British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

Sources of Inflation in Developing Countries: Evidence from some West African Countries

Olajide S. Oladipo[1,*], Alfred Ntoko[2] and Wayne Forrester[3]

Abstract

The paper examines the determinants of inflation in some West African countries. Using the Johansen technique and time series between 1970q1 and 2010q4 the study determines whether inflation in these African countries is mainly imported (via import prices and exchange rate movements) or predominantly a function of domestic factors.

Our results indicated that money supply, exchange rate movements, income and foreign prices have significant influences on the inflation rate in the long run. Also, short run dynamics based on an error correction model indicated that money supply, exchange rate and income, and in some countries foreign prices have notable effects on inflation.

Keywords: Inflation, Exchange rate, Money supply, expected inflation

[1] School of Business and Information Systems, York College of The City University of New York, e-mail: ooladipo@york.cuny.edu.

* Corresponding Author.

[2] School of Business and Information Systems, York College of The City University of New York, e-mail: antoko@york.cuny.edu

[3] School of Business and Information Systems, York College of The City University of New York, e-mail: wforrester@york.cuny.edu

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

1 Introduction

For over three decades, the annual inflation rate in some West African countries averaged more than 15 percent, with some countries experiencing rates of 20 percent or more. While prices have had an upward trend in some of these countries, the price instability is yet to reach the hyperinflation conditions once experienced in some Latin American countries.

Some of the reasons adduced for the sustained and persistent inflation rates in many developing countries include: high public sector budget deficits; monetization of public sector budget deficits; high military expenditure, inadequate rainfall; populist policies especially prior to elections; persistent inflationary expectations of economic agents; increase in money supply; increases in imported raw materials, inputs, and manufactured, rising interest rates resulting from the crowding-out effect of government borrowing; and unstable exchange rates before and since the adoption of IMF/World Bank adjustment programs.

Over the years, some West African countries with two-digit inflation rates have implemented several disinflation policies, without desired results. It is therefore important for policy makers to know the sources of inflation in these countries in order to address the problem. To understand the dynamics of inflation, the paper condensed some of the possible causes of inflation. There are ample reasons why it is important to do so. First, a number of factors are closely interrelated or may be seen as stemming from macroeconomic situation. Second, taking the various theoretical debates into consideration, it may be difficult to accept some factors as real causes of inflation. Finally, to enable policy makers come up with successful disinflation programs that will overcome this 'hydra', it is important to examine the major determinants of inflation in these countries.

In addition to this introductory section, the paper contains five other sections. The second section presents some background material on the proximate causes of inflation in West African countries. Section three contains the literature review, while theoretical framework, data sources, and the methods of analysis are laid out in section four. The empirical results are presented in section five and the last section contains concluding remarks.

2 Proximate causes of Inflation in West Africa: Trends and Relationships

In recent decades some countries in Africa, particularly West Africa have been experiencing considerably high levels of inflation. The reasons for high inflation rates in these countries are still subjects of debates and counter debates. Proper

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

understanding of the determinants of inflation in these West African countries requires adequate discussion of the movement of the relevant variable over time. As a result, in this section, the study discusses inflation rate trends, monetary growth, the real GDP and exchange rate movements.

Figures 1 and 2 depict countries that have experienced low level of inflation rates (often within a digit) and those with two-digit inflation rates between 1980 and 2010 respectively. Except for 1994, Benin, Burkina Faso, Cape Verde and Niger had a single digit inflation rate throughout the period under investigation.

