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Essays in inflation and monetary dynamics in developing countries

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ESSAYS IN INFLATION AND MONETARY DYNAMICS IN DEVELOPING COUNTRIES

By

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ESSAYS IN INFLATION AND MONETARY DYNAMICS IN DEVELOPING COUNTRIES

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This dissertation is consists of three essays. In the first essay, I analyze how the information contained in the disaggregate components of aggregate inflation helps improve the forecasts of the aggregate series using inflation data from Ghana. Direct univariate forecasting of the aggregate inflation data by an autoregressive (AR) model is used as the benchmark with which all autoregressive (AR), moving average (MA) and vector autoregressive (VAR) models of the disaggregates are compared. The results show that directly forecasting the aggregate series from the benchmark model is generally superior to aggregating forecasts from the disaggregate components. Additionally, including information from the disaggregates in the aggregate model rather than aggregating forecasts from the disaggregates performs best in all forecast horizons when appropriate disaggregates are used. The implication of these results is that better inflation forecasts for Ghana are produce by using information from relevant disaggregates in the aggregate model rather than direct forecasts of the aggregate or aggregating forecasts from the disaggregates.

In the second essay, I use a structural vector autoregression (SVAR) to model inflation so as to identify the relative importance of shocks to real output growth, monetary growth and exchange rate depreciation in inflation dynamics in Ghana. The results show that neither monetary growth alone nor structural factors alone

explain the inflation experience in Ghana and that the structural factors dominate monetary growth in the inflation dynamics. There is a fairly strong feedback between inflation and exchange rate depreciation both of which have weak relationship with monetary growth. These suggest that policies that boost domestic supply and therefore reduce import demand will be more potent than direct monetary management to curb inflation in Ghana.

Finally, in the third essay, I the test whether the West African Monetary Zone (WAMZ) is a common currency area by using a vector autoregressive model to study the variance decomposition, impulse responses of key economic variables and linear dependence of the underlying structural shocks of the countries in the zone. The variance decomposition shows that the zone a whole does not have common sources of shock, which is expected because of the diverse economic structures of these countries. The correlation of the structural shocks also shows that these countries respond asymmetrically to common supply, demand and monetary shocks and will therefore respond differently to a common monetary policy. It is therefore not in the interest of the individual countries to go into a monetary union now or in the near future unless the economies of these countries converge further.

DEDICATION

Vickita and Selasi (of blessed memory)

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CHAPTER 1: INTRODUCTION

1.1 Background

This study consists of three papers: "Does using disaggregate components help in producing better forecasts for aggregate inflation?", "Separating monetary and structural causes of inflation" and "Is West African Monetary Zone (WAMZ) a common currency area?" The motivation for the first paper stems from the fact that the private sector, governmental and international institutions as well as central banks use forecasts of macroeconomic aggregates, especially inflation in their decision-making. This makes inflation one of the main economic aggregates forecast by central banks around the world, because of their responsibilities in maintaining stable prices. Additionally, other macroeconomic policies depend on inflation forecasts.

Prior literature on inflation forecasting has employed univariate aggregate series. However, the question is whether inflation forecasts can be improved by aggregating forecasts from subcomponents. In an attempt to answer this question, studies have developed on sectoral disaggregation of inflation series (Aron and Mueller(2008), de Dois Tena et al.(2010) and Hendry and Hubrisch(2005)). While the theoretical literature is clear on the conditions under which forecasting aggregate series, empirical results have not reached any consensus on whether disaggregation by sectors improves forecast of the aggregate series. Also, the concentration of the studies on the heterogeneity across product categories and the neglect of spatial heterogeneity perhaps are based on the implicit assumption of the Law of One Price, which assumes that the product markets are efficient. While these assumptions may hold for the developed economies, spatial heterogeneity in price developments may be significant in developing and emerging market economies where information is asymmetric due to poor transportation and telecommunication infrastructure. This paper fills the gap by looking at the subcomponents in other dimensions such as the regional and rural-urban series.

The second paper is motivated by the fact that there are two schools of thought on what explains inflation; monetary growth or structural factors. The monetarist believes that money is all that matters in explaining inflation. Their argument is based on the link between monetary growth and domestic prices, which is rooted in the traditional quantity theory of money, which forms the basis of the monetarist statement that "inflation is always and everywhere a monetary phenomenon". The structuralists, on the other hand, believe that structural and institutional factors play a more prominent role in inflation dynamics. The structuralists' argue that inelastic food supply, infrastructural problems posing problems for distribution of output, lack of financial resources and low export receipts leading to foreign exchange shortages in less developing countries put pressure on domestic prices (London(1989)). The nominal exchange rate pass-through to domestic price inflation depends on how the changes in the exchange rates are passed through to import prices and therefore to domestic consumer prices (Mishkin(2008)). These structural factors can be categorized into supply, demand, monetary and direct price shocks to inflation. In the case of Ghana, it is not known what actually explains the inflationary dynamics, which is what this paper sets out to provide.

Finally, the proposal for the introduction of a single currency within the West African Monetary Zone (WAMZ) and the fact that there have been unsuccessful attempts at introducing it inspires the third paper to ascertain if the right economic conditions for a successful introduction and maintenance of a single currency exits in the zone. It has been initially proposed to implement the monetary integration process in in Economic community of West African States (ECOWAS) as a whole but due to the complexities of the process, it was later change to a two-stage implementation where a second monetary zone, the West African Monetary Zone (WAMZ) for the Anglophone West Africa is formed, which will later merge with the existing zone, the West Africa Economic and Monetary Union (WAEMU) for the Francophone West Africa. Since the introduction of the proposed single currency is in two stages analyzing the convergence of non-CFA countries alone will draw a better picture of what is needed now by ECOWAS.

1.2 Objectives of the study

The study aims at contributing to the literature by analyzing inflation and monetary dynamics of emerging economies. In the light of this, three distinct research papers will be produced.

The first research paper extends the previous studies by considering disaggregation across regions, rural – urban as well as product groups. Also, the study investigates whether including disaggregate information in the aggregate model for inflation can improve the forecasts of the aggregate series.

The second paper identifies the extent to which shocks to real output growth, monetary growth and exchange rate depreciation explain inflation dynamics in Ghana. Specifically, this paper explores two objectives. First, it identifies the relative importance of output supply shocks, money supply changes and exchange rate changes in inflation dynamics by analyzing the variance decomposition of the forecast error variance of inflation a Structural Vector Autoregression (SVAR). Secondly, the paper analyzes how shocks to changes in money supply and exchange rates transmit through to price developments and how fast these shocks dissipate.

The third research paper tests whether the economies of the ECOWAS member countries are exposed to similar sources of shock. This will be done by studying the impulse-response functions of the countries in a Structured Vector Autoregression (SVAR) to determine if it takes similar times for common shocks to dissipate across the region. The paper will also test the linear dependence of these shocks using Geweke(1982) measure of linear dependence.

1.3 Methodologies

Each of these research papers employs estimation strategy that is unique and addresses a specific research question. The overview of these methodologies a given below.

1.3.1 Does using disaggregate components help in producing better forecasts for aggregate inflation?

A benchmark model of the aggregate series with which all the other models are compared is the simple autoregressive (AR) model. Granger-causality tests are done to determine which of the disaggregate series contain more information in forecasting the aggregate series. The individual components of the aggregate inflation series are modeled jointly in an unrestricted Vector Autoregressions (VAR) and the forecasts from these models are aggregated and compared with the benchmark forecasts from the aggregate inflation series using on the Root Mean Square Error (RMSE) of the forecasts. Also, the disaggregate components are included in vector autoregressive (VAR) with the aggregate series and aggregate series forecast from these VARs and compared. The optimal lag selection for all the models are based on Akaike Information Criterion (AIC).

1.3.2 Separating monetary and structural causes of inflation.

The approach to modeling inflation in this paper is to identify the variables that are found to explain inflation dynamics in Africa, from the literature, and analyze these variables in a Structural Vector Autoregression by imposing appropriate economic theory on their dynamic relationship. Monetary growth and exchange rate depreciation have a significant positive relationship with inflation in African countries (Canetti and Greene(1991)), and the structuralist argument also maintained that real GDP growth explains the inflationary process in developing countries. So in modeling monetary policy transmissions to inflation in Ghana, four endogenous variables, real GDP, inflation, nominal exchange rate of the Ghanaian cedi against the US dollar and monetary growth are considered in a Structural Vector Autoregression (SVAR). The identification of the structural shocks from the SVAR are based on Blachard and Quah(1989).

1.3.3 Is West African Monetary Zone (WAMZ) a common currency area?

The method of identifying shock asymmetry across the WAMZ derives from the trivariate Structural Vector Autoregression (SVAR) used by Clarida and Gali(1994) and Kempa(2002) to recover demand, supply and monetary shocks to real economic activity, real exchange rate changes and price level changes. The three endogenous variables that will be considered are a measure of growth of economic activity of a country relative to the US, change in bilateral real exchange rates between each country's currency and the US dollar and change in price level of each country relative to the US price level. The identification of the structural shocks from the SVAR is based on Gali(1992).

1.4 Data sources

The data on inflation rates are obtained from Ghana Statistical Service. The published series are monthly data categorized by the level 1 of United Nation's Classification of Individual

Consumption by Purpose (CIOCOP) and by administrative regions of Ghana. The paper uses monthly data from January 2000 to December 2011.

Data on policy variables of the Banks of Ghana and other member countries of WAMZ are sourced from IMF's International Financial Statistics (IFS). Data on trade that are used as a measure of economic activity are obtained from Direction of Trade Statistics, which is also published by the IMF. These data are validated by the data from reports of the central banks of the countries and individual country reports published by the West Africa Monetary Institute (WAMI). For the models on monetary policy and common currency issues, monthly data covering the period January 1982 to October 2011 are used. The start date is chosen based on the preliminary survey of the data that indicates that data is available for all the countries in the sub-region for that period.

1.5 Organization of the study

The dissertation is organized into five chapters. Chapter 1 covers the introduction to the dissertation while the succeeding three chapters cover each of the papers respectively. Chapter 5 draws overall conclusions from the results and provides policy implications emanating from the findings of the three core chapters.

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CHAPTER 2: DOES USING DISAGGREGATE COMPONENTS HELP IN PRODUCING BETTER FORECASTS FOR AGGREGATE INFLATION?

2.1 Introduction

Central banks all over the world are charged with the responsibility of maintaining low and stable prices in their countries. To achieve their goals, the central banks adopt monetary policy frameworks that they believe address local inflation problems. Many of these central banks adopt inflation targeting as their monetary policy framework, which makes accurate inflation forecasts indispensable. Apart from the use of inflation forecasts by central banks and other macroeconomic policy authorities, consumers, businesses, and other policy oriented institutions need inflation forecasts for planning purposes. Additionally, other macroeconomic policies depends, to a great extend, on inflation forecasts. The standard practice, as seen in the published data sets, is that inflation is calculated for sectors and other disaggregate components but forecasting in many cases has been performed using the aggregate series.

A recent question arising in the literature is whether aggregate inflation forecasts can be improved by using information from the subcomponents. In attempts to answer this question, literature has developed on the use of information from sectoral disaggregates of inflation series (see for example Aron and Mueller(2008), de Dois Tenaet al.(2010), and Hendry and Hubrisch(2005)). These studies, however, concentrate on disaggregation by product sectors. The concentration of the studies on product categories and the neglect of spatial categories like regions and rural – urban classifications perhaps are based on the implicit assumption of the Law of One Price, which assumes that product markets are efficient. While these assumptions may hold true for the developed economies, spatial heterogeneity in price developments may be significant in developing and emerging market economies where information is asymmetric due to poor road and telecommunication infrastructure.

Although theoretical literature is clear on the conditions under which forecasting aggregate series from the sub-components will outperform the direct forecasting of the aggregate series, empirical studies have reached mixed conclusions. This study extends the previous studies by considering disaggregation across regions, rural – urban as well as product groups and applies the test to data from a developing economy, Ghana. Although previous studies have aggregated forecasts from the disaggregates, this study tests whether including the disaggregates in the aggregate model improves forecasts of the aggregate series. Also, the study investigates which form of disaggregation makes a more significant difference to the aggregate forecast and tests whether pooling forecast from both dimensions can make improve aggregate forecasts. Apart from using the rural – urban and regional forecasts to compare forecast improvements or otherwise of the series, forecasts of the components are important for regional and business planning.

The rest of the paper is structured as follows; section 2 is an overview of the existing literature on the subject. Section 3 discusses the methodologies used in the analysis of the data while section 4 discusses the empirical results. Section 5 states the conclusions and recommendations.

2.2 Literature review

The issue of whether micro models explain and/or forecast macro/aggregate series better started with Theil(1954) and expanded later by Grunfeld and Griliches(1960). Series of studies have been done after these pioneering works, which identify three alternatives to using the disaggregate components to improve on the direct forecasts of aggregate series. One approach is to model the subcomponents independently and aggregate the forecast from the independent models based on a weighting scheme. A second approach is to model the subcomponents jointly in a vector autoregression (VAR) and the forecasts of the subcomponents from the VAR are aggregated into an aggregate forecast. A third approach is to use the disaggregate components in the aggregate model and forecast the aggregate directly.

Grunfeld and Griliches(1960) show, by comparing R^2 from OLS regression from aggregate variable and composite R^2 calculated from $R^2{}'s$ of OLS regressions of individual components, that there is no gain in explaining an aggregate variable by aggregating the results of the components. A formal test for Grunfeld and Griliches(1960) procedure for discriminating between the composite model and the aggregate model stated in Pesaran et al.(1989) as choosing the micro models approach if the hypothesis $H_0: e_c{}'e_c < e_a{}'e_a$ holds, where $e_c{}'e_c$ is the composite sum of square error computed from the micro models and $e_a{}'e_a$ is the sum of square error from the aggregate model. Grunfeld and Griliches(1960) therefore conclude that if the data generating process at the micro level in not known, it is better to forecast the aggregate series directly. Building on this, Pesaranet al.(1989) note that Grunfeld and Griliches(1960) procedure suffers from finite sample bias and develops a choice criterion, and a test of perfect aggregation, for discriminating between aggregate and disaggregate models. Pesaranet al.(1989) test corrects for the finite sample bias and account for the contemporaneous correlation among the micro models. This test is further generalized by van Garderen et al.(2000) for application in non-linear models.

Pesaranet al.(1989)'s application of their tests to employment functions for the UK economy disaggregated by 40 industries and the manufacturing sector disaggregated by 23 industries find that the disaggregated model fits better than the aggregate model for the whole economy but not for the manufacturing sector. They however interpret the performance of the aggregate model in the case of the manufacturing sector as a misspecification of the aggregate model.

Kohn(1982) and Lutkepohl(1984) consider the problem in time series forecasting setting and give a set of conditions under which a linear combination of the components of an aggregate series can forecast the aggregate series from its past. According to these studies, if x_t is a $k-$dimensional (i.e. k components of an aggregate series) stationary process with $y_t = dx_t$ (the aggregate series) where $d = (d_1, d_2 \dots d_k)$ is a $k-$dimensional vector of weight, let F be an $m \times k$ matrix with rank m and the first row of the $k-$dimensional d, y_t is also stationary and both x_t and y_t have MA representations $x_t = \Psi(B)v_t$ and $y_t = \Phi(B)u_t$ respectively where v_t is $k-$dimensional and u_t $m-$dimensional vector of white noise. The optimal $h-$ step forecasts, as laid out in Lutkepohl(1984), are $x_{t(h)} = \sum_{i=0}^{\infty} \Psi_{h+i}v_{t-i}$ and $y_{t(h)} = \sum_{i=0}^{\infty} \Phi_{h+i}u_{t-i}$ with their mean square forecast errors $\sum_x(h)$ and $\sum_y(h)$ respectively, generally $\sum_x(h) - F\sum_y(h)F'$ is positive definite and zero if and only if $F\Psi(B) = \Phi(B)F$. These conditions mean that generally, pooling forecasts from sub-components of contemporaneously aggregated series outperforms direct forecast of the aggregate series if the data generating process is known. Kohn(1982) further adds that “if x_t is an ARMA process, then so is y_t and has the same AR and MA orders as x_t and if the moving average polynomial of x_t has all its roots on or outside the unit circle, then the same holds for y_t”. In a detailed review of the early literature on combining subcomponent forecasts into aggregate forecasts Clemen(1989) concludes that “forecast accuracy can be substantially improved through the combination of multiple individual forecasts”. The later literature, however, is mixed on the subject.

As noted by Hendry and Hubrisch(2010) these methods “focus on disaggregate forecasts rather than disaggregate information” and suggest an approach that uses the disaggregate components in the aggregate model. They find that forecasting aggregates directly using its past information or including disaggregate information in the aggregate model outperforms aggregate forecasts that are derived from aggregating the forecasts from the individual subcomponents. This supports Zellner and Tobias(2000) who find that aggregating forecasts from disaggregates outperforms direct forecast of the aggregate if the aggregate is not included in the disaggregate model. Hendry and Hubrisch(2010) also recommends dimension reduction by first combining the disaggregate variables and then include the aggregate information in the aggregate model. This reduces estimation uncertainty and mean square forecast error.

While the theoretical literature on the issue of forecasting the aggregate directly or through the subcomponents is conclusive that indirectly forecasting the aggregate series from the subcomponents performs better when the data generating process is known, empirical literature is mixed. In an earlier work, Hubrisch(2003) uses both univariate and multivariate linear time series models to forecast euro area inflation by aggregating the forecasts from the sub components and conclude that aggregating forecasts by component does not necessarily help forecast year-on-year inflation twelve months ahead. Hendry and Hubrsch(2005)) later investigate why forecasting the aggregate using information on its disaggregate components improves forecast accuracy of the aggregate forecast of euro area inflation in some situations, but not in others and conclude that more information can help, more so by including macroeconomic variables than disaggregate components. Hendry and Hubrisch(2005) find that multivariate models provide little costs or benefits compared to direct forecasts but as the forecast horizon increases aggregating forecasts from the disaggregates performs worst. They also find that including the disaggregates in a VAR with the aggregate series improves the forecasts of the aggregate series. The overall conclusion from Hendry and Hubrisch(2005) is that “the theoretical result on predictability that more disaggregate information does help does not find strong support in this forecasting context”.

Using vector equilibrium correction models Aron and Mueller(2008) evaluate the advantages of forecasting South African inflation data by aggregating projections from different sectors and geographical areas and find that inflation forecast can always be improved by aggregating projections from different sectors and geographical areas. They, however, emphasize that both levels of disaggregation are required in order to obtain a significantly better inflation forecast. Zellner and Tobias(2000) experiments also provide some evidence that improved forecasting results can be obtained by disaggregation. Benalal et al.(2004) using the euro area inflation find that the direct forecast of the aggregate inflation provides better forecasts than indirectly forecasting from the subcomponents for 12- and 18-steps-ahead forecasts, but the results are mixed for shorter horizons forecasts.

Fritzer et al.(2002) compare forecast performance from independent ARIMA models of the aggregate and disaggregates and VAR models for Australian inflation and find that VAR models outperform aggregation of forecasts from the independent ARIMA models for long-term forecasts horizons. For ARIMA models, they find that the indirect approach of aggregating forecasts from the individual ARIMA models is superior to the direct forecasts from the ARIMA model for the aggregate their results are mixed for the forecasts from the VAR.

2.3 Methodology

This section outlines the methodologies used in this study. The models for forecasting the inflation series are discussed followed by forecast pooling and evaluation methods and a description of the data and their sources. Finally, the approach used to reduce the data into a smaller number of variables is discussed.

2.3.1 Models

The method used in selecting which model performs best follows Hendry and Hubrisch(2010) in which five different models are used to forecast the US aggregate inflation series and the forecast performances compared using root mean square forecast error. In this paper, I use the following the models from Hendry and Hubrisch(2010).

i. An autoregressive (AR) model of the aggregate inflation series

ii. A moving average (MA) model of the aggregate inflation series

iii. Aggregating forecasts from independent autoregressive (AR) models of all the subcomponents (regions, sectors and rural-urban components) into aggregate forecasts

iv. Aggregating forecasts from independent moving average (MA) models of all the subcomponents (regions, sectors and rural-urban components) into aggregate forecasts

v. Modeling all the subcomponents jointly in a vector autoregression (VAR) and aggregating the individual forecasts from the VAR into an aggregate forecast.

vi. Including the all subcomponents in a vector autoregression (VAR) with the aggregate series and forecasting the aggregate series form the VAR.

2.3.2 Granger causality tests

This section outlines the procedure used in testing whether the information contained in one series helps in forecasting another series based on Granger(1969). As defined by Judge et al.(1988) "a variable y_{1t} is said to be Granger-caused by a variable y_{2t} if the information in the past and present y_{2t} helps to improve the forecasts of y_{1t} variable". This definition is operationalized in a bivariate vector autoregression p, VAR(p).

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \sum_{j=1}^{p} \begin{pmatrix} \theta_{11j} & \theta_{21j} \\ \theta_{21j} & \theta_{22j} \end{pmatrix} \begin{pmatrix} y_{1t-j} \\ y_{2t-j} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}$$

y_{1t} does not Granger-cause y_{2t} if and only if $\theta_{21j} = 0\,(j = 1,...,p)$ and y_{2t} does not Granger-cause y_{1t} if and only if $\theta_{12j} = 0\,(j = 1,...,p)$ (Judgeet al.(1988)).

