THE MACROECONOMICS OF THE MONETARY UNION OF SUB-SAHARAN AFRICA, THE CFA FRANC ZONE

Thesis submitted for the degree of

Doctor of Philosophy at the University of Leicester

by

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June 2007

To my parents John and Mary, my wife Wilhelmina and daughter Christine.

Abstract

Primarily, this thesis assesses the extent of macroeconomic convergence among the countries that make up the CFA Franc zone, the oldest single-currency arrangement in the world. The analyses is conducted from three perspectives and addresses the following issues: (i) Do the CFA Franc zone countries differ in the ways they respond to macroeconomic shocks? Here, we also consider some extensions: one is geographic - to include other non-CFA countries in the sub-region for comparison, and the other is based on oil-exporting status (i.e. Production Structure); (ii) To what extent has real exchange rate misalignment in individual member states of the Franc zone differed over the period 1960-99? There is a school of thought that the only devaluation in the history of the Franc zone, in January 1994, was implemented for the sake of the larger economies. This part of the thesis determines whether there is an empirical basis for this claim; (iii) Following a shock to inflation, how do member states of the Franc zone differ in terms of persistence in *food* and *non-food* price inflation? Under the assumption that the poor spend a larger proportion of their income on food, persistence in (especially) food price inflation is likely to have some deleterious consequences. Asymmetry in such persistence among member states will imply that policy makers will have to be particularly sensitive to such realities in forming the Zone's policy.

Chapters 1–3 review the background of the Franc zone and the empirical methods that are later used in the thesis. Chapters 4–6 are empirical studies, and are presented as separate units with each addressing a separate perspective, as listed above. To address the first issue, we apply the method of Blanchard and Quah (1989) in order to identify and estimate a structural VAR model appropriate for a small open economy. By decomposing the variance of the macroeconomic shocks in this way, the method extends the atheoretic VAR analysis and uses economic theory and time-series analysis to determine the sources of disturbances to economic variables in Chapter 4. Next, defining real exchange rate misalignment as the percentage deviation of the actual from the estimated equilibrium value, Chapter 5 estimates the degree of misalignment in the real exchange rate for twelve individual member states of the Franc zone. Due to the ties that bind the countries together, we allow for the possible cross-sectional dependence in all analysis including the unit-root tests (Pesaran, 2005). By using a SUR model, we account for the cross-sectional dependence that is likely to exist among the residuals across member states. Chapter 6 investigates the degree of inflation persistence in the *food* and *non-food* sectors of thirteen individual Franc zone countries; for robustness of our estimates, we avoid the knife edge I(0) / I(1) classification and make use of three semi-parametric methods [Geweke and Porter-Hudak (1983), Phillips (1999a,b) and Robinson (1995a)] of estimating the fractional integration parameter in an ARFIMA (*p,d,q*) model.

Findings from all three perspectives provide substantial evidence of some heterogeneity among the macroeconomies of the Franc zone countries. The research findings suggest that the conduct of uniform policy, such as monetary policy, within the monetary union by the central bank is likely to result in some net losers and net beneficiaries. There are important lessons to be learned from the Franc zone, and with other economies in the sub-region of sub-Saharan Africa considering forming other monetary unions, this area of research is particularly relevant. There are also some lessons the EU central bank can learn from the Franc zone. This is the subject of a Policy Brief titled '*What can the European Central Bank Learn from Africa?*' and recently written and discussed by David Fielding, United Nations University (November, 2005).

Acknowledgements

First, I would like to thank my initial supervisor, Professor David Fielding, for the invaluable and continuing guidance and encouragement he has provided me throughout the preparation of this thesis, including making his dataset available to me for portions of this work. Second, I am extremely grateful to Professor Mustafa Caglayan and Dr. Rodney Strachan for their guidance and supervision at various stages of this thesis, to Professor Stephen Hall and Dr. Sourafel Girma for their extremely helpful comments, and to Dr. Martin Hoskins for taking the time to advise me on various issues throughout my study and . Third, I wish to thank the editors of the *Journal of African Economies* and two anonymous referees who provided me with useful comments on an article version of Chapter 5 of this thesis, which I believe has improved the thesis. Finally, I thankfully acknowledge the United Nations University, World Institute of Development Economics Research (UNU-WIDER), Helsinki, Finland, for providing financial support during the period of my internship on the project '*Long-Term Growth in the CFA-zone Countries of Sub-Saharan Africa*', which resulted in Chapter 4 of this thesis and a chapter in the book '*Macroeconomic Policy in the Franc Zone*'. Financial support for my studies from the University of Leicester and the Overseas Research Scheme (ORS) is also gratefully acknowledged. Without the funding they provided, I would not have been able to complete this thesis.

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Chapter 1

INTRODUCTION

Following the formation of the European Monetary Union (EMU), interest in the economies of countries that have opted to be in monetary unions seems to have increased considerably, bringing into focus other long-existing monetary unions around the world. One such union is the *Communauté Financière Africaine* (the CFA, formerly *Colonies Françaises d'Afrique* - French Colonies of Africa) of sub-Saharan Africa, which comprises fourteen countries in sub-Saharan Africa (SSA) that has been in existence since 1948 - predating the EMU by many years.

The CFA was fashioned out of the former French empire in Africa, resulting from the transformation of the former French colonial empire and these countries' willingness, following independence, to maintain the institutional framework which had contributed to their macroeconomic stability. Their continued use of currencies that the French Treasury has guaranteed to exchange for Euros (formerly French Francs) at a fixed rate forms the cornerstone of the CFA union.[1]

Comprising of two groups of countries located in Western and Central Africa, the CFA of sub-Saharan Africa is made up of two distinct monetary unions, each with its

[1] The African Franc area is made up of 14 sub-Saharan African countries and the Comoros. However, this thesis focusses on the continental African countries, and refers to the collective group as the Franc zone.

own single central bank which issues their currency. The West-African group includes Benin (*Ben*), Burkina-Faso (*BFaso*), Côte d'Ivoire (*Civ*), Guinea-Bissau (*G. Bissau*), Mali (*Mal*), Niger (*Nig*), Senegal (*Sen*) and Togo (*Tog*) and the Central-African group comprises Cameroon (*Cam*), the Central African Republic (*CAR*), Chad (*Chd*), Congo Republic (*Con*), Equatorial Guinea (*GEQ*) and Gabon (*Gab*). Due to the regional distinction, the West-African group is referred to as the *Union Économique et Monétaire Ouest Africaine* (hereafter UEMOA), and uses a common currency *Franc de la Communuaté Financière de l'Afrique* (CFAF) issued by their regional central bank. The Central-African group, often referred to as the *Communauté Économique et Monétaire de l'Afrique Centrale* (hereafter CEMAC), uses a common currency called the *Franc de la Coopèration Financière Africaine* (CFAF) issued by their regional central bank. With the names of both currencies abbreviating to CFAF (or CFA Franc), the combined CFA region is typically referred to as the CFA Franc zone; a convention that has been followed in this thesis.[2]

It appears that the recent surge in interest in monetary unions has motivated some countries to consider forming regional monetary unions. Focussing on Africa, such proposed unions include the West-African Monetary Zone (WAMZ) comprising the English-speaking members of the Economic Community of West-African States (ECOWAS); and the South-African Development Community (SADC) monetary union comprising the Southern African countries - both of which are yet to fully take off. Given this growing interest in monetary unions, and the efforts being put into the venture by these countries, it should be of national importance to determine how the economies of individual countries may be affected by (somewhat) relinquishing control of some important policy instruments, such as the conduct of monetary policy. From

[2]A more detailed examination of the CFA Franc zone, including its origins and operational structure, has been provided in Chapter 2 of this thesis.

the Optimum Currency Area (OCA) theory, there may be potential costs of monetary union membership. If the countries experience heterogeneous macroeconomic shocks, the imposition of a single monetary policy may result in welfare costs for (at least) some member states relative to a world in which the countries have their own currencies, and hence their own monetary policy.

1.1 Motivation

The CFA Franc zone as it stands today has been the subject of much empirical research and discussion. The subject of such research particularly relates to how this group of countries are *working* together, being tied together largely as a result of what has been described as a 'historical accident' of being colonized by France rather than, say, Britain. Given that the grouping of the different countries into the two monetary unions that make up the CFA Franc zone (UEMOA and CEMAC) was largely aimed at easing the burden of administration, rather than on any sound economic rationale, it is possible (even likely) that countries with significant macroeconomic differences have found themselves in a common monetary union. The essential role of the single central bank is one of the fundamental features of any monetary union, hence large and persistent macroeconomic differences among member states are likely to make policy formulation and coordination among member states extremely difficult.

The potential for unequal welfare costs in some member states makes the issue of heterogeneity particularly relevant to policy formulation and is the main motivation for this thesis. In the light of this fact, studies aimed at uncovering macroeconomic similarities (or differences) should be of more than academic interest. Such similarities (or differences) will have important implications for the conduct of monetary policy by the central bank, and how their policies address the needs of individual member countries. For this reason also, this thesis considers the view that it is of more practical relevance for such studies to focus on country-level analyses, rather than (the more contentious) aggregated analyses. It may also be the case that the current grouping is indeed optimal, with each zone's member states showing significant macroeconomic similarities, which would then be an extremely happy accident.

The Franc zone is an extremely interesting case for such analysis for a number of reasons. Incidentally, all the oil-exporting countries in the CFA Franc zone (Cameroon, Congo Republic, and Gabon, and more recently Equatorial Guinea) are located in the CEMAC, which *a priori* suggests some homogeneity in their macroeconomies.[3] On the one hand, it is likely that countries with similar production structures may show similar responses to macroeconomic shocks. On the other hand, data reported in Tables 1.1 - 2.2 show that some marked differences exist in national income and other national development criteria, indicating that an *a priori* assumption of similar responses to (or relevance of) shocks may be misleading. Some discussion on the implications of Tables 1.1 - 2.2 has been provided below in Section 3 of Chapter 2, and highlights some of the differences among the countries.

Table 1.1: Human Development Index (HDI) for UEMOA Countries 1975-2003

Country	1975	1980	1985	1990	1995	2000	2003
Ben	0.304	0.336	0.362	0.368	0.395	0.422	0.431
BFaso	0.253	0.273	0.297	0.305	0.311	0.328	0.317
Civ	0.409	0.441	0.448	0.442	0.427	0.428	0.420
Mal	0.230	0.256	0.263	0.283	0.307	0.330	0.330
Nig	0.236	0.252	0.242	0.249	0.256	0.271	0.281
Sen	0.311	0.339	0.375	0.403	0.421	0.444	0.458
Tog	0.423	0.475	0.474	0.500	0.510	0.519	0.512

Source: Human Development Report 2005, United Nations Development Programme (UNDP).
Notes: The index numbers shown in the Table, as reported in the Human Development Report, provide an indication of where a country is developmentwise and are based on measures of three key dimensions: Education (Literacy and School Enrolment), Health (Life Expectancy) and Decent standard of living (Income). – indicates unavailable data.

[3]Significant amounts of oil reserves have recently (2003) been found in Chad, also in the CEMAC.

Table 1.2: Human Development Index (HDI) for CEMAC Countries 1975-2003

Country	1975	1980	1985	1990	1995	2000	2003
Cam	0.416	0.463	0.505	0.514	0.494	0.500	0.497
CAR	0.343	0.364	0.386	0.383	0.367	–	0.355
Chd	0.269	0.271	0.311	0.335	0.344	0.359	0.341
Con	0.452	0.499	0.540	0.526	0.531	–	0.512
GEQ	–	–	0.483	0.500	0.518	0.641	0.655
Gab	–	–	–	–	–	–	0.635

Source: Human Development Report 2005, United Nations Development Programme (UNDP). Notes: The index numbers shown in the Table, as reported in the Human Development Report, provide an indication of where a country is developmentwise and are based on measures of three key dimensions: Education (Literacy and School Enrolment), Health (Life Expectancy) and Decent standard of living (Income). – indicates unavailable data.

Table 1.3: Gross Domestic Product (GDP) for UEMOA Countries, 1980-2002

Country	1980	1985	1990	1995	2000	2001	2002
Ben	245.6	469.8	533.6	1082.9	1679.6	1832.06	1956.9
BFaso	272.0	663.1	850.2	1330.4	1832.4	2070.1	2251.2
Civ	2149.9	3134.8	2939.7	4987.7	7546.5	7869.5	8149.3
Mal	300.5	554.5	673.2	1358.1	1900.9	2222.9	2302.9
Nig	536.2	657.0	677.2	947.5	1176.4	1295.2	1418.7
Sen	740	1331	1556	2435	3332	3571	3720
Tog	238.4	338.2	442.5	768.6	946	955.3	1006

Source: International Monetary Fund's International Financial Statistics (IFS) database. Notes: The GDP is given in billions of CFA Francs.

Table 1.4: Gross Domestic Product (GDP) for CEMAC Countries, 1980-2002

Country	1980	1985	1990	1995	2000	2001	2002
Cam	1356.2	3896.0	3334.2	4365.5	6611.0	7136.7	7609.3
CAR	168.4	316.2	392.2	556.7	651.0	686.2	691.6
Chd	187.6	390.0	439.0	717.8	986.0	1246.0	1377.0
Con	360.4	970.8	762.1	1056.2	2309.8	2060.7	2118.5
GEQ	25.6	38.1	36.3	83.0	865.5	1302.3	1523.7
Gab	904.2	1500.5	1620.6	2474.6	3511.3	3176.7	3464.6

Source: International Monetary Fund's International Financial Statistics (IFS) database. Notes: The GDP is given in billions of CFA Francs.

Depending on the weight the researcher places on the similarities in production structure within each of the two groups, and on the differences in income (developmental) levels observed in Tables 1.1 - 2.2, it is reasonable to assume that different inferences about homogeneity may be made about member states.

The important policy implications of the above raise some issues. The first set of issues addressed in this thesis include the following, in the event of a macroeconomic shock:

1. How do the economies of individual countries differ in terms of the sources of disturbances to economic variables (i.e. the relative importance of macroeconomic shocks)?

2. Does the fixed currency-peg matter in this part of the world?

3. Does the *oil-exporting* status matter?

Using both time-series analysis and economic theory, these questions are addressed in Chapter 4 of this thesis.[4] The chapter focuses on the decomposition of the variance of macroeconomic shocks and determines the sources of disturbances to economic variables within member states. To assess whether adhering to a hard fixed currency-peg implies different responses to macroeconomic shocks, the chapter widens the geographical horizon of the analysis and makes some comparisons between the macroeconomic characteristics of Franc zone and some non-Franc zone countries within the sub-region. Finally, some comparison is also made between the oil-exporting and non-oil exporting groups.

Following the more general assessment of the similarities and differences in what drives macroeconomic shocks in member states in Chapter 4, it is instructive to focus

[4]The empirical methods applied in these analyses have been described in Chapter 3 of this thesis.

on a particular policy issue in the history of the CFA Franc zone and assess member states based on this common policy issue. Arguably, to date, the most important single policy event in the history of the Zone has been the collective devaluation of the CFA Franc *vis-à-vis* the French Franc in January of 1994. Largely, there is agreement among empirical studies that the collective devaluation was necessary to halt the degenerating macroeconomic position of the Zone as a whole, which was suffering serious balance of payment deficits partly due to the worsening Terms of Trade. With unilateral devaluation not available as an option in a monetary union, it is of some policy interest to know whether all member states actually required this devaluation, or whether such a major policy issue was implemented mainly for the benefit of the larger economies. An assessment of misalignment in the real exchange rate in individual member states in the years leading to the devaluation will shed more light on whether the decision was actually driven by the larger economies. This is the focus of Chapter 5, which estimates the degree of misalignment in the real exchange rate of individual Franc zone countries over the period 1960-99.

In a related matter, over the years leading to the 1994 devaluation, one important macroeconomic variable that clearly signalled imbalances across member states' economies was inflation. Despite some significant increases in inflation that were experienced across the Zone, it is worth noting that analysis of inflation rates in the Franc zone has been the subject of many studies, and generally there is agreement that inflation rates in member states are low and stable relative to non-CFA countries within the sub-region. Little attention has, however, been paid to the dynamics of inflation following a shock. Chapter 6 of this thesis aims to address this issue. It focuses on inflation persistence, which is in line with many recent studies in international macroeconomics that have sought to investigate the presence of unit roots in economic time series. The determination of the presence or otherwise of a unit root is based on the knowledge that when a series contains a unit root, the following characteristics apply. First, there is no long-run mean to which the series returns, implying that a shock is likely to persist continually. Second, the variance is time-dependent and approaches infinity with time.

The policy implications of a shock to inflation persisting continually has motivated some major organizations to set up dedicated teams to focus on this area of research. One example is the Inflation Persistence Network (IPN), which consists of economists from the European Central Bank (ECB) and national banks of the Eurosystem, who together conduct coordinated research projects on the patterns, determinants and implications of inflation persistence in the Euro area and in individual member countries.[5]

1.2 Objectives of the Thesis

As noted in the preceding section, and discussed further in Chapter 2 of this thesis, the formation of the Franc zone was hardly based on any economic rationale. Hence if there are large (and probably widening) fundamental asymmetries between the economies of these countries, there may have to be a rethink of the current groupings that make up the Zone. While it is possible that the individual countries that make up the Franc zone will have major *micro*-economic differences, that is not within the scope of this thesis which focuses on the *macro*-economic issues.

In empirical studies that investigate convergence in economic factors, it is typical to make a distinction between *nominal* and *real* convergence. On the one hand, *nominal*

[5] Examples are working papers by Gadzinski and Orlandi (2004), Levin and Piger (2004), Lünnemann and Mathä (2004), Marques (2004). Particularly, Andrews and Chen (1994) and Clark (2003), measure persistence as the sum of autoregressive coefficients (SARC), however some criticism of this method has been advanced by some researchers including Pivetta and Reis (2003) as highlighted in Section 2 of Chapter 6.

convergence usually refers to macroeconomic aggregates that may be under the control of the central bank and other policy makers such as average tax rates, government spending and national debts. On the other hand, *real* convergence is usually used to refer to the fundamental structure of the macroeconomies, which policy makers cannot directly control. In the case of the Franc zone, and for the purpose of the analysis in Chapter 4 of this thesis, this will be whether or not the country is classified as an *oil-exporter.*

The overall objective of this thesis is to assess, from different perspectives, the macroeconomic similarities (and differences) between member states of the CFA Franc zone of SSA, and to a lesser extent with some non-Franc zone countries.

In Chapter 4, we aim to shed some light on the extent to which the countries in the Zone are similar (or differ), in terms of the relative importance of macroeconomic shocks by assessing the variance decomposition of macroeconomic shocks. While the focus of the empirical chapters (Chapters 4 - 6) of this thesis is largely related to *nominal*, rather than *real* convergence criteria, Chapter 4 also includes some analysis which relates to *real* convergence criteria. Aside of the administrative distinction between the countries (UEMOA and CEMAC), member states can readily be grouped in terms of their oil-exporting status. As mentioned in the previous section, all the oil-exporting members of the Franc zone are located in the CEMAC group, whilst the oil-importers, and cash crop exporters are members of the UEMOA group. Therefore Chapter 4 also investigates whether there are any apparent similarities or differences between the oil-exporting group and the non-oil exporting group. We also widen the geographical boundaries of the analysis by making comparisons of the macroeconomic characteristics of the CFA states with some non-CFA states within the sub-region. In effect, this may shed some light on whether or not having a currency with a fixed peg implies having a different response to a shock.

The objective of Chapter 5 is to establish empirically, the extent of misalignment in the real effective exchange rate of individual member states. The chapter attempts to uncover the main beneficiaries of the collective devaluation of the CFA Franc, which will also indicate the countries for whom the devaluation was not an immediate necessity. Given that unilateral devaluation of the currency is not an option, unless there is a split in the monetary union, the analysis will, in part, highlight the costs and benefits of being in the Franc zone for member states. Specifically, the analysis determines the countries whose economies, in our opinion, were the driving forces behind the devaluation.

In Chapter 6, the possibility of persistence in sector-specific inflation series is analysed in individual countries of the Franc zone. In many previous studies on the Franc zone, the relative stability of aggregate inflation has been highlighted. While less attention has been paid, in empirical studies, to the investigation of asymmetries in inflation rates within the countries in the Franc zone, even less attention has been paid to sector-specific analysis of asymmetries in inflation. In fact, to the best of the author's knowledge, inflation persistence has not been investigated for the Franc zone. The objective of this chapter is, therefore, to fill this gap. We address the issue of possible asymmetries in *food* and *non-food* price inflation by obtaining the degree of persistence (memory) in each series for each country. Since monetary policy is formulated by a single central bank for each monetary union, findings from such an analysis should inform policy makers in the Zone about the measures to put in place following a change in policy. Findings of significant macroeconomic asymmetries should encourage policy makers to be aware of the potential asymmetries in the socio-economic effects of the policies they implement.

1.3 Structure of the Thesis

The rest of this thesis has been organized as follows. Chapter 2 provides a descriptive overview of the CFA Franc zone, highlighting the origins and objectives, including the background and structure of the Zone. In addition, the chapter discusses the relevant distinguishing features of the Zone. Chapter 3 presents an overview of the econometric methods that have been used subsequently in the empirical chapters of this thesis. These methods include Structural Vector Autoregression (SVAR) analysis, Seemingly Unrelated Regression Equations (SURE) estimation and Fractional Integration (ARFIMA) methods.

Following these introductory chapters are three empirical chapters of the thesis, which consecutively focus on investigating the degree to which macroeconomies of member states differ, or are similar. Each of Chapters 4, 5 and 6 aim to empirically investigate this issue from a different macroeconomic perspective. Building on the knowledge of the absence of any solid economic rationale for grouping countries within each of the two monetary unions that make up the CFA Franc zone (discussed in Chapter 2), Chapter 4 presents evidence to establish whether what drives macroeconomic shocks in member states of the Franc zone are similar or whether they differ significantly. A similar analysis is performed for oil-exporting and oil-importing member states. In both cases, some comparison is made between Franc zone member states and some non-Franc zone countries. Chapter 5 computes the real effective exchange rates for member states of the Franc zone and estimates the equilibrium real exchange rate - and hence the degree of real exchange rate misalignments over the period 1960-99 - and determines the main beneficiaries of the 1994 collective devaluation. Chapter 6 addresses the issue of persistence in inflation and assesses how member states are either similar or different so far as this measure is concerned, using data on *food* and *non-food* price inflation.

The thesis concludes in Chapter 7 with a discussion of the key results, the policy implications for the Franc zone, and finally, a presentation of the main contributions.

1.4 Analytical Tools

The thesis follows a rather eclectic approach, which has required the use of more than one analytical framework. For each of the empirical chapters, a model is developed and a methodology employed appropriate to the specific question the chapter seeks to address.

One issue worth mentioning at this stage is that of when it is sensible to look for cointegration restrictions in a model, and when it is not. A major decision factor is data availability and the degree of complexity of the model. In this thesis, at one extreme, the substance of the first empirical chapter (Chapter 4), has a relatively big multiple equation model with annual data, so we decide not to 'torture' the data with complex cointegration tests, although we perform some Johansen tests of cointegration to provide some level of econometric backing for the methods employed.[6,7] At the other extreme, Chapter 6 has some more sophisticated tests of integration in a single-equation framework using monthly data. The middle chapter (Chapter 5), is somewhere in the middle of the two extremes, a single-equation multivariate model using some panel-data unit-root tests with some basic cointegration tests.

In cases where data limitations hinder a more detailed analysis, we have drawn on methods adopted in other empirical studies and theoretical literature in an attempt to

[6] Some empirical evidence suggests that there are likely to be some limitiations to the use of the asymptotic critical values provided with the Johansen tests for sample sizes of 100 or smaller (Podivinsky, 1998). Despite this limitation, these tests still remain highly popular.

[7] In an attempt to extract more information from their data, a WIDER Research Paper 2004/22 (Fielding, Lee and Shields, 2004) attempts to use some cointegration restrictions in their VAR framework. The paper highlights the complexity of interpretation of attempting such analyses.

simplify the analyses. For example, in Chapter 4, the theoretical model from which the restrictions are derived is a description of the macroeconomic steady-state, and identification of the system of equations is based on the Blanchard and Quah (1989) framework. Due to data limitations, a modelling strategy utilized by Fielding and Shields (2001) is adopted, prior to estimating the VAR. Variance decompositions of macroeconomic shocks are then performed and analysed to decipher the sources of disturbances to economic variables. Using the single-equation approach to estimating the equilibrium real exchange rate, Chapter 5 utilises standard SURE methods to estimate a time-varying equilibrium real exchange rate for each individual country from which deviations are considered as misalignments. That is, the percentage deviation of the actual real exchange rate from the estimated equilibrium indicates the degree of misalignment over the period of analysis. In Chapter 6, three semiparametric methods, as proposed by Geweke and Porter-Hudak (1983), Phillips (1999a,b) and Robinson (1995a), are utilized in order to determine the degree of integration of food and non-food price series for each member state. The levels of integration of the series' are then compared to determine their relative degree of persistence.

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Chapter 2

THE CFA MONETARY UNION OF SUB-SAHARAN AFRICA

2.1 Introduction

This chapter presents a descriptive analysis of the CFA Franc zone, highlighting the origins, structural features and special arrangements that characterize the Zone. The analysis also highlights the administrative structures and operational features upon which the Zone is run.[1]

2.2 Origins and Objectives

2.2.1 Background

The arrangement between France and the then African colonies initially represented a simple trade arrangement, as most trade was by the barter system. Following (and

[1] The main sources of the information and historical review provided in this chapter have been listed in the bibliography to this chapter. Other relevant sources include the BEAC and BCEAO internet sites: <http://www.beac.int/index.html and http://www.beac.int/int_beac.html> and <http://www.bceao.int/>.

even, during) the French Revolution in 1789, however, increased requirement in the volume of raw materials required the use of a more organized form of exchange in trade, including the use of paper currency. Around 1850, the first colonial banks were established in most of the African colonies with each having a separate currency with a fixed conversion rate to the then French Franc (FF). Although the FF could be used in all these colonies, there was, at this stage, no formal indication of integration of the monetary system. The CFA Franc zone has developed and evolved significantly since the formation of a more formal monetary arrangement between France and its then colonies in 1948.

The First World War (WWI) and the after-effects had led France, and many other industrialized countries, to take measures to protect and to rebuild their economies. Due to these protectionist measures, some limits were set to trade, but producers of the raw materials that were needed for reconstruction still engaged in significant levels of trade with France. The importance of this channel to France required the infusion of some commonality and order to ensure the sustainability of both imports from and exports to these regions.

During the Second World War (WWII), an agreement between the French and English governments led to some parity between the French Franc (FF) and the Pound Sterling (£), implying some form of parity between the currencies in the French colonies and the Sterling. With the European empires still largely intact, after WWII, many economies around the world participated in some form of monetary union based on the major European currencies i.e. The Pound Sterling (England), Guilder (Dutch), Escudo (Portugal) and the Franc (France). The French, at this stage, had divided its colonies into zones - a North-African group, a sub-Saharan African group with currency the Franc of the *Colonies Francaises d'Afrique* (CFA Franc), and the colonies in the

Pacific with currency the Franc of the *Colonies Francaises du Pacific* (CFP Franc). The Central Bank for Overseas Territories - *Caisse Centrale de la France d'Outre-Mer* (hereafter CCFOM), had oversight responsibility over the monetary arrangement with the colonies, which included:

- Guaranteed convertibility of the CFA Francs to French Francs by the French Treasury on demand at a fixed value;
- Unrestricted movement of capital within the Zone;
- Common foreign exchange reserves held at the French Treasury;
- Establishment of a common trade and financial policy *vis-à-vis* the rest of the world (Boughton, 1991).

In the late 1950s and early 1960s, as most colonies around the world achieved political independence, several countries opted for complete economic independence and their own independent central banks. However, in contrast to this wide preference for total independence, the former colonies of France in the Western and Central-African regions (the *Colonies Francaises d'Afrique*) retained close economic and trade links with France. In 1960, the responsibility for monetary policy in the Franc zone was transferred from the CCFOM to two African central banks: the *Banque central des Etats de l'Afrique d'Ouest* (BCEAO) located in Dakar, Senegal and the *Banque Centrale des Etats de l'Afrique Equatorial et du Cameroun* (BCEAEC), later becoming *Banque des Etats de l'Afrique Central* (BEAC) located in Younde, Cameroon. These banks have, since then, had the exclusive responsibility of supplying bank notes and currencies in the Franc zone, and each bank has the responsibility for its own region. In 1974, the two central banks were granted increased authority, thereby increasing their scope for independent policy. Despite these reallocation of responsibilities, the underlying principles of the union have remained unchanged.

The CFAF (*le Franc des Colonies Française d'Afrique*) was pegged at 0.5 CFAF: 1 FF in October of 1948, but due to the introduction of the new FF in 1958, an adjustment was necessary. Due to this adjustment, the new FF was equivalent to 100 of the old FF. Although the CFAF rate remained unchanged relative to the old FF, the new parity became 50 CFAF: 1 new FF. This revised parity remained in place until January of 1994 when a 100% devaluation of the CFAF was implemented, making the rate 100 CFAF: 1 FF.[2]

Regarding membership of the Zone, there have been some departures and re-entries since 1948. Djibouti left in 1949, Guinea in 1958, Togo in 1960, Mali in 1962, Madagascar in 1963, and Mauritania in 1973; however, Togo re-joined in 1963 and Mali in 1984.[3] Two countries having no colonial relations with France joined the Zone much later i.e. a former Spanish colony, Equatorial Guinea in 1985 and a former Portuguese colony, Guinea-Bissau in 1997. Currently, the CFA Franc zone (now *Communauté Financière Africaine*) of sub-Saharan Africa is made up of 14 countries – 8 in West-Africa and 6 in Central-Africa. The West-African group, comprising Benin, Burkina-Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo make up the West-African Economic and Monetary Union (WAEMU) or *Union Économique et Monétaire Ouest Africaine* (UEMOA), and use the common currency *Franc de la Communuaté Financière de l'Afrique* (CFAF) issued by the BCEAO. The Central-African group comprises Cameroon, the Central African Republic, Chad, Congo Republic, Equatorial Guinea and Gabon and is often referred to as the *Communauté Économique et Monétaire de*

[2]Some texts have referred to this devaluation as a 50% devaluation, however this interpretation is simply based on the point of reference i.e. the CFAF before or after the devaluation. The meaning remains the same.

[3]Between 1962 and 1984, Mali was independent of the UEMOA and isssued its own CFAF, convertible at the rate of 100 CFAFM: 1FF.

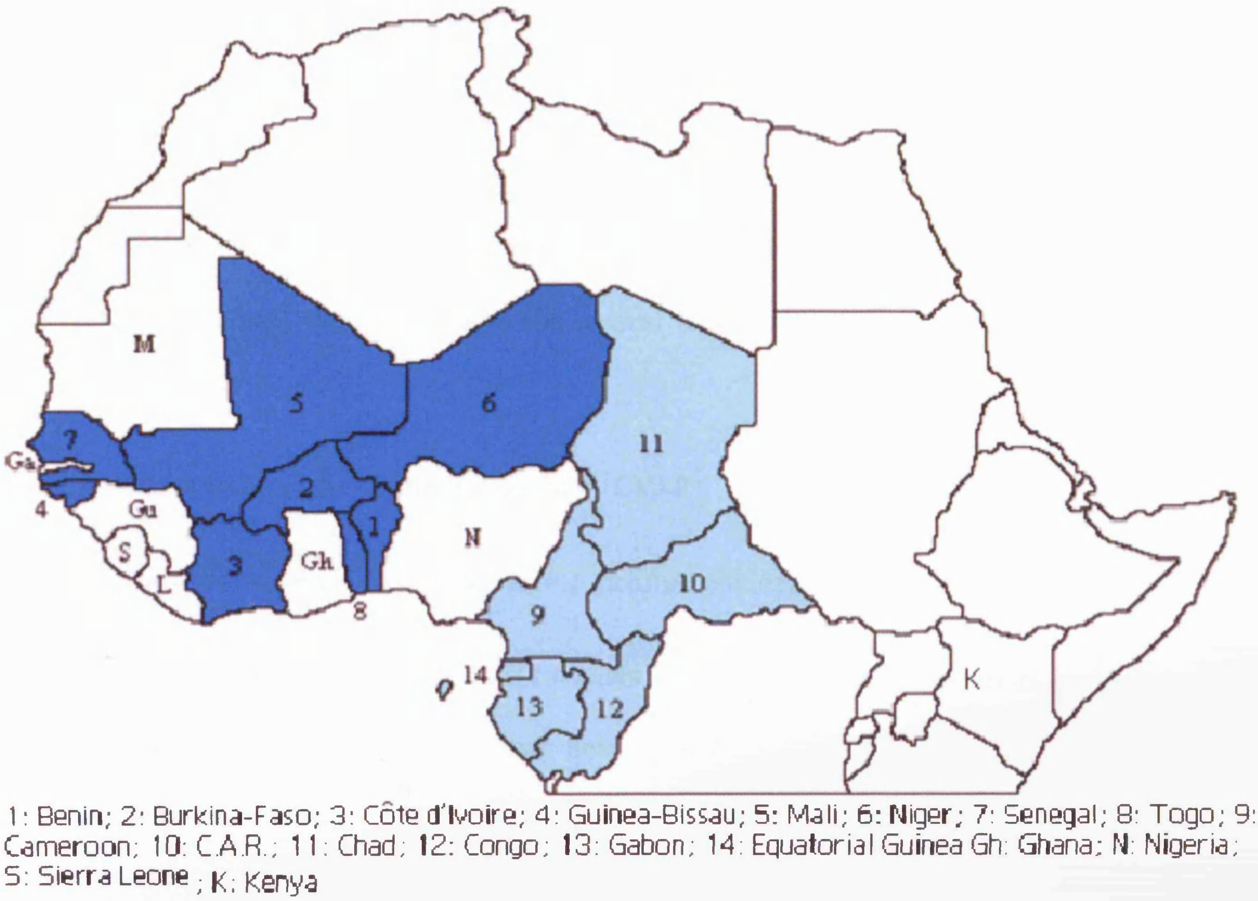

Figure 2-1: Franc Zone Members (1-14) and Selected non-Franc Zone Countries.

l'Afrique Centrale (CEMAC), using the common currency *Franc de la Coopèration Financière Africaine* (CFAF) issued by the BEAC. The two currencies are each specific to the zones in which they are issued, and are technically different. However, the guaranteed convertibility into FF (now Euros) at a common rate, and the relative ease of capital mobility between the Zones and with France has led to the view that they can be considered as a single currency area. Technically though, this is not so. Soon after gaining independence, countries in the Zone, though politically independent, were heavily dependent on France, which was the destination and source of over 60% of the Zone's exports and imports.

2.2.2 Structure of Franc Zone

The Franc zone is built on a set of fundamental principles and institutional structures, which are aimed at ensuring the smooth running of the union and prevent free-riding by member states.[4] Running of the Franc zone is built around the roles of the two central banks, and the functions of the central banks include (but are not restricted to):

- The supply of the common currency (CFAF);
- The holding of external reserves for member countries;
- The provision of credit facilities to banks and other financial institutions and also to governments of member states, holding and maintaining of separate accounts for member states.

In principle, the central banks hold individual Operations Accounts with the French Treasury, but in practice individual Operations Accounts are held for each member state. This is because each central bank has separate accounts for the member states, which show assets and liabilities of agencies within the country. Decisions that are taken regarding credit ceilings and other monetary decisions are then implemented by national Monetary Committees; and the central banks' day-to-day local operations and credit decisions are the responsibility of the national agencies and of the national directors.

Administrative Structures

Broadly, the administrative structures within the Zone are designed to promote the active participation of member states in the running of the Zone. Since 1974, when the

[4] Bathia, R. (1986) and Fielding, D. (2002) provide more indepth overviews of the CFA and its administrative structures and institutions.

central banks were given more authority, a hierarchical system has been used in the running of the Franc zone, providing a basis for both policy-formulation and decision-making.

In the UEMOA region, the Conference of Heads of State (*Conference des chefs d'état*) is at the top of the hierarchy, meeting at least once a year. It has the task of readdressing and resolving issues that the Council of Ministers (*Conseil des ministres*) have not resolved and also determines the broad policy directions of the region, with an authority to introduce new terms as required. Meeting four times a year, the Council of Ministers comprises two ministers from each member state, and are tasked with formulating general policy in the BCEAO, deciding on the adoption of the Banking Commission's (*Commission Bancaire*) proposals concerning supervision of the central bank and also to nominate the Governor of the BCEAO, who has a term of six years. Acts of the Council of Ministers and the Banking Commission are binding. In both the Council of Ministers and the Conference of Heads of State, a unanimous decision is required for issues discussed to pass.

The BEAC region is headed by the Monetary Committee (*Comité monétaire*), which is made up of the finance ministers of member states. The role of this committee is to oversee that the rules and policies of the Zone are implemented. The Mixed Monetary Committee (*Comité monétaire mixte*) comprises the *Comité monétaire* and representatives from France, and meets annually. In the BEAC the Administrative Council (*Conseil d'administration*) which is the main policy-formulating body, is comprised of four representatives from Cameroon, two from Gabon, one from each of the other four member states and three from France; and decisions are usually on a majority vote, but when major decisions are to be taken, a three-fourths ($\frac{3}{4}$) majority is then required. Another responsibility of the *Conseil d'administration* is to review the bank statements of accounts. Next in line and at the national level is the National Monetary Committee (*Comité monétaire nationaux*), which is made up of the Central Bank officials and government appointees who assess the financial needs of the economy in order to set credit limits granted to private banks and firms. The Regional Banking Commission (*Commission Bancaire de l'Afrique Centrale*) is in charge of regulating and supervising credit institutions. The Governor, national directors and others in the hierarchy of the central bank have stipulated administrative roles.

Operational and Constitutional Features

The constitutional and operational features of the Zone are designed to promote complete financial integration between member states. In pursuance of this goal, both France and the member states of the Franc zone have had to assume certain responsibilities, which have been enshrined in the central banks' constitutions. The adherence to these principles form the basis of the CFA monetary union as it stands.[5]

a) Fixed Parity

A fixed parity exists between the CFAF and the FF (now Euros (€)). Between 1948 and 1994, the parity was effectively 50 CFAF: 1 FF (Article 9 of BEAC constitution and Article 2 of BCEAO convention). This fixed parity would only be adjusted when there is a unanimous decision of all member states and with France. Only in January of 1994 was there a change in the rate, from 50 CFAF: 1 FF to 100 CFAF: 1 FF. An agreed feature between the member states and France is that, yearly, the French Treasury will compensate the CFA member states for any losses that are experienced through depreciations in the FF: SDR rate.[6] This compensation takes the form of

[5] In addition to the sources provided in the bibiography of this chapter and the references cited therein, another useful source of information has been the BCEAO internet site: <http://www.bceao.int/internet/bcweb.nsf/pages/umusel>.

