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Persistence and interdependence of macroeconomic variables in the West African Monetary Zone

Eshun, Richard

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MASTER OF MANAGEMENT BY RESEARCH

A RESEARCH REPORT ON

Persistence and interdependence of macroeconomic variables in the West African Monetary Zone

Submitted to

Wits Business School

University of the Witwatersrand

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Submitted by:

RICHARD ESHUN
Student #: **2262844**
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Supervisor:

George Tweneboah (PhD)

ABSTRACT

The introduction of monetary integration which enables member countries to adopt a common currency is not something which has just been discovered, For example, the Euro is used by the Eurozone as their regional currency; some francophone countries in Africa use the African Financial Community, which is the CFA Franc. Economic Community of West African States desire to introduce a common currency in the sub region has been in the offing since the birth of the regional integration body. This was considered expedient given the fact that there exist in the sub region one of the oldest monetary union which is the Union économique et monétaire ouest-africaine. In 2000, certain countries that belong to the Economic Community of West African States announced their intention to form a second monetary zone by creating the West African Monetary Zone. For the West African Monetary Zone to introduce a common currency, member countries are to fulfill some primary as well as some secondary criteria set up in the macroeconomic convergence criteria. Among some of the primary and secondary criteria are: inflation rate should be single-digit at the end of each year. Member countries are to ensure a stable real exchange rate as well as ensuring a positive real interest rate.

The overarching aim of this study is to assess the degree of integration of interest rate, inflation rate and exchange rate in the West African Monetary Zone and to analyse whether convergence as a prerequisite condition for the implementation of the common currency is achievable.

The study used a multi-criteria approach to examine the introduction of a single currency. This study used two approaches; the first approach which is Autoregressive Fractionally Integrated Moving Average and Fractionally Integrated Generalized Autoregressive Conditional Heteroskedasticity is used to test the degree of relationship of the macroeconomic variables, that is, interest rates, inflation rates and exchange rates independently and simultaneously in the West African Monetary Zone. The second approach which is wavelet-based methodology is used to test how the variables co-move independently and simultaneously across the West African Monetary Zone.

From the study, when there is a shock to any of the macroeconomic variables across the zone, its reversion to the mean varies and again the speed at which it returns to the mean varies as well whiles on the interdependence of the macroeconomic variables across the zone, the study shows that the overall correlations of the three macroeconomic variables are weak both in the short, medium and long term.

The evidence suggests that the zone is not ready to establish a monetary integration. Furthermore, from this study, if the zone wants to introduce a single currency for the entire region, it should be done in phases with countries that exhibit high similarities whiles the rest follow gradually as and when they achieve the convergence criteria.

DECLARATION

I, Richard Eshun, with student Number: 2262844 declare that this research report is my own work except where indicated in references and acknowledgments. It is submitted in fulfillment of the requirements for the degree of Master of Management by research at the Wits Business School, University of the Witwatersrand, Johannesburg.

It has not been submitted before for any degree or examination in this or any other university.

Signature……

Richard Eshun

Signed at…….. on the ……day of …….2020

DEDICATION

To

God Almighty,

My Wife: Mrs. Joana Boakye Eshun

And

My angels: Michelle Eshun

&

Richard Eshun Junior

ACKNOWLEDGEMENTS

I extend my earnest gratitude to the Lord for His insatiable wisdom, direction, knowledge, courage and the strength which enabled me to complete this dissertation successfully.

No thesis is a product of one man alone. A number of people have helped to shape this study in the way it is organized for an acceptable audience. The thought of an original research in the area of persistence and interdependence of macroeconomic variables in the West African Monetary Zone is mine. But its conceptualization into a realistic document is Dr. George Tweneboah, who is my supervisor. I take this opportunity to express my profound gratitude to him for playing a major role in stimulating my ideas, structuring and sequencing the thesis and increasing the clarity and vividness of the whole study.

Especially influential to me has been Professor Imhotep Paul Alagidede (Professor of Finance, Wits Business School, University of the Witwatersrand, Johannesburg) whose personal efforts and unbiased warmth, deep insight and thoroughness throughout the year of graduate study and research at Wits Business School have egged me along. I wish to express my appreciation to Peterson Owusu Junior (PhD Candidate, Wits Business School) and Maurice Omane-Adjepong (PhD Candidate, Wits Business School) for their immeasurable assistance throughout this work.

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LIST OF ABBREVIATIONS

ARFIMA	Autogressive Fractionally Integrated Moving Average
ADF	Augmented Dickey Fuller
ARIMA	Autoregressive Integrated Moving Average
CFA	Communauté Financière Africaine
ECOWAS	Economic Community of West African States
FIGARCH	Fractionally Integrated Generalized Autogressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GARCH	Generalized Autogressive Conditional Heteroskedasticity
IFS	International Financial Statistics
KPSS	Kwiatkowski, Phillips, Schmidt, and Shin
MODWT	Maximal Overlap Discrete Wavelet Transform
OCA	Optimum Currency Area
OECD	Organization for Economic Co-operation and Development
PPP	Purchasing Power Parity
RIP	Real Interest Parity

UEMOA	Union Économique ET Monétaire Ouest-Africaine
VECM	Vector Error Correction Model
WMC	Wavelet Multiple Correlation
WMCC	Wavelet Multiple Cross correlation
WAMZ	West African Monetary Zone
WAMI	West African Monetary Institute
WAEMU	West African Economic and Monetary Union
WDI	World Development Indicators
WACB	West African Central Bank

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.0 Background to the Study

There seems to be a vast array of foreign currencies moving around the world's economic monetary system despite the fact that the level of international trade continues to increase, coupled with the liberalization of the financial system, globalization and the increasing integration of the world's economies. The International Monetary Fund which has membership of around 188 countries has more than 150 currencies.

The introduction of monetary integration which enables member countries to adopt a common currency is not something which has just been discovered, the Europeans and other regional blocs in Africa have introduced monetary integration which enables the respective regions to use a common currency, For example, the Euro is used by the Eurozone as their regional currency; some francophone countries in Africa use the CFA Franc, that is, the African Financial Community, which at the moment is currently linked to the Euro as their common currency whiles the countries that constitute the Common Monetary Area in Southern Africa use the Rand as the common currency within the sub region.

The Optimum Currency Area theory has become the foundation as well as the benchmark for the introduction of monetary integration which enables member countries to use a single currency. This theory was first developed by Mundell (1961) and since then, it has been extended by Mckninnon (1963). The theory is based on the premise that member countries that wish to form a monetary union should attain certain criteria and when those criteria are met, the introduction of

a common currency becomes more feasible and the economic gain for that region, that is for member countries increases. Trade is promoted among the member countries when there is the usage of a common currency

The desire to evolve a common currency for the ECOWAS sub region has been in the offing since the birth of the regional integration body. This was considered expedient given the fact that there exist in the sub region one of the oldest monetary union – UEMOA. This informed the setting up of the 2nd West African Monetary Zone (WAMZ), proposed for non- UEMOA, as a prelude and "fast-track" approach to ultimate unification and adoption of a common ECOWAS currency. During the year 2000, some countries namely Ghana, Nigeria, the Gambia, Sierra Leone, Guinea which belongs to the Economic Community of West Africa States (ECOWAS) announced their intention to form second monetary zone by establishing the West African Monetary Zone (WAMZ). Initially the countries that formed the zone were five in number, Liberia stood as a watcher but later joined the zone and the six countries decided to use one currency as the region prepares to embrace monetary integration

For members to benefit from the formation of a monetary integration there are certain criteria that are to be met. Among some of the criteria are that, member countries should introduce some flexibility in their prices and wages, they should also embrace intra-regional factor mobility as well as openness to their trade, member countries should also embrace diversification of products and institute fiscal measures which will lead to the integration of their economies (Masson and Taylor, 1993), these measures when instituted and implemented can help to modify any asymmetric shock, thus, the motivation for the study to use the macroeconomic variables of the West African Monetary Zone to assess the level of integration of the six economies that constitute the zone.

It is understood that the formation of the second monetary zone would bring the desired stable exchange rate as well as stability in prices; again monetary integration will bring down the cost of transaction in regional trade. The introduction of the single currency by the WAMZ would be named as the 'ECO' and if implemented will encourage inter-regional trade and will also promote investments as well as bringing the needed capital flows in the sub region; the implementation of the single currency would increase employment and accelerate economic growth as well as improve the balance of payments situation. (West Africa Monetary Institute, 2002)

Among the requirement for the countries in the West African Monetary Zone (WAMZ) to achieve before the introduction of the single currency is that there should be synchronization in macroeconomic variables such as interest rate, inflation rate and exchange rate among member countries and from the perspective of Seck (2014), the appropriateness for the countries that constitute the WAMZ in meeting the convergence requirements seems unrealistic.

Assessing the difficulties of the countries that constitute the WAMZ in their attempt to achieve convergence in interest rate, inflation rate and exchange rates since they nurtured the idea of adopting a single currency, makes the study of persistence and interdependence an important exercise to embark on for policy-decision in the sub-region.

One of the prerequisite for the participating members of the WAMZ to commence and introduce the common currency (Eco) for the countries involved is that member countries need to bring their inflation rates to the barest minimum and also maintain stability in other macroeconomic variables like interest rate and exchange rate, that is WAMZ countries are to fulfill primary and secondary conditions; the primary criteria are that the various countries are to ensure that

inflation rate is single-digit annually; member countries fiscal deficit should not exceed 4% of the respective countries GDP; they are also to ensure that deficit-financing by each country's central bank is less than 10% of the last year's tax revenues; whiles gross external reserves that is capable of providing import cover for the respective countries for a minimum of three months (West African Monetary Institute, 2002).

There are again some secondary criteria which are instituted for member countries to meet for the successful implementation of the common currency. Those criteria are six in number for members to fulfill and among the criteria is that member countries should disallow new domestic default payments and liquidation of existing ones; member countries should ensure that their tax revenue is equal to or greater than 20 percent of the GDP; wage bill of member countries to their tax revenue should be equal to or less than 35 percent; and their public investment to their tax revenue should be equal to or greater than 20 percent; and participating member countries are to ensure a stable real exchange rate; as well as a positive real interest rate (West African Monetary Institute, 2002).

It is observed that, since the commencement of WAMZ in 2000 these primary and secondary conditions have been difficult to fulfill. Not only has there been persistent divergence in inflation and other macroeconomic variables but, the hope for accomplishing its convergence has also been weak which seems to further delay commencement. However if there should be any headway for convergence to be achieved, then there is the need for one to understand the level of integration of interest rate, inflation rate and exchange rate for the participating countries that constitute the WAMZ.

There are two schools of thoughts concerning the attainment of the convergence criteria of the West African Monetary Zone quest for the introduction of a single currency. One school is of the view that convergence can be achieved ex- ante whiles others are of the view that it can be achieved post ante. However it is evident from the empirical studies that the ex-ante conditionality for the introduction of the Eco, which is the single currency, may be difficult to achieve for the zone. However taking a clue from the UEMOA countries, the West African Monetary Zone can achieve convergence post ante (Balogun, 2007). Achieving post ante convergence is possible if there are common sources of shock and shock symmetry across the region and that is what this study sets out to measure the degree of relationship of macroeconomic fundamentals to ascertain the extent of similarities as well as to determine the interdependence of the macroeconomic variables across the zone.

This thesis employs Autogressive Fractionally Integrated Moving Average and the Fractionally Integrated Generalized Autogressive Conditional Heteroskedasticity (ARFIMA-FIGARCH) model to assess the tendency of how macroeconomic variables like interest rate, inflation rate and exchange rate in the WAMZ revert or not to its long run/equilibrium level when there is a shock.

This thesis, on the other hand employs the wavelet-based methodology to analyze the interdependence of interest rate and inflation rate as well as exchange rate in the West African Monetary Zone (WAMZ). This method makes it possible to assess simultaneously the frequency and the overall movement of time series variables of interest rate, inflation rate and exchange rate dynamics at any level and over time of the WAMZ countries. There are several methods to assess interdependence; however the advantage that the wavelet possesses is that it has the ability to accommodate frequency and time-scale domain of time series (Masih & Majid, 2013).

The contributions of the study are many. First concerning policymakers, if there are any deviations of the interest rate, inflation rate and exchange rate from a set target, the speed of how government would react in its attempt to use the appropriate measures, and the output cost of implementing, for instance, disinflation policy are critical. Second for academics, the fundamental dynamics of the macroeconomic variables and how the theory fits the facts are decisive and essential and for future research as well. Thirdly, for developing countries, such study would have important policy implications for domestic stabilization policy and also poverty reduction and inequities in wealth distribution and growth and development implications thereof. The extent of convergence between these macroeconomic variables would inform policy with respect to the direction of the West African Monetary Zone (WAMZ) experiment in particular as well as policies regarding interest rate, inflation rate and exchange rate in West Africa in general.

1.1 Problem Statement

With the undeniable progress of globalization, integration becomes the power word in many regions all over the world. African continent is not an exception, particularly not the area of Western Africa where the first ideas and initiatives for regional cooperation were formed right after the process of decolonization in 1960s.

There have been relatively few empirical studies that have used the dynamic nature of various macroeconomic variables such as interest rate, inflation rate and exchange rate to assess the symmetric or asymmetric nature of West African Monetary Zone economies and these studies have produced inconclusive results. For instance, one strand of studies revealed the existence of heterogeneity in the WAMZ macroeconomic variables and the studies attributed these

dissimilarities to the diverse economic structures of the West African economies (see: Alagidede et al. 2008; Tsangarides and Qureshi 2008; Asongu 2014; Harvey and Cushing 2015). On the other hand, another strand of empirical studies have made strong evidence of macroeconomic convergence when it comes to competitiveness since the West African Monetary convergence criteria was established in 2001 (see: Debrun et al. 2005; Coulibaly and Gnimassoun 2013). This thesis provides a contemporary examination of the degree of relationship between these macroeconomic variables to assess the asymmetry nature or otherwise of interest rate, inflation rate and exchange rate in the WAMZ.

The limited studies on interest rate, inflation rate and exchange rate persistence and interdependence on monetary union in the context of developing economies are the motivation for the study to use the case of WAMZ. This is in a bid to advance the literature on the dynamics of macroeconomic variables of a group of countries that appear to be determined to form a monetary union.

Even though there have been studies on the persistence and interdependence, most studies have not concentrated on the three macroeconomic variables simultaneously in checking for persistence and interdependence across countries overtime. This study closes that gap by using the three macroeconomic variables thus, interest rate, inflation rate and exchange rate to determine persistence and interdependence across the countries that constitute the WAMZ

Concerning persistence of the three variables, most studies used fractional integration and unit root test to assess the level of persistence of inflation rate, interest rate and exchange rate. Again this study closes that gap by introducing the ARFIMA-FIGARCH that is able to check for dual persistence both in the mean and in the variance.

Concerning interdependence of the three variables, most studies have not used the wavelet to examine the interdependence of the three variables simultaneously across countries. This study examines interest rate interdependence across the six countries that constitute the WAMZ, inflation rates interdependence across the six countries and exchange rate interdependence across the six countries for the WAMZ.

The launching of the currency, the 'ECO' has experienced several setbacks which includes several postponements because member countries find it difficult to attain the macroeconomic convergence criteria. The last date set for the launching of the common currency was 1st December, 2009, however this was not successfully materialized since most of the participating countries could not meet the criteria contained in the Macroeconomics Convergence targets.

The successful outcome for the establishment of a currency union depends on the fulfillment of a litany of conditions which is pertinent for policy coordination. Mundell (1961) propounded the Optimum Currency Area/ Region and enumerated certain conditions that countries wishing to form a currency area are to fulfill and the fulfillment of those conditions are what most African countries are faced with and it has become challenges for many of the countries. Most of the challenges are that there should be the existence of intra-regional trade leading to the formation of the OCA which would enable member countries to use a single currency, there should also be frequent movement of capital and labor within the union, there should be wage and price flexibility coupled with fiscal transfers to address the impact of any asymmetric shocks that the different countries may encounter (Jayaraman, Ward & Xu, 2007).

1.2 Purpose of the Study

The overarching aim of this study is to assess the level of integration of interest rate, inflation rate and exchange rate in the WAMZ countries and to analyse whether convergence as a prerequisite condition for the implementation of the common currency is achievable.

The contribution of this study is that, it would add to existing literature concerning a single currency introduction since limited research has been carried out in the ECOWAS region and Sub-Sahara Africa relative to that of the European Monetary Union. The approach adopted in this thesis enriches previous studies in the sub region by assessing the degree of integration that may exist for the members in relation to their response to shocks and how their macroeconomic variables move together.

Most of the methods adopted in earlier studies failed to make provision for the direct measurement of monetary shocks, and other shocks such as supply as well as demand shocks to the respective member countries and their responsiveness to common shocks. This would impart information on policy direction concerning the introduction of the common currency in the zone as well as direction on how the countries are converging ex-ante on the macroeconomic variables or will converge ex-post after the introduction of the eco. Again the findings may serve as an important document for other regional blocs in Africa that may be nurturing the idea of the introduction of a single currency to promote inter regional trade.

Consequently, When these variables; interest rate, inflation rate and exchange rate persistence and interdependence are studied, it will inform policy makers that, for instance a stable exchange rate helps to stimulate exports and that export is decrease when there is exchange rate appreciation. Concerning interest rate interdependence among countries, when there is interest

rate parity among countries, it can increase the attractiveness of domestic financial assets which may lead to the encouragement of capital flows.

1.3 Objective of the Study

This study aims to accomplish the purpose of the objectives enumerated in this section. This study use empirical analysis to examine the feasibility of the West African Monetary Zone quest for the introduction of a common currency by assessing the extent of relationship of interest rate, inflation rate and exchange rate in the West African Monetary Zone (WAMZ).

Particularly, the study has the following sub-objectives:

1. To establish the degree of integration of interest rate, inflation rate and exchange rate in the West African Monetary Zone (WAMZ).
2. To analyze the interdependence of interest rate, inflation rate and exchange rate in the West African Monetary Zone (WAMZ).

1.4 Research Questions

To better understand the level of relationship of interest rate, inflation rate and exchange rate in the West African Monetary Zone, the study has these sub research questions to deal with. Specifically, the sub research questions to be answered are:

1. What is the degree of integration of interest rate, inflation rate and exchange rate in the West African Monetary Zone (WAMZ)?
2. Is there any interdependence of interest rate, inflation rate and exchange rate in the West African Monetary Zone (WAMZ)?

1.5 Significance of the Study

This study augments the extant literature when it comes to the introduction of a single currency in the West African Monetary Zone. The feasibility of a single currency in the West African Monetary Zone has received limited research as compare to that of the European Monetary Union. The approach adopted by this study to assess the feasibility of a Monetary Union in the West African Monetary Zone used a multi criteria approach in the form of ARFIMA-FIGARCH and Wavelet methodologies. This study will increase the consciousness of member countries when it comes to the progress level in relation to their quest to achieve monetary integration which will enable the region to introduce a common currency.

Concerning methodology, this study introduces new approaches such as the ARFIMA-FIGARCH which is able to check the dual persistence in both the mean and the variance when examining the persistence of interest rate, inflation rate and exchange rate. The study closes the gap since most studies used the fractional integration to examine the persistence in inflation and other macroeconomic variables. This study uses this approach to assess the possibility of the adoption of a common currency using the macroeconomic variables such as interest rate, inflation rate and exchange rate by studying how these macroeconomic variables in the WAMZ countries revert to normal after experiencing shocks and again assess the interdependence of the three variables in the WAMZ to see if the countries are towards synchronization which is an indication of whether the countries are converging or diverging which is a condition for the establishment of the common currency.

The African continent has envisioned the introduction of a common currency for the entire region for some time now. It is anticipated that the introduction of a common currency in Africa is to be implemented in phases through a proposed stepwise convergence; this has necessitated

the introduction of monetary integration in the sub-region. Some regional blocs in Africa have introduced monetary integration already which has necessitated such regions to use a single currency. For instance, in southern Africa, there is the Common Monetary Area (CMA), these countries use the Rand as their common currency. In Central Africa, there is the Economic Community for Central African States (ECCAS) which also use one currency as well as several others. The findings from this study can be more beneficial to other regional blocs in Africa that are nurturing the formation of monetary integration.

1.6 Organization of the Study

This study is grouped into six chapters. The groupings are as follows. Chapter two deal with brief summary of the West African Monetary Zone. Chapter three is focused on the theoretical and empirical reviews on the Optimum Currency Area, the relationship and interdependence of the macroeconomic variables. Chapter four is the methodology used by this study. The estimations and the interpretations of the results are covered in Chapter five as well as the analysis and evaluations, and the discussions of the results. Chapter six provides the summary of the entire study and enumerates some policy recommendations for the West African Monetary Zone.

CHAPTER TWO

OVERVIEW OF THE WEST AFRICAN MONETARY ZONE

2.0 Introduction

This section gives a chronicle of the countries that constitute the West African Monetary Zone, brief process and status of the WAMZ as well as rationale behind the formation of the West African Monetary Zone and performance of the participating economies over the years.

2.1 Brief history of the WAMZ Countries

The countries that constitute the West African Monetary Zone are Ghana, Guinea, the Gambia, Liberia, Nigeria and Sierra Leone and these countries are found in the Western part of Africa.

With the exception of Liberia, Sierra Leone and Guinea that have boundaries connected to each of the countries, the other countries within the WAMZ are separated from each other geographically in terms of boundaries. The Atlantic Ocean in the South bounds the countries which constitute the WAMZ.

Countries that constitute the WAMZ cover an area which is around about 1,603,307 km2, and the country that has the largest land size is Nigeria with around 923,768 km2 whiles Gambia has the smallest land size of around 11,295 km2. Whiles the WAEMU is geographically bounded, the challenge with the WAMZ is that they lack such geographical linkage.

According to the world development Indicators, countries that constitute the six member countries that formed the West African Monetary Zone have a population totaling around 216.3929 million and in West Africa; these countries population has the numerical advantage. Again, according to the WDI, the most populated country in Africa which is Nigeria

coincidentally is also the biggest in terms of population among WAMZ and if you take the world population as a whole into consideration, Nigeria is placed seventh, and of the six countries that constitute the WAMZ, the second most populated country in the zone is Ghana which has a population of around 28 million. Gambia is the least populated among the countries that constitute the West African Monetary Zone. It has a population of around less than two million people and when it comes to the population density of the six countries that formed the WAMZ , it consist of about 14 persons per square kilometer. It shows that integration would be more beneficial since the market size would be large enough to promote inter regional trade among participating countries.

Many languages that are indigenous are spoken in the WAMZ even though when there is a common language, it promotes multilateral trade so easily. The WAMZ have many ethnic groups that speak different kinds of languages and some of the languages that are spoken include Temme and Krio in Sierra Leone; Kpelle and Bassa in Liberia; Wolof, Fulani and Mandinka, in Gambia; Peuhl as well as Malinke in Guinea; Mole-Dagbon, Akan and Ewe in Ghana; Hausa, Yoruba as well as, Ibo when it comes to Nigeria, however the official languages spoken are English and French. All the other countries in the WAMZ use English as their official language whiles Guinea uses French as their official language. In the nutshell, this is a brief history of the six countries that constitute the WAMZ.

2.2 Process and Status of the West African Monetary Zone

ECOWAS head of states during their meeting in the year 2000 approved that there should be the establishment of the second sub-regional zone that would promote trade and monetary integration in West Africa, five countries within ECOWAS came together to sign an agreement that would establish the creation of the WAMZ. The agreement also provides the establishment

of its operational secretariat, the West African Monetary Institute (WAMI), which was to be in Accra, Ghana. The zone was later joined by Liberia on 16th January 2010.

The WAMZ proposed January 2003 as the date when the new currency for the zone would be launch; however it was subsequently extended to July 2005 and yet still there were implementation problem as a result of the convergence criteria and again it further proposed a new date for the launch which was set for December 2009. The implementation of the new currency and the formation of the monetary union were captured on a blueprint known as the action plan. The plan consisted of the objectives of the union, the components, its activities, the time duration that is needed to complete the entire process as well as the responsibilities for implementation for the common currency were all documented and captured as the Banjul Action Plan.

Since member countries were finding it difficult to meet the convergence criteria, the actual date for which the common currency implementation was to take off was again extended to 2016. However the date for the launch which has seen different postponements has not deterred the member countries from bringing the monetary integration which may result with the establishment of the common currency into fruition. This reflects the ambitious goals and sheer desire of the participating members to achieve their monetary union. The countries constituting the WAMZ made provisions to establish an institution that was to be named the West African Monetary Institute (WAMI). The principal objective of the WAMI was that it was going to ensure that it carries out functions that will lead to the creation of the West African Central Bank (WACB).

The functions of the WACB were to undertake the under mentioned objectives:

i. The WACB was to ensure that all the preparatory work which is important for the smooth start of the West African Central Bank (WACB) were carried out,

ii. They were also to ensure the monitoring and assessment of compliance with the convergence criteria;

iii. The WACB was to make sure that price stability is made the core objective and that they are to ensure that monetary policies coordination are robust in order to achieve such objective:

iv. The WACB was to ensure that the necessary preparatory work for the smooth implementation of a common monetary policy was achieved.

v. The WACB was to make the necessary preparations concerning the issuance of a single currency,

vi. To oversee the development and implementation of an Exchange Rate regime as well as the West African Monetary Unit that would be responsible for settlements in the Zone. Another responsibility of the WAMI was to give an annual progress report on the respective countries of the WAMZ.

2.3 Rationale for the West African Monetary Zone

The willingness for the creation of a second monetary union in the ECOWAS region was necessitated by and large due to the lack of political will on the part of respective government to strive for a sturdy monetary integration between the CFA zone and the non-CFA zone. The emergence of the West African Monetary Zone as an effective monetary union is plausible and it makes it easier for the facilitation of the movement towards a single monetary zone in the sub-

region; this is because discussions and agreements will be made between two groups of countries in contrast to the current situation which is characterized by doubts and ambiguities about the process of integration in the sub-region. Irrespective of how long the potential or anticipated merger takes to materialize than presently envisioned, it is generally understood and accepted that the convergence of the two groups of countries will be less burdensome than the convergence of several countries with different currencies.

The fundamental economic policy objectives of the West African Monetary Zone is that member countries are to ensure price stability, they are also to ensure sound fiscal and monetary policy conditions as well as maintaining a sustainable balance of payments. To this end, the West African Monetary Zone is ordered to integrate into their economies a regional economic policy that will facilitate an effective coordination of member states' economic policies, and also to implement regional economic policy by embracing an open market economy as well as explicitly designing and implementing common monetary and exchange rate policies in the zone.