2.3.3 The AR and MA models

Forecasting of the aggregate series using autoregressive (AR) model is set as the benchmark with which all the other models are compared. The autoregressive (AR) representation of a stationary time series y_t assumes that the current level of the series y_t is a weighted average of the previous levels and an error. The general form of an autoregression of order p, $AR(p)$, for a univariate variable y_t is

$$\Phi(L)y_t = \delta + \varepsilon_t$$

where $\Phi(L) = 1 - \phi_1 L - \phi_2 L^2 - ... - \phi_p L^p$, L is the lag operator and $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$.

The moving average representation, on the other hand, assumes that y_t is a weighted average of the current and previous errors in the series. The general form of an $MA(p)$ is

$$y_t = \mu + \Theta(L)\varepsilon_t$$

where $\Theta(L) = 1 - \theta_1 L - \theta_2 L^2 - ... - \theta_p L^p$, L is the lag operator and $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$

These general forms of the models are applied to the aggregate inflation series and the subcomponents individually and the optimal lags for the final models are selected based on Akaike Information Criterion (AIC).

2.3.4 The VAR models

In order to test if including the disaggregates in a model with aggregate or aggregating forecasts from the disaggregates improve the forecasts of the aggregate, many vector autoregressions are run with the aggregate series and the subcomponents. Let x_t be a $k-$ dimensional vector, an unrestricted VAR(p) specification for x_t is of the form

$$A(L)x_t = \mu + \varepsilon_t$$

where $A(L)$ is a $k \times k$ matrix of coefficients, $A(L) = I - A_1 L - A_2 L^2 - ... - A_p L^p$ and $\varepsilon_t \sim N(0, \Sigma_\varepsilon)$. Different forms of the VARs are estimated with and without the aggregate and the results compared with the benchmark AR model. Optimum lag selection for the VARs is also based on Akaike Information Criterion (AIC). Granger causality tests are also done to determine predictive information content of the disaggregates in the aggregate. Also, in order to determine how the variables enter the models, unit root test are conducted using Augmented Dickey-Fuller tests.

2.4 Forecast pooling and evaluation

The aggregate consumer price index (CPI) is a weighted sum of all its subcomponents. Since the forecasts are performed for the inflation series rather than the consumer price index (CPI), the expenditure weights used in aggregating the CPI are not appropriate for aggregating the inflation series. In the following, I derive time-varying weights that are appropriate for aggregating the subcomponent forecasts for comparison with the direct forecast of the aggregate inflation series.

Let y_t be the aggregate price level (CPI), which is a weighted aggregate of two subcomponents x_{1t} and x_{2t} with constant weights α_1 and α_2 respectively. Then

$$y_t = \alpha_1 x_{1t} + \alpha_2 x_{2t}$$

Inflation is percentage change in CPI over time. Define aggregate inflation as $aggr_t = \frac{\dot{y}}{y}$ and the inflation for subcomponent i as $comp_i = \frac{\dot{x}_i}{x_t}$ where $\dot{y} = \frac{dy_t}{dt}$ and $\dot{x}_i = \frac{dx_{it}}{dt}$ therefore

$$\frac{\dot{y}}{y_t} = \frac{\alpha_1 \dot{x}_1 + \alpha_2 \dot{x}_{2t}}{\alpha_1 x_{1t} + \alpha_2 x_{2t}}$$

$$= \frac{\alpha_1 \dot{x}_1}{y_t} + \frac{\alpha_2 \dot{x}_2}{y_t}$$

$$= \frac{\alpha_1 \dot{x}_1}{y_t}\left(\frac{x_{1t}}{x_{1t}}\right) + \frac{\alpha_2 \dot{x}_2}{y_t}\left(\frac{x_{2t}}{x_{2t}}\right)$$

$$\frac{\dot{y}}{y_t} = \alpha_1\left(\frac{x_{1t}}{y_t}\right)\left(\frac{\dot{x}_1}{x_{1t}}\right) + \alpha_2\left(\frac{x_{2t}}{y_t}\right)\left(\frac{\dot{x}_{2t}}{x_{2t}}\right)$$

$$aggr_t = w_{1t}comp_{1t} + w_{2t}comp_{2t}$$

w_{1t} and w_{2t} are time-varying weights that are shares of each component in the aggregate inflation series and are functions of both the aggregate series and the subcomponent CPIs and $comp_{it}$ is inflation calculated from the ith subcomponent. For a CPI of n sectors

$$y_t = \sum_{i=1}^{n} \alpha_i x_{it}$$

and the aggregate inflation series is

$$aggr_t = \sum_{i=1}^{n} w_{it} comp_{it}$$

In-sample forecasts are aggregated using the weights derived above. Consistent with Hendry and Hubrisch(2010), out-of-sample forecasts are aggregated using the last weights from the sample since the future weights cannot be known at the time of forecast.

Forecast evaluation of the alternative models, that is, pooled forecasts and direct forecasts, is based on the Root Mean Square Forecast Error (RMSFE) defined as;

$$RMSFE = \sqrt{\frac{1}{F}\sum_{t=1}^{F} \varepsilon_t}$$

where $\varepsilon_t = y_{t+h} - \hat{y}_{t+h}$, y_{t+h} and $\hat{y}_{t+h}$ are the actual and forecast series respectively and F is the out-of-sample number of observations retained for forecast evaluation. $\hat{y}_{t+h}$ are obtained from recursive estimation of the models. These RMSFEs is used to judge the models' performance where lower RMSFE means better performance.

2.5 Data sources and description

Monthly data on Ghanaian Consumer Price Index (CPI) and inflation series are collected from Prices Section of Ghana Statistical Service. The sector classification of the series is done according to the level 1 of United Nation's "Classification of Individual Consumption by Purpose" (CIOCOP). This is a 12-sector classification that is made up of food and non-alcoholic beverages; alcoholic beverages, tobacco and narcotic; clothing and footwear; housing, water, electricity, gas and other; furnishings, household equipment etc.; health; transport; communications; recreation and culture; education; hotels, cafés and restaurants; and miscellaneous goods and services. This sector classification is further grouped into food and nonfood sectors. The series are also classified into rural-urban and by administrative regions of Ghana. Two regions, Upper East and Upper West, are merged into one for the purpose of the series publications so that we have nine regions instead of ten. The aggregate series is a weighted index of the subcomponents with the sector, regional and rural – urban weights derived from household expenditure patterns recorded in Ghana Living Standard Surveys (GLSS), a household expenditure survey that is conducted every five years in Ghana.

The sample data for the CPI cover the period 1997:9 to 2011:9 for the aggregate series and the subcomponents, which gives 169 data points. The inflation series cover 1998:9 to 2011:9 giving 157 data points for the study. The starting point of the sample necessitated by data availability from Ghana Statistical Service.

2.6 Reduction of the series

Given the relatively short sample with 12 sector and 9 regions, the estimation of VAR of such dimension will suffer from lack of degrees of freedom, so the estimation for the sector series is done using the two-sector classification of food and nonfood series. The estimation for the urban – rural models is also done using the published series. The problem, however, is with the regional series where there are nine regions. This problem is solved by first pooling the series of contiguous regions to have smaller number of variable in the VARs.

I group the regional data into three zones based on contiguity. South zone is made up of Western, Central, Greater Accra and Volta regions (the regions with coast lines); middle zone is made up of Eastern, Ashanti and Brong Ahafo regions; and north zone is made of northern region, upper east and upper west. The series generated for these zones are weighted series based on GLSS expenditure weights used by Ghana Statistical service in aggregating the regional series into the aggregate national series.

2.7 Empirical results

This section presents the empirical results of the models developed earlier. The main question I address in this section is whether including additional information from subcomponent in modeling aggregate inflation improves forecast results of the aggregate series. These results are also compared with the results of aggregating forecasts from the subcomponents and the benchmark model. I start with the time series characteristics of the data so as to decide whether the series enter the models at their levels or at their first differences.

2.7.1 Descriptive statistics

The descriptive statistics in Table 2.1 show that the inflation series are not different in terms of the average and volatility. On average, inflation is highest in the non-food sector over the period with the food sector recording the lowest average inflation among all the subcomponents considered. The food inflation series happens to be the most volatile while the non-food series is the least volatile among all the subcomponents.

Table 2.1: Descriptive statistics

	AGGR	FOOD	NFOOD	URBAN	RURAL	SOUTH	MIDDLE	NORTH
Mean	18.46	16.91	20.13	18.81	18.13	18.79	17.96	19.07
Std. Dev.	13.54	17.72	10.22	13.05	13.65	13.57	13.85	14.49
Observations	157	157	157	157	157	157	157	157

2.7.2 Time series characteristics of the series in the dataset

Since the ways the series are modeled depend on their time series characteristics, I investigate the series for their order of integration. The characteristics of the series are not clear from the visual examination of the graphs in Figure 2.1, so Augmented Dickey-Fuller (ADF) tests are used to determine whether the series have unit roots. Table 2.2 shows the results of the ADF tests and apart from the north series, all the series are stationary at 5 percent level of significance. This means that the series enter the models at their levels except the north series. Even though the north series is not stationary, including the first difference in the models do not produce any different result from including it at the level. I therefore treat the north series as all the other series and present the results for the levels of all the series. Similarities of the graphs also suggest that their characteristics should not be different.

Figure 2.1: Graphs of the level of the series in the dataset

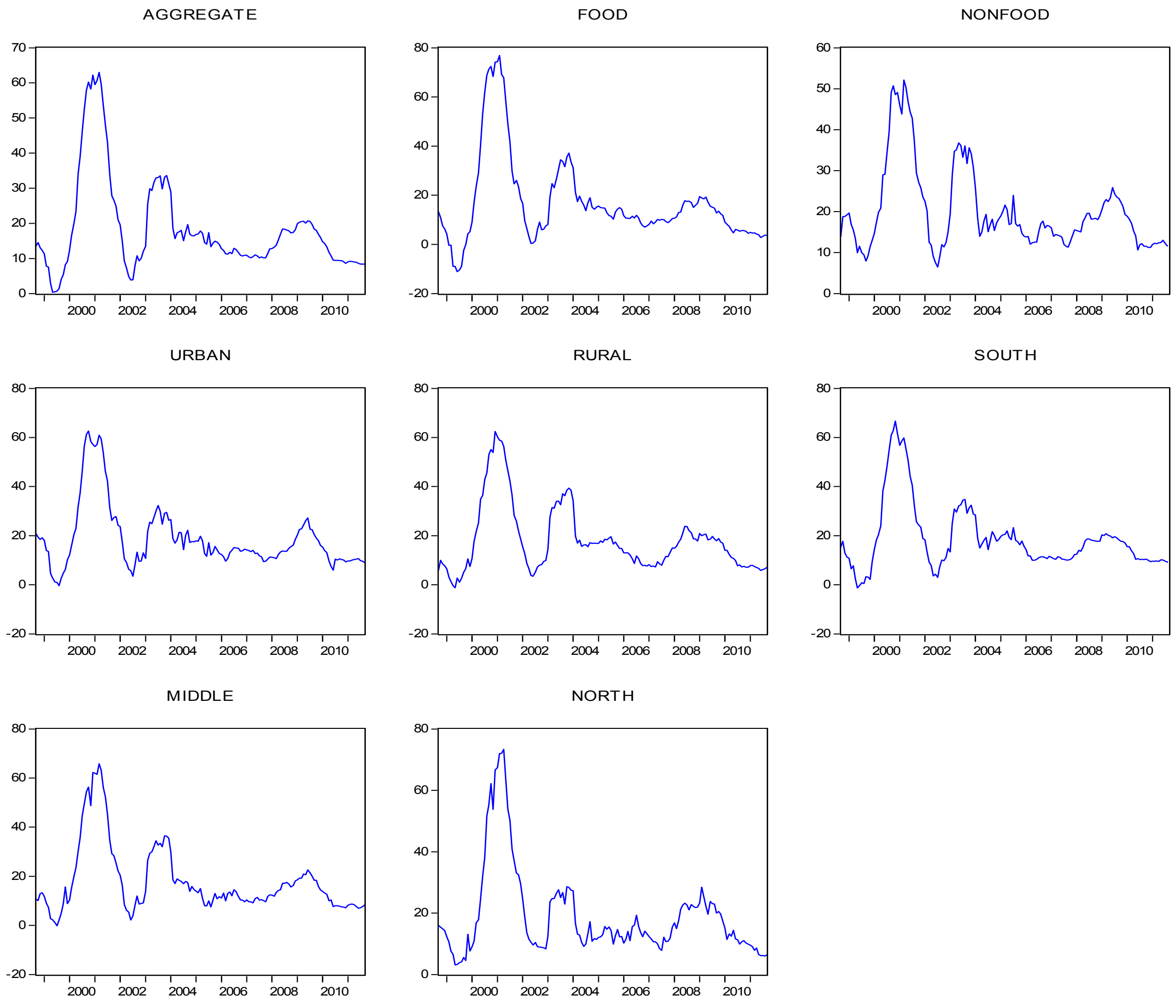

Table 2.2: Unit root tests of the variables in the data (ADF p-values)

	No. of lags	p-value
Aggregate	12	0.0388
Food	12	0.0301
Nonfood	13	0.0378
Urban	12	0.0223
Rural	13	0.0247
South	12	0.0318
Middle	12	0.0136
North	12	0.1522

2.7.3 Weights

The published weights from Ghana Statistical Service suggests that the weights are constant over the sample period but analysis of the data shows that aggregating the components with the published weights do not produce the same aggregate series as published. I, therefore, compute average ex-post weight for the sample period. The ex-post weights are regression coefficient from the regression of the aggregate series on respective components corrected for serial correlation. These weights are normalized to sum to 1 and the ex-ante weights are the published weights. Table 2.3 shows the ex-post weights, normalized ex-post weights and the ex-ante weights. A major observation is the reversal of the weights for the rural-urban series, which weights the urban series more that the rural series ex-ante. The normalized ex-post weights are used in calculating the time-varying weights for aggregating the forecasts. The use of these weights as opposed to the ex-ante weights does not change the results significantly enough to change the conclusions.

Table 2.3: Weights for aggregating forecasts

	Ex-post	Normalized	Ex-ante
Urban-rural			
Urban	0.448850	0.455834	0.535058
Rural	0.535828	0.544166	0.464942
Total	**0.984678**	**1.000000**	**1.000000**
Sectors			
Food And Non-Alcoholic Beverages	0.492863	0.492788	0.449084
Alcoholic Beverages, Tobacco and Narcotic	0.046323	0.046316	0.022299
Clothing and Footwear	0.111954	0.111937	0.112855
Housing, Water, Electricity, Gas and Oth	0.059017	0.059008	0.069844
Furnishings, Household Equipment and Rou	0.073029	0.073018	0.078266
Health	0.012603	0.012601	0.043276
Transport	0.054722	0.054714	0.062086
Communications	0.004378	0.004377	0.003133
Recreation and Culture	0.031762	0.031757	0.030439
Education	0.006419	0.006418	0.01597
Hotels, Cafés and Restaurants	0.073856	0.073845	0.082825
Miscellaneous Goods and Services	0.033227	0.033222	0.029924
Total	**1.000153**	**1.000000**	**1.000000**
Regions			
Western	0.115404	0.115448	0.115603
Central	0.066974	0.066999	0.06953
Greater Accra	0.240317	0.240408	0.242125
Eastern	0.093875	0.09391	0.09248
Volta	0.099928	0.099966	0.102775
Ashanti	0.22458	0.224665	0.223353
Brong Ahafo	0.077525	0.077554	0.076107
Northern	0.049047	0.049065	0.048918
Upper	0.031973	0.031985	0.02911
Total	**0.999623**	**1.000000**	**1.000000**

2.7.4 Granger causality tests

Table 2.4 is the result of Eviews' pairwise Granger causality tests that tests whether an endogenous variable can be treated as exogenous in a particular equation. For each equation in the VAR, Table 2.4 shows chi-square statistics for the joint significance of each of the other lagged endogenous variables in that equation in column 2, degrees of freedom (df) in column 3 and p-values in column 4. The statistics in the last row (All) are for the joint significance of all other lagged endogenous variables in the equation. The results from Table 2.4 show that food and nonfood series Granger-cause the aggregate series individually and jointly and there is a feedback from the aggregate series to nonfood but not to food series. The urban and rural series do not Granger-cause the aggregate series either individually or jointly. The aggregate series, however, Granger-cause the urban series. For the regional series, there is a strong joint Granger causality from the disaggregates to the aggregate series but none from the individual series. Feedback runs from the aggregate only to the north series. These results indicate that the food and nonfood series individually and jointly provide much information in forecasting the aggregate series but the urban and rural series do not provide much information in forecasting the aggregate series as the other disaggregates, either individually or jointly. The joint information contained of the regional series helps forecast the aggregate series but the individual series do not provide enough information to forecast the aggregate series.

Table 2.4: VAR Granger Causality/Block Exogeneity Wald Test between the aggregate and the disaggregate series

Excluded	Chi-sq	df	Prob.
Dependent variable: AGGREGATE			
FOOD	29.60471	12	0.0032
NONFOOD	29.79406	12	0.0030
All	60.55712	24	0.0001
Dependent variable: FOOD			
AGGREGATE	15.17709	12	0.2319
NONFOOD	22.73118	12	0.0301
All	49.19304	24	0.0018
Dependent variable: NONFOOD			
AGGREGATE	27.50577	12	0.0065
FOOD	33.31102	12	0.0009
All	89.18211	24	0.0000
Dependent variable: AGGREGATE			
URBAN	13.71157	12	0.3195
RURAL	16.52092	12	0.1685
All	25.69682	24	0.3687
Dependent variable: URBAN			
AGGREGATE	26.32206	12	0.0097
RURAL	19.85558	12	0.0699
All	50.29478	24	0.0013
Dependent variable: RURAL			
AGGREGATE	12.46291	12	0.4093
URBAN	7.822618	12	0.7988
All	43.4988	24	0.0087

Table 2.4 (Continued): VAR Granger Causality/Block Exogeneity Wald Test between the aggregate and the disaggregate series

	Chi-sq	df	Prob.
Dependent variable: AGGREGATE			
SOUTH	16.17355	12	0.1834
MIDDLE	17.03393	12	0.1483
NORTH	14.67319	12	0.2598
All	66.27316	36	0.0016
Dependent variable: SOUTH			
AGGREGATE	14.69423	12	0.2586
MIDDLE	15.8875	12	0.1964
NORTH	14.00068	12	0.3007
All	92.91287	36	0.0000
Dependent variable: MIDDLE			
AGGREGATE	11.73318	12	0.4673
SOUTH	12.33768	12	0.4190
NORTH	10.65658	12	0.5586
All	104.3503	36	0.0000
Dependent variable: NORTH			
AGGREGATE	27.12709	12	0.0074
SOUTH	28.88582	12	0.0041
MIDDLE	28.59004	12	0.0045
All	137.462	36	0.0000

2.7.5 Results of the various models and model comparison

Three main models are estimated in various forms; an autoregressive (AR) model of the aggregate series and the subcomponents, a moving average (MA) of the aggregate series and the subcomponents and a vector autoregressive (VAR) model of the aggregate and the different subcomponents or all the subcomponents. The VARs are labeled by the variables that enter it, for example VAR_aggr_food means a VAR with the aggregate series and the food series as shown in Table 2.5.

The results from the comparison of the Root Mean Squared Forecast Errors (RMSFE) from Table 2.5 show that, for all the categories considered, the benchmark autoregressive (AR) model of the aggregate inflation series outperforms aggregate forecasts that are obtained from aggregating forecasts from the subcomponents except for the 1-step-ahead forecasts for the product sectors where aggregating the forecasts from the subcomponents perform marginally better. For the moving average (MA) models, the direct forecasts are better in all the steps except for the regions where aggregating the forecasts performs better for the 1-step-ahead.

Including additional information from the subcomponents generally performs better for all the models at 1-step-ahead forecasts. The forecasts are, however, less accurate when only food, urban or south series is included in the aggregate model individually, even for the 1-step-ahead forecasts. These results imply that the subcomponents help in producing better short-term forecasts of aggregate inflation if the right subcomponents or their combinations are used in the aggregate model. For the product sector, including the nonfood series improves the forecasts most, while including the rural series improves the forecasts most in the case of the urban-rural classification. In the case of the regional classification, including all the subcomponents improves the forecasts most.