[6] The Special Drawing Right (SDR) was created by the IMF in 1969 to support the Bretton Woods

Table 2.1: Summary of Parity Milestones in the Franc Zone

Event and Date	Parity Condition
Parity Creation of the CFAF December 26, 1945	1 FF = 0.588 CFAF
Devaluation of the French Franc October 17, 1948	1 FF = 0.500 CFAF
Institution of the new FF in 1958	1 FF = 50 CFAF
Devaluation of the CFAF January 12, 1994	1 FF = 100 CFAF

Source: BCEAO internet site <http://www.bceao.int/internet/bcweb.nsf/pages/umusel>.

crediting the Operations Account. Conversely, if there is an appreciation in the FF: SDR rate, the calculated gain for the member states is calculated and deducted from future credits and not debited from the Operations Account. The rate of exchange of the CFAF to the Euro is currently €1 for 655.957 CFAF. From 1948 to January of 1994, the fixed rate was 1 FF: 50 CFAF, and since the 1994 devaluation, though, the rate changed to 1 FF: 100 CFAF up until France adopted the Euro. The current rate is, however, still equivalent to the post 1994 arrangement and a summary of the parities over time has been presented in Table 2.1.

b) Guaranteed Convertibility of CFAF

A guarantee of convertibility of CFAF on demand has been provided by France and forms the cornerstone of the union, with the French Treasury guaranteeing the exchange of Euros (formerly French Francs) for CFA Francs. Therefore, the Euros needed by both the BEAC and the BCEAO for the smooth running of the Zone's financial state is guaranteed. Article 2 of the BEAC constitution states that the union is based on France's guarantee of convertibility of the CFAF; and Article 1 of the UEMOA Accord specifies that the French Treasury will help member states to ensure free convertibility of the CFAF into FF (now Euros (€) since January 1999, with the launch of the Euroland Euro). Recent historical exchange valuations for the CFA Franc

fixed exchange rate system. Currently, the SDR has only limited use as a reserve asset, and its main function is to serve as the unit of account of the IMF and some other international organizations. The SDR is neither a currency, nor a claim on the IMF but is a potential claim on the freely usable currencies of IMF members.

include: December 1998 at 559.67 CFAF to $1US, May 2000 at 728.56, September 2003 at 582.32, January 2004 at 519.57, April 2004 at 547.39. In relation to the Euro, historical exchange quotes include: December 1998 at 658.24 CFAF: €1, February 1999 at 655.96 and April 2004 at 655.97. Currently, an equivalent rate of €1 $\equiv$ 655.957 CFAF is in place.

Although, in principle, this should imply the absence of any parallel markets in the Franc zone, it has been argued that some parallel markets are possible and have, indeed, occurred in the past. Fielding (2002, page 4) cites an example in Côte d'Ivoire, where in 1988 there was a marked divergence between the official (285.25 CFAF: 1 US$) and 'parallel' exchange rates (360 CFAF: 1 US$). He suggests that the divergence may be due to the finite risk of devaluation and/or secession from the union, implying an associated risk with the holding of CFAF.

c) Free Capital Mobility

This section deals with the free transfer of funds. Free capital mobility within the two Franc zones and with France has also been addressed in the banks' constitutions. Article 10 of the BEAC constitution and Article 6 of the UEMOA Accord both provide for this freedom of capital flow. The unrestricted transfer of funds between France and the member states has been an important feature of the Zone and allows easier access to markets across the Zone and France, by promoting capital mobility not only between France and member states, but also between UEMOA and CEMAC. In practice, though, this feature is constrained by some regulations which include the high commissions and multiple taxes charged by banks for capital transfers combined with the limits on net holdings of net foreign assets by commercial banks. In addition to the above, as from August of 1993, the two central banks put a stop on the purchase of bank notes held by economic agents outside their respective zones, which in itself calls into question the concept of 'free' mobility of capital. Although, recently, such restrictions and checks have been implemented, possibly in an attempt to combat money laundering in the Franc zone area, there is still a relatively high degree of unrestricted flow of capital between member states and with France.

d) Pooling of Reserves

Each of the two monetary unions, UEMOA and CEMAC, is subject to policy formulated by their respective central banks and for each group, currency is only issued by the single central bank. That is, the *Banque des Etats de l'Afrique Centrale* (BEAC) in the CEMAC region, and the *Banque Centrale des Etats de l'Afrique de l'Ouest* (BCEAO) in the UEMOA region. The central banks implement monetary policy and finance both government and private sector banking activity by controlling credit and loan facilities. Pooling of the foreign exchange reserves for each Zone encourages a rigorous administration of public finances, and fosters solidarity among member states. In effect, the welfare of member states are somewhat tied, encouraging economic and financial integration.

Operating Rules

The operating rules of the Zone require that each central bank (BCEAO and BEAC) satisfies the following conditions:

- Maintains at least 65% of their foreign assets in the Operations Account. A similar restriction applies to private banks as a means of regulation. When the Operations Account is in debit, the CFA as a whole receives credit from France at a very low rate of interest.

- Imposes a ceiling on accumulated credit extended to each member state as a proportion of the previous year's public sector revenue aimed at maintaining fiscal discipline, and keeping budget deficits to a minimum. Officially, prior to the 1994 devaluation, central bank credits to governments was limited to 20% of the previous year's fiscal receipts. This implied that in order to be able to obtain more credit for expenditure, the government needed to raise more revenue. The monetary reforms that followed the 1994 devaluation has further tightened the rule and net public borrowing from the central banks is virtually nil.

- Actively conducts its policies to prevent worsening of the external balance. In an attempt to do this, the reserve assets ratio is continually monitored and adjusted in order to curb the net indebtedness of the private banks, or in fact of governments. To this end, the reserve assets ratio is varied from month to month for each member state. Furthermore, large loan applications by private institutions are also routinely scrutinized under the scheme *Accords de classement*, injecting higher accountability into the credit market.

2.3 The Franc Zone Today

The Franc zone is a combination of two separate monetary unions comprising fourteen countries: twelve former French colonies and two later additions in SSA - former Spanish colony Equatorial Guinea in 1985 and former Portuguese colony Guinea-Bissau in 1997. Specifically, the two groups are the *Union Economique et Monétaire Ouest Africaine* (UEMOA) of West-Africa and the *Communauté Économique et Monétaire de l'Afrique Centrale* (CEMAC) of Central-Africa. Incidentally, the currencies of both groups bear the name 'CFA Franc'; in the UEMOA region, CFA Franc refers to *Franc de la Communuaté Financière de l'Afrique* and in the CEMAC region, *Franc de la Coopèration Financière Africaine* and both are convertible with the Euro (formerly the French Franc) at a fixed rate.

According to the United Nations Development Programme (UNDP) criteria (based on HDI reported in Tables 1.1 and 1.2), only four out of the fourteen countries can be classified in the medium human development group with the remaining ten being in the low human development group. Recent studies have shown that poverty levels are still significant within the Zone. A number of empirical studies on the topic in the book, '*Macroeconomic Policy in the Franc Zone*', edited by Fielding, D. (2005) address this issue adequately.

Based on the Human Development Indices shown in Table 1.1, which captures both human development and national income per capita, Mali (*Mal*), Burkina Faso (*BFaso*) and Niger (*Nig*) are clearly worse off in comparison with the other UEMOA states, with Niger seemingly in the worst position. In the CEMAC, Table 1.2 indicates that Chad (*Chd*) and Central African Republic (*CAR*) are on the margins, with Chad seeming to be in the worst position. For this reason we, in this thesis, classify the states of Chad and Niger as the '*fringe*' economies of the Franc zone. Conversely, Benin (*Ben*), Côte d'Ivoire (*Civ*), Senegal (*Sen*), and Togo (*Tog*) for UEMOA, and Cameroon (*Cam*), the Congo (*Con*), Equatorial Guinea (*GEQ*), Gabon (*Gab*) of CEMAC seem to be the main players in the Franc zone. However, considering the size of their national incomes, as reported in Tables 1.3 and 1.4, Côte d'Ivoire in the UEMOA and Cameroon in the CEMAC are the clear leaders, and we classify these two as the '*pivotal*' economies of the Franc zone.

Having been in existence since 1948, the Franc zone represents the oldest multinational single currency monetary arrangement still in existence, and the CFA Franc has only been (collectively) devalued once in 1994. Since the devaluation, some measures have been put in place by the central banks aimed at re-instilling discipline by requiring stricter adherence to the rules that govern the Zone. The public is also being

Table 2.2: Components of the Human Development Index for CFA Countries, 2002-2003

		Life Expectancy (yrs)		Adult Literacy (%)		GDP per capita (US$)	
Region	**Country**	2002	2003	2002	2003	2002	2003
UEMOA	*Ben*	50.7	54.0	39.8	33.6	1070	1115
	BFaso	45.8	47.5	12.8	12.8	1100	1174
	Civ	41.2	45.9	49.7	48.1	1520	1476
	G. Bissau	45.2	44.7	39.6	39.6	710	711
	Mal	48.5	47.9	19.0	19.0	930	994
	Nig	46.0	44.4	17.1	14.4	800	835
	Sen	52.7	55.7	39.3	39.3	1580	1648
	Tog	49.9	54.3	59.6	53.0	1480	1696
CEMAC	*Cam*	46.8	45.8	67.9	67.9	2000	2118
	CAR	39.8	39.3	48.6	48.6	1170	1089
	Chd	44.7	43.6	45.8	25.5	1020	1210
	Con	48.3	52.0	82.8	82.8	980	965
	GEQ	49.1	43.3	84.2	84.2	30130	19780
	Gab	56.6	54.5	71.0	71.0	6590	6397

Source: Human Development Report 2005, United Nations Development Programme (UNDP).

informed, on a regular basis, *via* Central Bank communiquès, about monthly decisions on the value of policy instruments. By such actions, the possibility of speculation which is believed to have worsened capital flight in the years leading to the 1994 devaluation is likely to be considerably reduced, if not avoided all together.

As indicated by the data in Tables 1.1 - 2.2, and as will be shown empirically in this thesis, some significant heterogeneity exists among member states. It is reasonable to presume that this is likely to pose a major hurdle for policy coordination within the Zone in the years ahead, particularly in the face of the widespread political instability and civil strife in some Franc zone countries, particularly in the largest economy of UEMOA (Côte d'Ivoire).

2.4 Summary and Conclusions

The Franc zone of sub-Saharan Africa has evolved from simply being a trade arrangement to a robust monetary arrangement between France and (mainly) its former colonies in sub-Saharan Africa. Currently comprising two distinct monetary unions, UEMOA and CEMAC, the Zone has been operating under specific guidelines that, in many ways, distinguish it from other countries in sub-Saharan Africa. Although there has been some debate regarding how binding the rules and regulations are in practice, many studies have found significant differences between the economies of Franc zone and non-Franc zone countries in the sub-region.

There can be little doubt that the arrangement of the Franc zone has provided some financial stability in the member states, however inherent heterogeneity among member states is likely to be a major issue to address if the full benefits of the union are to be realized.

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Chapter 3

ECONOMETRIC METHODS: AN OVERVIEW

3.1 Introduction

This chapter presents an brief overview of the econometric methods applied in the empirical analyses of the macroeconomies of the Franc zone presented in Chapters 4, 5 and 6 of this thesis. It focuses on Structural Vector Autoregressions (SVARs), Seemingly Unrelated Regression Equation (SURE) analysis, and Fractional Integration (ARFIMA) analysis.

3.2 Structural Vector Autoregression (SVAR) Models

Hurwicz (1962) provides an original definition of a structural model to be one that allows for the prediction of the effects of 'interventions' i.e. deliberate policy decisions, or changes in the economy. Clearly, this implies that the model should be able to inform how the effect of an observed change can be interpreted in terms of the other variables. A simple conceptual example, is where a set of equations describe, say, private sector behaviour and another set, policy behaviour. The basic principles underlying the Structural Vector Autoregression (SVAR) is provided below using a general framework.

3.2.1 VAR Representations

Below we consider a simple bivariate dynamic model:

$$\begin{aligned} y_{1t} &= \alpha_{10} - b_{12}y_{2t} + \alpha_{11}y_{1t-1} + \alpha_{12}y_{2t-1} + \varepsilon_{1t} \\ y_{2t} &= \alpha_{20} - b_{21}y_{1t} + \alpha_{21}y_{1t-1} + \alpha_{22}y_{2t-1} + \varepsilon_{2t} \end{aligned} \tag{3.1}$$

where it is assumed that both y_{1t} and y_{2t} are stationary; $\varepsilon_{1t}, \varepsilon_{2t}$ are the structural innovations and are uncorrelated white-noise disturbances with standard errors, σ_1 and σ_2 i.e. $\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \sim iid \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_1^2 & 0 \\ 0 & \sigma_2^2 \end{pmatrix} \right)$. Clearly, from Equations 3.1, the endogeneity of y_{1t} and y_{2t} will be determined by the values of b_{12} and b_{21}, which shows the contemporaneous effect of the two dependent variables on each other. When say b_{12} is not equal to zero, it implies that ε_{2t} would have an indirect contemporaneous effect on y_{1t}.

Using matrix algebra, Equations 3.1 may be re-written as:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{3.2}$$

or more compactly,

$$By_t = \alpha_0 + \Gamma_1 y_{t-1} + \varepsilon_t \tag{3.3}$$

where $B = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}$; $y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix}$; $\alpha_0 = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix}$; $\Gamma_1 = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}$ and $\varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$.

Given that Equations 3.1 are in a form where both y_{1t} and y_{2t} have a contemporaneous effect on each other, it is useful to transform this system of equations into a form that does not possess this feature - the so-called *reduced form.* A simple rearrangement of Equation 3.3 yields:

$$B(L)y_t = \alpha_0 + \varepsilon_t \tag{3.4}$$

where $B(L) = B - \Gamma_1 L$. The *reduced form*, a more usable form of Equations 3.1, may be found be simply pre-multiplying Equation 3.3 by B^{-1} (under an assumption that there exists a non-singular matrix B satisfying this condition). Hence, it is possible to re-write Equation 3.3 as:

$$\begin{aligned} y_t &= B^{-1}\alpha_0 + B^{-1}\Gamma_1 y_{t-1} + B^{-1}\varepsilon_t \\ \text{or} \quad y_t &= a_0 + A_1 y_{t-1} + u_t \end{aligned} \tag{3.5}$$

Equation 3.5, without the constant term, may then be re-written as:

$$y_t = (I - A_1(L))^{-1}u_t = \Psi(L)u_t \tag{3.6}$$

where $A_1(L)$, in this case, is a 2x2 matrix of lag polynomials; y_t denotes a 2x1 matrix of stationary variables and u_t denotes the *reduced form* errors. It is important to note that the reduced form errors, u_t, are linear combinations of the structural form errors (shocks) with zero means, constant variances and are individually serially uncorrelated. Since $u_t = B^{-1}\varepsilon_t$, it can be determined that:

$$u_{1t} = \frac{(\varepsilon_{1t} - b_{12}\varepsilon_{2t})}{1 - b_{12}b_{21}}; \; u_{2t} = \frac{(\varepsilon_{2t} - b_{12}\varepsilon_{1t})}{1 - b_{12}b_{21}} \tag{3.7}$$

However, u_{1t} and u_{2t} may be correlated such that the mean, variance and covariance of the two terms may be written, respectively, as:

$$
\begin{aligned}
E(u_{1t}) &= E\left(\frac{\varepsilon_{1t} - b_{12}\varepsilon_{2t}}{1 - b_{12}b_{21}}\right) = 0 \\
E(u_{1t}^2) &= E\left(\frac{\varepsilon_{1t} - b_{12}\varepsilon_{2t}}{1 - b_{12}b_{21}}\right)^2 = \frac{(\sigma_1^2 - b_{12}^2\sigma_2^2)}{(1 - b_{12}b_{21})^2} \\
E(u_{1t}u_{2t}) &= E\left(\frac{(\varepsilon_{1t} - b_{12}\varepsilon_{2t})(\varepsilon_{2t} - b_{21}\varepsilon_{1t})}{(1 - b_{12}b_{21})^2}\right) = \frac{-(b_{21}\sigma_1^2 + b_{12}\sigma_2^2)}{(1 - b_{12}b_{21})^2}
\end{aligned}
\tag{3.8}
$$

Note that the covariance matrix of u_t will only be diagonal only if $b_{12} = b_{21} = 0$ and the reduced form VAR (Equation 3.5) will be covariance stationary provided the eigenvalues of A_1 have modulus less than 1. The eigenvalues (λ) of A_1 satisfy the condition $det(I_2\lambda - A_1) = 0$.

3.2.2 Identification Issues and Blanchard and Quah Decomposition

In order to uniquely solve for the structural parameters (ε_t), given that values of the *reduced form* parameters can be obtained from Equation 3.5, some restrictions need to be imposed on the parameters of the SVAR. Considering the bivariate case in Equation 3.1, nine *reduced form* parameters (six coefficients and three covariance elements) can be obtained from the reduced form, one less than the ten structural form parameters (eight coefficients and two covariance elements). Hence at least one restriction is needed to exactly identify the SVAR. Typical identifying restrictions include either imposing zero (exclusion) restrictions or sometimes other parameter restrictions within (or across) equations, incorporating known identities in the model, or linear restrictions on the elements of the B matrix, or imposing parameter restrictions on the variance-covariance matrix on the matrix of structural disturbances.

Generally, for an n variable VAR with p lags, we note that the elements of the SVAR that need to be determined includes $n^2 - n$ elements from the B matrix (since main diagonal of the B matrix are known to be unity), plus n elements from the matrix of intercepts, plus n^2p unknown elements from the matrix of coefficients, plus n individual elements from $var(\varepsilon_t)$, making a total of $n^2 + n^2p + n$ unknowns. The elements of the *reduced from* VAR that can be estimated include n elements from the matrix of intercepts, plus n^2p unknown elements from the matrix of coefficients, plus $(n^2+n)/2$ independent elements from $var(u_t)$, making a total of $n+n^2p+((n^2+n)/2)$. Therefore, identification of the structural model from the estimated VAR, requires the imposition of $n(n-1)/2$ long-run restrictions on the SVAR.

One of the means of identifying the structural errors is the arbitrary restriction of the elements of the B matrix in a triangular fashion, the so-called Choleski decomposition. The dramatic effects of changing the ordering of the variables in the VAR is a major criticism of this mode of decomposition.[1] Another mode of decomposition is suggested by Beveridge and Nelson, 1981, [hereafter BN]. The key element of the BN decomposition is that a persistent time series is driven by more than one shock. The univariate BN decomposition identifies these shocks by assuming the trend or permanent component is a random walk, restricting the way in which the permanent component evolves over time and how the observed time series responds to this shock. In reality, the data may not always support the random walk assumption and this is a major criticism of the univariate BN decomposition.

An alternative mode of achieving structural identification, as used in an Chapter 4 of this thesis, is the Blanchard and Quah, 1989 (BQ) decomposition. It involves imposing restrictions on the long-run impact of a given shock on a series, and differs

[1] This is especially true when the correlation between u_{1t} and u_{2t} (taking the bivariate case) is not low.

from BN by not imposing a random walk on the data. BQ decompose a bivariate time series into permanent and transitory components by imposing zero restrictions on the long-run response of some variables in the time series on the data, based on economic theory (i.e. from Equation 3.6, $\Psi(L)B^{-1} = 0$). In their original study, Blanchard and Quah assume that aggregate demand shocks have only short-run effects on real GNP, but none in the long run. In which case, the cumulated effect of aggregate demand shock on the real GNP sequence (Δy_t) must be zero.

3.2.3 Forecast Error Variance Decompositions

The main purpose of forecast error variance decompositions is to determine the proportion of the variability of the errors that is due to each of the structural shocks, say for time $t+\tau$, given information at time t. By re-writing Equation 3.5 in the, so-called, moving average (or Wold) representation:

$$y_t = \mu + \Psi(L)u_t \tag{3.9}$$

where $\Psi(L) = (I_2 - A_1(L))^{-1} = \sum_{k=0}^{\infty} \Psi_k L^k$. $\Psi_0 = I_2; ...; \Psi_k = A_1^k$ and $\mu = (I_2 - A_1(L))^{-1}a_0$, therefore the moving average (or Wold) representation for $y_{t+\tau} = \mu + u_{t+\tau} + \Psi_1 u_{t+\tau-1} + ... + \Psi_{\tau-1}u_{t+1} + \Psi_\tau u_t + \Psi_{\tau+1}u_{t-1} + ...$

The best linear forecast of $y_{t+\tau}$ at time t is $\hat{y}_{t+\tau|t} = \mu + \Psi_\tau u_t + \Psi_{\tau+1}u_{t-1} + ...$, hence the forecast error is written as $y_{t+\tau} - \hat{y}_{t+\tau|t} = u_{t+\tau} + \Psi_1 u_{t+\tau-1} + ... + \Psi_{\tau-1}u_{t+1}$, or in terms of the structural shocks:

$$\begin{aligned} y_{t+\tau} - \hat{y}_{t+\tau|t} &= B^{-1}\varepsilon_{t+\tau} + \Psi_1 B^{-1}\varepsilon_{t+\tau-1} + ... + \Psi_{\tau-1}B^{-1}\varepsilon_{t+1} \\ &= \Theta_0\varepsilon_{t+\tau} + \Theta_1\varepsilon_{t+\tau-1} + ... + \Theta_{\tau-1}\varepsilon_{t+1} \end{aligned} \tag{3.10}$$

Hence, the forecast errors in matrix form may be expressed as:

$$\begin{bmatrix} y_{1t+\tau} - \hat{y}_{1t+\tau|t} \\ y_{2t+\tau} - \hat{y}_{2t+\tau|t} \end{bmatrix} = \begin{bmatrix} \Theta_{11}^{(0)} & \Theta_{12}^{(0)} \\ \Theta_{21}^{(0)} & \Theta_{22}^{(0)} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t+\tau} \\ \varepsilon_{2t+\tau} \end{bmatrix} + ... + \begin{bmatrix} \Theta_{11}^{(\tau-1)} & \Theta_{12}^{(\tau-1)} \\ \Theta_{21}^{(\tau-1)} & \Theta_{22}^{(\tau-1)} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t+1} \\ \varepsilon_{2t+1} \end{bmatrix}$$

implying that $y_{1t+\tau} - \hat{y}_{1t+\tau|t} = \Theta_{11}^{(0)}\varepsilon_{1t+\tau} + \Theta_{12}^{(0)}\varepsilon_{2t+\tau} + ... + \Theta_{11}^{(\tau-1)}\varepsilon_{1t+1} + \Theta_{12}^{(\tau-1)}\varepsilon_{2t+1}$ and $y_{2t+\tau} - \hat{y}_{2t+\tau|t} = \Theta_{21}^{(0)}\varepsilon_{1t+\tau} + \Theta_{22}^{(0)}\varepsilon_{2t+\tau} + ... + \Theta_{21}^{(\tau-1)}\varepsilon_{1t+1} + \Theta_{22}^{(\tau-1)}\varepsilon_{2t+1}$. Since it is assumed that $\varepsilon_t \sim iid$ with zero mean, and having a diagonal covariance matrix, the variance of the forecast error for $y_{1t+\tau} - \hat{y}_{1t+\tau|t}$ may be written as:

$$var(y_{1t+\tau} - \hat{y}_{1t+\tau|t}) = \sigma_1^2(\tau) = \sigma_1^2(\Theta_{11}^{(0)^2} + ... + \Theta_{11}^{(\tau-1)^2}) + \sigma_2^2(\Theta_{12}^{(0)^2} + ... + \Theta_{12}^{(\tau-1)^2}) \quad (3.11)$$

and the proportion of the variance that is due to each of the structural shocks, ε_1 and ε_2, the decomposed forecast error (θ_{11}^{τ} and θ_{12}^{τ}) , may be written as

$$\begin{aligned} \theta_{11}^{\tau} &= \frac{\sigma_1^2(\Theta_{11}^{(0)^2} + ... + \Theta_{11}^{(\tau-1)^2})}{\sigma_1^2(\tau)} \\ \text{and } \theta_{12}^{\tau} &= \frac{\sigma_2^2(\Theta_{12}^{(0)^2} + ... + \Theta_{12}^{(\tau-1)^2})}{\sigma_1^2(\tau)} \end{aligned} \quad (3.12)$$

and similarly

$$var(y_{2t+\tau} - \hat{y}_{2t+\tau|t}) = \sigma_2^2(\tau) = \sigma_1^2(\Theta_{21}^{(0)^2} + ... + \Theta_{21}^{(\tau-1)^2}) + \sigma_2^2(\Theta_{22}^{(0)^2} + ... + \Theta_{22}^{(\tau-1)^2}) \quad (3.13)$$

with

$$\begin{aligned} \theta_{21}^{\tau} &= \frac{\sigma_1^2(\Theta_{21}^{(0)^2} + ... + \Theta_{21}^{(\tau-1)^2})}{\sigma_2^2(\tau)} \\ \text{and } \theta_{22}^{\tau} &= \frac{\sigma_2^2(\Theta_{22}^{(0)^2} + ... + \Theta_{22}^{(\tau-1)^2})}{\sigma_2^2(\tau)} \end{aligned} \quad (3.14)$$

As earlier stated in this section, for the bivariate system, the forecast error variance decomposition, represented by Equations 3.12 and 3.14, shows the proportion of the variability that can be attributed to the shocks of each variable. If, say, ε_1 shocks explain none of the forecast error variance of y_2 at all forecast horizons, then it implies that y_2 is considered to be exogenous, or entirely endogenous if ε_1 shocks explain all of the forecast error variance of y_2 at all forecast horizons. It is typical, though, for a variable to be responsible for higher proportions of the forecast error variance at shorter horizons which may decrease at longer horizons.

In terms of the structural shocks, ε_t, Equation 3.6 may be written as $y_t = \Psi(L)u_t = \Psi(L)B^{-1}\varepsilon_t = \Theta(L)\varepsilon_t$, where the elements of the $\Theta(L)$ give the dynamic multipliers and the long-run multiplier as $t \longrightarrow \infty$ giving the responses of y_t to changes in the structural errors, ε_t. For a stationary y_t it must be the case that the elements of the $\Theta(L)$ is finite. Such analyses being referred to an Impulse Response analysis. The focus of the relevant chapter (Ch. 4) is on investigating similarity (or otherwise) of variance decompositions over the short-run, we do not focus on the impulse response analyses, however it is possible to do this as an extension.

3.3 Seemingly Unrelated Regressions

In Equation 3.1 in the previous section, each equation contains more than one endogenous variable i.e. $y_{1t}, y_{2t}, ...y_{nt}$. It is not unusual to have multi-equation models where each equation contains one and only one endogenous variable i.e. the dependent variable, in which case b_{12}, b_{21} of matrix B as defined in previous section are both equal to zero. Hence,

$$\begin{aligned} y_{1t} &= \beta_{11} M_{11,t} + \beta_{12} M_{12,t} + ... + \beta_{1k_1} M_{1k_1,t} + \varepsilon_{1t} \\ & ... \\ y_{nt} &= \beta_{n1} M_{n1,t} + \beta_{n2} M_{n2,t} + ... + \beta_{nk_n} M_{nk_n,t} + \varepsilon_{nt} \end{aligned} \quad (3.15)$$

for $t = 1, 2, ..., T$, or compactly as $Y_i = \beta_i M_i + \varepsilon_i$, where Y_i is a Tx1 vector of dependent variable, M_i is a Txk_i matrix of explanatory variables, and ε_i is an Tx1 vector of the error terms. Typically, the applicable estimation methods depend on the testable assumptions that are made regarding the error terms. For each equation:

1. The error terms have a zero mean - $E(\varepsilon_{it}) = 0$, $t = 1, 2, ..., T$ and $i = 1, 2, ..., n$;
2. The error terms have constant variance over time t, though these may be different for each i - $var(\varepsilon_{it}) = E(\varepsilon_{it}^2) = \sigma_i^2 = \sigma_{ii}$, $t = 1, 2, ..., T$;
3. The error terms for two different time periods $t \neq s$ are not autocorrelated - $cov(\varepsilon_{it}, \varepsilon_{is}) = E(\varepsilon_{it}\varepsilon_{is}) = 0$;
4. For a time t, the error terms for two different equations $(i \neq j)$ may be correlated (contemporaneous correlation) - $cov(\varepsilon_{it}, \varepsilon_{jt}) = E(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij}$;
5. For different equations $(i \neq j)$ and for different time periods $(t \neq s)$, the error terms are not correlated - $cov(\varepsilon_{it}, \varepsilon_{js}) = E(\varepsilon_{it}\varepsilon_{js}) = 0$.

In some situations it is possible to justify, by economic theory, that the error terms of two different equations are uncorrelated i.e. $cov(\varepsilon_{it}, \varepsilon_{jt}) = 0$ for $i \neq j$, in which case the ordinary least squares (OLS) estimator is efficient. However, it may not always be realistic to do so, in which case the OLS estimator is not efficient as it does not make use of the information from the contemporaneous correlation. A set of equations that have contemporaneous cross-equation error correlation is typically called a seemingly unrelated regression (SUR) system. At the first glance, though the equations may seem unrelated, the equations may be related through the correlation in their errors.

In such cases, the generalized least squares (GLS) estimator, given by:

$$\beta_{GLS} = (M'\Omega^{-1}M)^{-1}M'\Omega^{-1}Y \tag{3.16}$$

with its variance-covariance matrix given by:

$$var - cov(\beta_{GLS}) = (M'\Omega^{-1}M)^{-1} \tag{3.17}$$

is preferred, as it becomes the best linear unbiased estimator (BLUE). However, Equations 3.16 and 3.17 can only be of practical use when we know the variance-covariance matrix (Ω) of the error terms. Zellner's (1962) method of obtaining the *iterated SUR estimates* proposes an iteration process of obtaining the consistent estimates of the variance-covariance matrix (Ω) of the error terms using the OLS residuals. While the stepwise procedure is provided in many econometric textbooks, more recently many computer packages (such as *E-Views* and *STATA*) can routinely provide these estimates.

In models where there is reason to believe the existence of cross-equation contemporaneous correlation of the error term, and with only one endogenous variable per equation, the SURE methodology is preferred to applying OLS to each equation. Both the presence of contemporaneous correlation of the error terms (Breusch and Pagan 1980) and the possibility of imposing linear restrictions on the coefficients (Wald, 1943) can be tested. Both tests have been applied in Chapter 5 of this thesis.

3.3.1 Hypothesis Testing

In a multi-equation model, when it is established that there is no contemporaneous correlation, there is no need to apply the SURE methodology as OLS yields efficient estimates.

First, Breusch and Pagan (1980) suggest a test having a null hypothesis (H_0 : all covariances are zero, $\sigma_{ij} = 0, i \neq j$) and an alternative hypothesis (H_1 : at least one covariance is not zero). According to Breusch and Pagan (1980), the Lagrange multiplier statistic (λ)$= T\sum_{i=2}^{n}\sum_{j=1}^{i-1} r_{ij}^2$, where r_{ij}^2 represents the square of the off-diagonal elements of the residual correlation matrix and T is the number of observations, follows asymptotically the Chi-squared (χ^2-) distribution with $n(n-1)/2$ degrees of freedom. In other words, when λ is greater than the critical level of $\chi^2(n(n-1)/2)$ distribution, then some contemporaneous correlation does, in fact, exist and SURE provides efficient estimates.

Second, restrictions imposed on the set coefficients of the multi-equation model can be tested by means of the Wald (1943) statistic, which is assumed to follow a Chi-squared (χ^2-) distribution with J degrees of freedom. Where J is the number of rows contained in the matrix of restrictions. When the estimate of the statistic is greater than the critical value of the $\chi^2(J)$ then the null of having valid restrictions is rejected in favour of the alternative.

3.4 Fractional Integration

While it is considered analytically easier to work with stationary series, a trivial fact is that not all economic variables are stationary. In fact, in levels, most economic variables tend to exhibit some strong trends, not having a long-run mean to which the series reverts, and having time-dependent variance which tend to increase over time. The implications of unit roots in macroeconomic data are particularly relevant to the methods that can be applied to it, in order to avoid spurious regressions. In order to analyze the long-run impact of contemporaneous shocks, the two extreme possibilities are the $I(0)$ and $I(1)$ models. For series with unit roots, $I(1)$, it implies that they are characterized by shocks that have permanent effects, but differencing it *once* removes the non-stationarity. Innovations of $I(0)$ processes disappear so fast that the correlations decay at an exponential rate. Confining the behaviour of shocks to these two extremes has been found to be overly restrictive, as there is ample empirical evidence to suggest that many macroeconomic and financial series behave differently.

While simple differencing is often used to achieve stationarity, there are some arguments against differencing (Sims, 1980) suggesting that there is usually some loss of information which include identifying *cointegrating* relationships between series, where they do exist. However, a class of models that accounts for a richer scope of persistence types is given by the so-called Fractionally Integrated models. In the general case, a series can be described as being integrated of order d [denoted $I(d)$], where with respect to the ARIMA case, the d parameter is estimated rather than imposed.[2] When x_t is a non-stationary process and y_t can be expressed as:

$$y_t = \Delta^d x_t \tag{3.18}$$

[2]The restriction of the d parameter to integer values of 0, 1, 2, ... in ARIMA models has been shown to be over-restrictive in many types of series.

then the stationary autoregressive moving average (ARMA) representation can be written as:

$$\phi(L)y_t = \theta(L)\varepsilon_t \tag{3.19}$$

$$\text{and hence } \phi(L)\Delta^d x_t = \theta(L)\varepsilon_t \tag{3.20}$$

where Equation 3.20 is referred to as autoregressive integrated moving average (ARIMA) representation of order (p, d, q) where both $\phi(L)$ and $\theta(L)$ are stationary, with p and q lags respectively. The restriction may be relaxed so that the order of d does not need to be an integer, in which case the model is known as autoregressive fractionally integrated moving average and abbreviated to ARFIMA(p, d, q).[3] The value of the d parameter, which is often referred to as the *memory parameter*, determines the order of integration of the series. In Equation 3.20, while d captures the medium to long-run behaviour of the process, the terms $\phi(L)$ and $\theta(L)$ model the short-run dynamics.

The bigger the value of d, the more persistent the process is. In integrated series, say $I(1)$ or $I(2)$ processes where $[d \geq 1]$, it is well known that autocorrelations remain persistently high even at long lags. In contrast, autocorrelations of stationary processes $[d = 0]$ typically decay exponentially and imply *short-memory*. In between these two extremes, when $0 < d < 1$ the series may be either stationary or non-stationary and typically said to imply *long-memory*. First, when $0 < d < 0.5$, the process is stationary, but the autocorrelations die out more slowly than those of a stationary AR process. Second, when $0.5 \leq d < 1$, the process is no longer covariance stationary, as it possesses an infinite variance although it is still mean-reverting with the effects of the shocks dying away in the long-run. Finally, for $d \geq 1$, shocks have a permanent effect. Baillie (1996) provides an extensive review of such processes and states that:

[3] A class of models attributed to work by Granger and Joyeux(1980) and Hosking(1981).

'When viewed as the time series realization of a stochastic process, the autocorrelation function exhibits persistence that is neither consistent with an $I(1)$ process nor an $I(0)$ process. One of the most compelling motivations concerning the importance of long memory, fractionally integrated processes is related to the rate of decay associated with the impulse response coefficients of a process.'

It has been shown in many studies that in some cases, although the use of traditional tests for unit roots such as the augmented Dickey-Fuller (ADF) tests, may not be able to reject the unit root hypothesis, estimation of ARFIMA(p, d, q) models may indicate otherwise. For example, Greene (2003, page 649) reports on a study conducted by Cheung (1993) where the author investigates the presence of unit roots in the dollar spot-rates of the British Pound, the Deutshe Mark, Swiss Franc, French Franc, and the Japanese Yen. Whilst in almost all the cases, the unit root hypothesis is rejected in favour of long-memory using the ARFIMA(p, d, q) models, Greene reports that the ADF tests could not reject the unit root hypothesis.

A number of methods have been proposed to estimate the d parameter, these include Geweke and Porter-Hudak (1983), Phillips (1999a,b) and Robinson (1995a). A overview of the Fractional Integration method and these estimation methods have been further explained and applied in empirical Chapter 6 of this thesis.

3.5 Summary and Conclusions

Although further clarification has been provided in the appropriate chapters, this chapter serves as a prelude of the econometric methods and concepts to the empirical chapters.

First, this chapter describes the structural VAR approach. Using a simple bivariate system as an example, it describes the procedure of identifying the structural errors, and understanding the properties of the forecast errors. It also describes the basis for decomposing the forecast error variance of each equations in the model, which informs the proportion of the movements in a sequence that is due to its own shocks against the shocks due to the other variable(s). An application of this variance decomposition is applied to a macroeconomic model in Chapter 4.

Second, in a multi-equation model, when each equation contains one and only one endogenous variable, the chapter highlights that the only link between the equations is the contemporaneous correlation. Given that the use of OLS will not yield efficient estimates, due to the contemporaneous correlation, the chapter describes the method of 'Seemingly Unrelated Regression Equations (SURE)', which provides efficient estimates because the method also uses information on the contemporaneous correlation of the error terms. Chapter 5 utilizes this method in investigating misalignment in the real effective exchange rate of the CFA Franc zone countries.

Third, this chapter describes an issue that has gained much importance in applied econometrics in recent years - the order of integration of macroeconomic series and the characterization of time series as either stationary or non-stationary. Generally, the presence or otherwise of unit roots has important structural implications for any series since unit roots are associated with long-run behaviour. Particularly, it focuses on the importance of the development in econometrics concerning the order of integration which relates to the relaxation of the restriction that the order of integration has to be an integer. The order of integration is able to assume non-integer values, hence fractional integration. One obvious importance of the concept of fractional integration is that it decreases the possibility of erroneously classifying series as non-stationary when it may, in fact, be fractionally integrated, yet stationary. An empirical application to sector-specific inflation series is carried out in Chapter 6.

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Chapter 4

VARIANCE DECOMPOSITION OF MACROECONOMIC SHOCKS IN SUB-SAHARAN AFRICA

This thesis chapter is based on a chapter of the same topic written by the author and published in Chapter 4 (pages 64-85) of the book '*Macroeconomic Policy in the Franc Zone*', Edited by David Fielding (2005).

4.1 Introduction

Most countries in sub-Saharan Africa (SSA) are generally considered to be small economies, and are often the price-takers on the world market. However, since the 1980s, most African countries have increasingly been implementing policy reforms aimed at boosting economic growth and promoting their integration into the world economy. These reforms have been the subject of many studies (see for example World Bank, 1994 and references cited therein). To the extent that their economies are open, the quest comes with the added 'burden' of greater sensitivity to the external environment, in addition to domestic disturbances which may occur. In other words, for open economies, policy issues in foreign economies are usually of significant concern to national policy makers; and more so for small open economies, as they typically have less bargaining power.

In relation to the generally poor growth in almost all of Africa, some studies have sought to investigate the factors affecting long-run growth in this part of the world (see for example Ghura and Hadjimichael 1995; World Bank 1994). In fact, some studies have suggested that such dismal performances are best explained by understanding the unstable macroeconomies (see Ramey and Ramey 1995; Collier and Gunning 1999; Sachs and Warner 1996). However, understanding these unstable economies requires a thorough understanding of the sources of (and responses to) macroeconomic shocks in these economies.

Despite the generally poor growth, there appears to be some significant differences in economic performance among countries, and among economic blocs, in SSA. Notable among these differences are those observed between the countries within the Franc zone, having a fixed exchange rate regime *vis-à-vis* the French Franc (with the Euro since 1999) and other countries within the sub-region, but outside the Franc zone. Aside from the geographical and political heterogeneity that exists within African countries, some marked differences in economic performance (especially over the 1980s) have raised the question of whether being in a monetary union in this part of the world has caused the Franc zone countries to respond differently to macroeconomic shocks relative to the non-Franc zone countries. Also there is the question of whether such economies have fared better or worse, economically, than their neighbours who are not part of the monetary union. Devarajan and De Melo (1991) find that the Franc zone countries fared a lot worse than their non-Franc zone counterparts mainly in the 1980s due their inability to fully adjust in response to unfavourable external circumstances. In measuring the welfare costs arising from the inability of Franc zone countries to adjust their nominal exchange rate. Devarajan and Rodrik (1991), on their part, balance these costs against the benefits of lower inflation and find the costs to have been higher for Franc zone member states especially over the 1980s. Focussing on output growth as well as the performance of exports, investment, and savings, Elbadawi and Majd (1996) also find a weakening competitive position of the CFA members during the second half of 1980s relative to the first half, compared with non-Franc zone countries. Similarly, Ghura and Hadjimichael (1996) find that particularly between 1987-89, the Franc zone countries, as a group, fared worse than the average for sub-Saharan Africa through lower average government investment rates, and measures of human capital development.