2.4 Macroeconomic convergence criteria of the West African Monetary Zone

ECOWAS has planned that the West African Monetary Zone would merge with the CFA zone which will lead to the introduction of the long-awaited single monetary zone in the sub-region.

However, for this to be made possible, the member states of the West African Monetary Zone are to comply with some convergence criteria, the attainment of these convergence criteria will bring macroeconomic stability and reasonable growth among member states. The quantitative primary convergence criteria are:

- Single digit inflation rate by 2000 and 5% by 2003;
- budget deficit (excluding grants) of not more than 5% of GDP by 2000 and 4% by 2002;

- central bank financing of budget deficit to be limited to 10% of previous year's tax revenue; and
- Gross external reserves to cover at least three months of imports by end-2000 and six months by end-2003.

In addition, there are six secondary criteria, which will be observed in support of the primary criteria. These are:

- prohibition of new domestic debt arrears and liquidation of all existing arrears;
- tax revenue to be more than 20% of GDP;
- wage bill to be less than 35% of total tax revenue;
- public investment to be more than 20% of tax revenue;
- maintenance of real exchange rate stability in the context of an exchange rate mechanism; and
- Maintenance of positive real interest rates.

2.5 Macroeconomic performance of the West African Monetary Zone countries.

These are the financial and macroeconomic performance of the countries constituting the West African Monetary Zone as at 2016.

Table 1: Financial and Macroeconomic performance for the WAMZ Countries (as at 2016)

Indicators	Ghana	Guinea	Gambia	Nigeria	Sierra Leone	Liberia
Real GDP % Growth (2007-2016 average)	6.7	2.2	3.7	6.0	5.1	6.3
GDP (based on PPP) in $	$113.35b	$15.276b	$3.27b	$1,105.34b	$9.832b	$3.781b
GDP (per capita) in $	$4,135	$1,212	$1,642	$6,067	$1,524	$840
GDP (at Official Exchange Rate)	na	$6.754b	$886m	$415.1b	$4.289b	$2.168b

in $ 2016						
CPI Inflation (%)	17.2	8.0	6.5	9.0	9.9	7.7
External Debt Stock in $	$19.15b	$2.843b	$502.5m	$32.27b	$1.403b	na
External Debt as % of GDP	64.4%	29.5%	50.7%	2.1%	33.6%	24.0%
Exports of Goods (fob) in $	$10.36b	$1.611b	$113.2m	$45.89b	$569.4m	$330.8m
Imports of Goods (cif) in $	$13.47b	$2.173b	$365.1m	$52.33b	$1.575b	$2.232b
Current Account Balance in $	-$2.254b	-$1.730b	-$136m	-$16.127b	-$475m	-$1.014b
Current Account Balance as % of GDP	-8.2	-23.6	-20	-3.5	-11.3	-36.9
Annual Export % Growth (2010-2016)	-43.3	2.1	16.7	3.8	127.1	0.6
Trade Balance in $	-$1.403b	-$1.275b	-$208m	-$1.576b	-$155m	-$1.052b
Budget balance as % of GDP	-5.7	-7.5	-9.6	-3.4	-3.7	-5.6
International Reserves (gold and Forex)	$5.885b	$233.5m	$83.8m	$29.07b	na	na
Reserves (excluding gold)	N/A	$233.5m	$143.3m	$31.56b	$556.5m	na
Global Competitiveness Effect (%)	41.6	-3.0	9.3	-1.69	122.7	5.4
Economic Freedom Index	63.0	52.1	57.5	55.6	51.7	52.7
Monetary Freedom Index	69.2	66.7	70.8	70.4	68.5	72.2
Trade Freedom Index	64.8	61.2	65.0	63.8	70.2	74.4
Investment Freedom Index	65.0	40.0	65.0	40.0	55.0	40.2

Sources: Author's Own Compilation

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

Chapter three presents the theoretical and empirical reviews on monetary integration and the feasibility of the introduction of a common currency. This chapter forms the foundation for the setting up of the estimation model in the next chapter.

3.1 The concept of the Optimum Currency Area

Mundell (1961) propounded the Optimum Currency Area theory (OCA), and defines OCA as an area whereby members can move freely from one region to the other region without any restrictions, for instance the movement of capital and labor. According to Mundell (1961), this free movement of capital and labor from one region to the other is termed as the internal factor mobility where there is interregional as well as the movement in industrial activities.

Mundell proposition on the "optimum currency area" is that countries that are nurturing the formation of an OCA must achieve these four conditions. First, there should be large and integrated labor market that gives workers the flexibility to move freely within the currency union to fill employment gaps. Secondly, there should be price and wage flexibility, together with capital mobility that would be necessary to mitigate trade imbalances. Since these two conditions are there, Robert Mundell talked about the fact that thirdly, there should be a centralized mechanism for fiscal transfers to countries that suffer as a result of labor and capital mobility. Lastly Mundell talks about the fact that participating countries should have similar business cycles which may be necessary to avoid a shock in any one area.

Mundell concept of OCA has been explored by many authors and one of such authors is McKinnon (1963) and Kenen (1969) and recently Alesina and Barro (2002) have extended the concept of the OCA whiles Bayoumi (1994) has created Mundell concept into a multi-region and general equilibrium model.

Grubel's (1970) gives another perspective of the concept of Currency Area and concerning his description of currency area, countries forming a monetary union lose their monetary policy instruments to a central bank which would be established by the union. However, the issue of countries in the union maintaining their respective currency or adopting a single currency is not the issue according to Grubel. His understanding is that there should be a stable exchange rate among the participating countries.

Kenen (1997) seems to give a different perspective on currency area, where he espoused that once participating countries decide to have their bilateral exchange rates within narrow bands which may be agreed by having a central rate which cannot be changed by a member country unilaterally, the region is an OCA. According to Kenen's (1997) the imperative thing is that member countries maintain a fixed exchange rate among themselves not necessarily surrendering ones fiscal and monetary policies.

There have been several opinions on the OCA but the general consensus is that exchange rate for the countries should be stable. The perspectives from Mundell (1961) and Grubel (1970) on monetary union is where participating countries surrender the monetary tools of the respective central banks mandate to supra regional central bank.

The perspectives on the OCA by several authors (see; Kenen 1997; Grubel 1970; Yuceol 2006; Mundell 1961) concentrate on the monetary policy tool which is the interest rate and exchange

rates regimes. Some are of the view that when a nation surrenders its monetary policy tool to a central bank is not the issue but the critical issue is that countries should be able to maintain a fixed exchange rate regime or it should be kept within a certain bands so that member countries cannot unilaterally change the rate. The monetary policy tool which is the interest rate and the exchange rate here makes it imperative to review the theory of the optimum currency Area in the study since one of the study objectives is to examine the interdependence of interest rate and exchange rate for the countries that constitute the WAMZ.

3.2 Conditions for assessing an Optimum Currency Area

There are certain criteria that have to be met if an area is to be called an Optimum Currency Area and the associated cost that comes with it. However the cost in creating an Optimum Currency Area can be reduced substantially if participating countries are able to fulfill the OCA criteria. The unpleasant thing is that when countries form a currency union, such participating countries lose their national monetary sovereignty. When there is an asymmetrical shock which may be as a result of political factors or industrial structure, participating countries find it difficult to address the issue. The factors discussed below are some of the characteristics of an OCA

3.2.1. Openness of the Economy

If there is openness of economic activities among participating countries, it becomes much easier for monetary integration to be achieved. There would be more fluctuations in international prices which can be transferred to the domestic cost if the degree of openness among participating countries is high. According to McKinnon (1963), such a scenario is expected to minimize the peoples desirous for money and the exchange rate misapprehension for those who earn wages whiles according to Mongelli (2008) economic activities openness among participating members can be assess from different ways, that is the degree of economic

activities among participating countries as well as international trade; the degree of openness among countries that have decided to use the common currency should be high; another dimension so far as economic openness is concerned is how participating countries trade among themselves when it comes to tradable and non-tradable goods and services as well as the marginal propensity to import.

Mongelli's (2008) is of the view that countries that are willing to do business with the outside world but unwilling to trade with member countries that constitute the union are not supposed to benefit from the union. In other words, if member countries decide not to trade among themselves, then the full benefits are not going to be materialized by participating countries and as a result of that it may not be profitable.

3.2.2 Product Diversification

When there is product diversity among participating countries that intends to form a currency union, it makes the integration more of a success because countries that engage in more products that are diversified are likely not to experience much sector specific shock. The understanding is that when there is more diversification, then it has the tendency to reduce the changes that may arise as a result of trading through the nominal exchange rate mechanism and also when diversification is intense it serves against a variety of disturbance (kenen, 1969).

Countries that concentrate on product diversification are not going to be affected by a fall in demand because when there is a decrease in demand of one product, it might not have much effect on the entire demand and through that unemployment would also be reduced. Kenen's (1969)

In addition, Kenen' argues that countries may trade among themselves when there is more diversifications in terms of their products and asserted that such a condition can favor balance of payment however he argues that if participating members that constitute the union have product that are diversified in the same sector then inter-regional trade may not flourish. The best scenario arises when each member country diversifies their production from different sectors.

3.2.3 Structure of industries

The industrial structure is a factor when countries are considering forming a monetary union because if the industries are similar, trading among participating countries become more beneficial because when shocks are experienced, such countries are going to be affected by similar sector specific shock. It is an important factor to consider when countries want to form an optimum currency area. When countries have similar industrial structures, they become better candidates for a currency union, this is because as stated in the above when shocks are experienced, such countries are going to be affected by similar sector specific shock and as a result, those participating countries can rely on one central bank policy to address such shock (Mkenda 2001).

If countries have similar industrial structure, it becomes much easier for a centralized bank for the entire union to implement same policy for the all member countries especially when similar shocks are experience in a monetary union (Mkenda 2001).

3.2.4 Government willingness and Public Support

Government willingness among member countries is important requisite for the formation of a currency union. Members must agree, for instance on policies with other participating members. Political will brings about commitments and also it create more collaborations between member

countries on various fronts which may include policies on the economy, cooperation among countries also contribute to institutional togetherness (Mongelli 2008). Formation of a currency union may receive acceptance by citizens if there is government will, sensitization can be undertaken to broaden the citizens knowledge on the costs involved in the formation of the union as well as its numerous benefits for each participating member belonging to the zone.

3.3 Costs and benefits of Common Currency

The formation of a monetary union has its costs and benefits, though the benefits may outweigh the cost. In forming a monetary union one has to think about the costs as well as the numerous advantages that are associated with using a single currency and the conditions member countries are to meet prior to the formation. This section enumerates some of the benefits and its associated costs that come with the formation of a monetary union.

According to Talvas (1993), when countries form monetary integration, the advantage is that when they want to convert money, the transaction cost is entirely minimized and this invariably promotes economic efficiency. When member countries decide to maintain their own currencies, the benefit from the transaction cost cannot be realized since there will be an opportunity cost, that is, the time one has to spend in trying to convert currencies among member countries.

When countries formed a monetary union, another benefit is that the risk in foreign exchange is reduced and also there are substantial changes in relative price. Once there is monetary union, there would be fixed exchange rate among member countries and as a result of that exchange risk is minimized during regional trade (Emerson, 1992).

If member countries are to get the needed benefits from the formation of any monetary union, then it depends on the level of intra-regional trade among participating members. In a situation

where there is a high degree of trade among member countries, then the formation of any monetary union then becomes an advantage and as a result one key factor that any region seeking to form monetary integration which will enable member countries to use a single currency should consider is the level of trade among participating countries.

The costs as well as the benefits of an Optimum Currency Area was summarized by Masson and Pattilo (2004) and from the summary, when there is monetary integration, and countries start to use a single currency, it can save different forms of transaction costs among member countries, on the other hand when a country joins a monetary union, the understanding is that, it has to abandon her own currency and surrender her capability when it comes to using national monetary policy in responding to any asymmetric shocks.

The main problem when countries decide to use a single currency is their inability to use its monetary policy and exchange rate instruments again. When one is unable to use monetary policies as well as its exchange rate instrument, it becomes a problem when the currency region is faced with asymmetric shock. Member countries that wish to form any monetary integration need to institute procedures to reduce asymmetric shocks.

3.4 Optimum Currency Area and the dynamics of macroeconomic variables

The definition of an optimum currency area has explicitly been stated in this study from extant literature. However in simple terms, one can describe an OCA as purely a domain within which exchange rates are fixed, whiles there is also a stable average price internally and monetary policy been able to maintain full employment as well as been able to maintain a balanced international payments (Mundel, 1961). It is an area that maintains fixed exchange rates within the region but can maintain flexible exchange rates with the region's trading partners.

A popular criterion of OCA is the symmetry of dynamics of economic variables as established by the classical and contemporary theorists. It is very pertinent to incorporate the homogeneity of the dynamics of economic variables into OCA when assessing a proposed monetary integration. For instance, the more economic variables differ in the region, the more a common central bank would have problems in setting interest rate to deal with varying degrees of growth in money and credit. This theory thus underpins this study objective which seeks to assess the degree of integration of the macroeconomic fundamentals in the West African Monetary Zone.

3.5 Theoretical background of mean reversion

In this section the theory of mean reversion is presented and discussed. The reason for including this theory is that it forms the basis of the first objective in this study which seeks to establish the relationship of interest rate, inflation rate and exchange rate across the WAMZ.

Mean reversion is a concept in statistics which argues that over a certain period of time the variable tends to move towards its long-term average. Exley et al (2004) gave a simple but extensive definition of mean reversion as: *"*An asset model is mean reverting if asset prices tend to fall (rise) after hitting a maximum (minimum)." In narrowing the definition down Exley et al suggests a more accurate statistical definition of the mean reversion: "An asset model is mean reverting if returns are negatively auto correlated." The theory of mean reversion here is explained in relation to the stock market (market return).

3.5.1 Possible causes of mean reversion

This section gives some of the possible causes of mean reversion.

3.5.1.1 Overreaction of good news

There are several reasons for possible presences of mean reversion and among some of the reasons are enumerated below. Mean reversion can happen when investors normally pay much attention to their returns, if the return on their investment goes up; they believe that the returns will continue to give them higher returns especially when there is favorable news about a company which is brought to the public domain.

When the market overreacts after announcement of good news, traders pay more attention to the fundamental values of the variable, in this case, the stock, and as a result they try to sell stocks that are overpriced which eventually may bring the price down and as a result mean reversion pattern forms. When there are large magnitudes of prices fluctuations due to overreaction of the market participants, it leads to misapplication of funds, that is, the companies that have the better investment opportunities however get lower share price and thus eventually get little in terms of profit from stock market than those companies that have worse investment opportunities (Cutler, Poterba and Summers, 1991).

3.5.1.2 Changes in risk tolerance

When investors want to change risk in their investment, they normally switch to where risk in returns are lower, as a result they may change the riskiness of any investment, for instance buying of stock for an investment with risk free or much less risk for example interest on deposit from the bank which eventually may change the stock price and cause it to be mean reverting. When there are changes in interest rate, especially when there is an increase in deposit interest

rate, stock prices are affected which may eventually show mean reverting pattern, this scenario seems different as compare to the case of the stock market overreaction (Engle and Morris, 1991). Though interest rate volatility may cause mean reversion in prices, it does not necessarily create inefficiency in the market.

3.5.1.3 Attractiveness of lower prices

Another cause of mean reversion is the attractiveness of lower prices, and according to researchers, people are more satisfied when buying stocks at a lower prices as compared to higher prices which may cause underperforming stocks to be bought more thus performing better than outperforming stocks which may eventually leads to mean reversion (e.g., Tsekrekos, Yannacopoulos 2016.).

The mean reversion hypothesis is an offshoot of the overreaction hypothesis that stresses that market behavior is often influenced by the reactions (optimism and pessimism) of investors i.e. irrational behavior of noise traders, presence of asymmetric information, negative serial correlation among others (Wang et al., 2015).

3.6 Theory on interdependence

Interdependence is defined as the situation whereby there is positive and direct link of the interests of countries such that when there is a change in the direction of one state it affects the direction of others and in the same way.

When a country considers the direction of other states before it chart its own international and domestic policy, then there is higher interdependence between those countries. In this study, "interdependence" is understood to be the positive and direct link of the interests of states such

that when the direction of one country changes, the direction of others is affected, and in the same way.

There are several concepts and measures of interdependence. That is, the volume of the transactions between two societies can be classified as horizontal interdependence. Thus horizontal interdependence is whereby there is the flow of money, goods as well as men, and so on whereas Vertical interdependence, in contrast, indicates the economic response of one country to another, in terms of changes in factor prices.

There are several theories on Economic Interdependence. Michael Doyle (1997) argued that when there is interdependence, it brings about increased economic relations among countries and also it help to create international community where countries form a union and becomes one big family, interdependence promotes communications between individuals and companies as well as other subnational actors. Subnational economic actors such as interest groups promote foreign trade hence economic interdependence since their fortunes depend on international trade and as a result they press on their respective government to seek peaceful solutions to disputes.

Interdependence again creates an international economic order, whereby there are required behavioral standards to participate and stay in the market and also the morals to uphold to ensure stability in the economic system. However the idea that economic interdependence brings economic order on different levels, lack explicit and as a result difficult to prove that it indeed brings economic order.

Polachek, (1980) asserted that states have realized the gain from interdependence, for instance the numerous advantages derived from trading with other nations, and thus several nations try to sustain such trade, since societal goods are a function of government. Lastly, interdependence is

understood to mean common values which concerns trading and shared values, and these morals include the maintenance of international order through conflict reduction.

3.7 Empirical Review

This section presents the empirical reviews of interest rate, inflation rate and exchange rate persistence and interdependence across the countries. Existing literature on persistence and interdependence of the macroeconomic variables on monetary union in African economies is sparse.

3.7.1 Interest rate persistence

The study of real interest rate persistence is extremely important when it comes to equilibrium models in asset pricing, and modeling of central bank policy, as well as mechanisms of monetary policy (L.P. Hansen et al, 1982). When it comes to the role concerning government budget deficits and economic growth relationship, Persistence in interest rate again plays an important role in how governments finance its budget deficit (J.R. Barth et al, 1984).

When there is a random shock which moves real interest rate from its equilibrium or its steady state, then there is an exhibition of real interest rate persistence.

When unit root is present in real interest rates, it may suggest that there may be the existence of market inefficiencies, for example sticky prices or when the banking industry is experiencing imperfect competition, as well as information costs, when these market inefficiencies are present, it prevents nominal interest rates from adjusting one-to-one with inflation. A number of studies on interest rate persistence have indicated that when there is a budget deficit, it has significant influence on interest rates in the long run and limited effect on interest rate in the short run (R.J.

Cebula, 1997) Once it is understood that one of the ways by which budget deficits can affect the economy is through interest rate, it makes it imperative to study the persistence properties of interest rates.

Results from literature on whether when real interest rate experience random shocks are temporal or permanent in nature are mixed. When real interest rate moves away from it steady state, normally standard cointegration, unit root tests and fractional integration are used to check for persistent in the real interest rate, (see:T. Engsted, 1995; Koustas et al, 1999; and Rapach et al, 2004), these studies display evidence of interest rate persistence. Studies by Tsay, (2000) and Pipatchaipoom and Smallwood, (2009) examined interest rate persistent by employing fractional integration techniques and concluded that even though there is a pattern of mean reversion, there is persistence in real interest rates. Another study by Gil- Alana, (2004) used fractional integration as employed by Tsay, Pipatchaipoom and Smallwood on US long term interest rate, the study determine the order of integration and find evidence of unit root during the sample period 1940-2000

Das et al, (2014) employed fractional integration and took structural breaks into consideration, and finds real interest rate to exhibit mean reverting pattern. The study used ex post real interest rate in the long run in South Africa. Studies conducted by Caporale and Grier (2000), Rapach and Wohar (2005), and Lai (2008) find that structural breaks influence the level of real interest rates persistent. Their study gives credence to the assertion that structural breaks influence persistence

However, Huizinga and Mishkin (1986) conducted a study on real interest rate persistent by concentrating on the significance of regime changes on the effect of persistence of real interest rate and the conclusion is when there are changes in regimes, it substantially leads to a decrease

in persistence. Garcia and Perron (1996) studied the real interest rate in the US and described US real interest rate as a stationary process which experienced less regime changes and as a result make it difficult to reject or accept the null hypothesis that real interest rates in the US has unit roots.

Caporale and Grier (2005) and Bai and Perron (2003) gives credence to regime changes that it can affect persistence. Their study show that when there is regime changes, it leads to persistence in real interest rate and attributed the persistence to instability related to political regimes. Moreover, Rapach and Wohar (2005) also conducted test on changes in regimes for 13 industrialized countries and the result show that when there is regime change it indicates similar source across countries that relates to inflation, which implies that co-movement of real interest rates across countries underlies the role of monetary policy as a mechanism for persistence in real interest rates changes across regimes.

Rose (1988) conducted tests to check for the presence of unit roots using the short-term nominal interest rates and inflation rates on 18 countries from the Organization for Economic Co-operation and Development (OECD). The data used for the study covers the period 1947 to 1986. The result fail to reject the null hypothesis of a unit root in short-term nominal interest rates; however the study can repeatedly reject a unit root in inflation rates based on various price indices, example consumer price index. The study used augmented Dickey-Fuller (ADF) tests.

In another development, a study conducted on the US interest rate fails to reject the null hypothesis of a unit root in the nominal interest rate, matching the finding of Rose (1988). The study used the ADF unit root tests to the U.S. nominal 3-month Treasury bill rate as well as the

inflation rate, and EPRR relied on quarterly data for 1954 to1988 and adopted the GNP deflator inflation rate. The study was carried out by King et al. (1991) and Galí (1992).

The empirical review of real interest rate persistence shows that studies that used fractional integration show persistent in real interest rate, however when structural breaks are taking into consideration, it exhibit mean reverting pattern and also regime changes affect persistence, however the methods employed does not capture the short, medium and long memory properties of interest rate when there is a shock, this study employs the ARFIMA-FIGARCH which enables both the short and the long memory of interest rate to be captured and since most studies also used unit root and fractional integration to determine persistence of interest rate, this method has an added advantage since it is able to observe its return to the mean as well as the volatility of the return. Again, this study is significant because (it appears that) it complements no previous study that establishes evidence of long memory for real interest rates in West African Monetary Zone. Understanding the long memory properties of the real interest rate would enable this study to make inferences regarding the viability of monetary policy and asset pricing models in the West African Monetary Zone.

3.7.2 Inflation rate persistence

Several authors have used fractional integration and advanced panel unit root test to test for persistence in inflation since 2000 and some of the authors and their works are enumerated below.

Alagidede et al. (2014) used the case of Ghana to examine the critical problem of inflation persistence in Ghana to better inform the welfare and policy implications associated with it. Specifically, the study investigates the existence of persistence at both national and regional

levels and included investigation of persistence across thirteen sectors spanning across core and headline inflation persistence, and employs fractional integration methods to show that there are asymmetries in the levels of inflation persistence both regionally and sectorally.

Similarly, Canarella and Miller (2017) investigate the dynamics of inflation persistence for a sample of advanced countries namely; Canada, Sweden, and the United Kingdom and newly industrialized emerging market economies namely; Chile, Israel, and Mexico and adopted inflation targeting before the year 2000. The results came out with two empirical evidence using fractional integration and cointegration techniques to answer certain questions, first, it investigates to find out if individually, the six countries share similar persistence with any two of non-inflation targeting countries, Germany, which is the largest economy of the Euro Area, and the United States, the world's largest economy. Second, it examines inflation in each of the six inflation targeting countries with Germany as well as the United States to assess whether inflation rates are moved by a similar random path. The evidence on these issues are mixed, On one hand, the study finds that the inflationary processes concerning Germany, the United States, and the three advanced economies are fractionally integrated and stationary and has a mean reverting pattern, and share similar persistence in inflation. On the other hand, the inflationary processes in the three emerging market economies are fractionally integrated, mean reverting, non-stationary, and do not share a similar persistence with Germany and the United States.

In another development, Phiri (2016) investigated inflation persistence using annual CPI inflation collected between 1994 and 2014 for 46 African countries and the study groups the countries into panels according to whether they are inflation targets or not and conducts estimations for pre and post inflation targeting periods. Empirically, it finds that inflation persistence was much higher for inflation targets in periods before adopting their inflation

targeting regimes and inflation persistence dropped by 40 per cent for these countries after adopting the policy frameworks. For non-inflation targets, inflation persistence has increased by almost 290 per cent between the two periods.

Hofmann and Remsperger (2005) conducted a study on inflation rates in the euro zone and find that countries that have a history of low and stable inflation rates exhibit zero persistence while countries with history of high and unstable inflation rates exhibit high persistence in inflation rates. The study covered the period 1999Q1-2004Q2 and used the panel generalized method of moments .Based on the above findings, the authors concluded that the monetary policy of the Euro system is tilted toward maintaining low and stable inflation rates which should reduce persistence in inflation in the future for the euro zone

Another study conducted in the MENA countries by Bolat et al. (2017) investigated the dynamic behavior and seasonal property (with regime shift) of inflation using quantile regression approach developed by Roger Koenker and Zhijie Xiao (2004) came out with these findings, first, their empirical results show that the inflation rates are not mean-reverting, and they show the asymmetries in their dynamic adjustment and secondly they also find out that a seasonal unit root does not exist in the inflation rate for any country thus implying that shocks do not have lasting effects on the inflation rate

Baillie and Morana (2012) studied the G7 countries to check for inflation persistence and concluded that there is evidence of long memory as well as structural change in the conditional mean dynamics, and also in the conditional variance dynamics of inflation rates for the G7 countries. The study used the Adaptive ARFIMA model, which has a flexible Fourier form in the model that allows a time varying intercept. Martins and Rodrigues (2014) used a new

approach to examine persistence change in fractionally integrated models which is based on the recursive forward and backward estimation of regression-based Lagrange Multiplier tests and the approach was apply to several inflation rates across the world and it was found out that several of the series exhibit persistence changes.

Recently many studies have tested for persistence in inflation across countries to examine whether inflation Rates are stationary or non-stationary by using nonlinear unit root test. For instance, Henry and Shields (2004) use the approach of Caner and Hansen's (2001), the study discovered inflation rates in Japan and UK to have two-regime threshold unit root process and that when there is shocks to inflation, persistent is high in one regime, but the other regime shows finite lives.