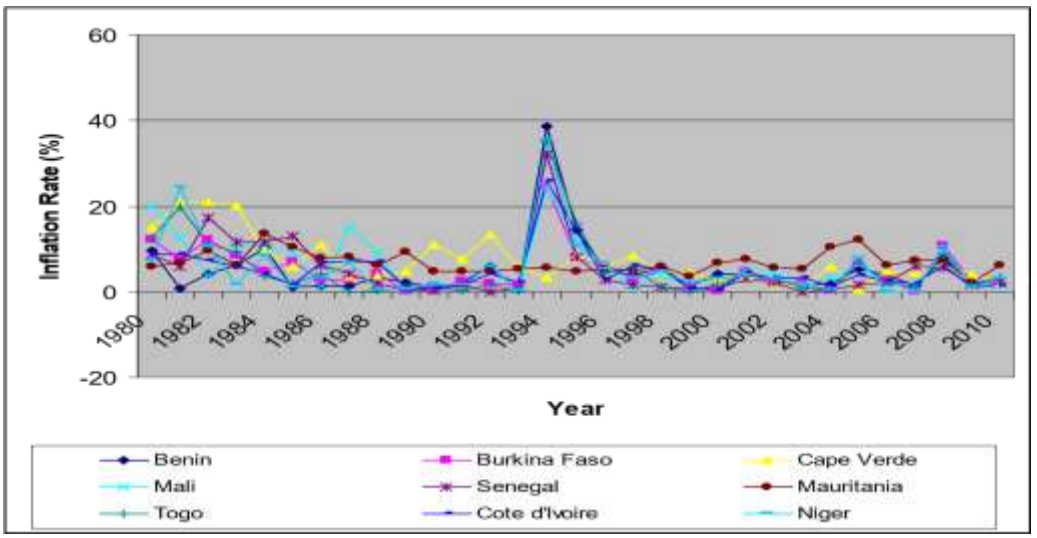

Figure 1: Inflation Rate

As shown in Figure 2, Guinea Bissau, Ghana, Gambia, Guinea, Nigeria and Sierra Leone experienced two-digit inflation rates for many years. It is adduced that some of the principal factors underlying the rising inflation in these countries include increased money supply (Chhibber, 1992). Others suggests that food prices followed by government administrated fuel prices increases and indirect taxation are primary impetus for the upward inflationary spiral, [see Montiel (1989), Loungani and Swagel (1996) and Ball and Mankiw (1995)]. Inflation in these countries might not be purely a monetary phenomenon, but rather an amalgam of various factors that include supply bottlenecks as well as money supply. There is a growing consensus that money supply is a significant factor in explaining inflation in high inflation countries than low inflation countries.

Table 1 provides a snapshot on inflation rates, exchange rates and broad money in Guinea Bissau, Ghana, Gambia, Guinea, Nigeria, and Sierra Leone. Ghana

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

had the highest inflation rate of 18.8 percent in 2009. Though inflation rate in some African countries might be edging downward gradually, a surge in the price of raw materials and oil could drive up the inflationary process.

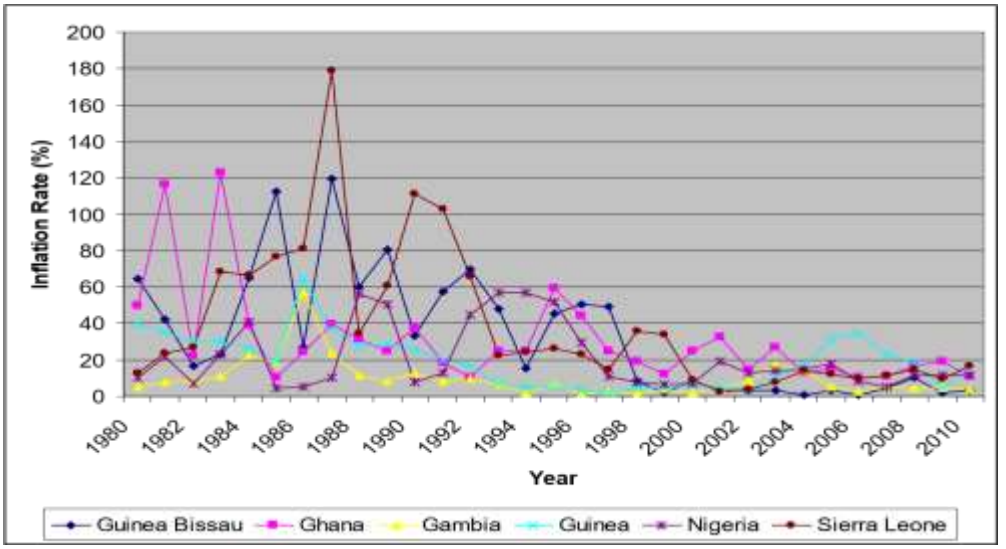

Figure 2: Inflation Rate

Table 1: Monetary Indicators in Countries with two-digit inflation rates

	Inflation Rate (%)		**Exchange Rate**		**Broad Money 2010**	
Country	**2009**	**2010**	**2009**	**2010**	**Level**	**% of GDP**
Guinea Bissau	10.5	2.5	479.2	448.7	80.6	40.8
Ghana	18.1	18.8	10578.6	14165.0	5879.3	23.6
Gambia	4.5	4.2	22.2	26.8	338.9	55.0
Guinea	18.4	4.8	4597.0	4964.7	2243.9	23.3
Nigeria	11.6	12.0	118.5	150.1	4357.7	17.6
Sierra Leone	10.5	10.7	2981.5	3161.6	1360.8	20.9

Sources: IMF World Economic Outlook & International Financial Statistics (2011) and authors' estimates

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

Since the end of the Bretton Woods's system of fixed exchange rates in the early 1970s, the number of countries with floating or 'managed' floating exchange rates has increased[1]. Across West Africa, currencies showed divergent movements especially since the stabilization and liberalizations programs of the 1980s and 1990s. In West African countries, as well as in other developing countries, policymakers in inflation prone countries are faced with the dilemma of whether policy priority should be given to containing inflation or to maintaining competitiveness through currency depreciation. The policy conflict continues to be aggravated by the fact that devaluation seems to have a positive impact on economic activity[2].