A number of other studies have focussed specifically on analysing the role of macroeconomic shocks in Africa. While not discounting the role of other studies, a few of these are particularly relevant to the objective of this chapter. Kose and Reizman (2001), in their paper, examine the role of external shocks in explaining macroeconomic fluctuations in African countries by using a quantitative, stochastic, dynamic multi-sector equilibrium model calibrated for a 'typical' African country. The external shocks they examine include trade shocks (proxied by fluctuations in price of exported primary commodities, imported capital goods and intermediate inputs) and financial shocks (proxied by fluctuations in world real interest rate). Another study, Fielding and Shields (2001) estimate a SVAR model and employ the method of Blanchard and Quah (1989) to identify shocks to output and prices in the economies of twelve Franc zone countries. Investigating sources of macroeconomic fluctuations in SSA, Hoffmaister, Roldós and Wickham (1998) also estimate a SVAR model, where identifying restrictions are derived from a long-run small open-economy model, to study the role of the Terms of trade and world interest rate shocks. While each of these papers focus on macroeconomic shocks in economics of SSA, some differences exist, particularly differences in modelling techniques. In addition, most of these studies' analyses are based on some aggregation or averaging of individual countries' responses to macroeconomic shocks. Fielding and Shields (2001), however, focus on individual-country analysis.

An aim of this chapter is to contribute to the literature examining macroeconomic shocks in SSA by investigating the relative importance of macroeconomic shocks to the real exchange rate, real output and real money balances within a sample of twelve Franc zone countries and four non-Franc zone SSA countries. The Franc zone countries considered are Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, the Republic of Congo, Gabon, Mali, Niger, Senegal and Togo. The non-Franc zone countries included in the study are Ghana, Kenya, Nigeria and Sierra-Leone.[1] Analysis of Franc zone and non-Franc zone countries of SSA provide a good test case of how the macroeconomies of countries in SSA respond to macroeconomic shocks (both domestic and external), given the special arrangements Franc zone countries have with France (highlighted in Chapter 2 of this thesis). The country-level analysis also allows us to readily identify possible heterogeneity within the Franc zone. This chapter, however, focuses on shocks in the domestic economy.

With macroeconomic instability generally perceived as a main inhibitor to growth in developing countries (Ramey and Ramey, 1995), knowledge about the relative importance of macroeconomic shocks should be of considerable importance to policy makers. First, to the extent that countries within the Franc zone pursue a high degree of policy

[1]This selection does not suggest that these four countries reflect the behaviour of all non-Franc zone countries in SSA. The choice of Ghana and Sierra Leone is based purely on geographical location *vis-à-vis* the UEMOA countries, Nigeria on being an important oil-producing country and Kenya having a relatively well-developed manufacturing sector. Guinea Bissau and Equatorial Guinea of the Franc zone are excluded from the sample due to insufficient data for these countries.

coordination, the ability of individual countries to pursue independent stabilization policies is limited. It is therefore of some interest to identify the relative importance of the macroeconomic shocks in each of these countries, and how this relates to the non-Franc zone countries. Second, on the basis that the oil-producing countries are more likely to face similar shocks, this chapter decomposes the macroeconomic shocks of aggregated groups of oil-producing and non-oil producing Franc zone countries and determines the similarities or otherwise in the decompositions. Third, this chapter draws a comparison between the decompositions observed from the Nigeria data and the oil-exporting Franc zone group.[2]

Although previous studies such as Fielding and Shields (2001) and Hoffmaister, Roldós and Wickham (1998) both investigate macroeconomic shocks within SSA and employ the method of Blanchard and Quah (1989), as we do in this chapter, there are some important differences worth highlighting. Fielding and Shields identify shocks to aggregate output growth and aggregate consumer-price inflation in the economies of twelve Franc zone countries over the period 1962-97. Hoffmaister, Roldós and Wickham investigate the sources of macroeconomic fluctuations in SSA by comparing (as two aggregated sub-groups) eight Franc zone countries and fifteen non-Franc zone countries by measuring the relative importance of domestic versus external shocks for the period 1971-93.

We note the following. First, Fielding and Shields (2001) consider inflation, output growth and growth in nominal money stock and condition on foreign price inflation, our model considers real exchange rate appreciation, growth in real aggregate output, and the growth in real money balances for each country. Our focus on real exchange rate growth is in line with the questions this chapter seeks to address, which include

[2]The comparison with Nigeria is based on the fact that Nigeria is Africa's single largest oil-exporter and a member of the Organization of the Petroleum Exporting Countries (OPEC).

the role of the exchange rate regime in influencing the other determinants associated with macroeconomic stability. Second, we condition our domestic variables on a wider scope of variables from the economy of the largest trading partner of the country being investigated. Third, like Fielding and Shields but unlike Hoffmaister Roldós and Wickham, our analysis of the Franc zone is based on underlying regressions that are country-specific rather than regional aggregations.

Focussing on the decomposition of macroeconomic shocks, our method extends the traditional atheoretic VAR analysis and uses both economic theory and time-series analysis to determine the sources of disturbances to economic variables. A UNU-WIDER Research Paper (Coleman, 2004) gives a broader analysis of shocks in sub-Saharan Africa based on an assumption that countries within each of the two Franc zones can be aggregated.

In Section 2 of this chapter, we present the theoretical basis that motivates our model and provide some insight into the empirical basis for our analysis. The data sources are then discussed in Section 3, before presenting our estimations and results in Section 4. Section 5 presents some concluding remarks.

4.2 Model Estimation and Identification

This section presents the theoretical issues considered in arriving at the model used in this chapter. It also summarizes the empirical methodology that is employed in our decomposition of macroeconomic shocks.

4.2.1 Theoretical Considerations

Reform by SSA countries has been aimed at improving integration into the world market and to increase growth through more efficient allocation of economic resources.

In many ways, this has rendered the sub-region more susceptible to both domestic shocks and the after-effects of economic shocks of their trading partners. With economic growth and macroeconomic stability a prime policy objective in the developing world, the need to increase output and to attract foreign direct investment (FDI) is paramount. It is reasonable to assume that any improvement in this regard will be substantially influenced by the capability of the macroeconomy to withstand shocks.

In a small open-economy framework, domestic variables are likely to be affected by the world economy, but not *vice versa*. For this reason, we examine the influence of growth in income (output) and in interest rates in the economies of the most important trading partner and use these as conditioning variables. In other studies, a measure of the *world* interest rate has been proxied solely by US interest rates, however given the obvious implications for trade and investment, a more realistic representation will be the use of interest rates of a major trading partner. In this thesis, our choice of the 'most important' trading partner is based on trade volumes as reported in the IMFs *Direction of Trade Statistics (DOTS)* Yearbooks. Data collected show that France is the most important trading partner for the Franc zone countries, the U.K. for Ghana and Kenya, the USA for Nigeria and Belgium for Sierra Leone. Given the relative size of these trading partners, it seems reasonable to treat their growth in output and in interest rates as exogenous in the model and condition upon them in this study.

Many existing empirical studies which involve indentification and cross-country comparison of macroeconomics shocks including Bayoumi and Eichengreen (1996) and Fielding and Shields (2001), estimate a reduced form VAR for inflation and output growth. From this, they identify the structural shocks to each variable by imposing a set of appropriate theory-based restrictions. The theoretical framework we use in this chapter follows Fielding and Shields (2001), in that, the theoretical model from which the restrictions are derived is considered to be a description of the macroeconomic steady-state. However, our model differs from theirs and has dependent variables Δr (growth in real interest rate), Δy (income growth), Δm (growth in nominal money stock) and Δp (growth in real exchange rate). In the steady state for each economy, the dependent variables are determined by making use of the following concepts:

First, the concept of aggregate demand – which, in theory, is used to measure the ability and the willingness of individuals and institutions to purchase goods and services – may be influenced by more factors outside national control than the norm. In Equation 4.1 below, we present an inverted version of an Aggregate Demand (AD) equation where the growth in aggregate demand [Δy] depends on the interest rate growth [Δr], and the growth in real exchange rate [Δp]. The willingness to invest and/or consume domestically will be influenced partly by changes in the real interest rates [Δr], and partly (affecting net export growth) by competitiveness, which is influenced by real exchange rate growth [Δp]. All things being equal, higher interest rates on loans will tend to reduce investment and potentially consumption, as would an appreciation in the real exchange rates - in effect increases in the growth of real interest rates and the real exchange rates will both tend to reduce aggregate demand:

$$\Delta r = a_0 + a_1 \Delta y + a_2 \Delta p; \quad \text{typically } a_1 \leq 0, a_2 \leq 0 \tag{4.1}$$

Second, Equation 4.2 presents a simplified Aggregate Supply (AS) equation, where even in the long-run, the equation allows the growth in aggregate supply to depend on the growth in the real interest rate [Δr]:

$$\Delta y = b_0 + b_1 \Delta r; \quad \text{typically } b_1 \leq 0 \tag{4.2}$$

An implication of Equation 4.2 is that producers must consider the real effects of changes in interest rates on factor inputs, including the capital stock. An increase in interest rates is likely to restrain the capital stock, and hence retard income growth in the long-run.

Third, Equation 4.3 states that the long-run real money demand is a function of growth in real income [Δy], the real interest rates [Δr], and the real exchange rate [Δp]. This represents a long-run money market equilibrium locus (LM curve) with currency substitution:

$$\Delta m = c_0 + c_1 \Delta y + c_2 \Delta r + c_3 \Delta p; \quad \text{typically } c_1 \geq 0 \geq c_2, c_3 \geq 0 \tag{4.3}$$

When income is high, it is likely that due to increases in expenditure the demand of money will increase. Based on the theory of liquidity preference, higher interest rates raise the cost of holding money thereby lowering the demand for money. With currency substitution, it is reasonable to expect even expectations of depreciation in the domestic currency to decrease the demand for the domestic currency. Fielding and Shields (2001) suggest that in the steady-state the nominal money stock can be assumed to clear the money market for a given level of nominal money demand.

Fourth, Equation 4.4 presents a form of relative PPP, which allows for a steady long-run growth in the real exchange rate (when f_0 is a constant); and also the possibility of an equilibrium (sustainable) long-run real exchange rate (when $f_0 = 0$). Real exchange rate fluctuations have important consequences for competitiveness, fiscal sustainability and monetary policy. A prolonged real appreciation may have an adverse effect on a country's competitiveness, as it induces a switch from domestic goods to foreign goods, which could possibly lead to a recession. The real exchange rate also affects debt repayments, a very important factor for countries in SSA, as most are rather highly indebted.

$$\Delta p = f_0; \quad \text{typically } f_0 \geq 0 \tag{4.4}$$

Data limitations require that we make some adjustments, as the interest rate data available for the sample are relatively inadequate.[3] This chapter, therefore, does not attempt to model Δr but rather adopts a method applied by Fielding and Shields (2001) to construct a *reduced form* of Equations 4.1 - 4.3 by substituting Equation 4.1 into 4.2 and 4.3. Any shock to output in the resulting model will, therefore, not be branded as either a strict 'demand shock' or 'supply shock', but rather broadly as aggregate 'real' shocks.

In an open economy, individuals and firms may choose to hold their wealth (or assets) in either the domestic or foreign economy. For the countries in question, being relatively small participants in an increasingly interdependent world, we allow for external influence on the domestic economy, with the model being augmented to include the return on holding foreign assets, like foreign money and foreign bonds. Considering the currency substitution literature, a variable often considered in the literature is the foreign real interest rate (see for example, Leventakis 1993; Khalid 1999); furthermore, there is some evidence to show that when trade and economic links exist among countries or regions, changes in national income (GDP) of the foreign partner may influence the domestic income (see Desruelle, Khan and Nord 1998: Table 1.2). For completeness, we condition the equations above on selected foreign variables – growth in real output $[\Delta y^*]$ and real interest rate $[\Delta r^*]$ of their largest trading partner. Therefore, in an open economy framework, our economic model in the steady-state, for each

[3] The official central bank discount rate is the most consistently reported interest rate for the Franc zone, but this is inappropriate as a viable measure of the cost of borrowing.

economy, is summarized as:[4]

$$\Delta p = q_0 + q_1 \Delta y^* + q_2 \Delta r^* \tag{4.5}$$

$$\Delta y = d_0 + d_1 \Delta p + d_2 \Delta y^* + d_3 \Delta r^* \tag{4.6}$$

$$\Delta m = g_0 + g_1 \Delta y + g_2 \Delta p + g_3 \Delta y^* + g_4 \Delta r^* \tag{4.7}$$

where q_n, d_n, g_n are derived from Equations 4.1 - 4.4. Hence $d_1 = \frac{b_1 a_2}{1 - b_1 a_1}$,

$$\begin{aligned} d_1 &> 0, \quad \text{when } b_1 a_1 < 1 \\ d_1 &= \infty, \quad \text{when } b_1 a_1 = 1 \\ d_1 &< 0, \quad \text{when } b_1 a_1 > 1 \\ g_1 &= c_1 + c_2 a_1 > 0 \\ g_2 &= c_3 + c_2 a_2 > 0 \end{aligned} \tag{4.8}$$

The steady-state for each economy is described by the values of the parameters in Equations 4.5 - 4.7. We then estimate the dynamics of the dependent variables in Equations 4.5 - 4.7 within a VAR framework of the macroeconomy of each country in our sample, and interpret the estimated innovations as macroeconomic shocks. We need some long-run theoretical restrictions to identify structural shocks in our VAR, and for this we make use of the Aggregate Demand (AD) equation, the Aggregate Supply (AS) equation, the Money Demand (MD), and a relative price equation based on the concept of relative Purchasing Power Parity (PPP). In the rather complex economies of SSA, financial sectors are in various stages of development, political institutions are usually

[4] All variables except Δr^* are expressed as changes in the natural logarithm of the appropriate series.

major players in the economy, prices and wages are sticky, and there is considerable private sector activity with strong dependence on international institutions and trade. In order to analyze the source of shocks, we need to impose some theoretical restrictions on our VAR, as noted in earlier in Chapter 3.2.2 of this thesis. In this sense, we have had to rely on a number of assumptions, nevertheless we have taken some care to make these assumptions realistic and few in number.

In Equation 4.6, given the typical inter-relationships between the variables in the VAR, the sign of d_1 may be positive or negative hence this possibility allows for the impact of a shock to the real exchange rate on Δy to be ambiguous. Typically, the expected outcome of a real exchange rate appreciation is that the effect on output is negative. However, in our model it may be either positive or negative depending on whether the product of b_1 (the elasticity of AS with respect to the real interest rate) and a_1 (the slope of the AD curve in Equation 4.1) is less or greater than 1. As predicted by economic theory, the elasticity of the real money demand growth with respect to the real exchange rate growth g_2 will be positive. Also from the initial equations, we would expect the slope of Equation 4.7 with respect to the real output growth g_1 to be positive, which is also consistent with economic theory.

Equations 4.5, 4.6 and 4.7 describe the steady state, following the impostion of the required long-run restrictions, we estimate the dynamics of the three variables: the real exchange rate growth [Δp], the growth in real income [Δy] and the growth in real money balances [Δm]. The variables Δy^* and Δr^*(external variables) are considered to be purely exogenous to the domestic economy. This triangular structure of Equations 4.5 - 4.7 applies only in the steady-state, but the variables are simultaneously determined in the short-run. As an example, in the short-run, when PPP does not have to hold, the model allows the real exchange rate to be influenced by all the other variables in the VAR. According to the model, the demand for real money balances, even in the long run, is influenced by real exchange rate (via domestic and foreign price inflation, for domestic purchases and for transaction purposes), interest rate changes (through both transaction requirements and portfolio allocation decisions, which could cause reallocation of money holdings), income (due to the increased level of activity and demand for liquid assets that accompany increases in income). Allowance is made for the influence of the external exogenous variables, Δr^* and Δy^*, which are likely to be more significant with stronger trade linkages.

In the short-run, therefore, the model without any restrictions can be expressed in matrix form as:

$$B(L)\begin{bmatrix}\Delta p_t \\ \Delta y_t \\ \Delta m_t\end{bmatrix} = \begin{bmatrix} q_0 \\ d_0 \\ g_0 \end{bmatrix} + F\begin{bmatrix}\Delta r_t^* \\ \Delta y_t^*\end{bmatrix} + \begin{bmatrix}\varepsilon_t^p \\ \varepsilon_t^y \\ \varepsilon_t^m\end{bmatrix} \tag{4.9}$$

where $B(L)$ is the 3 x 3 matrix of lag polynomials that summarizes the dynamics of the model, and F represents the 3x2 matrix of coefficients, which depict the contemporaneous effects of the exogenous variables on the endogenous variables. Finally, the vector containing the pure structural innovations ε_t^i are the pure structural shocks to the real exchange rate appreciation, the growth in real output (as defined earlier in this section), and the real money growth respectively.

4.2.2 Empirical Methodology

Structural Vector Autoregression (SVAR) models use the long-run properties of the variables to identify and recover the economic shocks. In our SVAR model, we use the approach of Blanchard and Quah (1989) to achieve this, where the long-run restrictions together with the independence of shocks (orthogonality conditions) are used to recover the structural shocks. The restrictions are used to distinguish and isolate the short-run effects of any shocks. The long-run restrictions, though based on the Blanchard and Quah (1989) methodology as used in Fielding and Shields (2001) and Hoffmaister, Roldós and Wickham (1998), are imposed on a macroeconomic structure that is different in terms of both variables used and size. One advantage of this methodology is that, it is based on long-run restrictions that are derived from economic theory. Although there is some criticism (see Sims, 1980) of some 'incredible identifying restrictions' being used at times to identify SVARs, this methodology is still widely used. Secondly, it is somewhat less controversial, at least in comparison to empirical evidence that imposes short-run or impact restrictions. We note that in using the Blanchard and Quah methodology, variations of this approach have been used by many researchers and in many different contexts as in Bayoumi and Eichengreen (1994); Bergmann (1996); Funke and Hall (1998); Keating and Nye (1999) for OECD countries; Enders and Lee (1997), Bergmann, Cheung and Lai (2000) in investigating the dynamics of real exchange rates.

The use of first differences (growth rates) is considered appropriate since preliminary tests for cointegration failed to reject the null of no cointegration in the data for the countries in our sample.[5] Secondly, in order to use the Blanchard and Quah technique, the variables , as used in the VAR, must be in the stationary form (see Enders, 1995 page 332). Hence, the variables in Z_t are presented as growth rates, instead of in levels. However, this does not affect the economic inferences that we make from the estimation of the model. In our model, the basic vector of three endogenous variables Z_t is given as:

$$Z_t = (\Delta p_t, \Delta y_t, \Delta m_t)^T \tag{4.10}$$

[5]The results of the Johansen tests of cointegration for each individual country, performed in *E-Views*, suggest that both the *Trace* and *max-Eigen value* statistics could not reject the null of no cointegration at the 5% level of significance.

The vector of external conditioning variables is also given as $M_t = (\Delta y_t^*, \Delta r_t^*)^T$. The model can also be summarized as:

$$BZ_t = \pi + FM_t + \Gamma_1(L)Z_{t-1} + \varepsilon_t \tag{4.11}$$

where $\Gamma_1(L)$ is a 3x3 matrix of lag polynomials and Z_t is the 3x1 matrix of stationary variables as shown in Equation 4.10. The structural shocks (ε_t) are assumed to be white-noise, with ε_t^p, ε_t^y, and ε_t^m being uncorrelated [$\text{cov}(\varepsilon_{it}\varepsilon_{jt}^{'}) = I_3$]. Since the structural VAR (Equation 4.11) allows the variables in Z_t to have a contemporaneous effect on each other, we transform it into the more usable reduced form, so for each country in the sample, we estimate the reduced form VAR:

$$Z_t = \eta + DM_t + A(L)Z_{t-1} + u_t = \mu + \varphi_1 M_t + (I - A(L))^{-1}u_t \tag{4.12}$$

where $D = B^{-1}F$, $A(L) = B^{-1}\Gamma_1(L)$ and $\varphi_1 = (I - A(L))^{-1}D$.

Estimation of this reduced form VAR (Equation 4.12) will provide us with the information required to identify and recover the structural shocks, which then allows us to make any meaningful economic interpretations. Since the reduced form residuals, u_t, are not uncorrelated across variables [$\text{cov}(u_{it}u_{jt}^{'})= \Omega$], we cannot make any explicit inferences from these, hence the need for identification and isolation of the pure structural shocks (ε_t). The reduced form of Equation 4.11 requires us to identify an invertible matrix (say, H) such that the reduced form innovations u_t may be expressed as $u_t = H\varepsilon_t$.[6] Clearly, the moving average representation can be written out as:

$$\begin{aligned} Z_t &= \mu + \varphi_1 M_t + C(L)\varepsilon_t \qquad (4.13) \\ \text{or } Z_t &= \begin{bmatrix} \mu_{11} \\ \mu_{12} \\ \mu_{13} \end{bmatrix} + \begin{bmatrix} \varphi_{11} & \varphi_{12} \\ \varphi_{21} & \varphi_{22} \end{bmatrix} \begin{bmatrix} \Delta r_t^* \\ \Delta y_t^* \end{bmatrix} + \begin{bmatrix} C_{11}(L) & C_{12}(L) & C_{13}(L) \\ C_{21}(L) & C_{22}(L) & C_{23}(L) \\ C_{31}(L) & C_{32}(L) & C_{33}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_t^p \\ \varepsilon_t^y \\ \varepsilon_t^m \end{bmatrix} \end{aligned}$$

where $C(L) = (I - A(L))^{-1}H$ and is typically called the Impulse Response Function (IRF).[7]

In the model with n endogenous variables, we need n^2 restrictions to exactly identify the structural shocks. The identification of our 3-variable system will therefore require nine restrictions: six $[n(n+1)/2]$ of which are achieved through the orthonormality condition of the variance of the structural shocks ($\text{cov}(\varepsilon_{it}\varepsilon_{jt}^{'}) = I_3$) and three $[n(n-1)/2]$ being from the long-run restrictions. In line with the Blanchard and Quah (1989) methodology, the imposition of the long-run restrictions, resulting in the long-run structure of Equations 4.5 - 4.7, provides the remaining three restrictions needed to exactly identify the model and allows us to recover the structural shocks. In relation to Equation 4.13, the three long-run restrictions are imposed such that, given the ordering of Z_t, the 3 x 3 matrix $C(L)$ is lower triangular. Therefore $C_{12}(L) = C_{13}(L) = C_{23}(L) = 0$, representing the three restrictions as is shown in the long-run (the steady-state) macroeconomic model (Equations 4.5 - 4.7). For example, the theoretical restriction that shocks to output have no long-run effect on the real exchange rate is represented by the restriction that the coefficients of $C_{12}(L)$ sum to zero and consequently, the long-run effect of ε_t^y on the level of the real exchange rate

[6] Where H is simply the inverse of the B matrix, that is B^{-1}.

[7] It is not uncommon for graphical representations of the IRF to be used to provide the visual representation of the behaviour of the variables in the VAR in response to various shocks.

(p_t) itself is zero.

4.3 Data Sources

The sample, as described in Section 4.1 above contains 12 Franc Zone countries and 4 non-Franc zone countries. The variables of the reduced form VAR include both endogenous variables (the real exchange rate growth, real output growth, and growth in the real money demand) and exogenous variables (growth in foreign real income and the foreign real interest rate).

Annual data is collected over the period 1960-99, and the real exchange rate sequence is calculated as the ratio of the change in the domestic price and foreign price indices.[8] The gross domestic product (GDP) deflator is used as a proxy for the domestic price index mainly because of the lack of complete CPI data for some countries within the study; in addition, this index is based on a broader class of goods in the economy and encompasses prices of investment goods, and goods bought by the public as well as consumer good prices. The source of this price index is the World Bank Development Indicators (WBDI) series 2001 and the World Bank Africa Database (WBAD) 2002 CD-ROM. The foreign price index is adjusted with the bi-lateral nominal exchange rate to have the price indices in a common (domestic) currency. As stated in Section 4.2.1 of this thesis, our choice of the 'most important' trading partner as the 'foreign' economy is based on trade volumes as reported in the IMFs Direction of Trade Statistics (DOTS) Yearbooks. Data collected over the period of interest show that France is the most important trading partner for each of the Franc zone countries, the U.K. for Ghana and Kenya, the USA for Nigeria and Belgium for Sierra Leone. Data for

[8] The term 'foreign' is used here to represent the largest trading partner of the country in question (the 'domestic' country). Therefore, the real exchange rate used in this chapter is bi-lateral.

real income for all the countries, including that for the 'foreign' economy, are taken from the same sources as the price indices above. The growth is therefore measured as the annual change in the logarithm of the real GDP (in Local Currency Units (LCU)). Using a broad definition of money (M2), the money series is measured as the sum of currency outside banks, demand deposits other than those of the central government, time deposits, savings deposits and foreign currency deposits. The data is taken from the same sources as the price indices and corresponds to lines 34 and 35 in the IMF International Financial Statistics (IFS) database. The Δm series is, therefore, taken as the annual change in the logarithm of the real money balances.

4.4 Estimation and Results

This section presents some information on the VAR estimation and also reports and discusses the results. We use *E-Views* to estimate the VAR coefficients and, through preliminary tests, select a maximum lag order of two (supported by the Akaike Information Criteria) of the unrestricted VAR. The criteria indicated an optimal lag length of 1 for two countries and 2 in the remaining. A uniform lag of 2 was therefore chosen in order to preserve the symmetry across estimation. The first notable consideration is the one-time 1994 collective devaluation of the CFA Franc *vis-à-vis* the French Franc which, as a particularly rare occurrence, introduces some distortion into the estimation. Secondly, initial time-series plots of the money variable used in the VAR for Kenya indicate a sizable spike in 1966, which is consistent with an unusual shock to the money supply. These two unusual, but significant incidents distort the normality of the residuals for the Franc zone countries and for Kenya respectively and for this reason, we introduce exogenous dummy variables $D94$ and $D66$, respectively, to isolate these effects. Their inclusion significantly improves normality of the observed residuals.

Presented in Table 4.1 - 4.3 is a summary of some regression diagnostic statistics from the unrestricted VAR. As a brief summary, we present the R^2 values for each equation in the VAR, the standard error and the Jarque-Bera statistic for normality of the residuals. In all cases, the null hypothesis that all residuals are univariate normal is not rejected at the 5% level, except in one case for Cameroon in Table 4.1. A further test for joint normality of the VAR residuals for that country (also reported in *E-Views*), indicate that the null hypothesis cannot be rejected at the 5% level.

In these tables, the R^2 values for all the countries considered, show some significant variations, but are all above 0.2 and typically above 0.5. The second column of Table 4.1 (R^2) indicates considerably good explanatory power, which is somewhat encouraging. In overall comparison, this is more so in the Franc zone countries.

To allow for identification and recovery of the structural shocks ε_t, the restrictions as outlined in Section 4.2.1, are imposed i.e. $C_{12}(L) = C_{13}(L) = C_{23}(L) = 0$.

4.4.1 Stability and Stationarity

Our variables are initially tested for the presence of unit roots. ADF unit root tests justify the use of first differences, which are $I(0)$ and stationary, which is a requirement for the use of the Blanchard and Quah technique (see Enders, 1995 pp.332).[9] Second, diagnostic tests on the lag structure show that the VAR as a whole is stable (stationary). The inverse roots of the characteristic autoregressive (AR) polynomial (as done in *E-Views*) are all found to have a modulus less than one, and lie within the unit circle, implying stability (stationarity). Our results also show that the VAR as used for each country [and oil/non-oil groups] is stable. The stability is necessary for the validity of the results, including standard errors of any resulting impulse responses.

[9] Although some criticism has been levelled against differencing (see Sims 1980, Doan 1992) that it 'throws away' information containing co-movements in the data, it remains a popular approach.

Table 4.1: Summary of Unrestricted VAR Regression Diagnostics

Δp equation			
	R^2	S.E.	JB-Norm
Ben	0.72	0.061	4.200 (0.122)
BFaso	0.74	0.067	3.708 (0.147)
Cam	0.85	0.047	6.327 (0.042)
CAR	0.68	0.083	4.558 (0.100)
Civ	0.68	0.073	5.186 (0.074)
Chd	0.55	0.078	5.522 (0.063)
Con	0.44	0.113	3.002 (0.222)
Gab	0.66	0.077	3.910 (0.141)
Mal	0.82	0.061	3.314 (0.190)
Niger	0.43	0.095	3.978 (0.137)
Sen	0.80	0.055	4.260 (0.118)
Tog	0.59	0.078	1.427 (0.489)
Gha	0.42	0.327	2.086 (0.352)
Ken	0.21	0.200	3.879 (0.143)
Nigeria	0.85	0.159	5.231 (0.073)
S.Leone	0.31	0.378	3.135 (0.208)

Notes: R^2 represents goodness of fit; S.E. represents the standard error of the equation; JB-Norm represents the Jarque-Bera Normality test statistic, with null hypothesis that all residuals are univariate normal for the country, figures in parenthesis represent the p-values from the $\chi^2(2)$ distribution.

Table 4.2: Summary of Unrestricted VAR Regression Diagnostics [Cont'd.]

Δy equation			
	R^2	S.E.	JB-Norm
Ben	0.64	0.052	3.387 (0.183)
BFaso	0.50	0.063	3.823 (0.147)
Cam	0.39	0.089	3.760 (0.151)
CAR	0.54	0.067	3.313 (0.190)
Civ	0.74	0.066	4.595 (0.100)
Chd	0.25	0.120	2.746 (0.253)
Con	0.46	0.103	3.025 (0.220)
Gab	0.61	0.119	4.375 (0.112)
Mal	0.75	0.047	5.132 (0.076)
Niger	0.45	0.109	2.893 (0.235)
Sen	0.66	0.049	3.082 (0.214)
Tog	0.36	0.099	1.861 (0.394)
Gha	0.62	0.130	4.567 (0.109)
Ken	0.30	0.181	3.239 (0.197)
Nigeria	0.31	0.170	2.856 (0.239)
S.Leone	0.40	0.058	3.639 (0.162)

Notes: R^2 represents goodness of fit; S.E. represents the standard error of the equation; JB-Norm represents the Jarque-Bera Normality test statistic, with null hypothesis that all residuals are univariate normal for the country, figures in parenthesis represent the p-values from the $\chi^2(2)$ distribution.

Table 4.3: Summary of Unrestricted VAR Regression Diagnostics [Cont'd.]

Δm equation			
	R^2	S.E.	JB-Norm
Ben	0.68	0.095	4.606 (0.100)
BFaso	0.56	0.069	2.756 (0.252)
Cam	0.63	0.103	3.045 (0.218)
CAR	0.51	0.113	3.031 (0.219)
Civ	0.54	0.106	3.082 (0.214)
Chd	0.37	0.148	3.515 (0.172)
Con	0.52	0.113	3.887 (0.143)
Gab	0.62	0.127	4.389 (0.111)
Mal	0.40	0.096	3.510 (0.172)
Niger	0.27	0.137	2.824 (0.243)
Sen	0.58	0.090	5.945 (0.051)
Tog	0.44	0.146	3.985 (0.136)
Gha	0.49	0.110	2.278 (0.320)
Ken	0.80	0.150	2.756 (0.252)
Nigeria	0.24	0.160	4.735 (0.093)
S.Leone	0.50	0.186	1.350 (0.508)

Notes: R^2 represents goodness of fit; S.E. represents the standard error of the equation; JB-Norm represents the Jarque-Bera Normality test statistic, with null hypothesis that all residuals are univariate normal for the country, figures in parenthesis represent the p-values from the $\chi^2(2)$ distribution.

4.4.2 Variance Decomposition

In principle, VARs are very useful in determining how variables interact with each other in the economy. If, say, ε_{1t} shocks explain none of the forecast error variance of the real exchange rate, then the sequence evolves independently of its own shocks, and Δp will be a purely endogenous variable. If, at the other extreme, it explains all of its forecast error variance, then the change in the real exchange rate is said to be evolve independently of other variables in the model. In this chapter, the analysis of the variance decompositions is meant to show the relative importance of each innovation and will form a basis for our short-run analyses. To address the main concern of this chapter, we proceed to determine the variance decomposition of these macroeconomic shocks in each of the countries. Under the stated assumptions (see Section 4.1), a similar exercise is performed for the aggregated samples of oil-producing and non-oil

Table 4.4: Percentages of Forecast Error Variance Decomposition of Real Exchange Rate Growth (Row 1, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Ben	1	0.061	93.827	6.136	0.035
	2	0.064	85.249	14.717	0.032
	3	0.065	85.340	14.602	0.056
	4	0.065	85.438	14.503	0.057
	5	0.065	85.334	14.607	0.057
BFaso	1	0.067	99.291	0.672	0.035
	2	0.071	98.354	1.606	0.038
	3	0.073	98.368	1.587	0.043
	4	0.073	98.373	1.583	0.042
	5	0.074	98.360	1.596	0.042
Cam	1	0.047	67.755	2.261	29.982
	2	0.055	51.714	1.924	46.360
	3	0.058	55.039	3.136	41.823
	4	0.059	54.537	4.106	41.356
	5	0.059	53.869	5.157	40.972
CAR	1	0.083	87.725	2.110	10.163
	2	0.089	75.772	2.598	21.629
	3	0.090	74.379	2.542	23.078
	4	0.091	73.291	2.770	23.937
	5	0.091	72.884	2.884	24.231
Chd	1	0.078	89.270	8.413	2.580
	2	0.081	82.431	14.943	2.624
	3	0.082	80.850	14.632	4.516
	4	0.082	80.214	14.733	5.052
	5	0.082	80.073	14.883	5.043

producing Franc zone countries over the period. Following the estimation of Equation 4.12, and the subsequent derivation of the structural shocks following the imposition of the stated restrictions, we present below a summary of the variance decomposition results for each of the structural shocks (ε_t) for each country considered. The structural innovations derived are represented by ε_t^p, ε_t^y, and ε_t^m respectively.

In Tables 4.4 - 4.7, the levels at which output growth shocks and money shocks explain real exchange rate fluctuations varies somewhat across the countries. The output shocks explain an important part of the real exchange rate fluctuations in Benin, Congo, Chad and Togo. The effect is somewhat smaller in all the other Franc zone countries, and close to zero in Burkina Faso, Gabon and Niger. Money shocks are

Table 4.5: Percentages of Forecast Error Variance Decomposition of Real Exchange Rate Growth (Row 1, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries [Cont'd.]

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Civ	1	0.073	97.489	2.474	0.035
	2	0.075	92.629	7.211	0.159
	3	0.077	91.662	8.161	0.176
	4	0.077	91.291	8.533	0.175
	5	0.077	91.210	8.614	0.174
Con	1	0.113	89.076	6.742	4.181
	2	0.121	83.367	10.712	5.920
	3	0.122	83.541	10.515	5.942
	4	0.123	83.668	10.438	5.892
	5	0.123	83.685	10.431	5.883
Gab	1	0.077	73.733	0.099	26.166
	2	0.086	59.449	0.534	10.016
	3	0.087	60.264	0.605	39.130
	4	0.088	60.368	1.029	38.602
	5	0.089	60.313	1.028	38.657
Mal	1	0.061	78.552	4.297	17.150
	2	0.072	75.083	4.941	19.974
	3	0.074	72.615	6.791	20.592
	4	0.074	72.099	7.312	20.587
	5	0.074	72.070	7.355	20.573
Niger	1	0.095	99.637	0.359	0.002
	2	0.097	98.706	1.290	0.002
	3	0.098	98.485	1.510	0.004
	4	0.098	98.475	1.519	0.004
	5	0.098	98.475	1.519	0.004

Table 4.6: Percentages of Forecast Error Variance Decomposition of Real Exchange Rate Growth (Row 1, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries [Cont'd.]

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Sen	1	0.055	96.624	3.357	0.018
	2	0.060	94.404	5.560	0.035
	3	0.061	94.579	5.386	0.034
	4	0.062	94.563	5.402	0.034
	5	0.062	94.580	5.396	0.034
Tog	1	0.078	99.649	0.295	0.055
	2	0.086	93.874	6.072	0.052
	3	0.090	85.708	14.059	0.231
	4	0.091	84.049	15.709	0.241
	5	0.091	84.017	15.736	0.246

Table 4.7: Percentages of Forecast Error Variance Decomposition of Real Exchange Rate Growth (Row 1, Equation 4.13) Due to Each Shock, Periods 1-5: Individual non-Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Gha	1	0.327	60.916	38.779	0.304
	2	0.344	63.409	36.062	0.528
	3	0.375	54.137	43.939	1.923
	4	0.375	53.655	44.174	2.170
	5	0.381	53.073	44.596	2.329
Ken	1	0.203	70.748	28.848	0.402
	2	0.218	63.498	35.610	0.891
	3	0.223	64.721	34.420	0.857
	4	0.223	64.636	34.479	0.883
	5	0.224	64.234	34.885	0.881
Nigeria	1	0.360	75.828	22.946	1.225
	2	0.378	69.863	23.423	6.712
	3	0.381	69.208	24.175	6.616
	4	0.384	68.130	25.059	6.809
	5	0.385	67.856	25.164	6.978
S.Leone	1	0.327	74.328	11.117	14.494
	2	0.344	75.590	9.410	14.999
	3	0.375	69.973	15.537	14.489
	4	0.379	70.065	15.704	14.230
	5	0.381	70.033	15.661	14.304

important in all the countries within CEMAC, including Cameroon, Central African Republic, Gabon, and to a lesser extent Chad and the Congo. This contrasts with the countries located in the West-African Monetary Union (except Mali), where variance in money plays a less dominant role.[10] In Niger, the real exchange rate shocks seem to be largely self-driven, evolving almost independently of the other structural shocks in the model. In the non-Franc zone countries, the impacts of output shocks seem to be generally higher than in any of the Franc zone countries in explaining real exchange rate fluctuations. The role of money growth shocks is, however, less uniform. In Nigeria and Sierra Leone, the money shocks explain significant movements in real exchange rate fluctuations, but this is not so in Ghana and Kenya. These results imply that changes in monetary policy, in the countries where the money shocks are significant,

[10]Mali, however, only rejoined the UEMOA, in 1984, after leaving in 1963.

Table 4.8: Percentages of Forecast Error Variance Decomposition of Real Output Growth (Row 2, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Ben	1	0.052	55.494	44.381	0.124
	2	0.057	56.958	42.927	0.113
	3	0.057	57.033	42.809	0.157
	4	0.057	57.109	42.730	0.159
	5	0.058	57.130	42.709	0.159
BFaso	1	0.063	13.418	86.411	0.170
	2	0.063	13.397	86.370	0.231
	3	0.064	13.260	86.474	0.265
	4	0.064	13.341	86.393	0.265
	5	0.064	13.349	86.384	0.265
Cam	1	0.089	11.923	85.785	0.291
	2	0.096	10.398	87.605	1.995
	3	0.101	9.875	85.839	4.285
	4	0.103	9.865	85.981	4.153
	5	0.105	9.860	85.994	4.145
CAR	1	0.067	37.437	59.544	3.017
	2	0.072	33.108	58.077	8.814
	3	0.074	30.875	58.774	10.349
	4	0.076	29.816	58.835	11.348
	5	0.077	29.115	58.966	11.918
Chd	1	0.120	65.552	33.813	1.084
	2	0.121	64.862	33.914	1.519
	3	0.124	62.326	33.504	2.863
	4	0.124	62.132	33.446	3.040
	5	0.124	62.112	33.464	3.045

will be important determinants of the real exchange rate.

