The demand for **M1** is less responsive to changes in the rate of interest.

5.4 TESTS FOR STRUCTURAL BREAK.

To test for the stability of the model, two approaches were employed (The CUSUM & CUSUMSQ tests as well as the Chow test). The CUSUM and CUSUMSQ tests which were applied to the chosen equations (i.e., 6 and 13) indicate that there are no structural breaks. Figures 1 to 4 in the appendix illustrate the results of the tests.

TABLE 5.12 CHOW TEST (CT) WITH LRM2 AS THE DEPENDENT VARIABLE.

VARIABLES	1969-1982	1969-1983	1969-1989
LRGDP	2.3516 (3.0150)a	2.3527 (3.6770)a	2.7696 (7.3932)a
LFI	-0.46579 (-3.0150)a	-0.46563 (-3.4163)a	-0.48870 (-5.1861)a
LDI	-0.61644 (-3.8945)a	-0.61669 (-4.9080)a	-0.59114 (-7.4688)a
LZ	0.74918 (2.4732)a	0.74991 (4.7796)a	0.72569 (7.2492)a
K	-19.9066 (-1.9522)	-19.9196 (-2.2998)	-25.5750 (-5.1361)
R^2	0.89543	0.93787	0.95223
Adjusted R^2	0.84896	0.91302	0.94028
F	19.2672	37.7374	79.7266
DW	2.6445	2.6457	2.5291
CT CHI-SQ(5)	4.9250	5.0601	5.8527
CT F(5,17)	0.98499	1.0120	1.1705

The Chow test was also carried out. Three years (1982, 1983, & 1989) were selected to check for structural breaks. 1982 was chosen because it was the period which ended the fixed exchange rate regime. 1983 was chosen because it was the beginning of the implementation of ERP and the year in which over a million Ghanaians were repatriated from Nigeria. The choice of 1989 was based on the fact that by then, many of the policies put in place during the ERP had started bearing fruits.

TABLE 5.13 CHOW TEST (CT) WITH LRM1 AS THE DEPENDENT VARIABLE

VARIABLES	1969-1982	1969-1983	1969-1989
LRGDP	2.0724 (2.9626)a	2.2650 (3.9291)a	2.9048 (7.3141)a
FI	-0.050299 (-2.4320)a	-0.045276 (-2.5541)a	-0.063542 (-5.4858)a
DI	-0.061359 (-3.2738)a	-0.067208 (-4.5972)a	-0.049412 (-6.5790)a
Z	9.9197 (2.9996)a	11.2818 (5.5986)a	10.3488 (6.69930)a
K	-20.4515 (-2.1636)	-23.1353 (-3.0044)	-31.6508 (-5.95520)
R^2	0.90272	0.94066	0.94322
ADJUSTED R^2	0.85949	0.91692	0.92903
F	20.8793	39.6286	66.4480
DW	2.7014	2.8366	2.3169
CT CHI-SQ (5)	6.7995	7.0126	4.7303
CT F(5, 17)	1.3599	1.4025	0.94606

The results as presented in Table 5.12 above indicates that there was no structural break in any of the selected periods. Also worthy of note is that in all three periods, the variables chosen were all significant at the 5% level. This reinforces the result, based on the CUSUM and CUSUMSQ tests, that no structural break is detected in the data used in this study. On the other hand, Table 5.13 below shows mixed results. While the Chi-sq test indicates structural breaks in all cases, the F test indicates otherwise. However, as indicated above, the CUSUM and CUSUMSQ tests indicate no structural breaks in the periods.

5.5 THE SHORT RUN MODELS

Having obtained mixed results on cointegration, especially by considering the ADF tests, a short run model which incorporates the error correction term is estimated to ultimately test for cointegration. Equations 6 and 13 are the selected long run models based on the various tests performed above. The short run models are based on the first difference of the variables in equations 6 and 13 (See Tables 5.4 and 5.9). The results of these estimations are given in Tables 5.14 and 5.15 below.

