The Monetary Sector in Cameroon
Money Demand and Causality Analysis

Paul Wuakoh Mbeleke

T. I. M. E. Research Institute
Department of Economics
University of Salford, Salford
United Kingdom

A Thesis Submitted to the University of Salford
for the Degree of Doctor of Philosophy

July 1997
This thesis is dedicated to all who have in one way or another helped me at various stages in life; with particular attention to my family, friends, and teachers.
CONTENTS

List of Tables 6
List of Figures 8
Acknowledgements 9
Abbreviations 10
Abstract 13
Introduction 14

Chapter One: Monetary Sector Characteristics of Cameroon 22
1.1: Introduction 22
1.2: CFA Exchange Rate System 23
1.3: Interest Rate Structure 28
1.4: Prices 38
1.5: Income 41
1.6: Money Supply 44
1.7: Concluding Remarks 49
Chapter One Notes 51

Chapter Two: A Theoretical Framework for Money Demand and Causality Under Fixed Exchange Rates 52
2.1: Introduction 52
2.2: Traditional Money Demand Considerations 53
2.3: Open Economy Money Demand Considerations 64
2.4: Money Supply 73
2.5: Other Perspectives 80
2.6: General Considerations and Conclusions 85
<table>
<thead>
<tr>
<th>Chapter Three: Money Demand and Causality Empirics in the African Context</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1: Introduction</td>
<td>87</td>
</tr>
<tr>
<td>3.2: Partial Adjustment Studies</td>
<td>88</td>
</tr>
<tr>
<td>3.3: Error Correction and/or Co-integration Studies</td>
<td>97</td>
</tr>
<tr>
<td>3.4: Causality Studies</td>
<td>108</td>
</tr>
<tr>
<td>3.5: General Considerations and Conclusions</td>
<td>112</td>
</tr>
<tr>
<td>Chapter Three Notes</td>
<td>115</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter Four: Data Description and Time Series Properties</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1: Introduction</td>
<td>116</td>
</tr>
<tr>
<td>4.2: Data Sources and Construction</td>
<td>116</td>
</tr>
<tr>
<td>4.2.1: Domestic Narrow Money Supply</td>
<td>117</td>
</tr>
<tr>
<td>4.2.2: Domestic Broad Money Supply</td>
<td>117</td>
</tr>
<tr>
<td>4.2.3: Domestic Consumer Prices</td>
<td>118</td>
</tr>
<tr>
<td>4.2.4: Domestic Exchange Rate</td>
<td>118</td>
</tr>
<tr>
<td>4.2.5: Gross Domestic Product</td>
<td>119</td>
</tr>
<tr>
<td>4.2.6: French Narrow Money Supply</td>
<td>120</td>
</tr>
<tr>
<td>4.2.7: French Consumer Prices</td>
<td>120</td>
</tr>
<tr>
<td>4.2.8: French Government Bond Yield Interest Rate</td>
<td>120</td>
</tr>
<tr>
<td>4.2.9: USA Government Bond Yield Interest Rate</td>
<td>121</td>
</tr>
<tr>
<td>4.3: Preliminary Considerations on Unit Root Tests</td>
<td>121</td>
</tr>
<tr>
<td>4.4: Applications, Results, and Discussions</td>
<td>131</td>
</tr>
<tr>
<td>4.5: Results Overview, Implications, and Conclusions</td>
<td>139</td>
</tr>
<tr>
<td>Chapter Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Chapter Five: Money Demand Analysis</td>
<td>141</td>
</tr>
<tr>
<td>5.1: Introduction</td>
<td>141</td>
</tr>
<tr>
<td>5.2: Preliminary Considerations</td>
<td>142</td>
</tr>
<tr>
<td>5.3: Applications, Results, and Discussions</td>
<td>158</td>
</tr>
<tr>
<td>5.3.1: Co-integration Analysis</td>
<td>158</td>
</tr>
<tr>
<td>5.3.2: Error Correction Analysis</td>
<td>175</td>
</tr>
<tr>
<td>5.4: Results Overview, Policy Implications, and Conclusions</td>
<td>196</td>
</tr>
<tr>
<td>Chapter Six: Causality Analysis</td>
<td>205</td>
</tr>
<tr>
<td>6.1: Introduction</td>
<td>205</td>
</tr>
<tr>
<td>6.2: Preliminary Considerations</td>
<td>206</td>
</tr>
<tr>
<td>6.3: Applications, Results, and Discussions</td>
<td>212</td>
</tr>
<tr>
<td>6.4: Results Overview, Policy Implications, and Conclusions</td>
<td>223</td>
</tr>
<tr>
<td>Chapter Seven: Overall Conclusions and Recommendations</td>
<td>228</td>
</tr>
<tr>
<td>Appendix</td>
<td>239</td>
</tr>
<tr>
<td>References</td>
<td>252</td>
</tr>
</tbody>
</table>
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1: HEGY Test Results</td>
<td>134</td>
</tr>
<tr>
<td>4.2: DF/ADF Test Results from Two Unit Roots</td>
<td>136</td>
</tr>
<tr>
<td>4.3: DF/ADF Test Results from Three Unit Roots</td>
<td>139</td>
</tr>
<tr>
<td>5.1: VAR Residual Specification Tests</td>
<td>161</td>
</tr>
<tr>
<td>5.2: Co-integration Test Results</td>
<td>164</td>
</tr>
<tr>
<td>5.3: Money Normalized Co-integration Vectors</td>
<td>165</td>
</tr>
<tr>
<td>5.4: Price and Income Homogeneity Test Results</td>
<td>167</td>
</tr>
<tr>
<td>5.5: French Money Normalized Co-integrating Vectors</td>
<td>167</td>
</tr>
<tr>
<td>5.6: Price Normalized Co-integrating Vectors</td>
<td>168</td>
</tr>
<tr>
<td>5.7: Income Normalized Co-integrating Vectors</td>
<td>170</td>
</tr>
<tr>
<td>5.8: Z Normalized Co-integrating Vectors</td>
<td>170</td>
</tr>
<tr>
<td>5.9: Weak Exogeneity Test Results</td>
<td>173</td>
</tr>
<tr>
<td>5.10: ΔM1 as Regressand in M1 CFA Model (TS-Estimation)</td>
<td>179</td>
</tr>
<tr>
<td>5.11: ΔP as Regressand in M1 CFA Model (TS-Estimation)</td>
<td>180</td>
</tr>
<tr>
<td>5.12: ΔM2 as Regressand in M2 CFA Model (TS-Estimation)</td>
<td>182</td>
</tr>
<tr>
<td>5.13: ΔP as Regressand in M2 CFA Model (TS-Estimation)</td>
<td>183</td>
</tr>
<tr>
<td>5.14: ΔM1 as Regressand in M1 World Model (TS-Estimation)</td>
<td>185</td>
</tr>
<tr>
<td>5.15: ΔP as Regressand in M1 World Model (TS-Estimation)</td>
<td>186</td>
</tr>
<tr>
<td>5.16: ΔM2 as Regressand in M2 World Model (TS-Estimation)</td>
<td>188</td>
</tr>
<tr>
<td>5.17: ΔP as Regressand in M2 World Model (TS-Estimation)</td>
<td>189</td>
</tr>
<tr>
<td>5.18: ΔM1 as Regressand in M1 CFA Model (SS-Estimation)</td>
<td>191</td>
</tr>
<tr>
<td>5.19: ΔP as Regressand in M1 CFA Model (SS-Estimation)</td>
<td>192</td>
</tr>
<tr>
<td>5.20: Diagnostic Problems of Various Models Compared</td>
<td>194</td>
</tr>
<tr>
<td>5.21: Predictive Ability of Rival Models</td>
<td>195</td>
</tr>
</tbody>
</table>
Table

6.1: Money Supply as Dependent Variable 215
6.2: Income as Dependent Variable 218
6.3: Prices as Dependent Variable 220
6.4: Joint Granger-Causality Results 222
A1: $\Delta y$ as Regressand in Various 2-Stage Estimation Models 239
A2: $\Delta z$ as Regressand in Various 2-Stage Estimation Models 241
A3: $\Delta m$ as Regressand in Various Joint Estimation Models 242
A4: $\Delta p$ as Regressand in Various Joint Estimation Models 245
A5: $\Delta y$ as Regressand in Various Joint Estimation Models 247
A6: $\Delta z$ as Regressand in Various Joint Estimation Models 249
A7: Engle-Granger First-Stage Estimation Results for Money as Regressand in M1 CFA Model 251
<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1: Evolution of Cameroon's Exchange Rate</td>
<td>27</td>
</tr>
<tr>
<td>1.2: Evolution of Cameroon's Discount Rate</td>
<td>32</td>
</tr>
<tr>
<td>1.3: Evolution of Cameroon's Money Multiplier</td>
<td>47</td>
</tr>
<tr>
<td>1.4: Evolution of Cameroon's Income Velocity</td>
<td>48</td>
</tr>
</tbody>
</table>
First and foremost, I am very grateful to the government of Cameroon for providing all the sponsorship for this thesis.

Secondly, I would like to express my warmest gratitude to my supervisor Dr. Robert Simmons for showing utmost competence in various aspects of the supervisory process. I am also grateful to Dr. Kevin Albertson for many useful suggestions.

Thirdly, I am thankful to Professor George Zis and Professor Derek Leslie of Manchester Metropolitan University for a number of useful discussions regarding some aspects of the money demand results in the thesis. Also, I am grateful to Dr. David Fielding of Nottingham University for useful discussions relating to chapter five of the thesis.

Last but not the least, I am very grateful to Mrs Sandra Pugh and Dr. Alan Fitton for polite and efficient assistance with various administrative matters.
ABBREVIATIONS

AR: Autoregressive
ARMA: Autoregressive Moving Average

BCAS or BEAC: Bank of Central African States or Banque des États de l’Afrique Centrale

CBEASC or BCEAEC: Central Bank of Equatorial African States and of Cameroon or Banque Centrale des États de l’Afrique Equatoriale et du Cameroun

CAMU: Central African Monetary Union

CFA: (1) Colonies Françaises d’Afrique or French African colonies. This is applicable to the colonial era.

(2) Communauté Financière d’Afrique or African Financial Community. This is applicable to West African Monetary Union.

(3) Co-opération Financière en Afrique Centrale or Financial Co-operation in Central Africa. This is applicable to Central African Monetary Union.

CFAF: CFA franc
CPI: Consumer Price Index
Cusum: Cumulative Sum
Cusumsq: Cumulative Sum of Squares
DF/ADF: Dickey-Fuller/Augmented Dickey-Fuller
DW: Durbin-Watson
E: Domestic Nominal Exchange Rate
ECM: Error Correction Mechanism (Model)
EMS: European Monetary System
EMU: European Monetary Union
FIML: Full Information Maximum Likelihood
Form: Functional Form
FPE: Final Prediction Error
F*: F-statistic for Regressors as a Group
GDP: Gross Domestic Product
GNP: Gross National Product
HEGY: Hylleberg, Engle, Granger, and Yoo
Hete: Heteroscedasticity
HoR: Homogeneity Restriction
I(d): Integrated of Order d, where d is an integer
IID: Independently and Identically Distributed
IFS: International Financial Statistics
IRP: Interest Rate Parity
IMF: International Monetary Fund
L: Lag Operator
LDC(s): Less Developed Country (Countries)
LM: Lagrange Multiplier
ln: Natural Logarithm Operator
M: Domestic Nominal Money
M1: Domestic Nominal Narrow Money
M2: Domestic Nominal Broad Money
M1_{FR}: French Nominal Narrow Money
MA: Moving Average
ME: Maximal-Eigenvalue
MSSPE: Mean of Sum of Squares of Prediction Errors
TR: Trace
Norm: Normality
OECD: Organisation for Economic Co-operation and Development
OPEC: Organisation for Petroleum Exporting Countries
OLS: Ordinary Least Squares
P: Domestic Prices
PPP: Purchasing Power Parity
PAM: Partial Adjustment Mechanism (Model)
PE: Prediction Errors
P_F: French Prices
R_F: French Long Term Interest Rate
R_us: US Long Term Interest Rate
R^2: Adjusted Coefficient of Determination
RoSCA(S): Rotating Savings Association(s)
SAPE: Sum of Absolute Prediction Errors
SDRs: Special Drawing Rights
SE: Standard Error
Seco: Serial Correlation
SI(d, s): Seasonally Integrated of orders d, s; d, s = integers
SS: Single-Stage
TS: Two-Stage
US(A): United States (of America)
VAR: Vector Autoregression
WAMU: West African Monetary Union
y: Domestic Real Income
Z: Capital Mobility Measure
Z_c: Capital Mobility Measure Within CFA Context
Z_w: Capital Mobility Measure Within World Context
\sigma^2: Variance
\Delta: Difference Operator
\Delta^d: Difference Operator Applied d Times; d = Integer
$: US Dollar
ABSTRACT

This thesis investigates the monetary sector in Cameroon within an open economy framework. Two main hypotheses: money demand and Granger-causality are investigated.

The data used are found to be non-stationary. Consequently, the money demand relationship is tested for the null hypothesis that it is spurious or not co-integrated. This is rejected in all the models put forward. The models are estimated and found to exhibit elasticities that are not unusual. Price homogeneity is found to be data incompatible. Income elasticities are generally found to be significantly less than unity suggesting economies of scale in money holdings.

Corresponding dynamic models in the form of error correction are constructed using the familiar general to specific methodology and generally found to exhibit desirable statistical properties. Model preference is in terms of the narrow M1 definition of money with explanatory variables which include a foreign interest rate.

For Granger-causality, the non-stationary data are transformed into stationarity where the null hypothesis of non-causality is tested in bivariate and multivariate contexts. Lag length selection is by the Final Prediction Error statistic. Results are mixed but two appear striking: domestic money and prices are found to be independent while domestic prices are Granger-caused by foreign variables but not by domestic ones.
INTRODUCTION

The understanding of the monetary sector of an economy is important for monetary policy in particular and macroeconomic policy in general. For this reason, this sector has been subjected to extensive empirical scrutiny in many countries. However, for Cameroon this scrutiny is lacking. This thesis is designed as a contribution aimed at improving this situation from money demand and causality perspectives. These perspectives are important for macroeconomic analysis, notably as vehicles for the formulation and implementation of macroeconomic policy.

The task envisaged for the thesis is not easy. For example, a major difficulty relates to data quality. In general, the data quality available for macroeconomic time series empirical investigations is poor especially in developing countries. Nevertheless, despite the data limitations, we were able to conduct an empirical analysis that can be tentatively relied upon for policy purposes.

The main body of the thesis is organised into two parts. In the first part which consists of chapters one, two, and three, attention is focused on background information that is necessary for the envisaged empirical analysis. The second part which comprises chapters four, five, and six, is the applied section of the thesis.

As the focus of the thesis is on the monetary sector of
Cameroon, it is natural that our analysis starts with a proper investigation of its characteristics. This is the subject of chapter one. Here, the nature of the exchange rate is particularly emphasised as the understanding of Cameroon's exchange rate is important for a proper understanding of its monetary sector. We note that Cameroon is a signatory to the CFA fixed exchange rate mechanism involving France and a number of its former colonies.

As the CFA system provides the channel through which Cameroon is linked to the rest of the world, it is naturally the starting point from where other open economy issues are addressed. In addition to the exchange rate, the interest rate structure, prices, output, and the money supply are given critical attention, and implications are drawn for the conduct of the empirical analysis. The main conclusion here is that Cameroon is unlikely to be totally insulated from significant foreign economic developments. This conclusion forms the basis of emphasis on open economy issues in this thesis.

The theoretical framework for the envisaged empirical analysis is examined in chapter two. This consists of theoretical considerations on money demand, money supply, and a number of related perspectives. In the discussion here, open economy aspects such as currency substitution, capital mobility, and purchasing power parity are examined, and implications are derived for the conduct of the envisaged empirical analysis.

In chapter three, we conduct a review of empirical studies on money demand and causality. This permits us to uncover current research directions and outstanding issues. The relevant
literature is voluminous and only those that are relevant for our study are examined. We limit the review to some defined set that does not significantly jeopardize the aim of the exercise. The set of African countries is used. Despite this, our review is rich in diversity which is noticeable in terms of geographical areas, empirical counterparts of the theoretical variables used, assumptions or constraints applied, empirical techniques employed, and results obtained.

Most of the studies examined are based on small open economies and suggest that open economy considerations are important for such economies. Here, two studies are particularly scrutinized. These are Fielding (1994) on money demand in Africa and Honohan (1992) on price and monetary convergence in African monetary unions. We attach particular interest to these studies because each includes Cameroon in the set of countries studied.

The review of past empirical studies completes the first part of the thesis. This leads us to the second part or the applied section. The structure here is familiar for an applied study. In particular, we provide a statement of the hypotheses to be investigated, the methods of investigation, derive results and critically examine them. These considerations are as follows.

Firstly, much of the bulk of traditional econometrics assumes that the data are stationary. However, empirical evidence provided by a number of authors, for example Nelson and Plosser (1982), shows this may not generally be the case. The penalty for wrongly assuming the data are stationary has been demonstrated by Granger and Newbold (1974) to be a greater incidence of spurious regression. For this reason, it has become standard
requirement in applied time series analysis that the stationarity properties of the data be checked and appropriately taken into account in the modelling process.

We examine the time series properties of our data in chapter four after reporting the sources and construction of the data. Two tests are used to determine the time series properties of the data: the (augmented) HEGY tests for seasonal and zero frequency unit roots and the (augmented) Dickey-Fuller tests for zero frequency unit roots. Care needs to be exercised in their implementation and interpretation, otherwise misleading inferences may be drawn from the results. Amongst others, the issues of treatment of deterministic components, serial correlation, and low test power have been emphasised. Our results which are derived from careful consideration of these issues suggest that the data of interest are generally non-stationary in levels due to unit roots at the zero frequency. The tests do not detect any roots at the seasonal frequencies.

The non-stationarity nature of the data is incorporated in the money demand analysis which is the subject of chapter five. At this stage, two potential money demand explanatory variables are eliminated as possible long run determinants of money demand in Cameroon. The first is the expected inflation rate. The second is the expected rate of currency depreciation, interpreted as a currency substitution measure. Their elimination is because the long run money demand analysis considered in this thesis is based on non-stationary variables while the above variables are shown to be stationary.

The overall money demand analysis is conducted within the
framework of co-integration and error correction which has been shown to be valid for the analysis of non-stationary data. Co-integration is used to analyze long run money demand while error correction is used to analyze its short run or dynamic implications.

Four models are constructed from two different monetary aggregates and two different capital mobility measures. For money, M1 and M2 are used. The rate of interest chosen from France is used as a capital mobility measure when open economy considerations are restricted to the CFA area where exchange rate movements are zero. The US interest rate adjusted for changes in the exchange rate is used as a capital mobility measure when open economy considerations are in terms of the overall world economy. We interpret the capital mobility measures as reflecting foreign or external opportunity costs of money holdings in Cameroon. The theoretical analysis examined in chapter two predicts that, in general, an increase in capital mobility as defined in any of the cases above would lead to a decrease in domestic money holdings. Results derived in this thesis appear to be consistent with this prediction.

Though an external opportunity cost measure is successfully used for the money demand analysis, no meaningful domestic opportunity cost measure is found. Consequently, the possibility of omitted variable(s) bias is taken seriously in the interpretation of our results.

The co-integration analysis is conducted using the Johansen full information maximum likelihood approach. A careful application of this approach requires that a number of issues be
addressed. In addition to the time series properties of the variables, our application addresses the issues of lag length specification and the incorporation of deterministic components such as intercepts, trends, and seasonals.

Testing co-integration within the Johansen approach is based on two tests: the maximal eigenvalue and the trace tests. For our application, these indicate the presence of a unique co-integrating vector in each data set examined. The estimates of the corresponding co-integrating vectors are derived and various normalizations are sought. The analysis is extended into an error correction or dynamic framework where the general to specific modelling approach is employed.

Empirical criteria such as weak exogeneity and other key model diagnostic properties as well as theoretical criteria are used to assess the relevance of each normalization. In relation to the normalization on money, the estimates of the long run elasticities are generally consistent with theory.

Furthermore, we test the price and income homogeneity postulates of money demand by imposing relevant restrictions on the co-integrating vectors. These are largely found to be data incompatible in all the normalizations.

A critical assessment of the normalization exercises leads us to prefer the narrow money normalization based on CFA open economy considerations. To conclude, important aspects of our results are recapitulated and their policy implications are examined.

An important aspect of our preferred money demand model is that it exhibits a significant error correction term. Following
Choudhry (1995), we interpret the significance of this term as suggesting causality from the explanatory variables to the independent variable.

The issue of causality is analyzed in greater detail in chapter six using the statistical concept of Granger-causality. The motivation behind the causality analysis is twofold. The first is to shed more light on the money demand analysis. The second is to examine linkages other than money demand, amongst monetary variables that may be relevant to Cameroon in an open economy framework.

As the statistical theory behind Granger-causality assumes stationary data, we first transform the non-stationary data into stationarity before conducting the analysis. Lag length selection is via the statistical minimum FPE (Final Prediction Error) criterion. Furthermore, residuals are checked for consistency with white noise property. Causality implications are assessed on the basis of the F-statistic and the FPE-statistic.

When the focus is on domestic variables, the possibility of feedback is taken into consideration. However, when foreign variables are introduced, the direction of causality is hypothesized as unilateral from foreign to domestic variables. This is because we assume that the domestic economy is small relative to the rest of the world.

Results indicate that domestic variables are generally Granger-caused by foreign variables where France is chosen as the foreign country. As in the case of money demand, these results can be interpreted as suggesting that open economy considerations are important for Cameroon.
The Granger-causality analysis completes the main body of the thesis. We then proceed to providing in chapter seven, the main conclusions relating to our research as well as indications for further research.

Given the above introduction, we now turn to the first chapter of the thesis.
1.1: Introduction

The hypothesis of money demand examined in the next chapter indicates that the real quantity of money desired by individuals in an economy is some function of a budget constraint or scale variable and some opportunity cost variable(s). Analysis in that chapter also suggests that this hypothesis can be examined as a relationship involving key macroeconomic variables such as the money supply, prices/inflation, the rate of interest, wealth/income, and the exchange rate.

By focusing on these variables, we examine in this chapter, the characteristics of the monetary sector of Cameroon that we consider appropriate for the empirical investigation of the above hypothesis as well as the pattern of causality that may exist amongst the variables. Our analysis is set in an open economy framework. Consequently, some foreign macroeconomic variables are entertained in the analysis.

In section two, we analyze the exchange rate. We note that Cameroon is a signatory to the CFA fixed exchange rate system. We emphasise that although the CFA exchange rate system is fixed, the fact that it is situated within a global world exchange rate
system where exchange rate flexibility also apply, implies that the effects of exchange rate flexibility cannot be completely ignored for the conduct of this thesis.

In section three, we examine the structure of interest rates. Here, attention is focused on both formal and informal financial sectors. Prices are examined in section four while output is examined in section five. Section six is concerned with the money supply where amongst other issues, the evolution of the money multiplier and the income velocity of money are analyzed.

To conclude the chapter, a number of implications are drawn for the progress of the thesis.

1.2: CFA Exchange Rate System

Cameroon is a signatory to the CFA monetary zone arrangements which date back to 1945 when France created a special currency called the CFA franc for its colonies in Africa and overseas territories and departments (outside Africa). CFA originally meant Colonies Françaises d'Afrique which can be literally translated as African French Colonies. However, today it has slightly different meanings (see list of abbreviations) depending on the part of the monetary zone within which the currency is issued. The main issuing bodies in Africa are the central bank of the Comoros Islands, the central bank of the West African Monetary Union (WAMU), and the central bank of the Central African Monetary Union (CAMU) which Cameroon is a member.
Outside Africa, these are the respective central banks of the overseas territories and departments. The main features of the CFA monetary system are as follows.

All currencies issued by authorised institutions in the zone are convertible at par. However, each currency is legal tender only within the jurisdiction of the issuing body concerned.

France guarantees unlimited convertibility of the CFA franc into its currency: the French franc. This is done by offering unlimited overdraft facilities on accounts called operations accounts described below. The rate of convertibility is fixed, though it can be changed by agreement involving all the members of the arrangements. Initially, it was set at 50 CFA francs to one French franc. This parity was sustained from 1948 until January 1994 when the CFA franc was devalued by 50 per cent. Foreign exchange as well as gold reserves are pooled and managed together. Nevertheless, individual country accounts remain separate. An important feature is that deficit members can easily borrow from surplus ones. These accounts, commonly known as operations accounts, are kept with the French treasury and managed so as to ensure the full convertibility of the CFA franc into the French franc. They are the cornerstone of the CFA monetary system. By convention, members have to hold at least 65 per cent of all their foreign currency and gold reserves (excluding IMF gold tranches and SDRs) in the accounts.

Capital movements within the zone are free and regulations for commercial and financial activities are common.

According to Cobham and Robson (1994), the CFA zone was not set up as a result of any process of monetary integration. They
argue that at no stage for example, were there separate central banks which were merged into or superseded by a single institution and that the zone has been and continues to be geared primarily to producing macroeconomic stability. This view is largely shared by many commentators.

From a direction of trade perspective, the direction of exchange rate fixity appears to have been appropriate. In particular, most of the trade of members is with France. However, the share of trade with France though still significant is a declining one. This implies that the direction of exchange rate fixity may not be appropriate in the future.

For our empirical analysis, exchange rate movements are assumed away when attention is focused exclusively within the fixed CFA exchange rate zone or related spheres of exchange rate fixity. Related spheres of fixity here stem from the fact that the French franc to which the CFA franc is fixed may be fixed with another currency.

In this regard, we note that the currency used by French Polynesia, New Caledonia, and Wallis-Futuna Islands is fixed to the French franc at a different parity from the CFA franc. Another sphere of fixity is the European Monetary System (EMS) in which currencies of members which include France are fixed to each other within flexible bands rather than a rigidly fixed parity as in the cases just mentioned. By implication, the CFA franc is fixed within the same flexible bands to EMS currencies. One implication of these additional considerations is that if the French franc is devalued/revalued, the CFA franc is devalued/revalued by a corresponding amount.
There is the argument that in the wider world context where flexible exchange rates also apply, exchange rate dynamics may still be relevant for a country with fixed exchange rates so long as the currency to which its currency is fixed is flexible against one or more currencies. This argument is relevant here as the French franc is flexible against many currencies including the US dollar and the Japanese yen: two major currencies in global trade.

In terms of the data used for the empirical analysis in this thesis, see chapter four for data issues and notice the data are quarterly, figure 1.1 below traces the evolution of the nominal CFA exchange rate for Cameroon, or appropriately scaled French exchange rate, defined as the number of CFA francs per dollar. Notice the sharp rise in the exchange rate in the mid-1980s. This corresponds to the era when the dollar appreciated sharply against the other major currencies in the 1980s.

The year 1973 falls within our data sample. This year represents the end of the Bretton Woods period of fixed exchange rates which was established in 1944. Though the Bretton Woods period has generally been labelled one of fixed exchange rates, it should be noted that exchange rates were modestly flexible at least in relation to our data as shown in figure 1.1.

In this thesis, the variability of the CFA exchange rate which in practice is the variability of the French exchange rate is considered strictly exogenous to the economy of Cameroon because it is determined outside that economy. It is in this qualified context that exchange rate dynamics are considered in the thesis.
The theoretical analysis presented in the next chapter indicates that when a currency is expected to depreciate, this may cause agents to substitute out of the depreciating currency into the appreciating one. For the empirical analysis of interest, when attention is focused exclusively within the CFA zone, currency substitution is assumed to be zero as exchange rate dynamics are zero. On the other hand, when attention is focused on the world as a whole, the plausibility of currency substitution is investigated because of non-zero exchange rate dynamics outside the CFA zone.

In particular, given that the evolution of the exchange rate
above reveals marked volatility, the issue of currency substitution is at least potentially relevant. For the empirical analysis of interest, we consider the potential substitution between the CFA franc and the US dollar. Our justification for using the US dollar is based on the dominance of this currency in the global world economy.

For our empirical analysis, the expected exchange rate depreciation which is considered as a measure of currency substitution is constructed as the first difference of the log of the exchange rate. The analysis in chapter four suggests that this measure is stationary. As the other long run money demand data in the thesis are found to be non-stationary, see chapter four, our interpretation is that currency substitution is not a long run determinant of money demand in Cameroon.

To end this section, we note that in money demand analysis there is the question as to whether there are structural changes in the money demand relationship due to structural developments such as the world movement from fixed to flexible exchange rates in 1973. In our empirical analysis, this question is addressed using a battery of structural stability tests.

1.3: Interest Rate Structure

The opportunity cost of money holding is often approximated by the rate of interest. Ghatak (1995) notes that in developing countries, limitations on the use of the rate of interest as the
opportunity cost of money holding arise because of the: (1) limited size of the organised financial market; (2) institutional pegging of interest rates; (3) limited array of financial assets; (4) limited degree of substitution between money and financial assets in comparison with the economically developed countries. As evident below, these features generally characterise the monetary sector of Cameroon which can be classified into formal and informal sectors.

The formal sector is mainly characterised by the central bank and the money taking/lending financial institutions which are mainly the commercial banks. On the other hand, the informal sector is characterised by savings/credit unions and rotating savings/credit associations or RoSCAs.

We noted earlier that Cameroon is situated in the CFA franc zone within a sub-zone: the Central African Monetary Union (CAMU). In addition to Cameroon, there are five other members of the union, namely: Central African Republic, Chad, Congo, Gabon, and Equatorial Guinea. These countries share a common central bank, the Bank of Central African States (BCAS) and as noted earlier, the currency issued within the sub-zone is legal tender only in the countries above. BCAS was established in 1973, replacing the Central Bank of Equatorial African States and of Cameroon (CBEASC) which was established in 1959.

The main function of BCAS is to set a common monetary policy for its members. In addition, this policy has to be consistent with the monetary and financial objectives of the CFA franc zone. In particular, policy has to be conducted to ensure the viability of operations accounts mentioned earlier. The interest rate
structure in Cameroon is largely determined by the monetary policy of BCAS which is broadly the same for all its members. This policy can be roughly separated into two parts. One is interest rate related and the other is non-interest rate related. These are discussed respectively below.

Interest rates are administratively fixed at two levels. One level relates to the central bank and the other applies to the money taking/lending institutions such as commercial banks. At the level of the central bank, there are three main types of interest rates. These are the rediscount rate, the treasury rate, and the penalty rate. With the money taking/lending institutions, these are the deposit and lending rates.

The rediscount rate is the principal instrument of monetary policy. According to Boughton (1991a), the emphasis on the use of rediscounting within the CFA zone reflects both the limited development of the domestic financial market and the absence of bank reserves requirements. It should be noted that the absence of bank reserves requirements does not imply banks do not hold reserves. There are two main types of rates applicable to rediscounting. One is classed as preferential and the other as normal. The main types of credit which are labelled as preferential are: (1) credit relating to co-operatives, state organisations, and other institutions of collective interest without profit motive; (2) special agricultural credit; (3) credit relating to small and medium-sized enterprises with indigenous capital and managers; (4) medium term credit directed to social housing; (5) credit given to indigenous people to buy existing agricultural enterprises that are foreign owned.
Credit that cannot be classified under the preferential category or any other category deserving of special treatment is labelled normal. Given the stress on rediscounting as an instrument of monetary policy, the discount rate can be viewed as a benchmark against which other interest rates are fixed.

An important aspect of the interest rate policy of the central bank has been to offer a stable financial environment for investment. For this reason, interest rates have seldom been changed. For illustration, from 1968 to 1985, the discount rate was changed only three times. It was changed from 4.5 per cent to 5.5 per cent in 1973. Secondly, it was changed from 5.5 per cent to 6.5 per cent in 1976. Thirdly, it was changed from 6.5 per cent to 8.5 per cent in 1979. This remained unchanged till 1985. Changes have occurred relatively more often from 1985. Such changes have been influenced to some extent by IMF structural reforms for Cameroon.

The discount rate mentioned above is the only meaningful domestic interest rate data available for the conduct of the empirical analysis in this thesis. However, because of low variance or lack of movements in the series, see figure 1.2 below which traces the evolution of this series, it did not generate economically sensible empirical results. Moreover, it was not available for the full sample period for this thesis. It was only available from 1968. For these reasons, domestic interest data are not retained for the final results reported in the thesis.
The treasury rate mentioned earlier is the rate at which the treasury can obtain credit from the central bank. Amongst the main interest rates in Cameroon, it is the lowest. Also mentioned earlier, is the penalty rate. This applies to regulated financial institutions that do not adhere to the central bank's policies. Amongst the rates applied by the central bank, it is the highest.

The other set of interest rates relates to deposit and lending rates. As noted earlier, these are also administratively fixed and apply to the money taking/lending institutions which are mostly the commercial banks. These are small in number. Lending rates in particular differ according to a wide variety
of factors. Two main factors are maturity and purpose of credit. On maturity of credit, two main interest rates are available, namely: short and medium term rates. There appears to be a shortage of long term credit in Cameroon. It may be that financial institutions find such form of credit too risky. On purpose of credit, two main rates are also available, namely: preferential and normal. Here, the reasons for classification of credit as preferential are broadly similar to those seen above.

The next category of policy instruments used by BCAS is non-interest rate related. These may be described as quantitative in nature. A number of examples can be cited. Certain ratios, for example: lending/capitalization ratios, liquidity ratios, and deposits/non-rediscountable loan ratios are imposed on the banking system. Non-remunerated obligatory reserves may also be imposed on the banking system. The amount of rediscount activity that can be conducted is limited for a given year. The maximum amount of credit that can be accorded to the government is limited to twenty per cent of past fiscal year's revenue. This is a key requirement set out in the CFA arrangements.

In general, the category of policy instruments discussed above is designed to supplement interest rate related policies and intended to make sure that excessive credit expansion which may jeopardize the smooth functioning of the CFA franc zone is curbed. Tightening credit may raise the cost of credit or the rate of interest. This in turn is expected to reduce money demand as suggested by the theoretical analysis in the next chapter.

The major limitation of monetary policy above lies in the fact that the formal sector to which it is most likely to
influence does not appear to involve the majority of the population. In particular, well above half of the population in Cameroon lives in rural areas where formal banking and other formal financial facilities are seldom available. Instead, in rural areas informal financial activities are rife.

According to Nana-Fabu (1992), financial institutions such as commercial banks in Cameroon find that it is unprofitable to operate in rural areas because of low business volume, poor infrastructure, high administrative costs, and difficulties of getting any collateral for advances made. Nevertheless, commercial banks have made some progress in the past in maintaining a presence in some rural areas even if only occasionally by using mobile offices.

There are a number of prominent players in the informal sector of Cameroon. Gadway (1986) notes that credit unions or caisses populaires as they are called in francophone Cameroon play a significant and growing role in the mobilization of domestic savings. Also active in the mobilizing of rural savings are the informal savings and credit associations which have been termed Rotating Savings and Credit Associations or simply RoSCAs. These are known as njangis in anglophone Cameroon and tontines in francophone Cameroon. These and related informal savings and credit associations are believed to mobilize more than 75 per cent of rural savings.

The main feature to note for the purpose of the empirical analysis in this thesis is that interest rates in the informal sector may be the appropriate ones for empirical analysis as they are often determined by market forces. However, the major
drawback here is that records are seldom kept. We were not able to obtain any interest rate data on this sector.

Ghatak (op. cit.) notes that the informal sector in developing countries is often related to the formal sector in that funds from the informal sector are often deposited in the formal sector where interest may be earned. In this case, the level of interest rates in the informal sector may be directly linked to that in the formal sector. This would imply that if we had useful interest rate data in the formal sector, the problem of lack of data in the informal sector would be less severe. However, the link between the formal and informal sectors in Cameroon does not appear strong. Heidhues and Weinschenck (1989) note that the informal sector in Cameroon appears to be completely fragmented from the formal sector.

In economies where credit is restrained, Wong (1977) has suggested that an index of credit restraint such as the negative of the ratio of domestic credit to income or the negative of the growth rate of domestic credit may be used as an opportunity cost measure for money holdings. The rationale is that in conditions of credit restraint, credit availability rather than its cost or rate of interest is more likely to influence demand. However, the empirical literature on money demand in LDCs has not generally provided support for the suitability of such credit restraint variables. These were experimented without success in our empirical investigation.

As Cameroon is under a fixed exchange rate environment with zero or negligible exchange rate costs, its interest rate policy has international implications. Some of these are usefully
summarized by Heidhues and Weinschenck (op. cit., p. 35) thus:

"Interest rates in Cameroon have been consistently negative in real terms and, also in nominal terms, well below international—and specially Paris-rates. Thus, with a fixed exchange rate to the French Franc and practically zero exchange costs, savings flow to foreign markets and the domestic financial system, deprived of those funds, remains underdeveloped."

Interest rates in France are important because France is the only economy within the CFA arrangements with a developed and sophisticated financial market offering a wide array of financial instruments. For other economies of the arrangements, financial markets are very limited or non-existent. For example, only very recently, have there been attempts at establishing some forms of viable financial markets in Cameroon and these are still at a rudimentary stage. One consequence is that there is little or no basis in Cameroon for policies like open market operations. Another feature which makes interest-related investments in France attractive is that France is arguably the most stable member of the arrangements.

However, it should be noted that despite the fact that it may be attractive to invest abroad, Cameroon has a system of exchange controls which may act as an impediment. On the other hand, it appears the controls have not generally been effective.

The theoretical analysis in the next chapter suggests that capital mobility effects on domestic money demand can be assessed
in terms of the foreign interest rate adjusted for the expected depreciation of the domestic currency. Within a fixed exchange rate zone such as the CFA, the expected rate of currency depreciation is zero implying that capital mobility effects can be assessed in terms of the foreign interest rate only. When this line of argument is entertained in this thesis, our choice of the foreign interest rate is from France for reasons outlined above.

On the hand, basing capital mobility considerations solely within the CFA zone rather than the world as a whole may be too restrictive. When attention lies within the world, exchange rate depreciation may not be zero as noted in the last section. In the empirical analysis in this thesis, when attention lies on capital mobility within the world as a whole, the US interest rate is used for consistency with the exchange rate definition which is in terms of the US as the foreign country. Also, the theoretical analysis in the next chapter suggests that there would generally be an inverse relationship between such capital mobility effects and money demand. The empirical results obtained in this thesis appear to be consistent with this generalization.

The causality implications of the foreign interest rate in this thesis are similar to those of the exchange rate mentioned earlier. In particular, the foreign interest rate is considered strictly exogenous. This is consistent with the small economy assumption of Cameroon.

To conclude this section, there is the argument that within a fixed exchange rate environment, interest rates will converge together. In this case, interest rate parity (IRP) is said to be valid. The validity of this argument for Cameroon is examined in
the next chapter in a more general context involving purchasing power parity (PPP).

1.4: Prices

There are a number of reasons why prices are examined in this thesis. Firstly, there is the price homogeneity postulate of money demand. Secondly, there is the issue of inflation as an opportunity cost of money holdings. Thirdly, there is the more general issue of the causality implications amongst money, prices, output, and the interest rate.

The theoretical money demand analysis presented in the next chapter suggests that money demand is homogeneous of degree one in prices implying that money demand will increase proportionately to increases in the price level. We do not find this postulate to be data acceptable in the empirical analysis in this thesis. Our evidence is supportive of that provided by Boughton (1991b) and Arestis et al (1992) for a number of developed countries.