In terms of the variation of output growth (Tables 4.8 - 4.11), the following points can be highlighted. First, real exchange rate movements explain a significant proportion of output growth shocks in all of the Franc zone countries, with the exception of Niger and Togo. On the one hand, the money shocks are significant in some Franc zone countries, marginally though in Cameroon, Chad, and Côte d'Ivoire. On the other hand, they are quite insignificant in Benin, Burkina Faso, Niger, Senegal and Togo. With the exception of Kenya, the three other non-Franc zone countries show that both real exchange rates and money shocks dominate in explaining output movements. Tables 4.12 - 4.15 show that both output and real exchange rate shocks play a role in

Table 4.9: Percentages of Forecast Error Variance Decomposition of Real Output Growth (Row 2, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries [Cont'd.]

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Civ	1	0.066	2.215	94.513	3.271
	2	0.069	7.862	88.122	4.015
	3	0.070	8.013	87.610	4.376
	4	0.070	8.017	87.607	4.374
	5	0.070	8.017	87.605	4.377
Con	1	0.103	72.604	6.714	20.681
	2	0.121	56.927	12.075	30.997
	3	0.123	57.726	11.917	30.356
	4	0.124	58.183	11.698	30.118
	5	0.125	58.270	11.663	30.065
Gab	1	0.119	3.866	96.129	0.003
	2	0.144	20.595	67.242	12.161
	3	0.154	26.274	61.421	12.304
	4	0.157	28.437	59.000	12.562
	5	0.159	28.039	57.704	14.256
Mal	1	0.047	6.446	90.906	2.647
	2	0.054	10.259	76.826	12.914
	3	0.056	10.100	70.954	18.945
	4	0.057	10.312	68.991	20.696
	5	0.058	10.309	67.865	21.825
Niger	1	0.109	0.004	99.845	0.149
	2	0.110	0.019	99.719	0.260
	3	0.111	1.329	98.407	0.263
	4	0.112	1.463	98.272	0.263
	5	0.112	1.465	98.270	0.264

Table 4.10: Percentages of Forecast Error Variance Decomposition of Real Output Growth (Row 2, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries [Cont'd.]

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Sen	1	0.049	6.819	93.177	0.003
	2	0.051	9.647	90.338	0.013
	3	0.051	9.881	90.101	0.017
	4	0.051	9.912	90.070	0.017
	5	0.051	9.923	90.058	0.017
Tog	1	0.099	0.346	99.104	0.548
	2	0.104	1.927	97.403	0.669
	3	0.105	3.130	96.021	0.847
	4	0.105	3.291	95.825	0.882
	5	0.106	3.280	95.834	0.885

Table 4.11: Percentages of Forecast Error Variance Decomposition of Real Output Growth (Row 2, Equation 4.13) Due to Each Shock, Periods 1-5: Individual non-Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Gha	1	0.133	50.458	27.770	21.770
	2	0.137	47.147	30.852	22.000
	3	0.159	36.528	47.027	16.444
	4	0.163	38.965	45.023	16.011
	5	0.165	38.727	44.880	16.392
Ken	1	0.185	96.762	3.209	0.028
	2	0.194	93.434	6.534	0.031
	3	0.207	81.891	18.027	0.080
	4	0.208	82.009	17.821	0.168
	5	0.210	81.392	18.439	0.168
Nigeria	1	0.169	45.541	29.486	34.972
	2	0.207	35.961	47.216	16.821
	3	0.219	32.671	46.570	20.758
	4	0.221	32.499	46.312	21.187
	5	0.222	32.587	46.235	21.176
S.Leone	1	0.058	0.447	58.327	41.225
	2	0.064	16.335	48.714	34.949
	3	0.068	23.779	44.995	31.224
	4	0.070	23.306	45.993	30.700
	5	0.070	23.317	46.005	30.676

explaining variations in money, although the effects are marginal in Cameroon, Niger and Togo.

As has been noted earlier, because of administrative and institutional rules and the commitment to fixed exchange rate, the Franc zone countries cannot individually use the nominal exchange rate as a policy tool. To the degree that policy coordination is important for the Franc zone countries, it is worth noting that similar responses to macroeconomic shocks will be preferable, in which case joint policy responses are more likely be beneficial to all members. Tables (4.4 - 4.7) – (4.12 - 4.15) indicate that the variance decompositions do not follow a clear pattern for the Franc zone countries, this gives some indication of some heterogeneity within the countries that make up each Zone. We note that a similar situation is also observed in the non-Franc zone countries. Nevertheless, money shocks seem to play a more significant role in explaining both

Table 4.12: Percentages of Forecast Error Variance Decomposition of Real Money Growth (Row 3, Equation 4.13 Due to Each Shock, Periods 1-5: Individual Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Ben	1	0.129	1.087	5.147	93.764
	2	0.130	5.575	5.492	88.932
	3	0.130	11.784	6.291	81.923
	4	0.130	11.871	6.612	81.515
	5	0.130	11.885	6.662	81.451
BFaso	1	0.069	2.345	2.823	94.830
	2	0.071	8.800	2.659	88.539
	3	0.074	12.529	6.035	81.435
	4	0.074	12.523	6.113	81.363
	5	0.074	12.552	6.156	81.291
Cam	1	0.103	10.413	0.026	89.560
	2	0.115	15.648	3.180	81.171
	3	0.125	23.444	3.948	72.606
	4	0.126	23.033	3.996	72.970
	5	0.127	24.143	3.984	71.871
CAR	1	0.113	43.895	9.189	49.915
	2	0.114	43.393	9.101	47.504
	3	0.116	42.239	8.868	48.892
	4	0.116	41.961	8.876	49.162
	5	0.116	41.757	8.949	49.292
Chd	1	0.148	1.662	1.313	97.023
	2	0.158	3.098	1.642	95.258
	3	0.162	2.966	6.296	90.736
	4	0.163	2.956	6.265	90.777
	5	0.163	2.977	6.278	90.744

Table 4.13: Percentages of Forecast Error Variance Decomposition of Real Money Growth (Row 3, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries [Cont'd.]

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Civ	1	0.106	2.552	5.845	91.601
	2	0.107	4.418	5.701	89.879
	3	0.110	7.179	7.117	85.702
	4	0.110	7.201	7.161	85.637
	5	0.111	7.346	7.149	85.504
Con	1	0.113	3.626	22.100	74.272
	2	0.119	4.720	22.326	72.952
	3	0.119	4.992	22.500	72.507
	4	0.120	5.130	22.419	72.450
	5	0.120	5.162	22.402	72.435
Gab	1	0.127	19.960	3.331	76.708
	2	0.154	32.829	2.282	64.887
	3	0.162	34.660	4.231	61.107
	4	0.165	36.106	4.324	59.568
	5	0.168	36.816	4.251	58.932
Mal	1	0.096	6.533	27.401	66.065
	2	0.096	6.732	27.350	65.917
	3	0.097	6.586	28.978	64.434
	4	0.098	6.523	29.053	64.423
	5	0.098	6.520	28.984	64.495
Niger	1	0.137	6.473	0.084	93.441
	2	0.138	7.396	0.629	91.973
	3	0.138	7.401	0.655	91.942
	4	0.138	7.406	0.656	91.937
	5	0.138	7.406	0.657	91.935

Table 4.14: Percentages of Forecast Error Variance Decomposition of Real Money Growth (Row 3, Equation 4.13) Due to Each Shock, Periods 1-5: Individual Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Sen	1	0.090	1.356	7.182	91.460
	2	0.095	6.140	10.968	85.891
	3	0.096	7.747	11.154	81.098
	4	0.096	8.082	11.122	80.795
	5	0.096	8.166	11.113	80.795
Tog	1	0.146	1.231	0.000	98.768
	2	0.147	1.267	1.440	97.292
	3	0.149	1.264	3.356	95.397
	4	0.149	1.273	3.452	95.273
	5	0.149	1.296	3.451	95.252

Table 4.15: Percentages of Forecast Error Variance Decomposition of Real Money Growth (Row 3, Equation 4.13) Due to Each Shock, Periods 1-5: Individual non-Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Gha	1	0.115	5.250	3.226	91.523
	2	0.120	7.767	5.389	86.523
	3	0.132	7.971	18.930	73.092
	4	0.135	9.935	19.470	70.591
	5	0.135	10.182	19.380	70.431
Ken	1	0.151	66.137	8.161	25.701
	2	0.158	61.649	14.887	23.462
	3	0.169	55.555	23.677	20.766
	4	0.169	55.717	23.540	20.741
	5	0.170	55.838	23.613	20.548
Nigeria	1	0.152	9.887	0.170	89.941
	2	0.171	16.510	10.724	72.764
	3	0.176	15.716	10.384	73.899
	4	0.176	15.701	10.363	73.934
	5	0.176	15.697	10.373	73.928
S.Leone	1	0.186	0.168	82.845	16.985
	2	0.210	1.564	75.181	23.254
	3	0.230	1.306	72.057	26.635
	4	0.239	1.341	69.965	28.693
	5	0.246	1.311	68.670	30.017

output and real exchange rate fluctuations in the included non-Franc zone countries, except in Kenya. Given the results shown, it is implied that some joint policy responses to common macroeconomic shocks may not yield commonly beneficial results for all the Franc zone members. Nashashibi and Bazzoni (1993) discuss some of the costs of the Zone's fixed parity commitment in relation to adjustment to macroeconomic shocks. They find that the internal adjustment strategies followed by Franc zone countries could not correct the imbalances caused by the macroeconomic shocks suffered by most of SSA even though relative stability in prices was still maintained.[11] As noted in an earlier description in Section 1 of this chapter, several studies, including Devarajan and De Melo (1991), have reported similar findings.

[11] There were two oil-price shocks in the 1970s and the Terms of Trade shocks in the 1980s, which for the Franc zone countries was worsened by the real appreciation of the French Franc *vis-à-vis* the US Dollar.

Table 4.16: Percentages of Forecast Error Variance Decomposition of Real Exchange Rate Growth (Row 1, Equation 4.13) Due to Each Shock, Periods 1-5: Oil and non-Oil Producing Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Oil	1	0.079	92.230	0.029	7.739
	2	0.083	84.888	0.107	15.004
	3	0.084	84.698	0.169	15.131
	4	0.084	84.511	0.191	15.297
	5	0.084	84.503	0.193	15.303
Non-Oil	1	0.072	98.738	1.261	0.000
	2	0.075	96.047	3.945	0.007
	3	0.076	95.416	4.566	0.017
	4	0.076	95.310	4.671	0.017
	5	0.076	95.291	4.691	0.017

Table 4.17: Percentages of Forecast Error Variance Decomposition of Real Output Growth (Row 2, Equation 4.13) Due to Each Shock, Periods 1-5: Oil and non-Oil Producing CFA Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Oil	1	0.113	14.965	81.137	3.896
	2	0.118	19.298	73.616	7.084
	3	0.119	19.820	73.142	7.037
	4	0.119	19.848	73.107	7.044
	5	0.119	19.851	73.104	7.043
Non-Oil	1	0.082	19.963	79.931	0.104
	2	0.082	20.572	79.284	0.143
	3	0.082	20.569	79.270	0.160
	4	0.082	20.569	79.270	0.160
	5	0.082	20.569	79.270	0.160

The role of monetary shocks in explaining other shocks in the non-Franc zone countries is in line with the failure by most of these countries to achieve price stability i.e. inflation levels in these countries have been known to vary widely, unlike in the Franc zone where period on period variations have been known to be relatively minor. One difference compared with the Franc zone (except in Kenya), is that money shocks play a more significant role in explaining output and real exchange rate fluctuations. This suggests that in flexible exchange rate regime money shocks are more likely to have real effects.

In Tables 4.16 - 4.18 we present results from the aggregated sample of oil-exporting

Table 4.18: Percentages of Forecast Error Variance Decomposition of Real Money Growth (Row 3, Equation 4.13) Due to Each Shock, Periods 1-5: Oil and non-Oil Producing Franc Zone Countries

	Period	S.E.	ε_t^p	ε_t^y	ε_t^m
Oil	1	0.120	24.337	17.351	58.310
	2	0.125	27.193	16.424	56.382
	3	0.126	26.824	16.385	56.790
	4	0.126	26.893	16.371	56.735
	5	0.126	26.885	16.370	56.743
Non-Oil	1	0.114	2.602	0.496	96.901
	2	0.114	2.630	0.530	96.839
	3	0.115	2.787	0.644	96.568
	4	0.115	2.796	0.653	96.550
	5	0.115	2.799	0.655	96.545

and non-oil exporting Franc zone countries.[12] Under the assumption that oil-exporting Franc zone countries are more likely to face similar output shocks, the variance decomposition of shocks to output growth will be of particular interest. Table 4.17 shows that, aside of the common role for the real exchange rate shocks, money shocks explain a significant portion of output shocks for the oil-exporting group. It can therefore be argued that there is a stronger relationship between money and output shocks in the oil-exporting sample compared to the non-oil exporting group. In Table 4.16, money shocks also significantly explain the fluctuations in the real exchange rate for the oil-exporting group, while an insignificant portion is explained by output shocks.

A comparison of output shocks between Nigeria and the oil-producing sample in response to an output shock shows some significant similarities. There is, however, an obvious difference between the proportions of the output shock explained by fluctuations in money – it is much higher in Nigeria than in the oil-exporting Franc Zone group. This is indicative of higher levels of monetary control within the oil-exporting Franc zone countries compared to Nigeria, although they are likely to experience similar

[12]Cameroon, Congo Republic and Gabon make up the oil-exporting group; non-oil-exporting countries in the Franc zone include Benin, Burkina-Faso, CAR, Côte d'Ivoire, Chad, Mali, Niger, Senegal and Togo.

oil-price shocks (see Tables 4.11 - 4.17).

The decomposition of output shocks in Kenya shows that, unlike in the other non-Franc zone countries, a minimal proportion of the variance is explained by money shocks. By contrast, the real exchange rate plays the most significant role in explaining fluctuations in Kenyan output. Although small on an international basis, Kenya's manufacturing sector is the most sophisticated in East Africa – though it still only supplies 13% of total domestic economic output, up from average of 10% throughout the 1980s. The manufacturing sector (with agro-processing accounting for just under half of Kenya's total manufacturing output) is the largest source of employment in Kenya by far, that is an estimated 66% of the economically-active labour force.[13] With Kenya's economy highly dependent on the manufacturing sector, capital goods including machinery and transportation equipment, petroleum products, motor vehicles, iron and steel, plastics form a high share of imports, and fluctuations in the real exchange rate are correspondingly more important.

4.5 Concluding Remarks

Using the Blanchard and Quah (1989) decomposition, this chapter identifies and decomposes structural shocks to three important variables (real exchange rate appreciation, real output growth and the growth in real money balances) in the macroeconomies of twelve Franc zone countries and four non-Franc zone countries over the period 1961-99. While there is no *a priori* reason to suggest that Franc zone countries' response to macroeconomic fluctuations will be identical, the policy coordination and restrictions on individual adjustment strategies within the monetary union suggest that there might be some degree of homogeneity.

[13]Source: Government of Kenya Information, December 2002.

However, our results of forecast error variance decomposition do not show a common response in the countries within either of the two monetary unions that make up the Franc zones. The heterogeneity within the Franc zone with respect to macroeconomic shocks implies that a rigid and common policy response to external imbalances and growth disturbances may be sub-optimal, as it may not meet the needs of all member states. The heterogeneity may be due to differences in national production factors, geography and natural resources, and also wage and price flexibility. According to Boughton (1991), when the Franc zone is viewed from the perspective of a currency union among the African countries, the Zone does not appear to constitute an optimum currency area, due to the pressure on the financial systems in a few countries. However, when France is viewed as an integral part of the Zone and it is viewed from the perspective of the discipline, credibility, and stability in international competitiveness, the benefits become more obvious.

Although our results do not support a view that the countries in the Franc zone's economies are homogeneous, it is evident that some common patterns do emerge in the results. In particular, money shocks generally feature more prominently in explaining macroeconomic shocks in the CEMAC compared to the countries in the West-African monetary union, and even more prominently in most of the non-Franc zone countries. They also appear to be more important in the oil-exporting sub-group than in the non-oil exporting sub-group.

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Chapter 5

ESTIMATING EQUILIBRIUM REAL EXCHANGE RATES IN THE CFA FRANC ZONE

At the time of writing this final version of the thesis, an article version of this chapter has been accepted by the editors of the *Journal of African Economies* for publication, on condition of minor revisions.

5.1 Introduction

Episodes such as the Brazilian devaluation of 1999, the Asian crisis of 1997, the Mexican currency crisis of 1994 and the devaluation of the CFA Francs of West and Central Africa also in 1994 have shown that growing financial integration has increased the costs associated with real exchange rate (hereafter RER) misalignment, and underscore the importance of avoiding such misalignments. In this chapter, misalignment in a given period t is defined as the percentage difference between the real effective exchange rate and the estimated equilibrium value in that period.

The increasing evidence of deleterious consequences associated with RER misalignments, combined with the formation of the European Monetary Union (EMU), have spurred a huge increase in research related to such misalignments. The aim of this chapter is to complement such research by estimating the degree of misalignment in the RER within member countries of the CFA Franc zone of sub-Saharan Africa over the period 1960-99. As has been reported in Chapter 1 of this thesis, the eight West-African countries (UEMOA) and six Central-African countries (CEMAC) that make up the CFA Franc zone each have a different currency (both referred to as CFA Franc), but are equally pegged to the French Franc (now to the Euro) with convertibility guaranteed by the French Treasury.[1]

Typically, estimation of the equilibrium RER is non-trivial, particularly as it is not observable, and in most developing countries this problem is compounded by the lack of sufficient historical data. Devarajan (1997) highlights some of these difficulties associated with various methods of estimating misalignment. Intuitively, a country's international competitiveness in foreign trade hinges on the level of the RER. On the one hand, an overvalued RER is likely to lead to a loss of competitiveness, which in turn implies hindered growth and slower convergence. Furthermore, an overvalued RER, according to theory, opens up a currency to speculative attacks and thus capital flight. On the other hand, an undervalued RER implies higher inflationary pressures since real appreciation will only be able to take place through higher inflation. Although high inflation is itself not a preferred state, 'tolerable' thresholds can differ significantly among countries. In fact, misalignment in the RER affects short-term capital flows and hence central bank balance sheets, thereby affecting monetary policy. The practical importance of the RER and misalignments make it one of the most debated issues

[1] See Chapter 2 of this thesis (also see Fielding, 2002, pages 1-14) for a review of the institutional arrangements within the CFA Franc zone.

in both theoretical and applied research on national and international macroeconomic policy. Williamson(1994) provides some insight into some of these debates and the lack of consensus on estimating the equilibrium exchange rate. Also, an extensive review of both theoretical and empirical issues related to definition, measurement, determinants and estimation of the real exchange rate is provided by Hinkle and Montiel (1999).

Traditional approaches for estimating the equilibrium RER include the relative purchasing power parity (PPP) approach (see examples Officer,1982 and DeGregorio and Wolf, 1994) and the trade-elasticities approach (see Krueger *et al.*, 1988). On the one hand, the relative PPP approach takes the traditional view on the determination of the long-run equilibrium RER (LRER), by essentially taking the LRER to be a constant. On the other hand, the LRER may be taken to be determined by some fundamentals; in which case individual stationarity or cointegration among any nonstationary fundamentals is important. The relative PPP approach takes the equilibrium RER as the value observed in the year when the current account is taken to be in equilibrium, and calculates the misalignment in other periods. In other words, whichever PPP approach is used to justify its use, the equilibrium RER may be estimated either by using a base-year or a long-term trend value. The former case involves identifying a base period in which, on the basis of independent evidence, it is believed that the actual RER represents the estimate of the equilibrium value. In the latter case, an analysis of the movements in the fundamentals is carried out to identify a base year in which, on average, the fundamentals and hence the RER are at sustainable levels. Misalignment in this case is calculated as the difference between the current year's actual RER and the equilibrium value in the base year. Despite the simplicity and limited data requirements of the PPP approach, its dependence on a relatively simple base-year or mean-trend estimate of the equilibrium RER may be problematic. This is especially so when there are structural breaks in the time series data for the RER or permanent changes in the fundamentals. The trade-elasticities approach involves establishing a quantitative relationship between the RER and imports, exports and hence the resource balance. Upon establishing this relationship, the change in the initial RER that will move the resource balance to the target level is computed, under the assumption that everything else is the same. Finally, the estimated LRER is computed as the one that corresponds to the target or equilibrium resource balance. The level of depreciation or appreciation necessary can then be computed, as the misalignment. In comparison, the data requirements for this approach are higher and the analysis more time-consuming.

Despite these two broad approaches, some variations exist and there seems to be a consensus among researchers that there are situations in which each is applicable. In fact, the main issues of contention regarding long-run equilibrium real exchange rate (LRER) are partly conceptual and partly empirical. Broadly speaking, most researchers agree with Nurkse's (1945) definition of the LRER, but differ on what constitutes the best choice of determinants and empirical approach. Nurkse (1945) defines the LRER as that value of the RER consistent with external and internal balance conditioning on specified values of other variables that may influence these balances.[2]

In principle, changes in RER can be captured in a variety of ways, including the use of traditional single-equation reduced-form models (Edwards, 1989, 1994; Razin and Collins, 1997), and by using cointegrating equations (Elbadawi, 1994; Elbadawi and Soto, 1994; Baffes *et al.*, 1999). However, in testing for the presence of unit roots and determining the presence of cointegration between RER and the 'fundamentals',

[2]See Edwards (1989) for a more recent exposition.

standard unit-root tests (for example ADF tests and Im *et al.* (2003) [IPS] tests) typically assume that errors are independent between countries. Coakley *et al.* (2005), O'Connell (1998), and Pesaran (2005) have each shown that such assumptions can provide misleading results.[3] Specifically, in multi-country analysis of RER misalignment, methods that ignore cross-sectional dependence are likely to provide misleading estimates and hence incorrect equilibrium(s).

This chapter focuses on the behaviour of the real effective exchange rate (REER) within the CFA Franc zone of Africa which has been in existence since 1948, and is currently made up of fourteen different mainly former French colonies that have come together to form two monetary unions. The fixed parity with the French Franc has been adjusted only once in January of 1994 through a 100% collective devaluation. Although debate related to the need, or otherwise, for this landmark devaluation goes beyond the issue of RER misalignment, it has been considered to be an important factor in research concerning the devaluation. Many important questions arise in relation to the CFA Franc zone and RER misalignment in light of the landmark 1994 collective devaluation. We attempt to address some of these questions. Were all the CFA Franc zone countries overvalued in the 1970s and 1980s, as has been suggested by some studies for most African countries (see Dollar, 1992)? What was the behaviour of the RER in individual member-countries in the period leading to 1994 that prompted the collective devaluation? How severe was the degree of misalignment in member states just prior to the 1994 collective devaluation? How different has been the path of the RER in member countries after the 1994 devaluation? Increased information about answers to these questions is particularly relevant for current and future policy within the CFA Franc zone. Particularly, an analysis which takes into account possible error

[3] The working paper, Pesaran (2005), has recently (2007) been published in the *Journal of Applied Econometrics*, 22: 265-312, with the same title.

dependence seems particularly relevant for these countries due to inherent economic dependency, spatial spillover effects and fundamental institutional arrangements.

The policy implications of the above questions call for a methodology that explores the period including the 1994 devaluation itself, and also accounts for cross-country error-dependence. In this chapter, we attempt to improve on previous research by making use of the fundamentals approach, from which policy concerns can be addressed. Secondly, we conduct panel unit-root tests that account for cross-sectional dependence by making use of a novel test proposed by Pesaran (2005). Furthermore, we use seemingly unrelated regression equations (SURE) estimation, which allows for non-zero contemporaneous error covariances - the validity of this approach is later confirmed by testing for contemporaneous correlation in the error terms based on a Lagrange Multipler statistic (λ). Finally, this chapter attempts to distinguish between misalignment based on two alternative 'equilibrium' RERs - the *short-run equilibrium (*SRER*)* and *long-run equilibrium (*LRER*)* real exchange rates. In this chapter, SRER refers to the value of the REER observed in the absence of speculative factors (for example asset market bubbles), whilst LRER refers to a function of the steady-state values of any predetermined variables and permanent (sustainable) values of the policy and exogenous variables. We find significant variation in observed misalignments across member states, but also uncover some interesting similarities - particularly between the main economically and politically influencial (*'pivotal'*) economies, which underwent the steepest RER appreciation just prior to the collective devaluation. The findings of this chapter suggest that this situation may have played a major role in the Zone's decision to devalue.

The rest of the chapter has been organized as follows. Section 2 discusses issues related to determinants of the equilibrium real exchange rate. Section 3 describes the specification of the real exchange rate equation and empirical methodology. The data and empirical results are presented in Section 4. Section 5 provides some concluding remarks.

5.2 Real Exchange Rates in the CFA Franc Zone

The RER is generally defined as the nominal exchange rate adjusted for price level differences between countries. In this chapter, we have taken into account several of the major trading partners of each of the twelve Franc zone countries in the sample. Hence, we examine the real effective (or multilateral) exchange rate (REER). RER_t between country i and j may be represented by:

$$RER_{t_{i,j}} = E_{t_{i,j}} \times \frac{P_{t_i}}{P^*_{t_j}} \tag{5.1}$$

where P_{t_i} refers to the domestic price level in country i at time t, $P^*_{t_j}$ to the foreign country price level in country j at time t, and $E_{t_{i,j}}$ the individual country bilateral nominal exchange rate (defined as foreign currency per unit domestic currency between countries i and j) in period t. Based on Equation 5.1, the real effective exchange rate (REER_{t_i}) can therefore be written as:

$$REER_{t_i} = e_{t_i} = \prod_{j=1}^{n} RER_{t_{i,j}}^{w_j} \tag{5.2}$$

where n represents the number of trading partners of country i, and w_j is a weight which represents the trade share with j as a share of country i's overall trade. The use of the geometric mean, rather than the arithmetic mean, has the advantage of treating changes in the RER symmetrically and is not dependent on the choice of the base year. By this definition, an increase in the REER (Equation 5.2) index implies appreciation of the real effective exchange rate (and therefore less competitive), and a decrease implies depreciation.

5.2.1 Determinants of the Real Exchange Rate

Analysis of the RER and its equilibrium requires us to take into account some economic variables, considered to be fundamental determinants of the equilibrium RER. This section briefly discusses the theory which motivates the choice of determinants of the RER (see Hinkle and Montiel, 1999). In this way, as has been demonstrated in many empirical studies, the equilibrium RER is not constant over time as suggested by the PPP theory, but subject to changes which derive from changes in its fundamentals.

The Balassa-Samuelson effect is usually considered to represent domestic supply-side influences, and may be represented by an asymmetric productivity shock favouring the traded-goods sector. The Balassa-Samuelson effect suggests that an increase in the relative productivity of 'tradables' versus 'non-tradables' of one country versus foreign countries raises its relative wage, thus increasing its relative price of 'non-tradables' and its relative average price, thereby inducing an appreciation of the real exchange rate (RER). In other words, the hypothesis is that, when measured in common currency, the price-level tends to be higher in a high-income country than in one with a lower level of per capita income. With a productivity shock that favours the traded-goods sector, research has generally shown that the equilibrium RER appreciates due to the excess demand created for non-traded goods, and thus there is a tendency for the trade balance to improve.

In principle, changes in composition of government spending between traded and non-traded goods are considered to influence long-run RER. Any tax-financed increases in spending on traded goods are considered to impose downward pressure on the trade balance, and will require real depreciation to maintain the external balance. Alternatively, tax-financed increases in spending on non-traded goods create initial excess demand in that market and will require real appreciation to restore equilibrium.

Changes in the international trade environment are usually captured by factors such as the Terms of trade for the domestic economy, availability of external transfers, level of world interest rates and the world inflation rate. Improvements in the Terms of trade tend to lead to an appreciation of the equilibrium RER by improving the trade balance, and also by creating excess demand for non-traded goods. Alternatively, it may also result in an overall depreciation if these spending effects are overcome by substitution effects on the supply and demand sides. Lower world interest rates will tend to encourage capital inflows, and thereby reducing the country's net creditor position over time; maintaining the external balance will require a real depreciation due to the long-run loss of net interest receipts. Increases in world inflation relative to domestic levels are generally considered to depreciate the long-run RER through the effects on transaction costs associated with real money balances respectively.

Finally, changes in commercial policy, usually proxied by some measure of trade liberalization, are generally associated with depreciation in the equilibrium real exchange rate by channeling of resources into the non-traded goods sector. The observed excess supply in the non-traded goods sector plays a significant role in the nature of the adjustment in the real exchange rate.

5.3 Econometric Specification and Methodology

The specification used in this chapter is based on a log-linearized form of the fundamentals approach to estimating the equilibrium RER (Williamson, 1994). Since the equilibrium RER is not directly observable, several combinations of fundamentals have been used to explain its movements.[4] Ideally, one may consider a list of proxies for fundamentals including government spending on traded and also on non-traded goods, resource balance, productivity differentials between traded and non-traded goods, the Terms of trade and an appropriate measure of the international economic environment and commercial policy.

Although there is no absolute consensus regarding determinants, this chapter identifies a set of variables that may potentially act as long-run fundamentals and attempts to determine the nature of their influence on the long-run RER. As described above, these include domestic supply-side factors, fiscal policy, changes in international economic environment and commercial policy. In this chapter, along with several variables considered in Baffes *et al.* (1999), we include government consumption as a share of GDP to proxy changes in fiscal policy assuming there exists a long-run equilibrium real exchange relationship in log-linear form, which can be written as:

$$\ln e^*_{t_i} = \beta_i^T F_{t_i}^P, \tag{5.3}$$

where $e^*_{t_i}$ is the equilibrium REER, $F_{t_i}^P$ represents the vector of permanent values of the fundamentals (also in natural logarithms), and β_i^T is the transpose of the vector of long-run parameters of interest for country i. The empirical estimation of β_i requires the use of observable variables, hence the model that captures the relationship may be written as:

$$\ln e_{t_i} = \beta_i^T F + \varepsilon_{t_i}, \tag{5.4}$$

[4]Different sets of determinants have been considered by various studies. For some examples see Edwards (1989, 1994), Elbadawi (1994), Elbadawi and Soto (1994), Feyzioglu (1997), Clark and MacDonald, (1998), Baffes *et al.* (1999); Kim and Korhonen (2002).

where F represents the vector of observed fundamentals. We note that the steady state has to be dynamically stable so that the RER will converge to its long-run equilibrium in Equation 5.3 in the absence of any shocks.

Estimating the equilibrium RER for countries in the CFA Franc zone requires some additional considerations, particularly due to the unique institutional arrangements within the monetary union and data availability. Given the determinants of the RER, as described in Section 5.2.1 above, data considerations require some compromises to be made as follows: Investment as a share of GDP (INVSH_t) is used to capture the domestic supply capacity and possibly technological progress (see Kim and Korhonen, 2002); Government consumption as a share of GDP (GOVCON_t) is used to capture the impact of changes in fiscal policy; the Terms of trade (TOT_t) is used to capture the impact of changes in the international economic environment. In addition, a measure of Openness to international trade (OPN_t), as in Appendix *B* is used to capture the impact of changes in Commercial policy or Trade regime. Furthermore, the Resource balance is treated as one of the fundamentals, consistent with an assumption that Franc zone member-states face an upward-sloping supply curve of external loans, thereby imposing a binding credit ceiling that shuts down the capital account and determines net interest payments.[5] Economic theory suggests that an increase in resource balance (associated with net capital inflow) will induce an increase in domestic absorption and shift the composition of potential output towards non-traded goods. However, as it *may* be argued that the RER is one of the primary determinants of the resource balance - one potential method is value of resource balance to GDP ratio (RBAL_{t-1}) to appear in the regression equations with a lag, as a measure of the effects of net capital inflows. Since RBAL_{t-1} is a predetermined variable, it is weakly exogeneous to

[5]For a more extensive discussion on this issue, see Hinkle and Montiel, 1999 (pages 12-13 and also Chapter 10, pages 410-412). In this thesis, all of these factors have been further explained in Section 5.4.

the Real Exchange Rate at t.

The Hausman tests for endogeneity of the RBAL and GOVCON was conducted and in both cases the tests do not reject the null of exogeneity in the data for all the countries in our sample (see Table 5.2). The term *resource balance* is used here to refer to the difference between the export and the imports of goods and nonfactor services as a share of GDP. In Equation 5.5 below, an attempt to account for the 1994 collective devaluation within the CFA Franc zone is made by using an impulse dummy variable (D94) which takes the value of 1 in 1994 and 0 otherwise.

In summary, the vector $F(z)$ represents RBAL_{t-1} (in levels), and GOVCON_t,INVSH_t,TOT_t and OPN_t (in natural logarithms) and i the home country. For country i, the long-run estimate of the REER may thus be represented by Equation 5.3:

$$\ln e^*_{t_i} = \beta_{0_i} + \beta^T_{1_i} F(z)_{t_i} + \beta_{2_i} D94_t, \tag{5.5}$$

where β_{0_i} represents the intercept, $F(z)_{t_i}$ is the vector of fundamentals, and $t = 1, 2, ..., T$ are the time periods. The steady-state relationship between RER and its fundamentals can therefore be estimated for each country using the relationship:

$$\ln e_{t_i} = \beta_{0_i} + \beta^T_{1_i} F(z)_{t_i} + \beta_{2_i} D94_t + \varepsilon_i, \tag{5.6}$$

where ε_i is a mean-zero stationary random variable. As before, the steady state is required to be dynamically stable. Hence, shocks that cause the RER to diverge from its equilibrium in the short run should, in the absence of any new shocks, produce eventual convergence to Equation 5.5. Keeping in mind the possibility of significant cross-country residual correlations, OLS may not be efficient and the use of seemingly unrelated regression equations (SURE) estimations to improve efficiency is preferred.

When some of the variables in Equation 5.6 are $I(1)$ in levels, and ε_i is stationary then there exists at least one cointegration relationship and the corresponding long-run relationship is stable. The equilibrium RER can then be identified as that unobserved function of the fundamentals towards which the actual RER gravitates over time (Kaminsky, 1988; Elbadawi, 1994; Elbadawi and Soto, 1994, 1997; Kim and Korhonen, 2002). Although time-series estimations have been used in many contexts to estimate the equilibrium RER (and misalignment) and to establish a long-run relationship between the RER and its fundamentals, this chapter suggests that considering the effects of cross-sectional dependence will improve the efficiency of the estimated results. Whilst recent developments have brought about many methods of estimating the equilibrium RER, the suitability of these methods depends mainly on the nature and span of the data, and also on the purpose of the study.

Pesaran *et al.* (1999) discuss alternative estimation methods for dynamic panels, including the seemingly unrelated regression equation (SURE) procedure, the Mean Group (MG) approach, the Pooled Mean Group (PMG) approach, the traditional methods – fixed effects (FE), instrumental variables (IV) and generalized method of moments (GMM) – and the Bayes approach. Under certain conditions each of these methods can be used to determine the long-run parameters for estimating the equilibrium RER. For our purposes, given the nominal exchange rate peg within the Franc zone and guaranteed currency convertibility arrangements (with the French Treasury), the assumption of a common long-run equilibrium relationship in Equation 5.6 across countries may seem reasonable (as in the Pooled Mean Group (PMG) approach, Pesaran, 1999). However, given that the formation of the CFA Franc zone was more on the basis of colonial administrative arrangements rather than economic design, one can also expect individual countries to exhibit some level of heterogeneity in the behaviour of institutional structures.

This chapter aims to allow for the possibility of non-zero error covariances and uses the traditional SURE estimation approach, which does not assume *a priori* independence of errors across countries; and also allows for conventional tests for contemporaneous correlation and also provides a basis for testing behavioural restrictions across countries (such as equality of coefficients). In order to capture the possible cross-country dependence within the Franc zone, whilst keeping in line with Equation 5.6, this chapter proceeds to estimate the long-run relationship between the REER and its fundamentals (of the form in Equation 5.6) in a SURE model. Next, we use the coefficients obtained from the long-run SURE model, for each country i, to calculate the equilibrium RER for each period t. Conceptually, the chapter distinguishes between the 'short-run equilibrium' RER (SRER) and the 'long-run equilibrium' RER (LRER). Specifically, SRER is computed simply by applying the estimated $\hat{\beta}$ to the predetermined and actual values of the policy and exogenous variables $[F(z)]$; and LRER, by applying the long-run parameters to 'sustainable' values of the fundamentals, which have been obtained by exponentially smoothing the fundamentals.

It is important, at this stage, to note that there may be efficiency gains by introducing dynamics into the SURE model, say by adopting the Dynamic Seemingly Unrelated Cointegrating Regressions approach (Mark, Ogaki and Sul, 2005). However, given the number of cross-sections (N) and time span (T) available in our dataset, this is not a feasible option as it demands many degrees of freedom. There is a trade-off between the gains of including dynamics and preventing the problems associated with loss of degrees of freedom. Given our sample size, either decision would have its drawbacks. The decision to estimate a static model is based on the view that it would not change the overall qualitative conclusions of the chapter.

5.4 Data and Empirical Results

5.4.1 Data

This study uses annual data for twelve countries in the CFA Franc zone over the period 1960-99. Specifically, our sample includes Benin (*Ben*), Burkina-Faso (*BFaso*), Cameroon (*Cam*), Central African Republic (*CAR*), Chad (*Chd*), Congo Republic (*Con*), Côte d'Ivoire (*Civ*), Gabon (*Gab*), Mali (*Mal*), Niger (*Nig*), Senegal (*Sen*) and Togo (*Tog*). Guinea-Bissau (*GBiss*) and Equatorial Guinea (*GEQ*) are not included due to lack of sufficient data.

As the actual data are not available for some of the determinants as specified above, we have provided information below on how we constructed the data set as used in the analysis. Construction of the REER has been shown in Section 5.2 above, using the specified price indices. Following Baffes *et al.* (1999), we have used the consumer price index (CPI) as an index for the domestic price level (P) and the trade-weighted index of the wholesale price-index (WPI) to measure the foreign price level (P^*).[6] Data on wholesale price indices (WPI) were obtained from various national data archives, most of which are freely available on the internet - for example, the Bank of Japan for Japanese price indices; Federal Statistical Office for German price indices; the Economic Information Office of the Federal Public Service Economy, SMEs, Self-employed and Energy of Belgium for Belgium's price indices; Central Bank of Nigeria for the Nigerian indices; National Institute for Statistics and Economic Studies for French indices; and the International Monetary Fund's (IMF) International Financial Statistics (IFS).

Data required for the construction of the other determinants was obtained from the World Bank Development Indicators (WBDI) 2003 CD-ROM in local currency units

[6] The foreign countries have been listed in Table 5.1 and provide the weights used in constructing the trade weighted REER, as shown in this section.