In another development, Giannellis (2013) tested for the presence of persistence in inflation rate differences across the euro area. His conclusion was that concerning countries like Finland, Germany, Ireland, Slovenia, Portugal, Austria, France, Malta and the Netherlands and Italy, nonstationary has been observed for these countries. He used the threshold unit root test developed by Caner and Hansen's (2001)

The level of inflation persistence was carried out in 19 OECD countries, and it was concluded that inflation rates follow non stationary process. The study was conducted by Ho (2009) who followed the approach of Chang's (2002) by using nonlinear panel unit root test. In another study using the same OECD countries, Romero-Avila and Usabiaga (2009) test for inflation persistence by selecting 13 countries over the period 1957–2005 and their findings accept the absence of a unit root in inflation, which lend strong support that regime-wise stationarity exist.

Beechey et al (2009) examine the persistence in the rates of inflation across the European zone from the period 1991 to 2006 and applied an ARMA (1, 1 1) model which has a time-varying autoregressive parameter, the study realized persistence in inflation rates dropped remarkably during the European Monetary Union third stage that started in January 1999 and since then there is no unit root behavior in inflation rates.

Narayan et al (2011) conducted test on G7 countries to check for persistence in inflation and they concluded that inflation rate for Canada has non-seasonal unit root; however inflation rate for Germany exhibit semi- annual unit root and find the G7 countries to exhibit no seasonal unit root at the annual frequency. The study used the current seasonal unit root test that has seasonal level shifts at unidentified times suggested by Popp (2007) to examine the rates of inflation for the G7 countries.

Mourelle et al. (2011) conducted test on how inflation behaves in a number of African countries and find out that persistence in inflation does not apply to most of the countries studied. His study used nonlinear unit root test as well as fractional integration.

Zhou (2013) conducted test on 12 European countries to check the existence of stationarity in inflation rates across those countries. His study used the approach of Kapetanios et al. (2003) and find inflation rates for most of these countries to follow stationary processes when they were experiencing periods of floating exchange rate. Chang *et al*. (2013) studied inflation rates of 22 OECD countries to assess whether inflation rates in these countries are mean reverting or otherwise for the period 1961 to 2011. They used flexible Fourier stationarity test which was first applied by Becker, Enders and Lee (2006) and their conclusion was that inflation rates indicate mean-reversion trend for the 22 OECD countries that were included in the study.

In a related development, Tsong and Lee (2011) also used OECD countries to check for the existence of mean reversion in their inflation rates. They selected 12 countries from the OECD countries and apply the regression quantile approach which was first applied by Koenker and Xiao (2004). The study examined the changing pattern of inflation rates for these countries and observed inflation rates across these countries to be mean-reverting as well as showing asymmetries in its dynamic adjustments. The study finds the mean reversion to be as a result of large negative shocks, while large positive shocks have no effect on strong mean reversion.

Kumar and Okimoto (2006) studied the US inflation rates to check for the existence of persistence in inflation. They used fractionally integrated processes and find that inflation persistence in the United States has taken a nosedive since the last 20 years.

Most Literature on inflation rate persistence does not capture the short, medium and long memory properties of inflation persistence when there is a shock, this study employs the ARFIMA-FIGARCH which has the ability to capture both the short and the long memory of inflation rate and since most studies also used unit root and fractional integration to determine persistence of inflation rate, this method has an added advantage since it is able to observe its return to the mean as well as the volatility of the return.

3.7.3 Exchange rate persistence

The purchasing power parity (PPP) hypothesis remains as one of the commonly debated conundrums in finance and economics. Ordinarily the, purchasing power parity hypothesis states that the real exchange rate between two countries is the same as the two countries comparative price levels (Cassel, 1918). Breaking this definition down, the PPP hypothesis states that if there

is any change in the nominal spot exchange rate between two countries, that change is similar as the differences in inflation between the two countries (see Holmes, 2000)

There are several methods for testing persistence in real exchange rate (or the PPP hypothesis); however most commonly used are the Unit roots or stationarity techniques. If the test is conducted and the time series of the real exchange rate has unit roots, the PPP hypothesis is rejected, which implies there is persistence in real exchange rate series.

In a very recent study which was conducted by Alagidede et al. (2008), they investigated the exchange rate in some countries in West Africa to ascertain if there is persistence in real exchange rate. Alagidede et al used the Johansen cointegration technique to test for PPP hypothesis for countries that constitute the WAMZ and use data that covers the period 1974 first quarter to the first quarter of 2007. Countries considered for the study are Nigeria, Gambia, Sierra Leone and Ghana, the study came out with these findings; first, real exchange rates in the WAMZ countries follow a random walk. Second, the results brought to light that nominal exchange rate as well as the nominal price series show different adjustment in terms of speed towards long-run PPP. In addition, the study realized that nominal exchange rate series improve quicker than the nominal price series in terms of adjustment to the long-run PPP. On the basis of these findings, the authors argue that for WAMZ to succeed in its quest for the introduction of a common currency depends on well-coordinated macroeconomic policies as well as PPP validity to eliminate arbitrages from trade and investments.

In another development, Odedokun (2000) conducted a study to examine the reliability of the Purchasing power parity hypothesis for 35 countries from Africa; the countries included in his study are Sierra Leone, Nigeria, Liberia, Ghana and the Gambia. The study covers the period

1980 to 1991 and relied on quarterly dataset of the CPI and exchange rate for these countries and applies Granger cointegration technique and subdivides the countries into Communauté Financière Africaine, known as the CFA zone and countries that does not belong to the CFA zone. The conclusion was that, 17 countries that does not belong to CFA zone, that is, The Gambia, Ghana, Nigeria, Liberia, and Sierra Leone exhibit long run PPP. The countries that belong to the CFA were rejected for the long run PPP and according to the study; the countries that were rejected for PPP were 18 in number.

In a related development, Kargbo (2003) conducted test to check for the PPP hypothesis in Africa using a number of 30 nations. He included Nigeria, Ghana, Sierra Leone and the Gambia which is very similar to the countries that Odedokun (2000) included in his study. Unlike Odedokun (2000) who used Granger cointegration technique, Kargbo used the Johansen cointegration test and included a set of data that consist of black market exchange rates as well as consumer price index that covered 1960 to 1997; his conclusion was that the countries that were included in the study had sturdy support for the PPP hypothesis. Kargbo (2003) used same approach to examine the PPP hypothesis for 25 countries in the long run in Africa. Countries that were studied are The Gambia, Sierra Leone, Nigeria, and Ghana which is same as his first study and he used annual data that covers the period from 1958 to 1997 on exchange rates as well as food price indices, and again used cointegration technique to examine the long run effect and still observes strong evidence of PPP hypothesis existing in the long run.

Baharumshah et al. (2010) examine the PPP hypothesis for some 11 countries in Africa in the long run and the study used real exchange rate series that are collated monthly which covers the period from 1980 to 2007. Among the countries included in the study were Ghana and Nigeria. When the study used the conventional panel unit root tests, it finds long-run PPP support for 11

countries, however when the study relied on the SURADF, that is the seemingly unrelated regressions augmented Dickey–Fuller used by Breuer et al. (2002), the study fails to support the PPP in the long run for 5 countries which include Ghana and Nigeria. The conclusion of this study is that the findings are mixed.

In a related development, Cheung and Lai (2000) analyze the bilateral real exchange rates fluctuations using monthly data for some countries across the world and the US. The study used data that covers the period after 1973 for 94 countries as well as the U.S; they reported PPP deviations seems to dwindle quicker for the developing nations as compare to the industrial nations.

Cashin et al (2006) on examining the persistence of real exchange rate parity deviations using monthly data after the Bretton Woods period for 90 countries consisting of developed and developing nations, find that advanced economies average half- life is around 8 years, which doubles the estimates of previous studies though in comparison, the estimates concerning the half-life for developing nations are shown to be equally spread, while much of the deviations from parity are permanent. Their result of slower parity reversion for lower-income nations is the same as the findings of Froot and Rogoff (1995).

Concerning what drives disparities in real exchange rate persistence between countries; Cheung and Lai (2000a) use flexible parameters to assess the cross-country association between half-lives of parity differences and structural features and concluded that there is negative rank correlation with inflation and half-life, whiles there is positive complementary relationship when considering government expenditure rather. Even though the study explicitly didn't analyze the relationship between persistence of real exchange rate and rigidity in nominal exchange rate, the

study indicates PPP rejection rate is somehow lower for currencies that are pegged to the U.S. dollar. Husain et al. (2005) in his study observed that the value of an increasingly flexible exchange rate system increases as a country becomes richer and more developed in terms of finances.

Achy (2003) conducted a test on 38 middle-income economies on their nominal exchange rate volatility. His conclusion indicate higher nominal exchange rate fluctuations coupled with growth in productivity and there is slower mean-reversion when government tends to spend in the bilateral real exchange rate, while on the other hand, capital mobility as well as high inflation reduce persistence of deviations from parity.

Studies conducted by Cashin and McDermott (2006) find an opposite relationship between nominal exchange rate fluctuations and misalignments of persistence in real exchange rate. However, it objects the empirical findings of Alba and Papell (2007) who find countries whose nominal exchange rate fluctuations to be moderate to exhibit stronger evidence of relative PPP. Cashin and McDermott (2006) also indicate mean-reversion is quicker in countries that experienced high inflation.

In turkey, Bahmani-Oskooee (1998) and Mustafaoglu (1999), studied Middle Eastern countries and used data collected quarterly for the period covering 1971.1 to 1994.4. In the study Turkey was considered as a member of the Middle East countries. They adopted the ADF and KPSS statistics and realized that when they used the KPSS, they find evidence of mean-reversion. Mustafaoglu (1999), on the other hand, also utilizes data collected quarterly, which covers the period of 1982.1-1998.2 on flexible exchange rate and used the ADF and PP tests; the study

takes one-time structural shifts into consideration using the ADF statistic. His finding indicates the null of a unit root can only be rejected for the RER if it is based on the British pound.

Again in turkey, Telatar and Kazdagli (1998) examined the validity of the PPP by relying on monthly data that covers the period 1980.10 to 1993.10 period, though part of Temurlenk's (1999) analysis are based on monthly data for the 1981.05 to 1996.12 period. Both studies do not give evidence of PPP hypothesis for these periods. The study didn't take into accounts structural shifts in the deterministic terms, even though Metin (1994) and Telatar and Kazdagli (1998) realized that this may be one of the reasons why the PPP hypothesis fail to hold.

Most Literature on exchange rate persistence does not capture the short, medium and long memory properties of exchange rate persistence when there is a shock, this study employs the ARFIMA-FIGARCH which has the ability to capture both the short and the long memory of exchange rate persistence and since most studies also used cointegration to determine persistence of exchange rate persistence, this method has an added advantage since it is able to observe its return to the mean as well as the volatility of the return.

3.7.4 Interest rate interdependence

Previous studies on interdependence of interest rate have been carried out across countries and regional blocks as well. This section looks at some of the interdependence of interest rate.

There have been several studies on interest rate interdependence or the RIP across countries of which the G7 is not an exception. Examining the presence of the RIP condition across countries have been carried out and recently studies on countries that belong to the G7 or each of the G7 studied alone with others outside the G7 have not being left out and several authors have studied

the RIP concerning the G7 (see; Fujii and Chinn (2001), Dreger and Schumaker (2003), Cumby and Mishkin (1986), Fountas and Wu (1999), Holmes (2005) Felmingham, Zhang and Healy (2000), Wu and Fountas (2000), Chung and Crowder (2004), Cavaglia (1992), among others.

Studies conducted by Dreger and Schumaker, (2003) on the G7 by examining the real interest rate parity or the RIP for the period 1980:1 to 1998:12 used monthly data over the sample period. They used the cross section of G7 nominal interest rates which has 3month term to maturity and in testing for RIP; the study used the deviations between similar nominal rates for a variety of countries and the US. The study used a bivariate approach and treated the US as a foreign country. The findings of the study rejected RIP between each of the countries belonging to the G7 and the US. The study did not take into account the effect of shocks and based its analysis on weak form tests for stability. Concerning the impact of shocks the study discarded the crisis in Asia during 1997 as well as the event of 11th September 2001.

In a related development, Wu and Fountas (WF) (2000) took structural breaks into consideration and used Gregory and Hansen (1996) test to examine real interest rate in the short term for the bivariate cointegration of G7 countries, which is subject to a non-predetermined structural break. Their study used data that covers the period 1974 to 1995 and the finding was that there is much evidence for bilateral interest rate synchronization between several of the G7 countries and the US. However, still on the G7, Canadian and UK rates in the long run are not affected by similar US rates and with this finding these countries can rely on the respective monetary policy to serve as stabilization tool when it comes to internal economic issues.

Cavaglia (1992) apply Kalman filtering technique and find support of the presence of RIP and the study find actual real interest rate differences to be somehow short lived and also possess a mean reverting pattern which suggests RIP holds in the long run.

Fujii and Chinn (2001) conducted test on the RIP situation for the G7 countries by taking the long as well as the short term end of the maturity spectrum into consideration by using data that are collected quarterly for the period 1976 to 2000 for short term maturities, whiles the long term, the study consider the period from 1973 to 2000. The study finds RIP evidences for the long term of the maturity spectrum nonetheless there is weaker evidence in the short term. Chung and Crowder (2004) used data that covers the period 1960-1996 and reject RIP over the long run and attributed the failure of RIP to the uncovered interest parity. Finally, Holmes (2005) finds strong consistency of real interest rate convergence among European Union members.

More recent studies have analyzed both strong and weak forms of RIP by adopting cointegration test for bivariate and multivariate analysis and several of the studies find no evidence for strong RIP but there is observations for the weak RIP.

Throop (1994) examined RIP for these countries; US, Japan and UK and his study used foreign trade-weighted real interest rate and apply the Johansen test. The study finds some evidence for the weak form of RIP and finds no support for the long-run, one-to-one relationship existing between US real interest rates and foreign real rates, i.e., strong RIP are rejected by the data.

Goodwin et al (1994) test for RIP for four countries namely the US, Canada, Germany and UK and covered the period1975 to1987 by using Eurocurrency as well as domestic money market interest rates for the specified period. Again the study used the US as the base country and

performs bilateral and multilateral tests and the study find that bilateral cointegration applies for the US against Canada, UK and Germany. This observation supports the weak form of RIP.

Most Literature on interest rate interdependence fail to notice the short, medium and long memory properties of interest rate interdependence or co-movement, this study employs the wavelet multiple correlation and wavelet multiple cross correlation which is able to capture both the short, medium and the long run co-movements of interest rates across different countries interest rate and since most studies also used cointegration to determine the RIP, this method has an added advantage since it is able to observe the frequencies at different time scales

3.7.5 Inflation rate interdependence

There are several studies that have found statistical significant interdependence of inflation rates across countries. Study by Ciccarelli et al (2010) when they used 22 countries that belong to OECD as their dataset on inflation rates came out with these findings. They realized that movement in domestic CPI inflation rates are as a result of divergence global inflation measures for instance the official OECD measure and the simple average as well as the first principal component of data that expound around 70 per cent of the convergence of inflation rates across countries. The study used national inflation data in year-ended terms and covered the period 1961 to 2008 which includes shocks, for instances the oil price shocks during the 1970s, and regime changes. As a result of this, Ciccarelli and Mojon estimate that international influences on inflation contribute around 30 per cent when the study de-trended the data to accommodate frequencies in business cycles.

Monacelli et al (2009) studied inflation rates for the United States and some European countries by using monthly disaggregated CPI data. The European countries are France, Germany and the

United Kingdom and covered a period of 1991 to 2004 and they came out with the conclusion that around fifteen to thirty per cent of deviation in domestic inflation is due to international factors. However since their data includes monthly as well as disaggregated data they seem to be noisier and have lower measured co-movement which is autonomous of the underlying associations in the data. The result is then thought to be of as a lower bound to the variation in domestic inflation which is as a result of 'global inflation'.

Neely et al (2008) also used national data and similar method used by Kose et al (2003) on movements of inflation and disaggregated national inflation rates into common, regional and idiosyncratic parts. The study used 64 countries which includes data from, Asia, Latin America, Middle East and Africa as well as North America and Europe, and allows for the distinction between common and regional effects. The sample period was 1951 to 2009 and their conclusion is that, averagely thirty-five per cent of the deviations in inflation rates domestically are as a result of global factor, while fifteen per cent is due to regional factors.

There have been several studies on OECD countries on inflation interdependence and one of such studies is conducted by Wang and Wen (2007), on 18 countries from the OECD and found inflation rates between countries on a quarterly basis to be highly correlated that is, on average, around 0.6 correlations.

However Mumtaz et al (2011) used sample from the 1800s for some countries and the study observed the amount of inflation deviation is as a result of a common factor which has increased after 1985. Work by Hyvonen (2004) on co-movement of inflation rates for a sample of countries that belong to the IMF and document inflation targeting as a result of that.

Most of the studies showed above concentrate on the statistical result that inflation rates tend to move together across countries. Most Literature on inflation rates interdependence fail to capture the short, medium and long memory properties of inflation rates interdependence or co-movement, this study employs the wavelet multiple correlation and wavelet multiple cross correlation which is able to capture both the short, medium and the long run co-movements of inflation rates across different countries inflation rates. This method has an added advantage since it is able to observe the frequencies at different time scales.

3.7.6 Exchange rate interdependence

The interdependence of exchange rates is often of interest in the areas of risk management, asset pricing, and portfolio management. The literature on the interdependence of exchange rate is extensive. One strand of literature concentrates on the co-movement of major currencies across countries. A study by Calvet et al. (2004) using data that covers the period 1973 and 2003 on US dollar exchange rate series between those periods understudied find evidence of strong patterns in volatility co-movement between US dollar exchange rate series as against major currencies. The study used multi frequency volatility decomposition.

Inagaki (2007) analyzed the euro and the British pounds from the period 1999 to 2004 by using the residual CCF method and his study finds evidence of unidirectional fluctuations spillover to the Great British pound from the euro. Similar results were obtained by Nikkinen et al. (2006) when he used the VAR methodology and the conclusion was that expectations from the market on future exchange rate fluctuations are very much associated with the main currencies in Europe , that is, Swiss franc and the pounds as well as Euro in the studied period from 2001–2003.

Drozdz et al. (2007) conducted a study using a basket of sixty currencies and covered a period of 1998 to 2005 and adopted cross correlation of the changes of the daily foreign exchange rates and they concluded that, the results seems heterogeneous, though the procedure of the correlations exhibit some similar traits for the currencies included in the study on a daily time scale, though alterations concerning the peripheral currency value is actually unaffected by the major currencies, but where there is more links between two countries economically their currencies are expected to follow the same trajectory.

Recently, Cristescu et al. (2012) used a new method which is known as the parameter motivated sliding window correlation analysis and the period covered was 1999–2011 and also applied daily currencies by using the GBP, RON, JPY, INR, SGD, KRW exchange rates to match the U.S. dollar. The results found by Cristescu et al gives strong evidence of correlation between the developed countries currencies but found no correlation for advanced countries as well as currencies for the less developed nations, though an obvious difference is found between the pre-and the post-crisis periods. However a different study by Gençay et al. (2001) using wavelet multiscaling came out with a different finding and his study realized JPY and DEM against the US dollar rate fluctuations followed distinct scaling laws at separate ranges since 1986 to 1996. The observation indicates market expectations are linked to the main exchange rates, namely GBP/USD, EUR/USD, and JPY/USD

Kearney and Patton (2005) investigated the exchange rate fluctuations in Europe prior to the beginning of the adoption of the euro by the countries that decided to use the common currency as against the main currencies in Europe, that is, German mark, Italian lira, ECU as well as the French franc. The results find volatility transmission support and the German mark as a leader.

In a related development, Antonakakis (2012) used the DCC model in examining return co-movements as well as the volatility spillovers for the main exchange rates prior to introducing the euro as well as after the implementation of the euro for the period 1986 to 2012. The study realized there are important return co-movements as well as volatility spillovers; however the degree in terms of average, is high before the euro period.

Much literature on exchange rates in Asia emerged when the Asian crisis dwindle during 1990s and focusing in that the region; Orlov (2009) examines the co-movements of exchange rates before and during the financial crisis period of 1996 to1998 by using nine countries time series on exchange rate for some countries in Asia. He used the cross-spectral method and discovered the crisis in Asia manifested in much high co-movements especially amongst high-frequency parts.

Liu et al. (2010) examine the level of asynchronous exchange rate returns for every two time series data by using the cross-sample entropy test and they find weak associations of exchange rates among the countries after the currency crisis in Asia, particularly for, Thailand, Taiwan, and Singapore and attributed that to policies change.

In a related development Feng et al. (2010) investigated the co-movements in exchange rates of some countries belonging to the Association of south East Asian nations by using the random matrix theory prior to the crisis in Asia, and before and after the reforms in China exchange rates. The study finds weak complementary relationship with currencies in Asia and the U.S. dollar after the crisis in Asia. Wang and Xie (2013) find important cross-correlations of the Chinese yuan exchange rate and Japanese yen, Euro, Korean won and the U.S. dollar. The study used cross-correlation techniques

Most Literature on exchange rates interdependence fail to capture the short, medium and long memory properties of exchange rates interdependence or co-movement, this study employs the wavelet multiple correlation and wavelet multiple cross correlation which is able to capture both the short, medium and the long run co-movements of exchange rates across different countries exchange rates. This method has an added advantage since it is able to observe the frequencies at different time scales.

In summing up the entire literature, it must be pointed out that, in spite of the growing issue of persistence and interdependence of interest rate, inflation rate and exchange rate, only a minor attention has been devoted to it in literature with majority of the extant studies focusing on the European Monetary Union.

The limited studies on interest rate, inflation rate and exchange rate persistence and interdependence on monetary union in the context of developing economies are the motivation for the study to use the case of WAMZ

Most of the in-reference citation of this study confirms that, the dynamics of interest rate, inflation rate, and exchange rate differed considerably across the Euro area before the start of the EMU. In line with the theoretical prediction, the study finds that the persistence especially on interest rate has decreased in the Euro area and that may be probably due to the effectiveness of the monetary policy of the European central bank.

It is against this background that, this study argues that ex-ante conditionality for the WAMZ would be difficult to achieve but there are prospects of monetary integration for the zone post ante only if effective monetary policy can be implemented.

For instance on inflation, the study can acknowledge that, only few studies, for example Alagidede et al (2010) seem to have explored the case of the WAMZ in an attempt to determine the extent to which the dynamic of inflation in the individual member countries of the WAMZ is dis (similar).

Again, it is against this background that the study aims to extend the literature on interest rate, inflation rate, and exchange rate persistence and interdependence for the WAMZ by exploring ARFIMA-FIGARCH and Multivariate wavelet that is consistent with time varying properties of macroeconomic variables and at the same time able to capture the short, the medium and the long term properties of the these variables.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

The feasibility study on the introduction of a single currency which is to be used by the countries that constitute the West African Monetary Zone is tested by this study using a multi-criteria approach. This study used two approaches for this test. The first approach test the degree of relationship of the macroeconomic variables, that is, interest rates, inflation rates and exchange rates in the West African Monetary Zone. The second approach is used to test how the variables, that is how interest rates co-move simultaneously across the West African Monetary Zone and how inflation rates co-move simultaneously across the Zone as well as how exchange rates co-move simultaneously across the West African Monetary Zone.

The first approach adopts persistence to assess the mean reversion of the macroeconomic variables when there is a shock and the second approach adopts interdependence to analyze the co-movements of interest rates, inflation rates as well as exchange rates across the Zone. The approaches adopted by this study are meant to assess whether the West African Monetary Zone in their quest for the introduction of a common currency is ready for the formation of a Monetary Union.

This chapter describes the variables used for the study and the type of data that is used. It also provides the source of the variables used for this study. It further gives the theoretical and empirical models employed by this study as well as the estimation method used to accomplish the set purposes and objectives of this study. This chapter again justifies the choice and the variables used in the model.

4.1 Data and Source

The data used for this study are secondary sources of data from the six countries that constitute the West African Monetary Zone i.e., Ghana, Guinea, Gambia, Nigeria, Sierra Leone and Liberia. These countries data consist of monthly time series from 2000 to 2018. The data used for the study was gleaned from the International Financial Statistics (IFS), which is an IMF data base and OxMetrics 7 and R. was used to analyze the data.

4.2 Proxy for each of the Variables

The study used lending rates as a proxy for interest rates for each of the six countries that constitute the West African Monetary Zone since inflation is also extensively studied in the same study. Consumer price index (CPI) is used as a proxy for inflation rates for the six countries' whiles each country's exchange rates against the US dollar is used as a proxy for exchange rates.

4.3 Justification of the variables

The study adopted interest rates, inflation rates and exchange rates as its variables because for monetary integration to be achieved, the area must be an optimum currency Area (OCA) and for an area to be termed an OCA according to Mundell (1961), First, there should be large and integrated labor market that gives workers the flexibility to move freely within the currency union to fill employment gaps. Secondly, there should be price and wage flexibility, together with capital mobility that would be necessary to mitigate trade imbalances. Since these two conditions are there, Robert Mundel talked about the fact that thirdly, there should be a centralized mechanism for fiscal transfers to countries that suffer as a result of labor and capital mobility. Lastly Mundel talks about the fact that participating countries should have similar business cycles which may be necessary to avoid a shock in any one area. For instance if

inflation and exchange rates disparities are high across the Zone, labor mobility is going to be affected and also if interest rates differentials are high, excessive capital mobility is going to be affected, hence the study justification for choosing these three variables to assess its relationship across the Zone.

4.4 Model Estimation

To investigate the relationship and interdependence of interest rates, inflation rates and exchange rates in the West African Monetary Zone, the study employed these estimation techniques.

4.4.1 The ARFIMA Model

Granger and Joyeux (1980) and Hosking (1981) introduced the Autogressive Fractional Integrated Moving Average model which is among the well-known parametric methods that's used in analyzing long memory properties of time series. ARFIMA model is the first to have a distinct component, which makes it possible for the distinguishing parameter to be a non-integer, and also considers the Fractional integration process *I* (*d*) that is in the conditional mean. Based on Hosking's model (1981), *d* is a non-standard distribution with the level of convergence much slower than the conventional rate of non-Fractional integration models. The ARFIMA (*p, d, q*) models have stationarity as well as invariability conditions and can be expressed as follows:

$$\emptyset(L)(1-L)^d\,(X_t-\mu)=\theta(L)\varepsilon_t \qquad (1)$$

$$\varepsilon_t = z_{t\sigma t^i} \qquad z_{t\sim N\,(0,1)} \qquad (2)$$

Where $\emptyset(L)=1-\emptyset_1\mathrm{L}-\emptyset_2\,L^2-\cdots-\emptyset_p\,L^P$ and $\theta\,(L)=1-\theta_I\,\mathrm{L}-\theta_2L^2-\cdots-\theta_PL^P$ are the Autoregressive and Moving Average polynomials where all the roots are situated outside of the

unit circle, d represent a fractional integration real number parameter, L represents the lag operator and ε_t is a white noise residual; $(1 - L)^d$ represents the fractional differencing lag operator.