Table 2.5: Root Mean Square Forecast Error (RMSE) for year-on-year inflation*

RMSFE	1-step		6-step		12-step	
	Direct	Indirect	Direct	Indirect	Direct	Indirect
Sectors						
AR**	0.137	0.131	0.341	0.739	0.647	1.346
MA	0.188	0.217	1.042	0.810	1.119	0.810
VAR_aggr_food_nonfood	0.077	0.095	0.676	0.706	1.290	1.356
VAR_aggr_food	0.151		0.553		0.755	
VAR_aggr_nonfood	0.061		0.661		1.254	
VAR_food_nonfood		0.093		0.700		1.309
Urban-rural						
AR	0.137	0.158	0.341	0.783	0.647	1.404
MA	0.188	0.207	1.042	0.837	1.119	0.837
VAR_aggr_urban_rural	0.098	0.170	0.736	0.801	1.522	1.708
VAR_aggr_urban	0.190		0.605		0.885	
VAR_aggr_rural	0.067		0.654		1.300	
VAR_urban_rural		0.165		0.747		1.725
Regions						
AR	0.137	0.153	0.341	0.727	0.647	1.308
MA	0.188	0.123	1.042	0.820	1.119	0.824
VAR_aggr_south_middle_north	0.052	0.256	0.670	0.692	1.617	1.760
VAR_aggr_south	0.150		0.491		0.838	
VAR_aggr_middle	0.080		0.670		1.285	
VAR_aggr_north	0.091		0.680		1.422	
VAR_aggr_south_middle	0.065		0.679		1.317	
VAR_aggr_south_north	0.065		0.674		1.309	
VAR_aggr_middle_north	0.065		0.674		1.309	
VAR_south_middle_north		0.088		0.697		1.438

** Direct forecasts are the forecasts of the aggregate series from a particular model, and the indirect forecasts are the aggregate forecasts that are obtained from aggregating forecasts from the disaggregates*

***The lag length for the AR varies between 1 and 3 that of the MA varies between 1 and 2*

2.8 Conclusions

This study investigates whether forecasting aggregate inflations series by modeling the subcomponents performs better than forecasting the aggregate series directly, and whether including the disaggregate components in the aggregate model improves the forecasts of the aggregate series. The benchmark model with which all the other models are compared is the univariate autoregressive (AR) of the aggregate series. The aggregate series is also modeled using moving average (MA) models. The subcomponents are modeled either independently as autoregressions (AR), moving average (MA) or jointly as vector autoregressions (VARs) with or without the aggregate series.

From the results direct forecasts of aggregate inflation outperform aggregate forecasts that are derived from aggregating forecasts from the subcomponents for all the steps of the forecasts. Including information from the subcomponents improves on the direct forecasts of the aggregate series for 1-step-ahead forecasts. This, however, depends on the subcomponents or their combinations that are used with the aggregate series. A careful selection of the subcomponents into the models is, therefore, needed to achieve more accurate forecasts. The results for 6-step-ahead and 12-step-ahead forecasts show that direct univariate forecasts are superior to the forecasts from all the models. This result should therefore be taken carefully because a longer sample is needed to evaluate more independent forecasts errors for these steps.

The results are similar to that of Hendry and Hubrisch(2010) who find that combining disaggregate information outperforms combining disaggregate forecasts. The results, however, contradict Aron and Mueller(2008) and others who find that aggregating forecasts from disaggregates is superior to direct forecasting of the aggregate series.

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CHAPTER 3: SEPARATING MONETARY AND STRUCTURAL CAUSES OF INFLATION.

3.1 Introduction and theoretical framework

There are two schools of thought on what explains inflation; monetary growth or structural factors. The monetarist school argues that money is all that matters in explaining inflation. This forms the basis of the monetarist statement that "inflation is always and everywhere a monetary phenomenon". The structuralist school, on the other hand, argues that structural and institutional factors play a more prominent role in inflation dynamics. The structuralists' argue that inelastic food supply, infrastructural inadequacies that pose problems for distribution of output, lack of financial resources and low export receipts leading to foreign exchange shortages in developing countries put pressure on domestic prices (London(1989)). "The nominal exchange rate pass-through to domestic price inflation depends on how the changes in the exchange rates are passed through to import prices and therefore to domestic consumer prices" (Mishkin(2008)). It is also argued that the lack of financial resources coupled with a limited tax base cause these less developed countries to resort to deficit financing through the central banks, that lead to inflationary pressures.

This study uses a structural vector autoregression to model inflation so as to identify the relative importance of monetary and structural factors in explaining inflation in developing countries by using data from Ghana. Specifically, this paper explores three things; first, the paper identifies the relative importance of output supply shocks, monetary growth shocks and exchange rate depreciation shocks in inflation dynamics by analyzing the variance decomposition of the forecast error variance of inflation. Secondly, the paper analyzes how shocks to real output growth, monetary growth and exchange depreciation transmit through to price developments and how fast these shocks dissipate. Lastly, the paper identifies what other channels of monetary policy transmission mechanisms exist in Ghana's monetary policy framework over the years. These help identify which of the variables has more information in better management of inflation in Ghana.

In 2002, Ghana adopted inflation targeting as its monetary policy framework, which requires appropriate target setting for inflation. The adoption of the inflation-targeting framework has certain prerequisites and technical issues as outlined in Blejer and Leone(2000). Among these prerequisites and technical issues are a clear understanding of the monetary policy transmission mechanism and reliable forecasts of inflation. This shows that setting appropriate inflation targets require not only accurate forecast but also knowledge of the channels through which policy variables affect inflation. The knowledge of the impact of these policy variables on inflation also helps in the efficient policy formulation to achieve the target. Also, "a successful implementation of any monetary policy regime requires an accurate and informed assessment of how fast the effects of policy changes propagate to other parts of the economy and how large these effects are. This requires a thorough understanding of the mechanism through which monetary policy actions and other forms of shocks affect economic activity" (Abradu-Otoo et al.(2003)). So knowing the forecast values from the univariate time series models is necessary but not sufficient for the inflation targeting monetary policy framework adopted by the Bank of Ghana.

3.2 Literature on inflation in Africa

The monetarists-structuralists debate makes it hard to determine what actually causes inflation, especially in Africa where structural factors are more highlighted. Some studies find that neither monetary nor structural factors alone explain inflation completely especially in Africa. Among the most relevant studies on monetary growth, exchange rate and inflation nexus in Africa are Chhibber et al.(1989), London(1989), Tegene(1989), Canetti and Greene(1991) and Imimole and Enoma(2011). Chhibberet al.(1989) observe that inflationary process goes beyond simple monetary explanation and identify three transmission mechanisms for the inflationary dynamics in Zimbabwe. First, cost-push factors such as nominal wage changes, pass-through effect of import prices and government price controls impact domestic prices directly. Secondly, excess money supply interactions with modes of deficit financing translate into pressure on prices and finally, unfavorable supply conditions pressure prices. London(1989) uses both cross-section data over several African countries and time series data for individual countries and finds that monetarists view on inflation holds in the cross-section equations but not in the individual time series models for all the countries. London(1989) suggests that there are other factors other than monetary growth that explain inflation dynamics in Africa. Some of these factors may be output shocks that arise from supply bottlenecks and exchange rate depreciation. Tegene(1989) identifies monetary growth and changes in real income as the soles sources of domestic inflation in six African countries including Ghana. He, however, argues that the monetary single equation adequately explains the inflation dynamics in these countries with only domestic factors explaining the inflation dynamics in Ghana. Canetti and Greene(1991) use VAR to separate the influence of monetary growth and exchange rate depreciation in explaining inflation in ten African countries and find that monetary dynamics dominate inflation levels in four of the countries, including Ghana, while exchange rates dynamics dominate in three of them. Imimole and Enoma(2011) studying the causes of inflation in Nigerian using an Autoregressive

Distributed Lag model concludes that exchange rate depreciation, monetary growth and real output constraints are the main explanatory factors for the behavior of inflation in that country.

On the relationship between inflation and money supply in Ghana, Chhibber and Shafik(1990) find that monetary growth was the main force driving inflation in Ghana. They trace the source of the monetary expansion to the large inflow of external resources during the Economic Recovery Program (ERP) of the early 1980s, which in turn generated strong inflationary pressures. Sowa and Kwakye(1993) add that the foreign inflows also led to the rehabilitation of factories and the import of final goods, which eased the supply pressures as well. They thus argue that the influence of money was not that strong as suggested by Chhibber and Shafik(1990) but rather other structural factors might account for Ghana's inflation experience. Sowa(1996) notes that inflation in Ghana, in either the long run or the short run, is influenced more by output volatility than monetary factors.

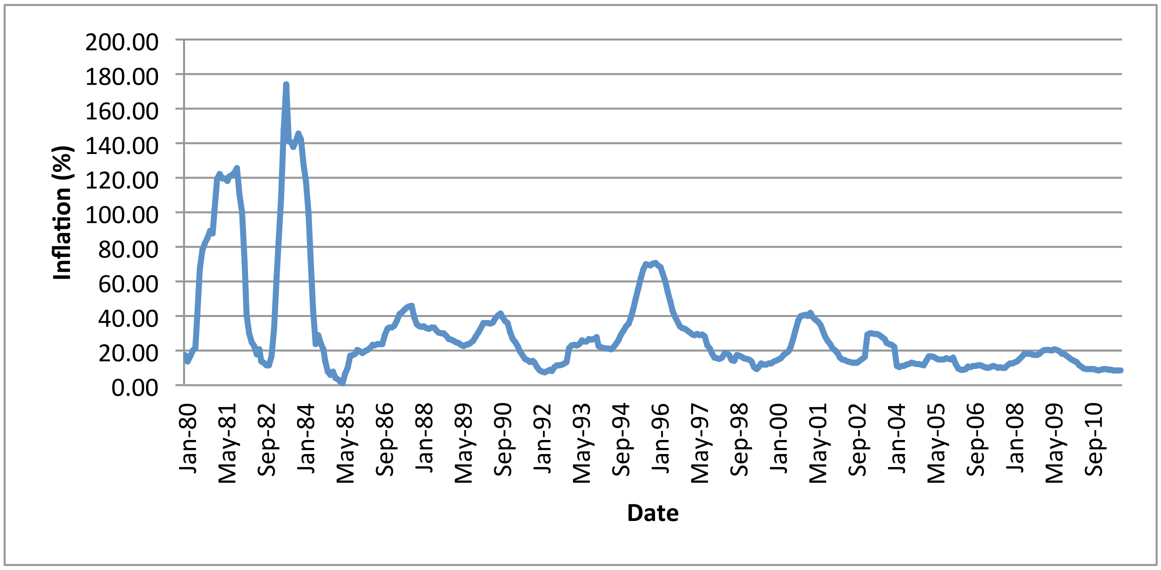
Ocran(2007) uses an error correction model to model inflation in Ghana and identifies inflation inertia, changes in money and changes in Government of Ghana treasury bill rates, as well as changes in the exchange rate, as determinants of inflation in Ghana. This study is similar to an earlier study by Bawumia and Abradu-Otoo(2003) who also uses an error correction model to analyze the relationship among monetary growth, exchange rates and inflation and confirm the existence of a relationship between inflation, money supply, the exchange rate, and real income. Ameyaw(2004) and Acheanpong(2005) also find empirical links between inflation and exchange rates in Ghana.

The major weakness of the studies on Ghana, in the context of monetary policy formulation and implementation is that their orientations are to measure the impact of individual variables on inflation in Ghana rather than identifying the transmission mechanisms through which shocks to monetary policy variables have their impacts on inflation in Ghana. They also did not measure the relative strength of these variables in explaining inflation in Ghana. The later questions are more relevant for monetary policy. In an earlier attempt to fill this vacuum Abradu-Otooet al.(2003) uses a seven-variable structural VECM to identify the mechanism through which monetary policy instruments affect inflation in Ghana. They conclude that monetary policy instruments affect inflation and output in Ghana in the long run through exchange rates. The endogenous variables they include in their model are inflation, real GDP, credit to the private sector, 91-day treasury bill rate, real exchange, m2+ a broader definition of money supply and price of crude oil. This, more monetary policy relevant study, suffers from degrees of freedom, given the large number of variables relative to the sample size, which brings the reliability of the results into question.

3.3 Inflation and monetary policy developments in Ghana

As acknowledged by Canetti and Greene(1991), inflation management is a significant problem in sub-Saharan Africa in the past several decades. Ghana’s inflation averaged 49.5 percent in the 1980s, 27.8 in the 1990s and 18.6 percent in the 2000s and as shown in Figure 3.1 the rates were very high in the 1980s, especially between April 1983 and February 1983 where the rates are above 100 percent. This period marks the start of Economic Recovery Program (ERP) which includes the financial sector reforms, where the inflow of resources led to more imbalances at the beginning.

Figure 3.1: Year-on-year monthly Inflation in Ghana



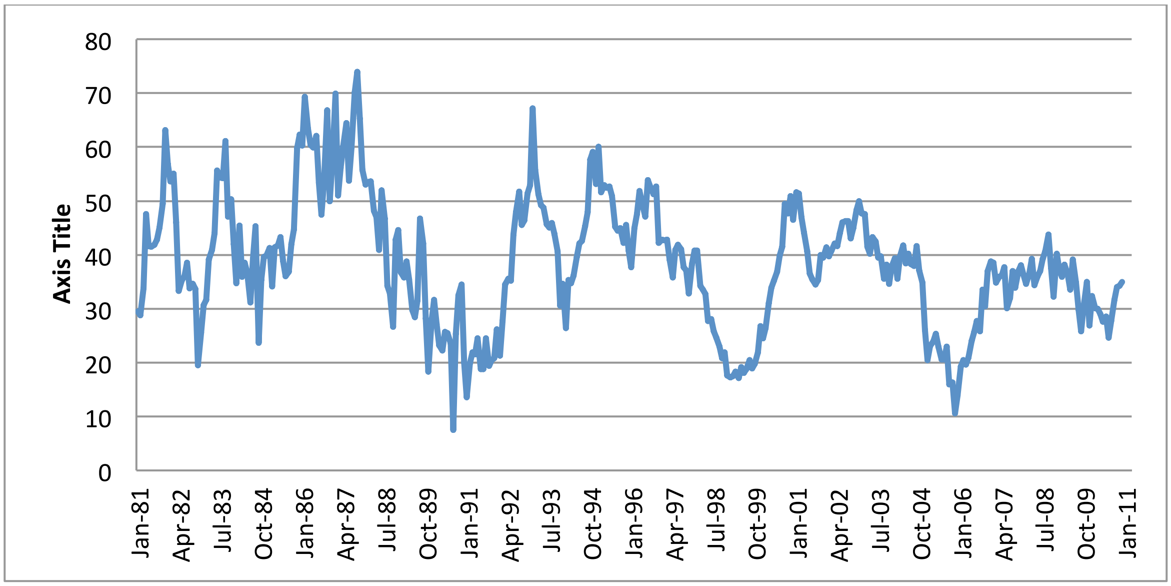
The high and persistent inflationary pressures led to several monetary policy experiments by the Bank of Ghana over the years. Most of these policy experiments were as a result of controversies over what causes inflation in general and in Africa in particular. The old time monetarist argument is that excessive monetary growth is the sole cause of inflation. There are other arguments for causes of inflation in Africa as reviewed in the previous section. United Nations' Economic Commission for Africa, for example, in its 1989 African Alternative Framework for Structural Adjustment Programs for Socio-Economic Recovery and Transformation identified exchange rate depreciation as the major cause of inflation in Africa.

According to Abradu-Otooet al.(2003), monetary management in Ghana has two phases; pre-1983 reform phase and post-1983 reform phase. In phase I, bank of Ghana implemented both global and sectoral credit controls by implementing different credit ceilings in different sectors in as it deemed it fit for the growth and stabilization goals of the country. The inefficiencies associated with these direct controls necessitate the 1983 financial sector reforms that led to the institution of market-based instruments of monetary policy in 1992, which constitute phase II of Ghana's monetary management. In the financial programming model introduced in collaboration with the IMF in this phase, there were basically three targets: the operating target (reserve money), the intermediate target (money supply) and the ultimate or final target (the general price level). The mechanics of the targeting process is based on the strong view that inflation is predominantly a monetary phenomenon (Abradu-Otooet al.(2003)).

In 2001, Bank of Ghana became an independent institution by an act of parliament, free to perform its main function of ensuring stable prices and economic stability. Monetary policy committee was formed in 2002 and charge with the responsibility of those functions. According to Amoah and Mumuni(2008) Ghana adopted the inflation-targeting framework since the latter part of 2002 and the formal announcement was made in May 2007. I designate the start of inflation-targeting framework as the beginning of phase III of the monetary management phases in Ghana.

The behavior of monetary growth through the phases as shown in Figure 3.2, relative to the inflation series in Figure 3.1 shows lack of any significant causation from monetary growth to inflation and therefore suggests that monetary growth alone does not explain the variability in inflation in Ghana. The monetary growth series is noisier than the inflation series. Theoretically, if the monetarists' view of inflation holds, we expect high monetary growth to lead to high rates of inflation but that is not generally the case by looking at the two figures. The high monetary growth in the late 1980s did not translate into inflation and the high inflation in the early 1980s cannot be accounted for by high monetary growth as found by Sowa(1996). The later years also seem to have more stable inflation rates that could not be explained by the variable monetary growth over the period.

Figure 3.2: Year-on-year monthly monetary (M2+) growth in Ghana



3.4 Methodology

As has been discussed in the literature, neither monetary growth nor structural factors alone can explain the inflation experience in an African country like Ghana. "Although monetary developments are an important determinant of price movements in Ghana, a number of other factors are also important. These include exchange rate depreciation, wages, exogenous shocks in the domestic food supply, petroleum prices, and government fiscal policy among others" (Bawumia and Abradu-Otoo(2003)). These other factors, which are exogenous to the following model, are classified into three namely, supply shocks, demand shocks, monetary shocks and direct price shocks, to the system. And the model below is set up to identify relative contribution of these shocks to inflationary developments in Ghana and trace their transmission mechanisms.

3.4.1 The model

The approach to modeling inflation in this paper is to identify the variables that are found to explain inflation dynamics in Africa, from the literature, and analyze these variables in a Structural Vector Autoregression by imposing appropriate economic theory on their dynamic relationship. Monetary growth and exchange rate depreciation have a significant positive relationship with inflation in African countries (Canetti and Greene(1991)), and from the structuralist argument, supply factors are more responsible for inflation dynamics in developing countries. So in modeling inflation and monetary policy transmissions to inflation in Ghana, I consider the behavior of changes in four endogenous variables, real GDP x_1, inflation x_2, nominal exchange rate of the Ghanaian cedi against the US dollar x_3 and monetary growth x_4 in a VAR. The changes in these variables are measured as the log-difference of quarterly levels of the variables so that they the quarterly growth rates. Let $y_t = \left(x_{1t}\, x_{2t}\, x_{3t}\, x_{4t}\right)'$ be a 4-dimensional vector of endogenous variable in the VAR where x_{1_t} is real GDP growth, x_{2_t} is monetary growth x_{3_t} is inflation, and x_{4_t} is changes in the nominal exchange rates of the cedi against the US dollar. The structural representation of the model is

$$\Gamma y_t = \mu + \sum_{j=1}^{p} B_j y_{t-j} + v_t \qquad (1)$$

where Γ is a 4×4 matrix of contemporaneous coefficients among the endogenous variables, μ is a vector of constants, B_j is a 4×4 matrix of structural coefficients, v_t is a vector of orthogonal structural shocks to the system so that $\Sigma_v = E\left(v_t v_t'\right) = I$. The reduced form of equation (1) is

$$y_t = \Gamma^{-1}\mu + \sum_{j=1}^{p} \Gamma^{-1} B_j y_{t-j} + \Gamma^{-1} v_t \tag{2}$$

this can be written as

$$y_t = v + \sum_{j=1}^{p} \Theta_j y_{t-j} + e_t \tag{3}$$

where $v = \Gamma^{-1}\mu$, $\Theta_j = \Gamma_j^{-1} B_j$, and $e_t = \Gamma^{-1} v_t$. Equation (3) can also be written as

$$y_t = v + \Theta(L) y_t + e_t \tag{4}$$

where $\Theta(L) = L + L^2 + ... + L^p$ and L is a lag operator. Given that the system in equation (4) is stable, we can re-write (4) as a moving average representation, by Wold's decomposition.

$$\left(I - \Theta(L)\right) y_t = v + e_t \tag{5}$$

$$y_t = \left(I - \Theta(L)\right)^{-1} v + \left(I - \Theta(L)\right)^{-1} e_t \tag{6}$$

$$y_t = \mu_0 + \sum_{j=0}^{\infty} \Phi_j e_{t-j} \tag{7}$$

Now suppose, as in Blachard and Quah(1989), Clarida and Gali(1994) and Kempa(2002) that the estimated MA representation, based on estimation of the reduced form equation in (4), is given by

$$y_t = e_t + C_1 e_{t-1} + C_2 e_{t-2} + ... \tag{8}$$

and the true MA representation of the data generating process is

$$y_t = A_0 v_t + A_1 v_{t-1} + A_2 v_{t-2} + ... \quad (9)$$

from equation (3)

$$e_t = \Gamma^{-1} v_t \quad (10)$$

substituting equation (11) to equation (8) gives

$$y_t = \Gamma^{-1} v_t + C_1 \Gamma^{-1} v_{t-1} + C_2 \Gamma^{-1} v_{t-2} + ... \quad (11)$$

comparing equation (9) and (11) give us

$$A_0 = \Gamma^{-1}, \qquad e_t = A_0 v_t \ for\ j = 0 \qquad A_j = C_j A_0\ for\ j > 0 \quad (12)$$

This shows the relationship between the vector of structural shocks v_t and the vector of reduced form residuals e_t. Therefore by knowing A_0, we can recover the structural shocks from the innovations. From equation (12) we can write

$$\Sigma_e = E(e_t e_t') = A_0 E(v_t v_t') A_0' = A_0 A_0' \quad (13)$$

This gives a system of 10 equations with 16 unknowns, so for A_0 to be identified, that is for the elements to have unique values so that the structural are recovered, it requires 6 restrictions. Also, since C_j is estimated from (3) and (8), we can also identify A_0 by imposing restrictions on the elements of $\sum_{j=1}^{\infty} A_j$ in the relationship $\sum_{j=1}^{\infty} A_j = \sum_{j=1}^{\infty} C_j A_0$ which are long run relationships because they imply that the cumulative effect of shocks to certain variables on others is zero.