According to Adekunle (1968) for example, the rate of inflation may be a more appropriate opportunity cost of holding money balances in a developing economy than the rate of interest because of the limited amount of financial assets relative to physical assets. As we shall see later, this statement does not appear to hold in terms of the empirical analysis in this thesis.

In an empirical analysis involving money demand, there is
the question of appropriate empirical counterpart for prices and hence inflation. Two familiar candidates are the CPI and GDP/GNP deflators. Margaritis and Maloy (1990) note that in an open economy, money can be used to buy both domestic and foreign goods so that the empirical counterpart for prices should incorporate the price of foreign goods.

According to these authors, this suggests using the CPI which includes the price of imported goods rather than the GDP deflator that excludes the price of imports. Nevertheless, a more pragmatic approach would entail experimenting with alternative measures. In our case, this was not possible as GDP/GNP deflator data, unlike CPI data was not available for the entire period of the empirical analysis in this thesis. For this reason, prices in the thesis are in terms of the CPI.

In terms of our (quarterly) CPI data, the inflation rate calculated here as \( \frac{P_t - P_{t-4}}{P_{t-4}} \) which may correspond to the annual rate of inflation, has an arithmetic mean value of 7.4 percent and a standard deviation value of 0.058. By developing country standards, this appears modest and not very variable.

The fact that inflation appears modest in Cameroon may be attributed to CFA monetary discipline. According to Boughton (1991a), there are three main ways of controlling monetary growth in the CFA zone. Firstly, interest is levied on any overdrafts on operations accounts as well as paid on any credit balances. Secondly, if the operations accounts were to fall below specified target levels, the central bank concerned will have to implement policies restricting credit expansion. These restrictions are primarily based on raising the cost of rediscounting paper with
the central bank and restricting access to rediscount facilities. In order to implement the credit restriction rules, each central bank's operations account is notionally allocated among the members with a residual allocated to the bank itself. Finally, credit from the central banks to the public sector of each country is limited to a maximum of 20 per cent of past year's fiscal revenue (as mentioned in the last section), presumably to prevent the monetization of budget deficits.

Ghatak *op. cit.*) notes that some measure of inflation can be important for money demand in developing economies which have suffered substantial inflation. The observation above that inflation in Cameroon has been modest leads us to predict that the expected rate of inflation may not be particularly important for the demand for money in that country.

This scepticism is confirmed by the fact that the integration tests conducted in chapter four of this thesis reveal that the price level is integrated of order one or needs to be differenced once in order to achieve stationarity. This implies that the inflation rate which is later computed as the first difference of the log of the price level is stationary. The co-integration analysis in chapter five suggests that it should be eliminated from the set of long run money demand determinants in Cameroon because the latter are found to be non-stationary. We interpret this as suggesting that expected inflation is not a long run determinant of money demand in that country.

To end this section, we note that in a small economy with fixed exchange rates, prices are often considered exogenous in the sense that they may be largely determined by the foreign
price level. The empirical causality analysis in this thesis appears to be consistent with this remark. The theoretical causality implications of prices in Cameroon are addressed in the next chapter from PPP perspectives.

1.5: Income

According to Margaritis and Maloy (op. cit.), the transactions view on money demand regards current income, a proxy of the volume of transactions in the economy, as a more appropriate choice for the scale variable of money demand while the portfolio approach favours wealth which is often proxied by permanent or expected income. However, a relevant argument here is that there is no compelling reason to suggest that one form of measure will necessarily be better in an empirical exercise so that the answer to the question of appropriate scale variable measure may be an empirical matter.

The use of expected income involves transforming the original series. There is no guarantee that this may leave the time series properties of the original series unaffected. Given that the income data in this thesis are interpolated from annual values as noted below, further transformation of the series is avoided and our approach uses current income.

A number of alternative measures have been used for income in empirical studies. Some prominent examples that have featured in empirical money demand literature are real consumption, real
GNP, and real GDP.

According to Mankiw and Summers (1986) for example, out of all components of income that generate transactions, consumption is likely to be more robust in terms of generating the most demand for money. Unfortunately, we were not able to obtain consistent data on consumption in Cameroon.

GDP and GNP are traditional aggregates used for income in money demand analysis. For our purpose, GDP is used because GNP was not available for the entire sample period investigated. However, GDP data does not exist in Cameroon on a quarterly basis which is the frequency of the data sample employed in the thesis. As a result, we had to interpolate annual GDP data into corresponding quarterly values.

Full details on the interpolation procedure are provided in chapter four. Such a procedure has been used by a number of authors, for example Arize et al (1991) for Thailand and Hoffman and Tahiri (1994) for Morocco. The interpolation is applied to nominal GDP which is then deflated by the CPI to obtain real GDP. Given the interpolation, some degree of caution must be placed on the interpretation of related results.

The growth rate of the above mentioned real GDP series defined as \( (y_t - y_{t-4})/y_{t-4} \) which may correspond to the annual growth rate has an arithmetic mean value of 5.3 per cent and a standard deviation value of 0.085. Thus, it appears Cameroon has experienced modest growth in terms of real GDP. The highest rates appear in the late 1970s and early 1980s. These periods correspond respectively to coffee/cocoa and petroleum boom years.

The impact of oil on the economy of Cameroon has been
important and merits further comments. In particular, it has changed the composition of output in a significant way. Most of all, it has inflated the output size and has increased per capita income figures. On the other hand, the gains from petroleum have not been evenly distributed as the rural areas where the majority of the population lives have not benefited in any significant way. For this reason, a more representative output figure for Cameroon has sometimes been constructed with the exclusion of petroleum. It may be argued that such a restricted definition of output would be more appropriate for our purpose.

Our objection is as follows. The advent of petroleum has had an impact on other variables that we have included in our empirical analysis. For example, the money supply has increased to levels that would not have otherwise been attained. Unless we are able to isolate and remove the impact of petroleum output on these variables, it would be inappropriate to use non-petroleum output in the analysis. Given the difficulty associated with using this sort of output, the figures of GDP used here are inclusive of petroleum production.

In the rural areas of Cameroon in particular, a significant amount of output does not pass through the market. Consequently, the issue of monetization may be important for our analysis. According to Aghevli (1980), the income elasticity of the demand for money will be biased upwards unless there is an independent proxy to capture the monetization effect.

Unfortunately, it is not possible to construct a meaningful monetization proxy. For example, Aghveli (op. cit.) uses the number of banks per capita. The main shortcoming here is that
there is no logical connection between monetization and the number of banks per capita. For instance, there are many banks in Cameroon but they are mostly concentrated in the urban areas which are generally considered as monetized. Moreover, as seen earlier in section three, banks maintain some degree of presence in some rural areas in Cameroon but the use of their services is much restricted in favour of the informal financial institutions. Thus, the number of banks as a proxy for the effects of monetization is of limited empirical significance. We could not find a meaningful monetization proxy for our empirical analysis.

Finally, in the theoretical framework put forward in the next chapter to explain the monetary sector of Cameroon, output is hypothesized to be determined by the underlying real factors in the economy. As the analysis in that chapter indicates, this hypothesis has implications for causality involving output as well as the neutrality proposition of money.

1.6: Money Supply

Macroeconomic data are not available on money demand given that the latter does not have any directly observable empirical counterpart. What is observed empirically is the money supply. Following convention, the assumption in this thesis is that the available money stock is willingly held by agents so that it can be equated to money demand. This raises the familiar question of identification.
When the domestic financial market is narrow as in Cameroon, the transactions motive for money holding is likely to dominate the speculative one. This implies that a monetary aggregate that most readily describes transactions is to be preferred. For our purpose, we use currency and demand deposits which are conventionally classified as narrow money and denoted M₁. On the other hand, some commentators have argued that the appropriate definition of money is an empirical matter. To accommodate this view, we use the broad definition of money defined as M₁ plus time deposits and conventionally denoted M₂. From this definition, it is evident that the definition of M₂ encompasses that of M₁. It is expected that if differences in results were to arise, these will be due to the non-M₁ component of M₂.

Below, we comment on the evolution of the above aggregates as well as that of related indicators. Our first comments relate to the relative composition of the money supply in terms of currency and demand deposits on one hand and savings deposits on the other. Secondly, we comment on the relation of money supply to GDP as a rough indicator of the level of finance of activity. Thirdly, we show the evolution of the money multiplier. Finally, we explore the dynamics of the income velocity of money.

For our data, a dynamic decomposition of total money supply in terms of currency and demand deposits on one hand and savings deposits on the other is as follows. In the early stages of monetization in Cameroon, total money supply consists almost entirely of currency and demand deposits or narrow money. The share of M₁ in total money supply is about 90 per cent in 1965. Over time, this drops significantly as savings deposits become
more and more important and by the mid-1980s, the two shares are roughly the same. The performance of the economy has deteriorated since the late-1980s. This has affected the ability to save, leading to a drop in the share of savings in total money supply.

Our next consideration is the index of the level of economic finance given by the level of broad money as a proportion of GDP. According to Heidhues and Weinschenck (op. cit.), this summarises the level of financial intermediation and reflects the range and diversity of financial instruments available to savers and the set of financing possibilities available to investors. For Cameroon, the authors note that the above index is well below those in countries with lower per capita income.

Time series data on the money multiplier in a given country serve as a guide to the extent to which base money has multiplied itself over time in that country. For our data, figure 1.3 below traces the evolution of the money multiplier defined as the ratio of the money supply to the monetary base for both M1 and M2.

The multiplier values are all above unity. This is consistent with the theoretical analysis given in the next chapter. Furthermore, the evolution of the multiplier suggests that the multiplier in Cameroon has not been constant. As discussed in the next chapter, the non-constancy of the multiplier is damaging to the multiplier theory of money supply. In particular, reliable predictions are unlikely to follow from non-constancy. However, it may be argued that what is required is that the multiplier relationship be stable which does not necessarily require constancy.
While figure 1.3 above traces the money multiplier, figure 1.4 below traces the evolution of the income velocity of circulation of money computed as the ratio of nominal income to the nominal supply of money. For both M1 and M2, velocity appears fairly stable prior to the 1980s. However, it is markedly variable after. This is not surprising as the 1980s in Cameroon have been considered by many commentators to be more turbulent in both economic and political terms than the 1960s and 1970s.
Figure 1.4 above appears to exhibit seasonal variation. This stems from potential seasonality in income/money from which velocity is derived. There are only two seasons in the tropics. The rainy season covers the period April to September while the dry season covers October to March. The former is usually a period of high activity while the latter is one of low activity because of heavy rainfall. In this thesis, the seasonality properties of the data are examined in chapter four.

Finally, we note that the neutrality proposition mentioned in the last section has a number of causality implications in relation to money. These are addressed in the next chapter.
1.7: Concluding Remarks

In this chapter, we have examined the characteristics of the monetary sector of Cameroon that may be important for money demand and associated causality. We have noted that these characteristics cannot be fully analyzed without recourse to open economy considerations as Cameroon is part of the Central African Monetary Union which is part of a wider CFA monetary zone within which exchange rates are fixed. The CFA zone has been shown to be imperfect in terms of the characteristics of an optimal currency zone.

Though exchange rate fixity is relevant within the CFA zone, the zone is nevertheless part of a world economy where flexible exchange rates also apply. France is the CFA member against which all other members have fixed their rates and its exchange rate is the channel through which flexible exchange rate effects are transmitted to CFA economies. Thus, for other CFA members such as Cameroon, exchange rate variability is exogenous in the traditional sense of being determined outside the system. It is in this limited sense that exchange rate variability effects are entertained in this thesis.

The monetary characteristics of Cameroon seen in this chapter reveal a familiar pattern associated with most developing countries. In particular, there is: (1) a large informal financial sector existing alongside the formal sector; (2) the institutional pegging of interest rates in the formal sector; (3) a limited array of financial assets. The narrowness of financial
assets imply the transactions approach to money demand is likely to predominate over the portfolio approach.

One important conclusion in this chapter is the lack of suitability of various empirical domestic opportunity cost measures for money holding in Cameroon. However, the analysis presented suggests money demand may be sensitive to some external opportunity cost measure such as the foreign interest rate adjusted if necessary for the expected depreciation of the exchange rate. The empirical analysis in this thesis employs either the French interest rate or the US interest rate adjusted for the expected depreciation of the exchange rate. The measure that performs better is to be preferred.

Bearing in mind the above conclusions, we now turn to the next chapter which is concerned with the theoretical framework for the empirical analysis of interest.
CHAPTER ONE NOTES

1.1: Initially, the CFA franc was pegged to the French franc at the rate of 0.5 CFA francs to one French franc. In 1968, France carried out a currency reform which resulted in the issuing of new French francs at the rate of one per hundred old French francs. The value of the CFA franc was left unchanged so that the exchange rate peg was adjusted to 50 CFA francs to one French franc.

1.2: Some authors such as Arize and Schwiff (1993) have used the real exchange rate in money demand analysis. Our motivation for using the nominal form arises from the theoretical discussion in the next chapter which is based on the expected depreciation of the nominal rate.
2.1: Introduction

In developing the theoretical framework for their study, Friedman and Schwartz (1982) note that every empirical study rests on a theoretical framework, on a set of tentative hypotheses that the evidence is designed to test. In this chapter, we follow this approach by developing the theoretical framework for our empirical analysis, bearing in mind the characteristics of the monetary sector of Cameroon discussed in the last chapter. As in that chapter, a significant proportion of our analysis is within an open economy context.

We start by examining in section two, traditional issues on money demand. Section three deals with open economy issues on money demand while section four is concerned with the money supply. Section five deals with additional perspectives which we consider useful for the conduct of our empirical analysis. In particular, attention is focused on the issues of money neutrality and price parity.

Finally, in section six, we draw a number of conclusions for the progress of the thesis.
2.2: Traditional Money Demand Considerations

It is important to note from the outset that critical to the theoretical analysis of money demand is the notion that an economic agent chooses to hold over a given period, a stock of money balances and does not merely happen to possess it. Consequently, this stock is perceived as a barren asset, assuming it does not earn interest.

A fundamental economic question then arises as to why any rational economic agent would want to hold a barren asset instead of an interest or profit yielding security. The answer to this question has been sought from a number of approaches.

Artis and Lewis (1991) note that in general there are two main approaches to money demand. One is the transactions approach which is derived from the medium of exchange function of money while the other is the asset or portfolio approach which is derived from the store of value function. The transactions approach reviewed here includes the precautionary approach to money demand assuming that such money is intended for transactions (if need arises).

For LDCs, Ghatak (op. cit.) notes that the transactions motive for holding money is supposed to dominate over other motives because of: (1) the limited size of the organised financial market; (2) the institutional pegging of interest rates; (3) the limited array of financial assets; (4) the limited degree of substitution between money and financial assets in comparison with the economically developed countries. As these
features were found to largely characterise our economy of interest, the transactions approach is emphasised in this thesis as noted in the last chapter. However, both the transactions and portfolio approaches are reviewed here because as shall be evident in due course, the money demand function used in the empirical analysis in this thesis can be considered as derived from a synthesis of both approaches.

A convenient starting point for transactions money demand theory is the classical quantity theory. It is generally regarded as concerned with the relationship between the money supply and the general price level. It has a number of formulations. However, the formulation that is generally regarded as having the ingredients of modern money demand theory is the Cambridge cash balance or the Marshall-Pigou formulation. It is based on a consideration of factors that may be important in influencing individual money demand where the real as opposed to the nominal quantity of money is emphasised. The main result is that the demand for nominal balances is formulated as being proportional to the level of nominal income as follows.

Denoting \( k = \frac{1}{v} \); where \( v \) is the income velocity of circulation of money or the average number of times that a unit of money changes hands in financing national output, money demand can be expressed as:

\[
M^d = kY = kyP \ldots \ldots (2.1);
\]

where \( M^d \), \( Y \), \( y \), and \( P \) are respectively nominal money demand, nominal output, real output, and the general price level. This
derivation is embedded in the classical economic framework where it is considered that institutional factors that determine \( v \) change rather slowly so that in the short run \( v \) can be treated as constant. Clearly, different manipulations are possible and the analysis can be expanded within the workings of the classical economic system. Overall, the analysis implies a transactions motive for money holdings. However, in the context of money demand, it comes short of explicitly incorporating the influence of the opportunity cost of money holding in the determination of money demand.

The classical approach to money demand has been modified by Keynes (1936) to include precautionary and speculative considerations. We have already dealt with transactions demand. Money held for transactions arising out of unforeseen contingencies is precautionary demand. Its consideration does not alter the form of money demand given above. The novelty here is speculative demand. We shall return to this later when we examine portfolio theory.

In much of the remainder of the discussion in this chapter, the domestic interest rate, \( R \), features in the analysis. As noted in the last chapter, a weakness of our empirical analysis is the absence of satisfactory data on this variable.

A number of authors have provided a rigorous inventory theory to transactions and precautionary demand. Unlike the classical approach above, use is made of the opportunity cost of money holding and the analysis is microeconomic rather than macroeconomic. Here, money is viewed as an inventory and its management is determined in the same way as that of any other
There are many studies that have been developed along the above line of reasoning. In what follows, our analysis is selective. In particular, we select key issues to illustrate salient features that may be important for our empirical study.

Starting with Baumol (1952), the main area of departure from the transactions theory presented above is that money balances held for transactions can be invested. At the simplest level, the main assumptions are as follows. Income is received once per time period and is spent evenly at discrete intervals during that period. There are two assets: money and an interest bearing security, say bonds. Bonds may be held in which case a known interest rate, R, is earned per period or money which earns no interest may be held. There are fixed brokerage costs, b, involved in making transfers between the two assets.

Given this scenario, the problem for the cost minimizing individual or firm is the optimal quantity of money to hold or demand in view of the brokerage (or transactions) costs involved. Considering the assumption that holding money incurs an opportunity cost in terms of interest forgone, one way that the individual may proceed is to hold bonds at the beginning of the period and to sell them off at discrete intervals to obtain money for transactions.

For the individual or firm seeking to minimize transaction costs, b, it can be shown that optimal money holdings are:

\[ M^d/P = 1/2[(2bT)/R]^{1/2} \ldots \ldots (2.2) \]
where $T$ is the real value of the volume of transactions, $R$ is the rate of interest, $b$ is the brokerage cost associated with effecting transfers between the two assets, and $Md$, $P$ are respectively nominal money demand and the price level.

Thus, the resulting money demand follows a square root rule which implies that transactions demand is negatively related to the interest rate with an elasticity of minus a half ($-0.5$) and positively related to real income with an elasticity of a half (0.5). The low income elasticity result is usually interpreted as suggesting economies of scale in money holdings. The empirical results in this thesis are loosely consistent with this finding.

Baumol (op. cit.) ignores integer constraints on the number of asset sales while Tobin (1956) rectifies this and finds it may not be worthwhile for some individuals to hold interest earning assets in which case their money demand is proportionate to lumpy income receipts.

Notice the inventory analysis so far implies money holdings are adjusted continuously and the assumptions imply the size and timing of expenditure plans are known with certainty. Miller and Orr (1966) assume uncertainty and adopt a stochastic framework. As noted by Goldfeld and Sichel (1990), this is a precautionary approach.

Results are similar to those above in suggesting economies of scale in money holdings. Goodhart (1989) notes that the most striking feature of this approach is that money demand is related to the variance as opposed to the level of transactions. Once again, the optimisation principle implies money balances are continuously adjusted.
The study by Akerlof and Milbourne (1980) is similar to Miller and Orr (op. cit.). The main deviation is that the monitoring of cash balances is by some constant target-threshold rule of thumb rather than by a formal optimisation principle. In their analysis, money balances are only adjusted when they reach an upper or lower target level. This implies that adjustment is not continuous. The main result here is that money demand is predicted to exhibit extremely low income elasticity.

The idea above that money balances may not be monitored continuously is also behind the buffer stock approach. Noticeably at the macroeconomic level, one interpretation relates to the possibility of disequilibrium in money holdings following the suggestion by Artis and Lewis (1976) that the stock of money actually held could be driven from its equilibrium level by exogenous shocks. According to Goodhart (op. cit.), the main objection to this line of approach to money demand is that the idea of disequilibrium runs contrary to the traditional economic thought whereby rational economic agents take immediate steps to eliminate disequilibria.

Critics of the inventory theories of money demand have questioned whether economic agents use formal optimisation principles in deriving the level of cash balances to be held. Furthermore, as noted by Cuthbertson (1985), the assumptions used are very restrictive.

Earlier, we mentioned that the novelty in the contribution made by Keynes (op. cit.) relates to speculative demand or the liquidity preference theory. It represents the origins of the portfolio approach to money demand.
Central to the liquidity preference theory is the existence of a rate of interest considered as normal for the individual. Expectations are also central and arise as a result of the individual having different opinions as to the future rate of interest. To proceed, let us assume that there are only two assets: money with a zero yield and bonds with \( R \) per cent yield where \( R \) is the current rate of interest. The individual's expectation about the future rate of interest denoted here \( R^e \) is known and independent of the current rate.

Given the above setting, the problem for the individual is whether to hold money or to invest in bonds knowing that there is a capital gain or loss, \( g \), associated with holding bonds. This capital gain or loss is given by:

\[
g = \frac{R}{R^e} - 1 \quad \cdots \quad (2.3).
\]

If \( R \) is such that \( R + g < 0 \), then only money will be held as holding bonds will involve a capital loss. On the other hand, \( R + g > 0 \) implies there is a capital gain to be made from investing in bonds. Under this condition, there is no reason why any money should be held. Consequently, only bonds are held. This can be expressed for the individual in terms of a normal value of the interest rate:

\[
R^e = \frac{R^e}{(1+R^e)} \quad \cdots \quad (2.4);
\]

so that if \( R \) is greater than \( R^e \), only bonds are held and if \( R \) is less than \( R^e \), only money is held.
It can be said that if the rate of interest is expected to rise above that considered as normal, the individual will prefer to hold money rather than bonds. However, what is considered as normal is subjective. Consequently, different individuals will have different normal rates of interest. This leads in aggregate to a negative relationship between money holdings and the prevailing rate of interest.

As noted already, a major implication of the above theory is that the asset holder either holds bonds or money and a mixture of them is ruled out. This is at odds with real world observation which in general is one of portfolio diversification.

Tobin (1958) develops a theory of portfolio diversification where the problem for the individual is to determine that combination of money and bonds holding that maximises return and risk knowing that less bonds holding means less risk at the cost of a reduction in expected interest rate return.

The main finding here is that the proportion of individual wealth held in the form of money varies directly with bonds riskiness and inversely with the rate of interest.

Friedman (1956) argues that the demand for money should be treated like that for any other good that yields utility to its owner. As shall be evident below, this approach can be considered as a synthesis of many of the ideas seen so far. The traditional theoretical basis for the empirical money demand analysis in this thesis can be viewed as largely derived from this unifying approach, where transactions aspects are emphasised.

More specifically, Friedman (op. cit.) argues that money is only one form that economic agents would choose to hold their
wealth and as such, its demand can be analyzed using value theory in exactly the same way as any other good that produces a flow of services to its holder. The basic analysis here can be summarized by this quotation from Friedman (op. cit., p. 4):

"The analysis of the demand for money on the part of the ultimate wealth-owning units in the society can be made formally identical with that of the demand for a consumption service. As in the usual theory of consumer choice, the demand for money (or any other particular asset) depends on three major sets of factors: (a) the total wealth to be held in various forms—the analogue of the budget restraint; (b) the price of and return on this form of wealth and alternative forms; and (c) the tastes and preferences of the wealth-owning units."

Friedman (op. cit.) defines the stock of wealth in a broad sense comprising both human and non-human wealth and representing all flows of income sources or consumable services. The rate of interest is seen as relating the total flow of incomes to the stock of wealth. Several forms in which wealth can be held are distinguished, namely: money, bonds, equity, physical goods, and human capital. The allocation of total wealth between these forms depends on their relative returns.

Money yields two returns. One is in kind due to the services that are associated with its holding. The other is the real yield which comes about as a result of changes in the price level. A rise in the price level implies a fall in the real value of
nominal balances and vice versa. Therefore, the demand for nominal balances is a function of the price level.

A bond is a fixed claim which yields a perpetual income with a constant nominal value. The return on it is the associated amount of nominal income and any change in the price of the bond over time.

An equity is viewed in a similar vein as a bond with the difference that it yields a perpetual stream of income with a constant real value. The return on it is the nominal return as in the case of a bond but with further adjustment for price changes and any change in the nominal price of the equity over time.

A physical good yields a return in kind from the flow of its services as well as a nominal return in the form of any appreciation or depreciation over time in its monetary value.

The yield on human wealth is however problematic to conceptualise owing to the fact that it is not readily measurable in the absence of a market for it. Instead Friedman (op. cit.) replaces it by the ratio of human to non-human wealth where the prediction is that the higher the human component of total wealth, the higher would be the demand for money.

Finally, changes in tastes and preferences are deemed to affect the individual's demand for money.

The above returns on the forms in which wealth can be held other than money are said to constitute the opportunity cost of holding money.

Friedman (op. cit.) also demonstrates that money demand is homogeneous of degree one in prices and incomes: a result largely
refuted in our empirical analysis as indicated in the last chapter.

It is important to stress that the above analysis refers to individual wealth holders. Friedman (op. cit.) shows that firms may face different constraints but this recognition does not change the general thrust of the analysis above.

To conclude, the synthesis above has come to be interpreted that the demand for money in nominal terms is a function of: the price level, a budget constraint or scale variable, and some opportunity cost variable(s). Alternatively, assuming price homogeneity, the interpretation is that the demand for money in real terms is a function of a budget constraint and some opportunity cost variable(s).

This general interpretation allows money demand analysis to be simplified for a given empirical exercise. For example, the budget constraint need not be measured strictly by wealth since for many countries, including ours, wealth statistics are not available. This definition also gives allowance for concepts that do not have any meaningful empirical counterparts such as human wealth and tastes and preferences to be ignored in an empirical exercise, as is the case in this thesis.

So far, the analysis has been conducted as if open economy issues did not matter. As the empirical review in the next chapter shows, open economy issues can be important for small open economies like Cameroon. For this reason, in the next section, we shall augment the discussion in this section to include open economy issues.
2.3: Open Economy Money Demand Considerations

In an open economy, wealth can be held in domestic and/or foreign forms. When the residents of a country invest in a foreign country in alternative assets, excluding money, capital mobility is said to occur. On the other hand, currency substitution occurs when they hold the currency of another country. Mckinnon (1982) notes that currency substitution could occur indirectly involving non-money assets. However, this type of currency substitution is unlikely to be important for the economy of interest here because of the narrowness of its financial market.

In what follows, we shall examine money services and portfolio considerations. In the portfolio approach, both capital mobility and currency substitution are analyzed together while the money services approach is intrinsically concerned with currency substitution.

To motivate the next stage of our analysis, we shall assume that the home country is small and open, implying that it cannot influence asset or goods prices in the rest of the world. This assumption is consistent with the characteristics of Cameroon discussed in the last chapter. Also, we shall assume that its currency does not circulate in the rest of the world. An implication stemming from this is that the phenomenon of currency substitution is asymmetric with relevance only for the small country. This is the context in which currency substitution is investigated in this thesis. Furthermore, we shall assume that
there are four types of assets in which wealth can be held, namely: domestic money, foreign money, domestic bonds, and foreign bonds.

Measuring the response of money demand to currency substitution and/or capital mobility is very controversial and not clear-cut. In what follows, we shall be mostly interested in issues that we consider relevant for the conduct of the empirical analysis in this thesis. In particular, we shall be interested in the roles of the foreign interest rate and/or the expected depreciation of the exchange: two open economy measures that feature in our empirical analysis.

To examine the money services approach, it is usual to assume that money holders diversify their cash balances in two stages. In the first stage, wealth is divided between money (both domestic and foreign) and other assets (bonds for example). This stage therefore, separates money where questions may arise concerning currency substitution from other assets where questions may arise concerning capital mobility. Having made this separation, the second stage is exclusively concerned with money where the issue of substitutability between domestic and foreign money is addressed. This stage constitutes the main concern of the money services approach and seeks to answer the question of optimal holding of domestic and foreign money balances.

Following Miles (1978), both domestic and foreign money can be regarded as inputs in a production function whose output can be viewed in terms of a stream of monetary services. According to Marquez (1992), the optimal balance between foreign and domestic money is achieved by changing money balances until the
gains in monetary services equal their opportunity cost.

In terms of production function, the optimal balance is achieved when the marginal product of each money equals its rental cost as measured by the associated rate of interest. If any of the associated rates of interest changes, there would be substitution between the two monies. An increase in the foreign interest rate would raise the cost of using foreign money so that, 

**ceteris paribus**, individuals substitute out of foreign money into domestic money and the question of interest relates to the extent of the monetary substitution effect. Notice that in this approach, exchange rate considerations do not feature explicitly in the determination of currency substitution.

However, some controversy surrounds this approach and can be traced to the works of Miles (op. cit.) who uses a constant elasticity of substitution production function in his analysis. In particular, denoting: (1) MS as the level of money services, (2) \( \alpha_1, \alpha_2 \) as weights reflecting the efficiency of domestic and foreign real money balances in producing money services, (3) \( \rho \) as the substitution parameter, the production function used can be written thus.

\[
\frac{MS}{P} = \left[ \alpha_1 (M/P)^{-\rho} + \alpha_2 (M_f/P_f)^{-\rho} \right]^{-(1/\rho)} \ldots \ldots (2.5);
\]

where M is domestic money, \( M_f \) is foreign money, P is the domestic price level, and \( P_f \) is the foreign price level. According to Miles (op. cit.), since real balances in both currencies are in goods terms, there is no need for an exchange rate, but for the purpose of empirical estimation, it is desirable to express the
function in terms of nominal cash balances and the exchange rate. In the first instance, he defines the exchange rate \( E = P/P_f \) from purchasing power parity and sets \( P = 1 \) so that the production function of interest becomes:

\[
MS = [\alpha_1 M^p + \alpha_2 EM_f^p]^{-(1/p)} \ldots \ldots (2.6).
\]

Furthermore, assuming the private sector holds \( M^* \) cash balances, he defines an asset constraint of the form:

\[
M^*/P = M/P(1+R) + M_f/P_f(1+R_f) \ldots \ldots (2.7);
\]

where \( R \) and \( R_f \) are respectively the domestic interest rate and the foreign interest rate. Introducing the exchange rate from purchasing power parity and setting the domestic price level to unity as before, the asset constraint is rewritten:

\[
M^* = M(1+R) + EM_f(l+R_f) \ldots \ldots (2.8).
\]

Maximising the production function under the asset constraint and applying the log operator, Miles (op. cit.) gets this expression.

\[
\log(M/EM_f) = 1/(1+\rho)\log(\alpha_1/\alpha_2) + 1/(1+\rho)\log[(1+R_f)/(1+R)] \ldots \ldots (2.9).
\]

Denoting \( \beta_0 = 1/(1+\rho)\log(\alpha_1/\alpha_2) \) and \( \beta_1 = 1/(1+\rho) \), (2.9) becomes:

\[
\log(M/EM_f) = \beta_0 + \beta_1\log[(1+R_f)/(1+R)] \ldots \ldots (2.10)
\]
The specification above has been criticised by a number of authors on grounds of mis-specification. For example, Bordo and Choudhri (1982) note that it is not clear the parameter $\beta_1$ represents a measure of the elasticity of currency substitution. According to Pentecost (1993), the argument is that if the foreign interest rate rises for example, domestic residents may switch from both domestic and foreign money into foreign bonds, so that the elasticity of substitution may, at least in part, reflect substitution between foreign bonds and foreign money rather than simply currency substitution.

Bordo and Choudhri (op. cit.) demonstrate that testing whether the expected exchange rate change (exchange rate depreciation) is a significant determinant of domestic money demand constitutes a valid test for currency substitution. Arango and Nadiri (1981) note that wealth holders evaluate their portfolio in terms of home currency, so that if the domestic currency is expected to depreciate, *ceteris paribus*, domestic wealth holders will substitute foreign for domestic currency and in so doing, reduce their domestic money holdings. Thus, the prediction is that if the exchange rate is expected to depreciate, this would lead to a reduction in domestic money holdings.

The empirical specification suggested by Miles (op. cit.) uses both domestic and foreign interest rates. As satisfactory domestic interest rate data are not available for Cameroon, currency substitution is not examined in our empirical analysis from interest rate considerations. Rather, we follow the suggestion by Bordo and Choudhri (op. cit.) which relates to
testing the statistical significance of the expected depreciation of the exchange rate. This approach requires exchange rate variability. Consequently, for Cameroon, it is only relevant in the wider world context where flexible exchange rates apply and not in the CFA fixed exchange rate zone.

In view of the discussion above, in our empirical analysis, a negative relationship is predicted between money holdings in Cameroon and the expected depreciation of the CFA exchange rate. Our exchange rate is defined in terms of CFA francs per US dollar so that an increase implies a depreciation of the CFA franc. As noted in the last chapter, in terms of the expected depreciation of the exchange rate, we do not find currency substitution to be a significant determinant of money demand in Cameroon.

Currency substitution as suggested by Bordo and Choudhri (op. cit.) is commonly analyzed within the portfolio approach where capital mobility issues are also addressed. In this approach, there is no division between money and bonds as assumed in the money services approach. Here, money is viewed as an asset which is a gross substitute for all other assets.

According to Marquez (op. cit.), the portfolio approach to currency substitution treats money as a non-interest-bearing asset that individuals hold because it facilitates commercial transactions. The convenience of holding domestic money, assuming it does not earn interest, entails opportunity costs given by:

1. \( R \), the rate of return on domestic bonds,
2. \( R_f + \Delta E^e \), the rate of return on foreign bonds,
3. \( \Delta E^e \), the rate of return on foreign money.

where, \( R \), \( R_f \), and \( \Delta E^e \) are respectively the domestic interest rate, the foreign interest rate, and the
expected depreciation of the domestic exchange rate. Wealth maximization suggests that asset holders would trade convenience for return and risk by continuously balancing their portfolio of monetary and non-monetary assets. To keep the analysis simple, we have ignored the specification of risk.

As noted already, the rate of return on domestic bonds, $R$, or the domestic interest rate is absent in the empirical analysis in this thesis due to the absence of satisfactory data.

The rate of return on foreign money, namely: $\Delta E^e$ or the expected depreciation of the domestic exchange rate has been interpreted earlier in terms of currency substitution where we commented on its role in our empirical analysis.

The rate of return on foreign bonds, namely: $R_f + \Delta E^e$, is usually interpreted in terms of capital mobility. An increase in this variable would generally imply the opportunity cost of holding domestic money increases, consequently, domestic money holdings are reduced as a result. Notice that the return on foreign bonds here is given as a composite term defined in terms of the foreign interest rate adjusted for the expected depreciation of the (domestic) exchange rate. The overall effect of an increase in the composite term is generally considered to lead to reduced money holdings because the effect of an increase in either of its component terms would generally lead to reduced money holdings as follows.

Firstly, we have already seen that an increase in $\Delta E^e$, or the expected depreciation of the domestic currency would generally lead to a reduction in domestic money holdings. Secondly, an increase in the foreign interest rate would
generally lead to a decrease in domestic money holdings because, *ceteris paribus*, it becomes more attractive to hold foreign bonds at the expense of other assets including domestic money holdings.

As noted in chapter one, when capital mobility considerations lie in the wider world context, exchange rate variability is important for Cameroon and the foreign interest rate is chosen from the USA for consistency with the definition of the exchange rate with respect to this country as the foreign country.

However, when capital mobility interests lie within the CFA zone, exchange rate variability is zero and the foreign interest rate is the sole variable used. In this case, France is chosen as the foreign country. It is predicted that if the rate of interest on bonds in France or the French rate of interest increases for example, it becomes more attractive for residents in Cameroon to hold more French bonds. On the other hand, *ceteris paribus*, they can only hold more French bonds by reducing their holdings of other assets which include domestic money. The same reasoning would apply to US bonds with the additional adjustment for the expected depreciation of the exchange rate.

Hence, in our empirical analysis, a negative relationship is predicted between domestic money holdings and the French interest rate or the US interest rate adjusted for the expected depreciation in the exchange rate.

From an empirical point of view, it is apparent from the analysis so far that the concepts of currency substitution and capital mobility are not clear-cut. In what follows, we shall use an empirical specification to demonstrate this claim.
Ignoring the disturbance term and denoting: (1) real money demand as \( m \); (2) real income as \( y \); (3) the domestic interest as \( R \); (4) the foreign interest rate as \( R_f \); (5) the expected depreciation of the exchange rate as \( \Delta E^e \); a familiar open economy empirical form first employed by Cuddington (1983) is:

\[
m = a_0 + a_1 y - a_2 R - a_3 (R_f + \Delta E^e) - a_4 \Delta E^e - a_5 m_{t-1} \cdots \cdots (2.11);
\]

where \( a_0 \) is a constant term and \( a_i \), \( i = 1,...,5 \) are parameters. The parameters \( a_3 \) and \( a_4 \) are usually interpreted respectively as measuring capital mobility and currency substitution. The specification above raises a number of problems.

Firstly, because both capital mobility and currency substitution parameters are linked either partly (in the case of capital mobility) or totally (in the case of currency substitution) to \( E^e \), ambiguity is bound to be in the interpretation of the parameters.

Secondly, the above specification is potentially problematic in econometric sense. For example, Cuddington \((op. cit.)\) acknowledges that if domestic and foreign interest rates are highly correlated, then there is a potential multicollinearity problem. Of course, we do not have this problem in our empirical analysis due to the absence of domestic interest rates. On the other hand, this introduces a potential omitted variable problem.

To conclude this section, it is important to stress that the ambiguity associated with the testing of currency substitution and capital mobility means that caution should be exercised in interpreting the empirical results in this thesis.
2.4: Money Supply

In econometric terms, it is often argued that the identification of the demand relationship for an item depends at least on the nature of the associated supply relationship and that the demand for money relationship is not an exception. This implies that even if we were interested solely in an analysis of money demand, that of the money supply would not be completely ignored, hence the discussion that follows.

The starting point in the theoretical discussion of the money supply is often the multiplier. The analysis below indicates that the multiplier approach is not appropriate for the determination of the money supply in Cameroon because it assumes that the money supply is exogenous. Our analysis imply the money supply in Cameroon would be endogenous.

To motivate the discussion here, let us define: (1) money, \( M \), as the amount of notes and coins in circulation with the non-bank public, \( C_p \), plus the value of bank deposits, \( D \); (2) the monetary base or high-powered money, \( H \), as bank reserves, \( R \), consisting of bankers' balances with the central bank, \( B_b \), and vault cash, \( C_b \), plus cash held by the public, \( C_p \), which is considered to be eligible as bank reserves. Alternatively, these statements can be written as the following identities.

\[
M = D + C_p; \quad H = R + C_p; \quad R = B_b + C_b \quad \ldots \ldots (2.12).
\]

Furthermore, let us assume that non-bank holdings of cash
are a proportion, \( c \), of bank deposits, that is, \( c = R/D \), and the banks' reserve ratio are a proportion, \( r \), of bank deposits, that is, \( r = Cp/D \). Given these conditions, the multiplier, \( m \), is often conceived as the ratio of the money stock, \( M \), to the monetary base or high-powered money, \( H \). In terms of the expressions just given, it can be written as:

\[
m = \frac{M}{H} = \frac{1 + c}{r + c} \quad \ldots \ldots (2.13).
\]

According to this expression, an increase in high-powered money or a fall in the reserve ratio and/or currency ratio will, \textit{ceteris paribus}, lead to an increase in the money supply. Conversely, a decrease in high-powered money or a rise in the reserve ratio and/or currency ratio will, \textit{ceteris paribus}, lead to a decrease in the money supply. In an open economy, high-powered money, \( H \), is the sum of domestic credit, \( DC \), and foreign exchange reserves, \( FR \). This means that, from a multiplier framework, the money supply in an open economy can be written:

\[
M = m(DC + FR) \quad \ldots \ldots (2.14).
\]

The value of the multiplier is always equal or greater than one by virtue of the fact that base money cannot be greater than total money itself. In this respect, the results of the multiplier values calculated for Cameroon in the last chapter are consistent with this remark.