If the ARFIMA model is $-0.5 < d < 0.5$, it means the process is stationary as well as invertible, and the impact of shocks ε_t decays at a slower rate to zero. If $d = 0$, then the process has a short memory, which means the effect of shocks declines geometrically. If $d = 1$, it means the unit root process is demonstrated. If $0 < d < 0.5$, it means the process has a long memory in order words it has positive long-term dependence and there is the presence of distant observations. If $-0.5 < d < 0$, the process exhibit intermediate memory and negative dependence known as anti-persistence. If $d \geq -0.5$, then the process is nonstationary, but if $d \leq -0.5$, the process is stationary but a non-invertible process, which makes it impossible to use the AR process to model time series.

The benefit of the FI long-memory models in relation to the mean and the standard deviation is they make the difference parameter I (d) to be a non-integer, which then gives more flexibility to the conventional whole number integration parameters of the autoregressive integrated moving average (ARIMA) and GARCH models. The distinct and enhance component makes the distinguishing'*d'* parameter to be a fraction.

4.4.2 The FIGARCH Model

Baillie et al. (1996) introduced the Fractionally Integrated Generalized Autogressive Conditional Heteroskedasticity model and expanded the traditional Generalized Autogressive Conditional Heteroskedasticity model to have fractional integration that would allow the differencing parameter d in the conditional variance to be a non-integer. The Fractionally Integrated Generalized Autogressive Conditional Heteroskedasticity model gives greater and more

flexibility in modeling long memory because it can differentiate the short-memory from the long-memory process in returns as well as the volatility of an econometric time series. The FIGARCH (*p*, *d*, *q*) model can be written as:

$$[\emptyset(L)(1-L)^d]\varepsilon_t^2 = \omega + [1-\beta(L)]\,(\varepsilon_t^2 - \sigma_t^2), \text{ or} \qquad (3)$$

$$\sigma_t^2 = \omega + \beta\ (\mathrm{L})\ \sigma_t^2 + [1-\beta(L)]\varepsilon_t^2 - \varphi\ (\mathrm{L})(1-L)^d\varepsilon_{t,}^2$$

$$= \omega[1-L]^{-L} + \lambda\ (\mathrm{L})\varepsilon_t^2$$

Where (L) represent the lag operator, $\lambda\ (L) = \sum_{i=1}\infty\lambda_i L^I\ and\ 0 \leq d \leq 1.\lambda\ (L)$ is an infinite summation that needs shortening in the applications and $(1-L)^d$ is the fractional differencing operator and it is defined as follows:

$$(1-L)^d = \sum_{k=0}^{\infty} \frac{\Gamma(\mathrm{d}+1)L^K}{\Gamma\ (\mathrm{K}+1)\Gamma\ (d-k+1)} \qquad (4)$$

$$= 1 - dl - \frac{1}{2}\mathrm{d}\ (1-L)\ L^2 - \frac{1}{6}\mathrm{d}\ (1-d)\ (2-d)L^3 - \ldots = 1\sum_{k=1}^{\infty} c_k\ (\mathrm{d})L^K$$

$$\text{Where } C_1\ (\mathrm{d}) = d, C_2\ (d)\ = (\frac{1}{2})\ \mathrm{d}\ (1-d)$$

The study used the multiple wavelet approach to analyze the objective two of this study which sought to determine the interdependence of interest rates, inflation rates and exchange rates across the West African Monetary Zone. The approach adopted to analyze the interdependence of the macroeconomic variables allow the study to assess simultaneously the co-movement of the time series at the frequency level and over time in the interest rate, inflation rate and exchange rate dynamics of the West African Monetary Zone countries. There are several methods to assess co-movement but among the widely used methodologies is the Vector Error Correction Model

(VECM). The shortfall of the VECM is that it is unable to accommodate the frequency and time-scale domain of time series whereas the wavelet captures both the frequency and time scale domain (Masih & Majid, 2013).

4.4.3 The Multivariate Wavelet Approach

This study employed the multivariate wavelet-based technique to examine the interdependence of interest rates across the West African Monetary Zone. The same method was applied to inflation rate and exchange rate as well across the zone. This approach was proposed by Fernandez-Macho (2012). The study chose this approach due to its ability to simultaneously capture the co-movement and contagion at the frequency level and across different time scales. (see; Morlet et al 1982 and Bekiros and Marcellino, 2013). The study classifies contagion as when there is strong wavelet coherence at higher frequencies and classifies interdependence as when there is strong wavelet coherence at the lower frequencies as used by Sati et al, 2016, Dewandaru et al, 2015 Bodart and Candelon, 2009, Vincent and Bertrand, 2005.

The wavelet multiple correlation and cross-correlation begins with the Maximal Overlap Discrete Wavelet Transform MODWT (see; Percival and Walden, 2000; Fernandez-Macho, 2012; Gençay, Selcuk, and Whitcher, 2001.) The MODWT is defined as follows:

Let $X_t = x_{1t,} x_{2t,}, ..., x_{nt}$ be a multivariate random process and $W_{jt} = w_{1jt,} w_{2jt,}, ..., w_{njt}$ represent their respective scale λ_j coefficients of the wavelets calculated by adopting the Maximal overlap discrete wavelet transform. The wavelet multiple correlations $(WMC)\psi X(\lambda_j)$ can be expressed as a single set of multiscale correlations from equation (1) subsequently.

$$\psi X(\lambda_j) = \sqrt{1 - \frac{1}{\max diag P_j^{-1}}} \qquad (1)$$

For each λ_j the square roots of the coefficients of determination of the regression formed by the linear combination of $w_{ijt,} i = 1,2,...,n$ variables for which the coefficient of determination is maximum. From extant literature, it is understood that for regression of a regressand z_t on a set of predictors $z_t \left\{ z_{k,} k \neq i \right\}$ a coefficient of determination can be procured as $R_i^2 = 1 - 1/\rho^{ii,}\, i^{th}$ diagonal element of the inverse of the complete correlation matrix $P.$ where P_j is the $(n \times n)$ correlation matrix of $W_{jt} = w_{1jt,} w_{2jt,}, ..., w_{njt}$ and maxdiag(.) elects the maximum element in the diagonal argument. From the regression theory; the fitted values of z_i as $\hat{z}_i$ WMC can also be expressed as equation (2), where w_{ij} is chosen to maximize $\psi X(\lambda_j)$ and $\hat{w}_{ijt}$ are the fitted values in the regression of w_{ij} on the rest of the wavelet coefficients at scale λ_j;

$$\psi X(\lambda_j) = \frac{Corr(w_{ijt}, \hat{w}_{ijt}) Cov(w_{ijt}, \hat{w}_{ijt})}{\sqrt{Var(w_{ijt}) Var(\hat{w}_{ijt})}} \qquad (2)$$

The wavelet multiple cross-correlation (WMCC) in equation 3 is generated by allowing a lag τ between observed and fitted values of the variables at each scale λ_j;

$$\psi X(\lambda_j) = Corr(w_{ijt}, \hat{w}_{ijt+\tau}) = \frac{Cov(w_{ijt}, \hat{w}_{ijt+\tau})}{\sqrt{Var(w_{ijt}) Var(\hat{w}_{ijt+\tau})}} \qquad (3)$$

Confidence intervals (CI) from WMC are computed using the Fisher (1915) transformation defined as $\arctan h(r)$, where $\arctan h(*)$ is the inverse hyperbolic tangent function.

For a complete reading on WMCC, WMC, MODWT, DWT, (see Carmona et al., 1998, Fern´andez-Macho, 2012; Tiware et al., 2013 In and Kim, 2013; Nason, 2010).

4.5 Time Series Unit Root Test

Stochastic trends or deterministic trends are usually associated with macroeconomic time series which indicates that most financial data possess random walk which indicates the presence of unit root that is non-stationary data. Without testing for the presence of unit root, most financial data may yield spurious results when one runs estimation with these series. Time series data becomes stationary when the mean, the variance and autocorrelation structure of the series remain constant over time. When these variables are stationary it is said to possess no unit root (Veerbek 2004).

The test to check for unit root is basically to assess if the time series under consideration has the same mean, variance and autocorrelation (i.e. stationary) or otherwise and also to determine its level of integration. The Kwiatkowski, Phillips, Schmidt, and Shin (1992) test is used to test whether the time series data is stationary by applying the R software.

In using KPSS test to check for stationarity, the null hypothesis states that the time series under consideration is stationarity, that is, it has no unit root and it is tested against the alternative of non-stationarity which means the time series possess a random walk hence the presence of a unit root. However if the results from the KPSS test rejects the null hypothesis of stationarity in levels, it means the time series possess unit root. With such a scenario, the study then proceeds to determine the level of integration by differencing the variable. If the KPSS test shows one unit root after the first difference, it means the series is integrated of order I (1), in a more appropriate statement, it means the level of integration is of order one I (1). However if the results from the KPSS test reject the null hypothesis of stationarity in levels and first differences and again proceed to rejects the null hypothesis test in second differences, it means the series possess two unit roots and it is integrated of order two I (2) (Verbeek 2004).

4.6 Conclusion

This chapter analyzed the various methods of assessing the feasibility of the introduction of a single currency to be used by all members that constitute the West African Monetary Zone. The time series used are monthly data from the six countries that constitute the West African Monetary Zone. The study made the assessment by employing multi criteria approaches of ARFIMA-FIGARCH and wavelet methodologies. The assessment of the similarities of the macroeconomic variables across the West African Monetary Zone is based on the degree of relationship which is measured by the level of persistence while that of co-movement of the variables are based on interdependence. To overcome spurious estimations, the time series data were tested for unit root using the KPSS where necessary.

CHAPTER FIVE

ESTIMATION AND DISCUSSION OF THE RESULTS

5.0 Introduction

This chapter presents the estimations results of both the ARFIMA-FIGARCH and the bivariate wavelet correlation and the wavelet multiple correlation as well as the wavelet multiple cross correlation. These methods are used to assess the feasibility of the introduction of a common currency for the West African Monetary Zone by using persistence and interdependence of interest rate, inflation rate and exchange rate of the countries that constitute the WAMZ. The persistence in this study is defined as when there is a shock to any of the macroeconomic variables, how long the shock will take to dissipate before the prices return to its steady state. This gives an indication of the similarities of the various macroeconomic variables of the respective countries and the interdependence gives a picture of the co-movement of the variables.

5.1 Persistence of interest rates, Inflation rates, Exchange rates

This section examines the degree of relationship of interest rate, inflation rate and exchange rate across the West African Monetary Zone countries.

5.2 Data description and statistical properties

The sample covers 1 January 2000–31 December 2018, giving a total of 227 observations for interest rates series and exchange rates series whiles inflations rates series have 226 observations. The study employs ARFIMA-FIGARCH model to reveal long-memory properties both in the conditional mean and in the conditional variance after a shock to interest rate, inflation rates and exchange rates of the respective WAMZ countries. The ARFIMA-FIGARCH is estimated using the normal distribution whiles the student distribution is used as a robustness check.

Kwiatkowski, Phillips, Schmidt, and Shin (1992) test was used to check for the stationarity of the monthly interest rates, inflation rates and exchange rates data. Table 2 below is the descriptive measures of interest rate, inflation rates and exchange rates series for the six countries.

Table 2: Descriptive/summary statistics

	Ghana	Guinea	Gambia	Nigeria	Sierra Leone	Liberia
Interest rate						
Mean	-7.653	-10.646	-25.128	-15.384	-18.574	-12.879
Variance	0.994	2.746	10.829	6.085	6.077	7.075
Skewness	-0.212	-4.235	-0.963	-1.422	-0.149	-1.282
Kurtosis	2.527	19.941	3.722	4.456	1.917	3.436
Number of observations	227	227	227	227	227	227
Log-Likelihood	30.176	533.334	-88.865	-102.118	-77.439	-150.583
Inflation rate						
Mean	0.010	-101.293	0.005	0.006	-0.003	0.025
Variance	2.184	4663.288	0.234	1.045	0.943	6.739
Skewness	-0.058	-0.462	0.276	-0.004	0.577	0.523
Kurtosis	8.661	1.875	9.063	4.519	22.206	4.959
Number of observations	226	226	226	226	226	226
Log Likelihood	-307.303	-493.678	-106.621	-277.499	-193.022	-460.449
Exchange rate						
Mean	0.011	-5261.564	-27.258	-157.022	-3911.546	-0.001
Variance	0.001	6194939.68	91.092	3581.194	2849632.56	9.808
Skewness	-1.022	0.005	-0.206	-1.636	-1.003	-0.188
Kurtosis	26.424	1.730	2.304	4.412	3.176	8.873
Number of observations	227	227	227	227	227	227
Log likelihood	692.564	-1413.017	-346.399	-672.258	-1156.131	-463.157

Source*:* Estimations done by Oxmetrics 7

5.2.1 Summary Measures

Table 2 above shows the summary statistics of the six countries that constitute the West African Monetary Zone. The study largely concentrated on skewness and kurtosis to assess the normality of the data distribution.

Skewness and kurtosis are functions of the third and fourth moments, respectively. Skewness gives information on the asymmetry of a distribution where symmetric distributions have zero skewness. Positive skewness means that distribution is skewed to the right and negative skewness means the opposite.

Kurtosis provides information on the"peakedness" of a distribution. If kurtosis is small, this implies the density function is relatively flat near its center. If Kurtosis is large, then density is peaked near the center. Equivalently, Kurtosis provides information on the fatness of a distributional tails. If kurtosis is small, it implies the distribution has fat tails and it is called Platykurtic, while if it is large it has thin tails and it is called Leptokurtic.

From the distributional measures in Table 2, all the monthly interest rates series for the six countries show negative skewness. A negatively skewed distribution characterizes the entire market system for the interest rate series. However, other things being equal and assuming rationality, investors in general would prefer assets with positive skewness, so there would be expected to trade at higher prices (or offer lower expected returns). The reason is that investors would be willing to pay a premium for assets whose return distributions are concentrated on the positive. Again investors commonly use standard deviation to predict future returns. On interest rate market, Ghana has less risk as shown by the variance which is 0.994; this implies that investors are likely to face little risk on their investment and this is as a result of stable monetary

policy for the country. Liberia, Nigeria and Sierra Leone has variance of 7.075, 6.085 and 6.077 respectively which indicates the risk level of interest rate market across the zone whiles Guinea experience moderate risk of 2.746 as shown by the variance

From the distributional measures on inflation rates series, Ghana, Guinea and Nigeria have negative skewness whiles the rest of the countries have positive skewness albeit higher kurtosis for all countries except Guinea. Guinea's market seems to be the most volatile with a variance of 4663.288 whiles Gambia has the lowest variability of 0.234. Generally, the quest to fulfill the criteria of single-digit inflation, which is one of the main pre-requisites for joining the WAMZ monetary union, might be responsible for the relative lower inflation rates in the WAMZ member countries.

From the distributional measures on exchange rates series, all the monthly exchange rate for the six countries shows negative skewness except Guinea. A negatively skewed distribution characterizes the entire exchange rates market system except Guinea albeit higher kurtosis with the exception of Guinea. Again, on exchange rate market, Guinea has the highest risk with variance of 6194939.68. Making an assessment on these measures, based on the skewness and kurtosis; the study could assume or deduce a substantial transgression from normality for the monthly interest rates series, inflation rates series and exchange rate series for the countries.

5.2.2 Test for stationarity

In assessing as to whether the sampled interest rates series, inflation rates series and exchange rates series follow stationarity, the study employed the stationarity test of Kwiatkowski, Phillips, Schmidt, and Shin (1992). The KPSS test proposed by Kwiatkowski et al. (1992) is a Lagrange multiplier (LM) used to test the null hypothesis that a given observable series is level stationary

or stationary around a deterministic trend. This test takes the null hypothesis as a stationary process against the alternative hypothesis of unit root process. Table 3 below shows stationarity test on interest rates series, inflation rates series and exchange rate series for the six WAMZ countries

Table 3: Stationarity test

	Ghana	Guinea	Gambia	Nigeria	Sierra Leone	Liberia
Interest rate						
KPSS Trend	0.027832	0.076051	0.071534	0.051307	0.10128	0.079651
Truncation lag parameter	4	4	4	4	4	4
P-Value	0.1	0.1	0.1	0.1	0.1	0.1
Inflation rate						
KPSS Trend	0.15256	0.056469	0.24686	0.24908	0.35914	0.23702
Truncation lag parameter	4	4	4	4	4	4
P-Value	0.04453	0.1	0.01	0.01	0.01	0.01
Exchange rate						
KPSS Trend	0.085951	0.044652	0.059911	0.060398	0.10405	0.15665
Truncation lag parameter	4	4	4	4	4	4
P-Value	0.1	0.1	0.1	0.1	0.1	0.04113

Source: Estimations done by R

The KPSS has a null hypothesis that the variable is stationary. The null hypothesis of the other tests is a unit root as against an alternative hypothesis that the variable is stationary. That is a P-Value which is less than 0.05 rejects the null hypothesis of stationarity whiles a P-value greater than 0.05 accepts the null hypothesis of stationarity. All the series became stationary at first difference for the interest rates data whiles for inflation rates series; all the series became stationary at second difference except Guinea which became stationary at the first difference and for the exchange rate series, all the series became stationary at first difference except Liberia

which became stationary at second difference. KPSS Trend for stationarity was estimated using R software.

5.3 Results and discussion of interest rates Persistence

The study used the ARFIMA-FIGARCH framework which allows for long memory in the data. ARFIMA (p,d.q) and FIGARCH (1,d,1) models were estimated using Gaussian distribution or the normal distribution. Since most financial data hardly follows a normal distribution, the study employed the student distribution in addition as a robustness check. The estimations were done by using the OxMetrics software.

However the results of the student distribution are not different from the Gaussian distribution. The study thus report the normal distribution estimates whiles the results of the student distribution is found in **Appendix 1**.

When *d* parameter has values greater or equal to 0.5, the series does not have stationary covariance, and consequently it has infinite covariance as shown by Baillie *et al*. (1996). When *d* is between 0 and 0.5, the lag length increases the autocorrelations decay hyperbolically to zero which implies long memory, while when $d = 0$, decays exponentially to zero which implies short memory. If *d* is between -0.5 and 0, then it is usually identified as having intermediate memory, since autocorrelations are always negative.

In sum, Significance of *d* parameter is evidence of long memory.

Table 4 below shows the estimation of the ARFIMA-FIGARCH for the six countries interest rate. OxMetrics software was used for the estimation.

Table 4: Estimation results of ARFIMA-FIGARCH for interest rates across the WAMZ

	Ghana	Guinea	Gambia	Nigeria	Sierra Leone	Liberia
Interest rate						
Cst(M)	-5.111011	-9.313474	-25.336030	-0.505984	-18.749669	-16.918816
	(0.0685)	(0.0000)	(0.0000)	(0.9907)	(0.0496)	(0.0000)
d-Arfima	-0.380734	0.380539	-0.642757	1.023784	0.841837	1.000000
	(0.0632)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
AR(1)	0.993514	0.982028	0.958881	1.011885	0.949697	-0.069978
	(0.0000)	(0.0000)	(0.00000	(0.0000)	(0.0000)	(0.6736)
MA(1)	-0.195922	0.194557	0.443161	-0.969606	-0.842327	-0.651335
	(0.2273)	(0.8788)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Cst(v)	0.005277	0.000000	0.000000	0.009345	0.016393	0.000000
	(0.2085)	(1.0000)	(1.0000)	(0.0000)	(0.6696)	(1.0000)
d-Figarch	0.834642	0.999928	1.000000	1.385209	0.227475	0.595408
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0174)	(0.0000)
ARCH(Phi1)	-0.288162	0.167509	0.000000	0.190444	0.000000	0.000000
	(0.0083)	(0.6947)	(1.0000)	(0.0520)	(1.0000)	(1.0000)
GARCH(Beta1)	-0.494221	0.182950	0.178023	0.819397	0.069275	0.272670
	(0.0000)	(0.6651)	(0.5902)	(0.0000)	(0.9426)	(0.4317)

Note: p-values are reported in parentheses

Results in Table 4 display the estimated parameters of the ARFIMA-FIGARCH of interest rate for the WAMZ. From the table, it is strongly noticeable that, there is evidence of long-range dependence for Nigeria, Liberia and Sierra Leone with all having a parameter'*dm'* of 1.023784, 1.000000 and 0.841837 respectively which is significantly different from zero. It implies that Nigeria, Liberia and Sierra Leone experience long memory if there is a shock to interest rates in the respective countries while Ghana and Gambia which has a differencing parameter of -0.380734 and -0.642757 respectively experience intermediate memory if there is a shock to its interest rate and Guinea which has a parameter'*d'* of 0.380539 experience somehow moderate persistence. However, the nature of range-dependence fluctuates between mean-reverting

persistence and more probably long-run mean-reverting persistence for Ghana and Gambia respectively. . In both cases, that is Ghana and Gambia, shocks to the market would be transitory, but quicker reversions would be experienced by Ghana than Gambia. Nigeria and Liberia has a parameter which is'*d*'>1 which implies that its long memory is explosive and non-mean reverting.

For the conditional volatilities, Nigeria, Gambia, Guinea, Ghana and Liberia interest rate market series recorded extremely significant positive *dv* values of 1.385209, 1.000000, 0.999928, 0.834642 and 0.595408 respectively which signifies the presence of volatility persistence of the interest rate market, whiles Sierra Leone shows very less volatility persistence of 0.227475. The estimated value of *dv* is within the range of 0.227475 to 1.385209 for the monthly interest rate market Series.

5.4 Results and discussion of inflation rates Persistence

To model persistence in inflation rates across the six WAMZ countries and volatility simultaneously, the normal distribution methods are used to estimate the ARFIMA-FIGARCH model whiles the student distribution is used as a robustness check. The ARFIMA part of the equation provides a basis to test for market efficiency by examining the size of the fractional differencing term, *d*, in the mean equation.

In particular, *d* measures the adjustment speed (relative to a stationary ARIMA case where *d* = 0), that is the adjustment speed measured by the fractionally differencing term as a criterion. On the other hand, the FIGARCH part of the model captures long memory in the conditional variance (volatility) of the data. The ARFIMA (p, d, q)-FIGARCH (1, *d*, 1) models are estimated

and presented in table 5. Table 5 presents the complete ARFIMA-FIGARCH model estimation results on inflation rates for the WAMZ countries.

Table 5: Estimation results of ARFIMA-FIGARCH for inflation rates across the WAMZ

	Ghana	Guinea	Gambia	Nigeria	Sierra Leone	Liberia
Inflation						
Cst(M)	0.004889	-25.161736	0.004020	0.007238	0.009148	0.008369
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0096)	(0.0002)
d-Arfima	-1.086342	1.000000	-0.931644	-0.830985	-0.271184	-0.984259
	(0.0000)	(0.0000)	(0.0924)	(0.0000)	(0.0036)	(0.0000)
AR(1)	0.461684	-0.531736	0.777062	0.456907	0.103908	0.320516
	(0.0000)	(0.0000)	(0.0427)	(0.0090)	(0.4916)	(0.3618)
MA(1)	0.447647	0.355274	-0.434531	-0.255321	-0.834618	-0.201066
	(0.0000)	(0.0000)	(0.1156)	(0.1104)	(0.0000)	(0.5482)
Cst(V)	0.018579	1.457804	0.153728	0.192812	0.155463	0.104115
	(0.2374)	(0.0000)	(0.0976)	(0.4916)	(0.1842)	(0.2493)
d-Figarch	1.905383	0.016267	-0.030134	0.204049	0.580679	0.692969
	(0.0000)	(0.0000)	(0.7052)	(0.2913)	(0.0000)	(0.0065)
ARCH(Phi1)	-0.664494	0.947261	0.302045	-0.294449	-0.629150	0.173088
	(0.0010)	(0.0000)	(0.5038)	(0.0504)	(0.0000)	(0.3508)
GARCH(Beta1)	0.956158	0.005491	-0.034741	-0.125481	-0.710711	0.822152
	(0.0000)	(0.0000)	(0.6465)	(0.5234)	(0.0000)	(0.0000)

Note: p-values are reported in parentheses

Table 5 reports the results obtained using ARFIMA–FIGARCH model. The ARFIMA–FIGARCH model suggests moderate evidence of long memory in the inflation rates across the West African Monetary Zone countries since the long-memory parameter in the conditional mean equation *dm* has negative values except Guinea which has a *dm* of 1.000000 which suggest long memory. From the table, it is seen that when it comes to long-range dependence, moderate evidence is found for all the inflation rates market except Guinea. Moreover, the nature of range-dependence fluctuates between mean-reverting persistence, that is -0.271184 for Sierra Leone

and more probably long-run mean-reverting anti-persistence for Ghana with a differencing parameter of -1.086342.

The findings show all the countries experience anti-persistence except Guinea. The negative value of the fractional differencing parameter of inflation rates for most of the WAMZ indicates anti-persistence. This suggests that inflation rates temporarily swing away from the mean, which leads to a violation of weak-form of market efficiency.

The FIGARCH component of the model captures long memory in the conditional variance (volatility). The differencing parameter, *d* estimated by the FIGARCH component for inflation rates across the WAMZ ranges from 0.294449 to 1.905383 which indicates that some countries experience less volatility persistence whiles others experience high volatility persistence when there is a shock. For instance Gambia and Nigeria experience less volatility persistence with values ranging from -0.030134 and 0.204049 respectively whiles Sierra Leone experience moderate volatility with a value of 0.580679. Ghana has the highest volatility persistence of 1.905383. This implies that volatility is a nonstationary process and hence unpredictable for Ghana, Sierra Leone and Liberia. Again, the long memory parameter in the conditional variance equations is significantly different from zero for Ghana, Sierra Leone and Liberia.

5.5 Results and discussion of Exchange rates Persistence

In examining long-memory behavior of the exchange rates series of the WAMZ countries, the study used the ARFIMA-FIGARCH class of models in the analysis. Popularly known for its dual detection of memory properties in conditional mean and variance, the method has been found useful in several market analyses relating to persistence studies (B.K. Uludag, & Z. Lkhamazhapov, 2014). The ARFIMA-FIGARCH method, as introduced in the work of Baillie

et al. (1996) has flexibility powers to simultaneously capture finite long-term dependence or LM properties, in conditional returns and volatility shocks of market series, hence its popularity over classical GARCH-type models. Table 6 presents the complete ARFIMA-FIGARCH model estimation results on exchange rates for the WAMZ countries.