TABLE 5.14 ERROR CORRECTION MODEL FOR LRM2D

REGRESSOR	COEFFICIENT	T-RATIO
LRGDPD	1.8608	3.9764a
LFID	-0.4090	-3.7824a
LDID	-0.4976	-3.6246a
LZD	0.52914	5.0468a
K	0.0046689	0.16706
ECM2(-1)	-0.9704	-4.1135a

R^2 = 0.72075 F (5,20) = 10.3239

Adjusted R^2 = 0.65093 DW = 1.9766

SC Chi-sq(1) = 0.035918 FF Chi-sq(1) = 1.9402

N Chi-sq(2) = 0.70983 H Chi-sq(1) = 0.61127

TABLE 5.15 ERROR CORRECTION MODEL FOR LRM1D

REGRESSOR	COEFFICIENT	T-RATIO
LRGDPD	2.1700	5.0135
FID	-0.052857	-3.7702
DID	-0.033701	-4.7458
ZD	9.9900	6.2067
ECM1(-1)	-0.99161	-4.1328
K	-0.0077537	-0.31622

R^2 = 0.75232 Adjusted R^2 = 0.69041 F(5,20) = 12.1502 DW = 2.0594 SC(CHI-SQ 1) = 0.61281 H (CHI-SQ 1) = 1.9192

FF(CHI-SQ 1) = 4.1946 N(CHI-SQ 2) = 0.051505

Recalling,

Lrm2d = 0.0046689 + 1.8608Lrgdpd - 0.40904Lfid - 0.49758Ldid (0.17)

(3.98) (-3.78) (-3.63)

+ 0.52914Lzd - 0.97040ECM2(-1).....(6) and

(5.05) (-4.11)

Lrm1d = - 0.0077537 + 2.1700Lrgdpd - 0.052857Fid - 0.033701Did (-0.31622)

(5.0135) (-3.7702) (-4.7458) + 9.9900Zd - 0.99161ECM1(-1).....(13).

(6.2067) (-4.1328)

NB: T-ratios are in parenthesis.

The short run income elasticities are lower than those of the long run as expected.

From Tables 5.14 and 5.15 above, it can be seen that all the variables are statistically significant at the 1% level. They also carry the right signs. The fit of the regression as indicated by the adjusted R^2 (i.e., 65%) is a good one. This implies that over 65% of the variations in the dependent variable or the short run dynamics is explained by the regressors. The diagnostic tests, as indicated in Table 5.14, show that there is no diagnostic problem. The critical value (Chi-sq{1}) of 3.84 is higher than the coefficients of 0.035918, 1.9402 and 0.61127 for serial correlation, functional form and heteroscedasticity, respectively. The critical value of 5.99 for normality (Chi-sq{2}) is also higher than the coefficient (0.70983). Hence, the null of diagnostic problem is rejected in all the cases. The F version (which is not reported here) also rejects the null. The results in Table 5.15 does not differ from those in Table 5.14. The only problem that is evident in Table 5.15 is related to the functional form when the Chi-sq is considered. However, the F Version of the diagnostic tests indicates that there is no diagnostic problem in the model (i.e., equation 13).

The results in Tables 5.14 and 5.15 also confirm our assertion above that there is cointegration in our chosen long run models. This is because the error correction terms (i.e., [ECM2(-1)] and [ECM1(-1)]) have the expected negative signs. They are also statistically significant at the 1% level. These not only confirm the existence of cointegration but also validate the error correction terms. The coefficients of the error correction terms (-0.97040) and (-0.99161) also indicate that errors in the system are fully corrected within the year. It should be noted that if there is no mis-specification in the models, the estimators from the levels and the differenced regressions should have the same probability limits (Maddala,

1992, p.513)[23]. Since the probability limits of equations 6 and 13 (the levels regression) and that of the ECMs (the first difference) are the same, we would say that our model is correctly specified.

5.6 THE BETA COEFFICIENTS

In order to calculate the Beta coefficients, the standard deviations of the variables must be known. This was obtained by looking at the correlations of the variables. Mfit is the package used. The standard deviations of **Lrm2**, **Lrgdp**, **Lfi**, **Ldi**, and **Lz** are as presented in the third column of Table 5.16. The coefficients in column 2 are from the original equation (i.e., equation 6). Table 5.17 presents the beta coefficients for **Lrm1**.

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[23] A general test for model mis-specification as provided by Plosser, Schwert and White (PSW), is applicable to time series only. The test involves the estimation of the regression models in levels and in first differences. It is asserted that the estimators from both regressions would have the same probability limits if the model is correctly specified. This implies that the results should corroborate each other. If the equation is :

$Y_t = \beta_1 X_{1t} + \beta_2 X_{2t} + U_t$

then, the PSW test involves estimating the expanded equation.

$$Y_t=\beta_1 X_{1t}+\beta_2 X_{2t}+\gamma_1 Z_{1t}+\gamma_2 Z_{2t}+U_t$$

where

$$Z_{1t}=X_{1,t+1}+X_{1,t-1}\ldots Z_{2t}=X_{2,t+1}+X_{2,t-1}$$

and testing the hypothesis

$$\gamma_1=\gamma_2=0$$

by the usual F-statistics.