(CFA Francs), and where necessary all data have been re-based with 1995 as the common base year. Resource balance (RBAL), the terms of trade (TOT), fixed investment share (INVSH), government consumption (GOVCON), and openness (OPN) are all constructed as follows:

1. Real Effective Exchange Rate ($REER$) – The ratio of domestic price level (CPI) to the trade-weighted index of foreign price level (WPI) each expressed in CFA Francs. This is calculated as a geometric average across home country *i's* n largest trading partners that make up about 70% of total trade. The trade shares are used as weights (w_j) and have been normalized to sum to unity.

$$REER_{t_i} = \prod_{j=1}^{n} RER_{t_i}^{w_j}.$$

2. Resource Balance to GDP Ratio ($RBAL$) – Value of exports ($EXPK$) minus the value of Imports ($IMPK$), as a ratio of the gross domestic product (GDP) all at constant prices and in local currency units (CFA Francs).

$$RBAL = \frac{(EXPK - IMPK)}{GDP}$$

3. Investment Share ($INVSH$) – Ratio of the gross fixed capital formation ($GFCFK$) to gross domestic product (GDP) also at constant prices and in local currency units (CFA Francs).

$$INVSH = \frac{GFCFK}{GDP}$$

4. Openness (OPN) – Ratio of the sum of imports and exports of goods and services

to GDP, all at constant prices and all in local currency units (CFA Francs).

$$OPN = \frac{(EXPK + IMPK)}{GDP}$$

5. The Terms of Trade (TOT) – Ratio of the export price deflator (P_X) to the import price deflator (P_M) both at constant prices and in local currency units (CFA Francs).

$$TOT = \frac{P_X}{P_M}$$

6. Government Consumption ($GOVCON$) - Ratio of Government consumption as a share of GDP, both at constant prices and in local currency units (CFA Francs).

$$GOVCON = \frac{GOVK}{GDP}$$

The list of the major trading partners that account for approximately 70% of the overall trade is provided in Table 5.1, and is based on trade volumes as reported in the IMF's Direction of Trade Statistics (DOTS) Yearbooks. We treat the trade weights, which is based on the average share of overall trade with the home country, as a fixed weight assigned to each major trading partner (and equal to its percentage share of its overall trade).

Stationary Tests

A variety of procedures have been developed in recent years to determine the presence of unit roots in a panel context, hence taking advantage of the variations in cross-sectional dimensions as well as improving on the well-known low power of standard unit-root tests such as the ADF tests.

In this context it is also prudent to note that tests such as the ADF tests typically assume cross-sectional independence. Although ignoring significant error cross-section dependence can lead to spurious results, Pesaran (2005) also emphasizes that in cases where cross-sectional dependence is not sufficiently high, a loss of power might result if a panel unit-root test that allows for cross-sectional dependence is used. Against this background, this chapter makes use of two panel unit-root tests: the standard Im, Pesaran and Shin (2003) [IPS] test, which assumes cross-sectional independence and a panel unit-root test proposed by Pesaran (2005) [CIPS], which allows for cross-sectional dependence (see for example Coakley *et al.*, 2005 for an empirical application). Also known as the cross-sectioanlly augmented IPS test, the CIPS test is based on the t-ratio (denoted $t_i(N,T)$), of the least squares estimate of b_i in the following cross-sectionally augmented ADF regression for each country:

$$\Delta q_{it} = a_i + b_i q_{i,t-1} + c_i \overline{q}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \overline{q}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \Delta q_{i,t-j} + e_{it} \tag{5.7}$$

where $\overline{q}_{it}$ is the cross-sectional mean of the series q_{it}. Pesaran computes the appropriate test statistic as $CIPS = \frac{1}{N}\sum_{i=1}^{N} t_i(N,T)$, and the critical values can be found in Pesaran (2005), Tables 3a–c.

Results of tests for the level of cross-sectional dependence are reported in Table 5.3, which in turn informs the determination of the preferred panel unit-root test result to be applied. In each case, the null of unit root cannot be rejected at the 5% level; in the light of this finding, a cointegration test needs to be carried out to establish stationarity of the equilibrium error term for each country.[7] In theory, one possible and simple approach will be to apply the CIPS test to the residuals obtained from the

[7] In this model, there is no cointegration between the variables across countries of the form discussed in Banerjee *et al.* (2005), which may distort the results of panel unit-root tests.

SURE estimation above, thereby allowing for cross-sectional dependence while checking for stationarity of the residuals. However, at the present time, the implication of the results of these tests, reported in Table 5.4, remain uncertain since recent studies in the forefront of these techniques (including Pesaran, (2007)) are yet to extend to this type of residual-based tests, and to provide the appropriate the critical values. So while it is reasonable to consider a residual-based test that considers possible cross-sectional dependence, a more practical approach is to resort to a panel cointegration tests. For this purpose, we use the Pedroni (1999) framework, which proposes seven tests for investigating heterogeneous panels, and allows for heterogeneous slope coefficients, fixed effects and individual specific deterministic trends.[8] Pedroni (1997) discusses the sample and size properties and finds that, on the one hand, for all seven statistics when the time span is long, the size distortions are minor and power is high. On the other hand, the evidence is more varied for shorter panels. However, Pedroni goes on to show that the *Group-adf* statistic and *Panel-adf* statistic generally perform best. Table 5.5 reports the results of the Pedroni tests and shows that the null of no cointegration can be rejected by the *Panel pp* statistic, the *Panel adf* statistic, the *Group-pp* statistic and the *Group-adf* statistic at the 1% level, not by the other test statistics. Given the above discussion concerning both power properties and size distortions, the evidence supports the existence of a cointegrating relationship. Hence, a steady-state equilibrium of the form in Equation 5.5 can be obtained through estimating Equation 5.6 by (in our case) SURE analysis.

To ascertain the appropriateness of the SURE estimation method for this analysis, we determine the extent of contemporaneous correlation in the residuals. We, therefore, determine the Breusch and Pagan (1980) Lagrange Multiplier (LM) test statistic and

[8]In its most simple form, it takes no cointegration as the null hypothesis and uses the residuals derived from the panel version of an Engle and Granger (1987) static regression to construct the test statistic and tabulate the distributions.

Table 5.1: Main Trading Partners of the Franc Zone Member States

Country	Main Trading Partners[a]
Benin	Côte d'Ivoire (8.35), China (11.66), France (38.76), Germany (7.39), Japan (4.31), Netherlands (10.02), UK (11.42), USA (8.09)
Burkina Faso	Côte d'Ivoire (34.14), France (42.06), Germany (4.17), Japan (5.52), Nigeria (5.90), U.K. (2.38), USA (5.83)
Cameroon	France (50.62), Germany (11.36), Japan (8.01), Nigeria (13.85), UK (5.21), USA (10.95)
Central African Rep.	Cameroon (12.47), Côte d'Ivoire (1.39), France (64.16), Germany (5.15), Japan (11.58), UK (1.39), USA (3.86)
Chad	Cameroon (10.63), France (62.19), Germany (3.44), Japan (2.48), Nigeria (11.35), UK (3.04), USA (6.87)
Republic of Congo	Côte d'Ivoire (2.37), France (65.62), Japan (3.35), Germany (4.79), UK (7.27), USA (16.60)
Côte d'Ivoire	Belgium (4.62), France (43.35), Germany (6.52), Japan (5.67), Nigeria (27.49), UK (4.13), USA (8.22)
Gabon	Côte d'Ivoire (3.22), France (73.68), Germany (3.63), Japan (5.45), UK (5.36), USA (8.66)
Mali	China (4.04), Côte d'Ivoire (38.63), France (36.84), Germany (6.44), Japan (2.33), UK (6.00), USA (5.72)
Niger	China (2.49), Côte d'Ivoire (18.49), France (44.26), Germany (7.23) Japan (6.06), Netherlands (4.83), UK (6.51), USA (10.13)
Senegal	Belgium (4.77), Côte d'Ivoire (4.99), France (52.01), Germany (6.81), Japan (5.04), Nigeria (14.09), UK (3.51), USA (8.78)
Togo	China (3.11), Côte d'Ivoire (15.65), France (47.24), Germany (10.59), Ghana (3.38), Japan (6.49), UK (6.60), USA (6.94)

[a] Source: Direction of Trade Statistics Yearbooks. Main Trading Partners' trade volumes make up about 70% of overall trade with the home country. Figures in parentheses refer to average percentage share of overall trade, and these have been normalized to add to 100%. We note here that these trade shares have been used to compute the trade weights $w_j = \frac{\textit{average percentage share of overall trade}}{100}$.

found it to be 410.73 (see Table 5.6), greater than the $\chi^2(66)$ critical value of 95.63. Therefore, we reject the null of no contemporaneous correlation at the 1% level of significance. Also results from Wald (1943) tests, restricting all coefficients across countries to be equal (see Table 5.7) imply a rejection of the null at the 1% level of significance. This means that, in such contexts, tests that impose such coefficient restrictions may be misleading. The long-run parameters are therefore obtained from estimations of the form in Equation 5.6 for each country by SURE, which have been reported in Table 5.8, along with some diagnostics.

Table 5.2: Hausman Tests for Endogeneity of RBAL and GOVCON

	1960-1999 (T=40)	
	RBAL	*GOVCON*
Ben	1.11 (0.98)	0.65 (0.99)
BFaso	0.23 (0.99)	0.35 (0.99)
Cam	1.46 (0.96)	1.36 (0.96)
CAR	1.75 (0.94)	4.38 (0.62)
Chd	2.22 (0.89)	2.11 (0.91)
Con	1.11(0.98)	11.04 (0.08)
Civ	2.62 (0.85)	2.28 (0.89)
Gab	7.40 (0.28)	1.14 (0.97)
Mal	2.32 (0.88)	2.27 (0.89)
Nig	0.03 (0.99)	5.00 (0.54)
Sen	7.12 (0.31)	11.44 (0.07)
Tog	3.90 (0.69)	6.31 (0.38)

Notes: Figures in table represent the Hausman test statistic and figures in parentheses are the respective p-values, with 6 d.f. i.e. $\chi^2(6)$ using two lags of RBAL and GOVCON as instruments, both of which are confirmed as valid instruments based on the Sargan test statistic (NR^2). The critical value at 5% level of significance is 12.59, hence the null of exogeneity of RBAL and GOVCON cannot be rejected at the 5% level.

Table 5.3: Cross-section Correlations of the Errors in the ADF(p) Regressions for Individual Series Across Countries; and Panel Unit-root Test Statistics (N=12)

	1960-1999 (T=40)			
	$\bar{\hat{\rho}}$	*CSD*	*IPS*	*CIPS*
$\ln e$	0.557	28.62	-1.354	**-1.683**
RBAL	0.068	3.54	**-1.821**	-2.563
$\ln OPN$	0.031	1.59	**-1.444**	-2.215
$\ln INVSH$	0.032	1.63	**-1.463**	-2.924
$\ln TOT$	0.095	4.89	**-1.852**	-2.428
$\ln GOVCON$	0.013	0.68	**-1.714**	-2.093

Notes: Specifically $\bar{\hat{\rho}} = \left(\frac{2}{N(N-1)}\right) \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}$, where $\hat{\rho}_{ij}$ are the computed pairwise cross-section correlation coefficients of the residuals from individual ADF(p) regressions. Number of lags included (p) for each Individual country is determined by the modified Schwarz Criterion (MSIC). Also $CSD = [\frac{TN(N-1)}{2}]^{0.5}\bar{\hat{\rho}}$. Under the null hypothesis of zero cross-sectional dependence, CSD is asymptotically distributed as $N(0,1)$. CIPS critical values for N=12 and T=40 are -2.50, -2.29 and -2.18 at the 1%, 5% and 10% level of significance respectively (see Pesaran, 2005 Table 3b). Critical values for IPS are -2.10, -1.94, - 1.85 respectively for 1%, 5% and 10% (Im et al., 2003, Table 2). To avoid loss of power, the $CIPS$ test statistic is preferred only when evidence of cross-sectional dependence is significant in both CSD and $\bar{\hat{\rho}}$. Entries in bold indicate the preferred panel unit-root test statistic.

Table 5.4: Panel Unit-root Test Results (on SURE Residuals)

	Ben	*BFaso*	*Cam*	*CAR*	*Civ*	*Chd*
$t_i(N,T)$	-6.02	-3.71	-2.52	-5.88	-1.68	-2.79
	Con	*Gab*	*Mal*	*Nig*	*Sen*	*Tog*
$t_i(N,T)$	-1.75	-1.87	-3.53	-5.00	-0.95	-3.88
$CIPS(N,T)$			-3.30*			

Notes: In this table, $t_i(N,T)$ represents the t-ratio of the lagged dependent variable (q_{t-1}) in the cross-sectionally augmented ADF regression for country i of the form $\Delta q_{it} = a_i + b_i q_{i,t-1} + c_i \bar{q}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \bar{q}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \Delta q_{i,t-j} + e_{it}$, where q_t is representing the residuals obtained from Equation 5.6, again using the Modified Schwarz Information Criteria (MSIC) to select the appropriate lag-length p. $CIPS$, the appropriate panel test statistic, is a computed as $CIPS = N^{-1} \sum_{i=1}^{N} t_i(N,T)$ having critical values for N=12 and T=40 are -2.50, -2.29 and -2.18 at the 1%, 5% and 10% level of significance respectively (Pesaran, 2005, Table 3b). * indicates rejection of unit-root hypothesis at the 1 % level.

Table 5.5: Pedroni Panel Cointegration Test

Panel	Panel	Panel	Panel	Group	Group	Group
ν-statistic	ρ-statistic	pp-statistic	adf-statistic	ρ-statistic	pp-statistic	adf-statistic
-0.8098	0.2276	-2.9671*	-3.1109*	1.3241	-2.9327*	-2.9685*

Notes: Critical values at 5% (1%) level for panel v-statistic and the other six statistics are 1.645 and -1.645 (1.96 and -1.96) respectively. *,**,*** indicates rejection of the null of no cointegration at 1%, 5% and 10% respectively. The formulae for computing these statistics can be found in Table 1 of Pedroni (1999). Panel ν is a nonparametric variance ratio statistic. Panel ρ and Panel pp are analogous to the nonparametric Phillips-Perron p- and t-statistics respectively. Panel-adf is a parametric statistic based on the augmented Dickey-Fuller (ADF) statistic. Group ρ is analogous to the Phillips-Perron p-statistic. Group-pp and Group-adf are analogous to the Phillips-Perron t-statistic and the ADF statistic respectively.

Table 5.6: Test for Contemporaneous Correlation, Residual Correlation Matrix of the SURE Residuals

	Ben	*Bfa*	*Cam*	*CAR*	*Cdi*	*Chd*	*Con*	*Gab*	*Mal*	*Nig*	*Sen*	*Tog*
Ben	1.0											
Bfa	0.29	1.0										
Cam	0.36	0.48	1.0									
CAR	0.38	0.57	0.51	1.0								
Cdi	0.27	0.12	0.78	0.29	1.0							
Chd	0.54	0.54	0.50	0.69	0.35	1.0						
Con	0.29	0.19	0.03	0.35	-0.23	0.44	1.0					
Gab	0.59	0.36	0.59	0.40	0.26	0.53	0.51	1.0				
Mal	-0.02	-0.01	0.13	0.13	0.22	0.07	-0.33	-0.09	1.0			
Nig	0.64	0.07	0.06	0.11	-0.02	0.40	0.40	0.53	-0.19	1.0		
Sen	0.21	0.51	0.83	0.53	0.75	0.53	-0.12	0.43	0.29	-0.05	1.0	
Tog	0.33	0.42	0.31	0.14	-0.14	0.20	0.19	0.52	0.04	0.44	0.12	1.0

Notes: Breusch and Pagan (1980) suggested that under the null hypothesis the Lagrange Multiplier statistic, λ_{SUR}, $= T(\sum_{i=2}^{G}\sum_{j=1}^{i-1} r_{ij}^2)$ follows asymptotically the $\chi^2(G(G-1)/2)$ distribution. Where G is number of equations, T is the sample period and r are the off-diagonal entries in the residual correlation matrix. In the above table, λ_{SUR}= 410.73, and $\chi^2(66) = 95.63$. The rejection of the null implies at least one covariance is *non-zero* supporting the validity of the SURE approach over OLS.

Table 5.7: Testing Linear Restrictions on SURE Coeffitients

Test Statistic	Value	df	Probability
Chi-square	2255.84	77	0.000

Notes: Following a test (in EViews) of linear restrictions on the coefficients across member states, the usual Wald (1943) statistic is greater than the 0.01 significant level critical value of $\chi^2(77) = 121.11$. The null hypothesis is therefore rejected in favour of at least one unequal coefficient across the member states.

Table 5.8: SURE Regression Estimates and Diagnostic Statistics, based on Equation 5.6

Equation 5.6: Dependent variable, $\ln e_{t_i}$; 1960-1999 (T=40)										
	C	$RBAL$	$\ln INVSH$	$\ln GOVCON$	$\ln TOT$	$\ln OPN$	$D94$	$\bar{R}^2$	DW	$S.E.$
Ben	4.36*	-0.96*	-0.01	-0.001	-0.07	-0.17*	-0.22*	0.56	1.48	0.05
	(0.15)	(0.17)	(0.02)	(0.04)	(0.05)	(0.03)	(0.04)			
BFaso	3.73*	-0.56	-0.28*	-0.02	0.13**	-0.25***	-0.22**	0.55	1.82	0.10
	(0.22)	(0.52)	(0.05)	(0.07)	(0.06)	(0.14)	(0.09)			
Cam	5.65*	1.54*	0.03***	0.42*	0.11	0.49*	-0.05	0.52	1.61	0.20
	(0.33)	(0.40)	(0.06)	(0.14)	(0.13)	(0.15)	(0.18)			
CAR	3.82*	0.23	0.17*	-0.71*	0.35*	0.23***	-0.12	0.63	1.59	0.13
	(0.24)	(0.60)	(0.06)	(0.08)	(0.09)	(0.13)	(0.13)			
Chd	3.08*	-1.62	-0.35**	-0.44**	-0.85*	0.62***	0.18	0.48	1.94	0.09
	(0.47)	(-1.18)	(0.15)	(0.19)	(0.23)	(0.33)	(0.28)			
Con	5.31*	1.15*	-0.004	0.21*	0.32*	0.07	-0.15***	0.37	1.53	0.13
	(0.09)	(0.23)	(0.05)	(0.06)	(0.08)	(0.11)	(0.08)			
Civ	5.12*	-0.007	0.21*	0.01	0.02	0.20	-0.50*	0.55	1.50	0.31
	(0.20)	(0.10)	(0.06)	(0.13)	(0.08)	(0.15)	(0.13)			
Gab	4.25*	-1.06*	-0.22*	-0.24**	0.05	0.25**	-0.22***	0.52	1.69	0.13
	(0.21)	(0.20)	(0.07)	(0.09)	(0.06)	(0.09)	(0.16)			
Mal	4.96*	0.06	0.13***	0.05***	0.27*	0.18*	-0.03	0.75	1.26	0.06
	(0.16)	(0.20)	(0.07)	(0.03)	(0.06)	(0.06)	(0.05)			
Nig	4.99*	0.39	0.06**	-0.05	0.30*	0.19*	-0.26*	0.70	1.93	0.08
	(0.14)	(0.24)	(0.02)	(0.07)	(0.06)	(0.05)	(0.08)			
Sen	5.27*	1.84**	-0.08	0.58**	0.19	-0.49*	-0.09	0.25	1.50	0.17
	(0.76)	(0.75)	(0.13)	(0.26)	(0.15)	(0.18)	(0.15)			
Tog	4.81*	-0.24*	0.02	0.07***	0.02	-0.08**	-0.24*	0.54	1.22	0.05
	(0.07)	(0.08)	(0.02)	(0.04)	(0.03)	(0.04)	(0.05)			

Notes: Figures in table represent the SURE estimates, and the figures in parentheses are the standard errors. C refers to the intercept; $\bar{R}^2$ to the Adjusted R^2; DW is the Durbin-Watson statistic and SE refers to the standard error of the regression.*,**,*** indicates statistical significance at 1%, 5% and 10% level of significance respectively.

Table 5.9: Estimated Overvaluation in the REER Based on SRER: 1980-99

	Ben	*BFaso*	*Cam*	*CAR*	*Civ*	*Chd*	*Con*	*Gab*	*Mal*	*Nig*	*Sen*	*Tog*
1980	0.0	-2.1	-4.3	0.8	-7.4	-0.5	2.7	1.9	-2.7	-1.4	-4.1	-0.3
1981	-1.5	-2.5	-4.9	0.6	-9.8	-1.5	2.8	-2.9	-1.8	1.0	-4.1	0.1
1982	0.5	-0.7	-3.0	0.0	-9.8	1.1	1.4	-0.3	-0.8	1.1	-4.5	0.4
1983	-1.0	-1.1	-4.0	-1.3	-10.3	-3.2	0.9	-1.9	0.6	-2.0	-4.9	0.8
1984	-1.1	-1.9	-7.8	-4.0	-14.5	-2.5	1.5	-1.1	0.0	-0.5	-4.1	-1.7
1985	1.0	2.7	-3.2	3.2	-4.5	1.8	3.4	0.5	-0.8	1.4	0.4	-0.3
1986	0.1	1.3	3.5	2.8	4.4	0.4	-0.8	1.8	0.4	1.3	3.4	0.6
1987	1.5	1.4	10.0	2.8	6.8	0.3	2.6	4.2	0.2	0.5	5.1	1.5
1988	-1.9	1.4	7.1	1.7	5.7	0.6	0.3	2.4	-0.9	-1.1	3.3	0.4
1989	0.0	1.8	4.5	2.2	6.5	1.5	3.7	2.9	-0.6	0.0	4.2	0.4
1990	0.6	2.9	4.3	4.4	2.8	3.8	2.4	4.9	-0.1	1.7	5.2	0.2
1991	0.9	3.5	3.0	3.2	3.1	3.1	1.3	2.8	0.5	0.6	4.7	0.3
1992	0.3	2.6	3.4	3.6	6.4	1.2	-0.2	0.0	0.7	-1.8	5.8	-0.5
1993	-0.2	2.3	6.5	2.8	9.2	0.9	-2.5	0.4	1.3	-2.4	5.9	-0.4
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	-0.8	-3.1	2.4	-1.0	8.8	-1.9	-3.8	-0.7	3.0	-2.1	1.7	-0.5
1996	-1.4	-2.1	0.1	-0.5	7.0	-2.9	-5.0	-3.2	1.6	-2.7	0.7	-1.1
1997	-1.2	-1.7	1.1	-2.5	6.1	1.6	-3.6	-3.5	0.1	-2.5	-0.2	-0.8
1998	1.0	-0.9	1.4	-1.2	5.6	0.5	-7.5	-2.5	0.6	-0.3	2.1	-0.6
1999	-0.3	0.0	2.5	-1.4	13.4	0.9	-5.0	-4.0	-0.5	-1.7	5.3	-1.8

Notes: Misalignment is computed as $(SRER - Actual\ REER) * 100/(Actual\ REER)$. A negative (positive) entry represents overvaluation (undervaluation) of the CFA Franc. All entries are computed from estimates of the $SRER$ and the actual $REER$, where $SRER$ is the fitted $REER$ values obtained directly from the regression based on Equation 5.6.

Table 5.10: Estimated Overvaluation in the REER Based on LRER ('Sustainable' REER): 1980-99

	Ben	*BFaso*	*Cam*	*CAR*	*Civ*	*Chd*	*Con*	*Gab*	*Mal*	*Nig*	*Sen*	*Tog*
1980	0.6	-1.3	0.1	2.1	7.2	-1.0	3.9	2.3	-1.5	0.0	-4.1	-2.0
1981	-1.4	-2.6	-3.8	0.9	-5.8	-1.4	4.5	0.9	-1.9	-0.4	-6.0	-0.1
1982	-0.5	-1.3	-5.2	2.7	-9.3	-1.9	1.8	-1.8	-0.2	1.0	-3.9	0.3
1983	-1.5	0.7	-2.2	-0.1	-10.6	-1.0	0.1	-0.8	0.6	-2.1	-3.1	0.5
1984	-3.0	-1.9	-3.0	-3.3	-11.2	-0.8	0.8	-3.1	0.6	-2.5	-3.5	-1.6
1985	0.4	0.1	-1.8	2.8	-8.4	-2.9	2.9	0.7	1.3	1.5	0.3	-0.3
1986	1.0	3.2	2.4	2.3	3.8	0.2	-2.7	2.3	0.6	1.6	4.2	1.2
1987	1.7	2.2	7.6	2.4	11.0	1.4	0.9	1.7	0.8	0.7	5.4	1.3
1988	-0.8	1.9	7.1	3.1	6.7	1.3	-0.1	1.7	-0.9	-1.9	3.8	-0.1
1989	-0.7	2.2	8.5	3.0	8.1	1.8	3.1	3.6	-0.7	-1.2	5.4	0.6
1990	0.9	2.1	7.5	2.7	7.3	2.5	3.2	4.3	0.9	0.2	4.7	0.7
1991	0.3	3.0	5.3	3.8	4.1	4.3	1.5	1.9	0.5	-0.6	4.8	-0.1
1992	0.1	2.9	4.0	3.1	5.8	0.9	0.0	-0.3	0.0	-2.1	5.7	-0.5
1993	0.0	2.9	4.0	2.8	7.9	1.0	-0.8	-0.1	0.9	-2.5	6.1	-1.1
1994	-5.8	-2.7	-1.9	-1.4	-0.2	-5.3	-10.7	-7.5	-2.2	-7.8	-1.2	-5.4
1995	-0.1	-2.4	1.8	0.4	8.6	-0.5	-4.6	-1.1	3.1	-2.2	2.0	-0.9
1996	-1.1	-4.1	1.1	-2.7	7.5	-1.3	-4.3	-2.8	2.0	-2.7	0.9	-1.5
1997	-1.3	-2.9	-0.3	-2.0	6.1	-2.7	-4.8	-3.0	0.5	-2.8	0.5	-0.5
1998	1.2	-0.9	1.7	-2.5	7.9	-0.2	-7.7	-2.9	0.5	0.1	1.3	0.0
1999	-0.4	-0.6	3.7	-2.2	11.7	1.9	-4.0	-4.0	-1.0	-2.6	5.0	-1.9

Notes: Misalignment is computed as $(LRER - Actual\ REER) * 100/(Actual\ REER)$. A negative (positive) entry represents overvaluation (undervaluation) of the CFA Franc. All entries are computed from estimates of the $LRER$ and the actual $REER$, where $LRER$ is defined as the fitted $REER$ with all fundamentals replaced by 'sustainable' values obtained through exponential smoothing methods.

5.4.2 The Equilibrium Real Exchange Rate

In empirical studies, the equilibrium real exchange rate is defined as the rate that prevails when the economy is in external and internal balance for sustainable values of the policy and exogenous variables (Baffes *et al.*, 1999). With the non-rejection of the unit root null hypothesis for the fundamentals, it is clear that they are likely to consist of both permanent and transitory components. Calculation of the equilibrium RER therefore requires us to extract the permanent components of the fundamentals, $F(z)^p$; the Beveridge-Nelson (BN) decomposition process has often been used in studies using this methodology. Baffes *et al.* note that the BN method assumes that the series follows an ARIMA$(p, 1, q)$ process with both the autoregressive and moving average parts generating stationary fluctuations around a random walk. The movements that generate the unit root part, being permanent, are then extracted as the permanent components of the fundamentals. In larger samples, the Beveridge-Nelson (BN) decomposition method has been found to be much less problematic compared to smaller samples. In small samples BN is highly sensitive to the underlying ARIMA specification and turning points may be amplified in ways which are economically implausible, furthermore there is a higher chance of mistakenly identifying a stationary series as nonstationary. An alternative method of extracting the permanent (sustainable) components of the fundamentals is used. As explained by Baffes *et al.* (1999), mechanically smoothing the data is typically regarded as a more appealing approach since individual series can be smoothed substantially more, and hence may yield more economically appealing results.

Based on the coefficients obtained from the long-run SURE model regression, for each country, we calculate the equilibrium RER for each period t as the fitted REER. As stated earlier, we conceptually distinguish between the 'short-run equilibrium' RER

(SRER) and the 'long-run equilibrium' RER (LRER). Specifically, SRER is computed simply by applying the estimated $\hat{\beta}$ to the predetermined (actual) values of the policy and exogenous variables $[F(z)]$; and the LRER, by applying the long-run parameters to the 'sustainable' values of the fundamentals, which have been obtained by mechanically smoothing the fundamentals.[9] Hence, in the case of the LRER, $\hat{\beta}' F(z)^p$, where $\hat{\beta}$ is the vector of estimated long-run parameters and $F(z)^p$, the 'permanent' values of the fundamentals.

Although in principle, the equilibrium RER may be estimated using the Pooled Mean Group estimator (PMG) [Pesaran *et al.*, 1999], which restricts long-run parameters to be the same across (in this case) countries, we found the equilibrium showed significantly less variability compared to the method used in this current version of the chapter. However, as noted by Pesaran *et al.*, the PMG estimator is designed for applications in which N and T are approximately the same order of magnitude - which is not so in our case.[10]

5.4.3 The Real Exchange Rate Misalignments

The computed equilibrium RER allows us to compute the RER misalignments, defined as percentage deviations of the estimated equilibrium RER from the actual RER. Figures $1 - 12$ of this chapter, graphically depict the estimated alternative equilibria together with the actual REER.[11] The degree of RER misalignment (M_t) in period t is simply the percentage difference between the calculated equilibrium and the observed

[9] The smoothing method applied in this section is the Hodrick-Prescott Filter, which is a smoothing method that is widely used among macroeconomists to obtain a smooth estimate of the long-term trend component of a series. It was first used in a working paper (circulated in the early 1980's and published in 1997) to analyse postwar U.S. business cycles.

[10] We acknowledge an anonymous referee for including this point in comments offered on an earlier article version of this chapter, which was submitted to the *Journal of African Economies.*

[11] It is possible for Figures $1 - 12$ to be complemented with confidence interval bands, based on the standard errors of the estimated parameters. However, this would add little to our analysis and also would also make the graphs visually complicated.

real effective exchange rate (REER) in that period. Tables 5.9 and 5.10 are directly related to Figures $1-12$, and columns $2-13$ report the estimated percentage deviation of the observed REER from its equilibrium value for member states over the period 1980-99. By construction, the SRER inherently shows more variablility due to the role of the actual data in its construction. Furthermore, it is stressed here that the use of the dummy ($D94$) and specification of the model restricts and imposes the REER to be equal to SRER in 1994, a feature which is due to the model contruction rather than suggesting that all the member-states had no misalignment in 1994 (see Table 5.9). Unless otherwise stated, our analysis below is based on the misalignments reported in Table 5.10, and based on the LRER.

Our discussion of the results follows the general trend of similar studies and focuses on three main periods - the period prior to 1985, 1985-93/4 and post-1994. The estimated misalignments captures the crucial occurrences in the CFA Franc zone over the period.

1960 to the mid-1980s:

The benefits accrued by the zone between 1960 and the mid-1980s due to rising raw material prices, when producer countries enjoyed virtual monopoly over these markets, is well documented.[12] This was helped by the fact that CFA Franc was pegged to a weak French Franc, which was twice devalued in relation to the $US (in 1958 and 1969), helping to counterbalance the effects of worsening CFA Terms of trade and soaring international interest rates especially after 1973. Our results, represented graphically in Figures $1-12$, indicate that while REER in a majority of countries were not misaligned prior to 1969, the 1969 devaluation of the French Franc *vis-à-vis* the $US resulted in a real devaluation of the CFA Franc - a tendency that continued until 1974. Post-1974,

[12] See for example Clement *et al.* (1996) and references cited therein.

the underlying susceptibility of these economies to these external shocks, including the gradual decline in raw materials prices (in 1976), begin to bite and the observed REER appreciated significantly. This situation was not helped by the oil-price shocks of the 1970s. However, despite some bouts of real overvaluation, most member states are known to have maintained a steady and positive economic performance. For example, from 1975 to 1985, the average annual real GDP growth in the CFA Franc zone rose to 4.6% with an annual inflation rate of 11.2% versus 1.4% and 17.8% respectively for the other sub-Saharan countries (Elbadawi and Majd, 1996 provide a more extensive discussion on this topic).

1985 to 1993/4:

Most member states began to experience significant and rapid REER appreciation - the effects of lax adherence to the Zone's monetary and fiscal policies, real appreciation of the French Franc against the $US, and real depreciation on the part of several key export competitors within sub-Saharan Africa. This was particularly the case in the larger economies of Cameroon, Côte d'Ivoire and Senegal which had the highest inflation rates.[13] In general, this period reveals significant differences among member states. The major (and most influential) economies in the Franc zone - Cameroon, Côte d'Ivoire and Senegal - are most affected and experience the most appreciation in their REER: about 29% hikes in Côte d'Ivoire, 11% in Cameroon and 7% in Senegal between 1985 to 1993.

On average Benin, Mali, Niger and Togo were virtually in equilibrium over the period, whilst Burkina Faso, and the Congo show only mild misalignment. The most misaligned group of countries include Cameroon, Central African Republic, Chad, Côte

[13] Demand for credit and the level of import duties in these countries are both known to be very high, in comparison with other member states.

d'Ivoire and Senegal; hence, not much distinction can be made on the basis of our earlier classification of the countries as either being *'fringe'* or *'pivotal'* member states at this time. However, over this period, the estimated average overvaluation (based on Table 5.10) is significantly higher in the three *'pivotal'* economies compared to other member states. The average overvaluation in Côte d'Ivoire over the period is found to be 6.8%, 5.8% in Cameroon and 5.0% in Senegal; above the relatively lower overvaluation estimated for other member states which averaged 1.1%. Using the SRER (based on Table 5.9), overvaluation in Côte d'Ivoire, Cameroon and Senegal are 5.6%, 5.3% and 4.7% respectively. Noticeably, the estimated misalignments in this chapter are significantly lower than estimates reported in other studies which do not account for cross-sectional dependence between member states. For Example Devarajan (1997) finds a 36% overvaluation in Côte d'Ivoire in 1993 and 9% in 1994. Baffes *et al.* (1999) find overvaluation to be about 35% by 1988. A possible explanation for such a sizeable difference may be that the loss of efficiency introduced by neglecting cross-country interdependence within the Franc zone has been grossly underestimated in these studies.

The ill-effects of the CFA Franc overvaluation included an increase in poverty levels, inability of the private sector to repay debts, public sector arrears, and speculation leading to capital flight (see Devarajan and Hinkle, 1994). By July of 1993, the estimated outgoing capital flows was in the region of 850 million French Francs per month, up from the reported 600 million French Francs in 1988.[14] With nominal devaluation not available as a policy instrument at the country level, adjustment by deflating the economy was slow, costly, and politically difficult. Attempts at country-level mock-devaluations by both Côte d'Ivoire and Senegal with export subsidies and increases

[14]Source: Revue Tiers Monde, No. 143, July – September, (1995).

in import tariff rates failed largely due to administration difficulties, and rigid labour laws that kept wages high (see Clément, 1994 and Foroutan, 1997). Figures 1 – 12 indicate that the 100% devaluation in 1994, aimed at halting the ill-effects of REER overvaluation brought the economies of member states in line with their SRER. However, by considering the LRER, this study finds that the devaluation rendered the observed REER in six member states (Benin, Chad, the Congo, Gabon, Niger and Togo) significantly undervalued relative to the equilibrium. Our results also indicate mild undervaluation in five other member states (Burkina Faso, Cameroon, Central African Republic, Mali and Senegal) following the devaluation. In fact, the evidence suggests that only Côte d'Ivoire, which commands about 40% of UEMOA's (and 22% of the whole CFA Franc zone's) GDP, settles into equilibrium based on both the estimate of SRER and LRER.

In another context, using a game theoretic approach to analyze both positive and normative policy decisions choices that governments of member states may make, Fielding (1996) finds that non-cooperation among the UEMOA countries results in a sub-optimal solution. More relevant to this chapter though, is that Fielding finds that there are likely to be some significant welfare asymmetries among member states. The paper then suggests that when financial institutions are shared between relatively economically powerful economies and less powerful and smaller economies, the smaller and weaker members are likely to be experience some welfare losses.

1994 to 1999:

It has been well-documented that both GDP and inflation responded favourably in the period following the devaluation, especially as there was an associated improvement in the terms of trade, increases in aid packages, some wage moderation and debt repayment rescheduling.[15] Ample data is widely available to support this improvement in the economic well-being of member states. In terms of growth rates in GDP and controlling of inflation, the currency devaluation is widely perceived to have been beneficial. On average, the real GDP is reported to have grown by an average of 5% between 1995 and 1998, and the rate of inflation was brought back down to 3.3% in 1998 from a peak of 32% in 1994. Up until 1997, Figures 1 – 12 show that most countries in the Franc zone were either only mildly undervalued or virtually in equilibrium. However, by this time the largest economy in the Zone, Côte d'Ivoire had again become overvalued by 6.1% (comparable to pre-1994 levels). By 1998 the outlook does not look very promising as Cameroon and Senegal (the 2 other '*pivotal*' member states) also follow suit, a pattern which is seen to continue in 1999. An in-depth study of how different the political economy of exchange rate policy within the Zone has been over the period after the devaluation and reforms could be a thesis in itself. However, the preliminary observations we make of this period in the analyses in this chapter do not appear encouraging so far as convergence is concerned.

5.5 Concluding Remarks

This chapter analyses real effective exchange rate misalignment across twelve countries of the CFA Franc zone and makes a number of new contributions to the existing literature. Firstly, unlike much of the previous research, this study is not restricted to analysis of the period before the 1994 collective devaluation. Secondly, the estimation methods adopted in this chapter allow for the effects of cross-country dependence. Finally, this paper implicitly distinguishes between *short-run* and *long-run* misalignments in the REER. In particular, we have accounted for cross-sectional dependence

[15] See Clément *et al.*, (1996) and Hernández-Catá, E., (1998) and references cited therein.

between the cross-sections, even in the preliminary unit-root tests, and also estimate the equilibrium REER in a SURE model that accounts for non-zero cross-country error covariances over the period 1960-99.

The following addresses the questions posed in the introduction of this chapter. First, our results cannot support the view that member states were systematically overvalued throughout the 1970s and 1980s. While there is some evidence of overvaluation in the late 1980s, the results are mixed and do not support this view for the 1970s. Second, there are significant differences between the estimated REER misalignment across individual member states. On average, our estimates are (in value terms) significantly smaller than those obtained in similar studies that have not accounted for cross-sectional dependence. By 1993, the highest overvaluation levels can be seen in the three *'pivotal'* economies of the zone: Cameroon (5.8%), Côte d'Ivoire (6.8%) and Senegal (5.0%). While these estimates of misalignment may not seem exceptionally large, an analysis of the rate of appreciation in the REER in these countries relative to the equilibrium value was rather staggering over the few years prior to 1994. Combined with exogenous real devaluations of export competitors in the sub-region, speculation regarding devaluation was rife and we have discussed, albeit briefly, some of the macroeconomic ill-effects during this critical period. We have also shown that some of the smaller economies were hardly misaligned and the uniform 100% devaluation resulted in significant undervaluation (relative to the LRER) in most member states. Interestingly, only the largest economy in the Zone, Côte d'Ivoire, was found to be in equilibrium immediately following the 1994 (with respect to both SRER and LRER) devaluation. Third, in the period after the devaluation, we have shown that the respite offered by the uniform devaluation was short-lived because by 1998 the three largest economies of the Franc zone again show all the signs of reverting to their pre-devaluation overvaluation levels.

Overall, this chapter has found some evidence of stark differences across member-states, and suggests that the increasing overvaluation in the three *'pivotal'* economies may have played a major role in prompting the uniform devaluation in 1994. A major contribution of this chapter is that it draws attention to the importance of accounting for cross-country interdependence when estimating REER misalignment across countries, particularly within monetary unions such as the Franc zone. Using the relatively simple single-equation estimation, this study has accounted for the effects of cross-country interdependence in estimating REER misalignment within the Franc zone, thereby providing a more complete analysis. Furthermore, Wald coefficient restriction tests suggest that an estimation method that constrains long-run parameters to be equal across countries, such as the Pooled Mean Group approach (Pesaran *et al.*, 1999) will be inappropriate for estimating REER misalignment in the Franc zone.