Table 6: Estimation results of ARFIMA-FIGARCH for exchange rates across the WAMZ

	Ghana	Guinea	Gambia	Nigeria	Sierra Leone	Liberia
Exchange rate						
Cst(M)	0.002164	-0.063146	-9.121211	-0.065365	-0.075165	0.003553
	(0.1174)	(0.9998)	(0.0000)	(0.9998)	(0.9999)	(0.0000)
d-Arfima	-0.397413	0.270717	1.639063	-0.322723	1.206639	-1.334133
	(0.0001)	(0.2428)	(0.0000)	(0.0561)	(0.0000)	(0.0000)
AR(1)	0.891795	0.999429	-0.489453	1.003670	0.999639	0.282376
	(0.0000)	(0.0000)	(0.0454)	(0.0000)	(0.0000)	(0.3452)
MA(1)	-0.146738	-0.197928	-0.744515	0.906631	-1.003172	0.114661
	(0.3496)	(0.1850)	(0.0000)	(0.0000)	(0.0000)	(0.6460)
Cst(v)	0.007329	100.0000	0.256614	0.466204	5.814791	0.350333
	(0.0000)	(0.7222)	(0.1444)	(0.0695)	(0.0090)	(0.3887)
d-Figarch	1.419746	0.597085	0.874350	1.400748	1.554736	0.552806
	(0.0000)	(0.2759)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ARCH(Phi1)	0.180563	1.000000	-0.976562	-0.278582	0.009501	-0.864474
	(0.0768)	(0.0000)	(0.0000)	(0.2211)	(0.9236)	(0.0000)
GARCH(Beta1)	0.955675	0.987325	-0.976001	0.897254	0.951966	-0.839406
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: p-values are reported in parentheses

Results in Table 6 display the estimated parameters of the ARFIMA-FIGARCH of exchange rate series of the West African Monetary Zone. From the table, it is clear that there is strong evidence of long-range dependence for Sierra Leone, Gambia and Guinea which has values significantly different from zero, which has differencing parameter values of 1.206639, 1.639063, and 0.270717 respectively which shows high persistence or long memory.

Ghana, Nigeria and Liberia have *'d'* parameter of -0.397414, -0.322723 and -1.334133 respectively which indicates anti-persistence or intermediate memory. Moreover, the nature of range-dependence fluctuates between mean-reverting persistence for the monthly exchange rate series and more probably long-run mean-reverting anti-persistence across the WAMZ countries. The evidence of Long memory properties could however not be discovered across board since some countries exhibit intermediate memory whiles others exhibit long memory.

When it comes to the conditional volatilities, all the exchange rate market series had highly significant positive *dv* values which range from 0.552806 to 1.419746 which signifies that there is volatility persistence in the entire market system of the West African Monetary Zone with Liberia experiencing somehow moderate volatility persistence. Sierra Leone has the highest volatility persistence of 1.554736 followed by Ghana with *dv* of 1.419746 and Nigeria having *dv* of 1.400748. However, the large significant *dv* values for the monthly exchange rate data for the WAMZ point out evidence of volatility persistence, overwhelmed with indubitable nonstationarity.

5.6 Conclusion

In this section, the Gaussian or normal distribution was employed to estimate ARFIMA-FIGARCH models to test for long memory in interest rates, inflation rates and exchange rates for the West African Monetary Zone countries. The study employed the student distribution as a robustness check since financial data hardly possess normal distribution. This section sought to find out the similarities of the macroeconomic variables of the countries that constitute the WAMZ by assessing the degree of integration when there is a shock to any of these variables and how long it will revert to the mean which invariably will in the long run give any indication of whether the six West African Monetary Zone countries have a certain degree of convergence or

divergence since one of the conditions for the WAMZ to introduce a single currency is to achieve convergence in these macroeconomic variables. The results from the ARFIMA-FIGARCH model for the three variables are mixed. The results show that, when there is a shock to interest rates among the West African Monetary Zone countries, most of the countries exhibit long memory. From the study it shows that when there is a shock to interest rate among the countries constituting West African Monetary Zone, Nigeria, Liberia and Sierra Leone has long memory, in other words, it will take longer time before it returns to the mean whiles Ghana and Gambia experience anti-persistence. Guinea seems to have moderate persistence. Similarities of interest rate persistence vary among the countries. Ghana, Gambia and Guinea seem to have shorter duration to the mean when there is a shock. Examining the similarities pertaining to the conditional volatility of interest rate for the WAMZ, it shows long persistence generally across the various countries. In other words, synchronization of interest rates across the WAMZ will be difficult to achieve since some countries even show very high persistent and non-mean reverting.

On inflation rates persistence, The results are not different from the interest rate persistent, again, the results shows that when there is a shock to inflation rates, almost all the countries show intermediate memory except Guinea, that is the reversion to the mean is somehow moderate and not very long but the volatility of the return to the mean of the respective countries inflation rates differs. Some exhibit low volatility persistence whiles others show moderate and high volatility persistence. The similarities among the countries in relation to shocks to inflation rates are not encouraging, which is a yardstick to measure the level of convergence among the countries inflation rates.

On exchange rate persistence, similar pattern follows, the results are mixed. When there is shock to exchange rate among the countries, some countries exhibit intermediate memory, that is, the

reversion to the mean is somehow moderate or not long but conditional volatility is high. For example, Ghana, Nigeria and Liberia show anti persistence or intermediate memory but have high volatility persistence. In summary, interest rate, inflation rate, and exchange rate persistence among the WAMZ countries vary and when there is a shock to any of the macroeconomic variables, its reversion to the mean and the conditional volatility of its return are mixed.

5.7 Data Analysis of Interdependence of interest rate, inflation rate and exchange rate

This section examines the co-movement of interest rate across the West African Monetary Zone and the co-movement of inflation rates across the West African Monetary zone as well as co-movement of exchange rate across the West African Monetary Zone. The section is divided into three sections. First, it examines the overall co-movement of interest rate across the West African Monetary Zone. Second, the study again examines the overall co-movement of inflation rates across the WAMZ and third, the study examines the overall co-movement of exchange rate across the WAMZ. The study employed the multiple wavelet approach.

5.8 Co-movement of interest rates, Inflation rates, Exchange rates

This section examines the interdependence or co-movement of interest rate, inflation rates and exchange rates independently and simultaneously across the West African Monetary Zone.

5.9 Data description and statistical properties

The sample covers 1 January 2000–31 December 2018, giving a total of 227 observations for interest rates series, inflation rates series and exchange rates series. The monthly interest rate series, monthly inflation rates series and monthly exchange rate series were all transformed into returns by taking the first difference of the logarithms as $r = lnpt - lnpt{-}1$, where pt and $pt{-}1$ are interest rate prices, inflation rates prices and exchange rates prices of the six countries

understudy at month t and t-1 respectively which reduces each series by one. The desirability of using returns rather than price series for analysis is extensively covered in extant literature.

Table 7: Descriptive/summary statistics

	Ghana	Guinea	Gambia	Nigeria	Sierra Leone	Liberia
Interest rate						
Min	-9.903	-18.947	-32.916	-23.114	-23.742	-20.256
Max	-5.737	-7.445	-20.566	-11.855	-14.593	-10.283
Mean	-7.563	-10.645	-25.128	-15.384	-18.574	-12.879
Std.Deviation	0.999	1.661	3.298	2.472	2.471	2.665
Coef.Var	-0.131	-0.156	-0.131	-0.161	-0.133	-0.207
Skewness	-0.211	-4.207	-0.956	-1.413	-0.148	-1.274
Kurtosis	-0.495	16.765	0.688	1.416	-1.099	0.406
Normtest.W	0.982	0.239	0.848	0.840	-1.099	0.406
Normtest.P	0.0063	0	0	0	0	0
Observation	227	227	227	227	227	227
Inflation rate						
Min	-255.68	-243.122	-159.512	-244.698	-209.58	-238.546
Max	-14.856	-25.921	-46.982	-23.675	-68.173	-32.995
Mean	-99.425	-100.961	-94.087	-99.029	-100.164	-95.474
Std.Deviation	67.858	68.471	30.867	59.351	36.691	49.336
Coef.Var	-0.683	-0.678	-0.328	-0.599	-0.366	-0.516
Skewness	-0.788	-0.465	-0.309	-0.748	-1.186	-0.749
Kurtosis	-0.487	-1.138	-0.767	-0.428	0.628	-0.121
Normtest.W	0.902	0.891	0.961	0.916	0.828	0.931
Normtest.P	0	0	0	0	0	0
Observation	227	227	227	227	227	227
Exchange rate						
Min	-0.225	-9300.87	-46.602	-307.276	-8370.35	-152.821
Max	0.157	-1588.6	-9.166	-94.293	-1659.23	-34.745
Mean	0.011	-5261.56	-27.258	-157.022	-3911.55	-68.908
Std.Deviation	0.028	2494.464	9.565	59.975	1691.816	23.106
Coef.Var	2.532	-0.474	-0.351	-0.382	-0.433	-0.335
Skewness	-1.015	0.005	-0.205	-1.625	-0.996	-1.526
Kurtosis	23.192	-1.285	-0.716	1.373	0.148	2.724
Normtest.W	0.66	0.911	0.953	0.721	0.883	0.868
Normtest.P	0	0	0	0	0	0
Observation	227	227	227	227	227	227

Source: Estimation done by R

In Table 7, the study presents a descriptive statistics of interest rate, inflation rates and exchange rates across the West African Monetary Zone. The descriptive measures for interest rate are recorded as follows: Ghana and Gambia shares the highest and lowest mean of -7.563 and -25.128 respectively albeit negative means throughout the series. Concerning the riskiness of the interest rate market across the West African Monetary Zone, Gambia and Ghana recorded the highest and lowest unconditional volatility of 3.298 and 0.999 respectively and this is measured by the standard deviation. However all the series have negative skewness whiles Sierra Leone witness the most severe skewness to the left with coefficient of -0.148. In terms of severity of skewness, Ghana comes second after Sierra Leone with -0.211 whiles Gambia takes the third position with -0.956. Liberia, Nigeria and Guinea follows in that order of fourth, fifth and sixth with coefficient of -1.274, -1.413 and -4.207 respectively. Ghana and Sierra Leone have series that are platykurtic whiles Guinea, Gambia, Nigeria and Liberia have series that are leptokurtic with Sierra Leone with coefficient of -1.099 taking occupancy in terms of the lowest peak. Assessing the normality of the data using kurtosis and skewness, the series are not normal with thinner tails. The coefficient of variation (or instability) which is the rate of standard deviation to the mean indicates a general low variability or high degree of stability in all countries.

On inflation rates, Gambia and Guinea recorded the highest and lowest mean with coefficient of -94.087 and -100.961 respectively albeit negative means throughout the series. When it comes to how volatile the inflation rates markets are across the West African Monetary Zone, Guinea and Gambia recorded the highest and lowest unconditional volatility with coefficient of 68.471 and 30.867 respectively as measured by the standard deviation. In terms of skewness, all the series recorded negative skewness whiles the most severe skewness is experienced by Gambia to the left with coefficient of -0.309 which is followed by Guinea, Nigeria, Liberia, Ghana and Sierra

Leone with coefficient of-0.465, -0.748, -0.749, -0.788 and -1.186 respectively. All the inflation rates series have platykurtic with the exception of Sierra Leone which has leptokurtic with coefficient of 0.628 whiles Guinea possessed the lowest peak with coefficient of -1.138. Measuring the normality of the inflation rate series by using kurtosis and skewness, the series are not normal with thinner tails. The coefficient of variation (or instability) which is the ratio of standard deviation to the mean indicates a generally low variability or high degree of stability in all countries.

On exchange rates, the highest mean of 0.011 was recorded by Ghana as against the least of -5261.56 for Guinea, apart from Ghana that recorded a positive mean, all the rest recorded negative means for the exchange rate series. The highest and lowest in terms of exchange rate risk market was recorded by Guinea and Ghana with unconditional volatilities of 2494.464 and 0.028 respectively. This is measured by the standard deviation. In terms of skewness, all the series recorded negative skewness except Guinea which has positive skewness. Moreover Guinea again witnessed the most severe skewness with coefficient of 0.0054. Gambia, Sierra Leone, Ghana, Liberia and Nigeria follows in that order in terms of severity of skewness with coefficient of -0.205, -0.996, -1.015, -1.526 and -1.625 respectively. Ghana, Nigeria, Sierra Leone and Liberia all have leptokurtic representing 23.192, 1.373, 0.148 and 2.724. Guinea and Gambia have series that are platykurtic representing -1.285, -0.716 respectively whiles Guinea (-1.285) possess the lowest peak. By using kurtosis and skewness as a measure, the series are not normal with thinner tails. The coefficient of variation (or instability) which is the ratio of standard deviation to mean indicates a generally low variability or high degree of stability in all countries. Lastly, the Shapiro Wilk (SW) statistic rejects the null hypothesis of gaussianity in all the series for monthly frequencies for all countries.

5.10 Results and discussion of Interest rates interdependence

In exploring the wavelet multiple correlations and wavelet multiple cross-correlations of the monthly interest rates of the WAMZ countries, the returns series are broken down into distinct time scales by applying the W2CWM2C approach proposed by Polance-Martinez and Fernandez-Macho (2012) together with MODWT using 4 scale with Daubechies Least asymmetric wavelet. First the countries codes are Ghana (C1), Guinea (C2), Gambia (C3), Nigeria (4), Sierra Leone (C5) and Liberia (C6). The study therefore examines the overall movement of interest rate simultaneously for the six West African Monetary Zone countries.

First the study analyzes the pairwise correlations for the interest rates of the six countries constituting the West African Monetary Zone for the short, medium, and long-term. These are shown in Fig 1 below with Wavelet bivariate correlations matrix (01/01/2000–31/12/2018)

Fig 1: Bivariate wavelet correlations matrix of interest rates for the WAMZ

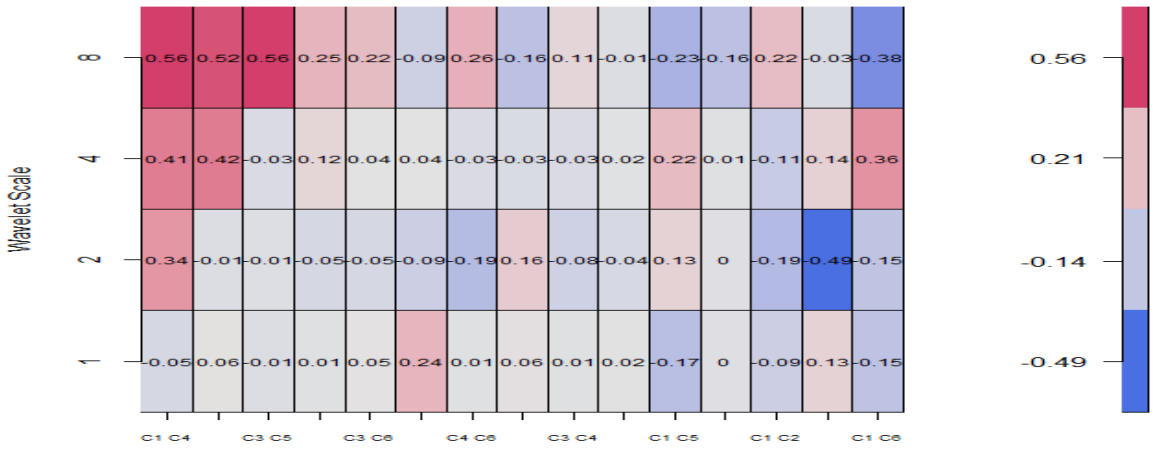


Fig 1 above is the interest rate wavelet bivariate correlations matrix (01/01/2000–31/12/2018). The codes for the variables are Ghana (C1), Guinea (C2), Gambia (C3), Nigeria (C4), Sierra Leone (C5) and Liberia (C6)

The combinations for the estimation of the wavelet correlation coefficients are displayed on the horizontal axis. The correlations amongst the pairs of interest rates become feeble as one navigates from left to right. The vertical axis on the wavelets scale indicates time periods. The color scale used in the figure indicates the strength of the bivariate wavelet correlation coefficients, from weak correlations in blue to strong ones in red.

The results sturdily portrays that the level of correlation across the various timescales varies. C1, C4 which represent Ghana and Nigeria has the highest degrees of correlations with coefficients which range from over 0.34 to 0.56 at different time-scales with an average of 0.32. The next in terms of high correlation is C3, C5 which represent Gambia and Sierra Leone with an average correlation of 0.13 (from -0.01 to 0.56). The next which is C3, C6 represents Gambia and Liberia which has average correlation of 0.01 (from 0.04 to 0.22), Nigeria and Liberia, that is C4, C6 has a correlation averaging 0.01 (from 0.01 to 0.26) which is same as the correlation of Gambia and Liberia, the next which is C3, C4 representing Gambia and Nigeria has an average correlation of around 0.003 (from 0.01 to 0.11) the study observe that C1 which is Ghana has an inverse correlation with or shows somewhat lower levels of correlation with most of the countries namely Sierra Leone, Guinea and Liberia with an average correlation of around -0.001, -0.04, -0.08 respectively.

In the short term, bivariate correlation between the countries are very weak, for example Ghana has negative correlation or inverse correlation with Nigeria, Guinea, Sierra Leone and Liberia with correlations -0.05, -0.09, -0.17, and -0.15 respectively. Assessing the bivariate correlation

from the lower scale which is at the highest frequency, one can observe that the degree of correlation is very low, but in the medium term, that is around scale 4, Ghana has high correlation with Nigeria and Liberia representing 0.41 and 0.36 respectively, the rest in the medium term still exhibit low levels of correlation. In the long term that is at lower frequency (higher scale), at scale 8, Ghana and Nigeria, C1, C4 has the highest correlation of 0.56 which is followed by Gambia and Sierra Leone, C3, C5 representing 0.52. Whiles Ghana and Liberia has 0.36 in the medium term, in the long term, the two countries have an inverse or negative correlation of -0.38. The rest has weak correlation even in the long term. Looking at this evidence, it suggests that the interest rates correlation vary among the countries.

The next section gives a graphical description of overall correlation of interest rates across the six countries which are shown in Fig.2

Fig 2: Wavelet Multiple Correlation of Interest rate across the WAMZ

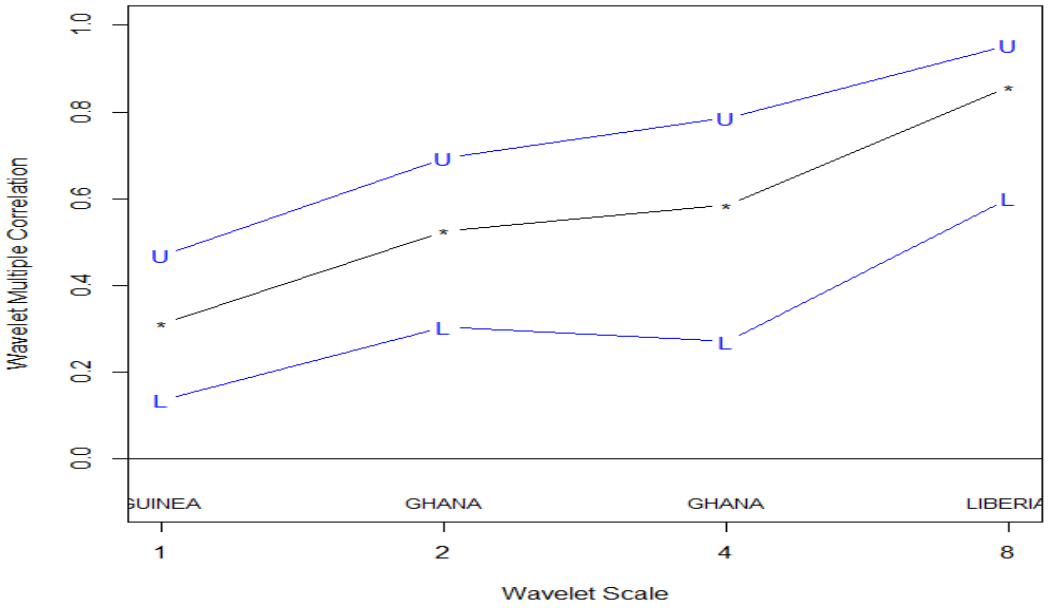


Fig.2. Wavelet multiple correlations of interest rates among the six countries' for the period 01/01/2000–31/12/2018. The blue lines are represented by the upper as well as the lower limits of 95% confidence interval. Figure 2 shows the graph results in terms of how the overall interest rates across the West African Monetary Zone co-move together across time.

The highest correlation of interest rate among the WAMZ seems to occur in the long run at 80% at scale 8. It is observe that at the lowest scale, overall co-movement or interdependence of interest rate is very low which is around 0.40 at the highest frequency, multiple correlation is seen to pick up slowly in the intermediate frequency with coefficient of around 0.50, which is the medium term. It is clearly seen that there is momentarily downwards pattern in overall interdependence as the markets witness the movement from scales 4 to 8, that is, getting to lowest frequency (higher scale) We can see that at the scale of 2-4, the correlation is just above 0.5, and it increases overall, reaching a value around 0.8 at the scale of 4-8. It implies that in the short run; around 50% of fluctuation in a particular market can be explained through the overall market behavior. And in the long run, almost the entire return movement of a market can be explained through other markets' behavior.

In the figure, you can see the corresponding country which currency maximizes the multiple correlation coefficients at that particular scale. As per the definition given by Macho, this is the potential leader/follower among the group at that particular scale. So, at a scale of 2-4 which is in the medium term, it is Ghana, that has the potential to lead. This movement shows that so far as interest rate is concerned, the WAMZ countries seem to have a reasonable correlation on a scale by scale basis. The scale depicts the overall correlation of interest rates across the six West African Monetary Zones. The overall correlation of interest rates shows an upward trend on a scale by scale basis. The fundamental rationale for the identified inconsistencies among the

interest rates for the WAMZ can be attributed to many factors and these factors often influence the market in terms of linkages over time.

The factors are ephemeral, in other words, they do not last for a long time and largely they are not limited to market occurrence or "events" such as shocks or surprises, etc., as well as other psychological factors. On the other hand, linkages in markets at the lower frequencies that have longer duration get manipulated by factors that happen at higher time scales. Principally these are macroeconomic in nature, and these tendencies have the ability to increase overall movement or interdependence of the markets at the long-run scales. Consequently, based on this argument, the differences in the markets as well as the low level of correlation of the interest rate across the WAMZ countries at the shorter scales do not constitute much surprise, since such occurrences could be attributed to different ephemeral variables. However, the evidence of high correlations experienced at the long-runs may be linked to the manipulation of macroeconomic factors such as the nature of monetary policy and business cycle, as well as inflation and market volatility, amongst others which causes makes market linkages to soar.

The graph in Figure 3 shows the result of the wavelet multiple cross-correlations in terms of the interest rate across the West African Monetary Zone at distinct wavelet scales and across time lags, which is up to 30 days. For each wavelet correlation, the multiple cross correlations are seen within 95% confidence interval. Portions which are in the confidence interval that spans zero are represented in white. The vertical black-dashed lines show the time lags by which the exact as well as the powerful correlation are localized. Localization is where there is maximum wavelet multiple correlations and this occurs in the linear combination of the interest rates for the WAMZ. The interest rate of a particular country that achieves the highest correlations then becomes the country that either lead or lag and the countries are represented on the WMCC heat

map. The heat map shows the strength of the wavelet correlation which is indicated from weak which has the blue-colored zone to perfect that is the red-colored zone. For each scale, the country that has the maximum combination of multiple cross-correlations over a linear combination of the remaining WAMZ interest rates is indicated at the right side of the scale. The WMCC shows both the time each country lead or lag as well as the actual lead or lag. The study can suggest tacitly that the country that leads may have a spillover effects on the other countries in terms of interest rates, this is because all localizations do not occur at the point of symmetry (i.e. zero time lags). Positive time lags are an indication of the interest rate of a country that lags whiles the opposite is true for negative time lags on the wavelet scales

Fig 3: Wavelet Multiple Cross Correlation of interest rates for the WAMZ

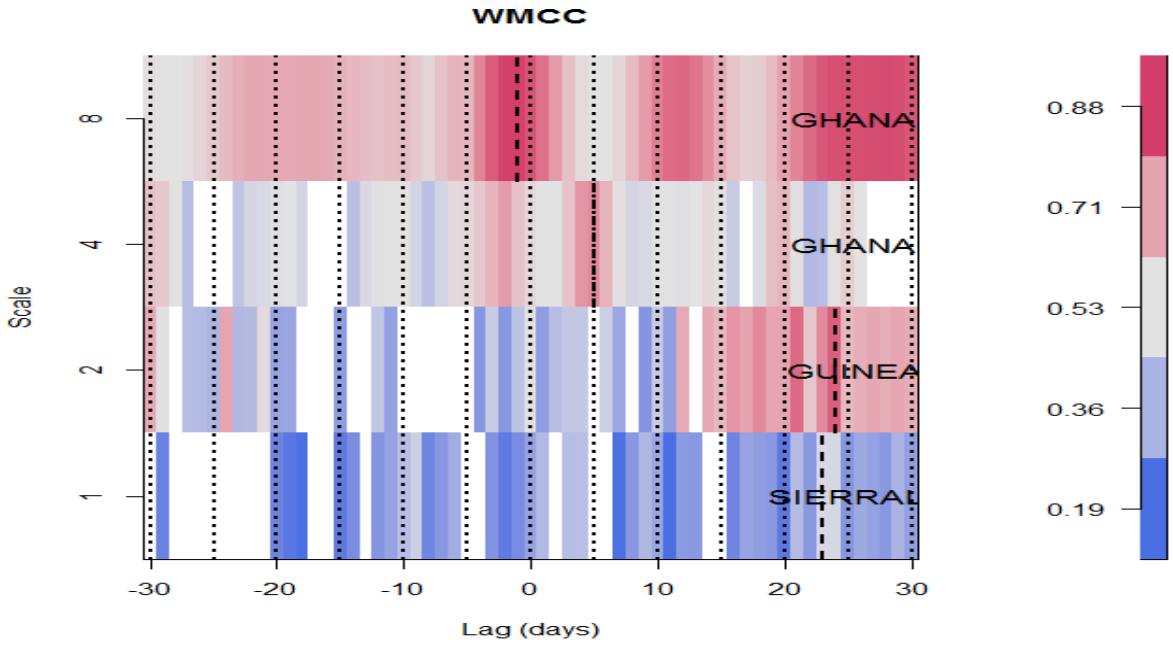


Fig.3. Wavelet multiple cross correlations of interest rates among the six countries' for the period 01/01/2000–31/12/2018

From Figure 3, the degree of correlation gets much weaker as one navigate from the highest to the lowest scale; the study again realized that the degree of integration becomes more weaker in the short-term, which is around the higher frequencies below wavelet scale 2. It is at the medium term that the study observes cross-correlations moving beyond 0.53 specifically around wavelet scale 2-4). These imply that when there is a shock in one market, its effects in other markets may be felt but with the passage of time since information flow between the markets may be slow.