\textit{Papademos and Modigliani} (1990) show that so long as the supply of money, whether narrow or broad, is a well defined
multiple of a financial aggregate controllable by the central bank, the size of the multiplier is fundamentally determined by the fact that reserves maintained by banks are a fraction of their deposits. In this case, the banks respond to an increase in reserves created by the central bank by creating additional deposits equal to a multiple of that increase.

Thus, it is possible to formulate different and perhaps more complex versions of the multiplier which still have the basic ingredient that the money stock is some fixed proportion of the monetary base. A major implication of the multiplier approach is that the money supply is exogenously determined. There are a number of criticisms of this approach which are relevant to Cameroon.

Stevenson et al (1988) note that although the supply of the monetary base is under the control of the monetary authorities in the sense that it comprises the liabilities of the central bank, in reality, the actions of the monetary authorities in controlling the monetary base may affect, say interest rates, prices, or incomes in a manner which feeds back into the budget identity. A common version of this identity states that the stock of monetary base is increased by fiscal deficits, balance of payments surpluses, and central bank lending to the monetary sector on one hand and reduced by (net) open market bond sales to the private sector as well as balance of payments deficits and fiscal surpluses on the other hand.

Under a fixed exchange rate regime such as the one of interest in this thesis, the price of foreign currency in terms of domestic currency is fixed and can only be altered by
devaluation or revaluation. The monetary authorities are thus committed to buying and selling foreign exchange at a fixed price. Under such a setting, a balance of payments deficit is an additional channel which the authorities have to finance. Given the budget identity, this deficit implies a decrease in high-powered money and thus the money supply. In the case of a surplus, residents sell foreign currency for home currency and, ceteris paribus, this ultimately leads to an increase in the money supply.

The authorities can sterilise or neutralise the effects of balance of payments deficits (surpluses) through open market operations by buying (selling) bonds from (to) the public. In doing so, they would try to bring about changes that are identical in magnitude but opposite (in sign) to the change in the money supply. The narrowness of the money market in Cameroon implies open market operations are likely to be of limited significance: a point stressed in the last chapter.

Overall, it is doubtful whether the monetary authorities in any country can sterilise significant balance of payments deficits or surpluses in the long run. The implication here is that under a fixed exchange rate system, the money supply is no longer at the control of the monetary authorities. Under these circumstances, a familiar interpretation is that the money supply becomes largely endogenous and adjusting largely to money demand.

High-powered money and hence the money supply would also become endogenous if the authorities were to pursue a policy of interest rate targeting. That is, the authorities cannot determine simultaneously the level of interest rates and that of
the money supply. This is the familiar monopolist dilemma where either the price or the quantity of a product is controlled by the monopolist but not both. Overall, there is no guarantee that an interest rate target would be successful. For example, if interest rates are driven upwards, they may instead stimulate an increase in the money supply if they reduce the currency ratio and fail to reduce the amount of credit.

In general, the multiplier theory which depicts the money supply determination as an exogenous process relies on the constancy (or more appropriately the stability) of the reserve and currency ratios to be useful as a policy tool. However, these ratios may not be constant or stable. We shall use a number of examples to illustrate this point.

To start with, bank reserves are customarily non-interest bearing so that an increase in the interest rate imposes increased opportunity costs on holding reserves. In this case, it is logical to expect the reserve ratio $r$ to vary inversely with the rate of interest. Furthermore, the reserve ratio may depend on the composition of bank liabilities. Take for example, the composition of these liabilities between sight and time deposits. Given that the former may be more variable in terms of day to day withdrawal, Stevenson et al. (op. cit.) note that banks may choose to maintain a higher reserve ratio against these deposits in contrast to time deposits. In such a setting, if the composition of deposits changes, the overall reserve ratio would be affected.

Recall from the last chapter that rediscounting is a major monetary policy tool in Cameroon. The existence of this practice
reduces the demand for precautionary or excess reserves. If the discount rate is increased, it becomes more costly for banks to use the rediscount facility. Consequently borrowed reserves of high-powered money may be expected to vary inversely with the discount rate.

Interest rates can also affect the currency ratio. In particular, in the face of rising interest rates, the public would attempt to economize on its holding of cash. This implies the currency ratio would like the reserve ratio be inversely related to the rate of interest. Thus, the money supply would be positively related to the rate of interest as \( r \) and \( c \) are inverse functions of the rate of interest.

Another consideration that may affect the multiplier relates to real income/wealth. According to Papademos and Modigliani (op. cit.), an increase in the level of real income will have a positive effect on the multiplier if its effects on both the currency and time deposit ratios are negative as would normally be the case.

Thus, the contention that the money supply is exogenous as implied by the multiplier theory is questionable as the discussion above shows. In fact, portfolio theorists consider the money supply as an endogenous entity determinable via the portfolio adjustments of the public, banks, non-bank financial institutions as well as the actions of the monetary authorities. Here, the rate of interest is likely to be a key variable in determining portfolio adjustment. On the other hand, such a general portfolio approach as a reasonable theory for explaining the determination of the money supply in Cameroon is questionable
Our next objective is to relate money supply determination to demand. According to Friedman (1992), the factors that determine the money supply determine the nominal and not the real quantity of money. The real quantity of money is the outcome of the interaction between the nominal quantity supplied and the real quantity demanded. In the process, changes in real money demand have feedback effects on variables determining the nominal quantity supplied and changes in the nominal quantity supplied have feedback effects on variables determining the real quantity demanded. The feedback effects are relatively minor so that the nominal quantity of money supplied can be generally regarded as determined by a set of variables that are distinct from those that affect the real quantity demanded.

The problem with the above analysis is that there is no guarantee that feedback effects will be minor. Thus, the money supply may be determined by the same factors that determine money demand: the empirical consequence being the identification problem. For our purpose, the empirical technique of co-integration adopted in this thesis is used to address this issue. In particular, in our co-integration analysis, a set of variables deemed to constitute money demand variables but which may nevertheless constitute money supply variables are analyzed. A single co-integrating vector is uncovered. When normalized on money, the corresponding estimates appear more consistent with those conventionally identified with money demand.

The determination of the money supply is not only important for money demand analysis but is germane to any general analysis due to the narrowness of the financial market.
of the monetary sector of an economy as shall be evident in the next section which deals with additional open economy perspectives that may be useful for our empirical analysis.

2.5: Other Perspectives

The concepts of price parity: purchasing power parity (PPP) and interest rate parity (IRP) as well as money neutrality were alluded to in chapter one without proper consideration as to their meanings and perhaps the extent to which they may or may not be relevant to the empirical analysis of interest. The analysis that follows is intended to address this shortcoming.

The definition of PPP follows directly from the law of one price which states that the price of a given product in all markets shall be the same after allowing for transport costs and tariffs. There are two definitions of PPP: absolute and relative. The absolute version states that the general level of prices when converted into a common currency, will be the same in all countries. On the other hand, the relative version states that one country's inflation rate can only be higher (lower) than another country's to the extent that its exchange rate depreciates (appreciates). For a fixed exchange area such as the CFA zone, this reduces to a statement about equalization of inflation rates.

Officer (1976) notes that the main uses of PPP relate to the conversion of data from one national currency to another and as
a theory of exchange rate determination. As these are not of relevance to this thesis, we shall not dwell on them here.

The mechanism that ensures PPP is arbitrage whereby profit maximising agents buy from an area where the price of a product is low and sell where it is high. Arbitrage is thought to be most effective in well integrated markets.

On the other hand, as we discussed in the last chapter, the open economy CFA zone which is of immediate interest in this thesis is not well integrated. For this reason, we may reasonably expect price differentials to persist within the zone even beyond the short run. For example, the stationarity test results in chapter four suggest that prices in Cameroon have different time series properties from those in France. An interpretation of interest here is that PPP does not hold between the two countries.

At a more general level, the main striking criticism of PPP relates to the problem of non-tradeable goods and aggregation. In particular, PPP ignores non-tradeable goods and is of little empirical significance to the extent that if it were to hold across countries, there would be no robust way of knowing this directly as it is not possible to construct a price index that includes all commodities. More generally, Officer (op. cit.) notes that even if all commodities were represented, additional problems would arise as the weighting pattern used to construct the general price level is unlikely to be the same across countries.

Interest rate parity (IRP) can be perceived as a version of price parity in relation to interest rates. As with PPP, there
are two forms: one is said to be covered and the other uncovered. The covered form states that the domestic interest rate must be lower (higher) than the foreign interest rate by an amount equal to the forward premium (discount) on the domestic currency where the forward premium (discount) is the proportion by which a country's forward exchange rate exceeds (falls below) its spot rate. The uncovered form states that the domestic interest rate must be higher (lower) than the foreign interest rate by an amount equal to the expected depreciation (appreciation) of the domestic currency. In case of fixed exchange rates, this reduces to a statement about the international equalization of interest rates.

In view of the fact that IRP is still price parity, the criticisms above that apply to PPP largely apply to it. For example, capital immobility would reduce the general applicability of IRP just as non-traded goods do in the more general PPP case.

This leads us to the question of capital mobility within the CFA zone. Although by agreement capital is supposed to be completely mobile within this area in all forms, the low integrated nature of the area means that in practice the scope and size of arbitrage would be much reduced.

Furthermore, the provision of interest rate instruments in the area is asymmetric. For example, many of the instruments found within the French economy are not available in the other CFA states. In this case, France is like a monopoly state within the zone. Consequently, it is not unreasonable to expect interest rate differentials within the zone.
Another objection to IRP relates to the existence of risk and uncertainty. The risk and uncertainty element in investment varies across countries. For developing countries, this is usually considered to be high. If risk and uncertainty are unevenly distributed across countries, there would be no *a priori* reason to expect IRP to hold.

Kenen (1989) notes that if money is neutral, then PPP holds. As noted by Harris (1981), money neutrality is a theoretical problem that is implicitly or explicitly central to all analyses of the role of money in the economy.

The proposition that money is neutral can be stated in two forms. The weak or conventional form is simply known as the neutrality proposition while the strong form is known as the super-neutrality proposition. Our definition of both forms is adapted from Orphanides and Solow (1990). Money is neutral if a change in the level of nominal money does not affect real variables while it is super-neutral if a change in its growth rate has no effect on the same variables. Consequently, the use of data in first log differences or growth rates in the empirical Granger-causality analysis in this thesis imply super-neutrality considerations.

Blanchard (1990) emphasises that the neutrality proposition of money hinges on price flexibility. Furthermore, he notes that even with competitive markets, full information and flexible prices, this proposition is only an approximation. For a less integrated and competitive economy such as that of interest in this thesis, the proposition would be less of an approximation when compared to the more advanced countries.
Orphanides and Solow (op. cit.) note that money seems to have effects in the short run and that this much seems to be well established. A similar conclusion is made by Brunner (1992) who contends that short run variations in monetary growth contribute to variance in economic activity and long term monetary growth determines approximately the inflation rate in the long run. In this case, it may be reasonable to consider the generation of output for the economy of interest here as independent of monetary factors only in the long run: a typical classical view.

Investigations on money neutrality have often centred on the causality implications amongst money, incomes, prices, and occasionally interest rates. If the effects of money on output are neutral, then the argument runs that at least in the long run, changes in the money stock will be reflected only in the price level.

Thus, if the neutrality proposition is valid for Cameroon, in our empirical analysis, we would conjecture causation to run from money to prices and not from money to real income. This does not preclude the possibility of causation running from income to money or the so called reverse causation. In any case, the causality tests in this thesis are very general in that they test for all "reasonable" causality flows between the variables. We shall return to some of these issues in the empirical chapter on Granger-causality.

The main conclusion here is that the issue of money neutrality is a controversial one. It appears, as with many controversial issues in economics, empirical research can only shed light on the issue but not definitely resolve it.
2.6: General Considerations and Conclusions

We began this chapter by considering the concept of money demand. Our analysis led to the conclusion that, assuming price homogeneity, it can be considered as a functional relationship between real money holdings, some budget constraint, and some opportunity cost variable(s). Potential opportunity cost variables were considered from both closed and open economy perspectives.

From a closed economy perspective, the domestic interest rate featured in much of our analysis. However, as noted in chapter one for example, this variable is absent from our empirical analysis due to the absence of satisfactory data, implying that caution should be exercised in the interpretation of our empirical results.

From an open economy perspective, the theoretical analysis examined in this chapter suggests that for a small open economy like Cameroon, the standard closed economy money demand function should be augmented to include the expected depreciation of the exchange rate which can be interpreted as a measure of currency substitution and the foreign interest rate adjusted, if necessary, for the expected depreciation of the exchange rate which can be interpreted as a measure of capital mobility.

The question of demand is intrinsically related to that of supply as often discussed under the question of identification. Consequently, the next stage of the analysis in this chapter involved theoretical considerations relating to the money supply.
The traditional multiplier approach was discussed and found to be inadequate as a tool for explaining the money supply process in Cameroon because it assumes that the money supply is exogenous. For a small open economy with fixed exchange rates like Cameroon, the money supply process would be endogenous, thus responding largely to demand.

The final set of issues considered in this chapter concerned a number of additional theoretical perspectives that may be useful for the conduct of the empirical analysis of interest. In particular, we discussed the issue of money neutrality and purchasing power parity. We concluded that purchasing parity may not hold in the CFA zone, even in the long run, because of low economic integration within the zone.

Given the above conclusions, we now turn to the next chapter which is concerned with a review of past empirical studies that may be relevant for the conduct of our empirical analysis.
3.1: Introduction

As noted in the introduction of this thesis, a useful requirement for empirical analysis is the need to be informed of various aspects of past relevant empirical knowledge. This chapter is an attempt to fulfil this requirement. In particular, it is designed to critically evaluate past relevant empirical research so as to uncover current research directions that may be relevant to us.

The literature on empirical money demand and/or causality is enormous and a comprehensive treatment is not intended here. We shall limit our treatment to the African context where our economy of interest is situated, while relating results where possible to other studies in the wider world context. Nevertheless, even within our chosen limits, the discussion here embodies a large amount of diversity reflected in terms of: (1) geographical areas examined; (2) empirical counterparts of theoretical variables used; (3) time periods covered; (4) constraints and assumptions imposed; (5) empirical techniques used; (6) results obtained.

Section two of this chapter focuses on empirical money
demand studies in the African context that have employed the traditional partial adjustment mechanism. Section three is concerned with those that have employed the more recent concepts of error correction and/or co-integration. Causality studies are given attention in section four.

Finally, in section five, a number of conclusions and implications relating to this chapter are drawn for the conduct of the remainder of the thesis.

3.2: Partial Adjustment Studies

We shall first outline the partial adjustment specification which is common to the studies reviewed here. Following Fair (1987), supposing we stipulate that the long run desired level of real money balances, $M_t^*/P_t$, is a function of real income, $y_t$, and interest rate, $r_t$, where all the variables are in logs for simplicity. This may be written:

$$ M_t^*/P_t = \alpha + \beta y_t + \gamma r_t \ldots \ldots (3.1); $$

where $\alpha$ is an intercept, while $\beta$ and $\gamma$ are parameters.

Suppose adjustment of actual to desired money balances is in real terms, then the corresponding partial adjustment equation may be written:

$$ M_t/P_t - M_{t-1}/P_{t-1} = \lambda(M_t^*/P_t - M_{t-1}/P_{t-1}) + \epsilon_{1t} \ldots \ldots (3.2); $$
where $\lambda$ is a parameter and $\epsilon_{1t}$ is an error term.

On the other hand, suppose adjustment is in nominal terms and $\epsilon_{2t}$ is the relevant error term, then the corresponding partial adjustment equation is:

$$M_t = M_{t-1} = \lambda (M^*_t - M_{t-1}) + \epsilon_{2t} \ldots \ldots (3.3).$$

Combining (3.1) and (3.2), we get:

$$M_t/P_t = \lambda \alpha + \lambda \beta y_t + \lambda \gamma x_t + (1-\lambda)(M_{t-1}/P_{t-1}) + \epsilon_{1t} \ldots \ldots (3.4).$$

Combining (3.1) and (3.3), we get:

$$M_t/P_t = \lambda \alpha + \lambda \beta y_t + \lambda \gamma x_t + (1-\lambda)(M_{t-1}/P_t) + \epsilon_{2t} \ldots \ldots (3.5).$$

In the above specifications, equation (3.4) is the real partial adjustment specification and differs from equation (3.5) which is the nominal adjustment specification by the lagged money term $M_{t-1}$. In the real specification, $M_{t-1}$ is divided by $P_{t-1}$ while in the nominal specification, $M_{t-1}$ is divided by $P_t$ only.

According to Fair (op. cit.), preference for either of the adjustment hypotheses may be tested by including both lagged money variables in the equation for estimation and choose that which is statistically (more) significant. However, a more robust approach to discriminate between the hypotheses would be to employ non-nested tests.

Before we review the relevant studies in this section, three comments are necessary. Firstly, we note that though there
are a number of money demand studies in the African context prior to the late 1980s, they are generally characterised by short sample sizes, hence the problem of insufficient degrees of freedom. Three examples are Tomori (1972) and Teriba (1974) on Nigeria and Pathak (1981) on Kenya. It is only in the latter part of the 1980s that studies with reasonably long sample sizes began to appear.3.1 Our review is based on the latter group of studies.

Secondly, in view of the emphasis placed on open economy issues in this thesis, the review in this and subsequent sections shall be mainly concerned with open economy studies.

Finally, the review in this and subsequent sections shall not be particularly concerned with South Africa, though it has a rich empirical money demand literature, because part of its economic structure does not fit neatly into the developing nature of the other African economies.

Given the comments above, the first study reviewed in this section is Darrat (1985). This is based on Kenya. Quarterly data for the period 1968 to 1978 are used. Both M1 and M2 definitions of money are employed. The scale variable is GNP. Its quarterly magnitudes are interpolated from annual ones.3.2 Prices are given by the CPI. The opportunity cost of holding money is approximated by the (expected) rate of inflation and a foreign interest rate measure to account for capital mobility considerations.

The Almon method as opposed to the conventional Koyck method is used in the estimation exercise on grounds that it implies a less restrictive lag structure. Permanent real income is found to significantly affect money demand with an elasticity that reveals that money is a luxury good. Expected inflation and the
short term foreign interest rate are also found to be significant determinants of money demand. Using a battery of stability tests, namely: the Chow, the Gujarati, and the Farley-Hinich tests, money demand is found to be stable.

The use of a battery of stability tests reflects the importance of the issue of stability in money demand analysis. When a single test is employed, it is often the Chow (1960) test. To implement the test, the usual procedure is to divide the sample into two sub-samples, estimate the model for the full sample and the sub-samples and use the F-test to test the null hypothesis that the estimated coefficients for the sub-samples are equal. However, this test is known to be limited in a number of respects.

Firstly, a choice must be made on where to split the data. There is no *apriori* theory guiding this choice so that the test may be sensitive to the split-point choice. Secondly, as shown by Toyoda (1974), the test is inappropriate when model residuals are heteroscedastic.

Just as the Chow test, the Gujarati test suffers from the problem of choosing a break-point. On the other hand, the Farley-Hinich test does not require splitting the data because the test is applied to the full sample.

Our next study in this section is Darrat (1986a) for three OPEC countries, two of which are in Africa. These are: Nigeria, Libya, and Saudi Arabia. The period of study covers 1963 to 1979 and quarterly data are used.

The definitions of money used are M0, M1, and M2 where the data are allowed to determine the most appropriate empirical
counterpart. The price variable used is the CPI while the scale variable employed is GNP. Quarterly GNP series are interpolated from annual ones. The opportunity cost variables used are the (expected) rate of inflation and the foreign interest rate measured as the arithmetic average of short term interest rates of OECD countries.

As with the study on Kenya above, the author uses the Almon method in the estimation exercise. Results indicate that M0 is more appropriate for Saudi Arabia, M1 is more appropriate for Libya, and M2 is more appropriate for Nigeria. The foreign interest rate and the domestic rate of interest appear significant in each estimated equation.

The Chow test, the Gupta test, and Farley-Hinich test are used to evaluate the stability of the regression coefficients. Results do not indicate instability and the author notes that without the foreign interest rate variable, all the estimated money demand functions appear seriously mis-specified and structurally unstable. This appears to indicate that open economy considerations may be necessary for the proper specification of money demand in small-open-developing economies.

Arize et al (1990) investigate the relationship between capital mobility, monetization, and money demand in seven African countries. These are: Egypt, Gambia, Mauritania, Morocco, Niger, Nigeria, and Somalia.

They hypothesize that real money holdings are positively related to monetized real income and negatively related to the expected rate of inflation and the foreign interest rate adjusted for the expected exchange rate. We shall return to this
specification later as it has a number of aspects that are relevant to the empirical specification in this thesis.

For each country: (1) monetized income is defined as total income less agricultural income where income is given by GDP; (2) money is defined as narrow and given by the sum of currency and demand deposits; (3) prices are approximated by the CPI; (4) foreign interest rates are approximated by the average of interest rates taken from the following five major OECD countries: US, UK, France, Germany, and Japan; (5) the exchange rate is defined as the domestic currency per US dollar; (6) expectations are assumed to formed rationally and are generated from the errors-in-variables approach; (7) annual data are used for the sample 1960 to 1987.

Results obtained are as follows. Long run real monetized income elasticities are: 1.76 for Egypt, 1.10 for Gambia, 1.75 for Mauritania, 7.50 for Morocco, 0.57 for Niger, 1.49 for Nigeria, and 1.32 for Somalia while short run elasticities range from 0.20 for Nigeria to 0.49 for Somalia. The authors interpret these results as suggesting that apart from Niger where there are economies of scale in money holding, money is a luxury good in the other countries.

For Morocco, long run real monetized income elasticity appears rather very high, at least in comparison with those in the other countries investigated. This may be due to the concept of monetized income used. As noted in chapter one, it is very doubtful whether this concept can be adequately measured in an empirical exercise. There is no evidence put forward by the authors to suggest that in the countries investigated, most
agricultural output is not monetized. In fact, when they modify the measure of income to include agricultural output, the results relating to Niger and Morocco are markedly different and no longer significantly different from those for the other countries.

The modified long run elasticities are 1.97 for Egypt, 1.17 for Gambia, 1.64 for Mauritania, 1.81 for Morocco, 1.31 for Niger, 2.03 for Nigeria, and 1.77 for Somalia while the associated short run elasticities range from 0.18 for Niger to 0.47 for Egypt. The remainder of the results based on monetized output are as follows.

Expected inflation has a negative effect as predicted by theory in three countries: Gambia, Niger, and Somalia. However, it is statistically significant in only Somalia. For the other countries, it has a positive effect contrary to theoretical predictions.

Though the authors define capital mobility as a composite term consisting of the foreign interest rate adjusted for the expected exchange rate, they also experiment with its individual components, that is, the foreign interest rate on one hand and the expected exchange rate on the other. They find that for Egypt, Gambia, Nigeria, and Somalia, the composite term performs better and has a negative sign as suggested by theory.

On the other hand, separate inclusion of the foreign interest rate and the expected exchange rate terms is found to perform better for Mauritania, Morocco, and Niger. The signs on these terms are negative and interpreted by the authors to be consistent with theory. They conclude that, jointly or
separately, capital mobility variables do exert an important effect on domestic money demand in all the countries investigated.

The use of the exchange rate in the above study is worth commenting on. Notice that the authors use the expected exchange rate rather than the expected exchange rate change as suggested by theory as seen in the last chapter.

For model evaluation, the authors use a battery of tests where functional stability is given adequate attention through the Chow and Farley-Hinich tests. The tests do not indicate instability.

Finally, the authors find the real version of the partial adjustment hypothesis to be appropriate for Gambia, Niger, Nigeria, and Somalia and the nominal version to be appropriate for Egypt, Mauritania, and Morocco.

The last study in this section is Kallon (1992) which is based on Ghana and uses quarterly data from 1966 to 1986. The money variables used are termed by the author as (real) cash and money. Cash would appear to be standard M0 while money is explicitly given as M1. Quarterly GNP data are interpolated from annual series due to lack of the former on a quarterly basis. Prices are in terms of the CPI.

For the opportunity cost measure, the author uses an adjusted (unofficial) interest rate which he considers applicable in rural societies. This is defined as the sum of the official interest rate, the (expected) rate of inflation, and the village money lenders' "mark-up prices". For estimation purposes, only the sum of the official interest rate and the (expected) rate of
inflation is used. The main criticism here is that if the official interest rate already allows for the effect of (expected) inflation, the use of this measure will be flawed. With strong reservations, the author also experiments with the open economy measures of the foreign interest rate and the foreign interest rate adjusted for the expected change in the exchange rate. The reservations stem from the fact that he does not consider open economy considerations to be particularly relevant to money demand functions in the African context.

Results show that the (expected) inflation adjusted interest rate is a significant determinant of money demand in Ghana, although the magnitude of this effect is small. The foreign interest rate and the foreign interest rate adjusted for the expected exchange rate change appear insignificant, thus supporting the author's scepticism noted earlier.

Functional stability is given adequate attention as both the Chow test and the Farley-Hinich test are used in this respect. These tests do not indicate instability.

The author addresses the question of whether short run adjustment is in nominal or real terms. Using an implied Koyck adjustment mechanism, he concludes that Ghanaians adjust their short term cash holdings in real terms and their real M1 holdings in nominal terms.

To conclude this section, we note that although the review here has been informative in a number of respects, the general methodological approach used has been heavily criticised in recent times. In particular, the partial adjustment hypothesis implies a very restrictive lag structure. It has been commented
by some authors, for example, Gordon (1984) that invalid exclusion of relevant lags of the explanatory variables may have resulted in overly long speeds of adjustment.

In more recent times, error correction and related modelling strategies, which we examine next, have been perceived as more robust approaches that partly address some of the weaknesses implied by the partial adjustment hypothesis.

3.3: Error Correction and/or Co-integration Studies

The theoretical concepts of integration/co-integration and error correction upon which the empirical studies reviewed in this section are based are examined in chapters four and five. Integration is examined in chapter four while co-integration and error correction are examined in chapter five. Here, we shall merely introduce them.

Integrated time series are perceived as exhibiting unit roots and interpreted as non-stationary. Traditional econometric analysis assumes that the data of interest are stationary. As noted in the introduction of this thesis for example, the application of traditional econometric methods to non-stationary data is more likely than not to led to spurious results. The appeal of co-integration relates to the fact that the data may be non-stationary in terms of individual series as the case appears to be with most macroeconomic time series but some linear combination of the individual series is stationary so that
According to the Granger representation theorem, see Engle and Granger (1987), the existence of co-integration implies that of error correction and vice versa. Thus, the concepts of error correction and co-integration are particularly close. Co-integration has been interpreted as a statistical concept that is useful for analyzing long run or equilibrium economic relationships. On the other hand, error correction has been interpreted as a corresponding concept for short run or dynamic analysis where it is assumed that past deviations from equilibrium are corrected over time so that equilibrium is maintained in the long run.

Given the comments above, we now examine the empirical studies which are the main concern of this section.

We start by examining the study by Domowitz and Elbadawi (1987) which is the first in the African context and perhaps in the developing country context to employ the error correction approach in the empirical modelling of money demand. Based on Sudan, it employs annual data from 1956 to 1982. Analysis is based on the narrow definition of money. The scale variable is GDP while prices are given by the CPI. Two opportunity cost variables are used, namely: the (expected) rate of inflation and the (expected) exchange rate.

According to the authors, the (expected) exchange rate is designed to measure the direct opportunity cost effect of holding foreign exchange as an alternative to domestic real balances. In addition, they contend that a shift in the return to foreign currency may have some influence on the transactions component
of money demand, but this effect is indirect and operates through the price level and (expected) inflation, both of which are included in the analysis. The use of the (expected) exchange rate as a measure of currency substitution here appears contrary to the theoretical discussion in the last chapter which suggests the use of the expected change in the exchange rate.

The price and income homogeneity assumptions of money demand are explicitly tested and taken into consideration in the modelling process. Results show that the error correction adjustment hypothesis is a valid representation of money demand in Sudan. The statistical validity of the model is explored in some detail. Particular attention is focused on the potential endogeneity of money demand determinants as well as structural stability of the model. Results are found to be satisfactory.

Further research involving the error correction approach in the domain of money demand in the African context is provided by Simmons (1992). This differs from the previous study in that a broad range of countries are investigated. These are Congo, Côte-d'Ivoire, Mauritius, Morocco, and Tunisia. A similarity with the above study is that annual data are employed. The sample periods are 1963 to 1986 for Congo, 1963-1986 for Côte-d'Ivoire, 1963-1987 for Mauritius, 1962-1988 for Morocco, and 1962-1989 for Tunisia.

The data used are as follows. For money, M1 the narrow definition of money is used. The scale variable is GDP. Prices are given by the GDP deflator for Mauritius, Morocco, and Tunisia while the CPI is used for Congo and Côte-d'Ivoire due to the absence of satisfactory GDP deflator series for these countries.
In addition to the domestic interest rate, the foreign interest rate or where applicable, the rate of currency depreciation is used as an additional opportunity cost measure. Modelling is via the general to specific approach to error correction analysis.

Income and price homogeneity assumptions of money demand are explicitly tested. Furthermore, model specification diagnostics are given full attention. In particular, the issue of exogeneity and model stability are addressed. Results are satisfactory and in general, confirm those by Domowitz and Elbadawi that the error correction mechanism can be usefully exploited to model money demand in African countries.

Unlike Domowitz and Elbadawi and Simmons above that deal primarily with short run or error correction analysis, Hoffman and Tahiri (op. cit.) on Morocco are primarily concerned with long run analysis.

The period of study is from 1959 to 1988 and quarterly data are employed. M1 and M2 are the money variables investigated. Prices are given by the CPI. The scale variable is in terms of GDP and GNP where quarterly data are interpolated from annual data. The opportunity cost variable is an open economy interest rate variable chosen from Switzerland as a representative measure.

The stationarity properties of the variables are explicitly tested and co-integration tests are performed. A single co-integrating vector is uncovered. Price and income homogeneity assumptions are tested and generally tend to be accepted. Stability of the long run elasticities is investigated and found satisfactory.
Morocco is also one of the countries studied by Simmons (op. cit.) where the long run income elasticity is found to be significantly greater than unity. On the contrary, Hoffman and Tahiri (op. cit.) find income homogeneity assumption to be data acceptable. In other words, they find an income elasticity which is not statistically different from unity. A number of explanations can be advanced for this difference.

Firstly, unlike Hoffman and Tahiri, Simmons does not explicitly test and model the stationarity properties of the variables by co-integration methods. A second reason that may have induced differences in results is that different data frequencies are used: one is based on annual data while the other uses quarterly data. Thirdly and more importantly, the empirical counterparts of some of the variables employed are different. However both studies find price homogeneity assumption to be data acceptable, thus offering empirical justification for the use of real money as the dependent variable.

Though the study by Hoffman and Tahiri above is focused entirely on co-integration or long run analysis, Adams (1992) which is based on Kenya has aspects of both the long run and short run. The study employs quarterly data for the period 1973 to 1989 involving 66 observations.

Five alternative definitions of money are investigated. These are M0, M1, M2, M3, and the divisia index counterpart of M3. GNP adjusted for changes in terms of trade is employed for the scale variable. Quarterly series are derived from annual ones via interpolation. Prices and (expected) inflation are given in terms of the CPI. In addition to (expected) inflation, the
domestic rate of interest and exchange rate depreciation are used to proxy the opportunity cost of money holding. The use of exchange rate depreciation is designed to capture the effects of currency substitution.

The time series properties of the data are explicitly considered. All variables are found to be non-stationary. This knowledge is incorporated in the modelling process. Money demand is cast in real terms but the assumption of price homogeneity does not appear to be explicitly tested. A serious worry is the use of seven lags for the co-integration analysis when there are only 66 observations.

For each monetary aggregate investigated, at least one co-integrating vector is uncovered. Where more than one vector is found, that which makes more economic sense is retained for further analysis. This is questionable because the prevalence of two or more vectors imply a system that needs to be analyzed as a whole given that there may be feedbacks in the system. Income elasticity is generally found to fall as the monetary aggregate investigated widens and is reported to be significantly lower than that reported by Darrat (1985) for the same country, see last section. The difference may be attributable to differences in methodology. The opportunity cost variables investigated are found to be significant.

Residuals from the long run money demand specification are then used to construct dynamic or short run money demand where a general to specific modelling approach is adopted. The derived dynamic models are generally found to be statistically well specified and stable. Furthermore, the author finds that the
divisia index representation of broad money, M3, performs better than its simple sum or conventional representation.

Kenya is also studied by Fielding (*op. cit.*) in addition to Nigeria, Côte-d'Ivoire, and Cameroon. The study is based on similar lines as that by Adams (*op. cit.*) and both co-integration and error correction hypotheses are studied using quarterly data. The main differences is that Fielding investigates many countries and introduces a price variability regressor, explained below.

For the countries of interest, namely: Cameroon, Côte-d'Ivoire, Kenya, and Nigeria, the sample periods are respectively 1976(1)-1987(2), 1974(3)-1987(4), 1975(2)-1989(2), 1976(1)-1989(2). Unlike Adams (*op. cit.*), only one definition of money, M2, is used. The price variable is the CPI while the scale variable is in terms of trade adjusted GDP where quarterly data for the latter variable are obtained by interpolation from annual data. The opportunity cost of money holding is in terms of: (1) the (expected) rate of inflation for all the countries investigated; (2) the discount rate for Cameroon and Côte-d'Ivoire on one hand and the treasury bill rate for Kenya and Nigeria; (3) a currency depreciation term which is allowed for Kenya and Nigeria but assumed to be zero for Cameroon and Côte-d'Ivoire as they are in a fixed exchange rate zone.

Price variability is deemed to be relatively high and unpredictable with a potential effect on money holdings. Consequently, a variability measure for both the interest rate and (expected) inflation is included in the money demand equation for each country. This is cast in terms of the moving average of the first difference of the series of interest. It is designed
to measure the magnitude of changes in the series regardless of
the direction of the changes.

Zero-frequency and seasonal-frequency unit root tests are
performed. The data are found to be non-stationary at the zero-
frequency and seasonal unit roots are not detected. Our results
support these findings. Employing the Johansen technique of
testing and estimating co-integrating vectors, multiple co-
integrating vectors are found for each country. Given multiple
cointegrating vectors, one preferred vector is chosen on
economic arguments. The main criticism here is that multiple co-
integrating vectors constitute a system, and as noted earlier,
should be analyzed together as there may be feedbacks.

For each country, the residuals from the preferred vector
are used in a second stage estimation exercise based on the
general to specific approach where dynamic money demand with an
error correction mechanism is analyzed. Results show that money
demand depends on income, (expected) inflation and interest rates
as well as the variability of (expected) inflation and interest
rates. The Chow test is employed in investigating the stability
of the money demand variables. Results are satisfactory.

Given that the above study is the only study reviewed here
that has investigated money demand in the context of Cameroon,
it is informative to note how the investigation in this thesis
differs from it.

Take the sample period for example. Ours is an improvement
in terms of the sample period covered. While the author covers
the period 1976 to 1987 or 12 years, ours covers the period 1964
to 1990 or 27 years. Thus, the above sample set falls within ours
and can be considered as a sub-sample of ours. Although ours covers almost three decades, we are still cautious of interpreting it as a study that fully reflects the long run. Consequently, the derived long run relationship in Fielding's must be interpreted with greater caution.

It is important to check that the price homogeneity assumption of money demand is data acceptable before casting an empirical money demand relationship in real terms. Fielding fails to carry out this check. As our results in chapter six show, this assumption is refuted for both the M1 and M2 definitions of money. Moreover, Fielding concentrates solely on the M2 definition, however, as seen in chapter one, Cameroon does not have an advanced financial sector and money is still mostly used for transactions. In this case, the M1 definition which is conventionally defined as notes and coins plus checkable deposits may be a more meaningful aggregate to investigate. At least, experimentation with narrow and broad aggregates should be conducted to see which performs better.

Also, as noted in chapter one of this thesis, we do not find expected inflation to be a long run determinant of money demand in Cameroon. The exclusion of this variable from the long run relationship is suggested by its time series properties. A more detailed discussion about this is given in chapter six. On the contrary, Fielding finds a long run (expected) inflationary effect as well as long run (expected) price variability effects. In our view, the theoretical justification for the inclusion of price variability effects for Cameroon are not clear. Consequently, we do not investigate these effects.
A further aspect that our work differs from Fielding's is that our search for a domestic interest rate is futile in two respects as explained in chapter one. Nevertheless, as Fielding demonstrates, it is possible to accommodate this variable in an analysis involving the sample size used in his analysis.

Furthermore, there are other aspects addressed by us that are not examined by Fielding. For example, unlike Fielding who employs only the Chow test in investigating functional stability, we employ a battery of tests in this area and investigate the issue of Granger-causality.

From the above comments, it is clear that our study differs from that offered by Fielding and therefore constitutes a distinct contribution to the literature.

A study not set in a money demand setting but which is nevertheless informative here is Honohan (op. cit.) where annual data are employed to model the convergence of prices in the CFA and Rand monetary zones. For the Rand zone, consumer prices and interest rates are investigated while for the CFA zone, only consumer prices are investigated due to lack of satisfactory interest rate data.

A simple error correction specification is employed and is derived from a simple long run relationship which relates prices in the periphery country to those in the core country. In the Rand zone, the core or dominant country is South Africa while in the CFA zone, it is France. A periphery country is a given member of either of the monetary zones other than the core country. Casting the error correction specification in first differences, the short run relationship investigated in terms of consumer
prices becomes a relationship involving inflation convergence between the core and periphery countries.

For both monetary zones, results indicate wide short run divergences and although convergence is slow, in the long run, consumer price inflation is largely determined by that in the core country. Similar conclusions are reached for interest rates in the Rand zone.

However, some of the above results must be viewed with caution as the empirical findings in this thesis indicate a likely mis-specification at least in relation to Cameroon. This mis-specification arises because the author fails to address the time series properties of the data. In particular, we find in chapter five of this thesis that while consumer prices in Cameroon need to be differenced once to achieve stationarity, those in France need to be differenced twice to achieve the same result.

This means that using first differences to model the two series, as Honohan did, entails a mis-specification as a stationary series is modelled against a non-stationary one without taking this information into consideration. On the other hand, it may be argued that the data in this thesis are quarterly while Honohan's are annual so that differences in result may be attributable to differences in data frequency used. If this were the case, one would expect this to be partly reflected in seasonality. However, seasonality is not found in this thesis to be responsible for non-stationarity in our data, so the strength of our criticism does not appear to be affected.

Honohan's study above concludes our review of studies with
error correction and/or co-integration. One question that may be asked here relates to the relative merits of these studies in relation to traditional ones for example.

In terms of empirical findings, many controversies still exist just as in the case with partial adjustment modelling. However, where the time series properties are explicitly taken into consideration in the modelling process, this can generally be taken as an attempt at minimizing the risk of mis-specification or "spurious specification".

As indicated earlier, the error correction adjustment hypothesis is usually considered a less restrictive hypothesis on the lag restructure of the variables than the partial adjustment hypothesis. Consequently, it is not surprising that it has been shown to nest the partial adjustment hypothesis.