While only briefly discussed in this chapter, the state of misalignment across the Franc zone in 1999 and factors such as the recent political unrest in Côte d'Ivoire, falling export prices of agricultural commodities, recent rises in the strength of the Euro as well as rising world oil prices suggest difficult times ahead for the Franc zone if the current parity is to be maintained, and would be an interesting extension to this chapter.

Figures 1-12: Time Series Plots of the REER, SRER and LRER for Individual Member States

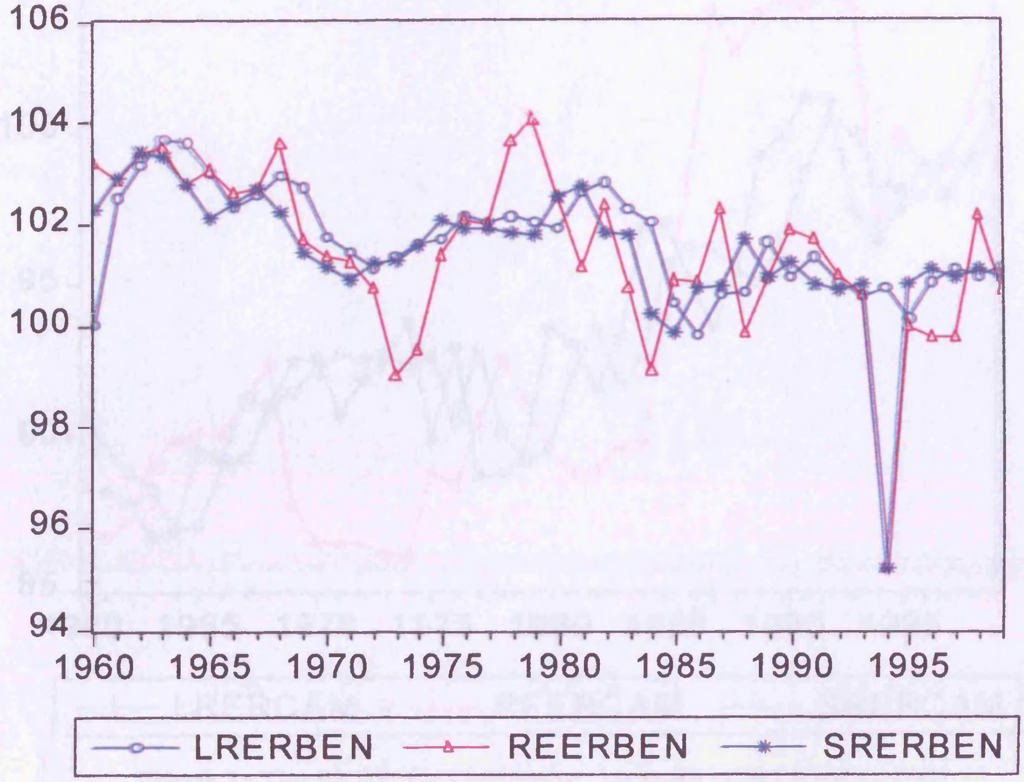

Figure 1: The REER for Benin, 1960-99 (1995 REER=100)

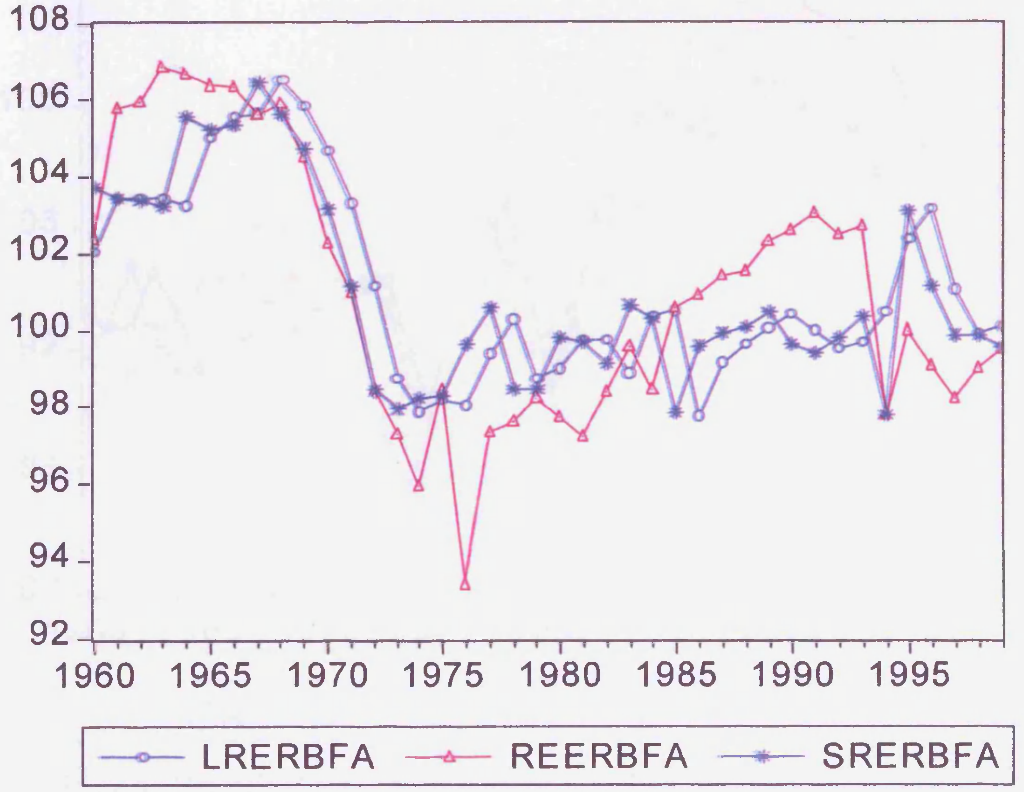

Figure 2: The REER for Burkina Faso, 1960-99 (1995 REER=100)

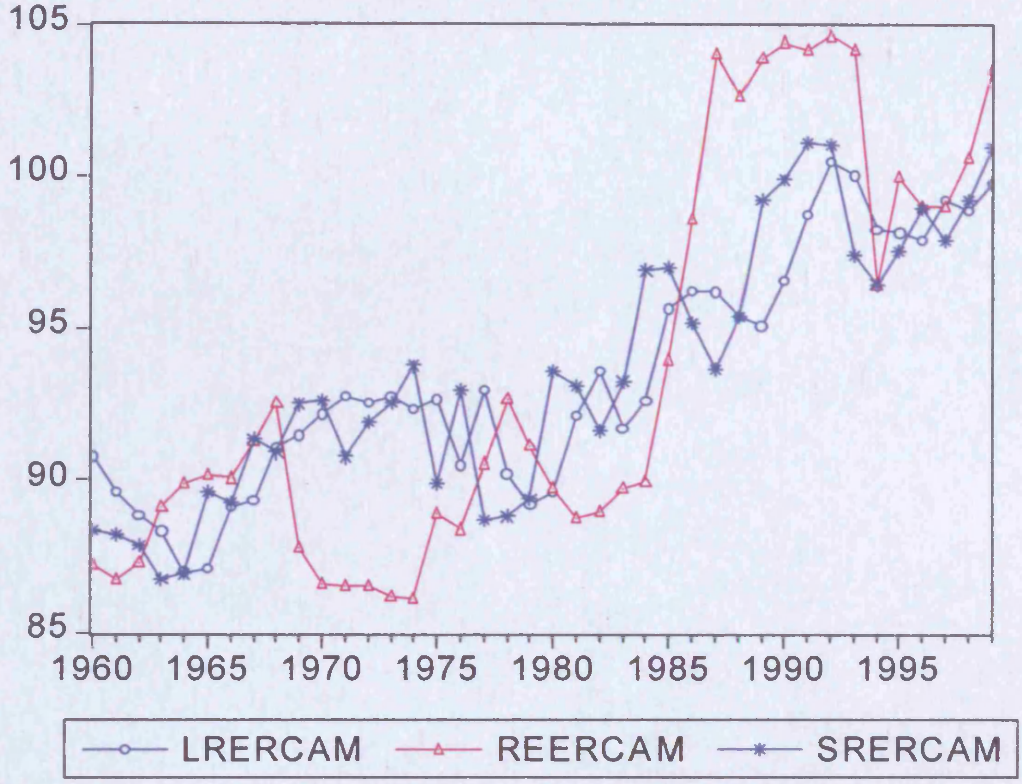

Figure 3: The REER for Cameroon, 1960-99 (1995 REER=100)

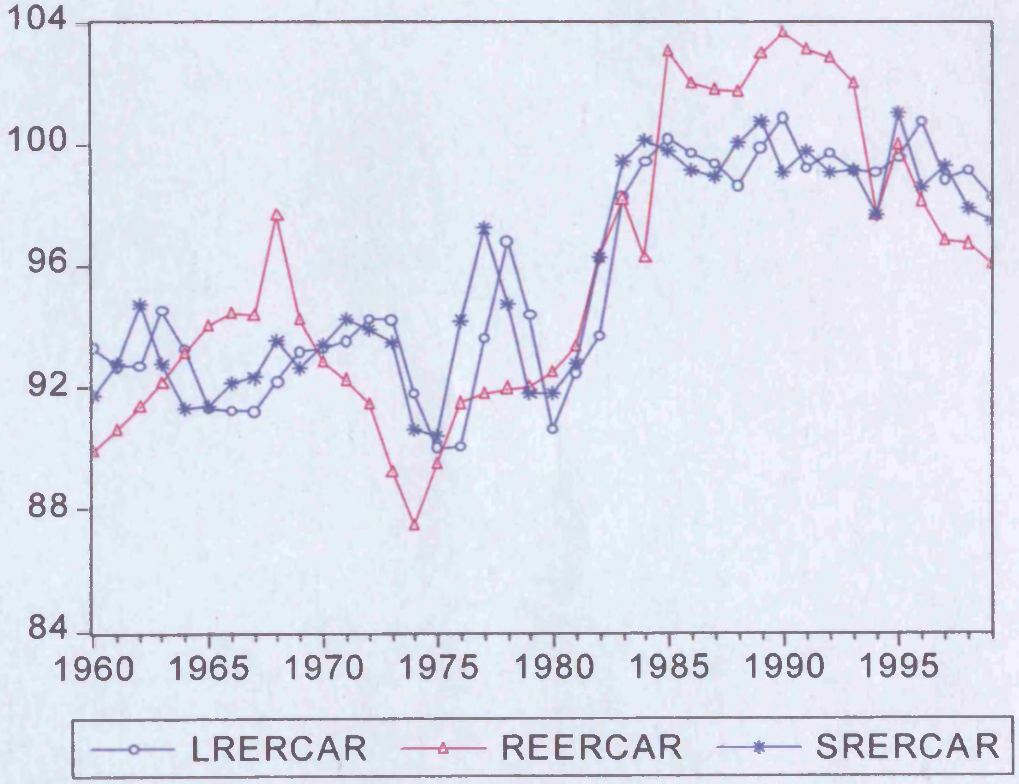

Figure 4: The REER for Central African Republic, 1960-99 (1995 REER=100)

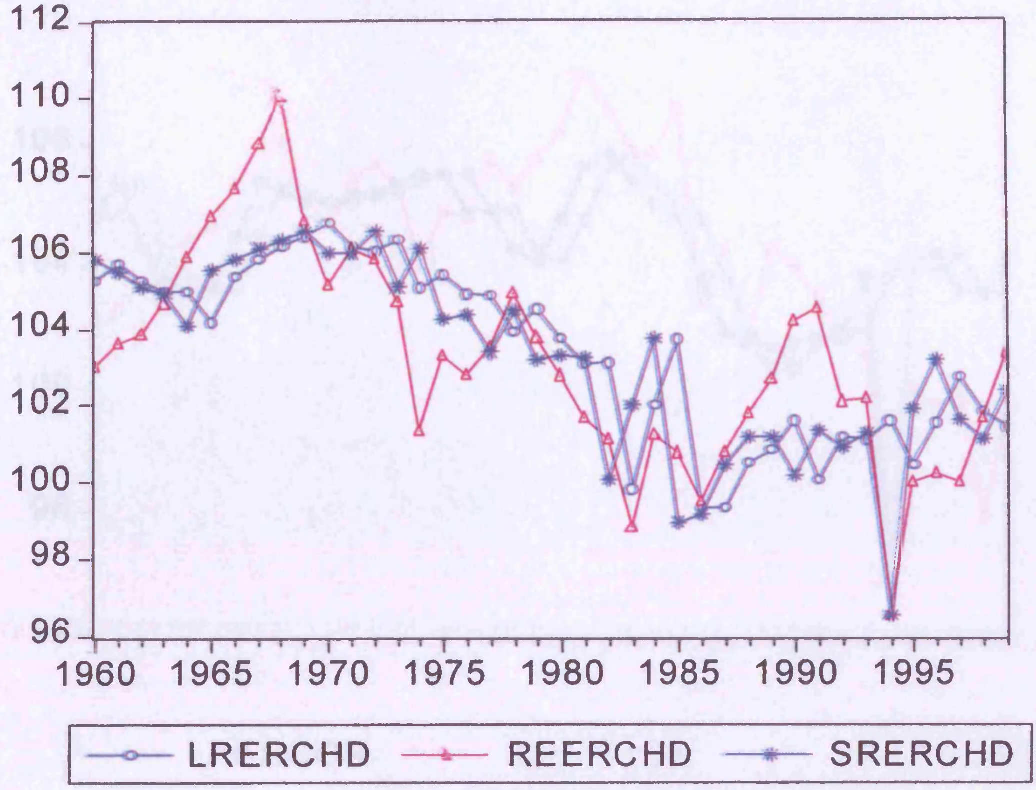

Figure 5: The REER for Chad, 1960-99 (1995 REER=100)

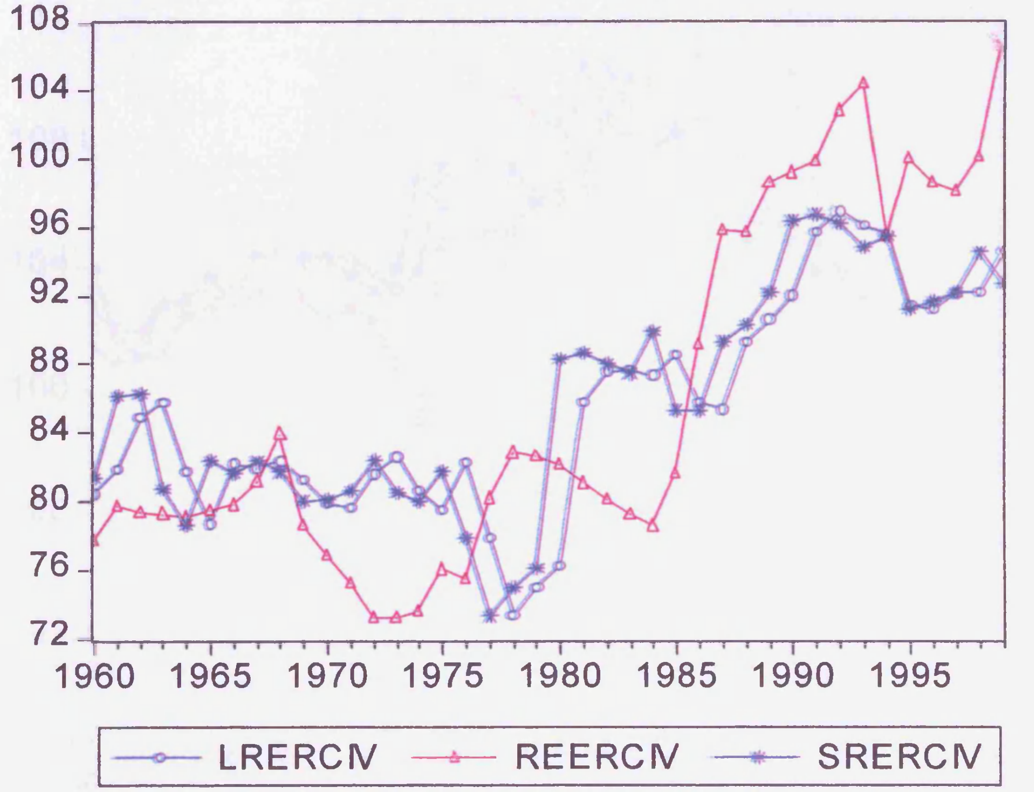

Figure 6: The REER for Côte d'Ivoire, 1960-1999 (1995 REER=100)

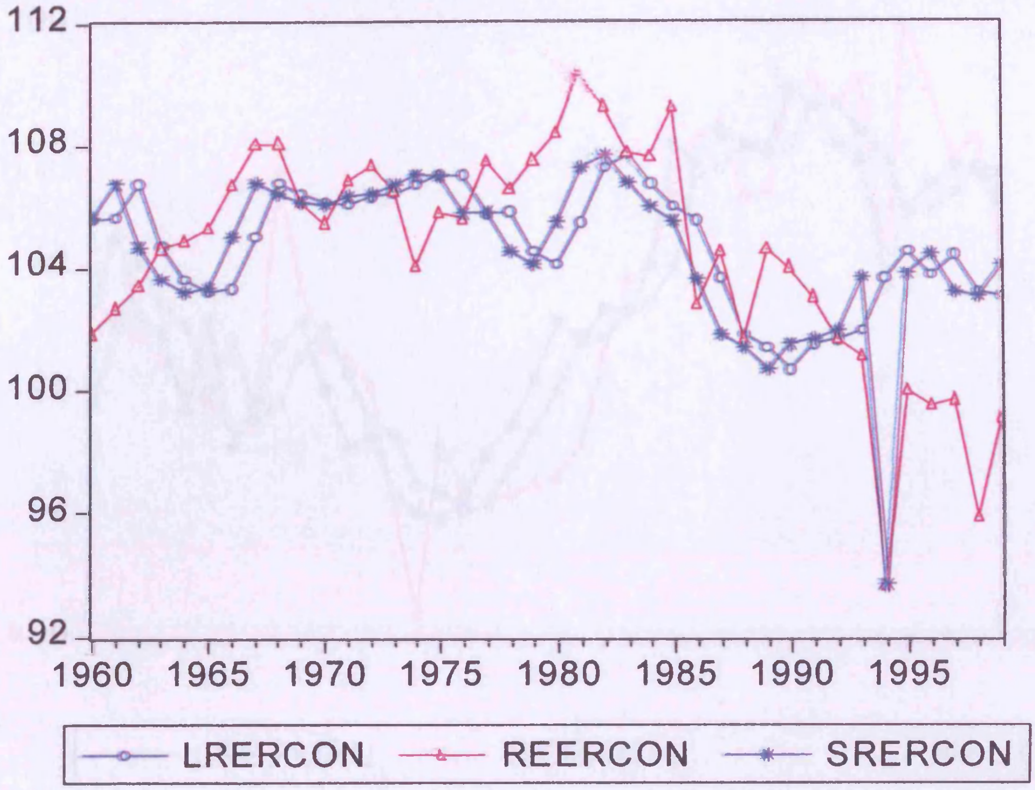

Figure 7: The REER for Congo Republic, 1960-1999 (1995 REER=100)

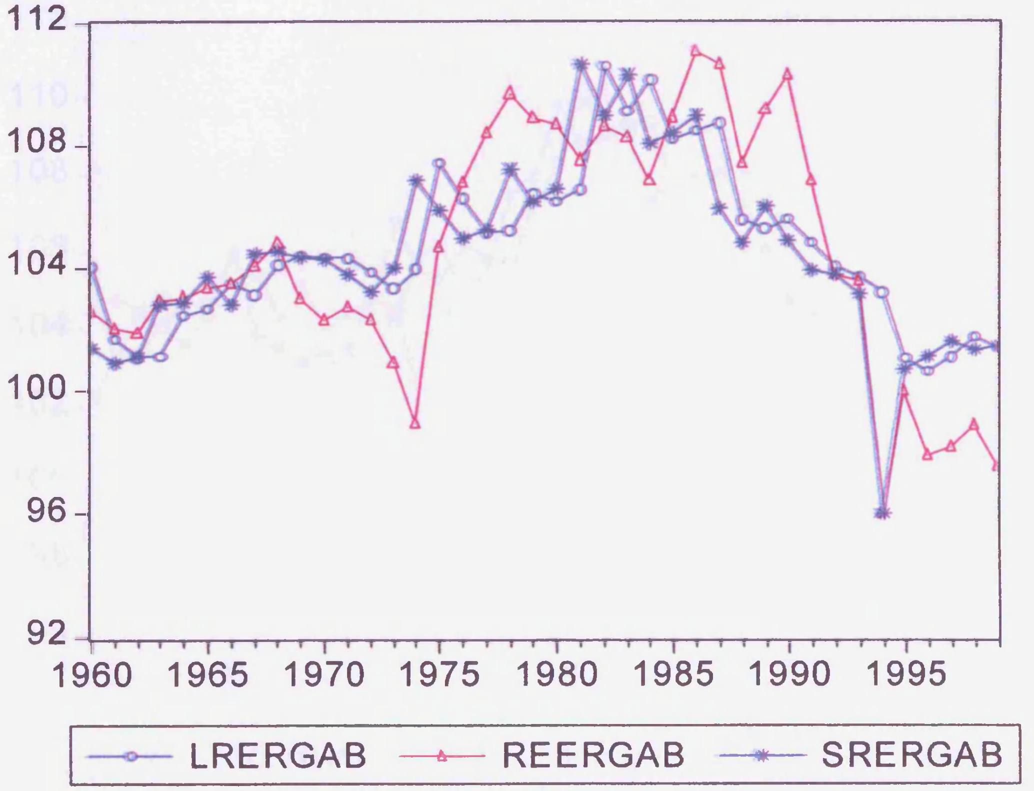

Figure 8: The REER for Gabon, 1960-1999 (1995 REER=100)

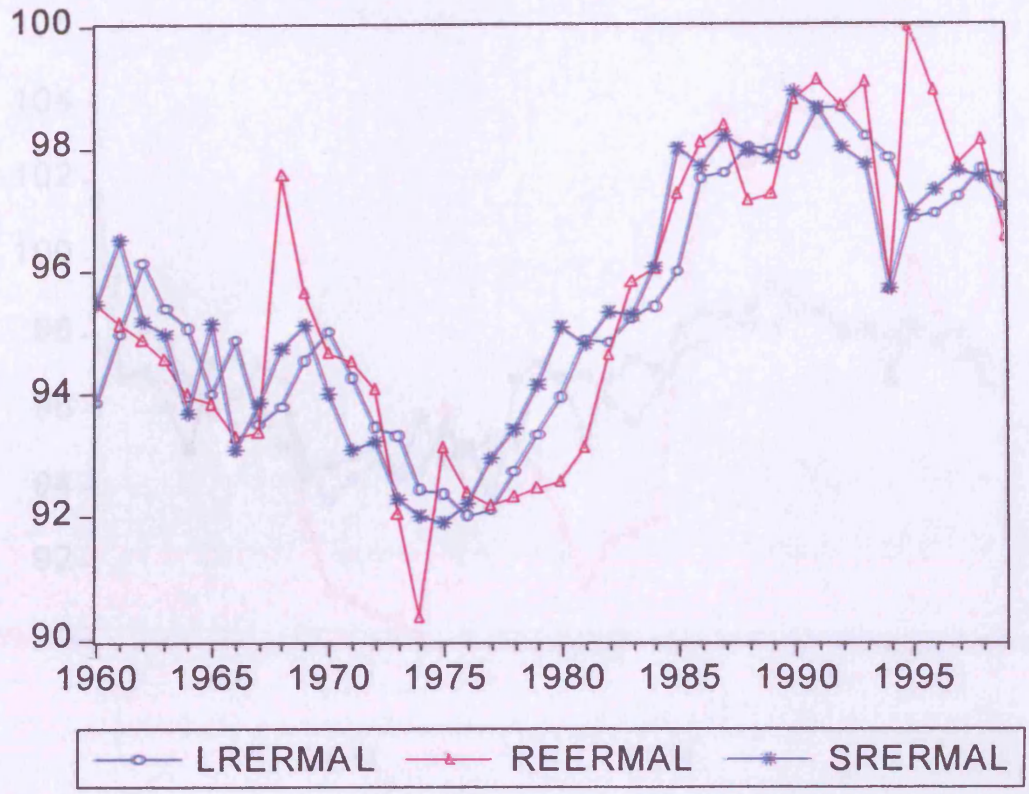

Figure 9: The REER for Mali, 1960-1999 (1995 REER=100)

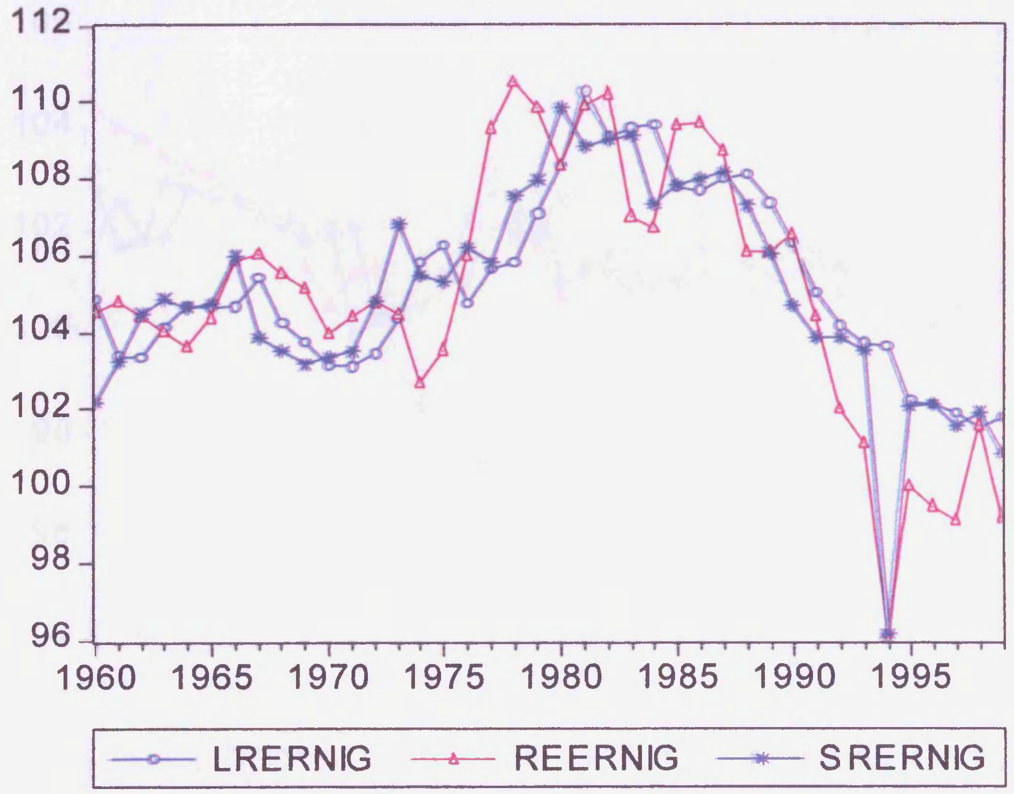

Figure 10: The REER for Niger, 1960-1999 (1995 REER=100)

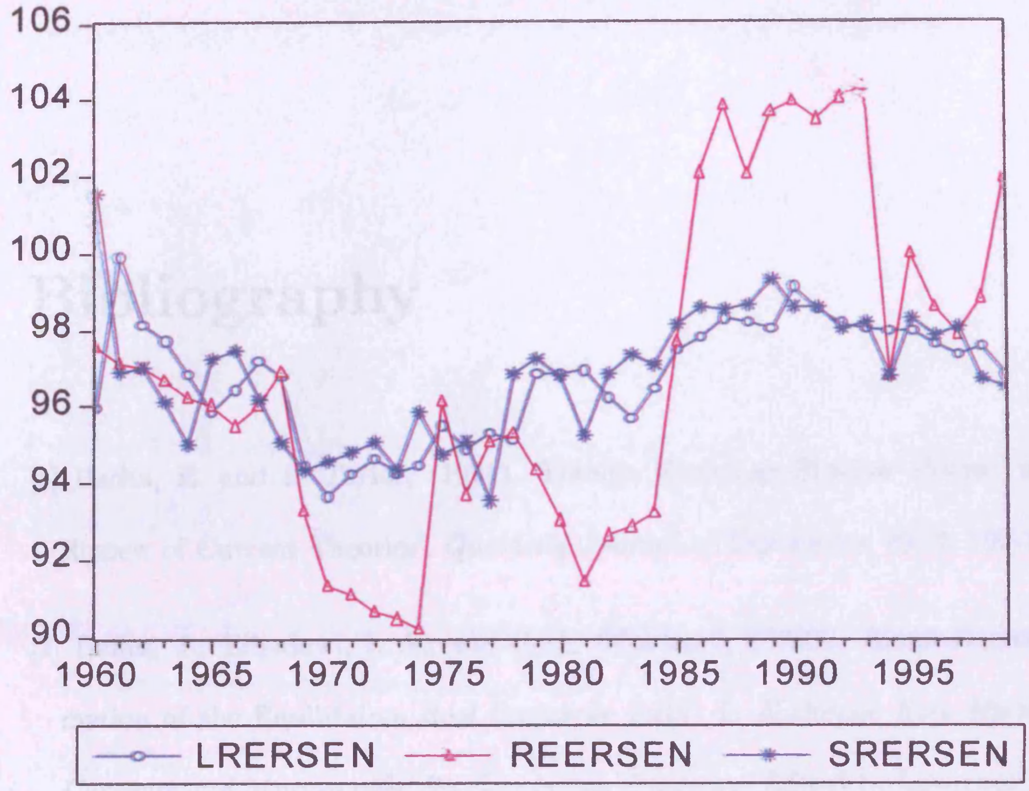

Figure 11: The REER for Senegal, 1960-1999 (1995 REER=100)

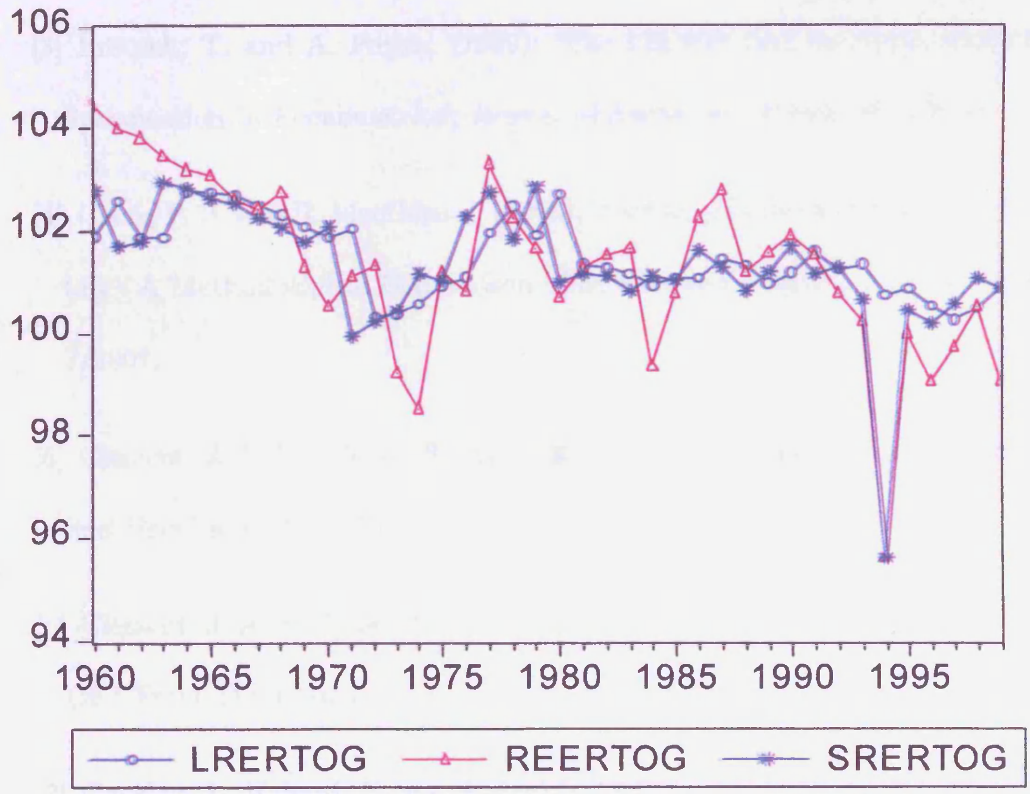

Figure 12: The REER for Togo, 1960-1999 (1995 REER=100)

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Chapter 6

INFLATION PERSISTENCE IN THE CFA FRANC ZONE: EVIDENCE FROM DISAGGREGATED PRICES

6.1 Introduction

Typically, maintaining price stability remains the mandate of monetary authorities and, a central bank's decisions and targets are influenced by how sluggishly inflation converges after a shock. Therefore, an understanding of the dynamic properties of inflation should be of more than academic interest, and of primary importance to policy makers. In particular, an improved knowledge about the dynamics of inflation provides policy makers with information on the short-term effects of monetary policy decisions; and for researchers, it is crucial for forecasting the behaviour of the economy following a shock or major monetary policy decision. Three additional points are worthy of note: First, accuracy of forecasts can rest heavily on a forecaster's ability to adequately predict the pattern of absorption of the shock. Second, knowledge about the dynamics of inflation can provide valuable information regarding what motivates asymmetries in levels of inflation across countries or regions. For areas that are likely to be subject to common policy shocks, such as countries or regions within a monetary area, such knowledge is likely to be particularly interesting, informative and relevant. Third, inflation can have practical importance for the economy through its effects on wealth distribution and on economic efficiency. In recent years, much research has been conducted in this area of policy formulation; however most of these studies have focussed on more developed economies such as Europe, the United States and the other OECD countries.[1] An area of research that seems to have received less attention in the literature is persistence of inflation in developing economies.

In relation to the effects of changes in inflation on the economy, some existing research, including Romer and Romer (1998) and Easterly and Fisher (2000) have established the relationship between monetary policy and well-being of the poor. Using a large sample of countries, Romer and Romer (1998) investigate the short-run and long-run effects of monetary policy in shaping poverty and inequality and provide cross-sectional evidence to show that low inflation and stable aggregate demand improve welfare of the poor in the long-run. Using US data, the authors also show that an expansionary monetary policy is associated with improved conditions for the poor in the short-run. Easterly and Fisher (2000), on their part, determine the correlation between some direct measures of improvement in well-being of the poor (including the change in the poor's share of national income, the percent decline in poverty, and the percent change in the real minimum wage) and inflation in pooled cross-country

[1] Working papers produced by the Eurosystem Inflation Persistence Network (IPN) of the European Central Bank (ECB) and cited in this chapter fall into this category.

samples. The findings from both studies support the view that, on average, low inflation is welfare-improving. In the light of these studies, the short to medium-term effects of monetary policy decisions may therefore prove very important for welfare of the masses, particularly of the poor. While such analysis may be relevant for developed economies, they are likely to be even more relevant for developing economies where central-government sanctioned welfare system schemes are virtually non-existent or, at best, less developed. More recently, Fielding (2004) examines how the effects of monetary policy decisions are likely to be shared between the rich and the poor in the West-African Economic and Monetary Union (UEMOA) of the CFA Franc zone. Using disaggregated price inflation data (i.e. *food* and *non-food* price inflation for the major urban cities for each country), Fielding simulates the response profiles of the aggregate consumer price index for three hypothethical income groups for each country in his sample in response to a percentage point change in monetary policy instruments.[2] His results suggest that poorer households in a subset of countries within the UEMOA are more burdened by the price volatility that follows a change in monetary policy by the Central Bank than others.

Given this background and the practical implications for wealth distribution and economic efficiency, sluggishness of inflation in returning to a target after a change in central bank's monetary policy may have deleterious implications for welfare, especially of the poor. The findings from this area of research should, therefore, be of considerable importance to policy makers concerned with the welfare of the poor. Of more direct interest, however, to both policy makers and researchers, will be sector-specific inflation (e.g. *food*) persistence within a monetary area. Major asymmetries in the levels of

[2]The sample included Cotonou (Benin), Ouagadougou (Burkina Faso), Abidjan (Côte d'Ivoire), Bamako (Mali), Niamey (Niger), Dakar (Senegal), and Lomé (Togo). The two monetary polcy instruments are the stock of currency in circulation in the UEMOA (m) and the Central Bank's base interest rate (r).

persistence in inflation among countries (or regions) within a monetary area are likely to make policy formulation particularly difficult, as it will result in some clear net gainers and net losers. For the net losers in a monetary union, the incentive to renege on commitment to the union is likely to be higher, thereby threatening the stability of the monetary union.

This chapter aims to uncover underlying asymmetries in inflation dynamics across countries that are typically considered to have similar dynamic properties. It focuses on the CFA Franc zone, which is particularly interesting in the light of the following. First, the Franc zone represents the oldest multinational *single currency* monetary arrangement currently in existence. Second, despite the fact that inflation rates in the Franc zone have been typically shown to be both low and stable relative to their sub-Saharan African neighbours, some recent studies (for example Fielding, 2004) have shown that some significant asymmetries may exist among member states regarding the short-term response of prices to a shock in instruments of monetary policy. Third, each of the two groups of countries that make up the two monetary unions of the Zone is subject to monetary policy formulated by their regional central bank, and hence countries within each of these unions are likely to be subject to similar policy shocks. Fourth, in recent years it appears that the surge in interest in monetary unions has motivated some countries to consider forming regional monetary unions. Focussing on Africa, such proposed unions include the West-African Monetary Zone (WAMZ) comprising the English speaking members of the Economic Community of West African States (ECOWAS); and the South African Development Community (SADC) monetary union comprising the Southern African countries - both of which are yet to fully take off, however, these countries can learn a lot from the Franc zone. The availability of disaggregated data for each country in our sample allows for analyses of both country-specific and sector-specific inflation persistence for the Franc zone.

Traditionally, tests of inflation dynamics provide a knife-edge analysis, by classifying inflation as either having a unit-root or not (i.e. $I(1)$ or $I(0)$) having used standard unit-root tests such as the ADF and KPSS tests. However, a number of researchers have also analyzed the dynamics in some time-series, and focussed on the memory (persistence) of the series using other less restrictive methods than the standard unit-root testing methods. In principle, persistence in a series can be measured in a number of ways, and will be described in Sections 2 and 3 of this chapter. In this chapter, we assess the dynamics of inflation by determining the order of integration based on the fractional integration process. The importance and relevance of fractional integration, which allows for the order of integration to be $0 < d < 1$, has been highlighted by Baillie (1996) as quoted in Chapter 3.4 of this thesis.