3 The Literature Review

While most empirical studies have focused on the causes and the transmission of inflation across industrialized countries, some studies have begun to examine inflation transmission in developing countries. Montiel (1989) opines that inflation in developing countries may be linked to underlying fiscal imbalance. Montiel showed that fiscal imbalance often leads to increases in inflationary rates either by triggering higher money growth as in Sargent and Wallace (1981) or by triggering a balance of payment crisis and forcing exchange rate depreciation as in Liviatan and Piterman (1986). Agenor and Montiel (1996) pointed out that exchange rate depreciation has only a short-run impact on inflation in small but open developing countries. They argued that very high inflation rates result when large unsustainable deficits are financed by money creation.

In the same vein, Loungani and Swagel (1996a) used a VAR model (which included money growth, exchange rate depreciation, deviations of output from trend, oil prices and inflation) to examined the sources of inflation in a group of 51 developing countries during the period from 1964 to 1992. They confirmed money growth as having the most appreciable influence on inflation in countries with high average inflation rates. In countries with low average rates of inflation, the past value of inflation appeared to be the most significant element in explaining the rate of growth of prices. They attributed this inertia to factors such as inflation expectation, labour market rigidities and indexation schemes.

Pahlavani and Rahimi (2009) examined the major determinants of inflation in Iran using annual time series data between 1971 and 2006 and adopted the ARDL approach. They found that in the long-run, the main determinants of inflation in Iran

[1] We are aware that many CFA franc countries still have fixed exchange rate regimes.

[2] For a review of empirical studies on the relationship between exchange rate, inflation and output, see Quirk (1994), Kamin (1997) and Kamin and Klau (1997).

are the liquidity, exchange rate, the rate of expected inflation and the rate of imported inflation. These variables also have significant effects on the inflation rate in the short run. The error correction estimate obtained (-0.3995) was negative and statistically significant. Also, Mukhtar and Zakaria (2010) investigated the conventional notion that persistent high budget deficits often give rise to inflation for Pakistan. Using annual data from 1973 to 2003, their results suggested that in the long-run inflation is not related to budget deficit but only to supply of money, and supply of money has no causal connection with budget deficit. They concluded that their findings implies that the hard government budget constraint does not find empirical support for Pakistan. Vu (2011) examined the causes of recent inflation in Vietnam using quarterly data from 2004q1 to 2008q4. He found that supply and demand shocks seem to explain a large part of inflation in Vietnam.

Extending the debate, Fedderke and Schaling (2005) employed an expectations-augmented Phillips curve framework to investigate the link between inflation, unit labour cost, the output gap, the real exchange rate, and inflation expectations. They found robust evidence for mark-up behaviour of output prices over unit labour costs. Further, Canetti and Green (1992) investigated the determinants of inflation in ten Sub-Saharan African countries from 1978 to 1989. While they found that monetary growth and exchange rate depreciation did explain a portion of inflation innovations, they concluded that much of the inflation innovation for these countries was left unexplained. In a recent study on Sub-Saharan African countries, Barnichon and Peiris (2008) found increases in the growth rate of the money supply, or, alternatively, the gap between money supply and estimated money demand as the main source of inflation. Also, findings by Thornton (2008) on sources of inflation in Sub-Saharan African countries suggest that money supply is significantly more important in explaining inflation in highinflation countries than in low-inflation countries. This paper infers from these studies that the supply-side factors play an important role in determining inflation dynamics – negative shocks to economic growth or lower estimated values for potential GDP raise inflation rates. London (1989) examined the role of money supply and exchange rate in the inflationary process in twenty-three African countries. The pure monetarist model of the Harberger type was employed and the results revealed that in the period between 1974 and 1985 the growth of money supply, expected inflation and real income were significant determinants of inflation in the sample countries. London, however, argued that because the results obtained give account only of the period averages of the countries studied, they should be seen as suggestive rather than definitive.

The literature on inflation in Guinea Bissau, Nigeria, Ghana, Guinea, Gambia and Sierra Leone are relatively scarce. The few available country-level studies, conducted immediately after the economic reforms of the early 1980s and 1990s, shed some light on sources of inflationary pressures. For Pinto (1987) the

monetization of the foreign exchange earnings from crude oil export which vastly expanded the growth of M1 constituted the single most important factor to explaining movements in general price levels in the 1970s and early 1980s in Nigeria. The study by Moser (1995) on Nigeria focused on the effect of domestic economic policies on inflation, ignoring the influence from the rest of the world. Interestingly, he found that the depreciation of the Naira, whose value is pegged to the US dollar, is significantly related to inflation in Nigeria. The study by Oladipo (2007) shows that there is significant, albeit imperfect, pass-through for a variety of products in Nigeria, therefore, changes in the nominal exchange rate will impact inflation.