3.4.2 Identification

Different types of restrictions have been used to identify VAR as an alternative to the standard Choleski decomposition, which have been criticized for its lack uniqueness because different arrangements of variables in the VAR give different results. Bernanke(1986) and Sims(1986) propose alternatives to the Choleski decomposition by using zero identifying restrictions on the contemporaneous coefficient matrix.

Other identifying restrictions have been used in the literature to identify monetary policy shocks to macroeconomic variables. Bernanke and Blinder(1992) show that monetary policy shocks can be identified without necessarily identifying the whole system by assuming that monetary policy shocks do not affect any of macroeconomic variables contemporaneously. This identification restriction implies setting the contemporaneous coefficient matrix in equation (3) Θ_0 to zero, (i.e. $\Theta_0 = 0$). Estimating the resulting system by standard VAR followed by Choleski decomposition of the variance-covariance matrix, with the policy variable coming last in the ordering, gives estimated exogenous monetary policy shocks (Bernanke and Blinder(1992)).

Since the objective of this paper is to identify all the structural shocks, I use the identification restrictions proposed by Gali(1992) who uses a combination of contemporaneous and long run restrictions to identify all the structural shocks. In the IS-LM used by Gali(1992)

$$y = \alpha + u_s - \sigma(i - E\Delta p_{+1}) + u_{is} \qquad \text{IS equation}$$

$$m - p = \phi y - \lambda i + u_{md} \qquad \text{LM equation}$$

$$\Delta m = u_{ms} \qquad \text{Money supply process}$$

$$\Delta p = \Delta p_{-1} + \beta(y - u_s) \qquad \text{Phillips' curve}$$

where y, i, p and p are the log of output, interest rate, log of money supply and log of price level and u_s, u_{is}, u_{md} and u_{ms} are supply, demand, money demand and money supply shocks respectively, restrictions are imposed based on the behavior of the economy.

Like Blachard and Quah(1989), Gali(1992)'s long run restrictions are that only supply shocks affect real GDP growth, making use of the neutrality of the nominal variables in the model. This imposes three long run zero restrictions on the elements of $\sum_{j=1}^{\infty} A_j$ in the four-variable VAR discussed above. In addition to these long run restrictions, Gali(1992) impose five short run restrictions, three of which are relevant for the current paper and are used as the three additional restrictions needed to identify the structural shocks. First, there is no contemporaneous effect of money supply shocks on output, which imposes one zero restriction on A_0. Secondly, shocks to inflation do not affect money supply contemporaneously, which imposes another zero restriction on A_0. Finally, contemporaneous real output changes do not enter the money supply rule, which implies that the coefficient of real output changes in the money supply function is zero in the current period which is a zero restriction on Γ. The last two restrictions are based on the fact that monetary authorities are unable to measure the real GDP and price variables contemporaneously, which is true because real GDP is measured quarterly at best while price is measured monthly with a lag.

The first set of Gali(1992) identification restrictions imply which, this model setting that

$$\sum_{i=0}^{\infty} a_{21i} = \sum_{i=0}^{\infty} a_{31i} = \sum_{i=0}^{\infty} a_{41i} = 0$$

The first and the second short run assumptions imply that

$$a_{210} = a_{310} = 0$$

The third restrictions also imply that

$$\gamma_{21} = 0$$

The last restriction is a non-linear restriction because it is imposed on contemporaneous relationships among the variables but not on the relationships among the shocks. That is, this restriction is on Γ and since $A_0 = \Gamma^{-1}$ it is non-linear in terms of the shocks. Putting all the restrictions together gives the

$$\sum_{j=1}^{\infty} A_j = \sum_{j=1}^{\infty} C_j A_0 = \begin{pmatrix} * & 0 & 0 & 0 \\ * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{pmatrix} \quad , \quad A_0 = \begin{pmatrix} * & 0 & 0 & * \\ * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{pmatrix} \text{and} \quad \Gamma = \begin{pmatrix} * & * & * & * \\ 0 & * & * & * \\ * & * & * & * \\ * & * & * & * \end{pmatrix}$$

where *'s are values to be estimated and the 0's are the identifying restrictions. These together identify the structural shocks v_t.

3.4.3 Data sources and description

Three main sources of data are used for this study, International Financial Statistics (IFS), Statistical Bulletin of Bank of Ghana and National Accounts Statistics of Ghana Statistical Service. Real GDP and exchange rate data are obtained from International Financial Statistics (IFS), money supply data from Statistical Bulletin of Bank of Ghana and inflation data from Ghana Statistical Service.

Quarterly data covering the period 1980 to 2010 are used to estimate the models in the study. The period of the data is chosen for convenience so that all the variables in the model have data. Though data for all the variables, except real GDP, are available monthly, quarterly data are used in estimating the model because of real GDP data, which is available quarterly. Monthly data are aggregated into quarterly data depending on the type of data; quarterly exchange rates and CPI are period quarterly averages of the monthly data while money supply for the quarter is the sum of monthly data for the quarter. Annual real GDP data for the period preceding 2006 are interpolated using COTRIM 1.01 Disaggregation Software which is based on Boot et al.(1967). Changes in these variables are calculated as quarterly changes.

3.5 Empirical results

This section presents the results of the models discussed in the previous sections with applications to the Ghana data. Time series characteristics of the data, including the graphs and Augmented Dickey-Fuller test for stationarity, are discussed followed by variance decomposition of inflation and impulse response functions of the variables in the model.

3.5.1 Characteristics of the data

The graphs of the variables in Figure 3.3 show that they are stationary at their levels and these are confirmed by the Augmented Dickey-Fuller tests presented in Table 3.1. The optimum lag selection for the VAR is based on Akaike Information Criteria and two lags are found to be optimal for the final models.

Figure 3.3: Graphs of the variables in the models

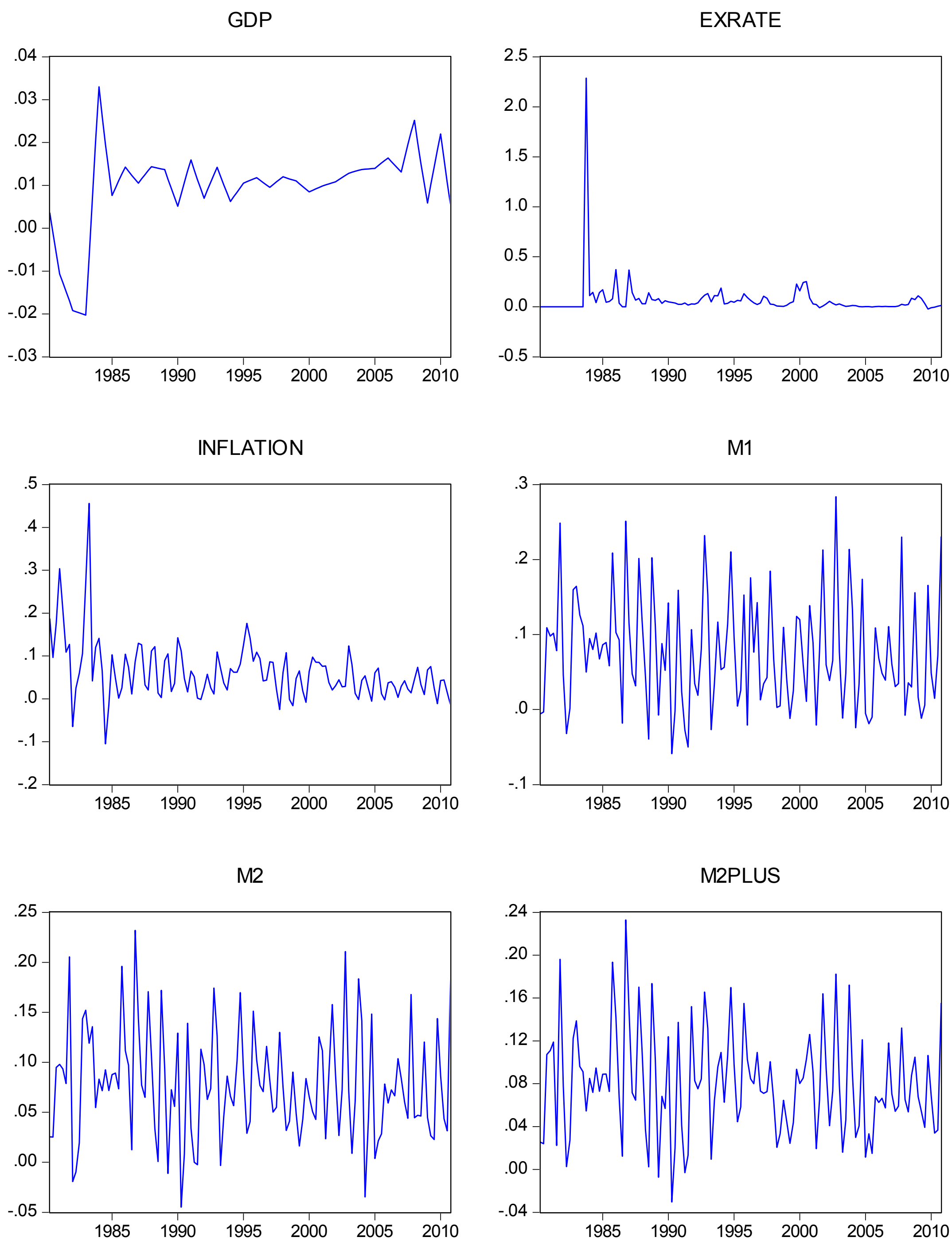


Table 3.1: Augmented Dickey-Fuller tests

Variable	lags	p-value
Real GDP growth	9	0.0001
Exchange rate	0	0.0000
Inflation	5	0.0000
M1	3	0.0024
M2	5	0.0008
M2+	3	0.0308

3.5.2 Variance decomposition and monetary policy transmission

The variance decomposition of inflation shows the relative importance of the monetary and structural shocks in explaining the forecast error variance of inflation at various forecast horizons. Three monetary aggregates are used in the VARs but only the results of the VAR including M2+ monetary aggregate is reported since the results are not sensitive to the type of aggregate used. The variance decomposition for the horizons 1, 6, 12, 24, 36 and 40 are reported in Table 3.2 to Table 3.5.

The variance decomposition for real output growth in Table 3.2 shows that exchange rate depreciation explains a significant percentage (52 percent) of variability in real output growth in the first round. This falls quickly to 27 percent in the third round and to about 5 percent after the results stabilize in the 24th round. Monetary growth and inflation account for less than one percent of the variability in real output growth. Over the longer horizon, real output growth explains the variability in itself, which is consistent with the argument that nominal variables do not explain real output growth in the long run.

The result for inflation in Table 3.3 stabilized after 12 rounds and as shown in the table, most of the variability in inflation is explained by real output growth in the long run. At 1-period-ahead forecast, monetary shocks explain 56.15 percent while real output shocks explain 26.6 percent.

The percentage variability explained by monetary growth reduces quickly over the forecast horizons to about 20 percent while real output growth, exchange rate depreciation and inflation itself explains about 80 percent.

This structure of the variance decomposition of inflation suggests that inflation in Ghana is not necessarily a monetary phenomenon. Structural factors like excess import demand and shortages in export supply that reflect in exchange rate depreciation and local supply shocks in an agriculture led economy that heavily relies on rainfall explain more of the inflationary dynamics in Ghana than monetary growth.

Table 3.2: Variance decomposition of real output growth

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	47.074	0.000	0.000	52.926
3	72.656	0.127	0.066	27.151
6	87.753	0.067	0.258	11.922
12	93.073	0.040	0.157	6.730
24	94.820	0.031	0.119	5.029
36	95.216	0.029	0.111	4.644
40	95.272	0.028	0.109	4.591

Table 3.3: Variance decomposition of inflation

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	26.648	56.149	4.748	12.455
3	45.460	29.442	4.317	20.782
6	47.434	28.924	5.168	18.474
12	55.417	24.749	4.491	15.342
24	61.338	21.433	3.891	13.338
36	63.015	20.488	3.720	12.777
40	63.262	20.349	3.695	12.694

Table 3.4 indicates that variability in exchange rate depreciation is mainly explained by inflation, real output growth and its own history. This finding, together with that of Table 3.3 where a significant percentage of variability in inflation is explained by exchange rate deprecation,

establishes a fairly strong feedback between inflation and nominal exchange rate depreciation in Ghana. Table 3.5 also shows that real output growth and exchange rate depreciation are the main explanatory shocks to the variability in monetary growth.

Table 3.4: Variance decomposition of exchange rate

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	4.570	9.222	81.598	4.611
3	10.758	6.517	67.188	15.537
6	14.202	7.046	64.004	14.749
12	23.968	6.317	56.581	13.134
24	32.193	5.634	50.402	11.771
36	34.547	5.437	48.637	11.380
40	34.898	5.407	48.374	11.321

Table 3.5: Variance decomposition of money supply (M+)

Step	GDP growth	Monetary growth	Inflation	exch. rate dep
1	55.387	14.689	1.033	28.891
3	50.276	19.548	6.952	23.224
6	61.058	17.145	5.418	16.379
12	70.250	13.300	4.133	12.317
24	76.045	10.657	3.314	9.985
36	77.504	9.990	3.107	9.398
40	77.714	9.894	3.078	9.314

The fact that the history of inflation explains little of its variability suggests that univariate time series methods will not forecast inflation as accurately as multivariate methods that include GDP growth, monetary growth and exchange rate depreciation.

3.5.3 Impulse response of inflation

In addition to the variance decomposition of the previous section, this section analyzes the impulse response of inflation to the shocks of the other variables in the model. The impulse response functions, as shown in Appendix, are graphs of the effect of a 1-standard deviation shock to the orthogonal structural shocks on the variables.

At impact, inflation rises in response to real output growth shocks and thereafter falls through various oscillations. The shock decays slowly through time to return to its mean after the 20^{th} period. This shows that real output growth will lead to fall in inflation in the long run. The response of inflation to monetary growth shocks decays quickly within the 6^{th} period from the initial rise. Exchange rate depreciation has an initial effect of lowering inflation, but over 12 periods inflation increase back to it mean. While real output growth shocks have a long lasting effect on inflation, the effect of monetary shocks and exchange rate shocks dissipate quickly over time.

3.6 Conclusions

This study separates monetary and structural causes of inflation in Ghana by using a variance decomposition and impulse responses from a Vector Autoregression with monetary and structural variables as the endogenous variables. The results indicate that structural factors explain more of the inflation dynamics in Ghana than the monetary factors. While the structural shocks take a longer time to decay, monetary shocks dissipate quickly over a shorter period.

Inflation is found to be explained less by its past rather than the structural and monetary shocks. These results are consistent with other studies on Africa, especially Canetti and Greene(1991) where inflation in ten African countries studied is largely explained by exchange rate depreciations and real incomes. The results, however, contradicts Ocran(2007) where inflation inertia, defined as lags of inflation, which reflects inflationary expectations impacts significantly on the evolution of inflation in Ghana.

The implications of the conclusions from this study are that the monetarist view of inflation that only money matters in inflation dynamics does not seem to hold for Ghana as the structural factors dominate monetary growth over the various lags. Even supply shocks alone explain more of variability in inflation than monetary shocks so inflation in Ghana is more of a structural phenomenon than monetary.

These conclusions show that to attain the goal of low and stable inflation, monetary management alone is not enough in inflation management in Ghana. These should be supported by other policies that may be more effective than monetary management alone. Addressing supply bottlenecks in agriculture and bureaucratic impediments in industry, which together form over 50 percent of the Ghanaian economy will ease aggregate supply problems domestically and reduce the export shortfall that put pressure on exchange rates and pass through to domestic prices.

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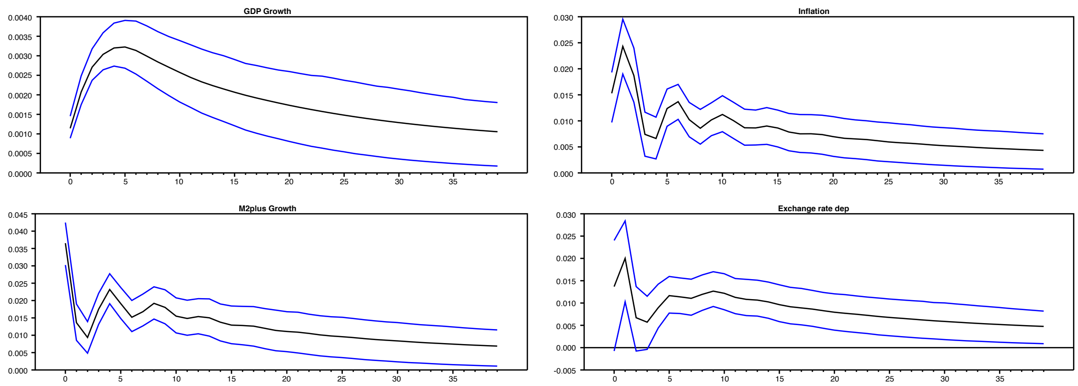
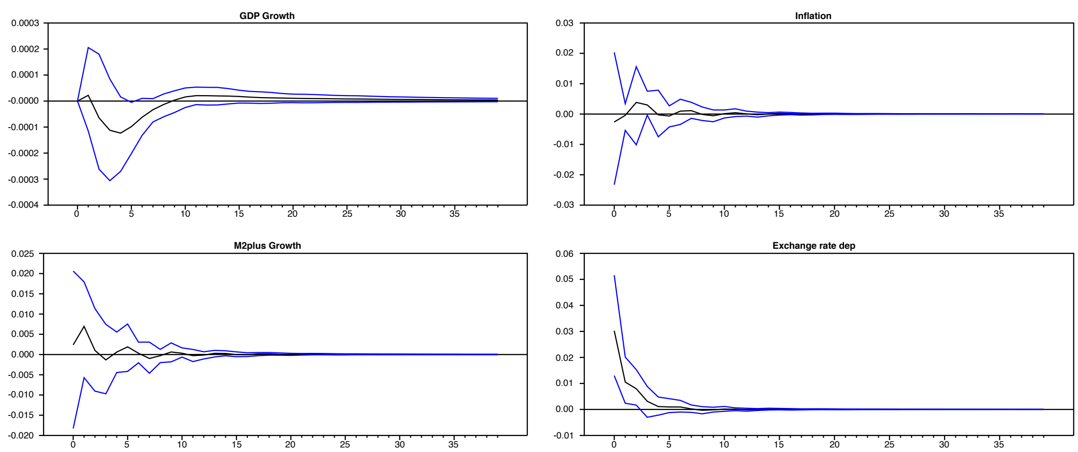
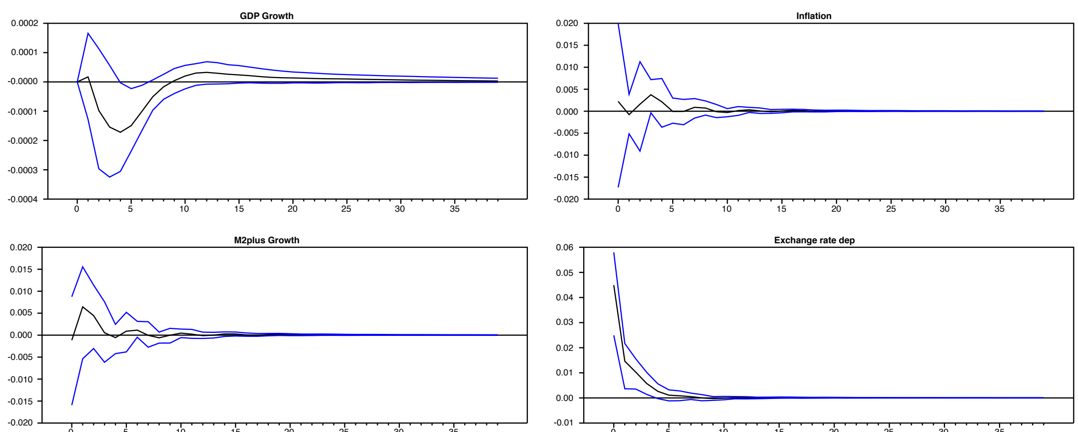
Appendix: Impulse response functions for all the variables to each shock



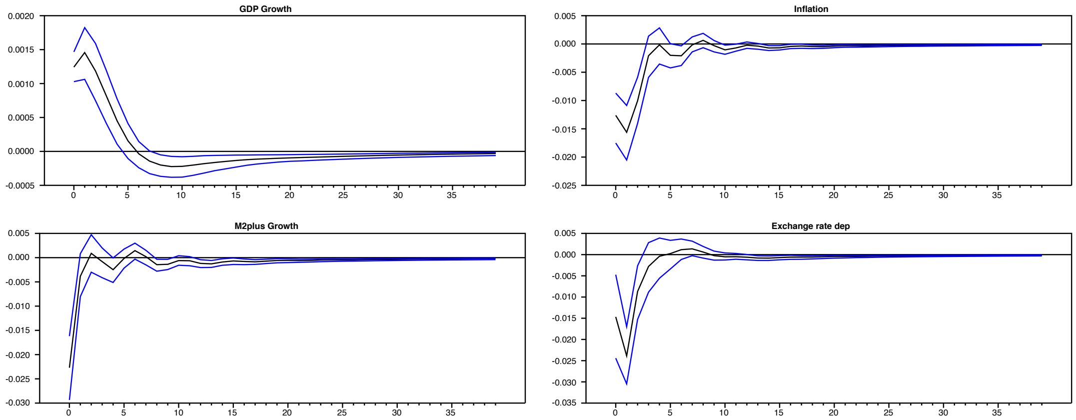
Responses to GDP growth



Responses to Monetary growth



Responses to Inflation



Responses to exch. rate dep

CHAPTER 4: IS WEST AFRICAN MONETARY ZONE (WAMZ) A COMMON CURRENCY AREA?