Specifically, this chapter analyzes the possibility of the existence of persistence (or memory) for *food* and *non-food* price inflation rates in thirteen Franc zone countries using three semiparametric methods as proposed by Geweke and Porter-Hudak (1983), Phillips (1999a,b) and Robinson (1995a) respectively. We also make inferences regarding the susceptibility, or otherwise, of *'fringe'* and *'pivotal'* states (as classified in Chapter 2.3 of this thesis) to inflation persistence. To our knowledge, this is the first study which investigates asymmetries in sector specific inflation persistence for the CFA Franc zone; and as described above, the findings should significantly inform policy decisions. Our results support the long-held view of stable inflation across the Franc zone (see Elbadawi and Majd, 1996). However, some asymmetry is evident among member states regarding the extent of persistence in inflation, which may have implications for people spending a larger proportion of their income on a sector that experiences persistence after a shock.[3]

While determining the causes of any observed inflation persistence would be important, it falls outside the scope of this chapter. However, for completeness, we make mention of some studies that attempt to address this issue. Amato and Laubach (2003) provide a theoretical analysis of the matter, and also review some studies that focus on this area of research. Factors suggested as potential reasons in their review include (a) the sluggish response of firms' real marginal cost to fluctuations in output (Sbordone, 2002; Gali and Gertler, 1999), and (b) allowing the choice of some agents (price-setters) to deviate from optimal behaviour due to limited capability of forming fully rational expectations (Roberts, 1997). The assumption of a possible 'rule-of-thumb' behaviour by a fraction of firms in price-setting is then further explored by the authors.[4] Backward-looking indexation and uncertainty about the degree of indexation, uncertainty about the fraction of 'rule-of-thumb' price-setters, and uncertainty about the degree of price and wage indexation are also suggested reasons for inflation persistence (see Levin and Moessner, 2005). In our study, the point of interest is the existence and possible effects of inflation persistence, and not the reasons.

The rest of this chapter is organized as follows. Section 2 presents a review of the popular measures of measuring persistence and Section 3 describes the empirical methodologies applied in this chapter. Section 4 presents the data sources, empirical estimates and some policy implications of our results, and Section 5 summarizes and concludes.

[3]For example, it is intuitive that the poor will spend a larger proportion of their income on food. Hence, persistence in the food sector is likely to make the poor relatively worse off.

[4]The 'rule-of-thumb' that the authors consider implies that decisions by a fraction of the population today mimic yesterday's behaviour of all agents (including the optimising agents).

6.2 Measures of Persistence

Specifically relating to measuring persistence in economic series, a number of methods exist. Generally, the impulse response function (IRF) is considered to visually display the long run nature of persistence in a series following a shock, with the IRF not dying out for unit-root series, but dying out for stationary series. However, in comparing levels of persistence, it is often considered more useful to focus on a scaler measure of persistence rather than visually comparing IRFs, which can sometimes look similar. A measure that is directly related to the IRF, and yet is a scaler measure is the cumulative impulse response (CIR) which is the sum of the IRF across time:

$$CIR = \sum_{t=0}^{\infty} IRF_t \tag{6.1}$$

One obvious disadvantage of the CIR, though, is that in comparing levels of persistence it is not likely to be very informative when the IRFs are different in shape. An example is when one is, say, positive at all points and the other oscillates between positive and negative, and yet they sum up to give the same CIR. Generally, the CIR, as a measure of persistence, will also not be able to distinguish between two series in which one exhibits a large initial increase and then a subsequent quick decrease in the IRF while the other exhibits a relatively small initial increase followed by a subsequent slower decrease in the IRF.

Another related measure of persistence is the sum of the autoregressive (AR) coefficients, say α, in an AR(p) model, where $CIR = \frac{1}{1-\alpha}$. Empirical studies including Batini (2002) and Gadzinski and Orlandi (2004) both make use of α in their studies. In some studies it has been suggested that, in AR(p) models with a time trend, estimation of α using the method of least squares (LS) has a problem of bias. Therefore, instead of using the least square (LS) method to obtain α, Andrews and Chen (1994) propose a median-unbiased estimation method for α which involves the use of an α that yields a median of the α_{LS} (the α obtained from the least squares method). According to the authors, the AR(1) case provides an exactly median-unbiased estimator, and an approximately unbiased estimator in the case of the AR(p) model. Using simulations, they subsequently show that the approximately unbiased estimator is a very good one. Furthermore, in order to obtain the other parameters in the model, the estimate of α is imposed on the model and then and ADF least square regression is run.

In their study, Andrews and Chen (1994) also show that although the magnitude of the largest root in an AR(p) model is sometimes used as a measure of persistence in the series (see Stock, 1991), it is not very informative. They show that two series having the same dominant root can have different persistence properties since the other roots may differ, and hence may be misleading as a measure of persistence. For example, an AR(2) process with roots equal to, say, 0.8 and 0.6 will be more persistent than another AR(2) process with roots of, say, 0.8 and 0.2. However, using the largest root alone as a measure of persistence, makes them indistinguishable - an argument which holds despite the possibility of computing asymptotically valid confidence intervals for the corresponding estimates.

Another scaler measure of persistence (see Marques, 2004) explores the relation between persistence and mean reversion. In this context, the ratio:

$$\gamma = 1 - \frac{n}{T} \tag{6.2}$$

is proposed as a measure of persistence, where n represents the number of times the plot of the series crosses the mean during a time interval with $T + 1$ observations. Marques shows that for a series with zero mean and constant variance, the expected value of γ is 0.5, in other words a value of $\gamma \approx 0.5$ is indicative of no (or little) significant persistence (i.e. white-noise behaviour). Meanwhile, according to Marques, a value of γ significantly greater than 0.5 will be indicative of significant persistence, and a value below 0.5 will signal a negative α (negative long-run autocorrelation). A few important criticisms of this method. First, as is evident in Marques (2004), the mean of the series can be generated in a number of ways - it may be time-varying, constant, or even piece-wise constant - however, the resulting γ, through n, can vary significantly depending on the chosen mean. Second, it is possible that the value of n may be somewhat subjective depending on the properties of the series.

Finally, another measure used in some studies, is the "half-life" statistic, τ_{HL}, which is defined as the number of periods that the IRF remains above 0.5 following a unit shock. Although τ_{HL} (being measured in units of time) seems a practical measure of persistence, it is easily seen that if the IRF oscillates, then the half-life statistic can understate the persistence of the process. Secondly, even when the IRF is monotonically decaying, the use of τ_{HL} is likely to be problematic when comparing two different series if one exhibits a faster initial decrease and then a subsequent slower decrease in the IRF than the other. Furthermore, when two IRFs are either both highly persistent (or otherwise), comparison is always problematic as they are often not easily distinguishable.

As noted in the preceding section the autocorrelation function typically exhibits persistence that may be neither consistent with an $I(1)$ process nor an $I(0)$ process. Hence, the use of traditional unit-root tests are likely to be overly restrictive and underscore the importance of using long memory and fractionally integrated processes. Section 3.1 of this chapter expands on the fractional integration methods applied in this chapter.

6.3 Empirical Methodology

This section describes, briefly, the basis of the fractional integration estimation methods employed in this chapter to determine the extent of inflation persistence, where present. In order to check robustness of our results, and confirm the presence (or absence) of persistence in the series, we have obtained our estimates of the fractional differencing parameter, d, using three separate semiparametric methods, for different sample sizes.[5] Graphical representations of the inflation series used in this chapter are presented in Figure 6.1.

6.3.1 Fractional Integration Estimation Methods

Generally, the model of an autoregressive fractionally integrated moving average process of order (p, d, q) is denoted by ARFIMA (p, d, q). For a series y_t with mean μ, such a process may be written using operator notation as:

$$\Phi(L)(1-L)^d(y_t-\mu)=\Theta(L)\epsilon_t \tag{6.3}$$

where $\epsilon\tilde{}iid(0,\sigma_\epsilon^2)$, L is the backward-shift operator, $\Phi(L)=1-\Phi_1L-\cdots-\Phi_pL^p$, $\Theta(L)=1+\varphi_1L+\cdots+\varphi_qL^q$, and $(1-L)^d$ is the fractional differencing operator may be defined as a hypergeometric function:

$$(1-L)^d=\sum_{k=0}^{\infty}\frac{\Gamma(k-d)L^k}{\Gamma(-d)\Gamma(k+1)} \tag{6.4}$$

where $\Gamma(.)$ represents the *gamma* function and the fractional differencing parameter, d, is allowed to assume any real value and determines the order of integration of the

[5]Here, sample size refers to the number of harmonic ordinates in the spectral regression.

series.[6] In fact, for any real d, Equation 6.4 can be expressed in terms of its binomial expansion such that:

$$(1-L)^d = 1 - dL + \frac{d(d-1)}{2!}L^2 - \frac{d(d-1)(d-2)}{3!}L^3 + ... \tag{6.5}$$

The infinite-order autoregressive representation of fractional white-noise is given by:

$$y_t = \sum_{k=0}^{\infty} \pi_k y_{t-k} + \epsilon_t \tag{6.6}$$

In principle, the d parameter is used to determine the extent of persistence in the series. If $d = 0$ in Equation 6.3 then y_t corresponds to a stationary and invertible ARMA process and can be said to exhibit *short-memory* [i.e. $I(0)$]. Alternatively, when $|d| = 1$, it corresponds to the unit root case and the series is nonstationary and non-mean-reverting [i.e. $I(1)$]. However, there is the possibility that the order of integration is neither $I(0)$ nor $I(1)$, and d is fractional (i.e. $0 < |d| < 1$). Generally, if $d > 0$ in Equation 6.3, y_t is said to be a *long-memory* process, so-called because of the strong degree of correlation between observations widely separated in time. However, if $|d| < 0.5$, and all roots of $\Phi(L)$ and $\Theta(L)$ lie outside the unit-circle then y_t is covariance stationary and mean-reverting. Alternatively, if $|d| \in (0.5, 1)$ then y_t is no longer covariance stationary, but is still mean-reverting with the effects of the shocks dying away in the long run.

Interestingly, when $|d| \in (0, 0.5)$, some distinctions can be made as follows. On the one hand, when $d \in (0, 0.5)$ and $d \neq 0$, Hosking (1981) showed that the correlation function, $\rho(\cdot)$, of an ARFIMA process is proportional to k^{2d-1} as $k \longrightarrow \infty$. In other

[6] We note that in practice since $(1-L)^d$ is an infinite lag order, a truncation method needs to be applied in each method to estimate the d parameter. Also, the standard autoregressive integrated moving average (ARIMA) model is obtained by the arbitrary restriction of d to integer values.

words, the autocorrelations of the ARFIMA process decays hyperbolically to 0 as $k \longrightarrow \infty$, slower than the faster, geometric decay of a stationary ARMA process; such an ARFIMA process is said to exhibit *long-memory.* On the other hand, for $d \in (-0.5, 0)$, and $d \neq 0$ the process is said to exhibit long-range negative dependence (or anti-dependence), and is still mean-reverting i.e. all the autocorrelations are negative.[7] A significantly negative estimate of d ($d \in (-0.5, 0)$) for our inflation series would therefore imply mean reverting behaviour for the given price series.

It is worth mentioning that these methods were pioneered by Granger and Joyeux (1980), Granger (1980), and Hosking (1981). More recently, some theoretical justification has been provided by Parke (1999) in terms of duration of shocks (using an Error-Duration model). Considering the cumulation of a sequence of shocks that switch to zero after a random delay, Parke shows that if the probability that a shock survives for k periods (say p_k) decreases with k at the rate $p_k = k^{2(d-1)}$ for $d \in (0, 1]$ then the error-duration model generates the same autocovariance structure as an $I(d)$ process. Baillie and Bollerslev (1994), and Gil-Alaña and Robinson (1997) and Baum, Barkoulas and Caglayan (1999a,b) also provide some relevant empirical applications of fractional models.[8] Upon re-examining an earlier study on cointegration relationships between seven nominal exchange rates, Baillie and Bollerslev (1994) rather find evidence of long memory, and hence fractionally integrated process. Re-accessing an extended version of the Nelson and Plosser (1982) data set, Gil-Alaña and Robinson (1997) also show that although traditional unit-root tests by Nelson and Plosser failed to reject the null of a unit root, when the possibility of fractional integration is allowed the results are less clear cut. In fact, when the residuals (ϵ_t) are considered to be white-noise, they find evidence for the rejection of the unit root hypothesis in as many

[7] Baum *et al.* (1999b) refer to this process as Intermediate Memory .

[8] An extremely thorough summary and an extensive review of estimation methods is provided by Baillie (1996), and references cited therein.

as five series in favour of greater degree of non-stationarity, but less than $I(2)$, but the evidence was less when ϵ_t was AR. Baum, Barkoulas and Caglayan (1999a,b) allow for the possibility of fractional dynamic behaviour in investigating whether absolute purchasing power parity (PPP) did hold as a long-run equilibrium concept during the post-Bretton Woods period of flexible exchange rates (1999a) and in international inflation rates (1999b) respectively. In the first case, their findings, even allowing for fractional dynamic behaviour, does not support absolute long-run PPP in all cases considered. In the second, regarding world inflation rates, the authors find substantial evidence to support fractional dynamic behaviour.

A number of methods can easily be found in the existing literature to adequately estimate, and test the statistical significance of, the fractional differencing parameter, d, and can broadly be categorized as either parametric or semiparametric. With the parametric methods [see examples in Fox and Taqqu, (1986); Dahlhaus (1989); Sowell (1992); Robinson (1994)], the model is specified up to a finite number of parameters. However, with such an approach, the correct choice of the model is important and if it is misspecified, the estimates may be inconsistent. In other words, misspecification of the short-run components of the series tends to affect also the long-run parameter estimates. Due to these disadvantages, some studies on the topic advocate semiparametric methods which do not require an exact model specification [see examples in Phillips (1999a,b), Robinson (1995a), Baum, Barkoulas and Caglayan (1999a,b)].

In this chapter, we have used three semiparametric methods - the spectral regression [Geweke and Porter-Hudak (1983)], the modified spectral regression [Phillips (1999a,b)], and the Gaussian semiparametric approach [Robinson (1995a)] - to estimate the fractional differencing parameter (d) and assess the robustness of the estimates. A brief description of these estimation methods is provided below.

Prior to any further analysis, it is worth noting that some recent empirical studies, including Batini (2002) and Levin and Piger (2004), have shown that the presence of structural breaks in a series may lead to some misleadingly high parameter estimates of the persistence measure. As earlier demonstrated by Perron (1990) with a simulation experiment:

> '...if the magnitude of the change is significant, one can hardly reject the unit-root hypothesis even if the series would consist of *iid* disturbances around a deterministic component (albeit one with a shift in the mean)...The problem is one of misspecification.' (p. 155)

To avoid the potential problem of spurious overestimation of the persistence parameter (d) by not accounting for the occurrence of a structural break, we first test for the presence of any such breaks in the mean of each series (see Section 4.1 below). We explore the possibility of breaks in the mean of each series by applying the procedure of Bai and Perron (2003), and allow for the possibility of up to five breaks.[9]

Brief Description of Fractional Integration Methods

I) The Spectral Regression approach put forward by Geweke and Porter-Hudak (1983) [hereafter GPH] proposes a regression of the form:

$$\ln I(\xi_\gamma) = \alpha_0 + \alpha_1 \ln\{4\sin^2(\frac{\xi_\gamma}{2})\} + \eta_\gamma, \gamma = 1, 2, ..., \upsilon \tag{6.7}$$

where $I(\xi_\gamma)$is the periodogram of the time-series at the Fourier frequencies of the sample $\xi_\gamma = \frac{2\pi\gamma}{T}(\gamma = 1, 2, ..., \frac{T-1}{2})$, T being the number of observations, and the number

[9] In Bai, J. and P. Perron (2003), the authors have made available a GAUSS procedure to apply a range of methods that can be used to determine multiple structural breaks in the mean of a series.

of Fourier frequencies included in the spectral regression is $\gamma = G(T) << T$. Periodogram, $I(\xi)$, of the demeaned series is found i.e. $I(\xi) = \frac{1}{2\pi T}\left[\sum_{t=1}^{T}(y-\bar{y})e^{-it\xi}\right]^2$. The spectral regression of the GPH estimator is then computed by regressing a number of the logarithmic periodograms on a constant and a nonlinear function of the frequencies, according to Equation 6.7.

Therefore assuming that $\lim_{T\to\infty} G(T) = \infty$, then $\lim_{T\to\infty}[\frac{G(T)}{T}] = 0$ and $\lim_{T\to\infty}[\frac{\ln(T)^2}{G(T)}] = 0$, the estimate of the fractional differencing parameter, according to GPH, is based on the slope of the spectral density function around the angular frequency $\xi = 0$. This parameter of interest (the fractional-differencing parameter, d), may now be estimated as the negative of the slope coefficient in Equation 6.7. A choice of γ needs to be made, though.[10] The presence of statistically significant long memory can then be tested by a simple t test of the estimate of d i.e. the null hypothesis of no long memory corresponding with a parameter value of zero. By their method, GPH prove consistency and asymptotic normality for $d < 0$, but not for against alternatives of estimates of $d > 1$. In other words, the method is inconsistent against $d > 1$ alternatives.

II) In view of the inconsistency of the GPH when $d > 1$, it is unsuitable for testing the null of $d = 1$. In the Modified Spectral Regression approach, Phillips (1999a,b) improve on this inconsistency (a short-fall of GPH approach) and provide an estimate of d by proposing a modification of the dependent variable to reflect the distribution of d under the null hypothesis that $d = 1$. As for conventional unit-root tests, when there are deterministic trends in the model it is desirable that they are extracted prior to using this test. By default, a linear trend is removed from the series, to cater for possible trend stationarity. The Modified Spectral Regression approach is simply a least squares regression of $\ln I(\xi_\gamma)$ on $\ln|1 - e^{i\xi_\gamma}|$. Based on the above, Phillips (1999b)

[10] In many empirical applications, $T^{0.5}$ is often considered, however it is not always the optimal choice, especially in small samples.

provides the estimate of d as:

$$\widetilde{d} = \frac{1}{2}\frac{\Sigma_{\gamma=1}^{v} x_\gamma \ln I(\xi_\gamma)}{\Sigma_{\gamma=1}^{v} x_\gamma^2} \tag{6.8}$$

where $x_\gamma = \ln|1 - e^{i\xi_\gamma}| - \frac{1}{v}\Sigma_{\gamma=1}^{v} \ln|1 - e^{i\xi_\gamma}|$ and the semiparametric test for a unit root against fractional alternatives can be based simply on the statistic $Z_d = \frac{\sqrt{v}(\widetilde{d}-1)}{\pi/\sqrt{24}}$, with critical values obtained from the standard normal distribution and the test is consistent against both $d < 0$ and $d > 1$ fractional alternatives.

III) The Gaussian Semiparametric approach proposed by Robinson (1995a) estimates a self-similarity parameter H, which is related to the long-memory parameter (d) such that $H = 0.5(2d + 1)$. The spectral density of the the time-series is assumed to behave as follows:

$$f(\xi) \sim G\xi^{1-2H} \text{ as } \xi \to 0^+ \tag{6.9}$$

where ξ is as previously defined for GPH approach above. For $H = 0.5$, $f(\xi)$ tends to a finite positive constant at zero frequency. For $H \in (0.5, 1)$, $f(\xi)$ tends to infinity, whereas if $H \in (0, 0.5)$, $f(\xi)$ tends to zero. The estimate for the self-similarity parameter H, is obtained through minimizing Equation 6.10 below w.r.t. H:

$$R(H) = \ln \hat{G}(H) - (2H - 1)\frac{1}{\gamma}\sum_{\gamma=1}^{v} \ln \xi_\gamma \tag{6.10}$$

where $\hat{G}(H) = \frac{1}{\gamma}\sum_{\gamma=1}^{v} \xi_\gamma^{2H-1} I(\xi_\gamma)$ and $0 \leq H \leq 1$ (or $-0.5 \leq d \leq 0.5$), and $\xi_\gamma = \frac{2\pi\gamma}{T}; \frac{v}{T} \to 0$. Under finiteness of the fourth moment, Robinson shows the estimator to be $v^{0.5}$, with mean zero and variance $\frac{1}{4v}$. An important requirement, in asymptotic theory, is that v is assumed to tend to ∞ more slowly than T. The suggested advantages of the Gaussian

Semiparametric approach with respect to the GPH approach include consistency under mild conditions; also it displays asymptotic normality and increased efficiency under some stronger conditions. While GPH prove consistency and asymptotic normality for $d < 0$, Robinson (1995a) proves consistency and asymptotic normality for $d \in (0, 0.5)$ in the case of Gaussian ARMA innovations in Equation 6.3. To avoid biasing the estimates, Robinson(1995a) suggests that v should be not be more than $0.5T$ (i.e. $v \leq 0.5T$).

Velasco (1999) proposes a novel semiparametric approach, based on the Gaussian semiparametric estimation approach by Robinson (1995a) for stationary processes. Velasco shows that, even by narrowing the number of observations (say, by trimming out the low frequency ordinates) under Gaussian assumptions and for any degree of non-stationarity ($0.5 < d < 1$), the fractionally differencing parameter (d) may still be consistently estimated for the memory of the series.

6.4 Data and Empirical Estimates

6.4.1 Data

The dataset consists of monthly *food* and *non-food* price inflation series for 13 individual member states within the CFA Franc zone of sub-Saharan Africa: Benin (*Ben*), Burkina-Faso (*Bfaso*), Côte d'Ivoire (*Civ*), Mali (*Mal*), Niger (*Nig*), Senegal (*Sen*) and Togo (*Tog*) and Cameroon (*Cam*), Central African Republic (*CAR*), Chad (*Chd*), Congo Republic (*Con*), Equatorial Guinea (*GEQ*) and Gabon (*Gab*). Food comprises Foodstuffs: Drinks and tobacco; Hotel food, coffees, restaurants. Non-Food comprises Articles of clothing and foot-wear, Housing, water, electricity and other fuels; Furnishing, domestic equipment and servicing; Health; Transport; Leisures, spectacles and culture; Teaching; Other goods and services. The price indices for the West-African Monetary Union were extracted from the *BCEAO* publication, *Indices Harmonisés des Prix à la Consommation des Etats de l'Union Economique et Monétaire Ouest Africaine*, and hence are compiled from the components of the Harmonized Index of Consumer Prices (*IHPC, or sometimes written as HICP*). Generally, the dataset spans the period $1989m11 - 2002m9$, although the period is significantly less for some countries - see Figure 6-1 for an illustration of the inflation rate series used in the analysis. It was constructed as the month-on-month percentage changes in the price indices. Prior to any analysis, it is worth noting here that the data relates specifically to urban price inflation and does not cover rural areas in the member states, and the results and any analysis will therefore be applicable to urban areas.[11]

Structural Break Tests

We apply the procedure proposed by Bai and Perron (2003) [hereafter BP], allowing for up to $k = 5$ breaks in each series, and in accordance with the sample sizes we suppose a trimming parameter $\tau = 0.15$. The minimal segment length (h) is defined by BP as the integer value of the product of the trimming parameter (τ) and the number of observations of the dependent variable (T). i.e. $h = int(\tau(T))$ in a GAUSS algorithm. Primarily, the method tests for changes in the levels of the series by considering the representation $\pi_t^i = \varphi + \varsigma_t^i$, where φ is a constant capturing the level of the series and ς_t^i is a (short memory) linear process.[12] The main focus of attention here are any sharp changes of the constant term, i.e. φ. A non parametric correction is embedded in the algorithm to take account of autocorrelation and heteroskedasticity in the process ς_t^i. Table 6.1 summarizes the number of breaks suggested by the three main structural

[11] I am extremely grateful to Prof. David Fielding for providing me with the dataset used in this chapter. Guinea-Bissau is not included in this study due to lack of sufficient data.

[12] For an individual variable, the model is characterized as: $y_{jt} = \varphi + \rho y_{t-1} + u_t$; $t = T_{j-1}+1, \ldots, T_j$.

Table 6.1: Suggested Number of Breaks: BIC, Modified Schwarz Criterion and Sequential Procedure

	Food Sector			*Non-food Sector*		
	BIC	LWZ	SP	BIC	LWZ	SP
Ben	0	0	0	0	0	0
BFaso	0	0	0	0	0	0
Civ	0	0	0	0	0	0
Mal	0	0	0	0	0	0
Nig	0	0	0	2	0	0
Sen	0	0	0	2	0	0
Tog	0	0	0	0	0	0
Cam	0	0	0	0	0	0
CAR	0	0	0	0	0	0
Con	0	0	0	0	0	0
Gab	0	0	0	2	0	0
GEQ	0	0	0	0	0	0
Chd	0	0	0	0	0	0

Notes: BIC, LWZ and SP represent the Bayesian Information Criterion, Modified Schwarz Criterion of Liu et al. (1997), and Sequential Procedure respectively. The entries in the table represent the suggested number of breaks by the individual break detection measures suggested by Bai and Perron (2003).

break tests within the procedure:

1. The Sequential Procedure (hereafter SP) tests for ι breaks versus $\iota + 1$ breaks, hence in this chapter, allowing for a maximum of 5 breaks implies $\iota = 0, ..., 4$ - *This implies $\iota + 1$ tests of the null hypothesis of ι structural change(s) versus the alternative of $\iota + 1$ structural change(s). The test concludes in favour of $\iota + 1$ break(s) if the minimal value of the sum of squared residuals in the model with $\iota + 1$ break(s) is much smaller than that of the model with ι break(s).*

2. The Bayesian Information Criterion (hereafter BIC) and the modified Schwarz Criterion of Liu, Wu and Zidek, 1997 (hereafter LWZ) - *Either information criterion may be used in the selection of the model dimension, which then influences the number of breaks that may be detected.*[13]

[13] See Bai and Perron (2003) for an indepth technical information regarding these tests. All our tests are carried out with a GAUSS program provided by the authors.

For each series, the SP (using a 5% significance level) detects 0 breaks. The other break detection parameters, the BIC and the LWZ also detect 0 breaks in all cases, with the exception of the *non-food* inflation series for Gabon, Niger and Senegal where BIC detects 2 breaks each whereas the LWZ detected *no* breaks. Given this seeming disagreement in the number of breaks detected by the BIC and LWZ criteria, we make use of three further tests:

1. The *supF* tests for 0 breaks versus a fixed number of breaks ($k = 1, ..., 5$) - *In short, Bai and Perron (2003) describe this test as one that involves a minimization of the global sum of squared residuals or asymptotically equivalent to maximizing the F-test.*

2. The *UDmax* tests for 0 breaks versus an unknown number of breaks - *An equally weighted version of the test, this statistic is obtained by maximizing the F-test after the estimates of the break points are obtained by the global minimization of the sum of squared residuals for between* 1 *and* k *breaks (i.e.* $1 \leq k^* \leq k$*).*

3. The *WDmax* also tests for 0 breaks versus an unknown number of breaks - *A weighted version of the test, this statistic is obtained by maximizing the F-test after the estimates of the break points are obtained by the global minimization of the sum of squared residuals for between* 1 *and* k *breaks (i.e.* $1 \leq k^* \leq k$*).*[14]

Based on the results from all the three additional break tests listed above and reported in Tables 6.2 and 6.3, the test statistics do not reject the absence of any significant breaks at the 5% level of significance. Bai and Perron [2003 (p. 17)] advice that due to the downward bias that is sometimes observed with the information criteria, the SP test is usually preferred. Secondly, the authors submit that:

[14] Additional critical values for different sets of trimming parameter-number of breaks combinations have been provided in Bai and Perron (2001).

Table 6.2: SupF Test statistics: Testing for No breaks vrs a Fixed Number of Breaks

supF tests	*Food Sector*					*Non-food Sector*				
0 Breaks vrs:	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Ben	0.7	1.9	2.0	1.8	1.4	1.0	3.0	2.1	1.6	1.4
BFaso	1.8	3.0	3.2	2.5	2.0	2.3	2.2	1.8	1.7	1.3
Civ	2.9	4.5	4.6	3.4	1.6	3.2	4.2	3.4	2.7	2.4
Mal	1.9	3.7	3.5	3.2	2.7	3.1	3.3	2.8	2.4	3.1
Nig	3.3	3.4	3.0	2.5	2.0	7.3	4.8	3.4	2.8	2.3
Sen	3.5	2.8	2.9	2.3	1.6	7.0	3.7	2.7	2.3	1.8
Tog	3.2	4.9	4.9	3.0	2.5	3.1	1.2	1.4	1.4	0.9
Cam	1.7	1.6	2.0	1.8	1.6	3.8	4.8	4.1	3.4	3.3
CAR	2.1	4.9	3.3	2.6	2.2	1.3	1.4	1.2	1.1	0.8
Con	3.5	2.8	2.1	1.8	1.5	3.6	5.7	3.8	3.2	2.7
Gab	4.1	3.4	2.9	3.0	2.5	3.0	4.5	3.8	4.4	3.2
GEQ	0.8	1.5	1.0	0.8	0.6	1.8	3.6	2.3	1.9	1.8
Chd	2.2	2.9	2.5	1.9	1.8	3.9	6.3	2.8	3.9	2.7

Notes: Critical values for *SupF* tests using 5% significance level are 8.58, 7.22, 5.96, 4.99 and 3.91 for k=1, 2,.., 5 respectively.

"When no serial correlation is present in the errors, but the lagged dependent variable is present, the BIC performs badly when the coefficient on the lagged dependent variable is large. In such cases the modified SIC (LWZ) performs better...The method suggested by BP is based on the sequential application of the *supF* test..." (p. 15).

As this applies in our case, we therefore conclude in favour of zero breaks in the mean. Based on these results, the possibility of spurious overestimation of the d parameter is reduced.

6.4.2 Fractional Integration Estimates

The restrictiveness of standard unit-root tests, particularly regarding low-frequency dynamic behaviour, may underlie the failure to reject the unit-root hypothesis in inflation as has been observed in some studies, as has been described in Baum, Barkoulas

Table 6.3: Dmax and WDmax Test Statistics and Critical Values: Tests Against an Unknown Number of Breaks

	Food Sector				Non-food Sector			
	UDmax	*WDmax*			*UDmax*	*WDmax*		
		10%	5%	1%		10%	5%	1%
Ben	2.0	2.9	3.1	3.6	3.1	3.4	3.6	4.0
BFaso	3.1	4.3	4.6	5.1	2.3	2.8	3.0	3.4
Civ	4.5	6.1	6.5	7.3	4.2	4.8	5.2	5.9
Mal	3.7	5.4	5.9	6.7	3.4	6.3	6.8	7.8
Nig	3.4	4.1	4.3	4.9	7.3	7.3	7.3	7.3
Sen	3.5	3.9	4.2	4.7	7.0	7.0	7.0	7.0
Tog	4.9	5.5	5.9	6.5	3.1	3.1	3.1	3.1
Cam	2.0	3.2	3.5	3.9	4.8	6.7	7.2	8.2
CAR	4.9	5.5	5.8	6.4	1.4	1.7	1.9	2.1
Con	3.5	3.5	3.5	3.7	5.7	6.4	6.8	7.5
Gab	4.1	5.0	5.4	6.2	4.5	6.9	7.5	8.6
GEQ	1.4	1.6	1.7	1.9	3.6	4.1	4.3	4.8
Chd	2.9	3.6	3.9	4.5	6.3	7.1	7.5	8.3
10%cv	7.4	8.2			7.4	8.2		
5%cv	8.9		9.9		8.9		9.9	
1%cv	12.4			13.8	12.4			13.8

Notes: The UDmax and WDmax test statistics provided in the table are obtained as part of the Bai and Perron (2003) break detection procedure. The 10%, 5% and 1% critical values are presented in the bottom section (last 3 rows) of the table.

and Caglayan (1999a).[15] By allowing the order of integration of a series to take any real value, fractional integration estimates avoid the possibility of only the knife-edge $I(0)$ / $I(1)$ situation. Therefore, by means of the d parameter, a wider range of mean-reverting dynamics can be found.

An important feature of periodogram-based methods, such as the semiparametric methods employed in this chapter, is that they require the choice of the number of low-frequency periodograms to be used in the estimation. In fact, the estimate of d is likely to be biased if an improper inclusion of medium- or high- frequency periodograms is used; alternatively, too low-frequency periodograms is likely to increase sampling variability of the estimates. As a sensitivity and robustness check, our results in Tables 6.4 - 6.9 each report estimates of d (including standard-errors) for various estimation

[15]See Baum *et al.* (1999a) for a review of some previous studies and some discussion of conflicting evidence found in some earlier studies.

sample sizes ($v = 20, 30, 40, 50$ and 60). For each table of results, as expected, the lower periodogram ordinates (e.g. $v = 20, 30$ and 40) typically display higher standard-errors than when v is higher.

Due to the number of observations in each series [lowest: 83 and highest: 152], high sampling variability, typical in lower periodograms, is likely to bias the estimates. Therefore, the discussion of the evidence is typically based on estimates obtained for higher ordinates, $v = 50$ and 60. Evidence for *non-food* price inflation is presented first, followed by that for the *food* price inflation.[16]

Empirical Estimates for Non-food Price Inflation

The estimates of the fractional integration parameter (d), as obtained from the three estimation methods, for the *non-food* price inflation rates are reported in Tables 6.4 - 6.6 for each individual country in our sample.

Table 6.4 reports estimations based on the spectral regression approach [Geweke and Porter-Hudak (1983)] and reveal somewhat mixed evidence across member states. Generally, the estimates are fairly stable across estimation sample size (v), but less so in the case of Central African Republic. The d estimates for the *non-food* price inflation are typically not significantly different from zero, except in five countries - Cameroon, Chad, Gabon, Niger and Senegal - which are statistically significant and positive. Thus, there is some evidence of long-memory in *non-food* price inflation for these five member states, although they remain below 0.5 (i.e. $|d| \in (0, 0.5)$). There is also some evidence of long-memory for the largest economy of the Franc zone, Côte d'Ivoire when $v = 60$, however this is only statistically significant at the 10% level.

Table 6.5 reports the estimates of d based on the modified spectral regression ap-

[16] The estimates of d based on the three semiparametric methods used in this chapter, and described in Section 6.3.1, have been obtained using *STATA 8*.

proach [Phillips (1999a,b)]. The results are generally similar to that reported in Table 6.4, and the estimates of d for *non-food* price inflation in the same five countries - Cameroon, Chad, Gabon, Niger and Senegal - are statistically significant and positive, but remain below 0.5. With the possible exception of Central African Republic, the estimates are broadly stable across v for all member states.

Table 6.6 also reports estimates of d based on the method proposed by Robinson (1995a). Regarding evidence for the presence of long-memory in *non-food* price inflation, similar conclusions can be drawn as from the above methods. This is true with the exception of Cameroon, for which Robinson's approach cannot be applied for $v > 20$, due to construction and estimation sample size. In fact, to avoid biasing the estimates, Robinson(1995a) suggests that $v \leq 0.5T$. Therefore, evidence for the presence of long-memory in *non-food* price inflation is confirmed for Chad, Gabon, Niger and Senegal, but not for Cameroon, due to the small overall sample size of 83.

The results reported in Tables 6.4 - 6.6 broadly reinforce the presence of long-memory for *non-food* price inflation in Cameroon, Chad, Gabon, Niger and Senegal, but not in the other member states. Based on the country-classification proposed in the third paragraph of Chapter 2.3, this is a batch of both *'fringe'* and *'pivotal'* member states.

Empirical Estimates for Food Price Inflation

Similarly, the estimates of the fractional integration parameter (d) for *food* price inflation rates for each individual country in our sample, as reported in Tables 6.7 - 6.9, are obtained by applying the methods of Geweke and Porter-Hudak (1983), Phillips (1999a,b) and Robinson (1995a) respectively. As with the discussion on the evidence presented in Section 6.4.2 above for *non-food* price inflation, the discussion in this section is presented for each table in sequence.

Estimates of d, based on the spectral regression method, and reported in Table 6.7, indicate the absence of long-memory for *food* price inflation in most member states. However, in Chad, Equatorial Guinea, and Niger the estimates of d are significantly different from zero, particularly for higher estimation sample sizes (υ = 50 and 60). There is also some evidence of long-memory for Togo when υ = 60, however this is only statistically significant at the 10% level; also for Central African Republic, some evidence of long-memory exists only for small sample sizes ($\upsilon = 20, 30$ and 40), but not for higher estimation sample sizes. Interestingly, estimates of d for Equatorial Guinea are found to be negative and statistically significant, suggesting intermediate-memory (anti-persistence).[17]

Modified spectral regression estimates of the fractional differencing parameter for *food* price inflation series are reported in Table 6.8. The evidence of long-memory detected here is broadly consistent with the corresponding spectral regression estimates for *food* price inflation and confirm statistical significance of d in Chad, Equatorial Guinea and Niger. Again, for Central African Republic, evidence of long-memory exists only when $\upsilon = 20, 30$ and 40 are considered, which may be due to the inherent variability brought about by the small estimation sample size.

The Gaussian semiparametric regression estimates of the fractional differencing parameter for *food* price inflation series are reported in Table 6.9. The estimates reported in the table provide support for the evidence of long-memory found earlier for Chad, Equatorial Guinea and Niger. Similarly, the estimates of d for Equatorial Guinea are negative and statistically significant ($-0.5 < d < 0$). Again, the estimates of d obtained for Central African Republic are only statistically significant (and positive)

[17] See impulse response function graphs for Equatorial Guinea (FGEQ and RGEQ) in Figure 6-2 for an illustration of antipersistence.

for smaller sample sizes ($v = 20, 30$ and 40), but not for higher estimation sample sizes. For Togo, the estimate is only statistically significant at the 10% level when $v = 60$.

The results reported in Tables 6.7 - 6.9 reinforce the evidence of the presence of some persistence in *food* price inflation for Chad, Equatorial Guinea and Niger. An obvious inconsistency between the estimates obtained for *food* price inflation is the strong evidence of long-memory for *food* price inflation in Benin and Togo found from the modified spectral regression estimates, but not in the spectral regression and the Gaussian semiparametric regression approaches. With two of the three estimation methods suggesting no statistically significant estimates of d in Benin and Togo, the results are not as robust and conclusive. In this case, based on the country-classification proposed in the third paragraph of Chapter 2.3 of this thesis, it is mainly the member states lowest in the scale of *'fringe'* member states (that is Niger and Chad) that have the problem of inflation persistence in the *food* sector. Classifying Equatorial Guinea is not straightforward, given that although it has a high GDP per capita and rates fairly high on the HDI scale (see Table 1.2) these increases in the national income are fairly recent and is due to the oil revenues, as can be inferred from the past GDP values as reported in Table 2.2.

Figure 6-2 presents six representative impulse response graphs based on the spectral regression [Geweke and Porter-Hudak (1983)] estimates.[18] In the case of Equatorial Guinea (*GEQ*) where the fractional integration parameter for the *food* sector is such that $-0.5 < d < 0$ and statistically significant, the impulse response graphs show that the impulse decays somewhat faster than the *non-food* sector, where d is not statistically significant, confirming the antipersistance feature. In the case of Gabon (*Gab*) and Cameroon (*Cam*), both represent the case where d for the *non-food* sector

[18] The decision to illustrate only six impulse response graphs is simply to avoid repetition of visually similar plots, and to highlight the distint ones. R- and F- have been used to prefix individual country names and represent the *non-food* and *food* sectors respectively.

is positive and statistically significant ($0 < d \leq 0.5$), while not significantly different from zero for the *food* sector. Finally, for the case of Chad and Niger, where our results indicate positive ($0 < d < 0.5$) and statistically significant estimates of d for both sectors, the unit-shock persists much longer prior to settling, compared to the case of no persistence.

6.4.3 Implications for Franc Zone

The high policy importance of inflation persistence has been underscored by the formation of a dedicated research team by the ECB - the IPN - to conduct in-depth studies on inflation persistence and price stickiness in the Euro-area. Three potential areas for which the observed asymmetries may have important implications include (i) the conduct of monetary policy in the Zone; (ii) differences in the fundamental macroeconomic structure across member states; and (iii) the Optimum Currency Area (OCA) theory.