To conclude, the statements above imply that more faith may be placed on studies that have explicitly modelled the time series properties of the data than those that have not.

3.4: Causality Studies

A concept that has also received attention in the context of money demand variables is Granger-causality. As this concept is fully discussed with applications to our data in chapter seven, the discussion here shall be no more than definitional.

Essentially, Granger-causality from one variable x to another y is determined by examining whether the variable y can
be better predicted by using lagged values of $x$ in addition to its own past history than without. Thus, this concept is concerned with the statistical concept of prediction rather than causality per se.

Darrat (1986b) is one of the earliest studies involving causality in the African context. It is an investigation of the monetarist model of inflation which is framed as excessive growth of nominal money supply over real money demand. The study uses quarterly data from 1960 to 1980. Three countries are investigated, namely: Libya, Morocco, and Tunisia.

One novelty of the above study is that it takes into account the role of the foreign interest rate in determining the inflationary process. The narrow money stock is used for money. GNP is used for the scale variable of money demand. Quarterly GNP data are interpolated from annual data. Prices are given by the CPI while the interest rate measure is given by a simple average of short term OECD countries' rates.

In the causality tests conducted, the lag length is determined by a statistical criterion: a procedure generally preferred by most investigators over one that is arbitrary. Results indicate that the direction of causality is unidirectional from money supply to prices without any significant feedbacks.

In a more recent endeavour, Deme and Fayissa (1995) conduct a similar study for Egypt, Libya, and Tunisia. A departure from Darrat's study is the incorporation of the foreign inflation variable and the effective exchange rate variable into the analysis. Quarterly data are employed from 1964 to 1990. The
variables used are GNP, CPI, the US interest rate, and the real exchange rate measured as the domestic currency per US dollar times the ratio of import price index to export price index. As in Darrat's study, lag length choice is by statistical criterion.

Empirical results are mixed. Feedback is observed between the money supply and inflation for Egypt and between the exchange rate and inflation for Morocco and Tunisia. As these results indicate feedbacks between the money supply and inflation, they differ from those given by Darrat above. For Morocco and Tunisia, the results between the money supply and inflation are consistent with those of Darrat in that causation is unidirectional from the money supply to inflation. Unidirectional causality is also shown from the exchange rate to inflation in the case of Egypt.

Algeria is one of the North African countries not studied by Darrat because of lack of adequate data at the time. Perhaps, given improvement in data availability over time in that country, it is the focus of a similar study by Beltas and Jones (1993). Curiously enough, no mention is made of Darrat's work.

The study covers the period 1970 to 1988. The M1 and M2 definitions of money are used in conjunction with the CPI. Lag length selection is based on correcting for serial correlation. Empirical findings indicate strong unidirectional causality from money to inflation.

The final Granger-causality study in the African context here is Nwega and Ngola (1988). This study is focused on Kenya and employs quarterly data spanning the second quarter of 1970 to the last quarter of 1985. The study investigates the causal direction between changes in domestic credit and changes in net
foreign reserves. In particular, it focuses on whether the flow of domestic credit has been a significant Granger-cause of changes in net foreign reserves or vice versa. Lag length selection is based on correcting for serial correlation.

Analysis is based on the money supply identity which is derived by consolidating the balance sheets of the banking sector. This states that changes in net foreign reserves can be expressed as the difference between broad money supply and the flow of credit to the private and public sectors.

Results indicate that credit to the private sector exerts a significant and negative impact on net foreign reserves. On the other hand, changes in net foreign reserves exert a significant and positive impact on the flow of credit to the private sector. Also, the flow of credit to the public sector has a significant and negative impact on net foreign reserves. Furthermore, changes in net foreign reserves have a significant and negative impact on the flow of credit to the public sector. The sum of flow of domestic credit to both the private and public sectors has a significant and negative impact on net foreign reserves. On the other hand, the impact of changes in net foreign reserves on the flow of total credit in the economy is insignificant.

To conclude this section, we note that though the above studies serve to demonstrate that in the African context, causality analysis has received non-negligible attention, all the studies seem to be cast in a traditional framework which does not incorporate the time series properties of the data into the analysis. The usual caveat for this omission is that results may be spurious. By taking the time series properties of the data
into consideration, ours is an improvement over these studies.

3.5: General Considerations and Conclusions

In this chapter, we have reviewed a number of studies that have been concerned with empirical money demand analysis in the African context. In addition, we have reviewed studies that have empirically examined the issue of Granger-causality among a number of monetary variables in the same context.

The studies reviewed here, though selective, have been rich in diversity. This diversity has been noticeable in terms of geographical areas, sample periods covered, empirical aggregates used, methodologies employed, etc. Given such diversity, it is not surprising that our review has generally been characterised by controversial findings.

In relation to the findings, some of the broad questions that may be relevant for our empirical investigation are: (1) What are the appropriate empirical counterparts of money demand variables? (2) What is the appropriate way of modelling these variables? (3) Is the money demand relationship sufficiently stable as to be confidently used for policy purposes? (4) What is the appropriate way to model causality among variables?

Regarding the appropriate empirical counterpart of money, many definitions have been employed. However, it may be that if money is mostly used for transactions as the case appears to be in most African countries, then a narrow money aggregate such as
M1 may have greater expectations of performing well. On the other hand, to the extent that such a definition may be an empirical matter, various definitions should be investigated.

With respect to the appropriate empirical counterpart of scale variable, lack of wealth statistics in African countries in general preclude the use of this variable from their empirical money demand analysis at the moment. Instead, GDP or GNP has been used but there is no indication as to which performs better. A noticeable feature is that data on GDP/GNP are seldom available on a quarterly basis in African countries and perhaps in many other developing countries. Consequently, studies reviewed here that have used quarterly data have interpolated the data from annual series.

Concerning the appropriate empirical counterpart of prices, the CPI has generally been used, though some other deflators such as the GDP or GNP deflator have been employed. The review here appears to indicate that the choice of appropriate empirical measure for prices is an empirical matter.

Regarding the appropriate opportunity cost of holding money, traditionally, the use of the domestic rate of interest and/or the expected rate of inflation has been established. However, our review suggests open economy considerations should be taken into account in money demand in small-open African economies. In this area, the review indicates the foreign interest rate and/or some measure of expected currency depreciation may be employed.

From the statements above, it would appear that there is no clear consensus as to what constitutes the appropriate empirical counterparts of money demand variables.
Concerning the appropriate method of modelling the variables, suggestions from the studies reviewed here merely reiterate those that have been made elsewhere. In particular, it has been suggested that the time series properties of the variables must be taken into consideration in the modelling process, if the risks of spurious analysis and/or mis-specification are to be minimized.

On the question of reliability of the money demand relationship for policy purposes, the studies reviewed here suggest stable money demand relationships can be constructed in the African context. On the other hand, it is important to note that because a relationship is alleged to be stable according to a statistical criterion does not necessary make it so. At the very least, different statistical criteria should be used to address this matter. Just as the issue of stability should be rigorously addressed, so should that of general model specification. A battery of tests has usually been recommended where a given issue is deemed important.

On the question of modelling causality, though there is no unique way of doing this, the empirical literature seems to emphasise two aspects. These are the need to incorporate the time series properties of the data into the modelling process and the desirability of using a statistical criterion in lag length selection.

With these comments in mind, we now turn to the empirical section of this thesis which draws on the discussion in this and previous chapters.
CHAPTER THREE NOTES

3.1: This is not surprising given that many formal economies in the African context are relatively new. As in our case, these economies do not generally have meaningful data prior to the 1960s.

3.2: The main problem with the interpolation of economic time series data is that the procedures used are not economic theory based.
CHAPTER FOUR

DATA DESCRIPTION AND TIME SERIES PROPERTIES

4.1: Introduction

In the last chapter, we emphasised the need to incorporate the time series or stationarity properties of the data in the modelling process in order to minimize the risk of obtaining spurious results. In this chapter, we describe the data used in the empirical analysis in this thesis and determine their stationarity properties.

In the next section, we provide a description of the data to be analyzed in terms of sources and construction. In section three, we critically examine the methods or tests used to examine the properties of the data. Section four is an application of the tests and evaluation of results obtained.

Finally, in section five, the main findings of the chapter are recapitulated and implications drawn for the progress of the thesis.

4.2: Data Sources and Construction

The data set used for the empirical investigation in this
thesis is seasonally unadjusted time series data of quarterly frequency from the first quarter of 1964 to the last quarter of 1990, giving a total of 108 observations. It is constructed from various issues of IMF International Financial Statistics (IFS) and supplemented by a number of statistical publications of the Bank of Central African States (BCAS) of which Cameroon is a member. Except for the interest rate data, all other data are given in logarithmic form. Furthermore, upper case letters are used for nominal values while lower case letters stand for real values. Below, is a description of the data.

4.2.1: Domestic Narrow Money Supply

This is abbreviated in the thesis as M\textsubscript{1} and obtained from line 34 for Cameroon in IMF IFS. This is traditionally defined as coins and notes in circulation with the public plus demand deposits.

4.2.2: Domestic Broad Money Supply

It is abbreviated in the thesis as M\textsubscript{2}. This is the sum of M\textsubscript{1} defined above and quasi-money. Quasi-money is obtained from line 35 for Cameroon in IMF IFS and consists of various forms of time deposits. In this respect, quasi-money cannot be interpreted as having immediate purchasing power in the strict sense. Nevertheless, it may be perceived as having purchasing power after a time lag or even immediate purchasing power given discounting possibilities. However, such possibilities may entail non-negligible costs.
4.2.3: Domestic Consumer Prices

These are obtained from line 64 for Cameroon in IMF IFS and are abbreviated as P in the thesis. According to IMF IFS sources, they refer to the retail consumer price index of middle class Cameroonian families in Yaounde. The index is based on a family expenditure survey in Yaounde during the period 1964-65 comprising 764 middle class consumers as a proxy for urban consumers. The index covers 132 items. In this study, the price data are expressed relative to 1980. In other words, 1980 is the base year.

4.2.4: Domestic Exchange Rate

This is the nominal exchange rate between the CFA franc and the USA dollar. In particular, it is the amount of CFA francs per USA dollar. It is given by line rf for Cameroon in IMF IFS and refers to the period average. It is abbreviated in this thesis as E. In strict terms, as noted in chapter one for example, this rate is not the CFA franc/USA dollar rate. It is the French franc/USA dollar rate expressed in terms of CFA francs at the given CFA franc/French franc fixed exchange rate. For the entire period of this study, the level of fixity between the two currencies remained unchanged (at 50 CFA francs to one French franc): a point noted in the first chapter of this thesis. Thus, the relevant conversion factor for the period of study here is a constant implying zero exchange rate dynamics: a point emphasised with implications in chapter one.
4.2.5: Gross Domestic Product

This is obtained from line 99b for Cameroon in IMF IFS. The data were originally obtained in annual terms as quarterly data were not available. To arrive at corresponding quarterly data, the interpolation procedure employed by Goldstein and Khan (1976) was used. It is based on the following reasoning.

If \( x_{t-1}, x_t, \) and \( x_{t+1} \) are three successive annual observations of a flow variable \( x(t) \), then the quadratic function which passes through the three points is such that:

\[
\begin{align*}
\int_1^2 (\theta) \, dz &= x_{t-1}; \\
\int_2^3 (\theta) \, dz &= x_t; \\
\int_3^4 (\theta) \, dz &= x_{t+1};
\end{align*}
\]

where \( \int \) is the definite integral operator, \( \theta = az^2 + bz + c \). Integrating and solving for \( a, b, \) and \( c \) gives:

\[
\begin{align*}
a &= 0.5x_{t-1} - x_t + 0.5x_{t+1}; \\
b &= -2x_{t-1} + 3x_t - x_{t+1}; \\
c &= 1.8333x_{t-1} - 1.1666x_t + 0.333x_{t+1}.
\end{align*}
\]

Within any given year, \( t \), successive quarterly figures \( (q_1_t, q_2_t, q_3_t, q_4_t) \) can be interpolated thus.

\[
\begin{align*}
q_1_t &= \int_1^{1.25} (\theta) \, dy = 0.0548x_{t-1} + 0.2343x_t - 0.0390x_{t+1}; \\
q_2_t &= \int_1^{1.5} (\theta) \, dy = 0.0077x_{t-1} + 0.2657x_t - 0.0235x_{t+1}; \\
q_3_t &= \int_1^{1.75} (\theta) \, dy = -0.0235x_{t-1} + 0.2657x_t + 0.0077x_{t+1}; \\
q_4_t &= \int_1^{2.0} (\theta) \, dy = -0.0390x_{t-1} + 0.2343x_t + 0.0548x_{t+1}.
\end{align*}
\]
The above interpolation procedure was applied to nominal data only. The corresponding quarterly data were then deflated by the consumer price index mentioned above in order to arrive at real values abbreviated as $y$ in the thesis. As the income series are derived (from interpolation), caution should be exercised in the interpretation of results relating to them.

The application of the interpolation procedure above differs from that by Goldstein and Khan (op. cit.) as only nominal annual series were interpolated. These authors interpolate both the nominal and the real series. From these series, the implicit deflator is derived. As we have an acceptable price series, there is no need to derive a further series which would be arbitrary by construction.

4.2.6: French Narrow Money Supply

This is obtained from line 34 for France in IMF IFS and abbreviated as $M_1_{FR}$ in the thesis. The definition for this aggregate is the same as for Cameroon above. In other words, it is the sum of coins and notes in circulation with the public plus their demand deposits.

4.2.7: French Consumer Prices

These are obtained from line 64 for France in IMF IFS and refer to the Consumer Price Index. In this thesis, they are abbreviated as $P_{FR}$.

4.2.8: French Government Bond Yield Interest Rate

This is obtained from line 61 for France in IMF IFS and
abbreviated in the thesis as $R_{FR}$. This is expressed in decimals.

4.2.9: USA Government Bond Yield Interest Rate

This is obtained from line 61 for the USA in IMF IFS. It is abbreviated in this thesis as $R_{US}$ and expressed in decimals.

The last item above concludes the description of the data used in the empirical analysis in this thesis. We now turn to the investigation of their time series properties in the conventional manner of testing whether they possess unit roots or not. Firstly, in the next section, we shall examine a number of preliminary considerations which are germane to the conduct and interpretation of our preferred unit root tests.

4.3: Preliminary Considerations on Unit Root Tests

In the last chapter, we introduced the concept of integration and associated it with unit roots and non-stationarity. Here, we shall formally define it and consider a number of issues that may be relevant for the conduct of the empirical analysis of interest.

Following Engle and Granger (op. cit.), a series $x_t$ is said to be integrated of order $d$, denoted $x_t \sim I(d)$, if $\Delta^d x_t$ has stationary and invertible non-deterministic ARMA (autoregressive moving average) representation. The series $x_t$ has a non-deterministic ARMA representation if it can be written: $A(L)x_t =$
where A(L) and B(L) are lagged polynomials in the lag operator L; $\epsilon_t \sim \text{IID}(0, \sigma^2)$. According to Greenberg and Webster (1983), stationarity requires the roots of the characteristic equation associated with the lag polynomial A(L) to be inside the unit circle or be less than one in absolute value while invertibility requires the roots of the characteristic equation associated with the lag polynomial B(L) to be inside the unit circle. Consequently, the definition of integration implies the occurrence of $d$ unit roots at the zero frequency.

A criticism of the definition above is that the zero frequency is not the only frequency at which unit roots may be present in time series data of seasonal nature such as ours. For this reason, we amend the above definition to include seasonality. However, there are alternative approaches to this issue. Our preferred definition below is adapted from Hylleberg et al or HEGY (1990). This definition, unlike those put forward by others such Osborn et al (1988) is more appealing in that it distinguishes explicitly the different frequencies that seasonal unit roots may be involved in quarterly data.

A variable $x_t$ is defined to be seasonally integrated of orders $d$ and $s$, denoted $x_t \sim \text{SI}(d, s)$, if $\Delta^d S(L)^s x_t$ has stationary and invertible non-deterministic ARMA representation. Here, $\Delta$ is the (unit) difference operator; $S(L)$ is a seasonal filter that transforms the variable into a moving sum such that for quarterly data $S(L) = 1 + L + L^2 + L^3$ where $L$ is the lag operator. For quarterly data $\Delta^d S(L)^s = \Delta_4$. The definition of seasonal integration as stated above encompasses the more specific zero frequency definition stated earlier.
Past evidence suggests the case of \( d = 1 \) is the most encountered in empirical analysis involving macroeconomic data. Following the same evidence, while some variables such as prices may contain up to two unit roots, seasonal unit roots do not generally characterize macroeconomic times series data.

In view of the importance of properly modelling the time series of the data in an empirical exercise, considerable effort has been made in recent years in developing tests for determining the degree of integration or unit root properties of individual time series. Consequently, there are a number of tests available. Here, we shall be primarily concerned with those used in the empirical analysis in this thesis. These are the (augmented) HEGY tests and the (augmented) Dickey-Fuller or DF tests.

The HEGY tests are concerned with seasonal unit roots in addition to zero frequency roots while the DF tests are principally concerned with zero frequency roots. There are a number of justifications for choosing them here. The HEGY tests are appealing in that they identify different frequencies where unit roots can be found in seasonal data. In addition, HEGY tests are an extension of DF zero frequency tests which includes seasonality, hence a unified testing framework can be adopted for both tests as is the case in this chapter. Furthermore, DF tests have the advantage that they have arguably been more widely studied and applied than any other unit root tests. This in turn has generated a substantial pool of knowledge that can be used for guidance. Another appeal of the DF tests is that among a number of competing tests investigated by Schwert (1989), the (augmented) DF tests turn out to be least affected by the
In what follows, we shall consider the main framework for the tests conducted here in order to illustrate a number of salient features that are necessary for their application. To this effect, for a time series variable $x_t$, consider the following simplified autoregressive model which is at the heart of our preferred tests.

$$x_t = \alpha x_{t-1} + \epsilon_t \ldots \ldots (4.1);$$

where $\epsilon_t$ is a white noise error term.

In this framework, the hypothesis that $\alpha = 1$ constitutes the unit root hypothesis or the null hypothesis that the series $x_t$ is non-stationary. If $\alpha = 1$, $x_t$ is a random walk process. The hypothesis that $|\alpha| < 1$ is the standard alternative hypothesis to the unit root hypothesis and implies that $x_t$ is stationary. Equation (4.1) is usually rewritten (reparameterized) so that a test for the hypothesis that the coefficient on $x_{t-1}$ is zero is equivalent to a test for the presence of a unit root thus. Subtracting $x_{t-1}$ from both sides of equation (4.1) and arranging terms yields:

$$\Delta x_t = \beta x_{t-1} + \epsilon_t \ldots \ldots (4.2);$$

where $\beta = \alpha - 1$, so that a test for $\beta = 0$ is a test for $\alpha = 1$ or a unit root in $x_t$.

At first sight, the test $\beta = 0$ appears to be a standard $t$-test. However, it has been shown that under the null, the
relevant critical values are different and vary according to whether deterministic components such as constant and/or time trend are included or not. Fortunately, relevant critical values have been simulated in each case. Therefore, except otherwise mentioned, a t-test on a regression equation such as (4.2), should be understood in a non-standard sense. A similar analysis and conclusion can be made for the F-test.

The structure above constitutes the basic structure of the DF and HEGY tests. We shall now consider a number of further issues that are pertinent to the testing of the unit root hypothesis in this framework.

The first issue here concerns data transformation. It is customary to transform most time series data into logs in an empirical analysis. Banerjee et al (1993) note that many economic time series may contain an exact unit root if we consider logarithmic transformations of the form routinely applied to economic time series. Detecting roots that are not exact but say near-exact is often difficult. As we shall see below, this is because relevant tests have low power in distinguishing near-exact roots from exact ones. Therefore, a transformation in which roots appear exact would be helpful in the detection process. However, as pointed out by McAleer (1994), using logs rather than levels may constitute an incorrect transformation of the data which may alter the results of the unit root tests. In view of these remarks, it is not clear whether unit roots should be carried out on data in levels or in logarithmic form. Our choice is dictated by the empirical money demand considerations in the next chapter which suggest we use the logarithmic form for all
the variables except for the interest rate. Nevertheless, here, we provide results for both the logarithmic and non-logarithmic forms of the interest rate.

Harris (1995), notes that seasonal adjustment procedures often create bias towards the non-rejection of the unit root hypothesis. As indicated in the last section, the data used in this thesis are not seasonally adjusted. In order to accommodate seasonality, equation (4.2) can be augmented appropriately. The HEGY tests used here constitute a valid augmentation in this direction.

Campbell and Perron (1991) have pointed out forcefully that the treatment of deterministic components in a unit root specification such as in equation (4.2) is important as the calculated and critical values of the relevant test statistic depend on their specification. In our approach, we include an intercept to allow for the possibility of a drift in the series under the null. We also include a linear time trend which is designed to be zero under the null of difference stationary process and non-zero under the alternative of trend stationary process. In addition, in the tests involving seasonality, dummy variables are also included in addition to the constant and trend. Including as many deterministic components as possible ensures that the test regression nests both the null and a general stationarity alternative. However, according to the above authors, the power of a test of the unit root hypothesis against a stationary alternative decreases as additional deterministic regressors are included. More generally, they conclude that a non-rejection of the unit root hypothesis may be due to a mis-
specification of the deterministic components included as regressors. Consequently, it is important where possible to test for the significance of the deterministic terms. Our approach relies on the F-tests suggested by Dickey and Fuller (1981).

The property of the error term in equation (4.2) is explicitly white noise. If this property is not observed empirically, that is, if there is serial correlation, the associated unit root test will not be valid. Unfortunately empirical evidence shows that this property is unlikely to be observed unless appropriate modifications are made to the basic test regression suggested by equation (4.2). A popular modification which is adopted here is to add lags of the dependent variable as additional regressors. In this case, the test is said to be augmented. The major drawback here is the determination of the number, p, of regressand terms to be included as the relevant calculated statistic is sensitive to the choice of p.

It is recommended that the choice of p should not be fixed a priori. Our procedure is as follows. If p = n is free from auto-correlation but p = n - 1 exhibits auto-correlation, we choose p = n. If p = n = 0 is free from auto-correlation, then no lagged values are needed so that the test is not augmented.

McAleer (op. cit.) notes that heteroscedasticity will in general affect tests of the form given by equation (4.2). At first sight, this is not surprising as variance constancy is a property of the error term in equation (4.2). However, the tests here fall under the class of tests that according to Mackinnon (1991) do not have to be modified to allow for heteroscedasticity
as it does not affect their asymptotic distributions.

Normality is not a property of the specified error term in unit root tests as specified in equation (4.2).

The remarks above suggest that the main focus as far as standard diagnostic checks for the empirical study here are concerned, should be on serial correlation.

An important issue relating to unit root testing as spelled out in equation (4.2) is test power. In general, unit root tests do not have power in discriminating between unit roots and roots that are very close to unity. This has been attributed to the near-observational equivalence of trend and difference stationary processes. In particular, Campbell and Perron (op. cit.) note that in finite samples any trend stationary process can be approximated arbitrarily well by a unit root process in the sense that the auto-covariance structures will be arbitrarily close.

According to Shiller and Perron (1985), the power of a test of the unit root hypothesis against a trend-stationary alternative depends very little on the number of observations but is rather influenced in an important way by the span of the data. Therefore the use of quarterly data as in this study which leads to a greater number of observations in contrast to annual data of the same time span may not yield any significant relative gain in terms of test power.

Perron (1989) notes that failure to reject the unit root hypothesis may be due to structural breaks in the data. There are two empirical approaches to this issue. Perron (op. cit.) assumes that the break point is known. The main difficulty with this approach is that it is doubtful whether the break points (dates)
can be known in advance. The other approach consists of recursive testing for the possibility of a break. This approach involves the creation of sub-samples for the sequential tests. The main problem with this approach is that very many sub-samples would have to be investigated for it to be meaningful. We were unable to satisfactorily accommodate the structural break issue in our empirical analysis.

Finally, in unit root tests of the form suggested by equation (4.2), there is the issue of appropriate testing sequence as two general sequences are available: testing up and testing down. Testing up consists of testing from the null of a single unit against the alternative of no unit root or stationarity. If it cannot be rejected, the null of two unit roots against the alternative of a single unit root is tested and so on and possibly stopping only when the null is rejected. According to Diebold and Nerlove (1990) for example, a major weakness of this approach is that if the number of unit roots is greater than that hypothesized under the null, the empirical or actual test size will be greater than the nominal one. The alternative procedure suggested by Dickey and Pantula (1987) which we adopt here has the advantage of preserving the nominal test size. This consists of testing down from the maximum number, n, of unit roots under consideration as the null against the alternative of n-1 unit roots. If the null cannot be rejected, the process stops, if not, the null of n-1 unit roots against the alternative of n-2 unit roots is tested and so on and only stopping when the null cannot be rejected or when the process is exhausted. The sequential testing technique above can be based
on either the t-test or the F-test. However, according to Dickey and Pantula above, the t-test is generally more powerful in this case than the F-test.

A criticism of the testing down approach is that it supposes that the maximum number of unit roots under consideration is not greater than \( n \). This is not a major weakness here as empirical evidence does not suggest the presence of more than two unit roots in macroeconomic time series data. A safeguard which is adopted here is to set \( n \) equal to one plus the suspected number of unit roots.

Overall, the discussion above shows that unit root testing is not straightforward and empirical results should be interpreted with caution as the possibility of generating spurious results cannot be entirely eliminated. For this reason, a number of authors, for example, Maddala (1992), have recommended the application of the traditional Box-Jenkins graphical approach of inspecting the correlogram before applying formal unit root tests as they may not reject the unit root hypothesis even though graphical evidence suggests otherwise.

The correlogram is the auto-correlation function \( \rho(p) \) plotted against the lag length, \( p \), where the auto-correlation function \( \rho(p) \) is defined thus: \( \rho(p) = \frac{\sigma_k}{\sigma_0} \); where \( \sigma_k \) and \( \sigma_0 \) define the auto-covariance and the variance of the series respectively.

The Box-Jenkins approach consists of examining the correlogram and is based on the following decision rule. If the correlogram tapers away fairly quickly as the lag length increases, this may be taken as visual evidence that the data are
stationary. On the other hand, if it appears to be characterised by points which are non zero at relatively long lags giving a relatively smooth shape, we conclude the data are non-stationary. If it appears to be non-stationary, then we may difference the data and examine the differenced series in the same way as the original series. Differencing may continue until the transformed data are stationary or cannot be differenced into stationarity.

The Box-Jenkins approach as described above was applied to our empirical data. In general, all the series appeared non-stationary. However, we could not confidently determine the order of integration of the different series. Perhaps, formal tests to which we turn our attention would be more helpful in this regard.

4.4: Applications, Results, and Discussions

Following the discussion in the last section, our application begins with the HEGY tests. The following regression equation is employed.

\[ z_{4,t} = \alpha_0 + \alpha_1 T + \alpha_2 D_1 + \alpha_3 D_2 + \alpha_4 D_3 + \alpha_5 z_{1,t-1} + \alpha_6 z_{2,t-1} \]
\[ + \alpha_7 z_{3,t-2} + \alpha_8 z_{3,t-1} + \sum_{i=1}^{\Gamma_4} \Gamma_4 z_{4,t-1} + \epsilon_t \ldots \ldots \ldots (4.3); \]

with \( z_{1,t} = (1+L)(1+L^2)x_t = x_t + x_{t-1} + x_{t-2} + x_{t-3}; \)
\[ z_{2,t} = -(1-L)(1+L^2)x_t = -x_t + x_{t-1} - x_{t-2} + x_{t-3}; \]
\[ z_{3,t} = -(1-L)(1+L)x_t = -x_t + x_{t-2}; \]
\[ z_{4,t} = (1-L^4)x_t = \Delta_4 x_t; \]

where \( a_0 \) is the intercept; \( a_i \) \((i = 1, 2, \ldots, 8)\) are parameters; \( T \) is a trend term; \( D_i \) \((i = 1, 2, 3)\) are seasonal dummies; \( L \) is the lag operator; \( \Delta_4 \) is the quarterly difference operator; \( \Gamma_i \) \((i = 1, 2, \ldots, p)\) are parameters; and \( \epsilon_t \) is an error term.

Hylleberg et al (op. cit.) note that the intercept and trend portions of the deterministic mean influence only the distribution of \( a_6 \) while with the inclusion of the intercept, the seasonal dummies affect only the distribution of \( a_5, a_7, a_8 \), leaving the distribution of \( a_6 \) unaffected. Furthermore, they note that there will be no zero frequency unit roots if \( a_5 \) is different from zero and no seasonal frequency unit roots if \( a_6 \) and either \( a_7 \) or \( a_8 \) are different from zero. This constitutes the basis of testing here. The critical values are available from Hylleberg et al (op. cit.).

In the last section, we noted that empirical evidence suggests that there are seldom any seasonal unit roots in time series data. Consequently, we test downwards from a maximum of one unit root in each frequency. In order not to complicate the analysis, we extend this testing sequence to the zero frequency even though empirical evidence suggests there may be more than a single unit root at this frequency. Potential multiple zero frequency roots are investigated later using standard (augmented) DF tests. In any case, it is necessary to supplement the zero frequency component of HEGY tests with standard (augmented) DF tests as Ghysels et al (1994) note that the former has greater size distortion than the latter.
The results for the above tests are presented in table (4.1) below. The tests are carried out with and without trend and/or seasonal dummies. The conclusion reached for the unit root hypothesis is not contradicted in either case. The preferred results that are reported below are for the general model that includes an intercept, a linear time trend and seasonal dummies. This general specification allows the alternative hypothesis of stationarity to be very general.

In the table below, the variables under examination are shown in column one. Test results are in columns two, three, and four. The number, p, of lagged regressand terms necessary for the regression residuals to be white noise is given in the last column. Insignificant lagged terms are excluded unless their exclusion induces serial correlation. For example, if five lags are retained but the third turns out to be insignificant, it is excluded unless the exclusion induces serial correlation. The LM test distributed as $\chi(4)$ is used to check for the presence of serial correlation. The minimal number of augmented terms necessary to ensure the absence of serial correlation is retained.

Here, and in what follows: (1) an asterisk indicates significance at the 5% level; (2) where a variable is in non-logarithmic form, the prefix "n" appears before it, otherwise, it is in logarithmic form. For the definition of variables, see section two.
Table (4.1): HEGY Test Results

<table>
<thead>
<tr>
<th>variable</th>
<th>$a_5 = 0$</th>
<th>$a_6 = 0$</th>
<th>$a_7 = a_6 = 0$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>-1.90</td>
<td>-7.62*</td>
<td>12.76*</td>
<td>2</td>
</tr>
<tr>
<td>M2</td>
<td>-1.42</td>
<td>-9.27*</td>
<td>12.34*</td>
<td>2</td>
</tr>
<tr>
<td>P</td>
<td>-2.01</td>
<td>-3.72*</td>
<td>11.80*</td>
<td>1</td>
</tr>
<tr>
<td>Y</td>
<td>-1.69</td>
<td>-5.74*</td>
<td>64.40*</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>-1.99</td>
<td>-6.71*</td>
<td>35.90*</td>
<td>0</td>
</tr>
<tr>
<td>M1_{FR}</td>
<td>-2.20</td>
<td>-5.50*</td>
<td>40.66*</td>
<td>0</td>
</tr>
<tr>
<td>P_{FR}</td>
<td>-1.92</td>
<td>-7.35*</td>
<td>44.38*</td>
<td>0</td>
</tr>
<tr>
<td>nR_{FR}</td>
<td>-1.95</td>
<td>-6.51*</td>
<td>41.08*</td>
<td>0</td>
</tr>
<tr>
<td>nR_{US}</td>
<td>-1.81</td>
<td>-6.68*</td>
<td>44.28*</td>
<td>0</td>
</tr>
<tr>
<td>R_{FR}</td>
<td>-1.88</td>
<td>-6.68*</td>
<td>39.05*</td>
<td>0</td>
</tr>
<tr>
<td>R_{US}</td>
<td>-1.51</td>
<td>-6.42*</td>
<td>44.13*</td>
<td>0</td>
</tr>
</tbody>
</table>

The results for the test of a unit root at the zero frequency (that is, root +1) are presented in column two. The relevant 5% critical value for this test is -3.50. We reject the null of a unit root at the zero frequency if the calculated t-statistic is less than the 5% critical value. The results suggest that we cannot reject the null of a unit root with respect to any of the variables above.

The results in column three relate to a test of the presence of the seasonal unit root -1 which corresponds to a frequency of half cycle in a quarter or two cycles per year. The hypothesis is rejected if the calculated t-statistic is less than the 5% critical value of -2.94. The results indicate a rejection of the hypothesis.

Finally, as Charemza and Deadman (1992) for example note,
the seasonal unit roots $-i$ and $i$ are indistinguishable from one another in quarterly data, hence, the aliasing problem. Consequently, they are given the same interpretation as corresponding to one quarter cycle in a quarter or one cycle per year. We test them jointly using the F-statistic. The relevant 5% critical value for the corresponding F-test is 6.60. The null hypothesis of the presence of one or both roots is rejected if the calculated F-statistic exceeds the 5% critical value. The results which are presented in column four indicate a rejection.

At this stage, we can say that the tests conducted so far suggest the data are non-stationary at the zero frequency but stationary at the seasonal frequencies. To further examine the nature of non-stationarity at the zero frequency, we employ the (augmented) DF tests. Following preliminary analysis, we test downwards from three unit roots in the case of French prices, \( P_f \), and two unit roots in all other cases.

The tests for the maximum of two roots are outlined in the following regression equations:

\[
\Delta^2 x_t = \beta_{10} + \beta_{11} \Delta x_{t-1} + \Sigma_{i=1}^p \Gamma_{1i} \Delta^2 x_{t-i} + \epsilon_{1t} \ldots \ldots \ldots (4.4);
\]
\[
\Delta^2 x_t = \beta_{20} + \beta_{21} T + \beta_{22} x_{t-1} + \beta_{23} \Delta x_{t-1} + \Sigma_{i=1}^p \Gamma_{2i} \Delta^2 x_{t-i} + \epsilon_{2t} \ldots \ldots \ldots (4.5);
\]

where \( \beta_{10}, \beta_{20} \) are intercepts; \( T \) is a trend term; \( \beta_{11}, \beta_{21}, \beta_{22}, \beta_{23} \), \( \Gamma_{1i}, \Gamma_{2i} \) \((i = 1, 2, \ldots, p)\) are parameters; and \( \epsilon_{1t}, \epsilon_{2t} \) \((i = 1, 2)\) are error terms.

The test for the null of two roots is based on the calculated t-statistic on the parameter \( \beta_{11} \) in equation (4.4).
above. For our sample size of 104 observations, the relevant 5% critical value is -2.99 from Mackinnon (op. cit.) which is not very different from that of -2.89 from Fuller (1976). In general, the critical values derived from Mackinnon (op. cit.) for the tests here are approximately equal to those suggested by Fuller (op. cit.). Our results which are given in the second column of table (4.2) below, indicate a rejection of the null of two unit roots for all the variables examined.

Given the rejection of two unit roots, we proceed to testing the null of one unit root against the alternative of trend stationarity. As the alternative is one of trend stationarity, the test regression is augmented to include a trend term in order to nest the alternative. The relevant test equation is shown by equation (4.5) above.

<table>
<thead>
<tr>
<th>variable</th>
<th>2 Roots</th>
<th>1 Root</th>
<th>F*2</th>
<th>F*3</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>-10.82*</td>
<td>-0.54</td>
<td>9.81*</td>
<td>0.65</td>
<td>2/4/5</td>
</tr>
<tr>
<td>M2</td>
<td>-7.07*</td>
<td>-0.82</td>
<td>6.33*</td>
<td>0.76</td>
<td>2/8/9</td>
</tr>
<tr>
<td>P</td>
<td>-3.97*</td>
<td>-1.82</td>
<td>4.30</td>
<td>1.68</td>
<td>1/2/4/5/6</td>
</tr>
<tr>
<td>Y</td>
<td>-6.22*</td>
<td>-0.02</td>
<td>3.20</td>
<td>1.37</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>-6.15*</td>
<td>-2.06</td>
<td>1.44</td>
<td>2.12</td>
<td>0</td>
</tr>
<tr>
<td>M1FR</td>
<td>-7.80*</td>
<td>-2.17</td>
<td>16.71*</td>
<td>2.63</td>
<td>0</td>
</tr>
<tr>
<td>nRFR</td>
<td>-6.06*</td>
<td>-1.73</td>
<td>1.28</td>
<td>1.81</td>
<td>0</td>
</tr>
<tr>
<td>nRUS</td>
<td>-7.60*</td>
<td>-1.43</td>
<td>1.11</td>
<td>1.53</td>
<td>0</td>
</tr>
<tr>
<td>RF</td>
<td>-6.59*</td>
<td>1.63</td>
<td>1.38</td>
<td>1.83</td>
<td>0</td>
</tr>
<tr>
<td>RUS</td>
<td>-7.69*</td>
<td>1.23</td>
<td>1.36</td>
<td>1.68</td>
<td>0</td>
</tr>
</tbody>
</table>
The test for one unit root is based on the t-statistic on the parameter $\beta_{22}$ in equation (4.5) above. It is rejected if the calculated t-statistic is less than the 5% critical value of -3.45 from Mackinnon (op. cit.). The results which are given in column three of table (4.2) above indicate a non-rejection of the unit root hypothesis.

Given the non-rejection of the null of non-stationarity, it is informative to test for the significance of drift properties of the non-stationary data. In particular, we test that the data follow a random walk without drift as: $(\beta_{20}, \beta_{21}, \beta_{22}) = (0, 0, 0)$. This corresponds to the $\Phi_2$ F-test suggested by Dickey and Fuller (op. cit.). We also test that the data follow a random walk with drift or $(\beta_{20}, \beta_{21}, \beta_{22}) = (\beta_{20}, 0, 0)$. This corresponds to the $\Phi_3$ F-test suggested by Dickey and Fuller (op. cit.).

For our sample size, the relevant critical values for the two tests are respectively 4.88 and 6.49 from Dickey and Fuller (op. cit.). In each case, the hypothesis is rejected if the calculated F-statistic is greater than the relevant critical value.

Results for the $\Phi_2$-test are presented in column four of table (4.2) above while those of the $\Phi_3$-test are presented in column five of the same table. They suggest the money supply variables $M_1$, $M_2$, and $M_{1_{FR}}$ are non-stationary with drifts while the rest of the variables are non-stationary without drifts.

Finally, to test from the maximum of three unit roots for the French price level, we employ the following test equations.
$\Delta^3 x_t = \delta_{10} + \delta_{11} \Delta^2 x_{t-1} + \Sigma_{i=1}^p \Gamma_{1i} \Delta^3 x_{t-1} + \epsilon_{1t} \ldots \ldots \ldots \ldots (4.6) ;$

$\Delta^3 x_t = \delta_{20} + \delta_{21} \Delta x_{t-1} + \delta_{22} \Delta^2 x_{t-1} + \Sigma_{i=1}^p \Gamma_{2i} \Delta^3 x_{t-1} + \epsilon_{2t} \ldots \ldots (4.7) ;$

$\Delta^3 x_t = \delta_{30} + \delta_{31} T + \delta_{32} \Delta x_{t-1} + \delta_{33} \Delta^2 x_{t-1} + \delta_{34} \Delta^3 x_{t-1} + \Sigma_{i=1}^p \Gamma_{3i} \Delta^3 x_{t-1} + \epsilon_{3t} \ldots \ldots (4.8) ;$

where $\delta_{10}$, $\delta_{20}$, $\delta_{30}$ are intercepts; $T$ is a trend term; $\delta_{11}$, $\delta_{21}$, $\delta_{22}$, $\delta_{31}$, $\delta_{32}$, $\delta_{33}$, $\delta_{34}$, $\Gamma_{1i}$, $\Gamma_{2i}$, $\Gamma_{3i}$ ($i = 1, 2, \ldots, p$) are parameters; and $\epsilon_{it}$ ($i = 1, 2, 3$) are error terms.