4.1 Introduction

In this chapter, test whether the West African Monetary Zone (WAMZ) is a common currency area by using a vector autoregressive model to study the variance decomposition, impulse responses of key economic variables and linear dependence of the underlying structural shocks of the countries in the zone. The question of what constitutes an optimum currency area is pioneered by Mundell(1961) who defines an optimum currency area as a domain within which exchange rates are fixed. Within this domain, a single currency can be introduced under a single central bank with the power to issue and redeem currency and conduct monetary policy. The issue of an appropriate domain is addressed by Mundell(1961) by suggesting that the domain is a region that is defined such that there is internal factor mobility and external factor immobility and "if factors are mobile across national boundaries, then a flexible exchange system becomes unnecessary and may even be positively harmful".

The work of Mundell(1961) inspired a series of papers. In particular, McKinnon(1963) describes the optimum currency area as an area within which there is a single currency and within which the same monetary and fiscal policies and flexible external exchange rates can be used to address the objectives of employment, international payments and price stability which are sometimes in conflict. McKinnon emphasizes the need for price stability within the region and the openness of the economies that should be considered optimum for a single currency. McKinnon(1963) also added the importance of factor mobility across industries to Mundell's argument for factor mobility across countries in determining an optimum currency area.

The issue of factor mobility is further examined by Kenen(1969). He asserts that "when regions are defined by their activities, not geographically or politically, perfect interregional labor mobility requires perfect occupational mobility and this can only come about when labor is homogeneous "(Kenen(1969)). Kenen(1969) also advances product diversification and fiscal integration of a region as major criteria for an optimum currency area. Kenen(1969) argues that diversity in a region's product mix may be a more relevant criterion than labor mobility and that well diversified is economy is more likely to have a well-diversified export sector, which can mitigate external shocks by positive and negative shocks cancelling out without resulting to exchange rate changes in response to the shock. Fiscal integration also ensures that weaker economies within the region are supported during recovery from external shocks. Eichengreen(1991) also defines an optimum currency area as " an economic unit composed of regions affected symmetrically by disturbances and between which labor and other factors production flow freely."

These characterizations of the optimal currency area in the literature usually lead to categorization of all the criteria into three. Firstly, the region should be subject to common sources of shocks and symmetric response to shocks. This means that shocks that are external to the region should induce the similar responses across the region, that is, the response of the states in the region to external shocks must be similar to ensure that the same monetary and fiscal policies can address shock recovery similarly across the region. Since the introduction of a single currency in a region means that the countries that form the region give up their autonomy over monetary policy, their individual ability to respond to external shocks by using monetary policy is also surrendered, therefore shock symmetry in the region ensures that common monetary policy is feasible for the region. "The loss of monetary flexibility has cost and benefit. One hand, a country that gives up its currency loses a stabilization devise targeted to domestic shocks, on the other hand, the country may gain credibility and thereby reduce undesired inflation"(Alesina and Barro(2002)). Alesina et al.(2002) also argues that the costs of losing monetary autonomy are lower when shocks are symmetric across that region.

Secondly, factor mobility within the region ensures that shocks to the region dissipates quickly and similarly across. Factors must be easily movable from surplus members states to deficit member states in the region in times where shocks to the region have asymmetric effects. This ensures full employment and price stability in the region. Lastly, fiscal integration is needed in the region to redistribute resources among the member state. This is a system where fiscal policies of the different states in the region are coordinated by a common federal institution like the IRS and congress of the United States. By this arrangement, collection and disbursement of certain taxes are done by federal institution and in time economic downturn, weak states can easily be bailed out through these arrangements.

As summarized by Bayoumi(1994), "the choice of a currency union depends upon the size of the underlying disturbances, the correlation between these disturbances, the costs of transactions across currencies, factor mobility across regions, and the interrelationships between demand for different goods." So the obvious question to ask is whether ECOWAS is an optimum currency area, that is, does the region satisfy the criteria for the introduction of a common currency? This is the question this study sets to investigate.

It has been proposed to implement the monetary integration process in two stages by forming a second monetary zone, the West African Monetary Zone (WAMZ) for the Anglophone West Africa, which will later merge with the existing zone, the West Africa Economic and Monetary Union (WAEMU), which is for the Francophone West Africa. Since the introduction of the proposed single currency is in two stages, i.e. forming a monetary union among the non-CFA countries and later merge with the CFA countries, we think that analyzing the convergence on non-CFA countries alone will draw a better picture of what is needed now by ECOWAS.

In this paper, I test the first criterion for the West African Monetary Zone (WAMZ) which is a group of countries from Economic Community of West African States (ECOWAS) working to introduce a single currency for their members. The first criterion is indicative of the existence of the other two criteria. If there is factor mobility and /or fiscal integration, an external shock that is specific to a state in the region (idiosyncratic shocks) will dissipates faster. The paper tests the criterion by analyzing linear dependence of and feedback between the structural shocks recovered from a structural vector autoregressive (SVAR) model of key economic variables in the region. Countries with symmetric shocks are expected to have linearly dependent shocks and exhibit some level of feedback between these shocks. Also, the paper studies the variance decomposition of these variables. If the sources of shock to the region are common, then structure of the variance decomposition should look similar across the regions.

Apart from contributing to the academic literature on monetary integration in West Africa, the approach used in this paper adds value to the previous studies West Africa by measuring the level of integration achieved by the participating countries in terms of their response to common shocks. The methodologies used in the previous studies do not allow for the direct measurement of supply, demand and monetary shocks to the economies of the individual countries and their response to common shocks. This paper tries to determine whether ECOWAS is an optimum currency area by using a structural VAR to measure shock asymmetry in the region. This is to inform policy on the adoption of the single currency the eco in the sub-region and also to have an idea of how the economies of the sub-region converge ex-ante or will converge ex-post after the introduction of the eco.

4.2 Empirical Literature

The empirical testing of the optimum currency area criteria has taken several forms including testing the synchronization of business cycles of the members of the region and measuring shock asymmetry of the countries in the region, indices, among others. Among the many studies that use the business cycles approach are Frankel and Rose(1996), Frankel and Rose(1997) and Kouparitas(2001), and the general understanding is that the cost of losing autonomy over monetary policy will be lower if business cycles of the countries in the region synchronizes. Measurement of shock asymmetry using VAR have been done mainly for Europe, and the major studies in this area include Bayoumi and Eichengreen(1992), Kempa(2002) and Buigut and Valev(2005).

Bayoumi and Eichengreen(1997) construct an Optimum Currency Area (OCA) index for the European countries and use that to divide the countries in euro zone into three groups; high level of readiness, tendency to converge and little or no evidence to converge. Bayoumi and Ostry(2010) use correlation of output growth and inflation across countries in the regions and also regress real output per capita on its first and second lags and interpret the residuals to mean the underlying real output disturbances and conclude that there is little evidence that sub-Saharan African countries would benefit from currency union in the near future.

Unlike the European Union, studies on the ECOWAS monetary integration are scanty. Since the seminal work by Soyibo(1998), little empirical work has been done on the ECOWAS monetary integration process. Debrun et al.(2003) examine the rationale for establishing regional currency unions in western Africa and conclude that monetary unification might well be beneficial for a number of the member states of the Economic Community of West African States (ECOWAS) despite dramatic economic, political and historical differences between the two regions in the community. This is because the costs of these countries losing their monetary autonomy are often more than offset by the gains originating in the (partial) separation of monetary and fiscal powers. They argue however, that large countries with relatively ambitious public expenditure objectives, like Nigeria, would not be attractive partners because they would be expected to pressure the common central bank, creating excessive inflation in the entire union. Based on those arguments, they conclude that the desirability and sustainability of a currency union within ECOWAS critically depends on fiscal discipline among its members and on a strong fiscal surveillance procedure both in the transition phase and after the establishment of the union. Masson and Patillo(2003) conclude that “monetary union in West Africa can be effective agency of restraint on fiscal policies only if the hands of the fiscal policy authorities are also tied by a strong set of fiscal restraint criteria, applicable not just for accession to monetary union, but throughout the life of the union”.

Ogunkola(2005) uses real exchange rate model to analyze the viability of a single monetary zone in ECOWAS and concludes that ECOWAS is closer to a monetary union than before. Debrun et al.(2005) also conclude, based on the calibration of their model, that lack of fiscal convergence, not the low level of regional trade or asymmetry of shocks, is the primary obstacle to the creation of a well-functioning and acceptable monetary union in West Africa. These two studies consider both the CFA and non-CFA zones and conclude based on the two zones forming a single monetary union.

On the failure of the introduction of the single currency for three consecutive times, Ojo(2005)notes that the failures are attributable to inadequate political commitment, political instability and inability to sufficiently carry along all the stakeholders in the process of program implementation. There is the need for the common market program to be implemented to complement the monetary integration program (Obaseki(2005)). Sagbamah(2005) highlights the important lessons of the European Union that should be learned by ECOWAS and provide the needed political will, social enlightenment campaign and mobilization, homogeneous product and financial markets, basic infrastructural production and economic structures, before transiting into a monetary union.

Debrunet al.(2005) are of the view that fiscal heterogeneity indeed appears critical in shaping regional currency blocs that would be mutually beneficial for all their members. In particular, Nigeria's membership in the configurations currently envisaged would not be in the interests of other ECOWAS countries unless it were accompanied by effective containment on Nigeria's financing needs. But Iyare et al.(2005) note that while fiscal convergence among members is desirable, other mechanisms like payment systems and labor mobility issues should be established beyond fiscal convergence, if such a union is to be successful.

Balogun(2007) estimates a dynamic panel data model using data available on West African Monetary Zone (WAMZ) countries and examines the monetary and macroeconomic stability perspective for entering into monetary union. By testing the hypothesis that independent monetary and exchange rate policies have been relatively ineffective in influencing domestic activities (especially GDP and inflation), and that when they do, they are counterproductive, he concludes that the members of the WAMZ would be better-off surrendering their independence over some policy instruments to the planned regional body under appropriate monetary union arrangements.

Balogun(2009) examines the determinants of inflation differentials in a panel of West African Monetary Zone (WAMZ) states vis-à-vis its set benchmark for macroeconomic convergence since 2000. Over the sample period, he finds that the un-weighted average regional inflation rates were most often above a single digit target and vary widely among the countries. The major monetary policy instruments determinants of inflationary divergence are the pursuit of distorted interest rates, exchange rates overvaluation and expansionary monetary policies.

It is clear from the empirical evidence that the ex ante conditionality for the introduction of the single currency in West African Monetary Union will be difficult to achieve. But it is possible, like the UEMOA countries, for the WAMZ to achieve optimality ex post. Achieving ex post optimum currency area can be ensured if there are common sources of shock and shock symmetry across the region and that is what this study sets out to measure.

4.3 Evolution of the West African Monetary Union and West African Monetary Zone

The quest for monetary union within ECOWAS began with the establishment of the regional body in May 1975. This quest reflects in the objectives, as stated in article 2 section 2h of the 1975 Treaty of Lagos that the community shall ensure "harmonization, required for the proper functioning of the community, of the monetary policies of the member states." This is restated in article 3 section 2e of the July 1991 treaty as "the establishment of an economic union through the adoption of common policies in the economic, financial, social and cultural sectors, and the creation of a monetary union." The 15 member states that ratified the Treaty of Lagos are Benin, Burkina Faso, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo. Cape Verde joined the community in 1976 and Mauritania left in 2000, leaving the current membership still at 15 states. The community is made up of English, French and Portuguese speaking countries.

According Soyibo(1998) before ECOWAS was established in 1975, there were two monetary unions in West Africa. Under British colonial rule, Anglophone West Africa made up of Gambia, Ghana, British Cameroon, Nigeria and Sierra Leone used a common currency, the British West African pound managed by the West African Currency Board. However, when Ghana gained independence in 1957 and establish her central bank, the Bank of Ghana, she began issuing her own national currency the cedi in 1958. Nigeria also issued her national currency, the naira, in 1958 with establishment of the Central Bank of Nigeria to replace the British West African pound. By 1968, the British West African pound collapsed when the other members issued their own currencies.

The francophone West Africa, made up of Benin, Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal, and Togo, also had and still has a common currency; the CFA franc inherited from France the colonial rulers of these countries. The CFA franc survived the post independence collapse of monetary harmonization, unlike the case for Anglophone West Africa, and established the West African Economic and Monetary Union (WAEMU) in 1994 with a single central bank Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO) and a common currency (CFA) which was fully convertible within the French franc zone. The WAEMU countries have common monetary and fiscal policies. Lending to government, for example, is fixed at 20 percent of the estimated revenue of the previous year (Soyibo(1998)).

The West African Clearing House (WACH), a multilateral payment system, was set up in 1975, immediately after the founding of ECOWAS to provide settlement services among the central banks and to facilitate the monetary integration process in the whole of West Africa. This has been transformed into West African Monetary Agency (WAMA) in 1996. A more comprehensive program called the ECOWAS Monetary Cooperation Programme (EMCP) was launched in 1987 with its main objective of creating a single monetary zone and introducing a common currency. The initial idea had been to introduce a single currency for all the member states of ECOWAS at a time, but this idea was latter changed to the formation of a second monetary zone with a single currency, called the eco, when in April 2000 Accra Declaration four Anglophone members of ECOWAS Gambia, Ghana, Nigeria, Sierra Leone and one francophone member Guinea launched an initiative to establish the second monetary zone in West Africa. December 2000 Bamako Accord established the West African Monetary Zone (WAMZ), the West African Monetary Institute (WAMI) and Stabilization and Cooperation Fund (SCF) alongside eight-member francophone West African Economic and Monetary Union (WAEMU). WAMI was established by this accord to undertake all necessary tasks leading to the setting up of the West African Central Bank (WACB) and the introduction of a common currency (WAMI(2002)). The five countries had pledged to adopt a common currency by January 2003 and to work toward merging their planned monetary union with the WAEMU by January 2004 (Asante and Masson(2001)). These ambitious targets could not be met by these countries because of the failure to meet the set convergence criteria. Liberia later joined the WAMZ in February 2010 as the sixth member with Cape Verde an observer.

In November 2002 the Forum of Finance Ministers of WAMZ decided to facilitate the harmonization of fiscal and monetary policies by introducing two sets of convergence criteria, four primary and six secondary, for members. According to WAMI(2002), these criteria are as follows;

The primary criteria

i. Achieve and maintain price stability by recording single digit end of period inflation rate by 2003 and 5 percent by 2004;
ii. Ensure sustainable government fiscal position by reducing the ratio of budget deficit (excluding grants) on commitment basis to GDP to 4 percent or less throughout the period 2003-2005;
iii. Limit Central Bank financing of government budget deficit as a percent of previous year's tax revenue to 10 percent or less throughout the period 2003-2005
iv. Maintain sufficient level of gross official foreign exchange reserves of at least 3 months of import cover throughout the period 2003-2005.

The secondary criteria

i. Prohibition of new domestic arrears and liquidation of existing ones;
ii. Tax revenue to GDP ratio equal to or greater that 20 percent;
iii. Wage bill to tax revenue ratio equal to or less than 35 percent;
iv. Public investment to tax revenue equal to or greater than 20 percent;
v. Maintain real exchange rate stability; and
vi. Positive real interest rate.

The primary criteria would ensure that the economies of the member states converge in the sense of having symmetric shocks while the secondary criteria would ensure fiscal convergence. The details of these criteria are in the appendix to this chapter. Table 4.1 shows the level of satisfaction of the primary criteria by each of the member countries over the period 2001 to 2009. Throughout the period only two countries, Gambia and Nigeria, satisfy all four primary criteria in 2007 and 2008 and only Gambia satisfies all criteria in 2008 and 2009. These developments bring a lot doubts about the possibility of a successful introduction of a common currency, the eco, in the Anglophone Economic Community of West African States (ECOWAS). Debrunet al.(2005), for example, show that the proposed monetary union is not incentive compatible for most of the existing non-CFA members of ECOWAS unless there are institutional changes. A new time for the introduction of the new currency, by which it is hoped all the economies in the region will meet the convergence criteria, is 2015. These unsuccessful attempts at introducing the currency in the previous set dates also bring into focus the sustainability of the eco when it is introduced since there are still staggering efforts at introducing it.

Table 4.1: Performance of WAMZ countries on primary convergence criteria

	2001	2002	2003	2004	2005	2006	2007	2008	2009	Criteria
The Gambia										
Inflation Rate (end-period)	8.1	13	17.6	8	1.8	1.4	6	6.8	5	5
Fiscal Deficit/Surplus/GDP (%) excl. grants	-10	-9.1	-7.6	-8.6	-7.4	-2.7	-1	-3.3	-4.3	4
Central Bank Deficit Financing	80.7	22.4	63.1	0	0	0	0	0	5.4	10
Gross External Reserves (Months of Imports)	8.2	5.2	4.6	5	5.2	4.9	5.5	5.8	5.3	3
Number of Criteria Satisfied	2	1	1	3	3	4	4	4	4	
Ghana										
Inflation Rate (end period)	21.3	15.2	23.6	11.8	13.9	10.9	12.8	18.1	29.8	5
Fiscal Deficit/GDP (%) excl. grants	13.2	8.3	7.5	8.1	6.9	11.5	14.7	18.6	18	4
Central Bank Deficit Financing	0	12.1	0	0	0	0	14.8	38.7	15.5	10
Gross External Reserves (Months of Imports*)	1.4	2.7	5	4.6	4	3.8	3.9	2.2	2.3	3
Number of Criteria Satisfied	1	0	2	2	2	2	2	0	0	
Guinea										
Inflation Rate (end period)	1.1	6.1	14.8	27.6	29.7	39.1	12.9	13.5	7.7	5
Fiscal Deficit/GDP (%) excl. grants	-5.2	-8.1	-11.1	-6.5	-0.9	-0.2	-0.5	-1.7	2.9	4
Central Bank Deficit Financing	0	27.1	16.1	23.1	0	81.6	0	5.4	0	10
Gross External Reserves (Months of Imports*)	4.4	3.7	1.7	1	1.1	0.6	0.4	0.6	1.8	3
Number of Criteria satisfied	3	2	0	0	2	1	2	2	2	
Liberia										
Inflation Rate (end period)	19.4	11.1	5	16.1	7	8.9	11.7	9.4	9.1	5
Fiscal Deficit/GDP (%) excl. grants	1.9	1	3.7	4.4	0.9	-3	3.4	2	2	4
Central Bank Deficit Financing	0	0	0	0	0	0	0	0	0	10
Gross External Reserves (Months of Imports*)	2.6	0	0.2	0.2	0.1	0.1	0.7	0.7	0.7	3
Number of Criteria satisfied	1	1	1	1	1	1	1	1	1	
Nigeria										
Inflation Rate (end period)	16.5	12.2	23.8	10	11.6	8.6	6.6	15.1	7.7	5
Fiscal Deficit/GDP (%) excl. grants	3.2	3.9	2	1.2	1.3	0.6	0.5	-0.2	0.4	4
Central Bank Deficit Financing	0	0	37.6	0	0	0	0	0	0	10
Gross External Reserves (Months of Imports)	8.9	6.2	4.9	11.6	11.6	14.5	13.2	13.8	14.6	3
Number of Criteria Satisfied	3	3	2	3	3	4	4	3	3	
Sierra Leone										
Inflation (End Period)	3.4	-3.1	11.3	14.4	13.1	8.3	12.2	13.2	10.0	5
Fiscal Deficit/GDP (%) excl grants	-16.5	-11.7	-10	-8.6	-9.6	-8.5	-5	-7.9	8.1	4
Central Bank Deficit Financing	0	-5.8	24.3	-32	-19.6	17.9	1.3	0.3	0.5	10
Gross External Reserves (months of imports *)	2.4	2.7	1.7	3.8	4	4.2	4.8	4.3	4.6	3
Number of Criteria satisfied	2	2	0	2	2	2	2	2	1	
Number of countries satisfying all 4 criteria	0	0	0	0	0	2	2	1	1	

Source: West African Monetary Agency, Freetown

The economies of these Anglophone, even francophone, countries of Economic Community of West African States (ECOWAS) are plagued with problems of high rates of inflation, different and erratic levels of economic growth and development, and different economic structures. All these countries experience various levels of low standards of living, low levels of productivity, high and rising levels of unemployment and underemployment, over-dependence on agricultural production and primary product exports, and vulnerability in international relations. Table 4.2 shows the distribution of GDP among primary, secondary and tertiary sectors and real GDP growth rates of these economies. The structure varies from the tertiary sector dominance, e.g. 56.2 percent for Gambia, to the primary sector dominance, e.g. 68.2 percent for Liberia and 55.6 percent for Sierra Leone. Real GDP growth rates also vary widely across the region. While Guinea records real GDP growth of -0.3 percent in 2009, Nigeria records 6.7 percent. These wide disparities indicate lack of policy harmonization in the region and question the wisdom in calling for immediate introduction of a single currency.