It should be noted that if there are lagged dependent variables in the equation, the test needs a minor modification.

TABLE 5.16 BETA COEFFICIENTS WITH LRM2 AS THE DEPENDENT VARIABLE.

VARIABLES	COEFFICIENT	SD	BETA COEFFICIENT
LRM2	...	0.47181	...
LRGDP	2.4336	0.17260	0.89027227
LFI	-0.42989	0.36684	-0.33424651
LDI	-0.62926	0.59013	-0.78706514
LZ	0.62303	0.38637	0.510205593

TABLE 5.17 BETA COEFFICIENTS WITH LRM1 AS THE DEPENDENT VARIABLE.

REGRESSOR	COEFFICIENT	S D	BETA COEFFICIENT
LRM1	...	0.42760	...
LRGDP	2.5453	0.17260	1.0274059
FI	-0.062836	2.5859	-0.379999093
DI	-0.043956	8.5299	-0.876848186
Z	10.9560	0.023902	0.612418877

Recalling,

$$BC = \beta_x(\sigma_x/\sigma_y).$$

Substituting the values into the equation gives the beta coefficients as reported in Tables 5.16 and 5.17 above.

From Table 5.16, it is clear that the relative influence of the explanatory variables in descending order are as follows: **Lrgdp**, **Ldi**, **Lz** and **Lfi**. It should be noted that the relative strengths of the variables are determined based on the absolute betas. The sign of the variable determines the direction of the effect of the variable on the regressand. The results from Table 5.17 are not different from that obtained in Table 5.16. The relative strength of the explanatory variables follows the same order. The main result is that income has the most influence on the demand for money in Ghana. This finding is consistent with the empirical results of most studies on money demand.

CHAPTER 6: SUMMARY AND POLICY IMPLICATIONS

With the general view that money influences economic activities in the short to medium term, the study was set out to empirically analyse the determinants of money demand in Ghana and to test for the stability of the money demand function using the error correction technique developed by Engle and Granger (1987).

The DF and the ADF tests indicate that the money demand series in Ghana is an I(1) process, and the stationarity tests performed indicated that the variables were stationary and cointegrated. Several money demand equations were then estimated. In terms of explanatory power, correctness of signs and magnitudes of the parameter estimates, the study established that money demand in Ghana is a function of current income, and domestic and foreign interest rates. Financial liberalisation, proxied by the currency income ratio was also found to be a significant determinant of money demand. Previous studies have found income to be one of the determinants of money demand and so this study confirms their findings. On the other hand, the finding that the interest rate variables are significant in this study is contrary to some previous studies. While Amoako and Sowa found the domestic interest rate to be insignificant, Kallon found the foreign interest rate to be insignificant. In a study conducted on Morocco by Hoffman and Tahiri (1994), they found that foreign interest rate, proxied by the Swiss treasury bill rate, was statistically significant. However, Kallon's study showed that the domestic interest rate was significant. Hence, our finding that both interest rates are significant confirms Hoffman and Tahiri's as well as Kallon's studies. Exchange rate was found to be insignificant in this study and it confirms previous findings. Contrary to previous findings, however, this study found inflation and the lag of money to be insignificant.

The CUSUM and CUSUMSQ tests indicated stability of the money demand function. These tests indicated that there was no structural break in the data for the period under review. The Chow test performed also showed that the money demand function in Ghana is stable. The influx of deported Ghanaians from Nigeria and the bushfires and drought of 1983 did not bring about any significant changes in the demand for money. This implies that a reliable and predictable link exists between the monetary aggregates and the arguments in the demand for money function.

The relative influence of the various explanatory variables which entered the demand for money functions was tested using the beta coefficient. For both **M1** and **M2**, it was found that the most significant variable is current income. Its elasticity was greater than two. This implies that an increase in the level of income will lead to a more than proportionate increase in the money demand. This finding about the income elasticity reinforces other findings. The next variables with a strong influence on money demand were domestic interest rate, financial liberalisation and foreign interest rate. The significance of the interest rate variables suggests that wealth holders substitute more readily money with other financial assets than with real assets. This implies that interest rate can now be an effective monetary tool in the hands of policy makers in Ghana. Since Ghanaians view interest earning financial assets as attractive alternatives to real money balances, positive real interest rates will lead to portfolio adjustments and this will release appreciable resources to the financial sector.