Specifically, at the lowest scale, there is a conspicuous observation of much weakened correlations, observing the lower scale, it is realized that Sierra Leone has the potential to lag in terms of interest rates with coefficient of 23. Correlation slowly picks up as one ushers into the medium term with coefficient ranging from around 0.36 to around 0.71. In terms of the countries that show a brighter prospect to lag, Ghana and Guinea interest rate assumed that position for these periods. However, when it comes to the lowest frequency, which are at the highest scale wavelet correlations seems to have recorded significant coefficients throughout all time lags. Ghana interest rate has the potential to lead or lag at this period; this implies that, when there is a shock to interest rate in Ghana, it may have a spillover effect to other countries.

Nevertheless, in terms of actual lead/lag, the study find Ghana lead (at time -1) and the again Ghana Lag (at time 5) that is to say, Ghana has the maximum wavelet multiple correlations at these times. The study realized short transmissions to be slow and again seems to persist as they do not occur in the short-term, that is, at high frequencies. Ghana being the leader can be attributed to the fact that there is stable economy devoid of political interference like wars. However in the short term Guinea and Sierra Leone have the potential to lag (at time 24, 23 respectively).

5.11 Results and discussion of Inflation rates interdependence

This section delves into the wavelet multiple correlations and multiple cross-correlations of the monthly inflation rates of the WAMZ countries. The returns series are broken into distinct time scales by applying the W2CWM2C approach suggested by Polance-Martinez and Fernandez-Macho (2014) in addition to the MODWT using four scales with the Daubechies Least asymmetric wavelet.

First, this study analyze the pairwise correlations for the inflation rates of the six countries constituting the West African Monetary Zone for the short-, medium-, and long-term. Again the color scale used in the figure indicates the strength of the bivariate wavelet correlation coefficients, from weak correlations in blue to strong ones in red. These are presented in Fig 4 below with Wavelet bivariate correlations matrix (01/01/2000–31/12/2018).

Fig 4: Bivariate wavelet correlations matrix of inflation rates for the WAMZ

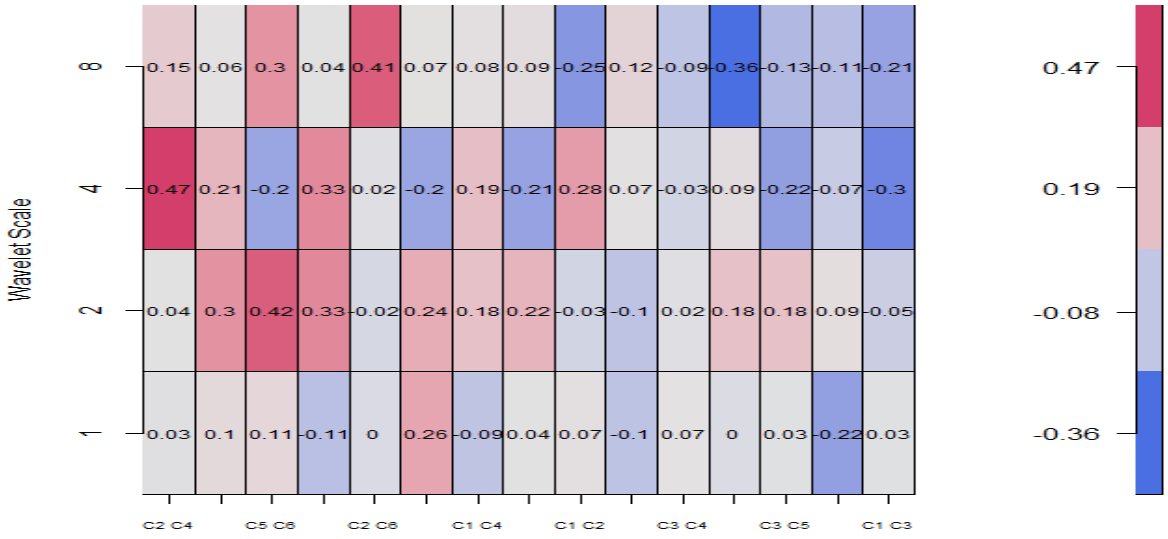


Fig 4 above with Wavelet bivariate correlations matrix (01/01/2000–31/12/2018)

The variables are coded as follows: Ghana (C1), Guinea (C2), Gambia (C3), Nigeria (4), Sierra Leone (C5) and Liberia (C6)

The combinations for estimating the wavelet correlation coefficients are represented on the horizontal axis. The correlations amid the pairs of inflation rates again get weaker as it moves from left to right. The time periods for the wavelet scales are represented on the vertical axis

The results indicate strongly again that the extent of correlation across timescales differs. Guinea and Nigeria exhibit the highest levels of correlations with coefficients range of 0.03 to 0.47 at various time-scales averaging 0.17. Sierra Leone and Liberia follows in terms of highest correlation after Guinea and Nigeria with an average correlation of 0.16 (from 0.11 to 0.42). The next which is C2, C6 represents Guinea and Liberia which has average correlation of 0.10 (from 0.02 to 0.41), followed by Ghana and Nigeria, that is C1, C4 with a correlation averaging 0.09 (from 0.08 to 0.19) the next which is C1, C2 representing Ghana and Guinea has an average correlation of around 0.018 (from 0.07 to 0.28) the study observe that C3 which is Gambia depicts negative or relatively lower levels of correlation with most of the countries namely Nigeria, Sierra Leone and Ghana with an average correlation of around -0.01, -0.04, -0.13 respectively.

In the short term bivariate correlation between the countries are generally low, the study realized that in the short term, that is at scale 2, Sierra Leone and Liberia has high correlation of 0.42. In the short term, that at the lower scale, bivariate correlation is seen to be weak, the weaker or lower correlation is again exhibited in the medium term, that is around scale 4, it is C2, C4 representing Guinea and Nigeria that has a high correlation of 0.47, which is followed by C1, C2, representing Ghana and Guinea which has a correlation of 0.28.

In the medium term, that is at a scale of 2 - 4, most of the countries exhibit negative or inverse correlation, for example C5, C6 which represent Sierra Leone and Liberia has a correlation of -0.2, while C3, which is Gambia has inverse or negative correlation with most of the countries namely Nigeria, Sierra Leone and Ghana with a negative correlation of -0.03, -0.22, and -0.3 respectively. The weaker correlation continues to the long term, at scale 8, which is at lower frequencies, most of the countries still exhibit very weak correlation. C2, C6 which represent Guinea and Liberia has a strong correlation of 0.41, followed by Ghana and Nigeria which has a correlation of 0.15. Again looking at this evidence, it suggests that the inflation rates correlation among the countries vary which is similar to the correlations of interest rates among the same countries. This implies that economic integration among the countries may be difficult to achieve. Implementation can thus be done in phases. The next section gives a graphical description of overall correlation of inflation rates across the six countries

Fig 5: Wavelet Multiple Correlation of Inflation rates across the WAMZ

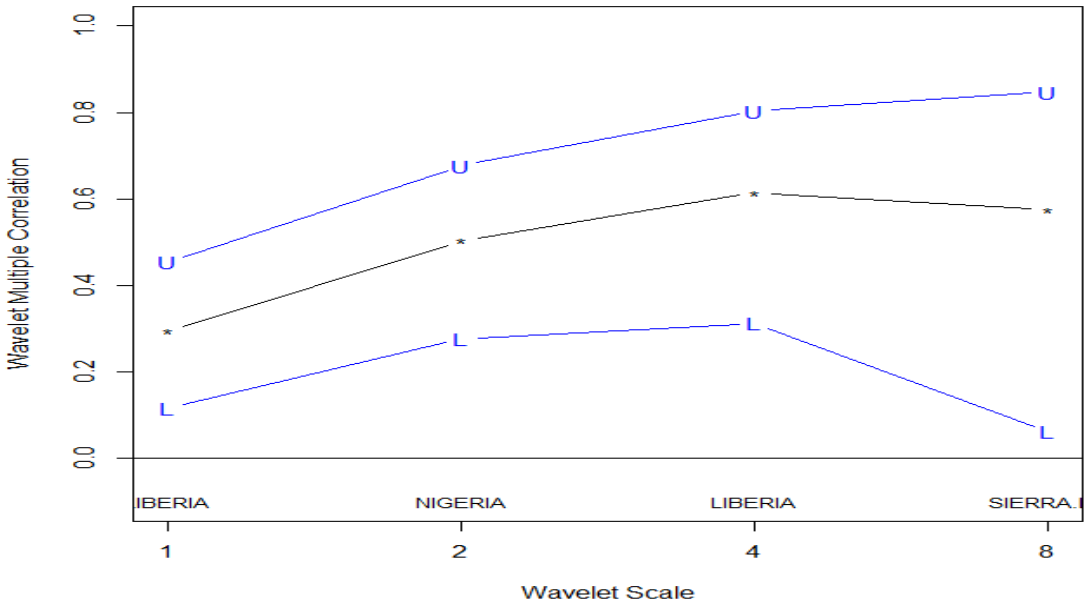


Fig.5. Wavelet multiple correlations of inflation rates among the six countries' for the period 01/01/2000–31/12/2018.

Again the 95% confidence interval with the upper and lower limits is represented by the blue lines respectively. Figure 5 shows the graph results of the wavelet in relation to the multiple correlations for the inflation rates returns for the WAMZ at 4 different time-scales.

The highest correlation of inflation rate among the WAMZ seems to occur in the medium term just below 60% at scale 4. Multiple correlation is noticeable actually low (0.40) at the lowest scale, that is the highest frequency at a scale of 1-2, but in the long term at around scale 8, correlation among the WAMZ inflation rates begins to decline to 0.5%, that's around 50% correlation. There is clear upward trend in terms of the degree of multiple correlations as the markets navigates from scales 2 to 4, until it begins to decline at the highest scale of 8, that is, getting to lowest frequency (higher scale)

We can see that at the scale of 2-4 months, the correlation is around 0.6%, that's around 60%, and it decreases overall, reaching a value around 0.5 at the scale of 4-8. It implies that in the short run; around 50% of fluctuation in a particular market can be explained through the overall market behavior. And in the long run, almost the entire return movement of a market can be explained through other markets' behavior.

In figure5, the study observes the corresponding country which inflation rate maximizes the multiple correlation coefficients at that particular scale. According to the definition given by Macho, this is the potential leader/follower among the group at that particular scale. So, at a scale of 2-4 which is in the medium term, it is Nigeria and Liberia respectively that has the potential to lead.

The scale depicts the overall correlation of inflation rates across the six West African Monetary Zones. The overall correlation of inflation shows an upward trend for some time until it drops to 0.5 again on a scale basis. Fig 6 shows the wavelet multiple cross correlation of inflation rates

Fig 6: Wavelet Multiple Cross Correlation of inflation rates for the WAMZ

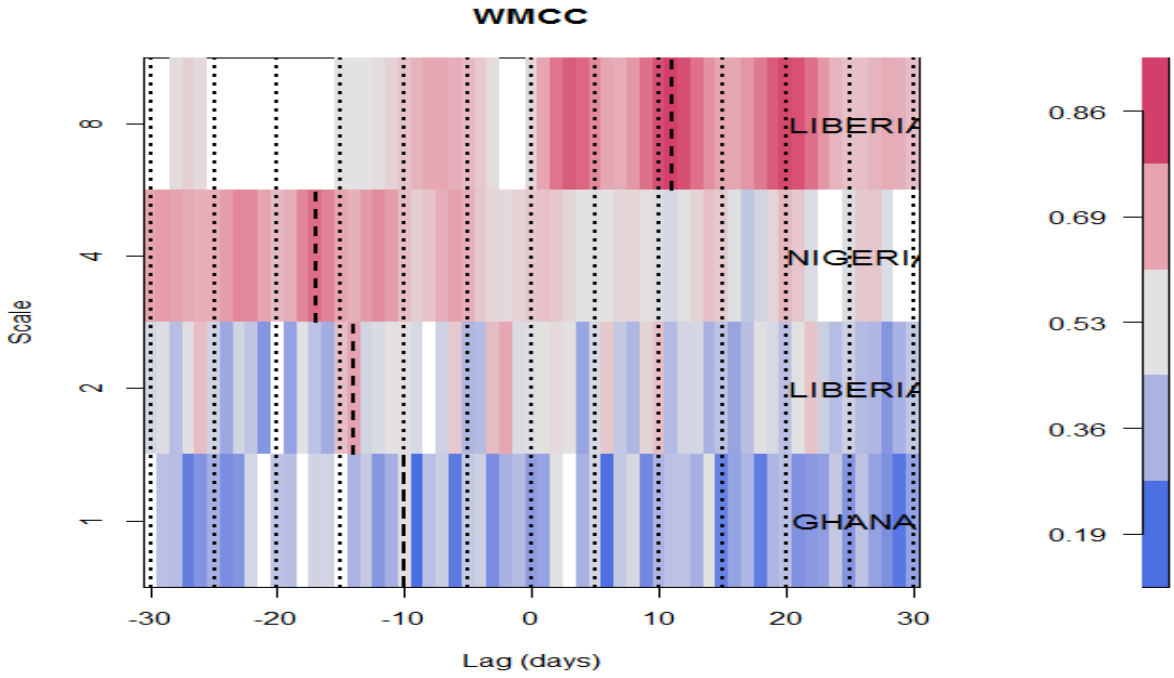


Fig.6. Wavelet multiple cross correlations of inflation rates among the six countries' for the period 01/01/2000–31/12/2018

Fig 6 presents the wavelet multiple cross-correlations for the inflation rates at different frequencies and across leads and lags up to 30 days. For each wavelet scale, the country that maximizes the cross-correlation over a linear combination of the remaining countries and the correlation at this localization are indicted. In the short term, that is at a scale of 1-2, there is not much correlation of inflation rates among the WAMZ countries. Again in the short term correlation is just around 0.19, which translate to around 19%. However in the medium term,

which is between scale 2 and 4, correlation among the countries inflation rate begins to move up. In the medium term, correlation is around 0.36 - 0.69, which in translation term is around 36% to 69%. However in the long term, correlation of inflation rates among the countries looks brighter at a rate of 0.86, which is 86% which is at scale 4-8. It means that at a lower frequency (high scale), correlation of inflation rates among the WAMZ countries is high but at a higher frequency (lower scale), correlation among the countries seems to be low and begin to rise in the medium term.

In terms of leading or lagging, in the short term, that is at a higher frequency Ghana has the potential to lead (at time -10), whereas in the medium term, Liberia has the potential to lead (at a time of -14), but getting to the twilight of the medium term, Nigeria has the potential to lead (at a time of -17). However in the long term, which is at a lower frequency, Liberia has the potential to lag (at a time of 11). These analyses suggest that information flow among the West African Monetary Zone countries is inefficient and as a result shocks that may be experienced by one market is likely to be transmitted to and felts in other markets with the passage of time.

5.12 Results and discussion of Exchange rates interdependence

To examine the wavelet both in relation to the multiple correlations as well as the multiple cross-correlations, the monthly exchange rate of the WAMZ countries against the US dollar returns series is broken down into distinct time scales by applying the W2CWM2C approach proposed by Polance-Martinez and Fernandez-Macho (2012) in addition to the MODWT by adopting a four scales with Daubechies Least asymmetric wavelet.

In this thesis, the wavelet multiple cross correlations for different time scales with 30 days are indicated by the new visualized plot whiles the wavelet multiple correlation is represented by the

graph. The graph of the wavelet multiple correlations makes it much easier to identify the symmetry of the correlations and the visualized plot also makes it a lot easier to identify the strength of wavelet multiple cross correlations.

Concerning the wavelet multiple cross correlation, the interpretation is made much easier, since the four plots are depicted on a single plot for easy visualization. Again, the time lag for which the strongest wavelet correlation is localized is precisely made easier. The localization is depicted by the vertical lines which has a long-dashed. Finally, the study thus identify as to whether the confidence interval spans zero particularly when the values are very near to zero. Again, one unique attribute of these plots is that they are able to identify the time lag at which the strongest or exact wavelet correlation coefficient is localized. This is represented by the vertical lines which are shown by the black dashed lines in the visualized plot.

Finally, the variable that maximizes the multiple cross-correlations against a linear combination of the remaining variables is shown visibly on the right side of each wavelet scale. The wavelet multiple cross-correlations for the exchange rates are estimated at different frequencies or wavelet scales as well as across time leads/lags up to 30 trading days. The wavelet coefficients are found within 95% confidence interval for each wavelet correlation.

In this section, the study analysis the monthly exchange rate returns by decomposing the series into several time scales using the Maximal Overlap Discrete Wavelet Transform (MODWT) with Daubechies Least asymmetric wavelet filters of length eight. First the study analyzes the pairwise correlations for the exchange rate of the six countries constituting the West African Monetary Zone against the US dollar. These are depicted in Fig 7 below with Wavelet bivariate correlations matrix (01/01/2000–31/12/2018). The codes for the variables are Ghana (C1), Guinea (C2), Gambia (C3), Nigeria (4), Sierra Leone (C5) and Liberia (C6)

Fig 7: Wavelet bivariate correlations matrix of Exchange rates for the WAMZ

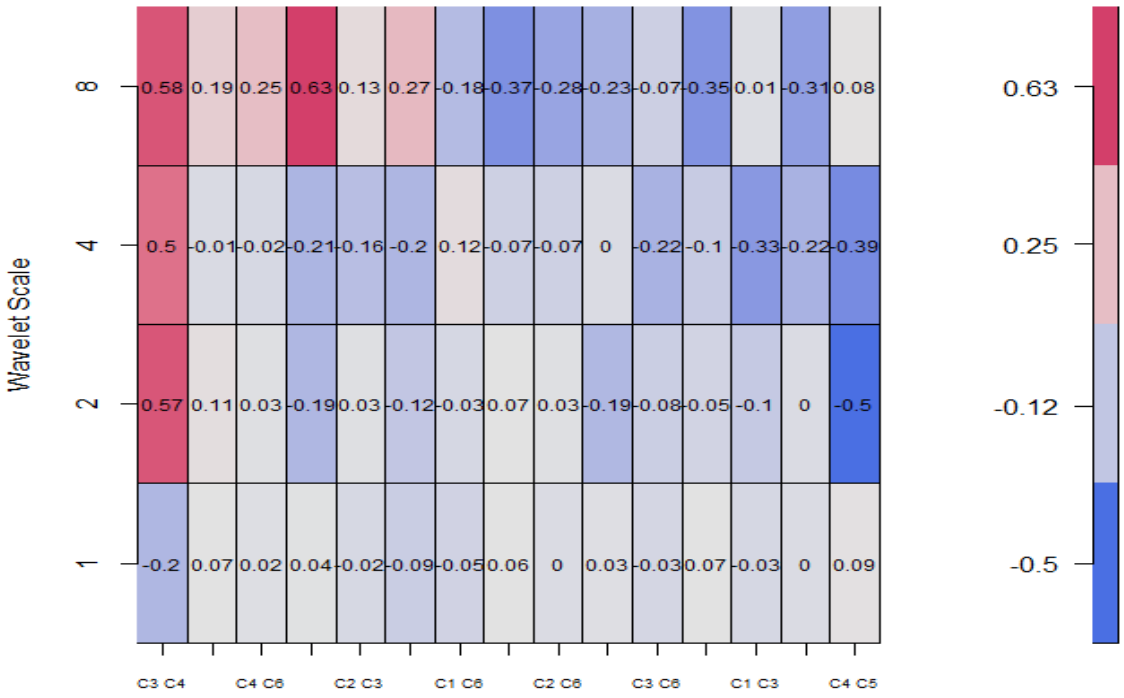


Fig7. Wavelet bivariate correlations of Exchange rates among the six countries' for the period 01/01/2000–31/12/2018

The combinations for the estimation of the wavelet correlation coefficients are represented by the horizontal axis. The correlations amidst the pairs of exchange rate get weaker as one navigate from left to right. The vertical axis on the wavelet scale represent time periods.

Fig. 7 presents the wavelet bivariate correlation matrix for exchange rate throughout the scales for the West African Monetary Zone. The results indicate strongly that the degree of correlation differs throughout the timescales. Gambia and Nigeria exhibit the highest levels of correlations with coefficients which vary from 0.5 to 0.58 at distinct time-scales which has an average of about 0.36. Nigeria and Liberia with an average correlation of 0.07 (from 0.02 to 0.25) follows

closely in second position in terms of highest correlation. The next which is C2, C3 represents Guinea and Gambia which has average correlation of -0.015 (from 0.03 to 0.13), followed by Ghana and Liberia with a correlation averaging -0.035 (from -0.5 to 0.12) the study realized that Liberia depicts relatively lower levels of correlation with all the exchange rates. The average correlations with Ghana, Guinea and Gambia are -0.035, -0.1025, -0.1, respectively. The correlation of Ghana and Gambia is -0.03 to 0.01, which averages -0.1125. Nigeria and Sierra Leone has a correlation of 0.09 to 10.08 averaging 2.32.This evidence suggests that the exchange rate correlation among the countries vary.

This analysis gives a clear picture that in the short run exchange rate correlation among the WAMZ countries as against the US dollar is extremely very weak. Some of the countries even exhibit inverse or negative correlation. This scenario is repeated in the medium term where the correlation is very weak as well. In the medium term at a scale of 2-4, the overall correlation is around -0.12 to around 0.25, it simply means that in the medium term exchange rate correlation among the countries is around 25%. It is only C3, C4 which represent Gambia and Nigeria that has a high correlation of 0.57, which is 57% in the medium term.

So far as exchange rate correlation among the WAMZ countries is concerned, a more weaker correlation is even found in the long run (that is, at a lower frequency) and again with only Gambia and Nigeria having a higher correlation of around 58%.

Gambia seems to have a higher correlation among the countries. This may be due to the fact that the country is the smallest in terms of population and as a result is not import led economy. The variation in exchange rate among the countries against the US dollar may be as a result of different fiscal policies for the participating countries. Fig 8 below is the Wavelet multiple correlation of exchange rates for the West African Monetary Zone.

Fig 8: Wavelet Multiple Correlation of Exchange rates across the WAMZ

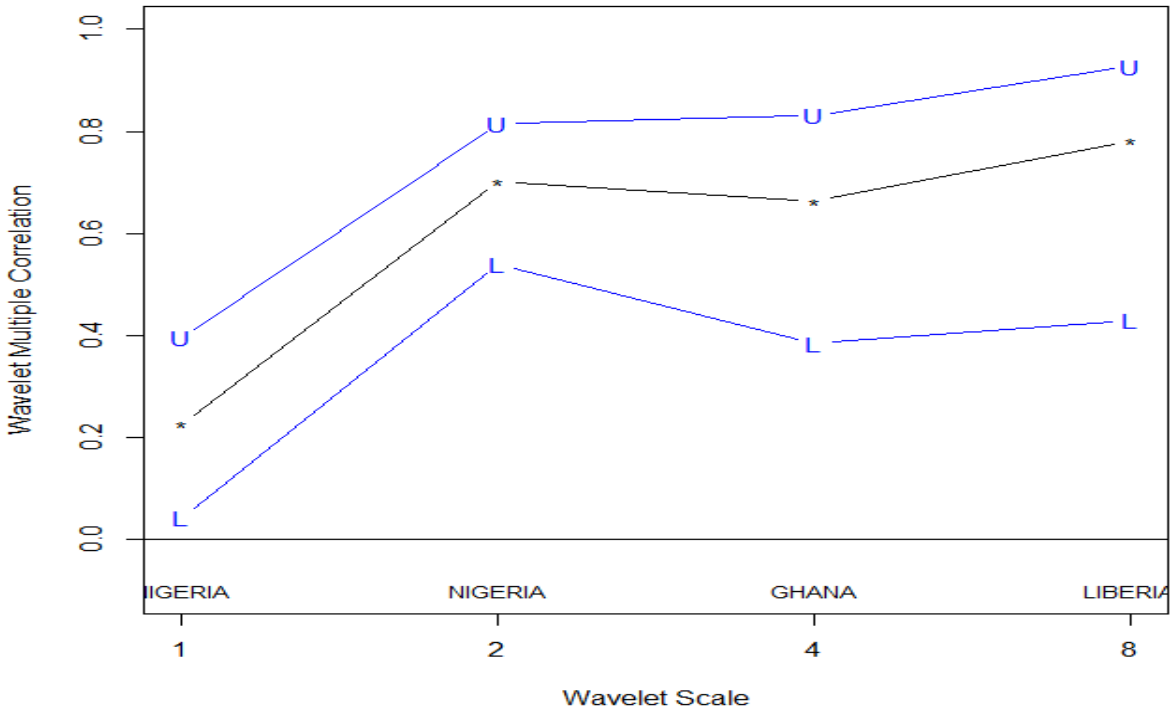


Fig.8. Wavelet multiple correlations of exchange rate among the six countries' currencies against the US dollar for the period 01/01/2000–31/12/2018.