The calls for a single currency in West Africa are mainly because of the perceived benefits of a monetary union, which include the promotion of regional solidarity, protection of individual country's currencies from speculative attacks, removal of exchange rate uncertainties and the creation of large common market that will attract foreign direct investment. These calls can only come true and benefits achieved under certain conditions. Soyibo(1998) in his seminal paper notes that there are non-tariff barriers amongst the ECOWAS states and non-ratification of ECOWAS protocols, which hinder the realization of such common currency.

Table 4.2: Structure and real GDP growth of WAMZ countries

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gambia										
Structure of GDP										
Primary sector	32.9	32.5	28.8	31.6	26.8	27.3	20.8	19.7	24.3	25.7
Secondary sector	12.5	11.4	11.6	11.4	13.6	12.8	14.3	13.1	12	11.5
Tertiary sector	54.6	56.1	59.6	57	66	65.3	71.2	74.4	69	56.2
Real GDP growth	5.5	5.8	1.3	7.4	6.6	0.3	3.4	6	6.3	5.6
Ghana										
Structure of GDP										
Primary sector	35.3	35.2	34.8	36.5	37.9	37.5	35.6	33.9	34.1	33
Secondary sector	25.4	25.2	25.1	25.2	24.7	25.1	26	25.3	24.3	24.4
Tertiary sector	28.8	29.2	29.8	29.1	28.7	28.9	30.1	32.1	32.9	33
Real GDP growth	3.7	4.2	4.5	5.2	5.6	5.9	6.2	6.3	6	4.6
Guinea										
Structure of GDP										
Primary sector	21	21.7	21.6	20.8	23.3	22.3	21.9	23.4	22.8	23.6
Secondary sector	31.4	31.8	31.3	31.7	30.5	32.1	36.7	36.5	38.7	36.8
Tertiary sector	47.6	46.4	47	47.5	46.2	37.9	33.4	32.4	29.9	30.9
Real GDP growth	2.8	3.7	5.2	1.2	2.3	3	2.5	1.8	4.9	-0.3
Liberia										
Structure of GDP										
Primary sector	72	73.8	76.2	76.1	71.2	69.6	68.9	67.7	67.8	68.2
Secondary sector	11.6	6.2	4.8	3.6	5	5.7	6.8	7.2	7.4	6.2
Tertiary sector	16.4	20	19.1	20.4	23.8	24.7	24.3	25.1	24.8	25.6
Real GDP growth	29.3	2.9	5.5	-23.2	21.1	9.8	6.1	8.3	7.8	4.6
Nigeria										
Structure of GDP										
Primary sector	29.9	35	36.5	32.6	34.2	32.8	32	33.2	33	37.2
Secondary sector	62.3	47.2	54.2	58.5	54.9	56.1	56.5	52.5	51.5	32.3
Tertiary sector	7.8	8.7	9.3	8.9	10.9	11.1	11.5	14.3	15.5	12.8
Real GDP growth	5.3	4.7	4.6	9.6	6.6	6.5	6	6.5	6	6.7
Sierra Leone										
Structure of GDP										
Primary sector	55	40.1	40.7	42.2	45.3	49.6	51	55.5	56.4	55.6
Secondary sector	26.8	8.1	9.9	11.5	11.2	9.7	8.5	8.1	6.4	5
Tertiary sector	18.2	51.8	49.4	46.2	43.4	40.7	40.5	36.4	37.2	39.4
Real GDP growth	3.8	18.2	18.2	10.9	9.6	7.5	7.5	6.4	4.4	4.5

Source: West African Monetary Agency, Freetown

4.4 Methodology

4.4.1 The SVAR Model

The empirical analysis of shock asymmetry is based on the stochastic rational expectations open economy macroeconomic model developed by Clarida and Gali(1994) and also used by

Kempa(2002) to analyze the convergence of the euro zone countries an optimum currency area. "The model exhibits the results of the standard Mundell-Fleming-Dornbusch model in both the short run when prices adjust sluggishly to demand, money and supply shocks and long run properties that characterize macroeconomic equilibrium in the open economy once prices adjust full to all shocks"(Clarida and Gali(1994)). The model is as follows

$$y_t^d = d_t + \eta(s_t - p_t) - \sigma(i_t - E_t(p_{t+1} - p_t)) \qquad \text{IS equation}$$

$$p_t = (1-\theta)E_{t-1}p_t^e + \theta p_t^e \qquad \text{Price setting equation}$$

$$m_t^s - p_t = y_t - \lambda i_t \qquad \text{LM equation}$$

$$i_t = E_t(s_{t+1} - s_t) \qquad \text{Interest parity condition}$$

The variables, except interest rate are measured in logs where y_t^d, s_t, p_t, i_t, p_t^e, m_t^s are demand for home output relative to foreign output, the nominal exchange rate, the relative price level, nominal interest rate in the home country, expected price level, relative money stock respectively and d_t is relative demand shock. Relative output supply y_t^s and relative money stock m_t are assumed to follow a random walk, that is, shocks to these variables are solely permanent while relative demand shock d_t is has both a transitory and permanent components. These assumptions are specified as

$$y_t^s = y_{t-1}^s + z_t$$

$$m_t = m_{t-1} + v_t$$

$$d_t = d_{t-1} + \delta_t - \gamma\delta_{t-1}$$

Solving the model with these assumptions, the flexible price equilibrium is shown by Clarida and Gali(1994) to be

$$y_t^e = y_t^s$$

$$q_t^e = (y_t^s - d_t)/\eta + (\eta(\eta+\sigma))^{-1}\sigma\gamma\delta_t$$

$$p_t^e = m_t - y_t^s + \lambda(1+\lambda)^{-1}(\eta+\sigma)^{-1}\gamma\delta_t$$

in which the level of relative output, y_t^e, the real exchange rate, $q_t^e = (s_t - p_t)$, and relative price level, p_t^e are driven by three shocks; supply, z_t, demand, d_t, and money, v_t. Real output is influenced solely by supply shocks, real exchange rate is influenced by both demand and supply shocks, and the flexible price level is influenced by supply, demand and monetary factors.

Let $y_t = \left(x_{1t}\ x_{2t}\ x_{3t}\right)'$ be a vector of endogenous variables where x_{1t} is a measure of growth of economic activity of a country relative to the US, x_{2t} is the change in bilateral real exchange rates between each country's currency and the US dollar and x_{3t} is the change in price level of each country relative to the US price level. The dynamic structural representation of the model is

$$\Gamma y_t = \mu + \sum_{j=1}^{p} B_t y_{t-j} + v_t \tag{1}$$

where Γ is a 3×3 matrix of contemporaneous coefficients among the endogenous variables, μ is a vector of constants, B_j is a 3×3 matrix of structural coefficients, v_t is a vector of orthogonal structural shocks to the system so that $\Sigma_v = E\left(v_t v_t'\right) = I$. The reduced form of equation (1) is

$$y_t = \Gamma^{-1}\mu + \sum \Gamma^{-1} B_t y_{t-j} + \Gamma^{-1} v_t \tag{2}$$

this can be written as

$$y_t = \nu + \sum_{j=1}^{p} \Theta_j y_{t-j} + e_t \tag{3}$$

where $\nu = \Gamma^{-1}\mu$, $\Theta_j = \Gamma_j^{-1} B_j$, and $e_t = \Gamma^{-1} v_t$. Equation (3) can also be written as

$$y_t = \nu + \Theta(L) y_t + e_t \tag{4}$$

where $\Theta(L) = L + L^2 + ... + L^p$ and L is a lag operator. Given that the system in equation (4) is stable, we can re-write (4) as a moving average representation, by Wold's decomposition.

$$\left(I - \Theta(L)\right) y_t = \nu + e_t \tag{5}$$

$$y_t = \left(I - \Theta(L)\right)^{-1} \nu + \left(I - \Theta(L)\right)^{-1} e_t \tag{6}$$

$$y_t = \mu_0 + \sum_{j=0}^{\infty} \Phi_j e_{t-j} \tag{7}$$

Now suppose, as in Blachard and Quah(1989), Clarida and Gali(1994) and Kempa(2002) that the estimated MA representation, based on estimation of the reduced form equation in (4), is given by

$$y_t = e_t + C_1 e_{t-1} + C_2 e_{t-2} + ... \tag{8}$$

and the true MA representation of the actual data generating process is

$$y_t = A_0 v_t + A_1 v_{t-1} + A_2 v_{t-2} + ... \tag{9}$$

from equation (3)

$$e_t = \Gamma^{-1} v_t \tag{10}$$

substituting equation (10) to equation (8) gives

$$y_t = \Gamma^{-1} v_t + C_1 \Gamma^{-1} v_{t-1} + C_2 \Gamma^{-1} v_{t-2} + ... \tag{11}$$

comparing equation (9) and (11) give us

$$A_0 = \Gamma^{-1}, \qquad e_t = A_0 v_t \ for\ j = 0 \qquad A_j = C_j A_0\ for\ j > 0 \tag{12}$$

This shows the relationship between the vector of structural shocks v_t and the vector of reduced form residuals e_t , which is equivalent to the C-model of Amisano and Giannini(1997). By knowing A_0 , we can recover the structural shocks from the innovations. From equation (12) we can write

$$\Sigma_e = E(e_t e_t') = A_0 E(v_t v_t') A_0' = A_0 A_0' \tag{13}$$

$$\begin{pmatrix} w_{11} & w_{21} & w_{31} \\ w_{12} & w_{22} & w_{32} \\ w_{13} & w_{23} & w_{33} \end{pmatrix} = \begin{pmatrix} a_{110} & a_{210} & a_{310} \\ a_{120} & a_{220} & a_{320} \\ a_{130} & a_{230} & a_{330} \end{pmatrix} \begin{pmatrix} a_{110} & a_{120} & a_{130} \\ a_{210} & a_{220} & a_{230} \\ a_{310} & a_{320} & a_{330} \end{pmatrix}$$

$$w_{11} = a_{110}^2 + a_{210}^2 + a_{310}^2$$
$$w_{22} = a_{120}^2 + a_{220}^2 + a_{320}^2$$
$$w_{33} = a_{130}^2 + a_{230}^2 + a_{330}^2$$
$$w_{21} = w_{12} = a_{120}a_{110} + a_{220}a_{210} + a_{320}a_{310}$$
$$w_{31} = w_{13} = a_{130}a_{110} + a_{230}a_{210} + a_{330}a_{310}$$
$$w_{32} = w_{23} = a_{130}a_{120} + a_{230}a_{220} + a_{330}a_{320}$$

This is a system of 6 equations with 9 unknowns since Σ_e is a symmetric matrix estimated from the VAR in equation (3), this implies that A_0 is not identified. In order to be able to identify A_0 and recover the structural shocks v_t we need to impose three additional restrictions on the elements of A_0. In this paper since the structural model derives from the structural model of Clarida and Gali(1994), the alignment of the shocks also follow. The shock to economic growth is aligned as the supply shock because supply shocks are known to be the main unexpected changes in output in developing countries especially. Shocks to real exchange rates are identified as demand shocks because these countries are import dependent so excess import demand drives exchange rates. Shocks to price changes are also labeled as monetary shocks because money is assumed to be neutral. Clarida and Gali(1994) and Kempa(2002) use Blachard and Quah(1989) decomposition to identify A_0. This decomposition states that "only supply shocks v_{1t} influence changes in real output levels in the long run, while both supply and demand shocks v_{2t} influence real exchange rates in the long run. Monetary shocks v_{3t} have no long run impact on either change in real output levels or real exchange rates" (Clarida and Gali(1994)). This statement imposes three restrictions on A_0. A short run view of these restrictions is

$$a_{210} = a_{310} = a_{320} = 0$$

given the arrangement of the variables in the VAR. Blachard and Quah(1989) restrictions are long run restriction therefore the restrictions imply that

$$\sum_{i=0}^{\infty} a_{21i} = \sum_{i=0}^{\infty} a_{31i} = \sum_{i=0}^{\infty} a_{32i} = 0$$

These restrictions imply that the matrix

$$\sum_{j=0}^{\infty} A_j = \sum_{j=0}^{\infty} C_j A_0$$

is a lower triangular matrix. Blachard and Quah(1989) show that these restrictions identify A_0 and we can recover v_t as

$$v_t = A_0^{-1} e_t$$

In order to ensure the stability of the VAR and be able to explore it's properties I check the stationarity properties of the series using Augmented Dickey-Fuller test. The optimum lag order selection is based on Akaike Information Criterion.

4.4.2 Linear Dependence of and feedback between the structural shocks

The linear dependence of two time series x_t and y_t can be decomposed into a sum of contemporaneous linear feedback between x_t and y_t, linear feedback from x_t to y_t and linear feedback from y_t to x_t. Geweke(1982) shows that if the series are stationary, nondeterministic, autoregressive and have moving average representation, then linear dependence of x_t and y_t ($F_{X,Y}$) can be decomposed as

$$F_{X,Y} = \hat{F}_{X \to Y} + \hat{F}_{Y \to X} + \hat{F}_{X.Y} \tag{14}$$

where $F_{X \to Y}$, $F_{X \to Y}$, and $F_{X \to Y}$ are calculated from the variances and covariance of the residuals in the following autoregressive models.

$$x_t = \sum_{s=1}^{p} E_{1s} x_{t-s} + u_{1t} \qquad \hat{\Sigma}_1 = \hat{U}_1^{'} \hat{U}_1 \tag{15}$$

$$x_t = \sum_{s=1}^{p} E_{2s} x_{t-s} + \sum_{s=1}^{p} F_{2s} y_{t-s} + u_{2t} \qquad \hat{\Sigma}_2 = \hat{U}_2^{'} \hat{U}_2 \tag{16}$$

$$y_t = \sum_{s=1}^{p} G_{1s} y_{t-s} + v_{1t} \qquad \hat{T}_1 = \hat{V}_1^{'} \hat{V}_1 \tag{17}$$

$$y_t = \sum_{s=1}^{p} G_{2s} y_{t-s} + \sum_{s=1}^{p} H_{2s} x_{t-s} + v_{2t} \qquad \hat{T}_2 = \hat{V}_2^{'} \hat{V}_2 \tag{18}$$

$$\hat{C} = \hat{U}_2^{'} \hat{V}_2 \qquad \hat{\Upsilon} = \begin{pmatrix} \hat{\Sigma}_2 & \hat{C} \\ \hat{C}^{'} & \hat{\mathrm{T}}_2 \end{pmatrix} \tag{19}$$

and

$$F_{X \to Y} = \ln\left(\frac{|\mathrm{T}_1|}{|\mathrm{T}_2|}\right), \qquad F_{Y \to X} = \ln\left(\frac{|\Sigma_1|}{|\Sigma_2|}\right), \qquad F_{X.Y} = \ln\left(\frac{|\mathrm{T}_2|.|\Sigma_2|}{|\Upsilon|}\right), \quad F_{X,Y} = \ln\left(\frac{|\Sigma_1|.|\mathrm{T}_1|}{|\Upsilon|}\right) \tag{20}$$

X and Y are linearly independent if and only if $\Sigma_1 = \Sigma_2$. Under the null hypothesis of no linear feedback where $n\hat{F}_{X,Y}$, $n\hat{F}_{X \to Y}$, $n\hat{F}_{Y \to X}$, and $n\hat{F}_{X.Y}$ have chi-squared distribution with degrees of freedom $kl(2p+1)$, klp , klp , and kl respectively, where k is the number of variables in x_t , l is the number of variables in y_t , p is the number of autoregressive lags and n is the number of observations.

Geweke(1982) is used to measure and decompose linear dependence between pairs of countries and compared with linear dependence of Germany, France, Spain, Italy and Greece to determine if the West African countries are ready for a monetary union. We expect the structural shocks of economies that are converge to be linearly dependent.

4.4.3 Data

The data for the estimation of the models are extracted from International Financial Statistics (IFS) and Direction of Trade Statistics (DOTS) by the International Monetary Fund (IMF) and directly from some central banks and statistical organizations of some of the countries. The data on consumer price index and inflation for all the countries are extracted from October 2011 edition of IFS, except for Guinea and where these data are collected from the website of Banque Centrale de la République de Guinée (BCRG) (bcrg-guinee.org). Data on nominal exchange rates of each of the countries are taken from the IFS except for Guinea where they are taken from the IFS for 1980 to 2005 and the rest of the years from the website of Institut National de la Statistique (stat-guinee.org) while the trade data is taken from DOTS. I use monthly data from February 1987 to April 2011 for all the series. The period of the data for the paper is chosen to insure that data is available for all the variables for all the countries in the study.

In measuring the variables that go into the models, many studies use real GDP growth as a measure of real growth of the economic activity but in the context of developing countries such as the ECOWAS countries Bayoumi and Ostry(2010) notes that “in Africa many of the shocks which affect economies are temporary supply disturbances such as climatic shocks to agriculture or terms of trade disturbances”. This is due to the subsistence nature of agriculture, which is the dominant sector in the economies of many of these countries. In this study I use growth in total trade of each these countries, that is, exports plus imports relative to US trade to measure growth of economic activity. The use of the trade data also makes it possible to use monthly data which increases frequency and range of the data. Therefore the real growth for country i in the region is measured as

$$x_{1i} = d\ln\left(\frac{(exports + imports)_i}{(exports + imports)_{US}}\right).$$

The exchange rate variables are bilateral real exchange rates of the countries' currencies to the US dollar. The real exchange rate for country i is measured as

$$x_{2i} = d(e_i - p_i + p_{us})$$

where e_i is the log of bilateral nominal exchange rate for country i, p_i is the log of CPI of country i and p_{US} is the log of CPI of the USA.

The price variable is measured according to Kempa(2002) where

$$x_{3i} = d\ln\left(\frac{p_i}{p_{US}}\right).$$

These variables are measured relative to the USA because the US dollar is seen as an anchored currency of these countries as shown in Alesinaet al.(2002).

4.5 Empirical results

The measurement of the variables that go into the models makes them naturally to be stationary at their levels. However, ADF tests are used to formally check the stationarity properties and found that they do not have unit roots. Akaike Information Criterion is used to select the optimum lag for the models and 2, 5, 3, 2, and 3 lags are found to be optimum for the models of Gambia, Ghana, Guinea, Nigeria and Sierra Leone respectively.

4.5.1 Variance decomposition

Variance decomposition is important in identifying the sources of variability in the variables in the models for each country in the region. This helps in determining whether the sources of shock to variables in the models are common across the region. Table 4.3 shows the variance decomposition of real growth of economic activity, real exchange rates and price level changes. The variance decomposition is presented for 1, 3, 6, 12, 24 and 36 lags to enable us compare the structure of the variance decomposition after the system stabilizes across. Panels a, b and c of Table 4.3 show the variance decomposition of real growth, real exchange rate change and price level changes respectively for all the countries. Panel a shows that the supply shocks dominate variability in output growth throughout, explaining at least 99 percent for Gambia, Ghana and Nigeria. While the structure of the variance decomposition looks similar for these countries in the region, the magnitude looks different for Sierra Leone with a higher percentage of the variability in real growth explained by demand shocks. Panel b of shows that for all the countries in the region, demand shocks are dominant and persistent over time in explaining exchange rate variability. Demand shocks explain at least 97 percent of real exchange rate across the region for the 1-month ahead forecast variance and this stabilizes after third period except for Sierra Leone. In panel c, the pattern of the variance decomposition for price level changes is different across the region. At 36 lags, after the system stabilizes, about 90 percent of the variance for Gambia is explained by monetary shocks, 91 percent for Ghana, 34 percent for Guinea 95 percent for Nigeria and 82 percent for Sierra Leone. Clearly, the forecast variance of prices is explained by different shocks across the zone except for Ghana and Nigeria which are close for all the variables. This suggests that the sources of external shock to real output growth and real exchange rates in the region are common to the four countries but the sources of shock to price level changes are not common to any.