The high cost of swapping bonds for money and vice versa has contributed to the relatively high income elasticity and low interest elasticity in this study. This high income elasticity might also imply that money is a luxury good. The low interest elasticity implies

that the financial sector is not highly developed. It is expected that an improvement in the financial sector, which has began, will help mobilise resources domestically for the nation's economic development. The significance of the foreign interest rate has an implication for policy makers in Ghana, which is that if the domestic interest rate is not attractive enough compared to the returns on foreign assets, people will choose to invest abroad.

In this study, two definitions for money (M1 and M2) were used. The results indicate that interest rates play a more significant role in **M2** than **M1**. **M2** also seems relatively more stable than **M1**. **M2** is currently the target of monetary control in Ghana. However, this study seems to be suggesting that **M1** could be targeted since it is also relatively stable. In both equations, the magnitude of the effect of income is almost the same. The equations differ only on the relative influence of interest rates with **M2** relatively more responsive to changes in interest rates.

This study differs from previous studies in several ways: It used the Error Correction Model which encompasses the partial adjustment model; it found the interest rate variables to be statistically significant; it included an additional variable (financial liberalisation) which exerted significant impact on the demand for money function in Ghana; and it formally established that the demand for money function in Ghana is stable and is an I(1) series.

The results of this study may be subject to a number of limitations. The paucity of data on itself is a limiting factor on the statistical analysis. Besides, the presence of controls in the economy and economic difficulties experienced during the period under review may have had an influence on the individual choices. The influence of such factors is, however,

not readily quantifiable. Furthermore, while according to the DF test, the financial liberalisation variable was integrated of order one, the ADF test indicated that it was not. One may argue therefore that the financial liberalisation variable should not have been included in the long run equations. In this respect, caution should be taken in interpreting and applying the results of this study. Despite these shortfalls, the results shed some new lights on the private sector's demand for money in Ghana.

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TABLE 4.1 SOME STUDIES WHICH FOUND INCOME AS THE MOST IMPORTANT DETERMINANT OF THE DEMAND FOR REAL BALANCES.

AUTHOR (YEAR)	COUNTRY
Hynes (1967)	Chile
Gujarati (1968)	India
Deaver (1970)	Chile
Fau & Liu (1971)	8 Dev'g Asian countries
Akhtar (1974)	Pakistan
Abe et al (1974)	Pakistan
Crocket & Evans (1980)	19 Dev'g countries
Moosa (1983; 1986)	Kuwait
Basha (1984)	Kuwait
Darrat (1984)	Saudi Arabia
Amr & Al Mahmeed (1987)	Kuwait
Ghamdi (1989)	Saudi Arabia
Mckenzie (1990) & Hemaya (1990)	Egypt
Ghamdi (1991)	Jordan
El Hage (1991)	Saudi Arabia
Diabi (1993)	Algeria

SOURCE: Author's compilation.