Chhibber and Safik (1990), and Sowa and Kwakye (1991) investigated the sources of inflation in Ghana. Their findings showed that money supply is the main determinant of inflation rate in Ghana, while variables such as the official nominal exchange rate and real wages were found to be insignificant. In a similar study, Bawumia and Atta-Mensah (2003), using a vector error correction forecasting model, concluded that inflation was a monetary phenomenon in Ghana. However, they did not explore the potential for real factors in price determination.

Atta, Jefferis and Mannathoko (1996) employed a model that incorporated a wider range of variables to estimate the cause of inflation in Botswana. The variables included in the VAR model were real income, narrow money supply, nominal interest rate (proxied by the savings deposit rate), the nominal exchange rates of the Pula against the Rand, Zimbabwe dollar and USA dollar, and foreign prices as represented by the South African, Zimbabwe, and American CPIs. Findings from this study confirmed a strong "pass through" co-integrated relationship of 92 percent between South Africa prices and Botswana prices. The changes in the Zimbabwean prices were also significant; with 14 percent after a one-year lag, but the influence of USA price changes, at 72 percent, was surprising (this was tentatively explained in terms of the larger proportion feeding through the SA price changes). Other variables also proved to be highly significant and had the expected signs, with changes in real income, money supply, interest rate and Rand/Pula nominal exchange rate explaining changes in Botswana prices. In many West African countries, ineffective revenue collection procedures and the underdevelopment of the financial markets tend to increase reliance on seignorage as a source of financing budget deficits. Also deficits are financed by the issuance of bonds (which raise interest rates and thereby make private investment less attractive), or by money creation with the usual inflationary consequences. Akcay et al (2002) argue that, even in the absence of deficit monetization, adjustments in the private sector to higher deficit policies may well lead to inflation.

African Development Bank (2012) examined the dynamics of inflation in East African countries: Kemya, Uganda and Tanzanian. The report concluded that the main driver of short-run inflation in Ethiopia and Uganda is surge in money supply,

accounting for 40 percent and one-third, respectively. In Kenya and Tanzania, oil prices seem to drive inflation, accounting for 20 and 26 percent respectively, although money growth also made significant contribution to the recent increases in inflation in these two countries. The difference in inflationary effects may be explained by differences in the intensity of expansionary monetary policies.

In general, there are multiple factors that cause inflation in sub-Saharan African countries. Domestic money supply often affects average prices with changes in the money supply coming from policy decisions (i.e., deliberate choices taken by the central bank) or from other sources (i.e., financial inflows linked to capital, external debt, or transfers which enter the domestic money supply). For some African countries, the nominal exchange rate and imported inflation is a significant factor, especially in countries in which foreign exchange reserves are relatively low. Demand for foreign exchange to finance imports can lead to a depreciation of the nominal exchange rate and introduce inflationary pressures. In a nutshell, external price shocks, such as fluctuations in global energy prices continue to play an important role together with domestic supply shocks. The impact of past inflation on future prices appears to be very important in some West African countries. Previous studies on inflation in African countries tend to focus on a subset of these factors when exploring the determinants of inflation. In this study, we examined a broader range of variables which capture, to some extent, these different sources of inflation, a departure from many previous studies.

4 Model Specification and Data

Following the exposition in Aghevli and Khan (1978), Agenor (1990), Moser (1995), and Obstfeld and Rogoff (1996), we motivate the model by starting from the relationship that the overall domestic price level (P) is a weighted average of the price of traded goods (P^M) and non-traded goods (P^N). Mathematically, the relationship can be described as:

$$\ln P = \alpha \ln P^N + (1-\alpha)\ln P^M \quad (1)$$

While α denotes the share of non-tradable goods in total expenditure, the price of tradable goods (P^M) is determined exogenously in the world market [and in domestic currency, represented by foreign prices (P^F) and the exchange rate(E)]. Therefore,

$$\ln P^M{}_t = \ln E + \ln P^F \quad (2)$$

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

This implies that given an increase in the exchange rate (in domestic currency terms), foreign prices will lead to an upward swing in general price level. The underpinning assumption is that the price of non-tradable goods depends on both supply and demand factors. We expect demand for non-tradable goods to be related to overall demand in the economy which for simplicity can be represented by the money market equilibrium and the climatic conditions. We therefore define the price equation for non-tradable goods as; $\ln P_t^N = \beta_1 \left(\ln M_t^S - \ln M_t^D \right) + \beta_2 \ln Z_t$ (3) where M^S and M^D represent the supply of and the demand for real money balances respectively and Z_t represents average rainfall[3].