The test for the null of three unit roots is based on the t-statistic on the parameter $\delta_{11}$ in equation (4.6). The null is rejected if the calculated value of the t-statistic is less than the critical value of -2.89 from Mackinnon (op. cit.). Results which are presented in the second column of table (4.3) below imply a rejection of the null of three unit roots. We then test for the null of two unit roots.

The test for the null of two unit roots is based on the t-statistic on the parameter $\delta_{21}$ in equation (4.7). It is rejected if the calculated value of the t-statistic is less than the critical value of -2.89 from Mackinnon (op. cit.). Results which are presented in the third column of table (4.3) below imply a non-rejection of the null of two unit roots. We conclude that the French price level is non-stationary with two unit roots.

As in the case of the other variables above, it is informative to test for the drift properties of the non-stationary data. The test regression used for this test is given by equation (4.8) above which is more general. Here, the $\Phi_2 F-$
test and $\Phi$, F-test mentioned above are framed respectively as:

$(\beta_{30}, \beta_{31}, \beta_{32}) = (0, 0, 0)$ and $(\beta_{30}, \beta_{31}, \beta_{32}) = (\beta_{20}, 0, 0)$. The critical values and the evaluation of these tests are the same as previously seen. Results shown in table (4.3) below indicate that the French price level is non-stationary without drift.

<table>
<thead>
<tr>
<th>variable</th>
<th>3 Roots</th>
<th>2 Roots</th>
<th>$F_{\Phi 2}$</th>
<th>$F_{\Phi 3}$</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{FR}$</td>
<td>-13.39</td>
<td>-2.43</td>
<td>2.60</td>
<td>1.50</td>
<td>0</td>
</tr>
</tbody>
</table>

The fact that prices in France have different time series properties from those in Cameroon can be interpreted as evidence against the prevalence of purchasing power parity between the two countries.

The results in table (4.3) above complete the unit root tests in this chapter. It is useful to compare the results with past empirical knowledge and to draw implications for the conduct of the money demand and causality analysis of interest. This is the purpose of the next section

4.5: Results Overview, Implications, and Conclusions

In this chapter, we have established that the proposed data for the empirical analysis in this thesis are non-stationary in levels as follows.

We have shown that French prices contain two unit roots at the zero frequency or are integrated of order two at that
frequency. The implication is that they need to be differenced twice in terms of first differences in order to be made stationary. Consequently, the French inflation rate is not stationary.

For the remainder of the variables, we have shown that they are integrated (of order one). The implication is that they need to be differenced just once in order to be made stationary. Furthermore, we have shown that while the money series are non-stationary with drifts, the rest of the non-stationary variables do not contain drifts. Finally, we have shown that our data do not contain seasonal frequency unit roots.

We interpreted the fact that prices in Cameroon have different stationarity properties from those in France as suggesting that PPP does not hold between the two countries.

How do our results compare with past empirical knowledge? They appear to be consistent with the remark made earlier that from past empirical research, most macroeconomic data can be perceived as integrated of order one at the zero frequency and seldom integrated at the seasonal frequencies. In this respect, our study supports previous research, for example, by Fielding (op. cit.) for Cameroon and Arize (1994) for four developing Asian countries.

The main conclusion in this chapter for the conduct of the remainder of the empirical analysis in this thesis is that in order to reduce the risk of obtaining spurious results, we need to incorporate the non-stationarity nature of the data into the modelling process. Bearing in mind this conclusion, we turn to the next chapter which is concerned with money demand.
CHAPTER FIVE

MONEY DEMAND ANALYSIS

5.1: Introduction

In chapter three, we noted that the concepts of cointegration and error correction are valid for the analysis of non-stationary data. As the empirical analysis in the last chapter suggests that our data are non-stationary (in levels), using the above concepts, the purpose of this chapter is to conduct the proposed money demand analysis using the non-stationary data.

Generalities relating to these concepts in terms of definitions and related issues are examined in section two. In addition, we specify the long and short run money demand hypotheses to be investigated as well as the specific techniques to be used.

Section three is concerned with the application of the co-integration and error correction analyses of interest. In particular, we derive results and critically examine them.

Lastly, in section four, we provide an overview of our empirical results, draw its policy implications and conclude.
5.2: Preliminary Considerations

The concepts of co-integration and error correction were examined briefly in chapter three. In what follows, we shall formally define them for the purpose of the empirical analysis in this thesis.

Co-integration can be defined in terms of a time series vector $x_t$ with $n$ components. Following Engle and Granger (op. cit.), the components of $x_t$ are co-integrated of order $d$, $b$, denoted $x_t \sim CI(d, b)$, if $x_t$ is integrated of order $d$, denoted $x_t \sim I(d)$, and there exist a non-zero vector $a$ such that $a'x_t$ is integrated of order $(d-b)$, denoted $a'x_t \sim I(d-b)$; with $d \geq b > 0$.

The vector $a$ is called the co-integrating vector. If $n = 2$, then the co-integrating vector is unique. If $n > 2$, there may be more than one co-integrating vector as there may be more than one equilibrium relationship linking the variables. In general, there can be at most $r = n - 1$ distinct co-integrating vectors in which case $a$ would be an $n \times r$ matrix with rank $q$ called the co-integrating rank. If $r = n$, the components of $x_t$ are stationary.

Co-integration relates to the idea that variables may be individually non-stationary but some linear combination of them is stationary. The main appeal of co-integration is that it offers an approach where traditional econometric techniques can be applied to non-stationary data so long as the data are co-integrated. It is usually interpreted as suggesting a given relationship is real and not spurious.
The next definition relates to error correction. Again, we follow Engle and Granger \(\textit{op. cit.}\) thus. A time series vector \(x_t\) has an error correction representation if it can be written:

\[ A(L)(1-L)x_t = -\gamma w_{t-1} + \epsilon_t; \]

where \(A(L)\) is a matrix in \(L\) the backwards shift operator; \(w = \alpha'x\), with \(\alpha'x\) as defined above; \(\epsilon_t\) is a stationary multivariate disturbance; \(A(0) = I\), \(A(1)\) has finite elements; and \(\gamma\) is non-zero.

Studies that have employed the error correction adjustment hypothesis have employed either of the following forms discussed by Deadman (1995) and given as equivalent error correction specifications with \(p\) exogenous \(x_j\) variables. For a dependent variable \(m\), where \(m = M/P\) for example in the case of real money demand, these may be written for \(q = \min (g, h)\) as:

\[
\Delta m_t = \alpha_0 + \sum_{i=1}^{q} \delta_i (m_{t-1} - \sum_{j=1}^{p} \gamma x_{jt-1}) + \sum_{j=1}^{p} \beta_{j0} \Delta x_{jt} \\
+ \sum_{j=1}^{p} \delta_j \sum_{i=1}^{q} \gamma_{jt} m_{jt-1} + \sum_{j=1}^{p} \beta_{j0} \sum_{i=1}^{q} \gamma_{jt} x_{jt-1} \\
+ \sum_{i=q+1}^{h} \alpha_i \Delta m_{t-1} + \epsilon_t \tag{5.1}.
\]

\[
\Delta m_t = \alpha_0 + \sum_{i=1}^{q} \eta_i (m_{t-1} - \sum_{j=1}^{p} \gamma x_{jt-1}) + \sum_{j=1}^{p} \beta_{j0} \Delta x_{jt} \\
+ \sum_{j=1}^{p} \delta_j \sum_{i=1}^{q} \gamma_{jt} x_{jt-1} + \sum_{j=1}^{p} \beta_{j0} \sum_{i=1}^{q} \gamma_{jt} x_{jt-1} \\
+ \sum_{i=q+1}^{h} \alpha_i \Delta m_{t-1} + \epsilon_t \tag{5.2}.
\]

In each case, there are \(q\)-error correction terms with the models containing lag lengths \(g\) and \(h\) of the levels of the \(p\) exogenous variables or the \(x_j\) variables and the level of the dependent variable \(m\) respectively.

However, in practice, a single error-correction term at lag \(q\) is often employed. Long run equilibrium is usually stipulated...
as being of the form:

\[ m_t = \sum_{j=1}^{p} \gamma_j x_{jt} + \epsilon_t \ldots ....(5.3). \]

The error correction terms are different in specifications (5.1) and (5.2). In (5.1) they appear as \( m_{t-1} - \sum_{j=1}^{p} \gamma_j x_{jt-1} \) while in specification (5.2) they appear as \( m_{t-1} - \sum_{j=1}^{p} \gamma_j x_{jt-1} \). This allows the equilibrium relationship to be written as in (5.3) without the \( \gamma_i \) coefficients necessarily equal to one. In this way, testing whether the long run function is homogeneous in the \( p \) variables is equivalent to testing the significance of the lagged \( x_{jt} \) variables. In specification (5.2), the non-homogeneity (\( \gamma_1 \neq 1 \)) aspect of the equilibrium relationship is directly taken into consideration.

It has been shown by Banerjee et al (op. cit.) that the estimated coefficients on the error correction terms, that is \( \delta_i \) and \( \eta_i \), will be equal in both specifications (5.1) and (5.2). Furthermore, suppose the \( \gamma_i \) coefficients in the long run model are assumed to be known as would be the case if the long run model is first estimated, then the lagged \( x_{jt} \) variables can be omitted from specification (5.2). Specifically, the lagged residuals from the estimated long run specification are inserted in the short run dynamic specification for estimation.

Extensions to the above definitions are possible. A common example relates to seasonal co-integration and related error correction. This is simply the case where co-integration occurs at seasonal frequencies. We shall not be concerned with its technical details here as this consideration does not
fundamentally change the meaning of the concept of co-integration given above in terms of two or more variables that are individually non-stationary but jointly stationary in terms of some linear combination. More importantly, the seasonal integration tests in the last chapter inform against modelling money demand in Cameroon via seasonal co-integration.

Intuitively, the relationship between error correction and co-integration can be explained as follows. The existence of co-integration among a set of time series variables is interpretable in terms of the existence of a long run equilibrium relationship among the variables. In the short run, equilibrium may not be observed so that there is some short run error (disequilibrium). However, assuming that the variables are co-integrated which may also be interpreted as suggesting equilibrium must be maintained in the long run, the short run error must be correcting in that if it increased in the last period, there will be a tendency for it to reduce in the current period, otherwise long run equilibrium will not be achieved. Consequently, the value of the error correction term is often predicted as negative.

Having defined the concepts of interest, our next objective is to relate them in terms of empirical specification to the main theoretical money demand hypothesis to be examined. This hypothesis was discussed in chapter two. It can be recalled as stating that the quantity of money demanded by individuals in an economy is a function of prices, a scale variable, and some opportunity cost variable(s).

In the discussion in chapter one, we examined in detail the potential empirical counterparts of money demand in Cameroon.
Here, we shall merely recall them.

For the empirical counterpart of money, the narrow money definition, M1, and the broad money definition, M2 were proposed. Our preference was in terms of M1 because the monetary characteristics of Cameroon seen in that chapter suggest money would be mostly held for transactions, implying an aggregate that most readily describes transactions such as M1 is to be preferred. In any case, as noted in that chapter, since broad money in this thesis is defined as narrow money plus time deposits, if differences in results were to arise, these will be due to the non-M1 component of M2.

For the empirical counterpart of prices, the domestic CPI, P, was proposed on the basis of data availability. On the same basis, real GDP, y, was proposed for the scale variable. For the opportunity cost variables, we reached these conclusions.

Firstly, no domestic opportunity cost variable was considered suitable for the empirical analysis. The domestic interest rate was eliminated on the basis of having little or low variance and not available for the entire sample period of the empirical analysis here. Credit constraint variables were found unsatisfactory on the basis of pre-experimentation because they did not perform well.

The rate of inflation was eliminated as a long run determinant of money demand on the basis of its time series properties. In particular, for the empirical analysis here, it is constructed as the first difference of the log of the level of the domestic CPI. Since the latter is integrated of order one according to the results in the last chapter, this suggests that
the corresponding inflation rate is stationary. For this reason, the stationary (expected) inflation rate is eliminated from the set of non-stationary long run money demand variables.

Secondly, plausible open economy effects on domestic money demand in Cameroon were suggested on the basis of the theoretical analysis in chapter two to be in the form of currency substitution effects and/or capital mobility effects. Currency substitution was considered measurable via expectations of domestic currency depreciation and capital mobility by the foreign interest rate adjusted, if necessary, for expectations of domestic currency depreciation.

Open economy effects were analyzed with respect to the CFA area in the first instance, and then the world as a whole because the interpretation of the exchange rate differs between these two areas. With respect to the CFA area, we assumed away currency substitution on grounds of zero exchange rate dynamics or no currency depreciation effects. Given zero currency depreciation effects, foreign interest rate effects become the sole effects in terms of capital mobility. Within the CFA area, the choice of the foreign interest rate was considered with respect to France. Amongst other reasons, this is because France is: (1) the only country in this area with interest rate data, both in terms of span and variance, that is suitable for the empirical analysis here; (2) the only financially sophisticated economy within the area. Here, our notation for capital mobility (French interest rate) effects is $Z_c$.

In the theoretical discussion in chapter two, we concluded that the effects of the foreign interest rate on domestic money
holdings would generally be negative. The argument is as follows. An increase in the foreign interest rate means it would be more attractive to hold foreign bonds. However, *ceteris paribus*, domestic residents can only hold more foreign bonds if they reduce their holdings of other assets, including domestic money.

Outside the CFA zone, exchange rate variability stemming from the variability of the French franc against which the CFA franc is pegged can impinge on CFA economies and hence their effects on Cameroon cannot be ignored. For the empirical analysis in this thesis, the expected depreciation of the exchange rate which is considered as a measure of currency substitution is constructed as the first difference of the log of the level of the exchange rate. As the log of the level of the exchange rate is integrated of order one according to the empirical results in the last chapter, this implies that the expected depreciation of the exchange rate is stationary. This eliminates it, as in the case of the (expected) inflation rate, from the set of non-stationary long run money demand variables.

For capital mobility, when concern is with the world as a whole, our choice of interest rate is from the USA. This is not unreasonable as the US economy is arguably the leading economy in the world so that other interest rates are likely to be highly correlated with its rates. Here, capital mobility effects within the world are given by the US interest rate adjusted for expectations of depreciation of the domestic exchange rate.

This is a composite term consisting of the US interest rate which is non-stationary, see the last chapter, and the expected depreciation of the exchange rate which has just been shown to
be stationary. Engle and Granger (1991, p. 7) state that a linear combination of a stationary and an integrated variable (of order one) is integrated which implies the resulting capital mobility variable here, denoted $Z_w$, is integrated or non-stationary as the other money demand variables of interest.

Earlier, we noted that the effects of an increase in the foreign interest rate on domestic money holdings would be negative. In the theoretical discussion on money demand in chapter two, we saw that the effects of the expected depreciation of the exchange rate on domestic money demand would generally be negative. In particular, if the domestic currency is expected to depreciate, individuals will tend to demand less of it. Thus, we may argue that the overall effects of the foreign interest rate adjusted for the expected depreciation of the exchange rate would impact negatively on domestic money holdings.

Given that two different definitions of money and two different definitions of open economy opportunity cost effects are adopted here, four different models or sets of data are distinguished and analyzed in this chapter. These are:

1. narrow money CFA model which comprises the variables: $M_1, P, y, Z_c$
2. broad money CFA model which consists of the variables: $M_2, P, y, Z_c$
3. narrow money world model which consists of the variables: $M_1, P, y, Z_w$
4. broad money world model which comprises the variables: $M_2, P, y, Z_w$. 
Having specified the variables to be used for the empirical analysis of interest, we now consider the issue of functional form specification for the relationship to be investigated. There are two main approaches to this issue.

One consists of employing the logarithmic form of all the relevant variables. The other consists of employing the logarithmic form of all the variables except for the interest rate. According to Fair (op. cit.), it may not be sensible to take the interest rate in the logarithmic form because interest rates can be quite low at times. Not taking the logarithmic form of the interest rate, permits the interest elasticity of money balances to rise in absolute value with the interest rate. We experimented with both forms of the interest rate. There were no striking differences between them. The preferred results here are in terms of the non-log form for reasons given above.

Following the discussion so far, we postulate the following empirical aggregate long run money demand function for Cameroon.

\[ M_t = \alpha_0 + \alpha_1P_t + \alpha_2Y_t + \alpha_3Z_t + \epsilon_{1t} \quad \ldots \ldots \quad (5.4) \]

where: (1) \( M \) is domestic nominal money which is either M1 narrow money or M2 broad money; (2) \( t \) denotes time in quarterly terms; (3) \( P \) is the domestic CPI; (4) \( Y \) is domestic real GDP; (5) \( Z \) is either foreign opportunity cost effects within the CFA area denoted \( Z_c \) or the world denoted \( Z_w \); (6) \( \alpha_0 \) is the intercept while \( \alpha_i, \ i = 1, 2, 3, \) are parameters; (7) \( \epsilon \) is an error term.

Where a variable associated with a given \( \alpha_i \) is in logarithmic form, the \( \alpha_i \) (parameter) is interpreted as an
elasticity; otherwise, it is a semi-elasticity. The theoretical discussion given in chapter two suggests that \( a_1 > 0, a_2 > 0, a_3 < 0 \). If price homogeneity holds, then the value of \( a_1 \) should not be significantly different from unity. Also, if income homogeneity holds, then the value of \( a_2 \) should not be significantly different from unity. As we shall show below, neither of these postulates is data acceptable for Cameroon, hence the nominal money demand specification above is retained for further empirical analysis.

Given that the variables of the money demand relationship given by equation (5.4) are non-stationary, it is necessary they be co-integrated before valid inference can be made from their analysis. If co-integrated, then it follows from the Granger representation theorem or the theorem that co-integration implies error correction and vice versa that the dynamic representation for equation (5.4) is the error correction representation which can be written as:

\[
\Delta M_t = \beta_0 + \sum_{i=1}^{e} \beta_{1i} \Delta M_{t-1} + \sum_{i=0}^{f} \beta_{2i} \Delta P_{t-1} + \sum_{i=0}^{g} \beta_{3i} \Delta Y_{t-1} + \sum_{i=0}^{h} \beta_{4i} \Delta Z_{t-1} + \beta_5 \text{ECM}_{t-1} + \varepsilon_{2t} \tag{5.5}
\]

where ECM is the error from (5.4) above. Assuming co-integration, all variables, that is, the differenced variables and ECM term are stationary in equation (5.5) above, so that valid inference can be drawn from the dynamic analysis even though the level variables are non-stationary. The intercept term of the above equation is \( \beta_0 \). The parameters associated with \( \beta_j, j = 1, 2, 3, 4 \) measure the response of money balances to changes in the
relevant regressors. Economic theory has no concrete explanation as to the generation of dynamics. Thus, we cannot say \textit{a priori} whether the associated parameters are expected to take negative or positive values.

The parameter $\beta_5$ measures the extent of short run adjustment to disequilibrium. It is expected to be negative as suggested by the interpretation of error correction given earlier. Kremers \textit{et al.} (1992) have suggested testing the validity of co-integration within an error correction formulation by testing the significance of the (estimated) parameter associated with the error correction term. They show that this approach produces a more powerful test than the conventional Engle-Granger single equation approach because, unlike the latter, it does not involve a common factor restriction. In our specification, this amounts to testing the significance of $\beta_5$ using the t-test for example.

Under the null hypothesis of no co-integration, the associated t-statistic has a non-standard distribution. Kremers \textit{et al.} (op. cit.) suggest using DF/ADF type critical values. On the other hand, Banerjee \textit{et al.} (op. cit.) argue that the distribution of the statistic is closer to the normal distribution than the DF/ADF type distribution, suggesting the conventional t-test may be used.

Note that the validity of this approach rests on the validity of the single equation specification, that is, on the weak exogeneity of the explanatory variables. As argued below, a single equation framework is not appropriate, at least as a first step, in testing for co-integration when there are more than two variables as in our case. Even where a systems approach
is used, Kremers et al (op. cit.) note that the common factor restriction problem may still exist.

One implication of the above specification is that the estimation exercise involves two main stages. The first stage consists of estimating the co-integrating relationship and saving residuals. In the second stage, the residuals are inserted into the short run dynamic model involving differenced data. The main criticism is that it arbitrarily restricts the levels or long run information to a single entity given by the residuals.

As noted earlier in this section, it is possible to estimate the long and short run parameters jointly. This unrestricted approach consists of estimating the dynamic or differenced (or stationary) variables together with the levels (or non-stationary) variables. Consequently, it involves only a single estimation stage rather than two as in the restricted approach.

In terms of the specification above, a joint relationship may be derived as follows. The term ECM\_t-1 can be written thus:

\[ ECM_{t-1} = M_{t-1} - \alpha_0 - \alpha_1 P_{t-1} - \alpha_2 Y_{t-1} - \alpha_3 Z_{t-1}. \]

If the right hand side of this equation is substituted for ECM\_t-1 in equation (5.5), we obtain an unrestricted version of that equation which permits a joint estimation of short and long run parameters thus.

\[
\Delta M_t = \delta_0 + \Sigma_{t-1} \delta_{11} \Delta M_{t-1} + \Sigma_{t-1} \delta_{21} \Delta P_{t-1} + \Sigma_{t-1} \delta_{31} \Delta Y_{t-1} + \Sigma_{t-1} \delta_{41} \Delta Z_{t-1} + \gamma_0 M_{t-1} + \gamma_1 P_{t-1} + \gamma_2 Y_{t-1} + \gamma_3 Z_{t-1} + \varepsilon_{3t} \ldots (5.6);
\]

where \( \delta_0 = \beta_0 - \beta_5 \alpha_0, \gamma_0 = \beta_5, \gamma_1 = \beta_5 \alpha_1, \gamma_2 = \beta_5 \alpha_2, \gamma_3 = \beta_5 \alpha_3 \). It is apparent that all the parameters of equation (5.4) and (5.5) can be recovered from equation (5.6).
For example, the error correction coefficient $\beta_s$ is $y_0$, the long run price elasticity $\alpha_1$ is $y_1$ divided by $\beta_s$, the long run real income elasticity $\alpha_2$ is $y_2$ divided by $\beta_s$, and assuming $Z$ is not in logs, the long term capital mobility elasticity $\alpha_3$ is $y_3$ divided by $\beta_s$ multiplied by the mean of $Z$. The main problem with this approach is that one or more of the levels variables needed for co-integration may be statistically insignificant.

In modelling error correction, we use the general to specific approach which has become standard in this domain. This approach consists of specifying a general autoregressive distributed lag model. This is then reduced to a smaller model through the imposition of model acceptable restrictions.

Although the general to specific approach has become standard in error correction analysis, in terms of co-integration, there is no standard approach. A number of approaches have been put forward. These can be broadly classified as single equation and multiple equation.

It must be emphasised from the outset that when the number of variables under consideration is more than two as is the case here, it is not appropriate to use the single equation method such as the Engle-Granger approach, at least as the initial method of analysis, unless it has been determined that: (a) only a single co-integrating vector is present; (b) all other variables apart from that to be used as regressand are weakly exogenous.

As these issues have not yet been resolved for our empirical analysis, we adopt a systems method. Our choice is the Johansen FIML procedure. This is motivated by a number of considerations.
It is arguably the most widely used and researched systems approach and its pitfalls are probably better known than those associated with similar approaches. Furthermore, it is an integrated approach that permits at least: (a) the testing of co-integrating relation(s); (b) the estimation of the relation(s); (c) the testing of linear hypotheses concerning the relation(s). Moreover, according to Kremers et al (op. cit.), it does not have the common factor problem noted above because all its dynamics are unrestricted.

To discuss this approach, assume that $x_t$ is a time series vector with $n$ components which are the money demand variables given in the last section. To keep the discussion at a less complicated level, we further assume that the individual components of the vector $x_t$ are each integrated, that is $I(1)$. This assumption is consistent with the integration results of the variables in the last chapter. Finally, we assume that there are no deterministic components such as intercepts, trends, and seasonals. Later, many of these assumptions are relaxed in light of our particular analysis without affecting the general analytical thrust.

Bearing in mind the above assumptions, consider the $p$-th order autoregressive representation for $x_t$ thus:

$$x_t = \Pi_1 x_{t-1} + \Pi_2 x_{t-2} + \ldots + \Pi_p x_{t-p} + \epsilon_t \ldots \ldots \ldots \ldots \ldots (5.7);$$

where $\epsilon_t$ is a Gaussian error term. This representation can be reparameterized into the following vector error correction form.
\[ \Delta x_t = \Gamma_1 \Delta x_{t-1} + \ldots + \Gamma_{p-1} \Delta x_{t-p+1} + \Pi x_{t-p} + \varepsilon_t \ldots \ldots \ldots \ldots (5.8); \]

where: \( \Gamma_i = -(I - \Pi_1 - \ldots - \Pi_i); i = 1, 2, \ldots, p-1; \)
\( \Pi = -(I - \Pi_1 - \ldots - \Pi_p). \)

Representation (5.8) is a traditional VAR model in first differences except for the term \( \Pi x_{t-p} \), where \( \Pi \) is a matrix that contains the long run information about \( x_t \). As indicated below, the information contained in \( \Pi \) is of two types.

As co-integration has been interpreted as a long run phenomena, the long run information matrix \( \Pi \) is pivotal to the co-integration analysis here. In particular, an important step in the analysis consists of determining the rank of \( \Pi \) and considering various outcomes associated with it as follows.

(a) If \( \text{rank}(\Pi) = n \), then \( x_t \) is stationary. This makes the co-integration inquiry redundant in the sense that a regression involving the levels variables would not be spurious and standard econometric analysis can be applied.

(b) If \( \text{rank}(\Pi) = 0 \), then \( \Pi \) is a null matrix. This means that co-integration does not exist among the variables and that any regression involving the level variables will be spurious. Also, this implies the appropriate model for the variables is not the error correction representation above. The variables should be in first differences only.

(c) If \( 0 < \text{rank}(\Pi) = r < n \), this implies the matrix \( \Pi \) has a reduced rank. In this case, though the elements of \( x_t \) are non-stationary, \( r \) linear combinations of them are stationary. The reduced rank \( r \) can be interpreted as the number of distinct co-
integrating vectors which exist among the elements of $x_t$. In this case, we can find two other matrices, say $\alpha$ and $\beta$ both of dimension $n$ by $r$ such that:

$$\Pi = \alpha \beta' \ldots \ldots (5.9);$$

where $\beta$ is called the co-integrating matrix as it represents the matrix containing the $r$ co-integrating vectors. The co-integrating vectors are given by the columns of $\beta$. It is possible to test linear hypothesis on these vectors. With respect to our application, price and income homogeneity hypotheses are tested.

Given the matrix $\beta$, it is also possible to obtain another matrix $\beta'x_{t-p}$ which forms a set of $r$ error correction mechanisms.

The matrix $\alpha$ represents the set of weights with which each co-integrating vector enters each equation in the error correction representation. It can be interpreted as the adjustment matrix where a low value for its elements implies slow adjustment to equilibrium and a high value represents fast adjustment. This matrix is the standard vehicle for testing the weak exogeneity properties of the variables. We shall return to this issue later in terms of an application to our data.

Given the discussion above, the main empirical concern here consists of determining the rank of the matrix $\Pi$ and (if necessary) estimating the matrices $\alpha$ and $\beta$ as well as testing relevant hypotheses. This and related applications are the subject of the next section to which we now turn.
5.3: Applications, Results, and Discussions

5.3.1: Co-integration Analysis

We start our application by considering a number of empirical issues which are pertinent to a careful application of the Johansen procedure. These relate to the treatment of deterministic components and the selection of the lag length for the VAR.

The deterministic components that are addressed here are intercepts, trends, and seasonals. Firstly, we shall consider the issue of allowing for an intercept and/or trend in the analysis.

Johansen (1992) suggests calculating the relevant test statistic for the null under different specifications of deterministic components and rejecting the null only if it can be rejected in all cases.

In the univariate unit root analysis of a variable, a constant or intercept term allows for a non-zero mean in the levels of the data. It is assumed that differencing the data results in a transformed series with a zero mean. For the Johansen procedure, this implies that a constant is allowed in the long run model or the co-integration space but is not allowed in the short run model. This accounts for units of measurement in the levels of the variables.

If there are linear trends such that the data can be viewed as non-stationary with drift, a constant is allowed in the short run model. However, according to Harris (1995), it is assumed
that the intercept in the long run model is cancelled by the intercept in the short run model. This leaves the intercept in the short run model as the overall intercept.

According to Doornik and Hendry (1995), a quadratic deterministic trend in the levels of the data is not a plausible long run outcome so the trend should be forced to lie in the co-integration space, thereby restricting the system to at most a linear deterministic trend in levels.

The preferred approach here is that of an (overall) intercept in the short run model as it allows the data to drift. This is preferable on the basis of the results in the last chapter which indicate that some of the variables of interest, notably the money variables, are non-stationary with drift.

The next issue concerns seasonal dummies. As our data are seasonal, we experiment with and without dummies. Our reported results are for the form with seasonal dummies as their inclusion improved the overall properties of the modelling process. These dummies are centred so that they sum up to zero, otherwise, according to Harris (1995), the underlying asymptotic distribution of the test statistics will be affected. Furthermore, he stresses that including any other dummy or dummy-type variable will affect the underlying distribution of the statistics. For this reason, no other dummies are employed.

The next issue relates to lag length selection. As the properties of the error term in the Johansen approach are explicitly Gaussian, the lag length should be selected such that the residuals do not suffer from autocorrelation, non-normality, heteroscedasticity etc.
A major criticism that can be labelled to most of the money demand studies reviewed in chapter three that have used the Johansen procedure is the failure to properly address the Gaussian properties of the VAR used. The main implication is that these studies may be misleading.

For example, Hall (1991) notes that if autocorrelation is present, under standard OLS rule, the parameter estimates generating the residuals and hence the parameters of the co-integrating vectors are still consistent but the estimates of the variance of the residuals are biased so that corresponding test statistics will tend to be unreliable.

A weakness of the lag length selection in our approach is that the residuals of interest suffer from non-normality even when up to eight lags are investigated. It is apparent that increasing the lag length further is unlikely to induce normality so we follow Parikh (1994) and Johansen and Juselius (1990) for example, to model as a second-best option, despite the presence of non-normality. Given non-normality, caution should be placed on the interpretation of our results.

The model specification properties of the VAR used here are presented below for serial correlation, heteroscedasticity and normality of VAR model residuals. Ignoring normality for the reason given above, the results for the minimum lag length that ensures that the VAR is free from serial correlation and heteroscedasticity are given in table (5.1) below.

Here and in what follows, the estimation procedure is OLS where PcFiml version 8.0 by Doornik and Hendry (op. cit.) and Microfit version 3.1 by Pesaran and Pesaran (1991) are used as
Recall from the discussion in the last section that the models of interest and their respective variables are:

\[(1) \text{ M1 CFA} = (\text{M1, P, y, Z}_c)\];
\[(2) \text{ M2 CFA} = (\text{M2, P, y, Z}_c)\];
\[(3) \text{ M1 World} = (\text{M1, P, y, Z}_w)\];
\[(4) \text{ M2 World} = (\text{M2, P, y, Z}_w)\];

where M1 is narrow money in logs; M2 is broad money in logs; P is domestic CPI in logs; y is domestic real income in logs; Z_c is CFA capital mobility measure given by French long term interest rate; Z_w is world capital mobility measure given by the US long term interest rate adjusted for the expected depreciation of domestic exchange rate. Z_c and Z_w are in absolute terms. Given these comments, the VAR specification test results are:

<table>
<thead>
<tr>
<th>Model</th>
<th>p</th>
<th>Seco(1-5)</th>
<th>Norm</th>
<th>Hete</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 CFA</td>
<td>2</td>
<td>F(80,266)=1.31</td>
<td>$\chi^2(8)=46.81^*$</td>
<td>F(160,565)=1.02</td>
</tr>
<tr>
<td>M2 CFA</td>
<td>6</td>
<td>F(80,187)=1.16</td>
<td>$\chi^2(8)=19.52^*$</td>
<td>F(480,148)=0.36</td>
</tr>
<tr>
<td>M1 World</td>
<td>2</td>
<td>F(80,250)=1.26</td>
<td>$\chi^2(8)=32.79^*$</td>
<td>F(160,531)=1.08</td>
</tr>
<tr>
<td>M2 World</td>
<td>5</td>
<td>F(80,203)=0.98</td>
<td>$\chi^2(8)=29.10^*$</td>
<td>F(400,262)=0.60</td>
</tr>
</tbody>
</table>

In the above table, p represents the lag length for the VAR while Seco, Norm, and Hete are respectively residual serial correlation, normality, and heteroscedasticity tests.

The serial correlation test is an LM test given by Doornik...
and Hendry (op. cit.) where the null hypothesis is of no autocorrelation. The term Seco(1-5) in the table above indicates that the test is for lags one to five.

The normality test is based on the test proposed by Doornik and Hansen (1994). This is a $\chi^2(2n)$ test for the null hypothesis of normally distributed residuals where the skewness and kurtosis of the residuals are checked.

The heteroscedasticity test is based on the White (1980) test where the null hypothesis is of no heteroscedasticity.

As in the last chapter, all the tests in this chapter are evaluated at the 5% significance level where an asterisk represents significance. Where possible, the F-version of the tests is reported as the $\chi^2$-version has been shown by Kiviet (1986) to over-reject in small samples.

As is evident from the table above, the null hypotheses related to residual serial correlation and heteroscedasticity cannot be rejected while the null hypothesis for residual normality is rejected.

Having addressed the Gaussian properties of our data, our next interest lies in testing co-integration. Results are presented in table (5.2) below for the usual Johansen likelihood ratio tests, namely, the maximal eigenvalue and trace tests which are abbreviated respectively below as ME-test and TR-test.

To motivate their explanation, it is sufficient to note that it can be shown that the Johansen procedure involves $n$ (estimated) eigenvalues. These are the squares of the canonical correlations between the residuals of the regressions involving each differenced variable on its lags as well as those of the
other differenced variables on one hand and each level variable on its lagged differences as well as those of the other variables on the other hand.

Suppose the estimated eigenvalues are denoted \( e_i, i = 1, 2, \ldots, n \), and ordered from largest to smallest thus: \( e_1 \geq e_2 \geq \ldots \geq e_n \), then the maximal eigenvalue test can be framed as follows:

\[
ME = -T \ln(1-e_{r+1}) \ldots \ldots (5.10);
\]

where \( T \) is the sample size and \( \ln \) is the natural logarithm operator. The null hypothesis is that there are \( r \) co-integrating vectors against the alternative that there are \( r+1 \) co-integrating vectors. In a similar vein, the trace test can be framed thus:

\[
TR = -T \sum_{i=r+1}^{n} \ln(1-e_i) \ldots \ldots (5.11);
\]

The null hypothesis is that there are at most \( r \) co-integrating vectors against a general alternative.

The testing procedure for the above tests is a sequential one which starts from the null that \( r = 0 \) or that there are no co-integrating vectors in the system. If it cannot be rejected, the testing stops and we conclude that no significant statistical evidence for the existence of co-integrating vectors between the variables has been found. If the hypothesis that \( r = 0 \) is rejected, we then examine the null hypotheses that \( r \leq 1; r \leq 2; \ldots; r \leq q \) such that if the null hypothesis cannot be rejected for \( r \leq q \) but has been rejected for \( r \leq q-1 \), then we conclude
that there are \( r = q \) co-integrating vectors. Table (5.2) below is a summary of our results.

**Table (5.2): Co-integration Test Results**

<table>
<thead>
<tr>
<th>Model</th>
<th>ME-test</th>
<th>TR-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ho</td>
<td>H1ME</td>
</tr>
<tr>
<td>M1 CFA</td>
<td>r=0</td>
<td>r=1</td>
</tr>
<tr>
<td></td>
<td>r≤1</td>
<td>r=2</td>
</tr>
<tr>
<td>M2 CFA</td>
<td>r=0</td>
<td>r=1</td>
</tr>
<tr>
<td></td>
<td>r≤1</td>
<td>r=2</td>
</tr>
<tr>
<td>M1 World</td>
<td>r=0</td>
<td>r=1</td>
</tr>
<tr>
<td></td>
<td>r≤1</td>
<td>r=2</td>
</tr>
<tr>
<td>M2 World</td>
<td>r=0</td>
<td>r=1</td>
</tr>
<tr>
<td></td>
<td>r≤1</td>
<td>r=2</td>
</tr>
</tbody>
</table>

In the table above, (1) Ho, (2) H1ME, (3) H1TR, (4) ST, and (5) CV stand respectively for: (1) the null hypothesis for both ME-test and TR-test; (2) the alternative hypothesis for the ME-test; (3) the alternative hypothesis for the TR-test; (4) statistic of interest; and (5) critical value of interest.

The results from both tests indicate that for each model, there is one significant estimated eigenvector which is associated with the estimated eigenvalues of interest and can be interpreted as an estimated co-integrating vector.

In empirical analysis, it is conventional to normalize the co-integrating vector on a given variable or component of the vector and interpret the vector in terms of that variable. Roughly speaking, this amounts to dividing the estimates on all the variables of the vector by the estimate on the variable of interest in the vector. In order to arrive at a preferred
normalization, it is important to consider the merit of the normalization relating to each variable.

In our case, we shall consider in the first instance the normalization on money as interest in this chapter lies primarily on money demand. This is presented in table (5.3) below.

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimated Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 CFA</td>
<td>$M_1 = 1.18P + 0.84y - 0.32Z_c$</td>
</tr>
<tr>
<td>M2 CFA</td>
<td>$M_2 = 1.51P + 0.76y - 0.21Z_c$</td>
</tr>
<tr>
<td>M1 World</td>
<td>$M_1 = 1.26P + 0.68y - 0.13Z_w$</td>
</tr>
<tr>
<td>M2 World</td>
<td>$M_2 = 1.53P + 0.72y - 0.11Z_w$</td>
</tr>
</tbody>
</table>

In the table below and other normalization tables that follow, all the coefficients of the estimated vectors represent long run elasticities. Furthermore, given that the opportunity cost measure Z is not in logs, the associated long run elasticity has been derived by multiplying the relevant semi-elasticity by the mean of Z.

The first question that arises on the money normalization above relates to identification. As there is only one co-integrating vector, (assuming the normalization on money is right) the normalization represents either money demand or money supply but not both. The question that follows is whether it is better to interpret the money normalization in terms of money demand or money supply?

Following past empirical knowledge, the money demand interpretation would appear to be preferred for the following
reasons. The elasticities on the (foreign) opportunity cost variables are all negative as suggested by money demand theory and their magnitudes are not unreasonable. Again, as suggested by money demand theory, the elasticities on the price and real income variables have positive signs. However, the magnitudes of these elasticities suggest that the usual price and income money demand homogeneity restrictions are unlikely to be data acceptable in most cases. The results in table (5.4) below support this suspicion. In that table, the abbreviation HoR stands for homogeneity restriction. The homogeneity restrictions here are imposed using the following test statistic.

\[ RT = T \sum_{i=1}^{r} \ln \left( \frac{(1-e_{1i})}{(1-e_{2i})} \right) \] .......(5.12);

where \( r \) represents the number of co-integrating vectors and \( e_{1i} \) and \( e_{2i} \) represent respectively the estimated eigenvalues from the restricted and unrestricted systems. The null hypothesis is that the restrictions are valid where the test statistic is asymptotically distributed as \( \chi^2(rn) \) where \( r \) is the number of co-integrating vectors and \( n \) is the number of restrictions that have been imposed.