Figure 8 shows the results of the wavelet multiple correlation for the exchange rates returns for the WAMZ at 4 distinct time-scales by the graph. The highest correlation of exchange rate among the WAMZ seems to occur in the medium term, which is around 70% at a scale of 2. Again getting to the end of the medium term, which is at scale 4, correlation declines a bit to around 0.61. The degree of correlation is seen to be weaken or much lower with coefficient of 0.20 at the lowest scale, that is at the highest frequency at a scale of 1-2, but in the long term at around scale 8, correlation among the WAMZ exchange rates is around 0.7%, that's around 70%

We can see that at the scale of 2-4, the correlation declines from 0.61 to around 0.6%, that's around 60%, and it increases overall, reaching a value around 0.7 at the scale of 8. It implies that in the short run; around 20% of fluctuation in a particular market can be explained through the overall market behavior. And in the long run, almost the entire return movement of a market can be explained through other markets' behavior. In figure 8, one can observe the corresponding country which exchange rate maximizes the multiple correlation coefficients at that particular scale. According to the definition given by Macho, this is the potential leader/follower among the group at that particular scale. So, at a scale of 2-4 which is in the medium term, it is Nigeria and Ghana respectively that has the potential to lead. The scale depicts the overall correlation of exchange rates across the six West African Monetary Zones. Fig 9 below is the wavelet multiple cross correlation of exchange rate for the West African Monetary Zone

Fig 9: Wavelet Multiple Cross Correlation of Exchange rates for the WAMZ

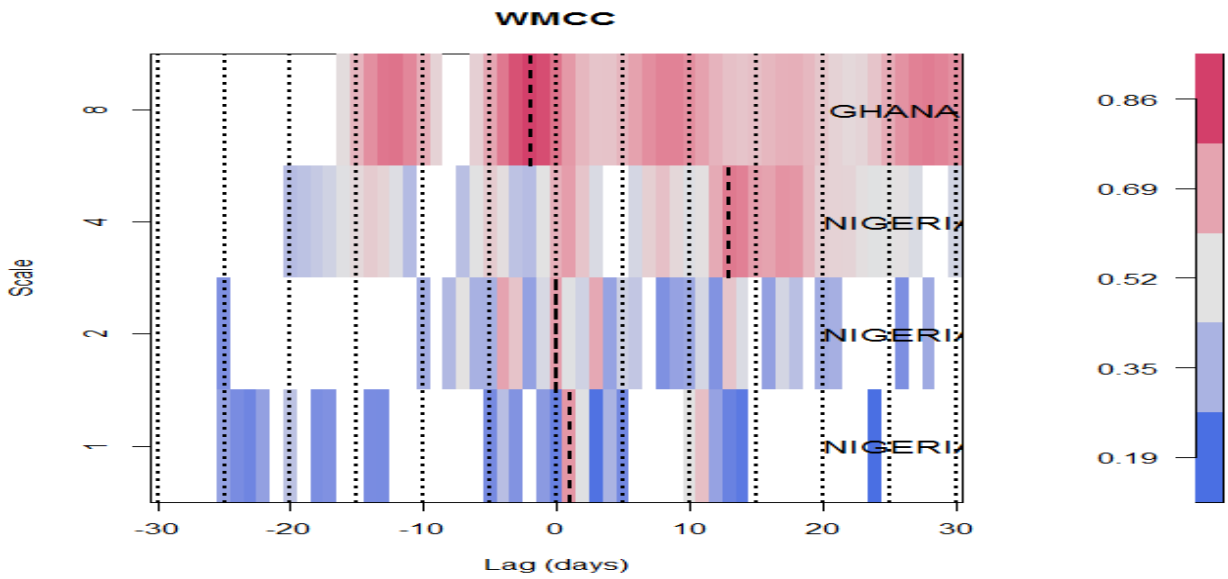


Fig9. Wavelet multiple cross-correlation of exchange rate for the six countries that constitute the WAMZ from 03/01/2000–31/12/2018

Fig9 present the wavelet multiple cross-correlations for the exchange rates at different frequencies and across leads and lags up to 30 days. For each wavelet scale, the country that maximizes the cross-correlation over a linear combination of the remaining countries and the correlation at this localization are indicted. In the short term, that is at a scale of 1-2, there is not much correlation of exchange rates among the WAMZ countries. Again in the short term correlation is just around 0.35, which translate to around 35%. However getting to the end of the medium term, which is at scale 4, correlation among the countries exchange rate begins to move up to around 0.69, which translates to 69%

However in the long term, correlation of exchange rates among the countries looks brighter at a rate of 0.86, which is 86% which is at scale 8. It means that at a lower frequency (high scale), correlation of exchange rates among the WAMZ countries is high but at a higher frequency (lower scale), correlation among the countries seems to be low and begin to rise in the medium term.

In terms of leading or lagging, in the short term, that is at a higher frequency Nigeria has the potential to lag (at time 0.1), whereas at the medium term, Nigeria again has the potential to lead or lag (at a time of 0 and 13), However in the long term, which is at a lower frequency, Ghana has the potential to lead (at a time of -3)

These analyses suggest that exchange rate among the WAMZ countries as against the US dollar varies, however during the long term correlation among the countries is somehow better which suggest that if information flow among the WAMZ countries is efficient , it may be transmitted to and felts in other markets with the passage of time.

5.13 Conclusion

In this section, the study assesses the co-movement of interest rates, inflation rates and exchange rates for the West African Monetary Zone countries. The study employed the wavelet multiple correlation and wavelet multiple cross correlation to determine the extent of interdependence of the macro economic variables for the West African Monetary Zone countries.

This section sought to find out the overall correlation of the macroeconomic variables of countries that constitute the West African Monetary Zone. The study sought to use the co-movement of these variables to measure if there is any indication of whether the six West African Monetary Zone countries have a certain degree of convergence or divergence since one of the conditions for the WAMZ to introduce a single currency is to achieve convergence in these macroeconomic variables. The results from the wavelets multiple correlations for the three variables are mixed.

This study used multivariate wavelet approaches to examine diagnostically the correlation and market interdependence of interest rates for the six West African Monetary Zone countries thus Ghana, Guinea, Gambia, Nigeria, Sierra Leone and Liberia markets. The monthly interest rates on lending returns are used as proxy for the respective countries.

These methods of WMC and WMCC do serve as robustness purposes to each other since they complement the other in terms of results and also address the shortcomings of the bivariate wavelet correlations.

This study summarizes the findings on interest rate interdependence among the WAMZ countries. First, the results indicate that degree of correlations varies across the timescales. The study shows that in the short run, co-movement of interest rates among the countries are weak,

thus multiple correlations are seen to have move up with the passage of time, that is there is a clear observation of movement from weaker correlations in the short-run, to moderate correlations and stronger correlations for the medium to the long-runs, respectively.

Ghana and Nigeria has the highest correlation from the short to the medium term and Gambia and Sierra Leone also has a higher correlation in the long term but during the short term correlation among the six countries is very weak. The study support the finding by Fujii and Chinn (2001) and Cavaglia (1992) whose findings indicate that in the short run interest rate parity seems to be weak but in the long run correlation among countries begins to move upwards. Second, the study again observed that even in the long run, correlation is not high among all countries but still very weak for most of the countries and Ghana interest rate has the potential to lead or lag in the medium to long term.

Third, the study finds that co-movement of interest rate among the WAMZ countries are overall weak, for instance Ghana has an inverse correlation with Sierra Leone, Guinea and Liberia in the short run. The study thus supports the findings by Wu and Fountas (2000), which suggest that there is bilateral interest rate co-movement among some countries which is seen among the West African Monetary Zone countries.

On inflation rate interdependence among the WAMZ countries (1) the results indicate that degree of correlations varies across the timescales. The study shows that in the short run, co-movement of inflation rates among the countries are very weak with only Guinea and Nigeria having a higher correlation of 0.47 whiles Sierra Leone and Liberia have 0.42 correlations at the end of the short term.

The study again finds that even in the long term, inflation rates correlation among the WAMZ countries are very weak as well, with only Guinea and Liberia having higher correlation in the long term. However generally, inflation rates correlations among the six countries are not encouraging both in the short, medium and long term.

When the overall correlation of inflation rates is viewed graphically, the picture seems to be the same as the bivariate pairwise correlation which again shows that, taking all the time scales into consideration, correlation of inflation rates among the West African Monetary Zone is very weak

However Liberia and Ghana has the potential to lead/lag in the short to medium term and in the medium to long term Nigeria and Liberia has the potential to lead/lag.
These findings supports studies by Ciccarelli eta al (2010), Monacelli et al (2009), and Neely et al (2008) that inflation deviations are as a result of global factors

On exchange rate interdependence among the WAMZ countries, first the results indicate that degree of correlations varies across the timescales. The study finds that exchange rate correlation among the West African Monetary Zone is very weak both in the short, medium and in the long term as well.

The weaker correlation is reflected in the sense that most countries have negative or inverse correlation both in all the time scales. Gambia and Nigeria has a high correlation of around 0.58 from the medium to the long term. This finding support Cristescu et al (2012) that correlation of exchange rate as against the US dollar for less developed countries is generally weak.

However when all the six countries exchange rate is depicted graphically as against the US dollar, the highest correlation among the countries seems to occur in the medium term, generally correlation is significantly very low in the short term.

In summary, interest rate, inflation rate, and exchange rate interdependence among the West African Monetary Zone countries vary and correlations of these variables for most of the countries are weak in the short run and in the long term, it is somehow in the medium term that, most of the macroeconomic variables among the countries are interdependent.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter summarizes the study on the degree of relationship of the macroeconomic variables of the West African Monetary Zone which is measured by persistence and interdependence of interest rates, inflation rates and exchange rates. The study makes conclusions and policy recommendation based on the research objectives for the West African Monetary Zone. The sections are grouped into two. Section 6.1 presents the summary and conclusion from this study and Section 6.2 enumerates some policy recommendations for the West African Monetary Zone from the summary and conclusion made from this study.

6.1 Summary and Conclusion

The overarching purpose of this study has been to examine diagnostically the preparedness of the West African Monetary Zone quest to create a monetary integration which will enable them to introduce a common currency by using persistence and interdependence of the macroeconomic fundamentals to measure the level of convergence or divergence of some of the primary and secondary criteria set by the West African Monetary Institute (WAMI).

Explicitly, this study attempted to identify the readiness for the establishment of a monetary integration as of the year 2020 using the three main macroeconomic indicators which is enshrined in the Macroeconomic Convergence Criteria.

The pertinent theoretical literature reviewed on this study demonstrate that, any aspiring countries that nurtures the formation of a monetary union should endeavor to establish an

Optimum Currency Area if such a region desires to reap the utmost benefits from such a Monetary Union. Theorists on Optimum Currency Area have suggested a number of prerequisite conditions for members willing to form a currency union to achieve. The convergence of macroeconomic indicators such as the variables been studied are some of the pre-conditions for countries nurturing the formation of monetary union to achieve.

The feasibility of achieving the proposed West African Monetary Zone by drawing from the experience of European Monetary Union (EMU) means that Monetary Union comes with costs and benefits for the integrating countries. A Monetary Union formation revolves around the theory of Optimum Currency Area (OCA) and WAMZ drawing its experience from EMU has the objective of fostering rapid integration of the six economies of West African countries into a monetary union.

Meanwhile, this objective has been hampered by weak macroeconomic policy coordination within the ECOWAS sub- region. Other key challenges include; the existence of trade barriers, unstable exchange rate, and money and capital flow contracts limiting formal intra-regional trade.

The West African Monetary Zone in its attempt to introduce a common currency formulated some objectives as a precondition that will enable the establishment of a Monetary Union or integration. The WAMZ used the Macroeconomic Convergence Criteria as their benchmark as a pre-condition for members to attain before the formation of the monetary union. The analysis depicts that under the reference period, that is as at the year 2020 per this study, the participating members that constitute the West African Monetary Zone are not prepared to form the Monetary Union based on the Macroeconomics Convergence Criteria benchmark which has inflation rates

among the primary criteria that participating countries should have a single digit inflation whiles among the secondary criteria, participating countries should have a stable exchange rate as well as a positive real interest rate.

This study has revealed that, these three macroeconomic variables behave differently across the West African Monetary Zone and as a result of that synchronization of the macroeconomic fundamentals will be difficult to achieve. To recap from the study, when there is a shock to any of the macroeconomic variables across the WAMZ, its reversion to the mean varies across the zone and again the speed at which it returns to the mean varies as well, that is the conditional volatility.

On the interdependence of the macroeconomic variables across the West African Monetary Zone, the study shows that the overall correlations of the three macroeconomic variables are weak both in the short, medium and long term. The study revealed that it will be cumbersome for all members that have signed to the WAMZ treaty to meet the set targets under the study's review.

The theoretical literature of this study is mainly based on the optimum currency theory and according to Mundell (1961) countries nurturing the formation of a currency union should satisfy the OCA criteria. Among some of the conditions are: there should be large and integrated labor market that gives workers the flexibility to move freely within the currency union to fill employment gaps and there should be price and wage flexibility, together with capital mobility that would be necessary to mitigate trade imbalances. There should be a centralized mechanism for fiscal transfers to countries that suffer as a result of labor and capital mobility.

Lastly Mundell talks about the fact that participating countries should have similar business cycles which may be necessary to avoid a shock in any one area.

The study revealed dissimilarities in the macroeconomic variables which show that labor mobility will be difficult as well as people migrating to fill employment gaps. This means that based on the critical examination of the conditions necessary for the creation an Optimum Currency Area as well as the thorough assessment of the macroeconomic fundamentals in the West African Monetary Zone, the obvious conclusion is that the Zone is not an Optimum Currency Area and also Monetary Union will be difficult to achieve or implement. This implies that the establishment of a monetary integration by the West African Monetary Zone at this stage, that is the year 2020 will not be beneficial.

However Rose and Frankel (1998) states that regardless of whether a region is an OCA or not, the introduction of a single currency expand trade amongst the member countries. That is to say the WAMZ must not necessarily become an Optimum Currency Area before such a region can introduce a single currency.

The understanding is that embracing a single currency will enable member countries to converge due to the trade intensity that may exist among them. In a very concise statement, the WAMZ can introduce or adopt the common currency without the zone necessarily becoming an OCA before introducing a single currency for that region.

However if the West African Monetary Zone wants to introduce a common currency, the results from the study objectives indicates that the introduction of a common currency can be executed in phases, by countries that have a higher degree of similarities, since similarities shows a certain

level of convergence whiles monetary, fiscal policies are strengthen for countries with less similarities.

6.2 Policy Recommendations

The study revealed that, it will be cumbersome for member countries to converge before the introduction of a single currency by the West African Monetary Zone. The study recommends based on empirical evidence that, the West African Monetary Zone should introduce monetary integration in phases that is countries that satisfy the macroeconomic convergence criteria can start the monetary union and gradually countries that later meet the requirement come on board as was done by the European Union. The European Union began with some countries and others came along by joining the EU later as and when they met the convergence criteria.

The study recommends that, the West African Monetary Zone can surmise that convergence can be realized or accomplished after the introduction of a common currency only if the West African Monetary Zone put in institutional measures that are robust based on theoretical and empirical evidence adduced by this study. This model was adopted by the West African Economic and Monetary Union (WAEMU), a regional bloc in Africa. The study revealed the dissimilarities behavior of the macro-economic variables across the WAMZ countries, this dissimilarities indicates that the level of intra-regional trade among the WAMZ is likely to be affected.

The study thus recommends for the WAMZ to remove all its impediments to trade within the region. Again, the study recommends that member countries should focus its resources in the industrial sector, which gives them comparative cost advantage in the areas of construction, manufacturing, and mining. Specialization within the zone can increase diversification of

products and also leads to the acceleration of intra-regional trade. Once the level of diversity in products goes up and trading among member countries also intensifies, players within the zone will be ready to transfer labor and capital freely from one region to the other and this will precipitate the increase in movement of economic activities and also encourage the opening of trading activities within the region. This may have a positive effect in the zone which invariably will enable the creation of the OCA which will bring a stable monetary integration. Nonetheless, the study recommends that labor mobility can be enhanced or increase swiftly across the Zone if member countries intensifies its national security level.

This study recommends based on the analysis on the research objectives that the feasibility of achieving a common currency should be anchored on strengthening the fiscal, monetary and exchange rate policies performances by all the integrating WAMZ countries and enforcement of the various regional agreements such as the ECOWAS trade liberalization scheme. The major stakeholders should adopt a realistic, pragmatic and gradual approach towards conducting the financial and monetary integration process.

However if the West African Monetary Zone wishes to inculcate some of the recommendations suggested by this study, then member countries should accept that the benefits from the formation of the monetary union may not be realized any time soon. This implies that the expected benefits may not be achieved in the short term and in the medium term as well. However, the benefit to be accrued in the long term is a possibility but not assured. This study adduced that if West African Monetary Zone institute both rigorous and vigorous institutional measures, it may precipitate the convergence of member countries' economies, however some countries within the zone might experience unfavorable economic environment and this may invariably retard economic growth and economic development within the region.

Lastly, this study suggests that there is more room for improvement that is if the West African Monetary Zone wishes to reap enough benefits from the monetary union. The West African Monetary Zone should have ample time in introducing the common currency for participating countries. The study make this suggestion because studies reveal that, the formation of the European union used almost 50 years for the preparation, however it is evidently clear that, the European union continue to suffer from economic downturns. If the European Monetary Union is experiencing some economic uncertainties despite the intensive preparations it instituted before commencement, it is an indication that the West African Monetary Zone must be cautious. The study thus recommend that, the West African Monetary Zone can learn from the blueprint of the European Monetary Union and institute pragmatic measures to avoid the mistakes encountered by the European Union.

REFERENCES

Alba, J. D. and Papell, D. H. (2007). Purchasing Power Parity and Country Characteristics: Evidence from Panel Data Tests. Journal of Development Economics, 83 (1), 240 – 251.

Achy, L. (2003). Parity Reversion Persistence in Real Exchange Rates: Middle Income Country Case. Applied Economics, 35 (5), 541–553.

Alagidede, P. Tweneboah, G., and Adam, A. M. (2008). Nominal Exchange Rates and Price Convergence in the West African Monetary Zone. International Journal of Business and Economics 7(3): 181–198.

Alagidede, P., Coleman, S. and J-C. Cuestas, (2011). Inflationary shocks and common economic trends: Implications for West African monetary union membership, *Journal of Policy Modeling*, 34(3), 460-475

Alesina, A. and R. J. B. (2002), "Currency Unions", *Quarterly Journal of Economics, 117 (2),* 409–436.

Antonakakis, N. 2012. "Exchange Return Co-Movements and Volatility Spillovers Before and after the Introduction of Euro." Journal of International Financial Markets, Institutions and Money 22, no. 5 (December): 1091–1109.

Asongu, S. (2014) REER imbalances and macroeconomic adjustments in the proposed West African Monetary Union. *South African Journal of Economics* 82 (2), 276-289.

Baharumshah, A. Z., Lau, E., and Nziramasanga, M. T. (2010). Purchasing Power Parity in African Countries: Evidence from Panel SURADF Test. South African Journal of Economics 78(1): 40–56.

Bekiros, S., & Marcellino, M. (2013). The Multiscale Causal Dynamics of Foreign Exchange Markets. *Journal of International Money and Finance*, 33, 282-305.

Baillie, R. T. and C.Morana, (2012), "Adaptive ARFIMA Models with Applications to Inflation,"*Economic Modelling*,29, 2451-2459.

Beechey, M. and P.Osterholm, (2009), "Time-Varying Inflation Persistence in the Euro Area,"*Economic Modelling*, 26, 532-535.

Becker, R., W.Enders, and J.Lee, (2006), "A Stationarity Test in the Presence of an Unknown Number of Smooth Breaks,"*Journal of Time Series Analysis*, 27, 381-409.

Bollerslev, T. (1986) Generalized autoregressive conditional heteroskedasticity, *Journal of Econometrics, 31*(3), 307–27.

Bahmani-Oskooee, M. 1998. "Do Exchange Rates Follow a Random Walk Process in Middle Eastern Countries?" Economics Letters 58, no. 3: 339-344

Baillie, R.T., Bollerslev, T., & Mikkelsen, H.O. (1996). Fractionally integrated generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics, 74*(1), 3–30.

Bodart, V., & Candelon, B. (2009). Evidence of Interdependence and Contagion using a Frequency Domain Framework. *Emerging Markets Review,* 10 (2), 140–50. doi: 10.1016/j.ememar.2008.11.003.

Bayoumi, T. (1994), "A Formal Model of Optimal Currency Areas," IMF Staff Paper 968, 41(4), 537-554

Bolat, S., Tiwari, A.K. and Kyophilavong (2017) Testing the inflation rates in MENA countries: Evidence from quantile regression approach and seasonal unit root test. Research in International Business and Finance

Calvet, L.E.; A.J. Fisher; and S.B Thompson. 2004. "Volatility Comovement: A Multifrequency Approach." Working Paper no. 300. National Bureau of Economic Research

Chang, T., O. Ranjbar, and D. P.Tang, (2013), "Revisiting the Mean Reversion of Inflation Rates for22 OECD Countries, *"Economic Modelling*, 30, 245-252.

Carmona, R., Hwang, W.-L., & Torresani, B. (1998). *Practical Time-Frequency Analysis: Gabor and Wavelet Transforms, with an Implementation in S* (Vol. 9). Academic Press.

Cutler, David M., Poterba, James M., and summers, Lawrence H., *Speculative dynamics*, Review of Economic Studies, 1991, 58, 529-546.

Cheung and Lai, K. S. (2000a). On Cross-Country Differences in the Persistence of Real Exchange Rates. Journal of International Economics, 50 (2), 375–397.

Cashin, P. and McDermott, C. J. (2006). Parity Reversion in Real Exchange Rates: Fast, Slow, or Not at All? IMF Staff Papers, 53 (1), 89–119.

Cheung and Lai (2008). Nominal Exchange Rate Flexibility and Real Exchange Rate Adjustment: New Evidence from Dual Exchange Rates in Developing Countries. Japan and the World Economy, 20 (3), 415–434.

C.J. Neely and D.E. Rapach, Real interest rate persistence: Evidence and implications, Federal Reserve Bank St. Louis Rev. 90 (2008), pp. 609–641.

Cavaglia S (1992) 'The persistence of real interest differentials: a Kalman filtering approach', Journal of Monetary Economics, 29, 429-43.

Chung S and Crowder W (2004) 'Why Are Real Interest Rates Not Equalized Internationally?, Southern Economic Journal, 71, 441-58.

Cumby R E and Mishkin F S (1986) 'The International Linkage of Real Interest Rates: The European-US Connection' Journal of International Money and Finance 5, 5-23

Chou, W. L.. (2006). "Convergence of Service Sector Employment in China: Panel Data Evidence", Discussion Paper in the *10th International Convention of the East Asian Economic Association*, 18-19November 2006, Beijing

Cham, T., (2009). “Is WAMZ an Optimum Currency Area (OCA)”? *West African Journal of Monetary and Economic Integration*, 9(2), pp. 96-120.

Cristescu, C.P.; C. Stan; E.I. Scarlat; T. Minea; and C.M. Cristescu. 2012. “Parameter Motivated Mutual Correlation Analysis: Application to the Study of Currency Exchange Rates Based on Intermittency Parameter and Hurst Exponent.” Physica A: Statistical Mechanics and Its Applications 391, no. 8 (April): 2623–2635

Ciccarelli M and B Mojon (2010), ‘Global Inflation’, The Review of Economics and Statistics, 92(3), pp 524–535.

Caner, M. and B.Hansen, (2001), “Threshold Autoregression with a Unit Root, *”Econometrica*, 69,1555-1596.

Coulibaly, I. and Gnimassoun, B. (2013) Optimality of a monetary union: new evidence from exchange rate misalignments in West Africa. *Economic Modelling* 32, 463-482.

Debrun, X., Masson, P. and Pattillo, C. (2005) Monetary union in West Africa: who might gain, who might lose, and why? *Canadian Journal of Economics/Revue canadienne d'économique* 38 (2), 454-481.

Dreger C and Schumacher C (2003) ‘Are Real Interest Rates Cointegrated? Further Evidence Based on Panel econometric Methods, Swiss Journal of Economics and Statistics 139, 41-53

Doyle, Michael W. ìKant, Liberal Legacies, and Foreign Affairs,î Parts 1 and 2. Philosophy and Public Affairs 12 (1983): 205-235, 324-353. ---. Ways of War and Peace: Realism, Liberalism, and Socialism. New York, NY: W. W. Norton, 1997.

Dewandaru, G., Masih, R., & Masih, A., M., M. (2015). Why is no Financial Crisis a Dress Rehearsal for the next? Exploring Contagious Heterogeneities across major Asian Stock

Markets. *Physica A: Statistical Mechanics and its Applications*, 419, 241–59. doi: 10.1016/j.physa.2014.10.046.

D.E. Rapach and C.E. Weber, Are real interest rates really nonstationary? New evidence from tests with good size and power, J. Macroecon. 26 (2004), pp. 409–430.

D.E. Rapach and M.E. Wohar, Regime changes in international real interest rates: Are they a monetary phenomenon? J. Money Credit Bank. 37 (2005), pp. 887–906.

Drozdz, S.; A.Z. Gorski; and J. Kwapien. 2007. "World Currency Exchange Rate Cross-Correlations." European Physical Journal B." 58, no. 4 (August): 499–502.

Engel, Charles and Morris, Charles S., *Challenges to Stock Market Efficiency: Evidence from Mean Reversion Studies*, Economic Review, 1991

Elliot, G. 1999. "Efficient Tests for a Unit Root When the Initial Observation Is Drawn from the Unconditional Distribution." International Economic Review

Froot and Rogoff (1995). Perspectives on PPP and Long-Run Real Exchange Rates. Handbook of International Economics, 3, 1647–1688.

Friedman, M. (1953). The Case for Flexible Exchange Rates. In M. Friedman (ed.), Essays in Positive Economics, University of Chicago Press

Frankel, J. A. and Andrew, K. R. (1998), "The Endogeneity of the Optimum Currency Area Criteria", *The Economic Journal, 108(449),* 1009-1025.

Felmingham B, Zhang Q and Healy T (2000) 'The Interdependence of Australian and Foreign Real Rates of Interest' Economic Record 76, 163-171

Feng, X.; H. Hu; and X. Wang. 2010. "The Evolutionary Synchronization of the Exchange Rate System in ASEAN+6." Physica A: Statistical Mechanics and Its Applications. 389, no. 24 (December): 5785–5793.

Fountas S and Wu J (1999) 'Testing for Real Interest Rate Convergence in European Countries' Scottish Journal of Political Economy 46, 158-174

Fujii E and Chinn M (2001) 'Real Interest Parity' Journal of International Financial Markets, Institutions and Money 11, 289 – 308

Fern´andez-Macho, J. (2012). Wavelet Multiple Correlation and Cross-Correlation: A Multiscale Analysis of Eurozone Stock Markets. *Physica A: Statistical Mechanics and its Applications*,391,1097-1104. http://www.sciencedirect.com/science/article/pii/S0378437111008375.

Gregory A and Hansen B (1996) 'Residual Based Tests for Cointegration in Models with Regime Shifts' Journal of Econometrics 70, 99-126

Granger, C., & Joyeux, R. (1980). An introduction to long memory time series models and fractional differencing. *Journal of Time Series Analysis*, *1*(1), 15–39.

Grubel, H. (1970), "The theory of Optimum Currency Area*", The Canadian Journal of Economics,* 3(2), 318-324.

Gençay, R.; F. Selçuk; and B. Whitcher. 2001. "Scaling Properties of Foreign Exchange Volatility." Physica A: Statistical Mechanics and Its Applications 289, nos.1–2 (January): 249–266.