Equation (3) implies that both excess supply of money and lower level of rainfall would result in an increase in the non-tradable goods' price. Given the nature of West African countries, the demand for real money balances M^D is represented as;

$M^D = f\left(y_t, \pi_t, r_{t+1}, r^*_t\right); y_t > 0, \pi_t, < 0, r_{t+1} < 0, r^*_t < 0$ (4) y_t represents real income, π_t denotes expectations formed in period $t-1$ of inflation in period t, and r_{t+1} is the expected nominal foreign interest rate in period $t+1$ adjusted by the expected change in the exchange rate in period $t+1$, and r^*_t the domestic interest rate[4].

The theoretical expectation is that an increase in the flow variable (real income) should stimulate money demand; conversely, an increase in the domestic opportunity cost variable (expected inflation) will lead to a decline. Based on adaptive expectation in period t, the expected inflation rate should be equal to: $\pi_t = d_1 \{\Delta \ln P_{t-1}\} + \{1 - d_1\} \pi_{t-1}$ (5) $\Delta \ln P_{t-1}$ represents the actual inflation in period $t-1$ and π_{t-1} the expected in period $t-1$. For ease of discussion, the paper assumes that $d_1 = 1$, so the reduced form of the equation is given as:

$$\pi_t = \Delta \ln P_{t-1} \quad (6)$$

[3] For our purpose, the study includes the influence of rainfall since the independent role of rainfall in influencing the predominantly food related consumer prices index cannot be overemphasized.

[4] The foreign interest rate represents the United States interest rate, as most transactions in developing countries are quoted in the US dollar.

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

With regard to expectations, the paper assumes that the expected foreign interest rate r_{t+1}, corrected for the expected change in exchange rate, is equal to the observed rate in period t :

$$E\{r_{t+1}\} = r_t \quad (7)$$

Ceteris paribus, future increases in foreign interest rates r_{t+1}, would decrease current real money demand as a result of substitution effects. Therefore, substituting equations (6) and (7) into equation (4) results in the log linear money demand function defined as: $\ln M^{D}_{t} = \gamma_0 \ln y_t - \gamma_1 \Delta \ln P_{t-1} - \gamma_2 r_t - \gamma_3 r^{*}_{t}$ (8)

The substitution of equation (5) into (3) gives: $\ln P^{N}_{t} = \beta_1 \{\ln M^{S}_{t} - \gamma_0 y_t$

$+\gamma_1 \Delta \ln P_{t-1} + \gamma_2 r_t + \gamma_3 r^{*}_{t}\} + \beta_2 \{Z_t\}$ (9) Further, substituting equations (2) and (8) into equation (1), we have:

$\ln P_t = \alpha\{\ln + E_t + \ln P_{Ft}\}\ {}_S y_t + \gamma_1 \Delta \ln P_{t-1} + \gamma_2 r_t + \gamma_3 r_{*t}) + \beta_2 (Z_t)]$ (10) $\{1-\alpha\}[\beta_1$

$(\ln M_t - \gamma_0$

Finally, we have:

$$P_t = f\langle M_t, y_t, E_t, r_t, r^{*}_{t}, \Delta P_{t-1}, P^{F}_{t}, Z_t \rangle \quad (11)$$

The paper speculates that an increase in real income or rainfall would lead to a decline in domestic prices. On the other hand, increase in nominal broad money, the local currency/U.S dollar exchange rate, nominal foreign interest rates adjusted for the expected change in exchange rate, expected inflation, or foreign prices would result in increased prices in period t .

4.1 Data and Data Sources

This research used series data from 1970q1 to 2010q4. Data on money growth, inflation and nominal exchange rates are obtained from IMF International Financial Statistics[5]. For these countries, the Treasury bill rate was used as a proxy for domestic interest rate. Domestic price level (inflation) is measured as the difference of the log of the consumer price index (CPI), income is proxied by gross national

[5] Money growth is the difference of the log of M2 (defined as currency plus demand, time and savings deposits held by the public).

product, while the nominal exchange rate is measured as the difference of the log of the bilateral nominal exchange rate and the U.S dollar. The exchange rate is specified as units of domestic currency per dollar, so that an increase in the exchange rate represents depreciation[6]. We use nominal rather than real exchange rate, as real exchange rates already take into account the inflation rate we seek to explain. The US consumer price index is used as a proxy for the foreign price level, while the foreign interest rate is proxied by the US Treasury bill rate. The rainfall variable was based on quarterly rainfall data (in millimetres).