TABLE 5.2: ORDER OF INTEGRATION TESTS USING THE ADF FACILITY

VARIABLES	LEVELS				FIRST DIFFERENCE			
	DF		ADF		DF		ADF	
	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND	WITHOUT TREND	WITH TREND
LRM1	-0.88 (-2.98)	-0.25 (-3.59)	-1.08 (-2.99)	-0.4 (-3.60)	10.88 (-2.99)	7.09 (-3.60)	5.81 (-2.99)	5.35 (-3.61)
M1l	0.91 (-2.99)	-3.66 (-3.60)	0.28 (-2.99)	-3.32 (-3.61)	-4.39 (-2.99)	-4.31 (-3.61)	-4.31 (-2.99)	-4.11 (-3.62)
LRGDP	0.61 (-2.9)	-0.59 (-3.59)	0.55 (-2.99)	-0.99 (-3.60)	-4.02 (-2.99)	-4.48 (-3.60)	-3.44 (-2.99)	-4.31 (-3.61)
FI	-1.69 (-2.98)	-1.71 (-3.59)	-2.62 (-2.99)	-2.61 (-3.60)	-3.49 (-2.99)	-3.41 (-3.60)	-4.21 (-2.99)	-4.35 (-3.61)
LFI	-1.78 (-2.98)	-1.81 (-3.59)	-3.05 (-2.99)	-3.03 (-3.60)	-3.23 (-2.99)	-3.15 (-3.60)	-5.33 (-2.99)	-5.74 (-3.61)
P^e	-5.54 (-2.98)	-5.43 (-3.59)	-3.02 (-2.99)	-2.97 (-3.60)	-9.96 (-2.99)	-9.73 (-3.60)	-5.36 (-2.99)	-5.23 (-3.61)
DI	-0.27 (-2.98)	-4.39 (-3.59)	1.03 (-2.99)	-1.64 (-3.60)	-10.8 (-2.99)	-11.2 (-3.60)	-4.47 (-2.99)	-4.99 (-3.61)
LDI	-0.87 (-2.98)	-4.40 (-3.59)	-0.77 (-2.99)	-3.41 (-3.60)	-7.40 (-2.99)	-7.24 (-3.60)	-5.20 (-2.99)	-5.07 (-3.61)
LER	1.14 (-2.98)	-1.94 (-3.59)	0.15 (-2.99)	-2.31 (-3.60)	-2.81 (-2.99)	-2.93 (-3.60)	-3.09 (-2.99)	-3.29 (-3.61)
Z	-1.48 (-2.98)	-1.11 (-3.59)	-1.45 (-2.99)	-1.35 (-3.60)	-3.57 (-2.99)	-3.51 (-3.60)	-2.47 (-2.99)	-2.37 (-3.61)
LZ	-1.57 (-2.98)	-1.25 (-3.59)	-1.50 (-2.99)	-1.43 (-3.60)	-3.92 (-2.99)	-3.87 (-3.60)	-2.70 (-2.99)	-2.64 (-s.61)

BOX 1 REFORMS IN THE FINANCIAL SECTOR, 1986-1991.

1986: September; Introduction of a weekly foreign exchange auction.
1987: September; Decontrol of maximum bank lending rates and minimum term deposit rates.

October; Introduction of a weekly auction for the sale of treasury bills.

November; Establishment of the consolidated Discount House.

1988: February; Decontrol of minimum bank savings rate.
Removal of sectoral credit controls, except for a minimum requirement for credit to the agricultural sector.

April; Establishment of foreign exchange bureaus.

September; Introduction of 90 day BoG bills, available for banks.

1989: July; Adoption by the government of a comprehensive restructuring plan for the banking sector.

August; Adoption of a revised banking law, strengthening the regulatory environment and bank supervision by the BoG.

December; Introduction of non-rediscountable medium term BoG instruments with maturities of 180 days, 1 year, and years, available to banks.

1990: January; Appointment of new management and boards of directors of financially distressed banks.

March; Unification of bank cash reserve requirements demand and time and savings deposits.

April; Unification of the exchange markets (bureau and auction markets).
Commencement of implementation of restructuring plan

May; Replacement of non-performing bank claims on state owned enterprises, primarily with BoG bonds.

November; Opening of a stock exchange.
Introduction of 30 day BoG bills and 180 day, 1 year and 2 year treasury bills, as well as a new 5 year government stock.
Widening of access to Bog medium term instruments to the non-bank sector.
Abolition of the requirement for bank lending to the agricultural sector.

BOX 1 CONTINUATION.

1990:November, Decontrol of all bank charges and fees.
Reduction in the required bank cash reserves and increase in the secondary reserves.
Commencement of implementation of restructuring plan for three additional financially distressed banks.

December; Introduction of a 3% remuneration on bank cash deposits with the BoG.
Replacement of revaluation losses of the BoG adopted by end-September 1990 by long term government bonds.
First compliance test based on new capital adequacy requirements.

1991: March; Finalisation of the restructuring plan for the 7th distressed bank.
Replacement of the non-performing claims on the private sector by the financially distressed banks, primarily with BoG bonds.

June; Opening of a discount house (Securities discount (House).

July; Further reduction in the bank cash reserve requirement and increase in the secondary reserve requirement, together with a modification of the eligible reserve assets.
Increase in the rate of remuneration on bank cash deposits with the BoG to 5%.

SOURCE: Kapur, I. et al (1991), Ghana: Adjustment and Growth, 1983-91.

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented in any University. All sources of materials for this thesis have fully been acknowledged.

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