Table 4.3: Variance decomposition of the variables in the model

	Gambia			Ghana			Guinea			Nigeria			Sierra Leone		
Period	Monetary	Demand	Supply	Monetary	Demand	Supply	Monetary	Demand	Supply	Monetary	Demand	Supply	Monetary	Demand	Supply
Variance Decomposition of real growth															
1	0.01	0.34	99.65	0.09	1.94	97.97	0.41	0.28	99.31	0.1	0.19	99.71	0.04	9.23	90.73
3	0.31	0.49	99.2	0.14	2.4	97.47	1.49	0.75	97.76	0.24	0.73	99.04	0.12	12.03	87.84
6	0.31	0.49	99.2	0.48	2.59	96.93	1.5	0.86	97.64	0.24	0.73	99.04	0.3	12.59	87.11
12	0.31	0.49	99.2	0.49	2.61	96.9	1.5	0.86	97.64	0.24	0.73	99.04	0.31	12.59	87.1
24	0.31	0.49	99.2	0.49	2.61	96.9	1.5	0.86	97.64	0.24	0.73	99.04	0.31	12.59	87.1
36	0.31	0.49	99.2	0.49	2.61	96.9	1.5	0.86	97.64	0.24	0.73	99.04	0.31	12.59	87.1
Variance Decomposition of real exchange rate changes															
1	0.425	99.211	0.364	1.908	96.042	2.05	0.485	97.951	1.564	0.375	99.605	0.02	7.85	85.392	6.758
3	1.689	96.976	1.335	1.35	94	4.651	0.916	97.234	1.85	0.549	98.47	0.98	11.685	81.941	6.374
6	1.716	96.95	1.334	1.439	92.696	5.865	0.931	96.349	2.72	0.553	98.402	1.044	12.505	81.093	6.402
12	1.716	96.95	1.334	1.61	92.454	5.936	0.931	96.348	2.721	0.553	98.402	1.044	12.535	81.061	6.404
24	1.716	96.95	1.334	1.61	92.452	5.938	0.931	96.348	2.721	0.553	98.402	1.044	12.536	81.06	6.404
36	1.716	96.95	1.334	1.61	92.452	5.938	0.931	96.348	2.721	0.553	98.402	1.044	12.536	81.06	6.404
Variance Decomposition of price changes															
1	91.971	7.785	0.244	90.307	9.187	0.506	33.573	64.728	1.699	95.6	4.226	0.174	84.02	10.064	5.917
3	89.896	8.921	1.183	92.524	7.036	0.44	33.806	64.265	1.929	94.517	4.698	0.785	83.165	9.923	6.912
6	89.696	9.12	1.185	91.519	7.652	0.829	33.512	63.687	2.801	94.503	4.711	0.786	82.253	10.806	6.941
12	89.696	9.12	1.185	91.196	7.931	0.873	33.511	63.686	2.803	94.503	4.711	0.786	82.194	10.833	6.973
24	89.696	9.12	1.185	91.195	7.931	0.874	33.511	63.686	2.803	94.503	4.711	0.786	82.194	10.833	6.972
36	89.696	9.12	1.185	91.195	7.931	0.874	33.511	63.686	2.803	94.503	4.711	0.786	82.194	10.833	6.972

4.5.2 Impulse response functions

Figure 4.1 to Figure 4.5 show the graphs of the impulse response functions of the all the variables for all the countries in the region. The first panel of the graphs for each country shows the response of real growth to a 1-standard deviation of supply, demand and monetary shocks while the second and third panels show the response of real exchange rate changes and price level changes respectively to the same shocks. The graphs display the dynamics of how the variables respond to the shocks. On impact, the economies of all the countries in the region shrink at different rates. The time it takes for the shock to dissipate varies among the countries. While it takes Gambia about 6 periods for the shock to dissipate, it takes Ghana about 5 periods, while Sierra Leone’s shock lingers through to the 10^{th} period. The response to supply and monetary shock are not similar either. The response of real exchange rates changes and price level changes to all shocks across the region differs greatly in structure and intensity. The differences in the rate at which the shocks dissipate through impulse response functions of the countries show that these countries have asymmetric shocks which is further investigated in the next section using a correlation of the structural shocks.

Figure 4.1: Impulse response for Gambia

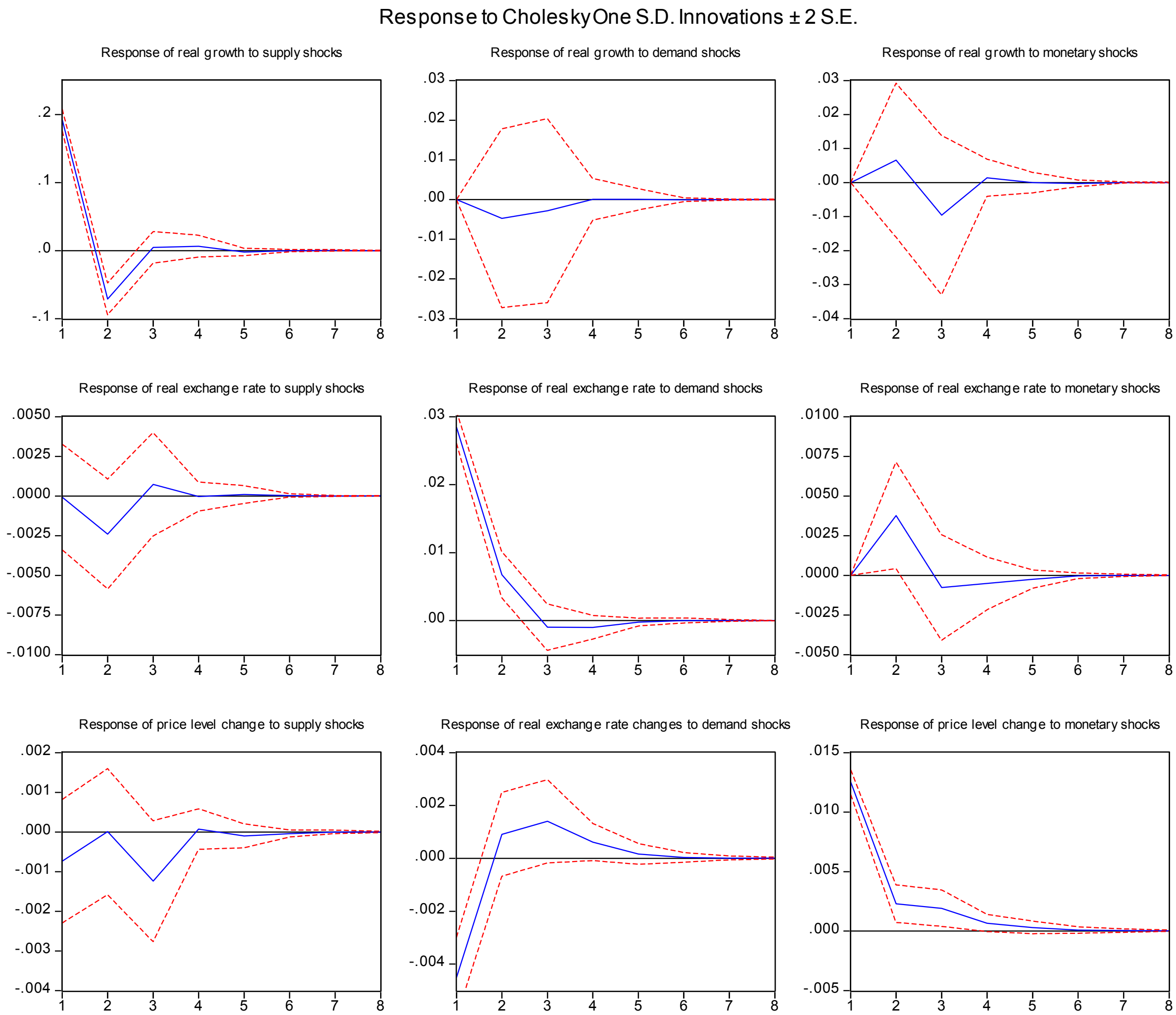


Figure 4.2: Impulse response for Ghana

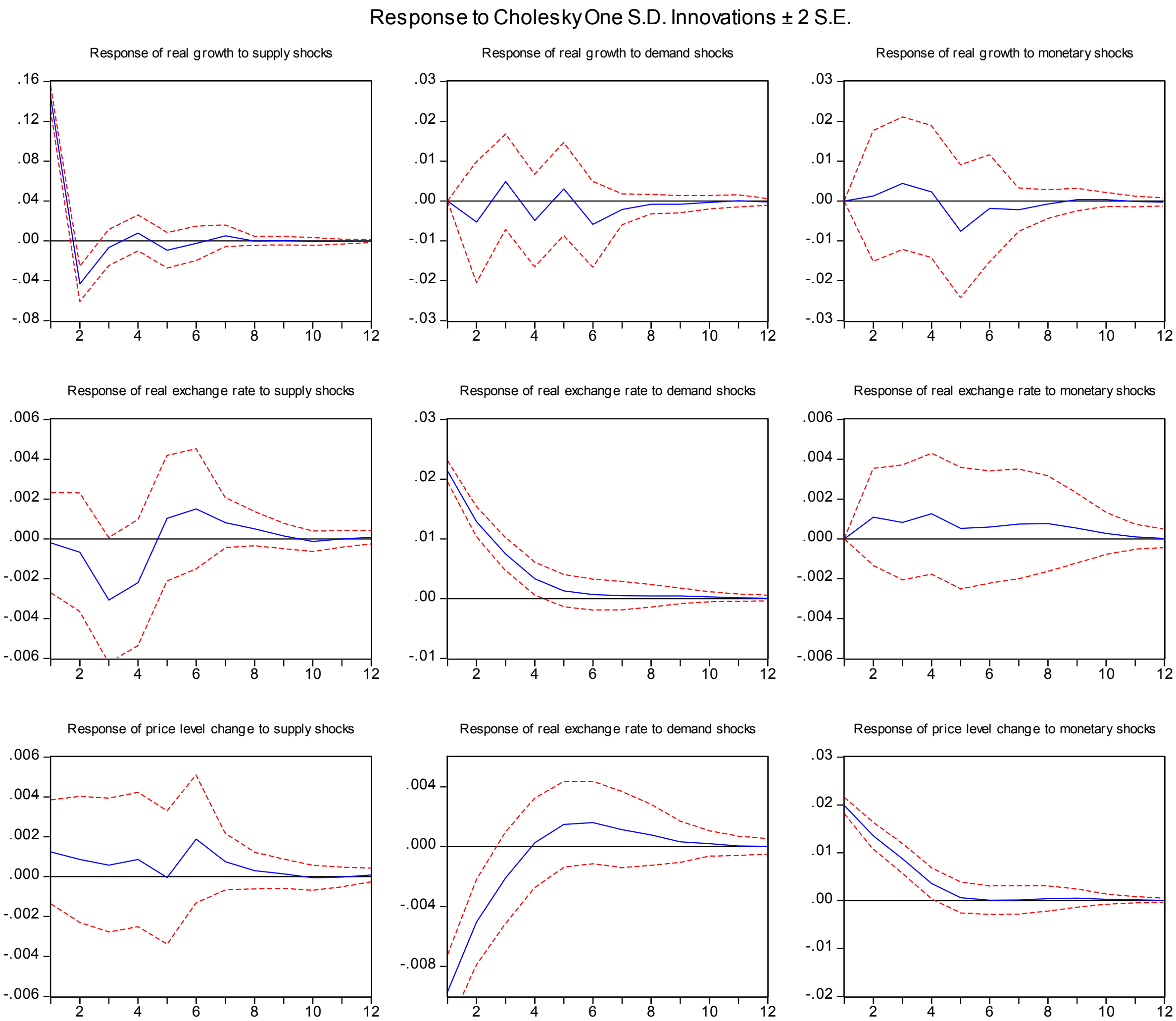


Figure 4.3: Impulse response for Guinea

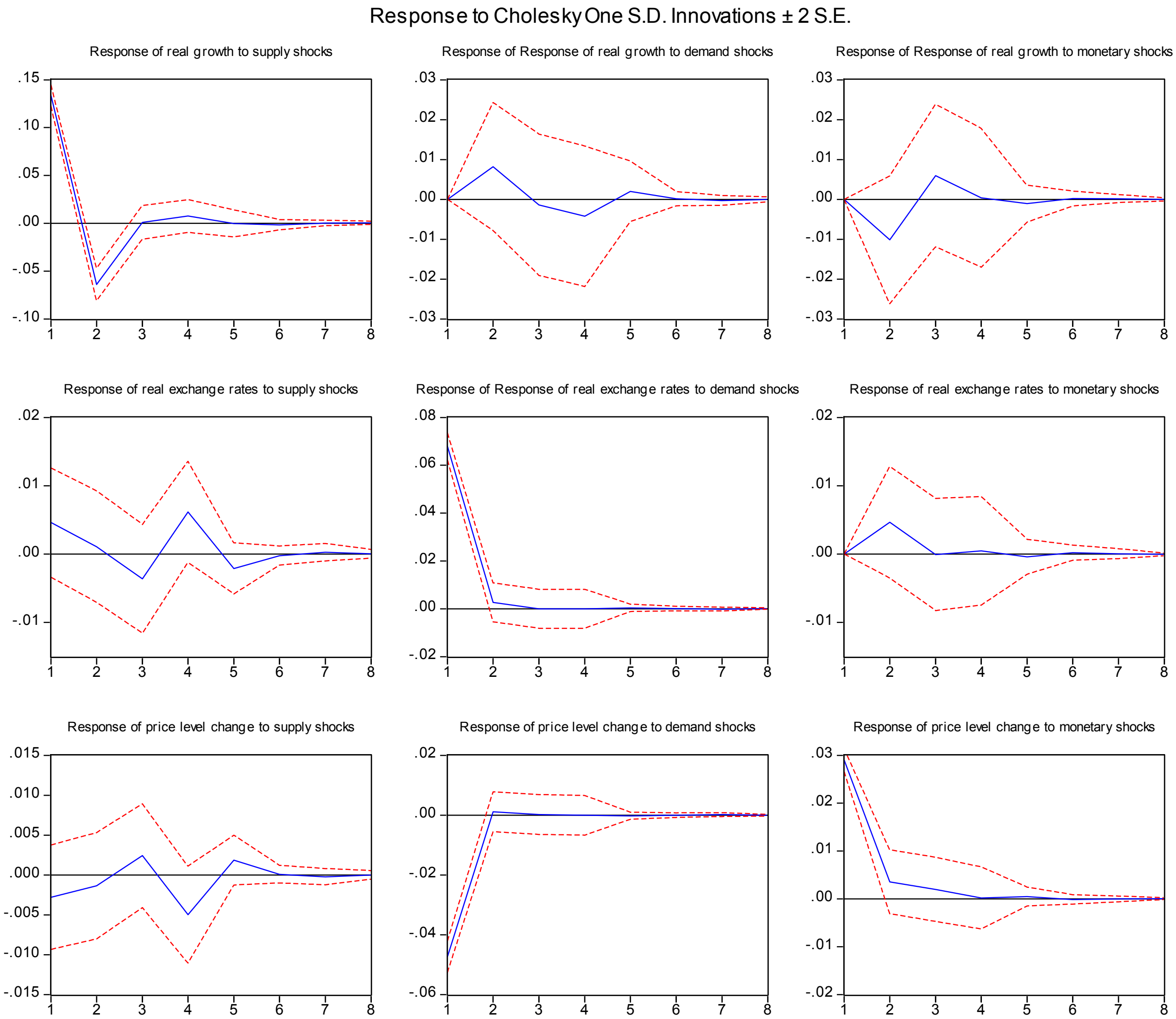


Figure 4.4: Impulse response for Nigeria

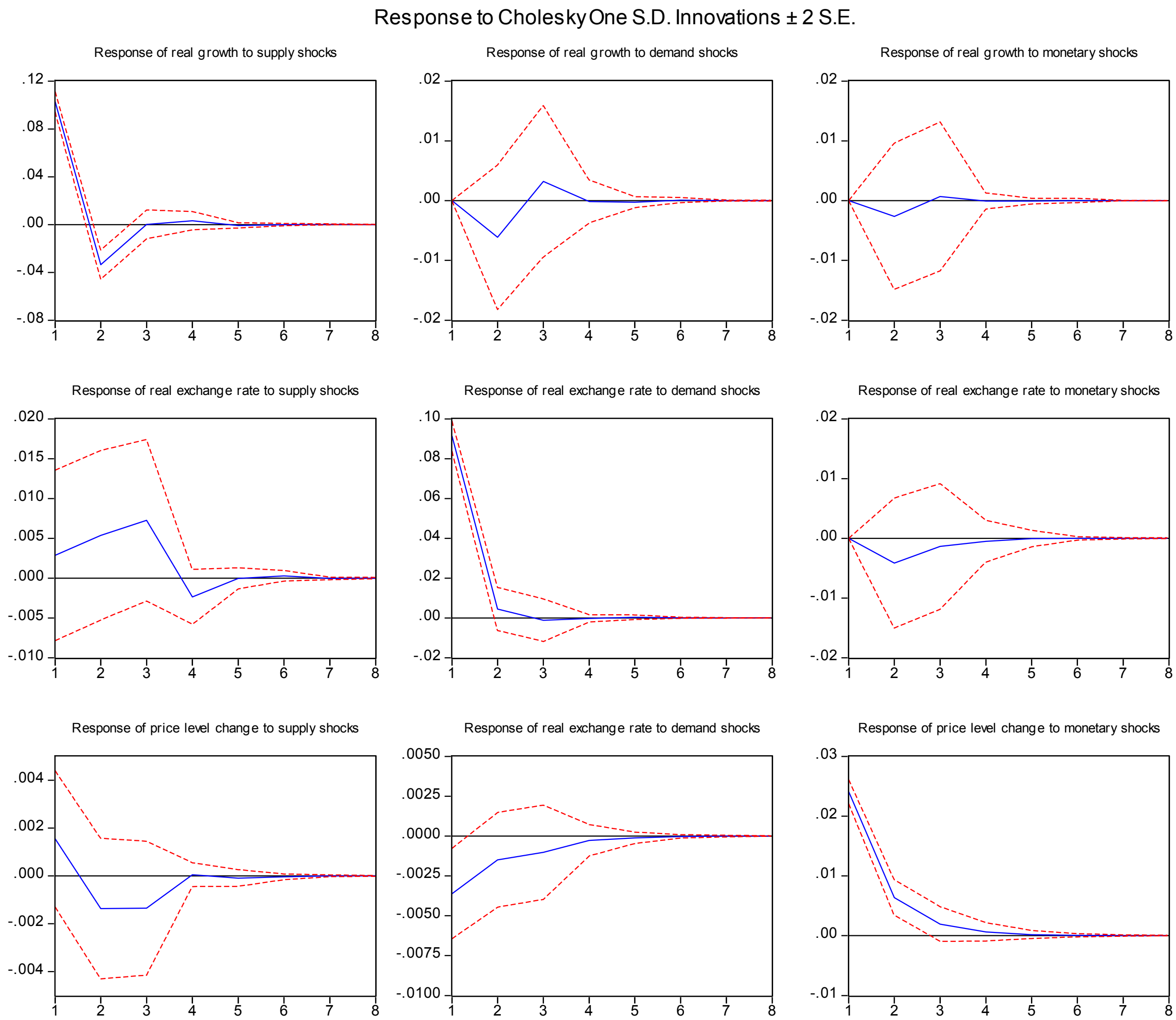
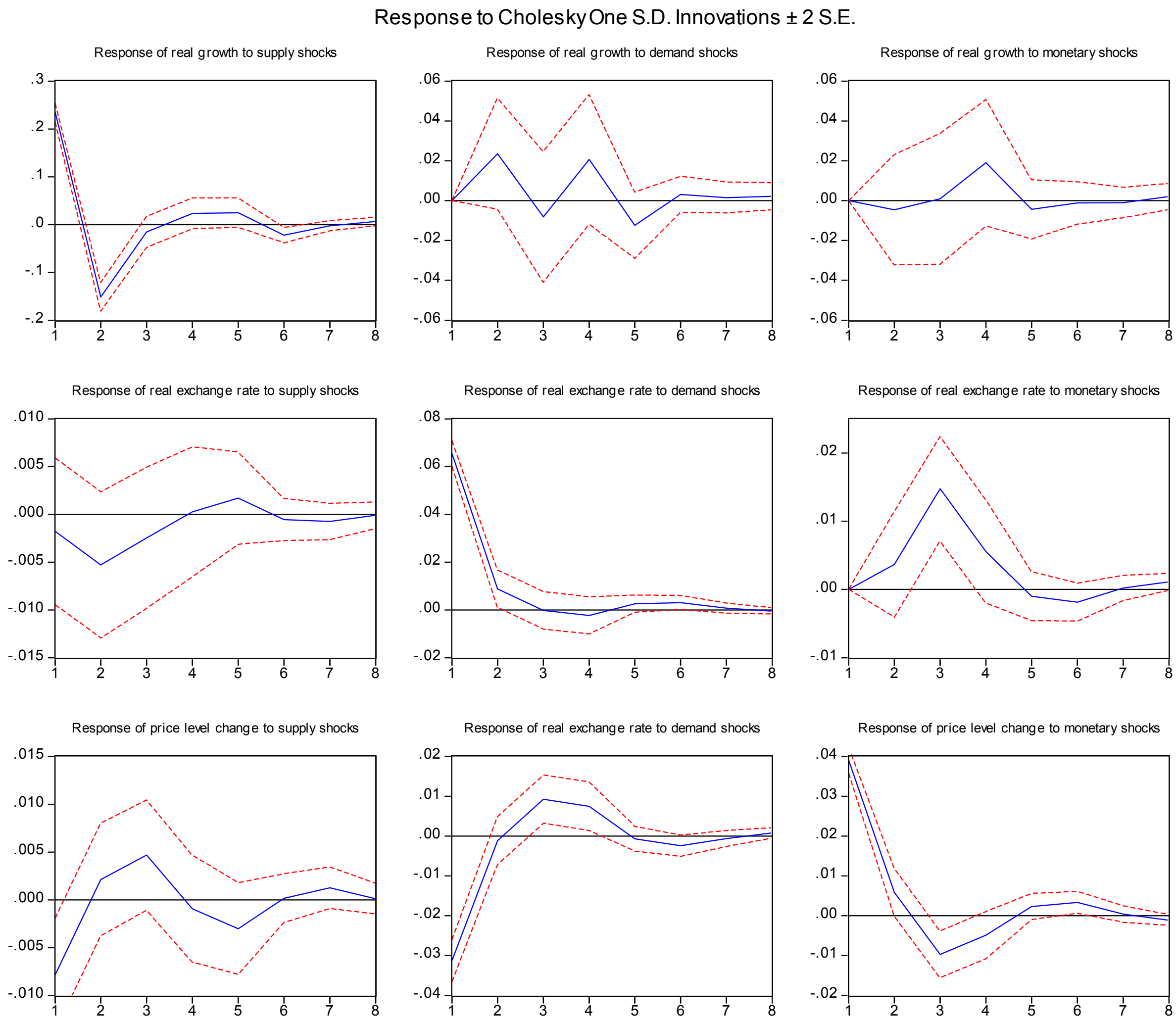


Figure 4.5: Impulse response for Sierra Leone



4.5.3 Linear Dependence of and feedback between the structural shocks

A measure of the level of convergence between the countries, in the sense of an optimum currency area, is shock symmetry between underlying structural shocks of the countries in the region. The size and correlation of the underlying disturbances is important for the choice of a currency union (Bayoumi(1994)). If two economies converge, we expect underlying disturbances to be linearly dependent, in the sense of Geweke(1982), because their response to the external shocks will be similar. Shocks are symmetric if and only if they are linearly dependent in this sense. The existence of feedback between the shocks of these countries in a region suggests that they have a mechanism to correct any imbalances that will arise as a result of external shocks that are specific to any of them. Also, linear dependence of shocks ensures that common policies transmit to these countries similarly. In this section I discuss the empirical results of measuring linear dependence and feedback of the structural shocks of the countries in the West African Monetary Zone (WAMZ) using Geweke(1982).