The price homogeneity restriction is conducted by setting the coefficients on nominal money and price to unity. By the same token, the income homogeneity restriction involves setting the coefficients on nominal money and income to unity. The restrictions administered jointly are given as price/income homogeneity restrictions.
As is evident from the table above, the price homogeneity restriction is not acceptable in any of the models. The income homogeneity restriction is acceptable in model M1 CFA only. The joint restrictions are also acceptable in model M1 CFA.

The rejection of the price homogeneity postulate in empirical money demand analysis is not without empirical antecedents. As noted in chapter one, Boughton (1991b) and Arestis et al (op. cit.) report a similar rejection for developed countries. In fact, Boughton (1991b) includes France from where the interest rate used here in the CFA models is taken. Though a developed country, it may be informative to show the results here. These are briefly presented in table (5.5) below.

### Table (5.5): French Money Normalized Co-integrating Vectors

**Source:** Boughton (1991b)

<table>
<thead>
<tr>
<th>Model</th>
<th>Price HoR</th>
<th>Income HoR</th>
<th>Price/Income HoR</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 CFA</td>
<td>$\chi^2(1)=4.03^*$</td>
<td>$\chi^2(1)=1.33$</td>
<td>$\chi^2(2)=5.25$</td>
</tr>
<tr>
<td>M2 CFA</td>
<td>$\chi^2(1)=25.52^*$</td>
<td>$\chi^2(1)=6.40^*$</td>
<td>$\chi^2(2)=28.80^*$</td>
</tr>
<tr>
<td>M1 World</td>
<td>$\chi^2(1)=7.95^*$</td>
<td>$\chi^2(1)=6.70^*$</td>
<td>$\chi^2(2)=7.95^*$</td>
</tr>
<tr>
<td>M2 World</td>
<td>$\chi^2(1)=22.98^*$</td>
<td>$\chi^2(1)=9.93^*$</td>
<td>$\chi^2(2)=23.57^*$</td>
</tr>
</tbody>
</table>

In the above table, RS and RL are absolute values of French short and long term interest rates. Recall that when interest
lies within the CFA zone (that is, M1 CFA and M2 CFA models in our study), the opportunity cost measure is represented by $Z_c$ and is approximated by the French long term interest rate.

Apart from the refutation of price homogeneity, there is an unusual similarity between Boughton's results and ours: the magnitudes of the income elasticity are similar in they are significantly less than one. This is unusual because income elasticity of money demand in the developing world context is often perceived to be significantly above unity: the luxury good hypothesis. It is thus possible to interpret our results as supporting the theoretical predictions of the Baumol model reviewed in chapter two that there are economies of scale in money holdings. However, the elasticity is far from one-half as predicted by the model.

There is the long standing contention first suggested by Walters (1967) that the conventional money demand variables may be more appropriately modelled as a price relationship rather than a money demand relationship. Thus, there is a strong reason here to consider the merits of the normalization on prices. The normalization is presented in table (5.6) below.

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimated Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 CFA</td>
<td>$P = 0.85M1 - 0.72y + 0.27Z_c$</td>
</tr>
<tr>
<td>M2 CFA</td>
<td>$P = 0.66M2 - 0.50y + 0.14Z_c$</td>
</tr>
<tr>
<td>M1 World</td>
<td>$P = 0.80M1 - 0.54y + 0.10Z_w$</td>
</tr>
<tr>
<td>M2 World</td>
<td>$P = 0.65M2 - 0.47y + 0.07Z_w$</td>
</tr>
</tbody>
</table>
Relating to the table above, there are no *a priori* theoretical reasons to suggest the elasticities on money and the foreign opportunity cost measures are unrealistic. However, the income elasticities suggest that an increase in real income leads to a less than proportionate decrease in prices: an outcome that is difficult to justify from a theoretical point of view.

Furthermore, as a price relationship in a fixed exchange rate zone, the long run price relationship (normalization) in the table above would appear to be mis-specified because it does not allow for some form of external price linkage. Overall, theoretical analysis suggests that prices in a small economy with fixed exchange rates would be exogenous in the sense they are likely to be determined by the level of foreign prices. Therefore, to the extent that prices are not determined within our economy of interest, they are likely to be exogenous.

At this junction, it appears the price normalization form of the co-integrating vectors is inadequate. However, although it may be perfectly sensible to choose a given normalization from a theoretical point of view, as we shall see below, empirical diagnostic analysis may suggest otherwise.

The next normalization concerns real income which is presented in table (5.7) below. If we were to prefer this normalization, this would tantamount to accepting that real income in Cameroon can be adequately explained in the long run by nominal money, prices, and the nominal level of the foreign interest rate or the foreign interest rate adjusted for expected exchange rate depreciation. This view would run contrary to the view expressed in chapter two which considers the determination
of real income in the long run to be largely based on the real side of the economy.

Table (5.7): Income Normalized Co-integrating Vectors

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimated Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 CFA</td>
<td>$y = 1.19M1 - 1.40P + 4.05Z_c$</td>
</tr>
<tr>
<td>M2 CFA</td>
<td>$y = 1.32M2 - 1.99P + 3.04Z_c$</td>
</tr>
<tr>
<td>M1 World</td>
<td>$y = 1.47M1 - 1.85P + 2.35Z_w$</td>
</tr>
<tr>
<td>M2 World</td>
<td>$y = 1.39M2 - 2.13P + 1.93Z_w$</td>
</tr>
</tbody>
</table>

Finally, the normalization on the foreign opportunity cost measures which is presented in table (5.8) below appears to be the least appealing for the following reason. Accepting the normalization on the foreign variables would amount to accepting that the French/US variables of interest here can be adequately explained in terms of variables from Cameroon only: a suggestion which is not reasonable in view of the small economy implications of Cameroon.

Table (5.8): Z Normalized Co-integrating Vectors

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimated Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 CFA</td>
<td>$Z_c = -0.29M1 + 0.34P + 0.25y$</td>
</tr>
<tr>
<td>M2 CFA</td>
<td>$Z_c = -0.43M2 + 0.65P + 0.33y$</td>
</tr>
<tr>
<td>M1 World</td>
<td>$Z_w = -0.63M1 + 0.79P + 0.43y$</td>
</tr>
<tr>
<td>M2 World</td>
<td>$Z_w = -0.72M2 + 1.10P + 0.52y$</td>
</tr>
</tbody>
</table>
At this junction, it is possible to conclude that there is stronger evidence for the normalization on money as opposed to other variables. In any case, the theoretical analysis in chapter two suggests that money would be endogenous in a fixed exchange rate. Thus, unless the evidence against the money normalization is overwhelming, our preference will be on money.

Earlier in this chapter, we noted that an important reason for using a systems method in co-integration analysis is that one or more of the regressors that would appear in single equation modelling may not be weakly exogenous. In what follows, we check the relevance of this statement for our analysis.

Harris (1995) notes that it is important to stress that testing for weak exogeneity in a particular vector of variables presumes that the vector represents a structural long run relationship and not a linear combination of the variables, otherwise the adjustment coefficients will also be a linear combination of the speed of adjustment so that testing for weak exogeneity in such a context would not be meaningful.

Unfortunately, the above presumption is not very robust. In particular, Dickey et al (1991) note that co-integrating vectors cannot be interpreted as representing structural equations because in general there is no way of going back from the reduced form of the system from where the vectors have been obtained to the structure without the use of identifying restrictions. Consequently, the weak exogeneity tests that follow should be interpreted with caution.

Testing for weak exogeneity in the Johansen procedure consists of testing the validity of zero restrictions on the
adjustment coefficients contained in the adjustment matrix, \( a \), using the test statistic seen earlier for testing restrictions. As before, the null hypothesis is that the restrictions are valid against the alternative that they are not. If valid, weak exogeneity holds for the variables on which zero restrictions have been imposed on their adjustment coefficients.

One implication when there is only a single co-integrating vector as in each of the model cases above, is that, \( a \), the adjustment coefficient matrix reduces to a column vector. This vector can be written here as \( a' = (a_m, a_p, a_y, a_z)' \) where \( a_m \), \( a_p \), \( a_y \), and \( a_z \) represent respectively the adjustment coefficients associated with nominal money, prices, real income, and the opportunity cost measure of interest. The weak exogeneity tests here consist of imposing zero restrictions on the coefficients associated with all other variables except that which would be considered as dependent in single equation modelling.

For example, to test whether in a model for money the regressor variables are weakly exogenous, we impose the following zero restrictions: \( a' = (a_m, 0, 0, 0)' \). If they are not rejected, the implication is that there is no loss of information from conditioning money on the weakly exogenous variables in single equation modelling. Results for these restrictions appear in column one in table (5.9) below.

As another example, to test whether in a model for real income, the regressor variables are weakly exogenous, we impose the following zero restrictions: \( a' = (0, 0, a_y, 0)' \). The implication for a non-rejection of the restrictions for real income model are interpretable in a similar vein as in the
previous case. The results for these restrictions appear in column three of table (5.9).

In columns two and four, similar restrictions apply for prices and the opportunity cost measures respectively. Generally, the rejection (non-rejection) of the zero restrictions tests here implies there is loss (no loss) of information from estimating the parameters of the model of interest in a single equation framework.

<table>
<thead>
<tr>
<th>Model</th>
<th>M</th>
<th>P</th>
<th>(\chi^2(3))</th>
<th>(\chi^2(3))</th>
<th>(\chi^2(3))</th>
<th>(\chi^2(3))</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 CFA</td>
<td>(\chi^2(3)=27.69^*)</td>
<td>(\chi^2(3)=3.72)</td>
<td>(\chi^2(3)=11.07^*)</td>
<td>(\chi^2(3)=25.39^*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2 CFA</td>
<td>(\chi^2(3)=22.54^*)</td>
<td>(\chi^2(3)=18.89^*)</td>
<td>(\chi^2(3)=32.82^*)</td>
<td>(\chi^2(3)=32.76^*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M1 World</td>
<td>(\chi^2(3)=30.46^*)</td>
<td>(\chi^2(3)=7.04)</td>
<td>(\chi^2(3)=12.32^*)</td>
<td>(\chi^2(3)=14.43^*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2 World</td>
<td>(\chi^2(3)=26.08^*)</td>
<td>(\chi^2(3)=4.91)</td>
<td>(\chi^2(3)=13.70^*)</td>
<td>(\chi^2(3) =27.04^*)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results above indicate in all cases that money cannot be modelled in a single equation framework without loss of information while in all but one (M2 CFA) model, prices can be modelled in a single equation framework without loss of information. This may be interpreted as suggesting the appropriateness of a systems approach for analysing our data as opposed to a single equation approach.

Given that we have already expressed caution in the reliability of our results so far, it may be necessary to check the robustness of the results using an alternative approach. A simple and robust test for weak exogeneity in an error correction framework is given by Engle and Granger (op. cit.).
Following Huang (1994), the test can be explained as follows for the money demand equation. For a given explanatory variable, invert the money demand equation such that the explanatory variable becomes the dependent variable and test the significance of the error correction term normalized on that variable in the inverted equation.

An insignificant error correction term means that the chosen normalization does not respond to past disequilibrium in the error-correction system and the variable upon which normalization is made is considered exogenous. This type of testing is preferred to the instrumental variables approach or the Wu-Hausman test in that it does not require the use of instruments which may be difficult to obtain or justify.

Hendry and Ericsson (1991) extend the testing further to include strong exogeneity. This requires the additional condition that the parameters in the system be constant over time.

The results of the significance of the error correction term as a test of weak exogeneity are given below as part of wider results relating to the short run analysis of interest.

As indicated in the last section, while co-integration is the appropriate concept for modelling non-stationary long run variables, error correction is the corresponding short run concept. Furthermore, we noted that in the context of error correction, the general to specific modelling approach is usually preferred. This is the subject of the next section.
5.3.2: Error Correction Analysis

The analysis of the error correction approach here is based on the general to specific modelling approach as just indicated above.

Our modelling approach is as follows. We regress the first difference of a given variable of the co-integrating vector on: (1) an intercept; (2) lagged differences of the regressand; (3) current differences of each of the other variables of the co-integrating vector as well as their lagged differences; (4) the one-period lag of the residuals from the co-integrating vector of interest normalized on the regressand or one-period lag of each of the appropriate level variables of the vector.

Where the one-period lag of the residuals from the co-integrating vector is used, this constitutes a two-stage estimation exercise denoted here as TS-Estimation. Where the level variables are estimated together with the differenced variables, this constitutes a single-stage estimation exercise denoted here as SS-Estimation. In each case, the estimated model is then reduced to a more parsimonious model by deleting the regressors that turn out to be insignificant according to a standard t-test.

Dummy variables, $D_i$, $(i = 1, 2, 3)$ and an intercept, $K$, are also included as additional regressors. Dummy variables that are insignificant according to a standard t-test and/or lead to a deterioration in the statistical properties of the model are deleted. The model specification diagnostics are assessed thus.

The null hypothesis of no serial correlation is tested using
the test proposed by Godfrey (1978).

The null hypothesis of no functional form mis-specification is tested via the test suggested by Ramsey (1969).

For normality, the test proposed by Bera and Jarque (1981) is employed to test the null hypothesis that the residuals are normally distributed.

The null hypothesis of no heteroscedasticity is tested using the test suggested by Pesaran and Pesaran (op. cit.).

The Engle (1982) test is used to test the null hypothesis of no autoregressive conditional heteroscedasticity (ARCH).

An important aspect of model specification is parameter stability for parameter instability would indicate that the regressand does not maintain consistent dynamic relationship with its determinants. Given the importance of this, we employ a battery of tests for the null hypothesis of parameter constancy.

Firstly, we employ Chow's second test for predictive failure by splitting the sample into two where 8 observations are allowed for forecast. Simmons (op. cit.) notes that unlike Chow's first test for parameter constancy, the second test does not have power against an increase in variance in the prediction period, hence caution should be exercised in interpreting its results.

Secondly, we employ the test suggested by Brown et al (1975) which is in two versions. The first version, denoted here as cusum, is based on the cumulative sum of recursive residuals while the second, denoted here as cusumsq, is based on the cumulative sum of the squares of recursive residuals. Results for both tests are assessed graphically, where for each graph, a pair of straight lines is plotted at the 5% significance level. If the
graph lies within (outside) the 5% critical value, this indicates stability (instability). According to Pesaran and Pesaran (op. cit.), the cusum test is particularly useful in detecting systematic changes in the regression coefficients while the cusumsq test is useful in cases where the departure from constancy of the regression coefficients is haphazard and sudden.

Thirdly, we employ the Farley et al (1975) test which is useful in situations where the shift in parameters is not known and may be gradual. This test is conducted here as the F-test for the joint significance of additional regressors constructed as \(tx_i\), where \(x_i\) are the explanatory variables and \(t\) is time.

As in the VAR diagnostic tests presented earlier, where possible, the F-version of the above tests is reported as the \(\chi^2\)-version has been shown to over-reject in small samples. The tests are evaluated at the 5% significance level. In the presentation of results, the following additional comments apply.

The operator \(\Delta\) before a variable is the first difference of that variable. The negative number in brackets after a variable is the lag of the variable. A regressor is retained if the associated t-ratio is at least two in absolute value.

The variable ECM\(_i\) represents the residuals from the normalized co-integrating vector of interest where \(i (i = M1 \text{ or } M2, P, y, Z_c \text{ or } Z_w)\) represents the variable upon which the normalization of the long run or co-integrating vector is made.

Furthermore, \(R^2\), \(F^*\), SE, and DW are respectively the coefficient of determination adjusted for the number of regressors, the regression F-statistic for testing the null hypothesis that all the regressors as a group except the constant
are zero, standard error of regression, and the Durbin-Watson statistic. Model diagnostic failures are highlighted using bold italics while a summary of diagnostics failures is given later. The presentation of results is as follows.

Firstly, we present the results for the two-stage estimation exercise or the case where the residuals from the relevant normalized co-integrating vector are used as the error correction term. The residuals used here are from the co-integrating vectors given earlier.

The significance of the error correction term has a dual interpretation here. Firstly, following Huang (op. cit.), we interpret a significant (insignificant) error correction term in weak exogeneity terms as suggesting the chosen normalization (dependent variable) is endogenous (exogenous). Secondly, following Kremers et al (op. cit.), see section two, we also interpret this as suggesting co-integration (lack of co-integration).

Next, we present the results for the joint estimation exercise or the case where the level variables constituting the error correction term and the differenced variables are estimated jointly.

Lastly, a comparative analysis of various models is given in terms of diagnostic problems and a preferred model is chosen in light of all the issues examined.

Commencing with M1 CFA Model, the results for money and prices as regressands in the two-stage estimation approach are given respectively in tables (5.10) and (5.11) below.
Table (5.10): ΔM₁ as Regressand in M₁ CFA Model (TS-Estimation)

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.113</td>
<td>4.954</td>
</tr>
<tr>
<td>ΔD₃</td>
<td>-0.061</td>
<td>-4.287</td>
</tr>
<tr>
<td>ΔM₁(-3)</td>
<td>0.226</td>
<td>3.061</td>
</tr>
<tr>
<td>ΔM₁(-6)</td>
<td>-0.575</td>
<td>-9.360</td>
</tr>
<tr>
<td>ΔP</td>
<td>1.058</td>
<td>2.730</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.141</td>
<td>3.045</td>
</tr>
<tr>
<td>Δy</td>
<td>0.948</td>
<td>2.870</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.710</td>
<td>2.359</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.438</td>
<td>2.532</td>
</tr>
<tr>
<td>ΔZₜ</td>
<td>2.201</td>
<td>2.644</td>
</tr>
<tr>
<td>ΔZₜ(-8)</td>
<td>3.113</td>
<td>3.435</td>
</tr>
<tr>
<td>ECM₉₉₁(-1)</td>
<td>-0.221</td>
<td>-4.082</td>
</tr>
</tbody>
</table>

Model Diagnostics

\[
R^2 = 0.73, \quad F^* = F(11, 83) = 23.81, \quad SE = 0.04, \quad DW = 2.23.
\]

Autocorrelation: \( F(1, 82) = 1.59, \quad F(2, 81) = 1.00, \quad F(3, 80) = 0.67, \)
\( F(4, 79) = 0.59, \quad F(5, 78) = 0.57, \quad F(8, 75) = 0.98, \quad F(12, 71) = 0.84. \)

Functional Form: \( F(1, 82) = 3.04. \)

Normality: \( \chi^2(2) = 2.11. \)

Heteroscedasticity: \( F(1, 93) = 0.76. \)

ARCH: \( F(1, 82) = 0.96, \quad F(2, 81) = 0.95, \quad F(3, 80) = 0.65, \quad F(4, 79) = 0.76. \)

Stability: (1) Chow's 2nd Test = \( F(8, 75) = 0.82; \) (2) Farley et al. = \( F(12, 71) = 1.02; \) (3) plot of Cusum and Cusum squares of recursive residuals lies within the 5% critical bounds.
Table (5.11): ΔP as regressand in M1 CFA Model (TS-Estimation)

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.022</td>
<td>-4.582</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.358</td>
<td>4.271</td>
</tr>
<tr>
<td>ΔM₁(-1)</td>
<td>-0.039</td>
<td>-2.693</td>
</tr>
<tr>
<td>Δy</td>
<td>-0.710</td>
<td>-15.417</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.359</td>
<td>4.963</td>
</tr>
<tr>
<td>Δy(-2)</td>
<td>0.120</td>
<td>2.635</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.198</td>
<td>-4.678</td>
</tr>
<tr>
<td>ΔZₜ(-4)</td>
<td>0.606</td>
<td>2.488</td>
</tr>
<tr>
<td>ΔZₜ(-5)</td>
<td>-0.795</td>
<td>-3.267</td>
</tr>
<tr>
<td>ECMₚ(-1)</td>
<td>-0.084</td>
<td>-6.703</td>
</tr>
</tbody>
</table>

Model Diagnostics

- $R^2 = 0.78$, $F^* = F(9, 88) = 39.36$, $SE = 0.010$, $DW = 2.17$.
- Autocorrelation: $F(1, 87) = 0.14$, $F(2, 86) = 1.15$, $F(3, 85) = 1.03$, $F(4, 84) = 1.15$, $F(5, 83) = 0.96$, $F(8, 80) = 2.20$, $F(12, 76) = 1.81$.
- Functional Form: $F(1, 87) = 3.06$.
- Normality: $\chi^2(2) = 5.69$.
- Heteroscedasticity: $F(1, 96) = 4.42$.
- ARCH: $F(1, 87) = 7.10$; $F(2, 86) = 3.49$; $F(3, 85) = 2.70$, $F(4, 84) = 1.97$.

Stability: (1) Chow's 2nd Test = $F(8, 80) = 1.08$; (2) Farley et al = $F(10, 78) = 1.53$; (3) plot of cusum of residuals lies within the 5% critical bounds but that of cusum of squares of residuals lies outside the 5% critical bounds from the late 70s to the late 80s suggesting instability during that period.
The model for prices in table (5.11) above appears quite satisfactory at first sight as the error correction term is negative and very significant. This can be interpreted in the dual significance terms stated earlier as suggesting co-integration on one hand and endogeneity of the regressand on the other. However, this interpretation is not reliable as the model diagnostics reveal a number of diagnostic failures. These relate to serial correlation, heteroscedasticity, ARCH, and stability.

In contrast, the corresponding model for money in table (5.10) does not exhibit any diagnostic failures. It has a negative error correction term as expected of a valid error correction model. Furthermore, the value of the t-ratio on the error correction term is very significant, suggesting co-integration and money endogeneity.

The coefficient on the error correction term in the money model is considerably greater than that in the prices model suggesting greater adjustment towards equilibrium in the former than in the latter.

In the money model, a conspicuous feature relates to the fact that the coefficients on the lag of the inflation (difference of the log of prices) term and the differenced interest rate terms are positive rather than negative. We shall return to this in the next section. Also, notice that the lag value of eight on the interest rate appears rather long.

We now turn to the results for M2 CFA Model where concern is with money and prices as regressands.
<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.244</td>
<td>3.294</td>
</tr>
<tr>
<td>AM2(-1)</td>
<td>0.356</td>
<td>3.468</td>
</tr>
<tr>
<td>AM2(-2)</td>
<td>-0.373</td>
<td>-4.413</td>
</tr>
<tr>
<td>AM2(-3)</td>
<td>0.233</td>
<td>2.582</td>
</tr>
<tr>
<td>AM2(-6)</td>
<td>-0.330</td>
<td>-4.198</td>
</tr>
<tr>
<td>ΔP</td>
<td>0.992</td>
<td>3.039</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.385</td>
<td>4.137</td>
</tr>
<tr>
<td>Δy</td>
<td>0.716</td>
<td>2.548</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.921</td>
<td>3.362</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.660</td>
<td>3.873</td>
</tr>
<tr>
<td>ΔZc(-4)</td>
<td>-1.636</td>
<td>-2.018</td>
</tr>
<tr>
<td>ECM_m2(-1)</td>
<td>-0.200</td>
<td>-3.265</td>
</tr>
</tbody>
</table>

Model Diagnostics

- $R^2 = 0.71$, $F^* = F(11, 85) = 22.76$, $SE = 0.04$, $DW = 2.06$.
- Autocorrelation: $F(1,84) = 0.38$, $F(2,83) = 0.76$, $F(3,82) = 0.64$, $F(4,81) = 0.50$, $F(5,80) = 0.41$, $F(8,77) = 1.32$, $F(12,73) = 1.55$.
- Functional Form: $F(1,84) = 0.83$.
- Normality: $\chi^2(2) = 1.44$.
- Heteroscedasticity: $F(1,95) = 0.07$.
- ARCH: $F(1,84) = 0.96$, $F(2,83) = 0.76$, $F(3,82) = 0.62$, $F(4,81) = 0.88$.
- Stability: (1) Chow's 2nd Test = $F(8,77) = 0.22$; (2) Farley et al = $F(12,73) = 1.73$; (3) plot of cusum of residuals lies within the 5% critical bounds but that of cusum of squares of residuals lies outside the 5% critical bounds in the early 80s suggesting instability during that period.
Table (5.13): $\Delta P$ as regressand in M2 CFA Model (TS-Estimation)

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.106</td>
<td>-6.999</td>
</tr>
<tr>
<td>$\Delta P(-1)$</td>
<td>0.327</td>
<td>3.859</td>
</tr>
<tr>
<td>$\Delta M2$</td>
<td>0.059</td>
<td>3.414</td>
</tr>
<tr>
<td>$\Delta M2(-1)$</td>
<td>-0.044</td>
<td>-2.594</td>
</tr>
<tr>
<td>$\Delta y$</td>
<td>-0.657</td>
<td>-14.376</td>
</tr>
<tr>
<td>$\Delta y(-1)$</td>
<td>0.319</td>
<td>4.327</td>
</tr>
<tr>
<td>$\Delta y(-4)$</td>
<td>-0.225</td>
<td>-5.233</td>
</tr>
<tr>
<td>$\Delta Z_c(-4)$</td>
<td>0.583</td>
<td>2.520</td>
</tr>
<tr>
<td>$\Delta Z_c(-5)$</td>
<td>-0.568</td>
<td>-2.379</td>
</tr>
<tr>
<td>ECM$_p(-1)$</td>
<td>-0.137</td>
<td>-7.500</td>
</tr>
</tbody>
</table>

Model Diagnostics

$R^2=0.79$, $F^*=F(9,87)=41.24$, $SE=0.01$, $DW=2.31$.

Autocorrelation: $F(1,86)=6.22$, $F(2,85)=3.16$, $F(3,84)=3.69$, $F(4,83)=3.08$, $F(5,82)=2.44$, $F(8,79)=3.72$, $F(12,75)=2.98$.

Functional Form: $F(1,86)=2.22$.

Normality: $\chi^2(2)=16.52$.

Heteroscedasticity: $F(1,95)=5.47$.

ARCH: $F(1,86)=10.38$, $F(2,85)=5.17$, $F(3,84)=4.09$, $F(4,83)=3.36$.

Stability: (1) Chow's 2nd Test=$F(8,80)=0.80$; (2) Farley et al=$F(10,78)=0.36$; (3) plot of cusum of residuals lies within the 5% critical bounds but that of cusum of squares of residuals lies outside the 5% critical bounds within the late 70s to the late 80s suggesting instability during that period.
The results above in tables (5.12) and (5.13) for money and prices respectively when concern is with M2 CFA model are quite similar to those for M1 CFA Model seen earlier.

The error correction term in both normalizations is quite significant according to the t-test and has the correct negative value. In terms of dual significance, this can be interpreted as suggesting co-integration on one hand and endogeneity of the regressand on the other.

Also, the diagnostic statistics differ significantly in both normalizations. Save for the diagnostic failure for the cusum of squares of recursive residuals, the remainder of the diagnostics are satisfactory for money as the regressand.

On the contrary, when prices are the regressand, the diagnostics are very poor. These relate to auto-correlation, normality, heteroscedasticity, ARCH, and cusum of squares of recursive residuals. Again, this implies that the model for prices is less reliable than the money model.

In what follows, most of the remaining models exhibit poor diagnostic properties. As a cautionary note, inferences drawn from them should be viewed with scepticism as they are unlikely to be valid.

Our next attention is focused on M1 World Model. In a pattern which is familiar at this stage, for money and prices as regressands, the results are presented respectively in tables (5.14) and (5.15) as follows.
Table (5.14): ΔM1 as regressand in M1 World Model (TS-Estimation)

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.114</td>
<td>2.198</td>
</tr>
<tr>
<td>D2</td>
<td>-0.062</td>
<td>-3.538</td>
</tr>
<tr>
<td>D3</td>
<td>-0.093</td>
<td>-5.711</td>
</tr>
<tr>
<td>ΔM1(-3)</td>
<td>0.194</td>
<td>2.862</td>
</tr>
<tr>
<td>ΔM1(-6)</td>
<td>-0.383</td>
<td>-4.243</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.156</td>
<td>3.880</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.762</td>
<td>3.142</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.569</td>
<td>3.194</td>
</tr>
<tr>
<td>Δy(-7)</td>
<td>-0.432</td>
<td>-2.663</td>
</tr>
<tr>
<td>ΔZw(-1)</td>
<td>0.348</td>
<td>3.764</td>
</tr>
<tr>
<td>ΔZw(-4)</td>
<td>0.210</td>
<td>2.209</td>
</tr>
<tr>
<td>ECM_m(-1)</td>
<td>-0.053</td>
<td>-1.237</td>
</tr>
</tbody>
</table>

Model Diagnostics

- $R^2 = 0.74$; $F^* = F(11, 84) = 26.21$; $SE = 0.041$; $DW = 1.95$
- Autocorrelation: $F(1, 83) = 0.03$, $F(2, 82) = 0.27$, $F(3, 81) = 0.18$, $F(4, 80) = 0.14$, $F(5, 79) = 0.19$, $F(6, 78) = 0.30$, $F(12, 72) = 0.28$.
- Functional Form: $F(1, 83) = 0.08$.
- Normality: $\chi^2(2) = 1.76$.
- Heteroscedasticity: $F(1, 94) = 0.002$.
- ARCH: $F(1, 83) = 3.08$, $F(2, 82) = 2.70$, $F(3, 81) = 1.81$, $F(4, 80) = 1.37$.
- Stability: (1) Chow's 2nd Test = $F(8, 76) = 1.36$; (2) Farley et al = $F(12, 72) = 2.33.4$; (3) plot of Cusum and Cusum squares of recursive residuals lies within the 5% critical bounds.
Table (5.15): ΔP as regressand in M1 World Model (TS-Estimation)

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.057</td>
<td>-4.339</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.487</td>
<td>5.742</td>
</tr>
<tr>
<td>Δy</td>
<td>-0.726</td>
<td>-13.927</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.457</td>
<td>6.273</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.138</td>
<td>-3.024</td>
</tr>
<tr>
<td>ΔZ_w</td>
<td>0.058</td>
<td>2.123</td>
</tr>
<tr>
<td>ECM_p(-1)</td>
<td>-0.068</td>
<td>-4.925</td>
</tr>
</tbody>
</table>

Model Diagnostics

- $R^2=0.71$; $F^*=F(6,92)=41.77$; $SE=0.01$; $DW=2.27$.
- Autocorrelation: $F(1,91)=4.58$, $F(2,90)=3.61$, $F(3,89)=2.87$
- $F(4,88)=4.07$, $F(5,87)=3.36$, $F(8,84)=2.28$, $F(12,80)=1.85$
- Functional Form: $F(1,91)=2.45$.
- Normality: $\chi^2(2)=11.04$
- Heteroscedasticity: $F(1,97)=22.16$.
- ARCH: $F(1,91)=4.13$, $F(2,90)=2.56$, $F(3,89)=1.89$, $F(4,88)=2.06$
- Stability: (1) Chow's 2nd Test=$F(7,85)=1.93$; (3) Farley et al = $F(7,85)=0.96$; (3) plot of cusum of residuals lies within the 5% critical bounds but that of cusum of squares of residuals lies outside the 5% critical bounds within the late 70s and to the late 80s suggesting instability during that period.
From tables (5.14) and (5.15) above, it is evident that the dynamic forms of the money and price normalizations of M1 World model are unsatisfactory in many respects.

For money normalization, in addition to the diagnostic failure associated with the Farley et al structural stability test, its error correction term is insignificant according to the t-test.

Though the error correction term in the corresponding dynamic price representation is very significant (according to the t-test), many aspects of the model are unsatisfactory. Firstly, there is the absence of money as short determinant of prices: a situation which is difficult to justify.

Secondly, many diagnostic properties are unsatisfactory. These relate to autocorrelation, normality, heteroscedasticity, ARCH, and cusum of squares of recursive residuals stability tests; hence the model is unreliable.

Our next set of results relate to M2 World model. Again in a similar fashion as before, for money and prices as regressands, the results are given respectively in tables (5.16) and (5.17) below.
### Table (5.16): ΔM2 as regressand in M2 World Model (TS-Estimation)

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.110</td>
<td>-1.710</td>
</tr>
<tr>
<td>ΔM2(-2)</td>
<td>-0.476</td>
<td>-5.542</td>
</tr>
<tr>
<td>ΔM2(-6)</td>
<td>-0.381</td>
<td>-4.919</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.389</td>
<td>5.031</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.829</td>
<td>3.526</td>
</tr>
<tr>
<td>Δy(-3)</td>
<td>0.330</td>
<td>2.077</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.429</td>
<td>2.581</td>
</tr>
<tr>
<td>Δy(-7)</td>
<td>-0.581</td>
<td>-3.733</td>
</tr>
<tr>
<td>ECM₉₂(-1)</td>
<td>0.092</td>
<td>1.962</td>
</tr>
</tbody>
</table>

**Model Diagnostics**

- $R^2 = 0.70; \ F^* = F(8,87)=28.12; \ SE=0.038; \ DW=1.80.$
- Autocorrelation: $F(1,86)=0.98, \ F(2,85)=0.77, \ F(3,84)=0.93, \ F(4,83)=1.11, \ F(5,82)=1.11, \ F(8,79)=1.51, \ F(12,75)=1.73.$
- Functional Form: $F(1,86)=0.001.$
- Normality: $\chi^2(2)=2.44.$
- Heteroscedasticity: $F(1,94)=0.11.$
- ARCH: $F(1,86)=0.27, \ F(2,85)=0.64, \ F(3,84)=0.74, \ F(4,83)=0.69.$

**Stability:** (1) Chow's 2nd Test=$F(8,79)=1.23; \ (2) \ Farley \ et \ al = F(9,78)=1.98; \ (3) \ plot \ of \ Cusum \ of \ recursive \ residuals \ lies \ within \ the \ 5\% \ critical \ bounds \ but \ that \ of \ cusum \ of \ squares \ of \ recursive \ residuals \ lies \ outside \ the \ bounds \ during \ the \ early \ eighties.
**Table (5.17): ΔP as regressand in M2 World Model (TS-Estimation)**

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.093</td>
<td>-5.591</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.463</td>
<td>5.705</td>
</tr>
<tr>
<td>Δy</td>
<td>-0.717</td>
<td>-14.529</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.418</td>
<td>5.831</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.210</td>
<td>-4.511</td>
</tr>
<tr>
<td>ΔZ_w</td>
<td>0.065</td>
<td>2.481</td>
</tr>
<tr>
<td>ΔZ_w(-3)</td>
<td>0.054</td>
<td>2.128</td>
</tr>
<tr>
<td>ECM_p(-1)</td>
<td>0.111</td>
<td>6.053</td>
</tr>
</tbody>
</table>

**Model Diagnostics**

- $R^2 = 0.75$; $F^* = F(7,90) = 41.68$; $SE = 0.01$; $DW = 2.27$.

- Autocorrelation: $F(1,89) = 3.82$, $F(2,88) = 4.20$, $F(3,87) = 2.82$; $F(4,86) = 3.39$, $F(5,85) = 3.05$, $F(8,82) = 2.16$, $F(12,78) = 1.92$.

- Functional Form: $F(1,89) = 2.11$.

- Normality: $\chi^2(2) = 7.57$.

- Heteroscedasticity: $F(1,96) = 18.77$.

- ARCH: $F(1,89) = 3.65$, $F(2,88) = 1.84$, $F(3,87) = 1.23$, $F(4,86) = 1.24$.

- Stability: (1) Chow's 2nd Test = $F(8,82) = 1.20$; (2) Farley et al. = $F(8,82) = 1.14$; (3) plot of cusum of residuals lies within the 5% critical bounds but that of cusum of squares of residuals lies outside the 5% critical bounds within the late 70s and to the late 80s suggesting instability during that period.
The results above for money (table 5.16) and prices (table 5.17) as regressands in M2 World model are very similar to those for M1 World model seen earlier and hence unsatisfactory.

In particular, the model for money is unsatisfactory as an error correction model because its error correction term is insignificant according to the t-test. Moreover, the money model is unstable according to the cusumsq test.

Although the error correction term in the price model is very significant according to the t-test, many aspects of the model are unsatisfactory. Note the absence of money as a short run determinant of prices: an outcome which has already been described as difficult to justify. Furthermore, note the presence of the following diagnostic problems: autocorrelation, normality, heteroscedasticity, and cusum of squares of recursive residuals, so that the model is not trustworthy.

In terms of the two-stage results above, the corresponding results for income and the foreign opportunity cost measures are unsatisfactory for all the models investigated. In order to avoid stifling the discussion here with tables, they are relegated to the appendix of the thesis (see tables A1 and A2) while the diagnostic problems associated with them are examined shortly below as part of an overall comparative diagnostic analysis.

In the analysis so far, the error correction term is a single entity encapsulating the joint effects of the level variables. However, it may be more appropriate to estimate the short run and long run variables together (single-stage estimation). Again, to avoid stifling the discussion here with
tables, the regression estimates for this approach are relegated to the appendix while the diagnostic problems associated with it are examined here.

To illustrate a number of issues, the first two of these tables are reproduced as tables (5.18) and (5.19) below. These are the corresponding joint estimation results for the two-stage estimation exercise given earlier for ΔM1 and ΔP as regressands in M1 CFA model.

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.487</td>
<td>1.924</td>
</tr>
<tr>
<td>D3</td>
<td>-0.060</td>
<td>-4.152</td>
</tr>
<tr>
<td>ΔM1(-3)</td>
<td>0.211</td>
<td>2.777</td>
</tr>
<tr>
<td>ΔM1(-6)</td>
<td>-0.569</td>
<td>-8.877</td>
</tr>
<tr>
<td>ΔP</td>
<td>1.046</td>
<td>2.570</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.306</td>
<td>3.266</td>
</tr>
<tr>
<td>Δy</td>
<td>0.834</td>
<td>2.353</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.862</td>
<td>2.682</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.604</td>
<td>2.942</td>
</tr>
<tr>
<td>ΔZ_c</td>
<td>2.123</td>
<td>2.434</td>
</tr>
<tr>
<td>ΔZ_c(-8)</td>
<td>2.891</td>
<td>2.789</td>
</tr>
<tr>
<td>M1(-1)</td>
<td>-0.230</td>
<td>-3.386</td>
</tr>
<tr>
<td>P(-1)</td>
<td>0.317</td>
<td>3.739</td>
</tr>
<tr>
<td>y(-1)</td>
<td>0.128</td>
<td>2.055</td>
</tr>
<tr>
<td>Z_c(-1)</td>
<td>-0.729</td>
<td>-1.823</td>
</tr>
</tbody>
</table>
Drobný and Hall (1989) note that a major disadvantage of the joint or single-stage estimation approach is that one or more of the long run variables necessary for co-integration may turn out to be insignificant, hence excluded from the resulting model.

As evident from the tables above, one of the long run variables is (marginally) insignificant in each case. However, this does not necessarily mean that the long run variables as a group would be insignificant. While real income is insignificant in the money model, the foreign opportunity cost term is insignificant in the price model.

Nevertheless, given that the other long run variables are individually quite significant, they are likely to be jointly significant which may justify the earlier approach where they appeared jointly as a single variable.
Assuming co-integration, the F-test for the joint significance of the long run variables is $F(4, 80) = 4.74$ for the money model and $F(4, 88) = 13.59$ for the price model which in each case implies a decisive rejection at the 5% level of significance of the null hypothesis that the variables are jointly insignificant.