4.2 Method of Analysis

4.2.1 Time Series Characteristics of the Data

There are several ways of testing for the presence of a unit root. Notable early studies include Dickey and Fuller (1979), Nelson and Plosser (1982), Said and Dickey (1984), but equally notable alternative approaches are suggested by Phillips (1987), and Phillips and Perron (1988). The augmented Dickey and Fuller (ADF) test is valid for stationary and invertible autoregressive moving average (ARMA) noise functions of unknown order, provided the lag length, *k* is chosen in relation to the sample size. The test is usually used to determine whether or not macroeconomic variables are stationary. Thus, if the variables are co-integrated, this implies that, they tend to move together over time and the linear combination of such variables is stationary.

Assume an infinite auto-regression of the following:

$$\Delta y_t = (\rho - 1) y_{t-1} + \sum_{i-1}^{\infty} d_i \Delta y_{t-i} + \varepsilon_t, \quad [\varepsilon_t \approx IID(0, \sigma^2)] \tag{12}$$

Dickey and Fuller (1979) and Said and Dickey (1984) suggest the following truncated version as an approximation, is given as;

$$\Delta y_t = (\rho - 1) y_{t-1} + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \varepsilon_t \tag{13}$$

Thus, the order of the truncated auto-regression is a function of the number of observations. The null hypothesis to be tested as earlier stated is:

[6] It would be preferable to use an exchange rate which takes into account bilateral exchange rates with each country's major trading partners (such as the effective exchange rate) but such a measure is not available for many countries under investigation.

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

$H_0: \rho = 1$ against the alternative hypothesis that $H_1: \rho < 1$,

The test is sensitive to the choice of the lag length, i.e. the order of auto-regression has significant power and size implications.

The unit root tests suggested by Phillips and Perron (1988) have two main advantages over the corresponding ADF test. First, in contrast to the ADF test, which includes more explanatory variables to deal with, the autocorrelated residuals reduces the effective number of observations, i.e. the degrees of freedom, the Phillips and Perron (PP) tests overcomes the problem of autocorrelation by using non-parametric correction. Second, the Phillips and Perron test is valid under more general assumptions about the sequence of innovations, hence, allowing for all finite ARMA processes. However, one of the drawbacks of Phillips and Perron unit root test is that the number of autocovariances used for the Newey-West estimator of the error term variances is arbitrary. Irrespective of the above comments on ADF (i.e. its demerits) and the merits of Phillips and Perron (henceforth PP) tests highlighted above, this study uses both ADF and PP tests to investigate stationarity.

4.2.2 Co-integration and Long-run Analysis

An important issue in econometrics is the need to integrate short-run dynamics with long-run equilibria. The traditional approach of modelling shortrun disequilibria (i.e. the partial adjustment) however, throws away potential valuable information about long-run relationships. The theory of co-integration developed in Granger (1981) and elaborated in Engle and Granger (1987) addressed the issue of integrating short run dynamics with long run equilibria, and was recently improved by Johansen and Juselius (1990) and Johansen (1991, 1995).

4.2.3 Johansen Maximum Likelihood Approach to Co-integration

Of course, the starting point of this analysis (general analysis) is the following VAR (k) specification for the $p \times 1$ vector of variables integrated of order one, X_t.

$$X_t = A_1 X_{t-1} + ... + A_k X_{t-k} + c + \psi D_t + \varepsilon_t \; t = 1.....T \qquad (14)$$

where c is a $p \times 1$ vector of constants terms, D is a $p \times 1$ vector of dummy variables and $\varepsilon_1, ..., \varepsilon_T$ are *i.i.d.* $N_p(0, \sum)$. The Johansen procedure entails setting out a model in error correction form[7], where Δ is the difference operator:

[7] This enables us to distinguish between stationarity due to linear combinations and stationarity due to differencing.

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + ... + \Gamma_{k-1} \Delta X_{t-k-1} + \Pi X_{t-k} + c + \Psi D_t + \varepsilon_t, \; t = 1,....,T. \qquad (15)$$

where,

$\Gamma_i = -(I - A_1 ....A_i)$, $i=1,..,k-1$, $\Pi = -(I - A_1 .....A_k)$

and where k is the lag length. Given our assumptions, if the data are integrated of order one, i.e. $I(1)$, then the matrix Π has to be of reduced rank, r. On the other hand, if Π is of full rank, this implies that all variables are $I(0)$. Also, if Π has zero rank, the term ΠX_{t-1} drops out of the equation and the variables in question are not co-integrated, where 0< rank of Π < P, there is at least one co-integration vector. Thus, we have:

$$\Pi = \alpha\beta'$$

where $\alpha$and β are $p \times r$ matrices and $r<p$. Therefore, $\beta' X_t$ represents the linear combinations of non-stationary variables which are stationary and $\alpha$is the matrix of adjustment coefficients. Further, according to the Granger representation theorem, when a vector comprising n $I(1)$ variables, X_t is co-integrated with a vectorα, there exists an equilibrium-correction representation:

$$A(L)\Delta X_t = -\gamma\alpha X_{t-1} + \beta(L)\varepsilon_t \qquad (16)$$ where $A(L)$ is matrix polynomial in the lag operator L with $A(0) = I_n$, γ is a $(nx1)$ non-null vector of constants, $\beta(L)$ is a scalar polynomial in L and ε_t is a vector of white noise errors. Therefore, in the short run, deviation from the long run equilibrium $(\alpha' X = 0)$ will impact on changes in X_t and lead to movement back to equilibrium. According to Agenor and Taylor (1993) if some element of the vector X is being driven by the equilibrium error, so that the relevant element of γ is non-zero, such a feedback response exists. If the nth element of γ is zero, the nth element responds only to short term shocks to the stochastic environment.