Goodwin, B. And Grennes, (1994) Real interest rate equalization and the integration of international financial markets. Journal of International Money and Finance, 13, pp. 107

Gimpel, H. 2007. Preferences in negotiations: the attachment effect. New York: Springer Science & Business Media

Gençay, R., Selcuk, F., & Whitcher, B., J. (2001). *An Introduction to Wavelets and Other Filtering Methods in Finance and Economics.* Academic Press. Retrieved from https://books.google.com/books?

Giannellis,N.,(2013), "Asymmetric Behavior of Inflation Differentials in the Euro Area: Evidence from a Threshold Unit Root Test,"*Research in Economics*, 67, 133-144.

Holmes M J (2005) 'Integration or Independence? An Alternative Assessment of Real Interest Rate Linkages in the European Union', Economic Notes, 34, 407-27.

Hyvonen M (2004), 'Inflation Convergence Across Countries', RBA Research Discussion Paper No 2004-04.

Hosking, J. (1981). Fractional differencing. *Biometrika*, *68*(1), 165–76.

Husain, A. M., Mody, A. and Rogoff, K. S. (2005). Exchange Rate Regime Durability and Performance in Developing versus Advanced Economies. Journal of Monetary Economics, 52 (1), 35–64.

Henry, O. T. and K.Shields, (2004), "Is There a Unit Root in Inflation?"*Journal of Macroeconomics*, 26,481-500.

Ho, T.,(2009), "The Inflation Rates May Accelerate After All: Panel Evidence from19 OECD Economies,"*Empirical Economics*, 36, 55-64

Harvey, S. K. and Cushing, M. J. (2015) Is West African Monetary Zone (WAMZ) a common currency area? *Review of Development Finance* 5 (1), 53-63.

Inagaki, K. 2007. "Testing for Volatility Spillover between the British Pound and the Euro." Research in International Business and Finance 21, no. 2: 161–174.

In, F., & Kim, S. (2013). An Introduction to Wavelet Theory in Finance: A Wavelet Multiscale Approach. World Scientific. Retrieved from https://books.google.com/books?

J. Huizinga and F.S. Mishkin, Monetary regime shifts and the unusual behavior of real interest rates, Carnegie– Rochester Conf. Ser. Public Policy 24 (1986), pp. 231–274

J. Bai and P. Perron, Computation and analysis of multiple structural change models, J. Appl. Econ. 18 (2003), pp. 1–22.

J.R. Barth, G. Iden, and F.S. Russek, Do federal deficits really matter? Contemp. Econ. Policy 3 (1984), pp. 79–95

Jayaraman, T. K., Ward B. D. and Xu, Z. L.. (2007). "Are the Pacific Islands Ready for a Currency Union? An Empirical Study of Degree of Economic Convergence", *Journal of the Asia Pacific Economy Vol.12, No. 4,* 504–521.

K.S. Lai, The puzzling unit root in the real interest rate and its inconsistency with intertemporal consumption behavior, J. Int. Money Finance. 27 (2008), pp. 140–155

Kearney, C., and A.J. Patton. 2005. "Multivariate GARCH Modeling of Exchange Rate Volatility Transmission in the European Monetary System." Financial Review 35, no. 1 (February): 29–48.

Kargbo, J. M. (2003). Cointegration Tests of Purchasing Power Parity in Africa. World Development 31(10): 1673–1685

Kose MA, C Otrok and CH Whiteman (2003), 'International Business Cycles: World, Region and Country-Specific Factors', The American Economic Review, 93(4), pp 1216–1239.

Kenen, B. P. (1997), "Common Currencies versus Currency Areas", *The America Economics Review,* 87 (2), 211-213.

Kapetanios, G., Y. Shin, and A. Snell,(2003), "Testing for a Unit Root in the Nonlinear STAR Framework," *Journal of Econometrics*, 112, 359-379.

Koenker, R. and Z. Xiao, (2004), "Unit Root Quantile Autoregression Inference," *Journal of the American Statistical Association*, 99, 775-787.

Koenker, R. and Z. Xiao, (2004), "Unit Root Quantile Autoregression Inference," *Journal of the American Statistical Association*, 99, 775-787.

L.A. Gil-Alana, Long memory in the U.S. interest rate, Int. Rev. Financial 13 (2004), pp. 265–276] P.C.B. Phillips, Econometric analysis of Fisher's equation, Am. J. Econ. Sociol. 64 (2005), pp. 125–168.

L.P. Hansen and K.J. Singleton. Generalized instrumental variables estimation of nonlinear rational expectations models, Econometrica 50 (1982), pp. 1269–1286

Liu, L.-Z.; X.-Y.Qian; and H.-Y. Lu. 2010. "Cross-Sample Entropy of Foreign Exchange Time Series." Physica A: Statistical Mechanics and Its Applications 389, no. 21 (November): 4785–4792.

Mayoral, L. and Gadea, M. D. (2011). Aggregate Real Exchange Rate Persistence through the Lens of Sectoral Data. Journal of Monetary Economics, 58 (3), 290–304

Mustafaoglu, Z. 1999. "The Empirical Investigation of Purchasing Power Parity: The Case of Turkish Real Exchange Rates." Working Paper, State Planning Organization, Ankara

Metin, K. 1994. "A Test for Long-Run Purchasing Power Parity and Uncovered Interest Rate Parity: Turkish Case." Discussion Paper 94-2, Department of Economics, Bilkent University, Ankara

Monacelli T and L Sala (2009), 'The International Dimension of Inflation: Evidence from Disaggregated Consumer Price Data', Journal of Money, Credit and Banking, 41(Supplement s1), pp 101–120.

Mundell, R.A. 1961. A Theory of Optimum Currency Areas, *American Economic Review*, 51: 645-665

Morlet, J., Arens, G., Fourgeau, E., & Glad, D. (1982). Wave Propation and Sampling Theory-Part I: Complex signal and scattering in multilayered media. *GEOPHYSICS,* 47(2), 203-221. https://doi.org/10.1190/1.1441328.

Masih, M., & Majid, H. A. (2013). *Comovement of selected international stock market indices: A continuous wavelet transformation and cross wavelet transformation analysis*

Mckinnon, R. I. (1963), "Optimum Currency Area", American Review, 53, 117-725

Mkenda, K. B. (2001), "Is East Africa an Optimum Currency Area?" Working paper in Economics No. 41, School of Economics and Commercial Law, Goteborg University

Mongelli and F. P. (2008), "European Economic and Monetary and the Optimum Currency Area Theory", The European economy, Economic paper 302/ February

Masson, P. and Rusuhuzwa T. (2012), "Design and Implementation of a Common Currency Area in the East African Community"

Masson, P. R .(1996), "Fiscal Dimensions of EMU," *The Economic Journal*, 106 (July)

Masson Paul, Pattilo Catherine (2004), "A single Currency for Africa?" *Finance and Development, 41(4),* 9-15

Mumtaz H, S Simonelli and P Surico (2011), 'International Comovements, Business Cycle and Inflation: A Historical Perspective', Review of Economic Dynamics, 14(1), Special Issue: Sources of Business Cycles, pp 176–198.

Mourelle, E., J. C.Cuestas, and A.Gil-Alana, (2011), "Is There an Asymmetric Behavior in African Inflation? A Non-Linear Approach,"*South African Journal of Economics*, 79, 68-90

Martins, L. F. and P. M. M. Rodrigues, (2014), "Testing for Persistence Change in Fractionally Integrated Models: An Application to World Inflation Rates," *Computational Statistics and Data Analysis*, 76, 502-522.

Nikkinen, J.; P. Sahlström; and S. Vähämaa. 2006. "Implied Volatility Linkages among Major European Currencies." Journal of International Financial Markets, Institutions and Money 16, no. 2 (April): 87–103.

Narayan, P. K. and S.Popp, (2011), "An Application of a New Seasonal Unit Root Test to Inflation,"*International Review of Economics and Finance*, 20, 707-716.
Nason, G. (2010). Wavelet Methods in Statistics with R. Springer Science & Business Media.

Neely CJ and DE Rapach (2008), 'International Comovements in Inflation Rates and Country Characteristics', Federal Reserve Bank of St. Louis Working Paper No 2008-025F, rev March 2011.

Nurkse, R. (1944). International Currency Experience: Lessons of the Interwar Period. 4, League of Nations

Onwioduokit P. (2002) "Economic and Monetary Integration: Lessons from other Regions/Zone" A paper presented at WAIFEM-WAMI Regional Workshop on Economic Integration, May 19-23,

Oshikoya, T. W. (2010) *Monetary and financial integration in West Africa*. Routledge

Orlov, A.G. 2009. "A Cospectral Analysis of Exchange Rate Comovements during Asian Financial Crisis." Journal of International Financial Markets, Institutions and Money 19, no. 5 (December): 742–758

O. Pipatchaipoom and A. Smallwood. Persistence in the Real Interest Rate and the Effects of Calculating Expected Inflation, Unpublished Manuscript, University of Texas, Arlington, 2009.

Odedokun, M. O. (2000). Fulfillment of Purchasing Power Parity Conditions In Africa; The Differential Role of CFA And Non-CFA Membership. Journal of African Economies,9 (2): 213-234

Polachek, Solomon. "Conflict and Trade." Journal of Conflict Resolution (1980): 55-78.

Percival, D., B., & Walden, A., T. (2000). *Wavelet Methods for Time Series Analysis, vol. 4 of Cambridge Series in Statistical and Probabilistic Mathematics*, Cambridge University Press, Cambridge, UK.

R.J. Cebula, An empirical note on the impact of the federal budget deficit on ex ante real long-term interest rates, 1973–1995, South. Econ. J. 63 (1997), pp. 1094–1099.

R. Garcia and P. Perron, An analysis of the real interest rate under regime shifts, Rev. Econ. Stat. 78 (1996), pp. 111–125.

S. Das, R. Gupta, P.T. Kanda, M. Reid, C.K. Tipoy, and M.F. Zerihun, Real interest rate persistence in South Africa: Evidence and implications, Econ. Change Restruct. 47 (2014), pp. 41–62

Saiti, B., Bacha, O., I., & Masih, M. (2016). Testing the Conventional and Islamic Financial Market Contagion: Evidence from Wavelet Analysis. *Emerging Markets Finance and Trade*, 52(8), 1832-1849.

Seck, D. (2014). *Regional economic integration in West Africa|Diery Seck|Springer*. Springer International Publishing. Retrieved from https://www.springer.com/gp/ book/9783319012810

T. Caporale and K.B. Grier, Political regime change and the real interest rate, J. Money Credit Bank. 32 (2000), pp. 320–334.

Tsekrekos, A. E.; Yannacopoulos, A. N. 2016. Optimal switching decisions under stochastic volatility with fast mean reversion, European Journal of Operational Research 251(1): 148–157.

Tsong, C.-C. and C.-F.Lee, (2011), "Asymmetric Inflation Dynamics: Evidence from Quantile Regression Analysis," *Journal of Macroeconomics*, 33, 668-680.

Tavlas, G. S., (1993), "The 'New' Theory of Optimum Currency Areas", The World Economy, 16 (6), 663-685

T. Caporale and K.B. Grier, Inflation, presidents, fed chairs, and regime changes in the U.S. real interest rate, J. Money Credit Bank. 37 (2005), pp. 1153–1163.

Tiware, A., K., Dar, A., B., Bhanja, N., & Shah, A. (2013). Stock Market Integration in Asian Countries: Evidence from Wavelet Multiple Correlations. *Journal of Economic Integration*, 441-456.

Torrence, C., and G.P. Compo. 1998. "A Practical Guide to Wavelet Analysis." Bulletin of the American Meteorological Society 79, no. 1 (January): 61–78.

T. Engsted, Does the long-term interest rate predict future inflation? A multi-country analysis, Rev. Econ. Stat. 77 (1995), pp. 42–54.

Taylor, A. M. and Taylor, M. P. (2004). The Purchasing Power Parity Debate. Journal of Economic Perspectives, 18 (4), 135–158.

Telatar, E., and H. Kazdagli. 1998. "Re-examine the Long-Run Purchasing Power Parity Hypothesis for a High Inflation Country: The Case of Turkey." Applied Economics Letters 5, no. 1: 51-53

Temurlenk, (999). "Weak and Strong Forms Tests for Purchasing Power Parity: Evidence from Turkey." Ataturk Universitesi, Iktisadi ve Idari Bilimler Fakultesi Dergisi 13, no. 1: 197-206.

Throop, a. (1994). International financial market integration and linkages of national interest rates. Economic Review. Federal Reserve Bank of San Francisco, pp. 3 -18.

Tsangarides, C. G. and Qureshi, M. S. (2008) Monetary union membership in West Africa: A cluster analysis. *World Development* 36 (7), 1261-1279.

Uludag, B.K., Lkhamazhapov, Z., (2014). Long memory and structural breaks in the returns and volatility of gold: Evidence from Turkey. *Applied Economics*, 46:31, 3777-3787. DOI: 10.1080/00036846.2014.929627.

Vincent, B., & Bertrand, C. (2005). Evidences of Interdependence and Contagion using Frequency Domain Framework.

Verbeek, M. (2004), *A Guide to Modern Econometrics* (2nd Edition), San Francisco: John Wiley and Sons.

Wu J L and Fountas S (2000) 'Real Interest Parity under Regime Shifts and Implications for Monetary Policy' Manchester School, 68, 685-700

W.-J. Tsay, Long memory story of the real interest rate, Econ. Lett. 67 (2000), pp. 325–330.

Wang P and Y Wen (2007), 'Inflation Dynamics: A Cross-Country Investigation', Journal of Monetary Economics, 54(7), pp 2004–2031.

Westbrook, J. A. (1998), "Monetary integration, inflation convergence and output shocks in the European Monetary System", Economic Inquiry, 36, 138-144.

WAMI (2008), "Study on the Preparedness of WAMZ for Monetary Union" *West African Journal of Monetary and Economic Integration*

Wang, J., Zhang, D., & Zhang, J. (2015). Mean reversion in stock prices of seven Asian stock markets: Unit root test and stationary test with Fourier functions. *International Review of Economics and Finance*, *37*, 157-164.

Wang, G.-J., and C. Xie. 2013. "Cross-Correlations between Renminbi and Four Major Currencies in the Renminbi Currency Basket. Physica A: Statistical Mechanics and Its Applications 392, no. 6 (March): 1418–1428

Yuceol, M. H. (2006), "Why European Union is not an Optimal Currency Area: The limits of Integration, *Ege Academic Review*, *6(2)*, 59-72.

Z. Koustas and A. Serletis, On the Fisher effect, J. Monetary Econ. 44 (1999), pp. 105–130.

Z. Koustas and J.-F. Lamarche, Evidence of nonlinear mean reversion in the real interest rate, Appl. Econ. 42 (2010), pp. 237–248.

Zhou, S., (2013), "Nonlinearity and Stationarity of Inflation Rates: Evidence from the Euro-Zone Countries," *Applied Economics*, 45, 849-856.

APPENDIX 1

ARFIMA-FIGARCH ESTIMATION USING STUDENT DISTRIBUTION FOR WAMZ COUNTRIES

INTEREST RATE				
GHANA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-9.270570	0.00028480	-3.255e+004	0.0000
d-Arfima	0.997209	7.9779e-006	1.250e+005	0.0000
AR(1)	0.969221	0.0022357	433.5	0.0000
MA(1)	-0.966912	0.0022702	-425.9	0.0000
Cst(V)	1.328681	5.0531e-005	2.629e+004	0.0000
d-Figarch	0.999489	5.6593e-006	1.766e+005	0.0000
ARCH(Phi1)	0.531131	8.2932e-006	6.404e+004	0.0000
GARCH(Beta1)	0.116789	1.1827e-005	9875.	0.0000
Student(DF)	2.000663	0.00028529	7013.	0.0000
GUINEA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-10.789014	0.27518	-39.21	0.0000
d-Arfima	0.674343	0.050979	13.23	0.0000
AR(1)	0.940293	0.020379	46.14	0.0000
MA(1)	-0.037720	0.30768	-0.1226	0.9025
Cst(V)	0.000040	7.6177e-007	52.37	0.0000
d-Figarch	0.998178	0.00080250	1244.	0.0000
ARCH(Phi1)	0.107998	0.084106	1.284	0.2005
GARCH(Beta1)	0.106260	0.083386	1.274	0.2039
Student(DF)	2.033123	0.0034653	586.7	0.0000
GAMBIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	4.364152	129.62	0.03367	0.9732
d-Arfima	0.968711	2.1878e-005	4.428e+004	0.0000
AR(1)	0.992073	0.042624	23.27	0.0000
MA(1)	-0.395888	0.014196	-27.89	0.0000
Cst(V)	0.002939	0.00018463	15.92	0.0000
d-Figarch	0.002611	0.00026283	9.934	0.0000
ARCH(Phi1)	0.995426	2.1811e-005	4.564e+004	0.0000
GARCH(Beta1)	0.000476	0.0032442	0.1466	0.8836
Student(DF)	2.015876	0.023008	87.62	0.0000

NIGERIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-52.358688	50.983	-1.027	0.3056
d-Arfima	0.105180	0.060016	1.753	0.0811
AR(1)	1.000000	1.7794e-005	5.620e+004	0.0000
MA(1)	-0.121548	0.090653	-1.341	0.1814
Cst(V)	0.036669	0.028163	1.302	0.1943
d-Figarch	1.000000	0.38625	2.589	0.0103
ARCH(Phi1)	0.000000	0.25482	0.00	1.0000
GARCH(Beta1)	0.580934	0.32462	1.790	0.0749
Student(DF)	2.430756	0.20631	11.78	0.0000
SIERRA LEONE				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-12.774988	5.0747	-2.517	0.0125
d-Arfima	1.069215	0.025216	42.40	0.0000
AR(1)	0.859189	0.061579	13.95	0.0000
MA(1)	-0.337231	0.19690	-1.713	0.0882
Cst(V)	0.000001	2.0163e-005	0.06250	0.9502
d-Figarch	1.000000	7.8666e-006	1.271e+005	0.0000
ARCH(Phi1)	0.000000	0.57170	0.00	1.0000
GARCH(Beta1)	0.041204	0.49438	0.08334	0.9337
Student(DF)	2.166503	0.11801	18.36	0.0000
LIBERIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-15.358421	1.6157	-9.506	0.0000
d-Arfima	1.000000	0.0020859	479.4	0.0000
AR(1)	-0.113008	0.14225	-0.7944	0.4278
MA(1)	-0.472856	0.13739	-3.442	0.0007
Cst(V)	0.000000	2.3325e-007	0.00	1.0000
d-Figarch	1.000000	0.00035437	2822.	0.0000
ARCH(Phi1)	0.090296	0.23703	0.3809	0.7036
GARCH(Beta1)	0.598690	0.076231	7.854	0.0000
Student(DF)	3.294631	0.30669	10.74	0.0000
INFLATION RATES				
GHANA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	0.004554	0.0025532	1.784	0.0759
d-Arfima	-1.000000	0.30685	-3.259	0.0013

AR(1)	0.540019	0.30882	1.749	0.0818
MA(1)	0.104528	0.18611	0.5616	0.5749
Cst(V)	0.019292	0.024406	0.7905	0.4301
d-Figarch	1.000000	0.39319	2.543	0.0117
ARCH(Phi1)	0.061898	0.27866	0.2221	0.8244
GARCH(Beta1)	0.740912	0.29101	2.546	0.0116
Student(DF)	3.628697	0.72318	5.018	0.0000
GUINEA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-25.946048	0.71185	-36.45	0.0000
d-Arfima	1.372072	5.9750e-005	2.296e+004	0.0000
AR(1)	-0.102075	0.00019149	-533.1	0.0000
MA(1)	0.222120	0.00019857	1119.	0.0000
Cst(V)	186.984716	0.020347	9190.	0.0000
d-Figarch	0.541358	0.00017172	3153.	0.0000
ARCH(Phi1)	0.647361	0.00017676	3662.	0.0000
GARCH(Beta1)	0.032326	3.0550e-005	1058.	0.0000
Student(DF)	2.001392	0.00028541	7012.	0.0000
GAMBIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	0.000511	1.2765e-005	40.03	0.0000
d-Arfima	-0.479356	0.0014987	-319.9	0.0000
AR(1)	-0.410308	0.0081111	-50.59	0.0000
MA(1)	0.272605	0.012851	21.21	0.0000
Cst(V)	0.057045	8.6492e-005	659.5	0.0000
d-Figarch	0.997782	2.1504e-005	4.640e+004	0.0000
ARCH(Phi1)	1.000000	1.6107e-005	6.209e+004	0.0000
GARCH(Beta1)	0.782040	5.4581e-005	1.433e+004	0.0000
Student(DF)	2.216311	0.040385	54.88	0.0000
NIGERIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	0.005252	0.00092172	5.698	0.0000
d-Arfima	-0.794013	0.055061	-14.42	0.0000
AR(1)	0.329202	0.21710	1.516	0.1309
MA(1)	-0.148206	0.24661	-0.6010	0.5485
Cst(V)	0.095725	0.19137	0.5002	0.6174
d-Figarch	0.707893	0.32878	2.153	0.0324
ARCH(Phi1)	0.000000	2.1006	0.00	1.0000
GARCH(Beta1)	0.357226	1.1890	0.3004	0.7641
Student(DF)	3.158242	0.54204	5.827	0.0000

SIERRA LEONE				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	0.000030	0.0093665	0.003180	0.9975
d-Arfima	-0.419309	706.73	-0.0005933	0.9995
AR(1)	0.231821	1091.7	0.0002123	0.9998
MA(1)	-0.276870	965.83	-0.0002867	0.9998
Cst(V)	0.000000	0.040319	0.00	1.0000
d-Figarch	1.000000	0.025214	39.66	0.0000
ARCH(Phi1)	0.016555	99.240	0.0001668	0.9999
GARCH(Beta1)	0.227299	512.05	0.0004439	0.9996
Student(DF)	2.510783	379.99	0.006607	0.9947
LIBERIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	0.007682	0.0021693	3.541	0.0005
d-Arfima	-0.872707	0.21764	-4.010	0.0001
AR(1)	0.751822	0.12696	5.922	0.0000
MA(1)	-0.767387	0.22599	-3.396	0.0008
Cst(V)	0.086981	0.15508	0.5609	0.5755
d-Figarch	1.000000	0.70627	1.416	0.1582
ARCH(Phi1)	0.063068	0.45220	0.1395	0.8892
GARCH(Beta1)	0.837641	0.28600	2.929	0.0038
Student(DF)	3.317515	0.55814	5.944	0.0000
EXCHANGE RATES				
GHANA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	0.001911	0.0011650	1.640	0.1024
d-Arfima	-0.093594	0.12049	-0.7768	0.4381
AR(1)	0.842530	0.059551	14.15	0.0000
MA(1)	-0.345779	0.10915	-3.168	0.0018
Cst(V)	0.004194	0.013214	0.3174	0.7512
d-Figarch	1.000000	0.33891	2.951	0.0035
ARCH(Phi1)	0.492466	0.19018	2.589	0.0103
GARCH(Beta1)	0.833365	0.20186	4.128	0.0001
Student(DF)	3.395250	0.43022	7.892	0.0000
GUINEA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-100.000000	690.69	-0.1448	0.8850
d-Arfima	1.000000	0.040933	24.43	0.0000

AR(1)	0.950947	0.044138	21.54	0.0000
MA(1)	-0.867631	0.062595	-13.86	0.0000
Cst(V)	2.474144	29.688	0.08334	0.9337
d-Figarch	1.000000	0.054628	18.31	0.0000
ARCH(Phi1)	0.000000	0.32152	0.00	1.0000
GARCH(Beta1)	0.620005	0.27323	2.269	0.0242
Student(DF)	3.004951	0.35394	8.490	0.0000
GAMBIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-2.539118	0.10496	-24.19	0.0000
d-Arfima	0.650803	0.00014590	4461.	0.0000
AR(1)	0.546532	0.00014585	3747.	0.0000
MA(1)	0.294097	5.9275e-006	4.962e+004	0.0000
Cst(V)	45.158110	0.0041223	1.095e+004	0.0000
d-Figarch	0.765637	3.9183e-006	1.954e+005	0.0000
ARCH(Phi1)	0.615574	9.3235e-006	6.602e+004	0.0000
GARCH(Beta1)	0.170730	8.2173e-006	2.078e+004	0.0000
Student(DF)	6.278164	0.25017	25.10	0.0000
NIGERIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-95.654128	0.081881	-1168.	0.0000
d-Arfima	0.999914	0.00040583	2464.	0.0000
AR(1)	-0.005823	0.013124	-0.4437	0.6577
MA(1)	0.074816	0.013546	5.523	0.0000
Cst(V)	34.955743	0.0011545	3.028e+004	0.0000
d-Figarch	0.627974	8.2680e-005	7595.	0.0000
ARCH(Phi1)	0.937133	0.00016926	5537.	0.0000
GARCH(Beta1)	0.636843	0.00019787	3218.	0.0000
Student(DF)	2.001914	0.00053789	3722.	0.0000
SIERRA LEONE				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	-100.000000	160.98	-0.6212	0.5351
d-Arfima	1.000000	0.086612	11.55	0.0000
AR(1)	0.904682	0.11064	8.177	0.0000
MA(1)	-0.697797	0.15987	-4.365	0.0000
Cst(V)	4.436012	55.462	0.07998	0.9363
d-Figarch	1.000000	0.97707	1.023	0.3072
ARCH(Phi1)	0.223441	0.26179	0.8535	0.3943
GARCH(Beta1)	0.740358	0.85299	0.8680	0.3864
Student(DF)	4.951557	0.94777	5.224	0.0000

LIBERIA				
	Coefficient	Std.Error	t-value	t-prob
Cst(M)	0.002878	0.0021319	1.350	0.1784
d-Arfima	-0.217897	0.14973	-1.455	0.1470
AR(1)	0.340473	0.12479	2.728	0.0069
MA(1)	-0.957016	0.022425	-42.68	0.0000
Cst(V)	0.653033	0.37456	1.743	0.0827
d-Figarch	0.886837	0.19933	4.449	0.0000
ARCH(Phi1)	0.000000	0.32726	0.00	1.0000
GARCH(Beta1)	0.415424	0.23947	1.735	0.0842
Student(DF)	3.139813	0.55567	5.650	0.0000

Source*:* Estimations done by Oxmetrics 7

The Mean Equation is ARFIMA (1, d, 1) model in all the series, there is no regressor in the conditional mean and the Variance Equation is FIGARCH (1, d, 1) model estimated with BBM's method (Truncation order: 1000). There was no regressor in the conditional variance and the study used student distribution.