In general, apart from the problem of insignificance of one or more long run variables, the joint approach did not yield results that are significantly different from the earlier two-stage approach.

A summary of the diagnostic problems associated with the two approaches is given below in table (5.20) as part of a wider comparative analysis of diagnostic problems associated with all the dynamic models investigated.

In the table below: (1) seco is serial correlation of residuals; (2) hete is heteroscedasticity of residuals; (3) non-norm is non-normality of residuals; (4) ARCH is autoregressive conditional heteroscedasticity of residuals; (5) instab is instability of model; (6) p-failure is predictive failure of model; (7) f-failure is functional form model specification failure; (8) insignif is insignificant.

Column one of the table refers to the different models examined. Column two shows the different regressands considered for each model. Column three indicates the problems for the two-stage estimation exercise. The last column presents the problems for the joint estimation exercise.
Table (5.20): Diagnostic Problems of Various Models Compared

<table>
<thead>
<tr>
<th>Model</th>
<th>Regressand</th>
<th>Restricted ECM</th>
<th>Unrestricted ECM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ΔM1</td>
<td>None</td>
<td>Z_c insignif</td>
</tr>
<tr>
<td></td>
<td>ΔP</td>
<td>seco, hete</td>
<td>y insignif</td>
</tr>
<tr>
<td></td>
<td></td>
<td>non-norm</td>
<td></td>
</tr>
<tr>
<td>M1 CFA</td>
<td>Δy</td>
<td>seco, non-norm</td>
<td>M1, P insignif</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td>ΔZ_c</td>
<td>seco, non-norm</td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td>ΔM2</td>
<td>instab</td>
<td>y, Z_c insignif</td>
</tr>
<tr>
<td></td>
<td>ΔP</td>
<td>seco, non-norm</td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>instab, ARCH</td>
<td></td>
</tr>
<tr>
<td>M2 CFA</td>
<td>Δy</td>
<td>seco, non-norm</td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td>ΔZ_c</td>
<td>non-norm</td>
<td>Z_c insignif</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>non-norm</td>
</tr>
<tr>
<td></td>
<td>ΔM1</td>
<td>ECM insignif</td>
<td>y, Z_c insignif</td>
</tr>
<tr>
<td></td>
<td></td>
<td>instab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ΔP</td>
<td>seco, non-norm</td>
<td>y insignif</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ARCH, instab</td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hete, f-failure</td>
</tr>
<tr>
<td>M1 World</td>
<td>Δy</td>
<td>seco, non-norm</td>
<td>P insignif</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td>ΔZ_u</td>
<td>p-failure</td>
<td>M1, P, y insignif</td>
</tr>
<tr>
<td></td>
<td>ΔM2</td>
<td>ECM insignif</td>
<td>P, y, Z_u insignif</td>
</tr>
<tr>
<td></td>
<td>ΔP</td>
<td>seco, non-norm</td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hete, instab</td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td>Δy</td>
<td>non-norm</td>
<td>seco, non-norm</td>
</tr>
<tr>
<td></td>
<td>ΔZ_u</td>
<td>P-failure</td>
<td>M2, P insignif</td>
</tr>
</tbody>
</table>
From the table above, the normalization on narrow money (money as regressand in M1 CFA model) appears more satisfactory than the others as it is free from diagnostic problems.

Further analysis in terms of prediction shows that its forecasting performance is reasonable. To appreciate it, a rival model is needed. The results for money as regressand in M2 CFA model presented earlier appear quite satisfactory, save for the marginal failure of the cusumsq test. It may thus be reasonable to adopt it as a rival model for the sake of comparison. The comparative results are presented in table (5.21) below.

<table>
<thead>
<tr>
<th>Period</th>
<th>Prediction Errors Money M1 CFA Model</th>
<th>Prediction Errors Money M2 CFA Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988Q1</td>
<td>-0.056</td>
<td>-0.065</td>
</tr>
<tr>
<td>1988Q2</td>
<td>-0.046</td>
<td>-0.091</td>
</tr>
<tr>
<td>1988Q3</td>
<td>-0.046</td>
<td>0.016</td>
</tr>
<tr>
<td>1988Q4</td>
<td>0.008</td>
<td>0.103</td>
</tr>
<tr>
<td>1989Q1</td>
<td>-0.009</td>
<td>0.018</td>
</tr>
<tr>
<td>1989Q2</td>
<td>0.065</td>
<td>-0.024</td>
</tr>
<tr>
<td>1989Q3</td>
<td>0.077</td>
<td>0.104</td>
</tr>
<tr>
<td>1989Q4</td>
<td>0.011</td>
<td>0.069</td>
</tr>
<tr>
<td>Mean PE</td>
<td>0.006</td>
<td>-0.016</td>
</tr>
<tr>
<td>Mean SAPE</td>
<td>0.040</td>
<td>0.061</td>
</tr>
<tr>
<td>Sum SPE</td>
<td>0.002</td>
<td>0.005</td>
</tr>
<tr>
<td>Root MSSPE</td>
<td>0.047</td>
<td>0.071</td>
</tr>
</tbody>
</table>
In the table above, Mean PE, Mean SAPE, Sum SPE, and Root MSSPE, stand respectively for mean of prediction errors, mean of sum of absolute prediction errors, sum of squares prediction errors, and root of mean of sum of squares of prediction errors. A model which exhibits low values for these statistics is desirable. In comparative terms here, the narrow money model is to be preferred.

At this stage, it is possible to take an overview of our results, draw policy implications, and conclude.

5.4: Results Overview, Policy Implications, and Conclusions

Starting from the beginning of the empirical analysis in this chapter, it is important to note that the Johansen approach used to derive the long run estimates of the co-integrating vectors is a systems approach. It has a major disadvantage: a problem with one equation is likely to affect the system as a whole. Thus, it is perhaps useful to re-evaluate key results obtained in the systems approach from a different perspective.

We noted from the outset that an alternative procedure such as the Engle-Granger approach would not be appropriate to start with. Pre-experimentation with this approach proved unsatisfactory. In particular, the diagnostic properties of its first stage were extremely poor. For illustration, in terms of our preferred model, these are provided together with regression estimates in the appendix.
In view of the importance of the weak exogeneity properties of variables in modelling, we conducted weak exogeneity tests from both long and short run perspectives.

The long run weak exogeneity tests conducted within the Johansen approach suggested that, in general, although it may be appropriate to use a single equation approach to model prices in Cameroon, a single equation approach would not be appropriate for money. It is important to emphasise that the long run money demand results in this chapter are valid as they were generated using a systems approach rather than a single equation approach.

From a short run or dynamic perspective, we interpreted the significance of the error correction term as a dual test for (weak) exogeneity on one hand, following Huang (op. cit.), and co-integration on the other, following Kremers et al (op. cit.). It is reasonable to suppose that such an interpretation is only meaningful for models with satisfactory diagnostic properties, which in terms of our results, are the money CFA models.

For these models, the error correction term appeared significant with a negative value suggesting co-integration on one hand and endogeneity of money (the dependent variable) on the other; implying it may still be possible to use a single equation framework for money demand in Cameroon. On balance, following empirical diagnostics and theoretical considerations, our preferred dynamic equation is in terms of money as opposed to prices or other variables examined.

The fact that the preferred equation for the variables in this chapter is in terms of money as opposed to prices for example is not unreasonable. In particular, theoretical analysis
suggests that for a small country in a fixed exchange rate system: (1) money would be endogenous; (2) prices would be exogenous in the sense of being largely determined by the foreign price level. Consequently, it is reasonable that in an equation involving both money and prices, money should be the dependent variable unless there is strong evidence against the choice.

In view of the fact that our preferred model is in terms of open economy considerations with respect to the CFA region, we may also conclude that it is more appropriate to consider open economy considerations on money demand in Cameroon from this more restrictive perspective than the wider world perspective.

Within the CFA setting, although narrow and broad money have been shown to share many satisfactory model properties, narrow money has been preferred in relation to broad money in terms of stability and predictability and can be recommended for policy. This is not surprising as broad money is more susceptible to instability than narrow money. For example, shocks that affect the non-M1 component of M2 would by definition not affect M1.

Theoretically, the contention that money demand is a demand in real terms implies that nominal money balances will be adjusted in a proportionate manner to changes in the price level in order to maintain the desired level of real money balances. In terms of our preferred model, the long run elasticities presented in table (5.3) in the last section suggest that, ceteris paribus, in the long run money demand would change more than proportionately to a change in the price level.

We have already noted that invalidation of the price homogeneity hypothesis in empirical analysis is not without
antecedents and cited the studies by Boughton (1991b) and Arestis et al (op. cit.) which use empirical methods similar to ours to support the claim. On the other hand, Laidler (1993) notes that studies in which the price homogeneity postulate is refuted may be a result of mis-specification in view of the overwhelming body of empirical evidence that supports this postulate. In fact, Hendry and Ericsson (op. cit.) have cited the prevalence of parameter stability and price homogeneity as key aspects of a well specified money demand model.

We do not have any antecedent knowledge on the price homogeneity issue in the context of Cameroon. For Cameroon and the rest of the countries investigated by Fielding (op. cit.), the issue of price homogeneity does not appear to be explicitly tested even though real money is used as the dependent variable. Overall, as indicated in chapter three, Fielding's study is limited because a relatively short sample period is used.

Fielding (op. cit.) finds support in favour of the luxury good interpretation of money or the case where the income elasticity of money demand is significantly greater than one. Our results are contradictory in that they show an income elasticity that is significantly less than one leading to the familiar interpretation of economies of scale in money holdings. In our context therefore, if a given change in real income occurs, ceteris paribus, the resulting change in money demand will be less. Thus, as real income in Cameroon rises as a result of development for example, the prediction from our results is that money demand will rise less than proportionately to the rise in real income.
At the beginning of this chapter, we showed that currency substitution and expected inflation are not significant determinants of money demand in Cameroon. These results are not unreasonable in view of fixed exchange rates and a low and stable inflation environment for the economy of interest. Consequently, in terms of policy, there is little or no empirical justification for targeting or predicting money demand in Cameroon from a consideration of currency substitution or expected inflation.

The question of whether monetary policy or fiscal policy should be emphasized in the stabilization debate is ongoing. Lack of domestic interest rate data in our case means that this issue cannot be addressed here in terms of the domestic interest rate. However, in developing countries, money demand is generally believed to be less sensitive to the interest rate than in developed countries because of the narrowness of the financial market. If money demand is sensitive to the interest rate, this offers justification for targeting it through the interest rate as an intermediate target for example. For Cameroon, as the discussion below demonstrates, an independent interest rate policy is not feasible.

From an open economy approach, the foreign interest rate elasticity of money demand for our preferred model is not overly large as it is less than minus one-half predicted by the Baumol-Tobin transactions theory of money demand for example. The results indicate that, ceteris paribus, there will be a significant shift from domestic money holdings into foreign financial assets in the long run following an increase in the foreign interest rate. This can be interpreted as supporting the
relevance of open economy considerations for money demand in Cameroon and hence should not be ignored from policy.

However, it is important to note that the foreign interest rate cannot be used as an intermediate target in terms of policy because neither the domestic monetary authorities nor the domestic public have any control over it. It is strictly exogenous in the sense that its determination and control is foreign. In this case, only joint CFA policy can be effective.

Another important point to note about the foreign interest rate in our analysis is that it may be capturing some of the effects of possible mis-specification arising out of the exclusion of the domestic rate. Therefore, the foreign interest rate effects in this chapter may not (fully) represent the effects of capital mobility arising out of money demand adjustment but rather the extent of mis-specification arising out of the omission of the domestic rate. Had reliable domestic rates been available, a more satisfactory test for capital mobility would have entailed the use of the differential between the foreign interest and the domestic interest rate.

It must be emphasised that African economies are not as sophisticated as many of the small open economies in the Far East such as Hong-Kong, South Korea, and Taiwan whose capital markets are highly integrated with the rest of the world. In such economies, domestic money demand may more readily be sensitive to changes in the foreign interest rate than in African economies. Even then, it is important not to lose sight of the fact that we are dealing with money demand by individuals. Unless in general or at least on average, individuals in an economy are
able to respond to changes in foreign economic conditions, there cannot be sound justification for the inclusion of these conditions in their behaviour.

The error correction term has being described in this chapter as measuring the degree of short run disequilibrium adjustment. In terms of money demand, the usual interpretation is that if in the last period for example, money balance holders consider their balances to be above the desired long run equilibrium level, they will attempt to restore them to their desired long run equilibrium level by running down their money balances in the current period.

For our preferred model, the error correction term has a negative value as predicted by theory. In particular, current money holdings are reduced by 22 per cent in response to past disequilibrium or error. Fielding (op. cit.), reports a response of 123 per cent for broad money which is rather unusual. In fact for the other countries examined in the study, he reports a response of 11 per cent for Nigeria, 15.4 per cent for Côte-d'Ivoire: a CFA member, and 60.8 per cent for Kenya.

For other studies in the African context, adjustment has generally been below 50 per cent. For example, using narrow money, Simmons (op. cit.) reports a value of 22.2 per cent for Congo: a CFA member, 41.8 per cent for Côte-d'Ivoire: a CFA member, 34.3 per cent for Mauritius, 28.6 per cent for Morocco, and 55.8 per cent for Tunisia. Using narrow money, Domowitz and Elbadawi (op. cit.) report a value of 18 per cent for Sudan.

The dynamics of an error correction model can be complex. In terms of our preferred model, the dynamics are as follows.
The coefficients on real income terms decrease with the passage of time implying smooth and dampening adjustment to long run equilibrium.

With respect to changes in prices (inflation) and the foreign interest rate, the size of the associated coefficients increase with the passage of time (or lag length) implying there is smooth but potentially explosive adjustment to long run equilibrium. Nevertheless, overall dynamic stability is assured as the error correction term is significant and negative in value as required for the overall dynamic stability of the model. The highest (significant) lag length, which is eight, features on the foreign interest rate: implying long adjustment in relation to that variable.

Nominal money balances adjust positively to what would be the (short run) opportunity cost variables: changes in prices and the foreign interest rate. The positive adjustment may appear puzzling in economic terms. However, it is important to reiterate the point made in section two of this chapter that the error correction model is statistical rather than economic. Economic theory on money demand is essentially a theory about equilibrium which is usually considered as more meaningful in the long run than the short run. It is thus not surprising that short run analysis may yield results that may run contrary to economic predictions.

Choudhry (op. cit.) notes that a significant error correction term implies causality from the independent variables in levels to the dependent variable even though the coefficient of the lagged changes in the independent variables may be
insignificant. We shall not dwell on the issue of causality here as a more exhaustive causality analysis of the variables used in the empirical analysis here is given in the next chapter as part of a wider analysis involving additional variables that may be important for monetary analysis in the context of Cameroon.

To conclude, it is important to note that, though our empirical analysis can be interpreted as offering support for the use of monetary policy, say in the stabilization process, its significance is likely to be limited in practice given the monetary characteristics of Cameroon examined in chapter one.

For example, the non-monetized sector of the economy is likely to hinder the effects of monetary policy. Also, another major impediment to monetary policy relates to narrowness of the financial market and in particular the limited array of financial assets.

The main implication is that the use of our model for predicting the future path of money demand in Cameroon and/or targeting money demand for policy purposes would need to be a cautious one. In any case, only a joint policy framework within the CFA area is likely to be effective.

The Granger-causality analysis in the next chapter to which we now turn our attention seeks to shed further light on monetary policy in Cameroon via a more comprehensive consideration of various linkages that may exist amongst the variables examined in this chapter as well as other variables that may be useful for policy purposes.
6.1: Introduction

In the last chapter, based on the empirical money demand results obtained, we argued that it is more appropriate to base open economy considerations in relation to Cameroon with respect to the CFA zone than the world as a whole. This is in accordance with previous monetary studies such as Honohan (op. cit.) and Fielding (op. cit.) that have considered open economy issues in relation to Cameroon.

As a monetary zone, the CFA zone is likely to have implications for the conduct of policy in member countries that extend beyond money demand. For Cameroon, it is our aim in this chapter to empirically analyze these additional implications. It is likely that there are various approaches for tackling this issue. For our purpose, we use the concept of Granger-causality. The review of the application of this concept in the African context was given in chapter three. Consequently, in this chapter, we shall primarily be concerned with our application.

In section two, we examine a number of preliminary issues that are important for the conduct of the empirical analysis of interest. Section three is concerned with the empirical analysis
per se. In particular, we specify the test structure used, derive results and critically assess them.

Finally, in section four, the main issues and findings are recapitulated and conclusions drawn.

6.2: Preliminary Considerations

From the outset, it is important to stress as we did in chapter three that the concept of interest here, Granger-causality, is not causality per se as commonly understood in terms of cause and effect. Instead, it relates to the statistical concept of prediction. Recall from chapter three that a variable $y$ is said to Granger-cause another $x$ if $x$ can be better predicted with information on both $x$ and $y$ than $x$ only.

Since the seminal paper by Granger (1969) on this issue, alternative testing approaches have appeared in the literature, however, with a unifying theme which consists of testing the null hypothesis of non-causality. Nevertheless, two main approaches have received most attention. There is the original Granger test or the direct test which consists of a regression of $x$ on its lag values as well as those of $y$ as discussed later below. There is also the Sims (1972) approach or indirect approach which consists of a regression of $x$ on past, current, and future values of $y$.

The approach for the empirical investigation here is direct. There are a number of justifications for our choice. For example, according to Charemza and Deadman (op. cit.), the Sims test is
more costly in terms of loss of degrees of freedom given that for a given lag length there are more parameters to estimate as a result of additional leading variables. Also, Beltas and Jones (op. cit.), basing their arguments on the Monte Carlo analysis by Geweke et al (1983), argue that the Granger test is more robust in ease of execution and desirable statistical properties.

In what follows, we consider a number of preliminary issues that are important for the empirical analysis of interest.

According to Stewart (1991), although the F-statistic is widely used in empirical Granger-causality analysis, the underlying statistical theory suggests that the appropriate test statistics are asymptotically distributed so that strictly speaking only those with Chi-square distributions should be employed. However, since there is no indication in the literature that the use of the F-statistic significantly affects the outcome of results, the analysis here is partly based on this statistic.

As mentioned in chapter three, there is the issue of lag length selection. The issue of lags occurs for at least two reasons. First and foremost, the test specification naturally makes use of lags to model the history of the variables involved. Secondly, the tests are unlikely to be valid if the disturbances are not white noise and as seen in regressions with autoregressive components in chapter four, it may be possible to achieve white noise through the accommodation of appropriately structured lags of the dependent variable. In the empirical literature, the use of a statistical criterion to determine the lag length is often perceived as more satisfactory in relation to arbitrary selection. Our criterion which is explained later
is based on the Final Prediction Error (FPE) statistic.

The definition of causality is in the context of stationary variables. Granger (op. cit.) notes that in the non-stationary case, the pattern of causality (prediction) will alter over time. Consequently, in a given empirical analysis, the time series properties of the data need to be checked and incorporated into the modelling process. From the integration analysis in chapter four, we know that our data are non-stationary in levels.

Given non-stationarity, there are perhaps two satisfactory ways to proceed. Firstly, if the variables of interest are co-integrated, then valid inference can be made from the causality tests using data in levels. We do not follow this approach because preliminary investigation indicates that some of the linkages are not co-integrated. This is not surprising. For example, the fact that co-integration exists among three variables does not automatically imply it occurs between a given pair of the variables. Thus, it is apparent that to conduct a uniform analysis for all the variables of interest here, we need an alternative procedure that is general.

The alternative approach adopted here consists of performing the tests on data that have been differenced into stationarity. However, there is no guarantee that tests performed with differenced data will lead to the same conclusions as those performed with data in levels because differenced data is of higher frequency while data in levels is of lower frequency. As our analysis is on differenced data, it is interpreted in terms of the short run rather than the long run which would have been the case if data in levels had been used.
Finally, there is the question of causal direction to be tested. As we shall recall from the pre-empirical part of this thesis, there are different causal views concerning the linkages among money, income, and prices. These views can be accommodated empirically in a pragmatic way. This requires an empirical specification which allows for all sensible causality directions to be tested. For example, we not only examine whether money Granger-causes income but we also examine whether income Granger-causes money. However, we do avoid a blind application of this pragmatic principle.

For example, when foreign variables are introduced, we do not consider the possibility of domestic variables having a significant influence on them as realistic, given the smallness of the domestic economy. This is because the economy of France which is considered as the foreign country here is many times greater than that of Cameroon. Indeed, some claim that (see Honohan *op. cit.*) the size of France's GDP is 13 times the combined GDP of all the other 13 countries that make up the CFA association. In this scenario, it is difficult to see how monetary developments in Cameroon can have any significant effect on those in France. For this reason, given open economy considerations, our tests are unidirectional, seeking to establish whether foreign variables Granger-cause domestic ones.

The main controversies regarding causal linkages amongst money, output, and prices can be recalled from the pre-empirical section of this thesis as follows.

Firstly, there is the debate as to whether the effects of money on real aggregates are neutral or not. If the effects of
money on real output for example are neutral, then the argument runs that changes in the nominal money stock will be reflected in the price level. While there appears to be less criticism of this contention when viewed in terms of the long run, the position is different as regards the short run. The argument is that if there is acceleration in the rate of growth of the money supply so that the expected rate of growth lies below the actual rate, then there will be an increase in real output as implied by the short run Phillips relation. Thus, in the short run, money may not be neutral.

A further controversial proposition which is relevant to our analysis is the price convergence proposition. As we indicated in chapter two, in a fixed exchange rate framework, this is a statement about the equalization of the domestic price level and the foreign price level. Alternatively, this proposition indicates that domestic inflation will equal foreign inflation. Critics of this argument claim that it hinges on the assumptions of purchasing power parity and interest rate parity which are questionable for developing countries. As mentioned a number of times already in the thesis, this criticism is particularly relevant to the CFA zone because it lacks the degree of economic integration that would warrant the adoption of fixed exchange rates.

Also, the theoretical analysis of money supply determination in a fixed exchange rate discussed in chapter two suggests that the causal linkage between domestic credit and foreign reserves may be controversial. This linkage is emphasised in the monetary approach to the balance of payments as noted by Ngwega and Ngola
In particular, they note that the monetary approach to the balance of payments predicts that a small open economy with fixed exchange rates and stable demand for money will have its flow of domestic credit fully offset in the long run by changes in the net foreign reserves of the banking system with the overall balance of payments reflecting disequilibrium in the demand for money relative to supply. For Kenya, the authors claim this view ignores non-monetary factors such as the terms of trade, climatic conditions, and structural characteristics beyond the control of domestic policy makers.

As indicated in chapter three, owing to our use of gross monetary aggregates here for consistency with their use in previous chapters, we are not able to explicitly test the causality direction between domestic credit and reserves. Instead, we investigate the causal effects of foreign money on domestic money. This line of investigation is not new as the causality analysis by Kamas and Joyce (1993) shows for a number of developing countries with fixed exchange rates. Indeed, it may be argued that any foreign development that affects net foreign assets and/or domestic credit would by definition affect domestic money.

Bearing in mind the issues discussed above, our next attention lies in the empirical specification, application, and discussion of results.
6.3: Applications, Results, and Discussions

The causality tests in this chapter are derived using the following data. A domestic data set comprising of: (1) domestic narrow money denoted $M_1$, (2) domestic real income denoted $y$, (3) domestic prices denoted $P$; is used in conjunction with a foreign data set comprising of: (1) French narrow money denoted $M_{1_{FR}}$, (2) French interest rates denoted $R_{FR}$, (3) French prices denoted $P_{FR}$.

Details relating to the sources and construction of these variables have already been addressed in chapter four. Thus, apart from real domestic income, all the other variables are in nominal terms. Here, the operator $\Delta^d$ preceding a variable indicates that the variable has been differenced $d$ times to achieve stationarity. The stationarity test results in chapter four suggest that $d$ should be set at two for the French prices and one for all the other variables. All the variables are in logs. This means that the resulting second difference variable used here for French prices is the acceleration of French prices or the rate of change of French inflation. This also means that the first differences of all the other variables used here are approximate growth rates.

To motivate the application of the empirical analysis of interest, consider the following empirical test specification.

$$\Delta^d x_t = \sum_{i=1}^{s} a_i \Delta^d x_{t-i} + \sum_{j=1}^{f} b_j \Delta^d y_{t-j} + \epsilon_{1t} \ldots \ldots (6.1)$$

$$\Delta^d y_t = \sum_{i=1}^{g} c_i \Delta^d y_{t-1} + \sum_{j=1}^{h} d_j \Delta^d x_{t-j} + \epsilon_{2t} \ldots \ldots (6.2)$$
where $\Delta^d$ refers to the difference operator applied $d$ times to a given variable; $\epsilon_{1t}$ and $\epsilon_{2t}$ are white noise error terms.

The appeal of the specification format here is that it allows a broad range of causality patterns to be tested. These are: (1) unilateral where causality flow is in one direction; (2) bilateral or feedback where causality flow is in two directions; (3) independence where there is no causality between the variables of interest.

More precisely, for our specification: (1) unilateral causality from $y$ to $x$ exists if the hypothesis of zero restrictions on the estimated coefficients on $y$ in equation (6.1) is rejected; (2) unilateral causality from $x$ to $y$ exists if the hypothesis of zero restrictions on the coefficients of $x$ in equation (6.2) is rejected; (3) If conditions (1) and (2) hold, then bilateral or feedback causality is said to occur; (4) if instead, the restrictions cannot be rejected in both conditions (1) and (2), then $x$ and $y$ are said to be independent.

The next issue is the determination of the lag structure. In the approach here, the maximum lag length is determined as in Saunders (1994) by choosing the lag structure that minimizes the value of Final Prediction Error (FPE) statistic given as $\text{FPE} = (\text{SEE})^2 \cdot \frac{1}{T} \cdot \frac{T + K}{T}$; where SEE is the standard error of the regression, $K$ is the number of parameters and $T$ is the number of observations. In what follows, up to twelve lags are considered in each case.

Following Kamas and Joyce (op. cit.), our causality implications are assessed on the basis of two test statistics: the FPE- statistic and the F-statistic.
In terms of the FPE-statistic, the testing procedure is as follows. For two variables \( x \) and \( y \) where the null hypothesis is that \( y \) does not cause \( x \), the relevant test equation is (6.1) above. Firstly, the FPE is used to determine the maximum number of lags for \( x \). The chosen FPE is denoted here as \( \text{minFPE}_x \). Conditional on the chosen lag length imposed on \( x \), the minimum FPE for \( y \) is sought. We denote this minimum as \( \text{minFPE}_{xy} \). To test for the (reverse) null hypothesis that \( x \) does not cause \( y \), the positions of \( x \) and \( y \) are simply reversed and the relevant equation is (6.2) above. We start by comparing the calculated minimum FPEs of the univariate and bivariate test specifications. If minimum \( \text{FPE}_{xy} \) is less than minimum \( \text{FPE}_x \), the null hypothesis that \( y \) does not Granger-cause \( x \) is rejected in favour of the alternative that it Granger-causes \( x \). On the other hand, if minimum \( \text{FPE}_{xy} \) is greater than minimum \( \text{FPE}_x \), then we do not reject the null hypothesis. To allow for the possibility of feedback in the causal flow direction, the positions of \( x \) and \( y \) are simply reversed and a similar analysis is conducted.

In terms of the F-statistic, we check the significance of zero restrictions on the estimated coefficients on the lags of \( y \) in a regression of \( x \) on its lags as well as those of \( y \). If the regression value of the F-statistic is greater than that from the F-table, we reject the null that \( y \) does not cause \( x \) in favour of the alternative mentioned above. Conversely, if it is less, we do not reject the null. Again, to allow for feedback in causality direction, the positions of \( x \) and \( y \) are reversed and a similar analysis conducted. This completes our causality assessment in a bivariate framework. A simple multivariate assessment procedure
is given later.

It is perhaps reasonable to suppose that if the FPE statistic and F-statistic approaches are both credible criteria for the assessment of causality patterns, they should generally not lead to conflicting results. We found that this is the case if a wider significance level band of 10% rather than the narrower 5% significance level used in previous chapters is adopted for the F-statistic. The problem here appears to lie with the F-test which as with any other significance level test, yields conclusions that may change with the level of significance adopted. The FPE criterion does not suffer from this defect as no significance level needs to be chosen a priori.

Our results are presented below in a series of tables. The policy implications of the analysis in this section are examined in the next section. The first table which follows directly below has money (growth) as the dependent variable.

Table (6.1): Money Supply as Dependent Variable

<table>
<thead>
<tr>
<th>Flow</th>
<th>Lag(s)</th>
<th>LMsc</th>
<th>FPEmin</th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔM → ΔM</td>
<td>6</td>
<td>F(4,86)=1.48</td>
<td>0.002635</td>
<td>F(6,90)=27.22**</td>
</tr>
<tr>
<td>ΔP → ΔM</td>
<td>1</td>
<td>F(4,85)=1.30</td>
<td>0.002658</td>
<td>F(1,89)=1.04</td>
</tr>
<tr>
<td>Δy → ΔM</td>
<td>7</td>
<td>F(4,78)=0.92</td>
<td>0.002591</td>
<td>F(7,82)=2.14**</td>
</tr>
<tr>
<td>ΔMf → ΔM</td>
<td>1</td>
<td>F(4,85)=2.11</td>
<td>0.002603</td>
<td>F(1,89)=2.99**</td>
</tr>
<tr>
<td>ΔApf → ΔM</td>
<td>2</td>
<td>F(4,84)=0.83</td>
<td>0.002635</td>
<td>F(2,88)=1.85</td>
</tr>
<tr>
<td>ΔRf → ΔM</td>
<td>1</td>
<td>F(4,85)=1.16</td>
<td>0.002686</td>
<td>F(1,89)=0.13</td>
</tr>
</tbody>
</table>

The first row of the above table deals with the univariate analysis which is used to determine the lag length for the
dependent variable. The remaining rows are for the bivariate analysis. The first column indicates the direction or flow of causality being tested. This is indicated by an arrow sign. Where the flow is from one variable to itself, the analysis is univariate. Otherwise, it is bivariate. Column two indicates the lag length retained for the variable from where the direction or flow of causality is being assessed. Column three gives the LM test results for serial correlation in the residuals of the regression abbreviated LMsc where an asterisk indicates significance at the 5% level or better (that is 1%). Column four and five give respectively the minimum FPE and F-test results for the variable from where the causality flow is being tested. For the F-test, two asterisks indicate significance at the 10% level or better (that is, 5% or 1%).

The second row of table (6.1) above relates to the bivariate results relating to whether prices Granger-cause money. The results indicate that prices do not Granger-cause money. In retrospect, how does this inform us about the debate in the last chapter about the relative merits of whether the variables examined in the last chapter should be better modelled in terms of prices as opposed to money? In order to address this question, we need to know whether money Granger-causes prices. The results are given later in table (6.3) where according to both our criteria of assessment, money does not Granger-cause prices.

If prices do not Granger-cause money and money does not Granger-cause prices, then the implication is that money and prices are independent in the short run as we are dealing with differenced variables. At first sight, these results may be
perceived as indicating that money should not be used to explain prices and prices should not be used to explain money either. Interpreted in this way may be misleading. In particular, Granger-non-causality for an explanatory variable does not mean it is not a significant determinant of the dependent variable. Rather, the implication is that it will be better to predict the dependent variable through the use of its history only.

The independence between money supply and prices appears unusual but not without antecedent in the African context. For example, Deme and Fayissa (op. cit.) reviewed in chapter three find a similar result for Tunisia. They relate it to the possibility of tight monetary control in that country. The same argument can be applied here for Cameroon. It should also be noted that our analysis is based on high frequency or short run data. Thus, the prevalence of independence in the short run is not necessarily guaranteed in the long run.

On money-income causality, our results indicate income Granger-causes money. On the other hand, if we look ahead at the results given in the next table where income is the dependent variable, we find that money does not Granger-cause income. Thus, the direction of causality regarding money and income in Cameroon is unidirectional from income to money. This can be interpreted as suggesting that the impact of money on real income is neutral in the short run. This result appears consistent with past empirical work. For example, Kamas and Joyce (op. cit.) which is also based on exchange rate fixity report similar results for India and Mexico.

We now turn to open economy considerations. The results for
foreign-domestic money causality indicate that foreign money
Granger-causes domestic money. On foreign prices-domestic money
causality, results are inconclusive in the case of minimum FPE
but those of the F-test suggest that foreign prices do not
Granger-cause domestic money. Our results also suggest that the
foreign interest rate does not Granger-cause domestic money. This
appears to support the caution expressed on the use of the
foreign interest rate in explaining domestic money demand in the
last chapter.

Our next set of results are given for income as dependent
variable in table (6.2) below.

<table>
<thead>
<tr>
<th>Flow</th>
<th>Lag(s)</th>
<th>LMsc</th>
<th>FPEmin</th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δy → Δy</td>
<td>1</td>
<td>F(4,96)=1.69</td>
<td>0.0006727</td>
<td>F(1,100)=24.34**</td>
</tr>
<tr>
<td>ΔM → Δy</td>
<td>1</td>
<td>F(4,95)=1.70</td>
<td>0.0006861</td>
<td>F(1,99)=0.00078</td>
</tr>
<tr>
<td>ΔP → Δy</td>
<td>4</td>
<td>F(4,89)=2.98*</td>
<td>0.0005510</td>
<td>F(4,93)=8.45**</td>
</tr>
<tr>
<td>ΔMf → Δy</td>
<td>1</td>
<td>F(4,95)=2.15</td>
<td>0.0006621</td>
<td>F(1,99)=3.58**</td>
</tr>
<tr>
<td>ΔApf → Δy</td>
<td>1</td>
<td>F(4,94)=2.88*</td>
<td>0.0006768</td>
<td>F(1,98)=2.23</td>
</tr>
<tr>
<td>ΔRf → Δy</td>
<td>3</td>
<td>F(4,91)=3.17*</td>
<td>0.0006600</td>
<td>F(3,95)=3.27**</td>
</tr>
</tbody>
</table>

The presentation in this table is almost identical to that
in the previous table save for the fact it relates to income as
the dependent variable. For this reason, we move directly to
discussing the results.

On whether money Granger-causes real income, the results
expressed in row two of the table above suggest as noted earlier
that money does not Granger-cause real income. Also, as noted
earlier, income Granger-causes money.

In relation to whether domestic prices Granger-cause income, the answer is affirmative. This result needs to be treated with caution as the hypothesis of no serial correlation cannot be rejected at the lag value suggested by minimum FPE. On the other hand, results presented in the next table show that income does not Granger-cause prices. Therefore, given the above caveat, Granger-causality between the two variables appears to be unidirectional from prices to income. Darrat (1986b) for example, notes that the effects of prices on real income can be ignored in the sense that real income is primarily determined by long run supply side factors such as technology, population, and the incentive structure of the economy. The implication is that if unilateral causality does exist between income and prices, one would expect it to run from income to prices and not vice versa as is the case here.

The test of whether foreign money Granger-causes domestic income yields an affirmative answer. As to whether foreign prices Granger-cause domestic income, the answer is not affirmative. However, the presence of serial correlation at the chosen lag suggested by minimum FPE means that this result should be viewed with caution. The same problem of serial correlation is noted with the test of whether the foreign interest rate Granger-causes domestic income. The answer which is affirmative should also be viewed with caution.

The next table relates to domestic prices as the dependent variable.
Again, the presentation in the above table is similar to that in the previous tables. The main results are as follows.

On money-prices causality, the result is that money Granger-cause prices. On the question of whether income Granger-causes prices, the answer is not affirmative. Recall from the last table that prices Granger-cause income implying that causation is unidirectional from prices to income. The fact that the domestic variables do not Granger-cause prices means that there may be little justification for modelling prices as a function of these variables. Consequently, the fact that we did not prefer the price normalization version of the co-integrating vector in the last chapter appears to be justified from the point of view of Granger-causality.

In an open economy framework, the results in table (6.3) above show that each of the foreign variables (namely foreign money, prices and interest rate) Granger-causes domestic prices. In terms of modelling, the Granger-causality implication here is that it would be preferable to model prices in Cameroon as a function of these foreign variables than a function of domestic
money and/or income.

The fact that the French price level Granger-causes the domestic price level in Cameroon may be viewed as supporting studies such as Honohan (op. cit.) that have found evidence in support of price convergence in the CFA area. However, as noted in chapter three, Honohan's results are questionable on the basis of mis-specification arising from failure to incorporate the time series properties of the variables into consideration. As noted already, the time series properties of prices in Cameroon are different from those in France, suggesting lack of PPP between the two countries.

The bivariate analysis above has been conducted in two stages. In the first stage, a univariate lag length was determined for the dependent variable. This was later taken as fixed in the bivariate analysis involving the lags of an additional variable. In what follows, we extend this reasoning to produce a simple multivariate analysis where the lags on the dependent variable are derived from the univariate analysis as above while those on the independent variables are derived from the bivariate analysis above.

For example, suppose we are interested in the causal effects of prices and income on money, then our procedure is as follows. The lag structure on money in the univariate analysis involving a regression of money on its lags has already been determined as six. The lag structure for prices as the independent variable involving money as the dependent variable has also been determined as one. The lag structure for income as the independent variable when money is the dependent variable has
also been determined as seven. Given this information, we then conduct a joint test of zero restrictions on all the coefficients of the independent variables: income and prices in this case. In a similar fashion, the joint influence of all the foreign variables on domestic money can be assessed. To complete the multivariate analysis, a similar analysis is conducted for income and prices as dependent variables. The results are presented in table (6.4) below.

Table (6.4): Joint Granger-Causality Results

<table>
<thead>
<tr>
<th></th>
<th>LMSC</th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Δy, ΔP) → ΔM1</td>
<td>F(4, 77) = 1.36</td>
<td>F(8, 81) = 3.22**</td>
</tr>
<tr>
<td>(ΔM1, ΔP) → Δy</td>
<td>F(4, 88) = 2.96*</td>
<td>F(5, 92) = 3.22**</td>
</tr>
<tr>
<td>(ΔM1, Δy) → ΔP</td>
<td>F(4, 82) = 0.22</td>
<td>F(2, 86) = 0.63</td>
</tr>
<tr>
<td>(ΔM1f, ΔAPf, Δrf) → ΔM1</td>
<td>F(4, 82) = 0.96</td>
<td>F(4, 86) = 1.59</td>
</tr>
<tr>
<td>(ΔM1f, ΔAPf, Δrf) → Δy</td>
<td>F(4, 89) = 3.87*</td>
<td>F(5, 93) = 3.02**</td>
</tr>
<tr>
<td>(ΔM1f, ΔAPf, Δrf) → ΔP</td>
<td>F(4, 77) = 0.188</td>
<td>F(7, 81) = 3.51**</td>
</tr>
</tbody>
</table>

The presentation in the table above is similar to that in previous tables. However, there are a number of differences. Since we are using lags that are pre-determined, see previous tables, they are not shown here. The causality assessment here is solely on the basis of the F-test because in a multivariate framework, assessing causality via the FPE criterion is not easily tractable.

The results from the table above are as follows. Domestic income and prices jointly Granger-cause domestic money. Domestic money and prices jointly Granger-cause income. However, the
results are not trustworthy because of autocorrelation. Domestic
money and income do not jointly Granger-cause prices. Again the
presence of autocorrelation implies the results are not trustworthy.

In terms of foreign considerations, foreign money, prices,
and the interest rate do not Granger-cause domestic money. On the
other hand, these variables Granger-cause income; a result that
is questionable in light of presence of autocorrelation. Finally,
the last results in the table above indicate that the foreign
variables jointly Granger-cause domestic prices.