The inclusion of equilibrium-error correction terms allows for adjustments of changes in variables in the vector X to their long run equilibrium values to be identified, providing information on the speed of adjustment to disequilibrium

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

errors. When equilibrium – correction term has a statistically significant coefficient and displays the appropriate negative sign, the hypothesis of an equilibrium relationship between the variables in the co-integration equation is valid. Of course, any attempt to fail to take account of co-integration between the variables would lead to mis-specification in the dynamic structure underlying our model. The equilibrium-error term generated from the Johansen co-integration procedures is included as an additional regressor to avoid the loss of potentially relevant information.

5 Empirical Results

As a first step in our analysis, we used the ADF and PP tests to determine the order of integration of the variables. The results of the unit root tests for nominal money supply (M2), real income (Y), exchange rate (E), domestic interest rate (R*), foreign interest rate (R), price level (P), Foreign price level (P^F), and the weather (Z) are reported in Table 2. The ADF and PP tests results for the variables are reported in their levels and first differences at 5 percent. The tests results indicate that we cannot reject the null hypothesis of a unit root at 5 percent level of significance for the variables in levels. However, we reject the null hypothesis of unit root at 5 percent for the variables after their first difference.

Table 2: ADF and Phillip-Perron Unit Root Tests Results[8]

Country	**Variable**	**ADF Tests**				**Phillip-Perron Tests**			
		With Trend		**Without Trend**		**With Trend**		**Without Trend**	
		Level	**FD**	**Level**	**FD**	**Level**	**FD**	**Level**	**FD**
Guinea Bissau	E	2.10	4.77*	1.98	4.75*	2.20	5.01*	2.00	5.02*
	M2	2.79	6.48*	0.96	6.50*	3.42	10.7*	1.25	10.7*
	R*	2.50	6.36*	1.72	6.42*	2.51	6.40*	1.61	6.49*
	P	3.30	3.76*	0.92	3.44*	2.16	3.46*	0.88	3.83*
	P^F	2.40	4.97*	1.11	6.69*	2.54	6.60*	1.10	6.67*
	R	2.31	4.17*	1.31	4.25*	2.02	4.31*	1.29	4.37*
	Z	2.11	5.08*	0.61	5.14*	2.23	5.10*	0.36	5.19*
	Y	2.04	3.72*	1.22	3.69*	1.59	3.65*	1.12	3.69*
Ghana	E	1.20	5.30*	0.70	5.41*	1.62	5.44*	1.01	5.52*