In order to put the results of the WAMZ countries in proper perspective, these same measures are computed for five European countries in the euro zone; France, Germany, Greece, Italy and Spain. These countries are chosen to include all the different characters within the euro zone presently. France and Germany remain strong after the introduction of the euro while Italy and Spain are troubled and Greece is at the brink. The idea is to look at the coefficients of linear dependence and feedback that are calculated for these European countries against their current economic performance and use that information to discuss the results of the WAMZ countries. I mostly use the coefficients of France and Germany to indicate most convergent economies and the coefficient for Greece or Italy with France or Germany as the least convergent economies. I discuss linear dependence and feedback for supply, demand and monetary shocks across the WAMZ.

Table 4.4 to Table 4.6 contain coefficients that measure linear dependence, contemporaneous feedback and feedback between countries in both directions. The tables contain the coefficients for supply, demand and monetary shocks respectively. The coefficients at the upper part of the table are measures of linear dependence; those at the middle part are measures of contemporaneous linear feedback. The lower diagonal of the lower part of the table contains coefficients that measure feedback from supply shocks of countries in the row to supply shocks of countries in the column. The upper diagonal does the reverse feedback.

4.5.3.1 Supply shocks

In Table 4.4, France and Italy have the strongest linear dependence of 0.500 while France and Germany have 0.358. Spain has a coefficient of 0.139 with Germany and 0.213 with Italy, this sets an upper limit of 0.500 and a lower limit of 0.139 for judging the convergence of the WAMZ countries relative to the euro zone. As shown in Table 4.4, none of the WAMZ countries has a coefficient with any other that fall within this interval. All these countries fall far outside the range, even Ghana and Nigeria's coefficient of 0.057, which is the largest in the zone falls far short of the interval.

Using similar arguments for establishing intervals for linear dependence, the intervals for contemporaneous linear feedback of the supply shocks is 0.474 to 0.054. Clearly, from the middle segment of the Table 4.4, all the WAMZ countries have feedback coefficients that are below the lower limit. These weak contemporaneous feedbacks imply that policies implemented in each country will have no effect in other and common policies will have different effects. For example, high rate of unemployment in Ghana will not be reduced by increased industrial activity in Nigeria and an expansionary monetary policy across the zone might be inflationary in Ghana and contained by the increased economic activity in Nigeria.

Table 4.4: Relationship between supply shocks

	Gambia	Ghana	Guinea	Nigeria	Sierra Leone	France	Germany	Greece	Italy	Spain
Linear Dependence										
Gambia										
Ghana	**0.025**									
Guinea	**0.049**	**0.044**								
Nigeria	**0.018**	**0.057**	**0.007**							
Sierra Leone	**0.029**	**0.002**	**0.024**	**0.018**						
France	0.065	0.087	0.046	0.051	0.051					
Germany	0.040	0.026	0.013	0.035	0.060	**0.358**				
Greece	0.041	0.030	0.033	0.075	0.051	**0.218**	**0.291**			
Italy	0.071	0.077	0.058	0.047	0.045	**0.500**	**0.276**	**0.284**		
Spain	0.057	0.038	0.045	0.077	0.039	**0.254**	**0.138**	**0.220**	**0.213**	
Contemporaneous Linear Feedback										
Gambia										
Ghana	**0.004**									
Guinea	**0.008**	**0.014**								
Nigeria	**0.004**	**0.044**	**0.002**							
Sierra Leone	**0.010**	**0.000**	**0.000**	**0.000**						
France	0.010	0.008	0.006	0.004	0.010					
Germany	0.036	0.015	0.004	0.010	0.026	**0.263**				
Greece	0.010	0.003	0.011	0.052	0.009	**0.064**	**0.255**			
Italy	0.019	0.005	0.014	0.009	0.002	**0.474**	**0.182**	**0.115**		
Spain	0.001	0.005	0.002	0.007	0.001	**0.200**	**0.054**	**0.073**	**0.163**	
Linear Feedback										
Gambia	0	0.00	0.02	0.01	0.02	0.05	0.00	0.03	0.04	0.05
Ghana	0.02	0	0.02	0.01	0.00	0.03	0.00	0.03	0.04	0.03
Guinea	0.02	0.01	0	0.00	0.01	0.03	0.00	0.01	0.04	0.04
Nigeria	0.00	0.00	0.00	0	0.01	0.03	0.02	0.01	0.03	0.05
Sierra Leone	0.00	0.00	0.01	0.01	0	0.04	0.03	0.03	0.03	0.04
France	0.00	0.05	0.01	0.01	0.00	0	0.01	0.01	0.02	0.05
Germany	0.00	0.01	0.01	0.00	0.01	0.08	0	0.02	0.08	0.08
Greece	0.00	0.00	0.01	0.01	0.01	0.15	0.01	0	0.14	0.14
Italy	0.01	0.03	0.01	0.00	0.01	0.00	0.01	0.03	0	0.04
Spain	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.01	0

4.5.3.2 Demand shocks

In Table 4.5, France and Germany have the strongest linear dependence of 0.470 while France and Italy have the lowest of 0.070 that give the upper and lower limits respectively. Ghana-Guinea and Ghana-Sierra Leone have strong linear dependence of 0.512 and 0.441 respectively. These are stronger than all the European countries including France-Germany. In terms of demand shocks, Ghana and Guinea seem to have high shock symmetry.

Contemporaneous linear feedback is weak among the WAMZ countries and is virtually zero for all the WAMZ countries. The linear feedback is not much different between WAMZ and the European countries.

Table 4.5: Relationship between demand shocks

	Gambia	Ghana	Guinea	Nigeria	Sierra Leone	France	Germany	Greece	Italy	Spain
	Linear Dependence									
Gambia										
Ghana	**0.006**									
Guinea	**0.068**	**0.512**								
Nigeria	**0.042**	**0.035**	**0.015**							
Sierra Leone	**0.024**	**0.441**	**0.081**	**0.079**						
France	0.054	0.558	0.009	0.019	0.245					
Germany	0.037	0.021	0.041	0.013	0.025	**0.470**				
Greece	0.026	0.541	0.012	0.014	0.178	**0.101**	**0.107**			
Italy	0.094	0.536	0.007	0.011	0.234	**0.070**	**0.155**	**0.102**		
Spain	0.074	0.540	0.019	0.008	0.249	**0.155**	**0.139**	**0.090**	**0.163**	
Contemporaneous Linear Feedback										
Gambia										
Ghana	**0.000**									
Guinea	**0.000**	**0.000**								
Nigeria	**0.014**	**0.000**	**0.002**							
Sierra Leone	**0.011**	**0.006**	**0.000**	**0.070**						
France	0.000	0.001	0.000	0.001	0.006					
Germany	0.000	0.002	0.000	0.000	0.000	**0.399**				
Greece	0.006	0.002	0.000	0.001	0.004	**0.021**	**0.059**			
Italy	0.014	0.000	0.002	0.001	0.000	**0.041**	**0.061**	**0.028**		
Spain	0.010	0.000	0.001	0.000	0.000	**0.120**	**0.072**	**0.008**	**0.154**	
Linear Feedback										
Gambia	0	0.000	0.007	0.021	0.007	0.049	0.008	0.020	0.051	0.050
Ghana	0.005	0	0.511	0.019	0.399	0.538	0.003	0.527	0.533	0.539
Guinea	0.061	0.001	0	0.001	0.001	0.002	0.021	0.008	0.002	0.014
Nigeria	0.007	0.016	0.012	0	0.005	0.006	0.001	0.004	0.008	0.005
Sierra Leone	0.005	0.036	0.080	0.004	0	0.236	0.021	0.171	0.232	0.243
France	0.006	0.019	0.007	0.011	0.002	0	0.010	0.000	0.016	0.026
Germany	0.028	0.016	0.020	0.012	0.003	0.061	0	0.026	0.048	0.051
Greece	0.001	0.013	0.004	0.008	0.003	0.080	0.023	0	0.054	0.053
Italy	0.029	0.003	0.003	0.002	0.002	0.012	0.047	0.020	0	0.004
Spain	0.014	0.002	0.005	0.003	0.005	0.009	0.017	0.029	0.005	0

4.5.3.3 Monetary shocks

An equivalent interval derived from Table 4.6 for Gewekey linear dependence, is 0.312 to 0.052. Only Ghana-Guinea coefficient of 0.101 falls within this interval. None of the WAMZ countries fall within the interval for the contemporaneous linear dependence. The feedback between monetary shocks of the WAMZ countries is as strong as stronger that of the European countries, including France and Germany.

Table 4.6: Relationship between monetary shocks

	Gambia	Ghana	Guinea	Nigeria	Sierra Leone	France	Germany	Greece	Italy	Spain
	Linear Dependence									
Gambia										
Ghana	**0.007**									
Guinea	**0.034**	**0.106**								
Nigeria	**0.031**	**0.083**	**0.018**							
Sierra Leone	**0.012**	**0.080**	**0.027**	**0.035**						
France	0.130	0.172	0.035	0.040	0.061					
Germany	0.076	0.079	0.025	0.037	0.016	**0.219**				
Greece	0.017	0.143	0.005	0.012	0.073	**0.052**	**0.089**			
Italy	0.136	0.120	0.018	0.036	0.048	**0.312**	**0.262**	**0.073**		
Spain	0.055	0.115	0.034	0.010	0.049	**0.214**	**0.072**	**0.073**	**0.226**	
	Contemporaneous Linear feedback									
Gambia										
Ghana	**0.002**									
Guinea	**0.002**	**0.001**								
Nigeria	**0.018**	**0.001**	**0.010**							
Sierra Leone	**0.001**	**0.001**	**0.002**	**0.023**						
France	0.062	0.059	0.007	0.022	0.002					
Germany	0.029	0.028	0.006	0.022	0.003	**0.160**				
Greece	0.006	0.002	0.000	0.001	0.016	**0.000**	**0.043**			
Italy	0.070	0.010	0.000	0.024	0.000	**0.280**	**0.193**	**0.009**		
Spain	0.010	0.002	0.003	0.001	0.000	**0.209**	**0.035**	**0.006**	**0.206**	
	Linear Feedback									
Gambia	0	0.005	0.003	0.012	0.005	0.044	0.000	0.011	0.046	0.041
Ghana	0.000	0	0.102	0.033	0.079	0.110	0.027	0.128	0.107	0.114
Guinea	0.030	0.003	0	0.002	0.002	0.024	0.006	0.002	0.010	0.025
Nigeria	0.001	0.049	0.006	0	0.002	0.015	0.002	0.003	0.007	0.008
Sierra Leone	0.006	0.000	0.023	0.010	0	0.044	0.011	0.045	0.045	0.045
France	0.024	0.003	0.003	0.003	0.014	0	0.006	0.002	0.028	0.000
Germany	0.046	0.023	0.013	0.013	0.002	0.053	0	0.012	0.058	0.033
Greece	0.001	0.013	0.003	0.008	0.012	0.050	0.033	0	0.058	0.045
Italy	0.021	0.003	0.008	0.005	0.002	0.004	0.011	0.006	0	0.009
Spain	0.003	0.000	0.006	0.001	0.004	0.004	0.004	0.023	0.011	0

4.6 Conclusions

This paper investigates whether West African Monetary Zone (WAMZ) is a common currency area by using a structural VAR of real growth, real exchange rates and price level of five of the six countries in the West African Monetary Zone (WAMZ). WAMZ is a smaller group of countries within Economic Community of West African States (ECOWAS) that is in the process of introducing a single currency the eco. The identification of the structural shocks is based on Blachard and Quah(1989).

The evidence from the variance decomposition of the variables in the SVAR suggests that the region as does not have common sources of shock. Also, the impulses response functions and the analysis of the structural shocks suggest that the countries in the region do not respond symmetrically to all external shocks. These suggest lack of ex-ante convergence in the region to form an optimum currency area. However, Ghana and Guinea seem to be close, both in commonness of sources of shock and symmetry of shocks, and may be able to cope with a single currency since the sources of shocks and shock recovery rate between them is somehow similar. A piecemeal approach to monetary union may be adopted where Ghana and Guinea adopts a single currency and the other countries ascend to it over time. This arrangement, however, may have serious implications for the other countries that are not in the union on the onset because as shown by Bayoumi(1994), while the gains from the monetary union in the form of lower transaction costs are limited to the members, the losses from the union in the form of lower output affects every country in the region. Unlike the Eurozone where Bayoumi and Eichengreen(1997) finds a core group of countries within the union that is a common currency area, the findings suggest that WAMZ does do not have such a group.

These results confirm some previous studies on Economic Community of West African States (ECOWAS) and contradict others. The results of Bayoumi and Ostry(1997) on Sub-Saharan Africa “indicate little evidence that Sub-Saharan African countries would benefit in the near future from larger currency unions” but Debrunet al.(2003), concludes that monetary union in

ECOWAS might be beneficial for a number of the member states. Debrunet al.(2005) also concludes that because of the fiscal heterogeneity of the countries in the union, Nigeria especially might not be compatible with the rest of the countries. Ogunkola(2005) also concludes that further convergence of the economies in the region is required for a stable region-wide monetary union in West Africa.

The results, however, contradict Balogun(2007) that argues that the countries of the WAMZ are better off surrendering their economies to a common monetary policy. This directly suggests that these countries are better of with a common currency. Also, Debrunet al.(2005) argue that asymmetric shocks are not the problem but lack of fiscal convergence. Even though the current study is on a sub set of ECOWAS, we can interpret the results together with Debrunet al.(2005) to mean that both asymmetric shocks and lack of fiscal convergence are the obstacles to the introduction of the common currency.

Lessons from the current euro crisis, suggests that fiscal integration should precede the introduction of a single currency even if the region satisfies all the other criteria, which is not the case for WAMZ. There is also the need for further policy harmonization and removal of barriers to factor mobility to enable transmission of shocks through these economies to synchronize.

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CHAPTER 5: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of finding and conclusions

This section summarizes the main findings and conclusions from the three papers in chapter one through three.

5.1.1 Does using disaggregate components help in producing better forecasts for aggregate inflation in Ghana?

Granger-causality tests show that there is a feedback effect between the aggregate series and all the disaggregates except the urban and rural series for which there is only a unidirectional causality from the aggregate series to the disaggregates. These findings indicate that the urban and rural series do not provide much information in forecasting the aggregate series as the other disaggregates.

The benchmark autoregressive (AR) model of the aggregate inflation series outperforms aggregate forecasts that are obtained from aggregating forecasts from the subcomponents except for the 1-step-ahead forecasts for the product sectors where aggregating the forecasts from the subcomponents perform marginally better. Including additional information from the subcomponents generally performs better for all the models at 1-step-ahead forecasts. The forecasts are, however, less accurate when only food, urban or south series is included in the aggregate model individually, even for the 1-step-ahead forecasts. These results imply that the subcomponents help in producing better short-term forecasts of aggregate inflation if the right subcomponents or their combinations are used in the aggregate model. For the product sector, including the nonfood series improves the forecasts most, while including the rural series improves the forecasts most in the case of the urban-rural classification. In the case of the regional classification, including all the subcomponents improves the forecasts most.

There is a problem with the published weights that are used in aggregating the inflation series in Ghana. The analysis of the data shows that aggregating the components with the published weights do not produce the same aggregate series as published and a computation of ex-ante weights show a complete reversal of the weights for the urban-rural series, which weights the urban series more that the rural series ex-ante.

From these findings, it is clear that directly forecasting aggregate inflation outperforms aggregating forecasts from the subcomponents and including information from the subcomponents improves on the direct forecasts of the aggregate series for 1-step-ahead forecasts. This, however, depends on the subcomponents or their combinations that are used with the aggregate series. A careful selection of the subcomponents into the models is, therefore, needed to achieve more accurate forecasts. The results for 6-step-ahead and 12-step-ahead forecasts are not clear to warrant a definitive conclusion. A longer sample is needed to evaluate more independent forecasts errors for these steps.

5.1.2 Separating monetary and structural causes of inflation in Ghana

Exchange rate depreciation explains a significant percentage of variability in real output growth in the short run. Monetary growth and inflation account for less than one percent of the variability in real output growth. Over the longer horizon, real output growth explains the variability in itself, which is consistent with the argument that nominal variables do not explain real output growth in the long run.

Most of the variability in inflation is explained by real output growth in the long run while monetary shocks explain the variability in the short run. The percentage variability explained by monetary growth reduces quickly over the forecast horizons to about 20 percent while real output growth, exchange rate depreciation and inflation itself explains about 80 percent. This structure of the variance decomposition of inflation suggests that inflation in Ghana is not necessarily a monetary phenomenon. Structural factors like excess import demand and shortages in export supply that reflect in exchange rate depreciation and local supply shocks in an agriculture led economy that heavily relies on rainfall explain more of the inflationary dynamics in Ghana than monetary growth. Variability in exchange rate depreciation is mainly explained by inflation, real output growth and its own history. This finding establishes a fairly strong feedback between inflation and nominal exchange rate depreciation in Ghana. Also, real output growth and exchange rate depreciation are the main explanatory shocks to the variability in monetary growth.

At impact, inflation rises in response to real output growth shocks and thereafter falls through various oscillations. The shock decays slowly through time to return to its mean after the 20th period. This shows that real output growth will lead to fall in inflation in the long run. The response of inflation to monetary growth shocks decays quickly within the 6th period from the initial rise. Exchange rate depreciation has an initial effect of lowering inflation, but over 12 periods inflation increase back to it mean. While real output growth shocks have a long lasting effect on inflation, the effect of monetary shocks and exchange rate shocks dissipate quickly over time. While the structural shocks take a longer time to decay, monetary shocks dissipate quickly over a shorter period.

The fact that the history of inflation explains little of its variability suggests that univariate time series methods will not forecast inflation as accurately as multivariate methods that include GDP growth, monetary growth and exchange rate depreciation. Additionally, the implications of the conclusions from this study are clear that the monetarist view of inflation that only money matters in inflation dynamics does not seem to hold for Ghana as the structural factors dominate monetary growth over the various lags. Even supply shocks alone explain more of variability in inflation than monetary shocks so inflation in Ghana is more of a structural phenomenon than monetary.

5.1.3 Is the West African Monetary Zone a common currency area?

While the structure of the forecast variance decomposition for real economic growth and real exchange rate changes are similar across the region, the forecast variance of inflation is explained by different shocks across the zone except for Ghana and Nigeria which are close for all the variables. This suggests that the sources of external shock to real output growth and real exchange rates in the region are common but the sources of shock to price level changes are not common to any. The differences in the rate at which the response to shocks dissipate through time for the countries show that these countries have asymmetric shocks.

There are weak or no contemporaneous and linear feedbacks between the structural shocks of the countries within the WAMZ. These imply that policies implemented in each country will have no effect in other and common policies will have different effects. For example, high rate of unemployment in Ghana will not be reduced by increased industrial activity in Nigeria and an expansionary monetary policy across the zone might be inflationary in Ghana and contained by the increased economic activity in Nigeria.

5.2 Agenda for further research

The basic problem with inflation data from Ghana is that the weights that are published are not the weights that are used in aggregating the component series into the aggregate series. These weights need to be revised and the data revised as well. It will be interesting to investigate what cause the discrepancies in the weight and devise ways of correcting them. In forecasting the aggregate series, information from the disaggregates should be considered in the aggregate model to produce superior forecasts. Due to lack of long series of the data, this study could not consider the components at lower levels of disaggregation. Future research should be able to consider a more detailed disaggregation.

On the issue of what explains inflation in Ghana, the findings show that to attain the goal of low and stable inflation, monetary management alone is not enough in inflation management in Ghana. These should be supported by other policies that may be more effective than monetary management alone. Addressing supply bottlenecks in agriculture and bureaucratic impediments in industry, which together form over 50 percent of the Ghanaian economy will ease aggregate supply problems domestically and reduce the export shortfall that put pressure on exchange rates and pass through to domestic prices. Further research should look into other channels through which monetary policy impacts inflation in Ghana.

The lessons from the current euro crisis and the findings from this study suggest that a lot more research on West Africa's Monetary integration agenda is needed. The extent of the unification of the banking system, labor laws and pension systems should be researched Also, fiscal integration should precede the introduction of a single currency even if the region satisfies all the other criteria, which is not the case for WAMZ. There is also the need for further policy harmonization and removal of barriers to factor mobility to enable transmission of shocks through these economies to synchronize.