As has been earlier stated in the introduction to this chapter, the primary goal of policy makers in a monetary union, regarding monetary policy, is to maintain price stability in member states while maintaining a healthy level of foreign reserves. Intuitively, inflation persistence is likely to have immediate consequences for the conduct of monetary policy. For example, the presence or absence of inflation persistence will determine the appropriate response to a shock. The consequences of persistence in inflation for policy design has received some attention in recent times in empirical literature. Benigno and Lopez-Salido (2002) find that heterogeneity in inflation persistence among different regions of the Euro area may imply sub-optimality of certain policies, such as the targeting of Euro-wide *HICP*. They suggest a weighting system for policy design, where a greater weight is assigned to regions with higher persistence.

Within the Franc zone, available policy instruments for the conduct of monetary policy include base interest rates, reserve assets ratio and credit ceilings on government borrowing and private sector lending; and policy decisions by the BCEAO and BEAC are applicable to the group of countries within its jurisdiction. Since the 1994 collective devaluation of the CFA Franc (CFAF), some significant reforms have been implemented and both central banks appear to have reorganized and are more open, even issuing regular communiqués to better inform the public. It is expected that changes in monetary policy, particularly when it has a direct impact on available money growth, will influence prices and hence inflation. Therefore, if the central bank policy makers implement a change in monetary policy, and influence inflation in individual member states, the results of this chapter imply that being in a monetary union does not necessarily guarantee similar effects of the policy across all member states. Any disturbances in inflation in the *non-food* sector of Cameroon, Chad, Gabon, Niger and Senegal; and the *food* sectors of two *'fringe'* states, Chad and Niger, are likely to persist, thereby placing more of a burden on those who spend a larger proportion of their income on the given sector.

It may be necessary for these countries to put in place dedicated programmes of action in anticipation of the social costs of changes in policy that affect inflation e.g. by issuing food stamps to those affected, and possibly provide targeted subsidies for domestic producers. Secondly, the central banks may need to provide funds to support such countries after a policy change, in an attempt to ensure smooth running of Zone. Although countries that experience some persistence do not altogether need to abandon monetary policy from the central bank, an awareness of the possible persistence is important.

Another interesting aspect of the monetary union relates to differences in the prevailing macroeconomy of member states. Differences in wage structures, level of foreign debt, average tax rates and per capita income may further compound the observed asymmetries by influencing the ability of these countries to respond promptly and adequately to a shock. For example, annual per capita GDP in the Congo, Mali and Niger is less than $US1,000, whiles countries such as Cameroon, Equatorial Guinea, Gabon have per capita income above $US2,000.[19] In effect, when responding to an inflationary shock, the ability to implement alleviation measures is likely to be influenced by these economic realities. For example, the effects of a shock to *food* prices may be lessened by issuing food stamps and the release of targeted subsidies for food production. Under an assumption of policy makers' willingness to promptly address such a problem, a potential pitfall would be the country's monetary inability to adequately provide such assistance.

The basic theory of OCAs suggests that for the arrangement in a monetary union to be considered as optimum, the following should hold: (i) the region should not be subject to asymmetric shocks; (ii) there should be a high degree of capital and labour mobility between member states; and (iii) there should be centralized fiscal policy to redistribute tax revenue to poorer countries since country-level monetary policy is not an available option. In this chapter, the asymmetries observed in the persistence of inflationary shocks run counter to the first requirement of an OCA, and especially so over the short-term. More focussed attention has been given to this aspect by other research and the jury is still out on the status of the Zone. In fact, the question of whether the Franc zone is an OCA can be analyzed in greater depth, however the results obtained in this chapter does not find evidence to suggest that it is currently an optimum arrangement.

[19]Source: What can the European Central Bank Learn from Africa? Policy Brief, written by David Fielding, United Nations University (November, 2005).

6.5 Concluding Remarks

Previous research analyzing asymmetries in inflation dynamics in the Franc zone is fairly limited. However, even more limited is the literature on asymmetries in sector-specific inflation dynamics across member states of the Franc zone. Recently, Fielding (2004) showed that some asymmetries exist across member states of the West-African group of the Franc zone *vis-à-vis* the short-run response to monetary policy changes, particularly related to different hypothetical income groups. Bamba (2005), investigating the speed of nominal convergence in the West-African group of the Franc zone, found that significant cross-country asymmetries in convergence performance exist between member states and episodes of convergence are rather short-lived.

Using three semiparametric methods of estimating the fractional integration parameter, as proposed by Geweke and Porter-Hudak (1983), Phillips (1999a,b) and Robinson (1995a) respectively, our results are consistent with the evidence that some asymmetries in inflation dynamics exist among member states. Analyzing persistence in *food* and *non-food* price inflation across 13 members of the Franc zone, this chapter establishes the following: (i) stable inflation is indeed a feature of the Franc zone; (ii) some evidence of persistence exists in the *non-food* sector of Cameroon, Chad, Gabon, Niger and Senegal; (iii) Chad, Equatorial Guinea and Niger also show some significant evidence of persistence in *food* price inflation. However, in the case of Equatorial Guinea the evidence is in favour of anti-persistence rather than long-memory and shocks do not persist as in Chad and Niger. Results for the *food* sector in Benin and Togo are not as robust, due to inconsistent evidence on statistical significance of estimates provided by the different methods. It can be argued here that the *'fringe'* member states are more prone to persistence in inflation, as exemplified by Chad and Niger's seeming susceptibility to persistence in both sectors.

These findings imply that policy makers of the Franc zone, and particularly the above-mentioned countries, may need to anticipate the dynamics of sector-specific inflation rates following a change in, say, monetary policy. This is because shocks in sector-specific inflation seem to have a longer-term effect in some member-states than in others, which is likely to lead to a higher burden being borne by those who spend a higher proportion of their income on the sector experiencing the persistence. Specifically, policy makers in this subset of member states, more than others, may need to put in place some programmes of action aimed at alleviating the possible social costs of implementing the Zone's policy.

In effect, both short and long-term forecasts of the future path of both *food* and *non-food* price inflation rates can be improved, which is instrumental to successful implementation of any deflationary policy and is particularly relevant in cases of inflation targeting. However, the performance of inflation forecasting is beyond the scope of this chapter and is not considered here. In their study, Baum *et al.* (1999c) have suggested, using US data, that monetary aggregates exhibit long-memory property which will be transmitted to inflation, given the dependence of long-run inflation on the growth rate of money. An analysis of persistence in the various components of the money stock in the Franc zone, particularly policy instruments, is likely to yield some useful information, and better inform policy decisions, regarding the source of observed persistence in inflation. This will form the basis of future research.

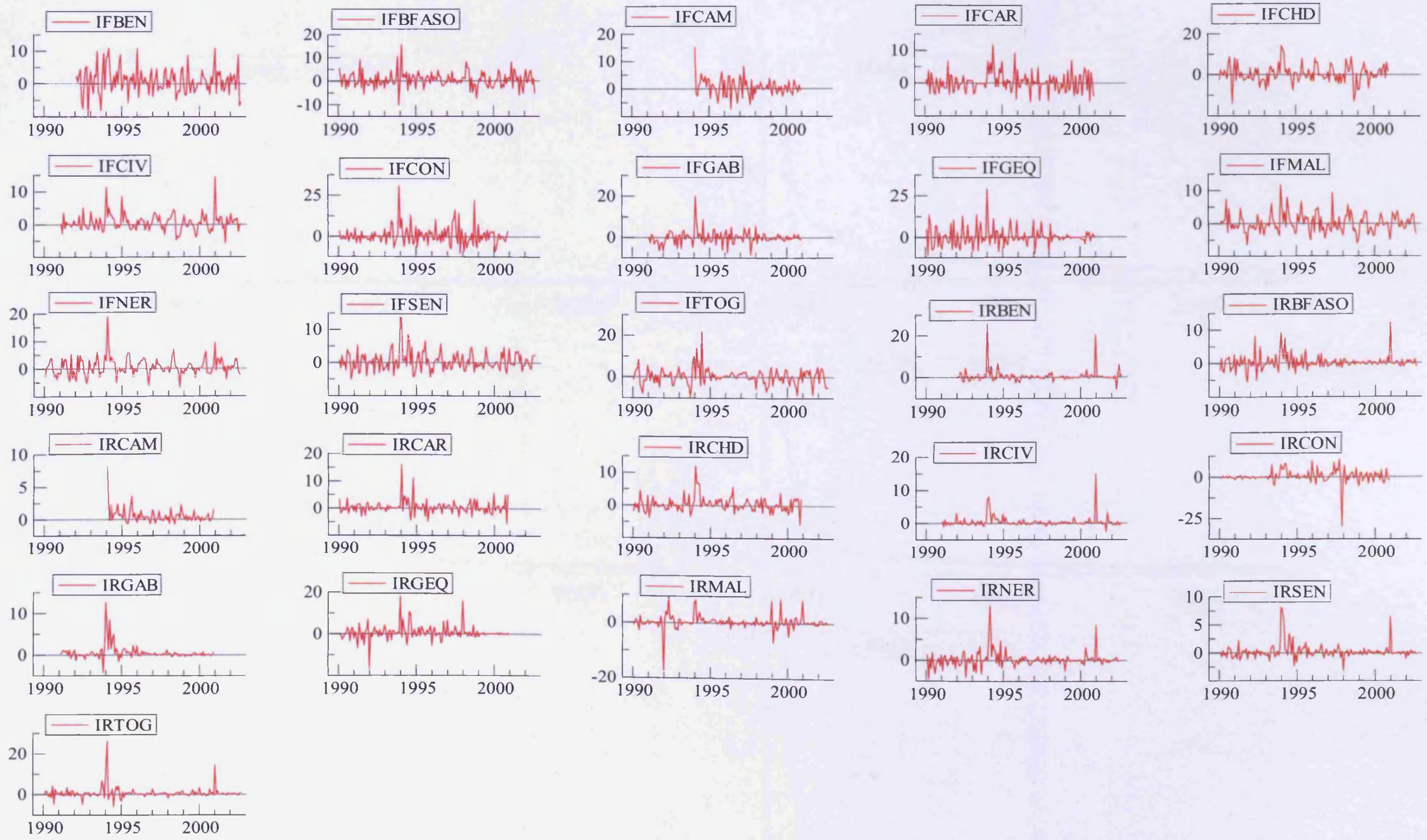

Figure 6-1: Time Series Plots of the Food (IF*) and non-Food (IR*) Price Inflation Rates for Individual Member States of the Franc Zone. [Note: * is the country name abbreviation].

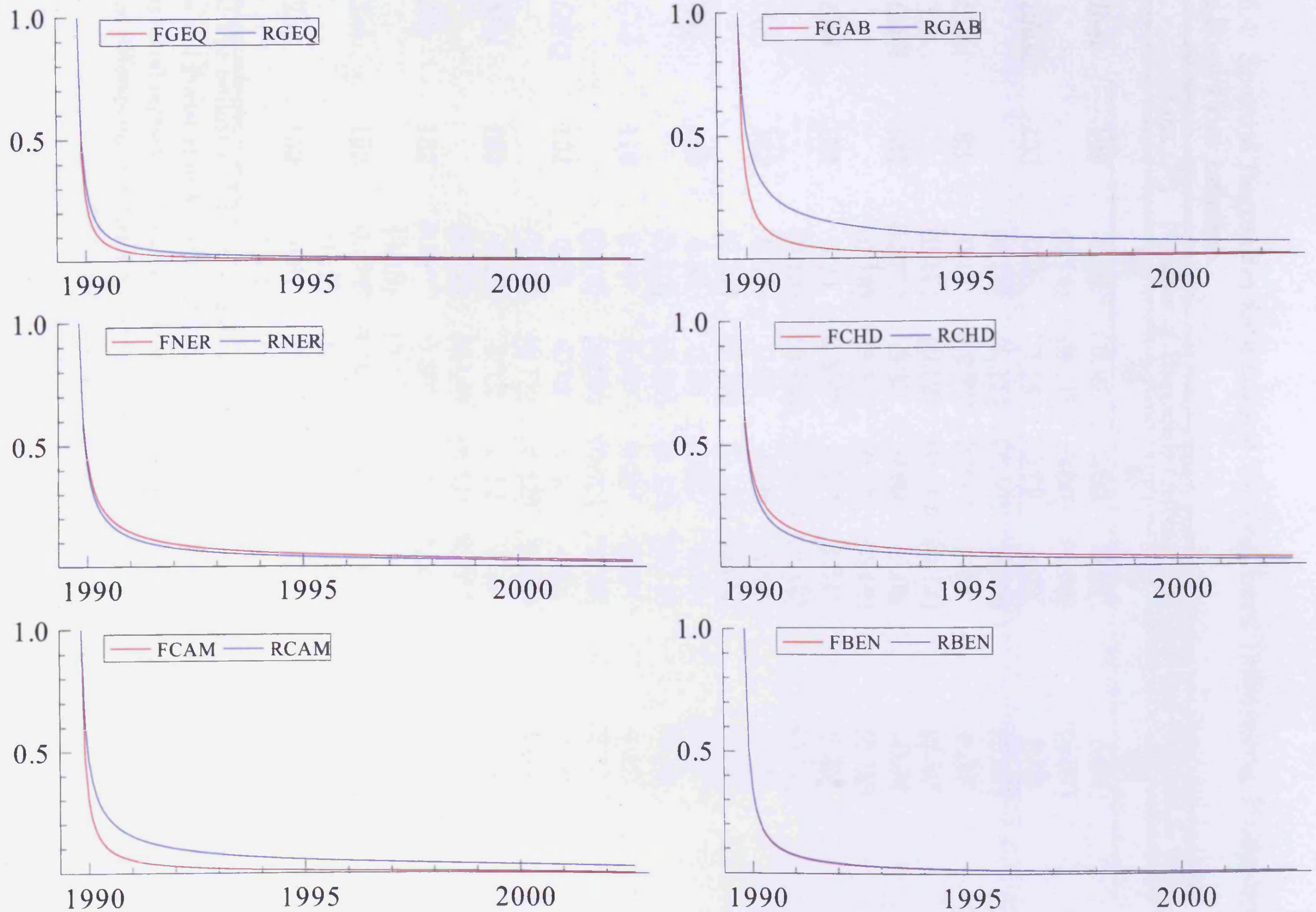

Figure 6-2: Sector-specific Impulse Responses for Selected Member States due to a Unit Shock to the Inflation Rate. [F* and R* represent *Food* and *non-Food* respectively in country *).

Table 6.4: Spectral Regression Estimates of the Fractional Differencing Parameter, d, for non-Food Price Inflation.

	Obs.(N)	Number of Harmonic Ordinates in Spectral Regression (v)				
		20	30	40	50	60
Ben	128	-0.01	0.07	0.02	0.03	0.04
		(0.14)	(0.11)	(0.09)	(0.09)	(0.07)
Bfaso	152	0.06	0.14	0.02	0.02	0.00
		(0.12)	(0.11)	(0.10)	(0.09)	(0.07)
Cam	83	0.11	0.23***	0.28**	0.32*	0.30*
		(0.17)	(0.12)	(0.11)	(0.11)	(0.10)
CAR	131	0.32***	0.20	0.09	-0.08	-0.08
		(0.16)	(0.13)	(0.11)	(0.10)	(0.10)
Chd	131	0.24	0.35**	0.37*	0.34*	0.30*
		(0.18)	(0.16)	(0.13)	(0.12)	(0.10)
Con	131	0.08	0.00	-0.08	-0.06	0.00
		(0.15)	(0.10)	(0.10)	(0.08)	(0.08)
Civ	140	0.30	0.16	0.21	0.15	0.18***
		(0.19)	(0.13)	(0.13)	(0.11)	(0.10)
Gab	119	0.54*	0.41*	0.29*	0.29*	0.42*
		(0.14)	(0.09)	(0.09)	(0.08)	(0.09)
GEQ	131	0.05	-0.02	0.03	-0.02	-0.01
		(0.19)	(0.13)	(0.12)	(0.12)	(0.11)
Mal	152	-0.29	-0.12	-0.14	-0.09	-0.09
		(0.17)	(0.14)	(0.11)	(0.10)	(0.08)
Nig	152	0.21***	0.39*	0.24**	0.26*	0.23*
		(0.10)	(0.13)	(0.11)	(0.09)	(0.08)
Sen	152	0.27**	0.19***	0.30*	0.33*	0.38*
		(0.12)	(0.10)	(0.09)	(0.08)	(0.08)
Tog	152	-0.02	0.13	0.04	0.02	0.08
		(0.13)	(0.11)	(0.09)	(0.08)	(0.08)

Notes: The estimates of d in this table are found by means of the spectral regression method of Geweke and Porter-Hudak (1983). Number of ordinates (v) indicate the estimation sample size of the spectral regression. Figures in parentheses indicate the conventional standard error of the fractional differencing parameter d; and *; **; *** indicate rejection of the null (H_0: $d = 0$) at 1%, 5% and 10% level of significance respectively.

Table 6.5: The Modified Spectral Regression Estimates of the Fractional Differencing Parameter, d, for non-Food Price Inflation.

	Obs.(N)	Number of Harmonic Ordinates in Spectral Regression (υ)				
		20	30	40	50	60
Ben	128	-0.02	0.06	0.04	0.04	0.06
		(0.14)	(0.10)	(0.08)	(0.08)	(0.08)
Bfaso	152	0.10	0.15	0.03	0.02	0.00
		(0.13)	(0.13)	(0.10)	(0.09)	(0.08)
Cam	83	0.18	0.28**	0.29**	0.32*	0.30*
		(0.19)	(0.13)	(0.12)	(0.11)	(0.10)
CAR	131	0.61*	0.41*	0.27**	0.08	0.08
		(0.14)	(0.14)	(0.12)	(0.11)	(0.10)
Chd	131	0.25	0.39**	0.43*	0.33**	0.31*
		(0.20)	(0.17)	(0.14)	(0.13)	(0.11)
Con	131	0.16	0.07	-0.03	0.00	0.04
		(0.14)	(0.10)	(0.10)	(0.08)	(0.08)
Civ	140	0.13	0.05	0.15	0.09	0.11
		(0.19)	(0.13)	(0.13)	(0.11)	(0.10)
Gab	119	0.52*	0.40*	0.26*	0.31*	0.42*
		(0.14)	(0.10)	(0.09)	(0.09)	(0.09)
GEQ	131	-0.01	-0.05	0.00	0.00	-0.01
		(0.19)	(0.13)	(0.12)	(0.12)	(0.11)
Mal	152	-0.25	-0.14	-0.14	-0.10	-0.06
		(0.16)	(0.13)	(0.10)	(0.10)	(0.09)
Nig	152	0.17	0.36**	0.23**	0.27*	0.23*
		(0.10)	(0.13)	(0.11)	(0.09)	(0.08)
Sen	152	0.18	0.19***	0.26**	0.33*	0.36*
		(0.14)	(0.11)	(0.09)	(0.09)	(0.08)
Tog	152	-0.01	0.15	0.03	0.03	0.08
		(0.11)	(0.10)	(0.09)	(0.08)	(0.07)

Notes: The estimates of d in this table are found by means of the spectral regression method of Phillips (1999a,b). Number of ordinates (υ) indicate the estimation sample size of the spectral regression. Figures in parentheses indicate the conventional standard error of the fractional differencing parameter d; and *; **; *** indicate rejection of the null (H_0: $d = 0$) at 1%, 5% and 10% level of significance respectively. Furthermore, in all cases, we can reject the null (H_0: d=1) at the 1% level of significance.

Table 6.6: The Gaussian Semiparametric Regression Estimates of the Fractional Differencing Parameter, d, for non-Food Price Inflation.

	Obs.(N)	Number of Harmonic Ordinates in Spectral Regression (v)				
		20	30	40	50	60
Ben	128	-0.03	0.06	0.03	0.03	0.05
		(0.13)	(0.10)	(0.08)	(0.08)	(0.07)
Bfaso	152	0.05	0.12	0.01	0.00	-0.01
		(0.11)	(0.11)	(0.09)	(0.08)	(0.07)
Cam	83	0.12				
		(0.15)				
CAR	131	0.33***	0.16	0.06	-0.10	-0.09
		(0.15)	(0.13)	(0.10)	(0.09)	(0.08)
Chd	131	0.22	0.35**	0.40*	0.29*	0.28*
		(0.17)	(0.14)	(0.12)	(0.10)	(0.09)
Con	131	0.05	-0.01	-0.09	-0.06	0.00
		(0.14)	(0.10)	(0.09)	(0.08)	(0.07)
Civ	140	0.26	0.13	0.21	0.13	0.14
		(0.18)	(0.13)	(0.13)	(0.10)	(0.09)
Gab	119	0.52*	0.38*	0.24*	0.29*	0.40*
		(0.13)	(0.08)	(0.08)	(0.08)	(0.07)
GEQ	131	-0.01	-0.03	0.02	0.01	0.00
		(0.18)	(0.12)	(0.11)	(0.11)	(0.10)
Mal	152	-0.23	-0.12	-0.13	-0.08	-0.04
		(0.17)	(0.13)	(0.10)	(0.09)	(0.08)
Nig	152	0.18	0.35**	0.22**	0.26*	0.22*
		(0.10)	(0.13)	(0.10)	(0.09)	(0.08)
Sen	152	0.23***	0.23**	0.28*	0.34*	0.35*
		(0.12)	(0.10)	(0.09)	(0.08)	(0.08)
Tog	152	-0.03	0.14	0.02	0.01	0.07
		(0.12)	(0.10)	(0.08)	(0.07)	(0.07)

Notes : The estimates of the d parameter is based on Spectral Regression method of Robinson (1995a). Number of ordinates (v) indicate the estimation sample size of the spectral regression. The figures in parentheses indicate the conventional standard error of the fractional di■erencing parameter d; and *; **; *** indicate rejection of the null (H_0: $d = 0$) at 1%, 5% and 10% level of significance respectively.

Table 6.7: Spectral Regression Estimates of the Fractional Differencing Parameter, d, for Food Price Inflation.

	Obs.(N)	Number of Harmonic Ordinates in Spectral Regression (v)				
		20	30	40	50	60
Ben	128	-0.12	0.16	-0.14	-0.10	0.03
		(0.12)	(0.11)	(0.08)	(0.08)	(0.10)
Bfaso	152	0.07	0.03	-0.02	-0.06	-0.06
		(0.21)	(0.14)	(0.11)	(0.09)	(0.08)
Cam	83	-0.07	-0.10	-0.05	-0.03	-0.08
		(0.27)	(0.19)	(0.16)	(0.15)	(0.14)
CAR	131	0.21**	0.21**	0.18***	0.08	0.06
		(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Chd	131	0.15	0.12	0.12	0.19***	0.21**
		(0.18)	(0.13)	(0.10)	(0.10)	(0.09)
Con	131	-0.08	0.01	0.03	0.03	-0.01
		(0.14)	(0.12)	(0.09)	(0.09)	(0.08)
Civ	140	-0.03	0.02	0.14	0.12	0.11
		(0.18)	(0.13)	(0.13)	(0.12)	(0.11)
Gab	119	0.12	0.15	0.05	0.04	0.03
		(0.23)	(0.21)	(0.16)	(0.14)	(0.12)
GEQ	131	0.10	-0.22	-0.26**	-0.21***	-0.21**
		(0.19)	(0.15)	(0.12)	(0.10)	(0.10)
Mal	152	0.07	0.13	0.02	0.05	0.05
		(0.26)	(0.18)	(0.14)	(0.12)	(0.10)
Nig	152	-0.05	0.09	0.19	0.28**	0.27*
		(0.16)	(0.12)	(0.12)	(0.10)	(0.09)
Sen	152	0.04	-0.02	0.07	0.04	0.07
		(0.14)	(0.11)	(0.11)	(0.09)	(0.08)
Tog	152	0.03	0.14	0.18	0.12	0.19***
		(0.15)	(0.14)	(0.11)	(0.10)	(0.10)

Notes: The estimates of d in this table are found by means of the spectral regression method of Geweke and Porter-Hudak (1983). Number of ordinates (v) indicate the estimation sample size of the spectral regression. Figures in parentheses indicate the conventional standard error of the fractional differencing parameter d; and *; **; *** indicate rejection of the null (H_0: $d = 0$) at 1%, 5% and 10% level of significance respectively.

Table 6.8: The Modified Spectral Regression Estimates of the Fractional Differencing Parameter, d, for Food Price Inflation.

	Obs.(N)	Number of Harmonic Ordinates in Spectral Regression (v)				
		20	30	40	50	60
Ben	128	0.31*	0.19**	0.18**	0.18**	0.27*
		(0.12)	(0.10)	(0.09)	(0.08)	(0.09)
Bfaso	152	0.53***	0.39**	0.22	0.15	0.12
		(0.27)	(0.18)	(0.15)	(0.12)	(0.11)
Cam	83	0.05	-0.06	-0.02	0.02	-0.02
		(0.20)	(0.14)	(0.14)	(0.14)	(0.13)
CAR	131	0.40**	0.32**	0.25**	0.13	0.09
		(0.15)	(0.12)	(0.10)	(0.09)	(0.09)
Chd	131	0.24	0.21***	0.17	0.22**	0.26*
		(0.16)	(0.12)	(0.10)	(0.10)	(0.09)
Con	131	-0.04	0.04	0.03	0.05	-0.01
		(0.15)	(0.11)	(0.09)	(0.09)	(0.08)
Civ	140	-0.06	-0.03	0.09	0.09	0.07
		(0.17)	(0.13)	(0.13)	(0.12)	(0.10)
Gab	119	0.06	0.17	0.02	0.04	0.01
		(0.23)	(0.23)	(0.18)	(0.15)	(0.13)
GEQ	131	0.03	-0.24	-0.26**	-0.23**	-0.22**
		(0.19)	(0.15)	(0.12)	(0.10)	(0.10)
Mal	152	0.19	0.18	0.09	0.11	0.13
		(0.22)	(0.16)	(0.13)	(0.11)	(0.09)
Nig	152	0.14	0.31***	0.30**	0.36*	0.34*
		(0.16)	(0.15)	(0.11)	(0.10)	(0.09)
Sen	152	0.13	0.06	0.14	0.09	0.13
		(0.13)	(0.11)	(0.12)	(0.10)	(0.08)
Tog	152	0.36***	0.39**	0.30**	0.24**	0.29*
		(0.19)	(0.16)	(0.13)	(0.10)	(0.09)

Notes: The estimates of d in this table are found by means of the spectral regression method of Phillips (1999a,b). Number of ordinates (v) indicate the estimation sample size of the spectral regression. Figures in parentheses indicate the conventional standard error of the fractional differencing parameter d; and *; **; *** indicate rejection of the null (H_0: $d = 0$) at 1%, 5% and 10% level of significance respectively. Furthermore, in all cases, we can reject the null (H_0: $d=1$) at the 1% level of significance.

Table 6.9: The Gaussian Semiparametric Regression Estimates of the Fractional Differencing Parameter, d, for Food Price Inflation.

	Obs.(N)	Number of Harmonic Ordinates in Spectral Regression (υ)				
		20	30	40	50	60
Ben	128	-0.10	0.15	-0.11	-0.06	0.06
		(0.11)	(0.10)	(0.08)	(0.08)	(0.09)
Bfaso	152	0.02	0.05	-0.04	-0.05	0.06
		(0.20)	(0.13)	(0.10)	(0.08)	(0.07)
Cam	83	-0.04				
		(0.26)				
CAR	131	0.28**	0.22**	0.18***	0.06	0.03
		(0.11)	(0.09)	(0.09)	(0.08)	(0.07)
Chd	131	0.14	0.13	0.10	0.17***	0.21**
		(0.17)	(0.12)	(0.10)	(0.09)	(0.08)
Con	131	-0.06	0.03	0.02	0.04	-0.02
		(0.13)	(0.11)	(0.09)	(0.08)	(0.07)
Civ	140	0.02	0.02	0.13	0.12	0.08
		(0.18)	(0.12)	(0.12)	(0.11)	(0.09)
Gab	119	0.09	0.16	0.01	0.03	0.00
		(0.22)	(0.20)	(0.15)	(0.12)	(0.10)
GEQ	131	0.03	-0.24***	-0.26**	-0.22**	-0.20**
		(0.19)	(0.14)	(0.11)	(0.09)	(0.09)
Mal	152	0.06	0.09	0.00	0.03	0.05
		(0.25)	(0.17)	(0.14)	(0.11)	(0.09)
Nig	152	-0.03	0.19	0.21***	0.28*	0.25*
		(0.15)	(0.15)	(0.11)	(0.09)	(0.08)
Sen	152	0.02	-0.01	0.06	0.03	0.08
		(0.13)	(0.11)	(0.10)	(0.09)	(0.08)
Tog	152	0.05	0.18	0.16	0.12	0.18**
		(0.14)	(0.13)	(0.11)	(0.09)	(0.09)

Notes : The estimates of the *d* parameter is based on Spectral Regression method of Robinson (1995a). Number of ordinates (υ) indicate the estimation sample size of the spectral regression. The figures in parentheses indicate the conventional standard error of the fractional differencing parameter *d*; and *; **; *** indicate rejection of the null (H_0: $d = 0$) at 1%, 5% and 10% level of significance respectively.

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Chapter 7

CONCLUSIONS AND POLICY IMPLICATIONS

The thesis has adopted an eclectic methodological approach, with the three empirical sections presented in Chapters 4, 5 and 6 being discussed as separate units, each analyzing a specific issue. At the end of each of these chapters, a brief summary and the conclusions of the chapter have also been reported. In this concluding chapter, I will present the key results of these individual studies, discuss the policy implications for the CFA Franc zone and finally highlight the main contributions of the thesis. It is, however, instructive at this stage to briefly review the objectives of the thesis prior to such a discussion.

The main objective was to assess the extent to which countries in the CFA Franc zone are similar (or differ), which is important in addressing the issue of maintaining the status quo in the Franc zone. The topic is also informative for other countries in the sub-region that are seriously implementing measures towards forming monetary unions. The thesis initially reviews how the CFA Franc zone came into being, which is important to understanding the country-level heterogeneity that is evident in our studies. The main objective of the thesis has been examined from three macroeconomic perspectives: (a) whether the CFA Franc zone countries differ in the ways they demonstrate relative importance of macroeconomic shocks; some extensions have been made, one is geographic to include other non-CFA countries in the sub-region and the other based on oil-exporting status (b) the extent of real exchange rate misalignment in individual member states over 1960-99, hence including the period of the 1994 collective devaluation (c) the extent of persistence in *food* and *non-food* price inflation in individual member states following a shock to inflation.

7.1 Summary of Results

Analysis of the extent to which Franc zone member states demonstrate relative importance of macroeconomic shocks generate somewhat mixed results. Decomposing the variance of shocks to real exchange rate appreciation, output growth and growth in real money balances, we observe few common patterns among member states within the two monetary unions that make up the CFA Franc zone - UEMOA and CEMAC. Despite the observed similarities, which may innately be due to the fact that all the oil-exporting countries in the Zone are located in the CEMAC region, the results do not, by any stretch of the imagination, indicate complete homogeneity within each region, as some heterogeneity in what drives the shocks is also evident. Upon widening the scope of the analysis to compare this feature in the Franc zone member states with that of some non-Franc zone countries, we observe some marked differences. Shocks in the Franc zone member states appear to be less pronounced in comparison to their non-Franc zone counterparts. Our results suggest that oil-producing status of countries in this part of the world appears to be relevant, as we find some similarities between oil-exporting countries (both in Nigeria and within Franc zone); and also some similarities between the non-oil exporting countries' variance decomposition of macroeconomic shocks.

Despite some obvious bouts of real exchange rate overvaluation observed in the 1980s, our results in Chapter 5 cannot support the view expressed by some authors that the real exchange rates in most African economies (hence including member states of the Zone) were systematically overvalued throughout the 1970s and 1980s. By 1993, the highest overvaluation levels can be seen in the three pivotal economies of the zone: Cameroon (5.8%), Côte d'Ivoire (6.8%) and Senegal (5.0%). Whilst these estimates of misalignment may not seem exceptionally large numerically, an analysis of the rate of appreciation in the REER in these countries relative to the equilibrium value was rather staggering over the few years prior to 1994. While the chapter shows that some stark differences did exist among member states regarding misalignment in the REER especially prior to the 1994 devaluation, it also highlights the role of the speed of appreciation particularly in the pivotal economies.

The results obtained from three semiparametric methods of estimating the fractional integration parameter, as proposed by Geweke and Porter-Hudak (1983), Phillips (1999a,b) and Robinson (1995a), for *food* and *non-food* price inflation for member states suggest that inflation in both sectors are stable, as the fractional integration parameter, d, is typically found to be below 0.5. Despite the stationarity observed in each series, statistical tests of significance indicate that some evidence of persistence exists in the *non-food* sector of Cameroon, Chad, Gabon, Niger and Senegal. For Chad, Equatorial Guinea and Niger, the results show some significant evidence of persistence in *food* price inflation. However, in the case of Equatorial Guinea, who joined the Zone as late as 1985, the evidence is in favour of antipersistence rather than long-memory and shocks do not persist as in Chad and Niger. Results for the *food* sector in Benin and Togo are not as robust, due to inconsistent evidence on statistical significance of estimates provided by the different methods.

7.2 Policy Implications

Based on the historical review of the origins of the Franc zone, it is quite indisputable that the groupings in the CFA Franc zone is one based on area of colonization, rather than on any sound economic rationale. Against this background, and the pivotal role of a single central bank in any monetary union, it is instructive to analyze the extent of similarity among member states as they are typically subject to 'one-size-fits-all' policies. Secondly, in recent years (following the formation of the EMU), interest in monetary unions seems to have been rekindled. For example, in Africa, the WAMZ and the SADC are both in the process of being formed by some countries in West-Africa and Southern-Africa respectively. Establishing the macroeconomic similarities (or otherwise) of member states of the Franc zone and the implications for the conduct of policies by the two central banks should be of significant importance, both to current Franc zone member states and also to the countries considering venturing into monetary unions. Clearly, large differences among members will make it particularly difficult for a central bank to conduct monetary policy concurrently pleasing to all members.

In this thesis, asymmetries among the member states of the Franc zone have been investigated, and we have shown, from three different perspectives, that there are indeed some macroeconomic differences among the member states. In Chapter 4, the finding that macroeconomic shocks may have different implications for individual member states, is indicative of the fact that 'one-size-fits-all' policies by the central bank may be proving costly to some member states, even within each of the two individual monetary unions.

In Chapter 5 also, we have shown the existence of some asymmetries among member states, with some marked differences between the extent of misalignment in the REER among member states, especially just prior to the 1994 collective devaluation. Our results suggest (see Chapter 5, Figures 1 – 12) a wide dispersion in REER overvaluation measures particularly in this period, with only the politically influential countries (Cameroon, Côte d'Ivoire and Senegal) registering any substantial overvaluation. In such a case, zonal policies attempting to reduce misalignment in the REER in these larger economies, where overvaluation was more prominent, may pose difficult problems for the other member states who were less (or even not) misaligned. Potentially the possible problems include stifling of the economy, particularly through inflationary pressures and reductions in the real wage, and dampening of export potential. Arbitrary collective nominal currency devaluation is not available as a policy instrument in the monetary union, and unilateral devaluation is also not available as a feasible option unless the break-up of the union is deemed acceptable. In fact, country-level measures taken by Côte d'Ivoire and Senegal in an attempt to rein in their overvalued RER failed mainly due to administration difficulties, and rigid labour laws that kept wages high.

Chapter 6 also buttresses our previous findings of the presence of some asymmetries within the CFA Franc zone by examining inflation persistence in food and non-food prices. Based on our results, a common shock to inflation, which could be due to a central bank policy change, indicate that the effects will die out at some stage. However, we have shown that an inflationary shock in a sector is likely to be more persistent in some member states, and not in others. Against this background, the conduct of monetary policy by the central bank should be implemented with full knowledge of some countries' proclivity for persistence. Following some earlier reported research findings on UEMOA economies which indicate that the poor are likely to bear most of the burden of price changes following a monetary policy change, our results suggest that some countries would need some help in order to stabilize their economies following such a shock.

Due to the macroeconomic asymmetries we have highlighted in this thesis, it will be prudent for the central banks (BCEAO and BEAC), in tandem with governments, to firstly acknowledge the possible lack of uniformity in response to both policy decisions and other shocks among member states. Furthermore, an anticipation of heterogeneous responses may require that some monetary or other economic assistance be provided for the net losers within the Zone to minimize worsening of the state of their economies. In conclusion, the possibility of the observed asymmetries widening over time increases the relevance, of empirical research in this area, to policy formulation and coordination.

7.3 Main Contributions of the Study

The main contributions of this thesis may be summarized as follows:

- This study has addressed the important issue of investigating the extent of similarity (or asymmetry) within member states of the CFA Franc zone from three separate perspectives - assessing the relative importance of macroeconomic shocks; the misalignment in real exchange rate over time; and in sector-specific inflation persistence. As the motivation for any monetary union is provided by the general framework of the theory of optimum currency areas, such an assessment from more than one perspective is very informative not only from the academic point of view but also from the policy viewpoint.

- Complementing other studies that have addressed macroeconomic shocks in the

Franc zone in other ways, we have decomposed and compared the relative importance of macroeconomic shocks for each of the member states, looking for patterns which may suggest that the current grouping of the Franc zone is optimal. Our results in Chapter 4 do not indicate that this is the case, since we detect asymmetric behaviour. We have also extended the analysis to compare oil-exporting economies in the region and their non-oil exporting counterparts, under the assumption that having similar production structures may imply less asymmetry.

- Earlier studies on real exchange rates have tended to focus on industrial countries and less on developing economies. In more recent times, there has been an increase in the number of studies focussing on developing economies. Chapter 5 of this thesis aims to complement such studies. By making the Franc zone our focus, our findings contribute to an area of important policy focus in sub-Saharan Africa and in other developing countries.

- We do not assume cross-sectional independence of the error terms in using the single equation approach of estimating the equilibrium real exchange rate. As advised by an anonymous referee of an earlier article version of Chapter 5, we have used the CIPS method (Pesaran, 2005), which allows for cross sectional dependence, to test for unit roots in the fundamentals. In addition, we have used a SURE model, thus allowing for contemporaneous cross-sectional correlation of the error terms, in estimation of the relative influences (i.e. coefficients) of the fundamental determinants.

- In our opinion, the relatively small overvaluation estimates, relative to previous studies, underscore the importance of accounting for cross-sectional dependence where present. By this we also implicitly suggest that not accounting for this feature may have led to the relatively high estimates found in previous studies which did not account for this feature.

- The equilibrium real exchange rate was estimated using sustainable values of fundamentals that have been consistently used in the literature on equilibrium real exchange rates.

- This is the first work, to the author's knowledge, which investigates the presence and degree of persistence in sector-specific inflation in the CFA Franc zone over any period. Because the study has concentrated on *food* and *non-food* sectors in these countries, we believe that the findings would be of much importance to policy makers in the Franc zone as well as in other countries.

- By using three different semiparametric methods of estimating the degree of inflation persistence, our overall results are made more robust and the findings will prove useful to applied economists and policy makers in the CFA Franc zone and other developing countries.

- Recent heightened interest in forming monetary unions across Africa (for example WAMZ and SADC monetary union) suggests the need for relevant information on the experiences of other such unions in the sub-region. The findings and implications of this thesis, as have been discussed, will prove helpful to policy makers in these countries in determining and designing new policies for their respective monetary unions.

- Due to macroeconomic asymmetries within the economies of the Franc zone, a key policy implication of this thesis is that implementing a one-size-fits-all policy for member states within the Zone is likely to be less than optimal, as there are likely to be net losers and net beneficiaries.

- Finally, while it will be extremely premature to suggest a redrawing of the boundaries of the Franc zone, the author suggests that the design and conduct of the Zone's policy should be formulated and implemented with careful consideration of the possible asymmetric effects in member states.