The question that arises at this stage relates to the policy
implications of the analysis here. In the next section, we shall
provide an overview of the results, draw policy implications and
conclude.

(6.4): Results Overview, Policy Implications, and Conclusions

To begin, it is necessary to provide a cautionary note
regarding the results derived in this chapter. Our results should
be assessed against a statistical rather than an economic
background. The concept of Granger-causality like integration and
co-integration seen in the last two chapters, is statistical
rather than economic. Hence, our analysis here does not yield any
empirical information on the structure of our economy of
interest, rather, it yields information on how better predictions
concerning a number of variables may be achieved.
Bearing in mind the cautionary note above, from a general point of view, the implications associated with Granger causality are as follows. Where a variable $y$ is found to Granger-cause another $x$, for policy purposes, this implies that predictions of variable $x$ based on its past values shall be inferior unless those of variable $y$ are included. Given this remark, the following results can be recapitulated.

Domestic money will be better predicted using its lagged values and those of either: (1) domestic income or (2) foreign money or (3) the joint lags of domestic income and foreign prices.

Domestic real income will be better predicted using its lagged values and those of either: (1) domestic prices or (2) foreign money or (3) the foreign interest rate or (4) domestic money and domestic prices or (5) foreign money, foreign prices, and the foreign interest rate. However, the income variable results should be interpreted with caution as most regressions related to it here have been shown to exhibit autocorrelation. This may be due to the fact that, unlike the other variables used in this analysis, the quarterly income variable has been interpolated.

The domestic price level will be better predicted using its lagged values and those of either: (1) foreign money or (2) foreign prices or (3) the foreign interest rate or (4) the joint lags of all these variables. Thus, the domestic price level is not Granger-caused by the domestic variables used in the money demand investigation in the last chapter. This result appears to lend support to the conclusion arrived in the last chapter.
against re-normalizing the preferred money demand relationship as a price relationship.

Further implications and caveats relating to our results are as follows. Suppose the monetary authorities in Cameroon were interested in targeting/predicting the growth of domestic money for example, one implication is that the variables above that Granger-cause it could be used as intermediate targets. However, as indicated in the last chapter, foreign variables are not suitable targets as they are determined in a different economy and consequently not under the influence of domestic authorities.

To the extent that the determination of one or more key macroeconomic variables in Cameroon is significantly influenced by one or more foreign variables, the conduct of macroeconomic policy cannot be considered independent. In general, as noted in the last chapter, an independent monetary policy is not an option which is available to the authorities in Cameroon. The policy dilemma in Cameroon relates to how to set sound domestic economic policies that do not conflict with the full convertibility of the CFA franc to the French franc and consequently to other currencies, assuming full convertibility of the French franc into these currencies. In the CFA zone, convertibility has been assured through very tight monetary policy or strict control of monetary growth.

As noted in chapter one, there are three basic mechanisms for controlling monetary growth in the zone. Firstly, interest is charged (paid) on individual CFA pooled international accounts that are overdrawn (in credit). Secondly, these accounts must not fall below a specified level, otherwise the monetary authorities
of the country concerned must implement policies restricting credit expansion. The policies focus mainly on raising the cost of rediscounting as well as restricting access to rediscount facilities. Thirdly, fiscal deficit financing is heavily controlled. In particular, central bank credit to the public sector of each country is limited to a maximum of twenty per cent of the fiscal revenue from the previous year.

Tight monetary control has manifested itself in overall low inflation in the zone, not only in comparison with other developing countries but in comparison with developed ones as well. For example, Boughton (1991a) notes that on average, the CFA countries registered inflation rates in the 80s that were close to or below those in France. In particular, he notes that the average for the zone was 4.2 per cent compared to 6.5 per cent for France in the same period.

The limited development of the financial market can be particularly obstructive to the effective operation of monetary policy as indicated in the last chapter. Consequently, if monetary policy were to be successful in Cameroon then measures must be taken to develop the financial sector.

Withdrawal from CFA membership is an option available to members. However, prior to the recent devaluation of the CFA franc, withdrawal was not considered by the government of Cameroon to be a net beneficial course of action at least as far as the immediate future was concerned. It seems, if EMU comes into existence in the next few years as currently planned, the CFA countries will switch the current peg to the ECU as the CFA franc is currently fixed to the ECU by virtue of the French franc
fixity to the ECU.

As Boughton (*op. cit.*) notes, CFA trade is not only significant to France in particular but to the whole of Western Europe in general as 70 per cent of all CFA trade is conducted with France and other Western European countries. In any case, by belonging to the CFA monetary arrangements, Cameroon will continue to give up the exchange rate as instrument of monetary policy.

To end, the main conclusion from the results in this chapter is the same as the one given in the last chapter. In particular, open economy considerations with respect to the CFA zone cannot be ignored in the formulation of effective monetary policy in Cameroon. This conclusion is reiterated in the last chapter of this thesis to which we now turn our attention.
CHAPTER SEVEN

OVERALL CONCLUSIONS AND RECOMMENDATIONS

At the introduction of this thesis, we set two main important objectives: to carry out a money demand inquiry on one hand and a Granger-causality inquiry on the other for the monetary sector of Cameroon. Having completed the task, we now proceed to providing an overview of what has been achieved, its limitations and indications for further research.

At the beginning of the thesis, we noted that a major problem for empirical macroeconomic analysis relates to data quality and that this problem is worse in LDCs. As the recapitulation below indicates, a number of data problems were encountered in our empirical analysis. Despite this, we were able to generate results that can be cautiously used for policy.

Lack of a satisfactory domestic opportunity cost variable for our money demand analysis probably meant that opportunity cost effects on money demand were not adequately represented. However, recent monetary reforms in Cameroon have resulted in much more flexible and market determined interest rates. Such data could be more meaningful in future empirical studies than the data available to us.

The interpolation of the income series in this thesis meant that the series were derived in an arbitrary way. This may
explain why some of the results relating to the income equation in the causality analysis had serially correlated errors. However, the interpolated income variable was not generally seen to exhibit significantly different time series properties from the other variables used. On the other hand, since income data in Cameroon is still available only annually, any study in the near future based on greater frequency of data observations would have to rely on some form of interpolation.

In addition to data limitations, our results should also be assessed in light of the limitations of the econometric techniques used. In particular, VAR, co-integration, and error correction techniques have been described as techniques that are largely devoid of economic theory. Consequently, although our analysis was guided where possible by economic theory, there is some arbitrariness in the economic interpretation of our results.

Co-integration was interpreted in terms of the long run. However, there is the more general philosophical question of how long the long run is. Consequently, our study needs to be checked against a longer data span than that used in this thesis. On the other hand, our error correction analysis was interpreted in terms of the short run. However, the error correction approach has been shown to involve backwards looking behaviour or expectations although it has been observed that such behaviour may also be the result of forward looking behaviour: the observational equivalence problem.

The theme of the Lucas critique that the parameters of an econometric model may not remain constant following policy changes in the presence of rational expectations means that it
may be necessary to explicit model expectations rationally in an empirical exercise. Given that rational expectations were not explicitly modelled in this thesis, further research may seek to remedy this situation.

Goldfeld and Sichel (op. cit.) note that a proper money demand analysis may need to be conducted within a complete macroeconomic model of the economy. This approach has been beyond the scope of this thesis. One problem with this approach for Cameroon relates to data limitations. However, as improvements in data occur over time, this may become feasible but would require considerably more effort.

Given the above remarks, a recapitulation of the main findings in this thesis is as follows.

For money demand, the data set used was given as: (1) nominal M1 or M2 as empirical money definition; (2) CPI as empirical definition of prices; (3) real GDP as empirical definition of income/output; (4) the French interest rate given static exchange rates as a capital mobility measure within the CFA area or the US interest rate adjusted for the expected depreciation of the exchange rate as a capital mobility measure within the wider world economy.

For Granger-causality, M2 was dropped as well as the capital mobility measure within the wider world economy. This decision was motivated by the money demand results obtained which indicated that the CFA area is more appropriate for open economy considerations for Cameroon than the whole world. On the other hand, the French M1 definition of money was included as well as French prices in terms of the CPI.
The issue of properly addressing the time series properties of the data was a recurrent theme in much of the thesis. The penalty for ignoring this was considered to be in terms of a greater incidence of spurious results. Consequently, our data were explicitly checked for their time series properties in terms of integration or unit root tests.

The tests employed for the empirical unit root analysis were the (augmented) HEGY tests and the DF/ADF tests. The HEGY tests were considered to be more general than the DF/ADF (zero frequency) tests in that they are designed for examining seasonal frequency unit roots in addition to the zero frequency roots, and as a result were interpreted as encompassing the latter.

The empirical results indicated that all our data in levels contained unit roots. In particular, at the zero frequency, the French CPI contained two unit roots or needed to be differenced twice to be made stationary while the other variables each contained a unit root or needed to be differenced once only to be made stationary. No unit roots were found at the quarterly seasonal frequencies. The fact that prices in Cameroon have different stationarity properties from those in France was interpreted as suggesting lack of purchasing power parity between the two countries.

Overall, the results appeared consistent with past empirical observation which suggests that macroeconomic data are generally non-stationary due to unit roots at the zero frequency. The results were explicitly taken into account in the empirically modelling of money demand and Granger-causality.

One implication of our unit root tests is that they ruled
out inflation or unit differences of the log of domestic prices and currency substitution as approximated by unit differences of the log of the domestic exchange rate as plausible determinants of long run money demand in Cameroon. This is because these differences were already stationary and could not be modelled as part of the long run variables that were non-stationary.

The finding that inflation is not a long run determinant of money demand in Cameroon is not unreasonable. We found that the CFA is a zone of strong financial discipline. Inflation in member countries such as Cameroon has been rather modest in numerical terms and variance. In such circumstances, inflation may not be an appropriate domestic opportunity cost of money holdings.

What then constitutes the appropriate domestic opportunity cost of money holdings in Cameroon? Unfortunately, we could not answer this question for lack of any meaningful domestic opportunity cost variables. Official domestic interest rates were not available for the entire sample length of the investigations in this thesis which is from the first quarter of 1964 to the last quarter of 1990. Furthermore, on the short sample that they were available, they had very low variance. The empirical problems with such series are well known in terms of generating results that are difficult to interpret.

Our experimentation with credit constraint variables did not give any meaningful results.

Thus, the question of appropriate domestic opportunity cost measure in Cameroon remains open. As we discovered, it may be futile to answer this question quantitatively via recourse to the informal financial sector because of lack of statistics in this
sector. Nonetheless, as the analysis below indicates, an opportunity cost measure was found for domestic money demand in terms of foreign interest rates.

The non-stationary properties of our data in levels was incorporated into the empirical analysis. For money demand, co-integration and error correction techniques were employed as these have been shown to be valid for the analysis of non-stationary time series data. For Granger-causality, the data were differenced into stationarity. Below, we shall recall the key aspects of the results and their policy implications.

For money demand, we started by examining whether the money demand relationship was co-integrated or not. To uncover the co-integrating properties of the variables of interest, the Johansen procedure was employed. Model specification tests revealed residual non-normality that we were unable to eliminate; hence we interpreted our results with caution. The resulting co-integration tests rejected the null hypothesis of no co-integration for the two versions of money and the two versions of external opportunity cost considerations or four sets of data combinations. In particular, the tests indicated the presence of a unique co-integrating vector in each case. The estimates of the corresponding co-integrating vectors were then derived and various normalizations were sought. These related to money, prices, income, and the opportunity cost measures.

The analysis was extended into an error correction or dynamic framework where the general to specific modelling technique was employed. Empirical criteria such as weak exogeneity and other key model diagnostic properties as well as
theoretical criteria were used to assess the appropriateness of each normalization.

In relation to the money normalization, the estimates of the long run elasticities were generally consistent with theory. Furthermore, we tested the price and income homogeneity postulates of money demand by imposing relevant restrictions on the money normalized co-integrating vectors. These were not generally found to be data acceptable.

On balance, in terms of all the normalizations investigated, the money normalization cast in terms of the CFA open economy framework was preferred. Furthermore, within the CFA setting, although narrow money and broad money shared many satisfactory model properties, the narrow money model was preferred over broad money in terms of stability and predictability.

Based on weak exogeneity tests, the evidence as to whether money demand in Cameroon should be conducted in a single or multiple equation framework was not very clear. However, preliminary investigation informed against the use of the Engle-Granger single equation co-integration approach as it generated poorer diagnostic statistics than the systems approach used.

The fact that our preferred money demand relationship was given in terms of narrow money was considered as not surprising. We conjectured at the beginning of the thesis that because money in Cameroon appeared to be held mostly for transactions, a narrow definition of money which is usually interpreted as largely reflecting transactions may perform better in the envisaged empirical analysis than broad money. The appeal for its use in policy lies in the fact that broader definitions of money are
susceptible to a broader range of potentially destabilising shocks. For example shocks that affect only the non-M1 component of M2 would by definition not affect M1.

In view of data incompatibility of the price homogeneity postulate of money demand, we concluded that money demand based policies in Cameroon should be framed in terms of nominal money, otherwise they may run contrary to empirical observation. More specifically, we found that the price elasticity of money demand in Cameroon is significantly greater than unity.

A surprise element in our money demand result related to the magnitude of the income elasticity of money demand. It was significantly less than unity implying economies of scale in money holdings; a situation which is often associated with developed economies. Specifically, in the developing economy context, the traditional perception is in terms of an an income elasticity which is significantly greater than one; an outcome often interpreted as suggesting money is a luxury good. Therefore if the standard of living in Cameroon were to increase, leading to a higher level of per capita income, we would conjecture that the increase in money demand would be less than proportionate.

Traditionally, the interest elasticity of money demand is one of the key parameters used to address the question of efficacy of monetary or fiscal policy. We could not address this issue from a domestic interest rate perspective as domestic interest rates were not used in our empirical analysis as stated earlier.

However, we found that money demand in Cameroon is sensitive to the foreign interest rate as approximated by the French
interest rate. From a policy point of view, we noted that this is problematic in the sense that the foreign interest rate cannot be targeted or manipulated from a domestic source. In this case, joint CFA policy was advocated. On the other hand, a common CFA policy is difficult to establish because the interest rate that would be appropriate for a developed country such as France is unlikely to be that which would be appropriate for a developing economy like Cameroon. On the other hand, policies that result in substantial differences in interest rates in the CFA region can be potentially destabilising.

For example, Heidhues and Weinschenck \textit{(op. cit.)} note that because interest rates in Cameroon have been much lower than those in France, this has lead to substantial savings flow from Cameroon into France, leaving the domestic financial market, deprived of the funds, underdeveloped. In addition, they note that to the extent that enterprises, particularly large or expatriate firms have access to the more efficient and diversified services of the Paris market, the development of such services and financial intermediation in general, tends to be hampered.

The limited development of the monetary sector in Cameroon is likely to constitute a significant impediment to monetary policy. In these circumstances, policies such as open market operations will not be reliable.

We interpreted the French interest rate as measure of capital mobility within the CFA zone. However, we warned that this interpretation should not be taken at face value. It is arguable that the French interest used may have proxied the
effects of the omitted domestic interest rate.

Particular interest is sometimes placed on dynamic models because of their implications for short run economic policy. The prevalence of structural stability is usually emphasised for such models. For this reason, we used a variety of stability tests in assessing this issue. For our preferred model, the tests did not indicate instability. Furthermore, other familiar model diagnostics were checked and found to be satisfactory.

We interpreted the dynamic or error correction results of money demand in this thesis in the usual manner as suggesting that if in the last period for example, money balance holders consider their money balances to be above the desired long run equilibrium level, they will attempt to restore those balances to the desired long run equilibrium level by running down their money balances in the current period.

The dynamics of an error correction model can be complex. This observation was reflected in terms of our preferred money demand model. On balance, the dynamic path of money demand appeared smooth with overall dynamic stability assured as the error correction term was significant and negative in value as required for the overall dynamic stability of the model. We also interpreted the significance of the error correction term as implying causality from the independent variables in levels to money demand in the short run. A problem with dynamic adjustment is that it may be rather long implying that policy induced changes or shocks to the economy may take a long time to be fully reflected in the target variable.

The Granger-causality results can be recalled as follows.
Regarding money, we found that it will be better predicted using its lagged values and those of either: (1) domestic income or (2) foreign money or (3) the joint lags of domestic income and domestic prices. For domestic income, we found that it will be better predicted using its lagged values and those of either: (1) domestic prices or (2) foreign money or (3) the foreign interest rate or (4) domestic money and domestic prices or (5) foreign money, foreign prices, and the foreign interest rate. We interpreted the income results with caution as they exhibited residual autocorrelation. Finally, for the price variable, we found that it will be better predicted using its lagged values and those of either: (1) foreign money or (2) foreign prices or (3) the foreign interest rate or (4) the joint lags of all these variables.

The main conclusion from this thesis is that it is possible to conduct a money demand and causality analysis for Cameroon that can be cautiously used for macroeconomic policy. In order for policy to be feasible from our analysis, two main factors would have to be taken into account. Firstly, the domestic financial sector though developing, is not well developed implying such policy can only play a limited role and needs to be complemented with other policies. Secondly, to the extent that the determination of one or more key macroeconomic variables in Cameroon is significantly influenced by one or more foreign variables, the conduct of macroeconomic policy cannot be considered independent. In this thesis, we emphasised the importance of joint CFA policy.
### Table (A1): Δy as Regressand in Various 2-stage Estimation Models

#### (A1.1): Δy as Regressand in M1 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.018</td>
<td>-3.048</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.685</td>
<td>8.448</td>
</tr>
<tr>
<td>Δy(-2)</td>
<td>0.118</td>
<td>2.285</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.485</td>
<td>-5.175</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.304</td>
<td>3.338</td>
</tr>
<tr>
<td>ΔM1(-1)</td>
<td>-0.038</td>
<td>-2.284</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.978</td>
<td>-15.148</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.640</td>
<td>6.279</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.419</td>
<td>-3.781</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>0.325</td>
<td>3.017</td>
</tr>
<tr>
<td>ΔZc(-3)</td>
<td>0.763</td>
<td>2.935</td>
</tr>
<tr>
<td>ΔZc(-5)</td>
<td>-0.535</td>
<td>-2.039</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>-0.047</td>
<td>-3.823</td>
</tr>
</tbody>
</table>

#### (A1.2): Δy as Regressand in M2 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.087</td>
<td>-4.201</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.612</td>
<td>7.405</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.275</td>
<td>-3.307</td>
</tr>
<tr>
<td>ΔM2</td>
<td>0.050</td>
<td>2.231</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.997</td>
<td>-13.434</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.591</td>
<td>5.780</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.222</td>
<td>-2.105</td>
</tr>
<tr>
<td>Δ(-3)</td>
<td>0.599</td>
<td>2.214</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>-0.058</td>
<td>-4.512</td>
</tr>
</tbody>
</table>
### (A1.3): Δy as Regressand in M1 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.053</td>
<td>-3.680</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.749</td>
<td>9.502</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.467</td>
<td>-4.737</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.334</td>
<td>3.652</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.910</td>
<td>-14.004</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.737</td>
<td>7.398</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.422</td>
<td>-3.644</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>0.313</td>
<td>2.862</td>
</tr>
<tr>
<td>ΔZ_w</td>
<td>0.076</td>
<td>2.560</td>
</tr>
<tr>
<td>ΔZ_w(-3)</td>
<td>-0.065</td>
<td>-2.357</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>-0.032</td>
<td>-3.865</td>
</tr>
</tbody>
</table>

### (A1.4): Δy as Regressand in M2 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.076</td>
<td>-3.726</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.736</td>
<td>9.083</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.488</td>
<td>-4.952</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.292</td>
<td>3.068</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.931</td>
<td>-14.066</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.733</td>
<td>7.303</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.421</td>
<td>-3.632</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>0.302</td>
<td>2.741</td>
</tr>
<tr>
<td>ΔZ_w</td>
<td>0.079</td>
<td>2.729</td>
</tr>
<tr>
<td>ΔZ_w(-3)</td>
<td>-0.067</td>
<td>-2.419</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>-0.042</td>
<td>-3.842</td>
</tr>
</tbody>
</table>
### Table (A2): ΔZ as Regressand in Various 2-Stage Estimation Models

#### (A2.1): ΔZ as Regressand in M1 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.002</td>
<td>-1.288</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>-0.068</td>
<td>-2.713</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>0.025</td>
<td>2.163</td>
</tr>
</tbody>
</table>

#### (A2.2): ΔZ as Regressand in M2 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.013</td>
<td>-1.894</td>
</tr>
<tr>
<td>ΔZ(-1)</td>
<td>0.372</td>
<td>4.172</td>
</tr>
<tr>
<td>ΔM2(-1)</td>
<td>0.034</td>
<td>3.626</td>
</tr>
<tr>
<td>ΔM2(-2)</td>
<td>-0.032</td>
<td>-2.664</td>
</tr>
<tr>
<td>ΔM2(-4)</td>
<td>-0.023</td>
<td>-2.306</td>
</tr>
<tr>
<td>ΔM2(-5)</td>
<td>-0.028</td>
<td>-3.056</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>-0.057</td>
<td>-2.732</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>0.027</td>
<td>2.134</td>
</tr>
</tbody>
</table>

#### (A2.3): ΔZ as Regressand in M1 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.168</td>
<td>3.463</td>
</tr>
<tr>
<td>ΔP</td>
<td>0.643</td>
<td>2.069</td>
</tr>
<tr>
<td>Δy</td>
<td>0.703</td>
<td>2.748</td>
</tr>
<tr>
<td>Z(-1)</td>
<td>-0.228</td>
<td>-3.517</td>
</tr>
</tbody>
</table>

#### (A2.4): ΔZ as Regressand in M2 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.245</td>
<td>3.965</td>
</tr>
<tr>
<td>ΔP</td>
<td>0.758</td>
<td>2.406</td>
</tr>
<tr>
<td>Δy</td>
<td>0.783</td>
<td>3.073</td>
</tr>
<tr>
<td>Z(-1)</td>
<td>-0.247</td>
<td>-4.005</td>
</tr>
</tbody>
</table>
Table (A3): $\Delta M$ as Regressand in Various Joint Estimation Models

(A3.1): $\Delta M_1$ as Regressand in Joint M1 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.487</td>
<td>1.924</td>
</tr>
<tr>
<td>D3</td>
<td>-0.060</td>
<td>-4.152</td>
</tr>
<tr>
<td>$\Delta M_1(-3)$</td>
<td>0.211</td>
<td>2.777</td>
</tr>
<tr>
<td>$\Delta M_1(-6)$</td>
<td>-0.569</td>
<td>-8.877</td>
</tr>
<tr>
<td>\Delta P</td>
<td>1.046</td>
<td>2.570</td>
</tr>
<tr>
<td>\Delta P(-1)</td>
<td>1.306</td>
<td>3.266</td>
</tr>
<tr>
<td>\Delta y</td>
<td>0.834</td>
<td>2.353</td>
</tr>
<tr>
<td>\Delta y(-1)</td>
<td>0.862</td>
<td>2.682</td>
</tr>
<tr>
<td>\Delta y(-5)</td>
<td>0.604</td>
<td>2.942</td>
</tr>
<tr>
<td>\Delta Z_c</td>
<td>2.123</td>
<td>2.434</td>
</tr>
<tr>
<td>\Delta Z_c(-8)</td>
<td>2.891</td>
<td>2.789</td>
</tr>
<tr>
<td>M1(-1)</td>
<td>-0.230</td>
<td>-3.386</td>
</tr>
<tr>
<td>P(-1)</td>
<td>0.317</td>
<td>3.739</td>
</tr>
<tr>
<td>y(-1)</td>
<td>0.128</td>
<td>2.055</td>
</tr>
<tr>
<td>Z_c(-1)</td>
<td>-0.729</td>
<td>-1.823</td>
</tr>
</tbody>
</table>
(A3.2): AM2 as Regressand in Joint M2 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.411</td>
<td>2.015</td>
</tr>
<tr>
<td>ΔM2(-1)</td>
<td>0.336</td>
<td>3.118</td>
</tr>
<tr>
<td>ΔM2(-2)</td>
<td>-0.385</td>
<td>-4.444</td>
</tr>
<tr>
<td>ΔM2(-3)</td>
<td>0.214</td>
<td>2.319</td>
</tr>
<tr>
<td>ΔM2(-6)</td>
<td>-0.315</td>
<td>-3.919</td>
</tr>
<tr>
<td>ΔP</td>
<td>0.897</td>
<td>2.647</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.389</td>
<td>3.877</td>
</tr>
<tr>
<td>Δv</td>
<td>0.601</td>
<td>2.037</td>
</tr>
<tr>
<td>Δv(-1)</td>
<td>0.934</td>
<td>3.224</td>
</tr>
<tr>
<td>Δv(-5)</td>
<td>0.676</td>
<td>3.831</td>
</tr>
<tr>
<td>ΔZ_c(-4)</td>
<td>-2.019</td>
<td>-2.341</td>
</tr>
<tr>
<td>M2(-1)</td>
<td>-0.202</td>
<td>-2.808</td>
</tr>
<tr>
<td>P(-1)</td>
<td>0.312</td>
<td>3.189</td>
</tr>
<tr>
<td>y(-1)</td>
<td>0.121</td>
<td>1.557</td>
</tr>
<tr>
<td>Z_c(-1)</td>
<td>-0.224</td>
<td>-0.700</td>
</tr>
</tbody>
</table>
(A3.3): AMI as Regressand in Joint M1 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.611</td>
<td>2.812</td>
</tr>
<tr>
<td>D2</td>
<td>-0.068</td>
<td>-3.985</td>
</tr>
<tr>
<td>D3</td>
<td>-0.096</td>
<td>-5.889</td>
</tr>
<tr>
<td>ΔM1(-3)</td>
<td>0.179</td>
<td>2.664</td>
</tr>
<tr>
<td>ΔM1(-6)</td>
<td>-0.319</td>
<td>-3.519</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.245</td>
<td>4.108</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.842</td>
<td>3.345</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.644</td>
<td>3.344</td>
</tr>
<tr>
<td>ΔZ_u(-1)</td>
<td>0.277</td>
<td>2.703</td>
</tr>
<tr>
<td>ΔZ_u(-4)</td>
<td>0.216</td>
<td>2.268</td>
</tr>
<tr>
<td>ΔZ(-1)</td>
<td>-0.146</td>
<td>-2.591</td>
</tr>
<tr>
<td>P(-1)</td>
<td>0.219</td>
<td>3.072</td>
</tr>
<tr>
<td>y(-1)</td>
<td>0.029</td>
<td>0.539</td>
</tr>
<tr>
<td>Z_u(-1)</td>
<td>0.024</td>
<td>0.225</td>
</tr>
</tbody>
</table>
### Table (A3.4): ΔM2 as Regressand in Joint M2 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.167</td>
<td>0.765</td>
</tr>
<tr>
<td>ΔM2(-2)</td>
<td>-0.472</td>
<td>-5.415</td>
</tr>
<tr>
<td>ΔM2(-6)</td>
<td>-0.359</td>
<td>-4.672</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>1.452</td>
<td>5.295</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.820</td>
<td>3.483</td>
</tr>
<tr>
<td>Δy(-3)</td>
<td>0.346</td>
<td>2.182</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.530</td>
<td>3.039</td>
</tr>
<tr>
<td>Δy(-7)</td>
<td>-0.480</td>
<td>-2.889</td>
</tr>
<tr>
<td>M2(-1)</td>
<td>0.033</td>
<td>0.559</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.040</td>
<td>-0.458</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.060</td>
<td>-0.974</td>
</tr>
<tr>
<td>Z_w(-1)</td>
<td>0.203</td>
<td>2.362</td>
</tr>
</tbody>
</table>

### Table (A4): ΔP as Regressand in Various Joint Estimation Models

#### (A4.1): ΔP as Regressand in Joint M1 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.060</td>
<td>-1.089</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.329</td>
<td>3.726</td>
</tr>
<tr>
<td>Δy</td>
<td>-0.656</td>
<td>-13.287</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.359</td>
<td>4.891</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.209</td>
<td>-4.602</td>
</tr>
<tr>
<td>ΔZ_c(-5)</td>
<td>-0.726</td>
<td>-3.020</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.057</td>
<td>-3.623</td>
</tr>
<tr>
<td>M1(-1)</td>
<td>0.035</td>
<td>2.682</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.025</td>
<td>-1.831</td>
</tr>
<tr>
<td>Z_c(-1)</td>
<td>0.438</td>
<td>5.462</td>
</tr>
</tbody>
</table>
### (A4.2): ΔP as Regressand in Joint M2 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.032</td>
<td>-0.621</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.269</td>
<td>3.063</td>
</tr>
<tr>
<td>ΔM2</td>
<td>0.041</td>
<td>2.309</td>
</tr>
<tr>
<td>ΔM2(-1)</td>
<td>-0.036</td>
<td>-2.103</td>
</tr>
<tr>
<td>Δy</td>
<td>-0.653</td>
<td>-13.931</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.295</td>
<td>3.973</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.223</td>
<td>-5.120</td>
</tr>
<tr>
<td>ΔZc(-5)</td>
<td>-0.614</td>
<td>-2.634</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.105</td>
<td>-5.094</td>
</tr>
<tr>
<td>M2(-1)</td>
<td>0.069</td>
<td>4.392</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.064</td>
<td>-3.669</td>
</tr>
<tr>
<td>Zc(-1)</td>
<td>0.438</td>
<td>5.870</td>
</tr>
</tbody>
</table>

### (A4.3): ΔP as Regressand in Joint M1 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.151</td>
<td>-2.492</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.489</td>
<td>5.645</td>
</tr>
<tr>
<td>Δy</td>
<td>-0.678</td>
<td>-12.194</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.419</td>
<td>5.394</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.174</td>
<td>-3.438</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.081</td>
<td>-4.664</td>
</tr>
<tr>
<td>M1(-1)</td>
<td>0.054</td>
<td>3.868</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.020</td>
<td>-1.321</td>
</tr>
<tr>
<td>Zw(-1)</td>
<td>0.058</td>
<td>2.150</td>
</tr>
</tbody>
</table>
### Table (A4.4): ΔP as Regressand in Joint M2 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>-0.133</td>
<td>-2.321</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.461</td>
<td>5.520</td>
</tr>
<tr>
<td>Δy</td>
<td>-0.711</td>
<td>-13.211</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.405</td>
<td>5.399</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.218</td>
<td>-4.370</td>
</tr>
<tr>
<td>ΔZ_w</td>
<td>0.068</td>
<td>2.368</td>
</tr>
<tr>
<td>ΔZ_w(-3)</td>
<td>-0.054</td>
<td>-2.087</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.108</td>
<td>-5.475</td>
</tr>
<tr>
<td>LM2(-1)</td>
<td>0.066</td>
<td>4.638</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.039</td>
<td>-2.297</td>
</tr>
<tr>
<td>Z_w(-1)</td>
<td>0.109</td>
<td>3.750</td>
</tr>
</tbody>
</table>

### Table (A5): Δy as Regressand in Various Joint Estimation Models

#### (A5.1): Δy as Regressand in Joint M1 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.095</td>
<td>1.371</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.697</td>
<td>8.265</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.430</td>
<td>-4.292</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.346</td>
<td>3.530</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.925</td>
<td>-12.681</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.671</td>
<td>6.043</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.433</td>
<td>-3.639</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>0.332</td>
<td>2.893</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.046</td>
<td>-2.919</td>
</tr>
<tr>
<td>M1(-1)</td>
<td>0.030</td>
<td>1.913</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.029</td>
<td>-1.402</td>
</tr>
<tr>
<td>Z_c(-1)</td>
<td>0.292</td>
<td>2.944</td>
</tr>
</tbody>
</table>
### (A5.2): Δy as Regressand in Joint M2 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.044</td>
<td>0.689</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.549</td>
<td>6.465</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.283</td>
<td>-3.408</td>
</tr>
<tr>
<td>ΔM2</td>
<td>0.048</td>
<td>2.352</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.988</td>
<td>-13.271</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.511</td>
<td>4.818</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.282</td>
<td>-2.705</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.078</td>
<td>-4.028</td>
</tr>
<tr>
<td>M2(-1)</td>
<td>0.070</td>
<td>3.968</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.096</td>
<td>-3.884</td>
</tr>
<tr>
<td>Z_c(-1)</td>
<td>0.428</td>
<td>4.422</td>
</tr>
</tbody>
</table>

### (A5.3): Δy as Regressand in Joint M1 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.039</td>
<td>0.550</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.742</td>
<td>8.998</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.444</td>
<td>-4.478</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.377</td>
<td>3.988</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.880</td>
<td>-12.754</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.740</td>
<td>7.315</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.403</td>
<td>-3.447</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>0.355</td>
<td>3.190</td>
</tr>
<tr>
<td>ΔZ_w</td>
<td>0.072</td>
<td>2.361</td>
</tr>
<tr>
<td>ΔZ_w(-3)</td>
<td>-0.066</td>
<td>-2.372</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.040</td>
<td>-2.528</td>
</tr>
<tr>
<td>M1(-1)</td>
<td>0.037</td>
<td>2.417</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.040</td>
<td>-1.943</td>
</tr>
<tr>
<td>Z_w(-1)</td>
<td>0.083</td>
<td>2.644</td>
</tr>
</tbody>
</table>
### Table (A5.4): Δy as Regressand in Joint M2 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.046</td>
<td>0.659</td>
</tr>
<tr>
<td>Δy(-1)</td>
<td>0.720</td>
<td>8.691</td>
</tr>
<tr>
<td>Δy(-4)</td>
<td>-0.451</td>
<td>-4.595</td>
</tr>
<tr>
<td>Δy(-5)</td>
<td>0.345</td>
<td>3.580</td>
</tr>
<tr>
<td>ΔP</td>
<td>-0.888</td>
<td>-12.975</td>
</tr>
<tr>
<td>ΔP(-1)</td>
<td>0.727</td>
<td>7.260</td>
</tr>
<tr>
<td>ΔP(-4)</td>
<td>-0.403</td>
<td>-3.494</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>0.333</td>
<td>2.998</td>
</tr>
<tr>
<td>ΔZ_w</td>
<td>0.084</td>
<td>2.764</td>
</tr>
<tr>
<td>ΔZ_w(-3)</td>
<td>-0.067</td>
<td>-2.435</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.054</td>
<td>-2.960</td>
</tr>
<tr>
<td>M2(-1)</td>
<td>0.048</td>
<td>2.810</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.063</td>
<td>-2.448</td>
</tr>
<tr>
<td>Z_w(-1)</td>
<td>0.102</td>
<td>3.193</td>
</tr>
</tbody>
</table>

### Table (A6): ΔZ as Regressand in Various Joint Estimation Models

#### (A6.1): ΔZ_c as Regressand in Joint M1 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.015</td>
<td>0.651</td>
</tr>
<tr>
<td>ΔP(-5)</td>
<td>-0.061</td>
<td>-2.360</td>
</tr>
<tr>
<td>Z_c(-1)</td>
<td>-0.038</td>
<td>-1.264</td>
</tr>
<tr>
<td>M1(-1)</td>
<td>0.019</td>
<td>3.380</td>
</tr>
<tr>
<td>P(-1)</td>
<td>-0.018</td>
<td>-2.871</td>
</tr>
<tr>
<td>y(-1)</td>
<td>-0.019</td>
<td>-3.047</td>
</tr>
</tbody>
</table>
### (A6.2): $\Delta Z_c$ as Regressand in Joint M2 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K$</td>
<td>0.003</td>
<td>0.143</td>
</tr>
<tr>
<td>$\Delta Z_c(-1)$</td>
<td>0.358</td>
<td>3.986</td>
</tr>
<tr>
<td>$\Delta M2(-1)$</td>
<td>0.027</td>
<td>2.942</td>
</tr>
<tr>
<td>$\Delta M2(-2)$</td>
<td>-0.037</td>
<td>-3.092</td>
</tr>
<tr>
<td>$\Delta M2(-4)$</td>
<td>-0.024</td>
<td>-2.403</td>
</tr>
<tr>
<td>$\Delta M2(-5)$</td>
<td>-0.030</td>
<td>-3.294</td>
</tr>
<tr>
<td>$\Delta P(-5)$</td>
<td>-0.048</td>
<td>-2.148</td>
</tr>
<tr>
<td>$\Delta Z_c(-1)$</td>
<td>-0.016</td>
<td>-0.601</td>
</tr>
<tr>
<td>$M2(-1)$</td>
<td>0.025</td>
<td>3.241</td>
</tr>
<tr>
<td>$P(-1)$</td>
<td>-0.033</td>
<td>-3.232</td>
</tr>
<tr>
<td>$y(-1)$</td>
<td>-0.024</td>
<td>-2.785</td>
</tr>
</tbody>
</table>

### (A6.3): $\Delta Z_w$ as Regressand in Joint M1 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio[Prob]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K$</td>
<td>0.245</td>
<td>1.415</td>
</tr>
<tr>
<td>$\Delta P$</td>
<td>0.614</td>
<td>2.142</td>
</tr>
<tr>
<td>$\Delta y$</td>
<td>0.744</td>
<td>3.177</td>
</tr>
<tr>
<td>$\Delta Z_w(-1)$</td>
<td>-0.543</td>
<td>-6.042</td>
</tr>
<tr>
<td>$M1(-1)$</td>
<td>-0.0009</td>
<td>-0.019</td>
</tr>
<tr>
<td>$P(-1)$</td>
<td>0.050</td>
<td>0.908</td>
</tr>
<tr>
<td>$y(-1)$</td>
<td>-0.036</td>
<td>-0.709</td>
</tr>
</tbody>
</table>
### Table (A6.4): ΔZ_w as Regressand in Joint M2 World Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.204</td>
<td>1.174</td>
</tr>
<tr>
<td>ΔP</td>
<td>0.802</td>
<td>2.842</td>
</tr>
<tr>
<td>Δy</td>
<td>0.907</td>
<td>3.918</td>
</tr>
<tr>
<td>Z_w(-1)</td>
<td>-0.564</td>
<td>-6.271</td>
</tr>
<tr>
<td>M2(-1)</td>
<td>-0.074</td>
<td>-1.477</td>
</tr>
<tr>
<td>P(-1)</td>
<td>0.140</td>
<td>2.131</td>
</tr>
<tr>
<td>y(-1)</td>
<td>0.040</td>
<td>0.670</td>
</tr>
</tbody>
</table>

### Table (A7): Engle-Granger First-Stage Estimation Results for Money as Regressand in M1 CFA Model

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>T-Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0.22021</td>
<td>0.64932</td>
</tr>
<tr>
<td>D2</td>
<td>-0.062176</td>
<td>-3.1956</td>
</tr>
<tr>
<td>D3</td>
<td>-0.10387</td>
<td>-5.3339</td>
</tr>
<tr>
<td>LP</td>
<td>1.0126</td>
<td>23.6335</td>
</tr>
<tr>
<td>LY</td>
<td>0.80463</td>
<td>13.1452</td>
</tr>
<tr>
<td>RF2</td>
<td>2.5025</td>
<td>6.2127</td>
</tr>
</tbody>
</table>

**Diagnostic Statistics**

\[ R^2 = 0.99; F^* = (5, 98) = 3797; SE = 0.08; DW = 0.51 \]

**Autocorrelation:** \( F(4, 94) = 32.87 \)

**Functional Form:** \( F(1, 97) = 39.45 \)

**Normality:** \( \chi^2(2) = 1.15 \)

**Heteroscedasticity:** \( F(1, 102) = 5.68 \)
REFERENCES


Fuller, W. A. (1976), Introduction to Statistical Time Series, John Wiley and Sons.