[8] Unit root tests are performed using Eviews 7.0

	M2	2.05	4.94*	0.72	4.62*	1.95	10.4*	0.94	10.3*
	R*	2.38	3.42*	1.90	3.40*	2.14	8.87*	1.86	8.90*
	P	2.67	8.31*	2.20	8.41*	2.65	8.34*	2.04	8.45*
	P^F	3.01	5.90*	2.94	6.51*	2.96	14.9*	2.85	11.9*
	R	2.92	4.76*	2.57	4.71*	1.82	3.50*	1.86	3.55*
	Z	1.75	3.66*	2.56	2.94*	0.86	7.22*	3.01	7.38*
	Y	2.26	6.89*	2.21	6.79*	2.40	6.68*	2.32	6.78*
Gambia	E	0.98	4.57*	1.01	4.58*	1.36	4.60*	0.96	4.61*
	M2	2.70	3.25*	0.26	3.34*	2.36	4.80*	0.54	4.86*
	R*	2.26	5.74*	2.25	5.82*	2.40	5.76*	2.41	5.83*
	P	2.51	6.66*	0.72	6.75*	2.57	6.86*	0.49	6.93*
	P^F	3.41	5.38*	1.10	5.47*	2.66	4.91*	1.08	5.09*
	R	2.40	4.96*	2.31	5.65*	1.96	7.23*	2.08	5.94*
	Z	1.24	4.93*	2.76	3.78*	0.74	7.89*	3.14	7.09*
	Y	1.56	3.61*	1.60	3.46*	2.14	10.6*	3.34	10.0*
Guinea	E	2.08	3.77*	1.56	3.80*	1.89	3.89*	1.44	3.90*
	M2	1.94	3.98*	0.84	3.89*	1.58	9.68*	0.72	9.74*
	R*	2.67	5.04*	2.63	4.83*	3.12	10.8*	3.47	10.7*
	P	3.20	5.91*	2.13	6.01*	2.85	8.26*	2.10	8.49*
	P^F	2.64	5.60*	2.41	5.77*	2.86	5.81*	2.70	5.89*
	R	1.00	4.56*	1.03	4.57*	1.36	4.60*	0.95	4.61*
	Z	2.18	3.49*	0.02	3.50*	1.42	10.4*	0.30	10.4*
	Y	2.56	6.69*	0.72	6.77*	2.60	6.88*	0.51	6.96*
Nigeria	E	1.99	6.69*	2.13	6.74*	1.98	6.72*	2.10	6.74*
	M2	3.34	3.87*	1.28	3.68*	2.90	5.87*	1.38	5.79*
	R*	3.26	3.74*	1.59	3.81*	2.56	3.71*	1.64	3.76*
	P	2.21	4.92*	2.04	4.86*	2.25	5.01*	2.05	5.07*
	P^F	1.20	5.31*	0.64	5.41*	1.60	5.43*	0.96	5.51*
	R	2.08	6.81*	2.14	6.91*	2.34	6.81*	2.25	6.91*
	Z	2.00	3.80*	0.81	3.82*	1.96	3.99*	0.41	4.02*
	Y	1.92	3.67*	1.14	3.62*	1.51	3.59*	1.04	3.62*
Sierra Leone	E	2.01	3.72*	0.82	3.76*	1.97	3.91*	0.43	3.95*
	M2	3.21	3.74*	1.40	3.57*	2.02	3.71*	1.51	3.69*
	R*	4.37	8.09*	3.65	8.24*	4.31	15.6*	3.62	14.6*
	P	3.20	4.98*	2.01	4.76*	2.87	6.25*	2.59	6.04*
	P^F	2.73	3.70*	0.01	3.65*	1.84	6.78*	0.76	6.72*
	R	2.78	6.47*	0.96	6.55*	3.42	10.8*	1.25	10.8*
	Z	2.36	4.22*	1.33	4.31*	2.07	4.36*	1.36	4.39*
	Y	2.44	5.01*	2.34	5.65*	1.99	7.23*	2.08	5.87*

Note: * denotes significance at the 5 percent level. Numbers in the Table are the pseudo t-statistics for testing the null hypothesis that the series is non-stationary. The critical values

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

of the ADF and PP statistics with a constant but no trend are -3.47, -2.88, and -2.57 at the 1, 5 and 10 percent levels while tests statistics with a constant and trend are -4.01, -3.43, and -3.14 at the 1, 5 and 10 percent levels.

The variables are integrated of order one suggesting the possibility of the presence of co-integration. The results from Johansen co-integration tests are presented in Table 3.

Table 3: Co-integration Test Results (Maximum Eigenvalue and Trace Statistic)

Country	H_0	H_a	λ_{Trace}	λ_{Trace} **CV**	λ_{Max}	λ_{Max} **CV**
Guinea Bissau	$r=0$	$r=1$	21.47*	15.49	20.35*	14.26
	$r\leq 1$	$r=2$	01.12	03.84	01.12	03.84
Ghana	$r=0$	$r=1$	16.27*	15.49	15.47*	14.26
	$r\leq 1$	$r=2$	00.79	03.84	00.79	03.84
Gambia	$r=0$	$r=1$	18.56*	15.49	17.06*	14.26
	$r\leq 1$	$r=2$	01.49	03.84	01.49	03.84
Guinea	$r=0$	$r=1$	19.54*	15.49	18.42*	14.26
	$r\leq 1$	$r=2$	01.11	03.84	01.11	03.84
Nigeria	$r=0$	$r=1$	17.72*	15.49	16.89*	14.26
	$r\leq 1$	$r=2$	00.82	03.84	00.82	03.84

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

Sierra Leone 14.26	$r=0$	$r=1$	17.01*	15.49	16.94*
	$r\leq 1$	$r=2$	00.06	03.84	00.06

Note: r indicates the number of co-integrating vector(s), CV is the critical value at 5 percent and * denotes the rejection of null hypothesis of no co-integration at 5 percent significance level.

The trace and maximum eigenvalue tests indicate the presence of at least one co-integrating vector. Thus, there exists a long run relationship among the variables at 5 percent level of confidence for the countries.

The dynamics to the long run equilibria were also estimated. This is of interest because it indicates the behaviour of the changes in inflation over time. The variables included were ΔM_{it}, Δy_{it}, ΔE_t, Δr_{it}, Δr^*_{it} Δp^F_{it} and Δz_{it}. The equilibrium correction term generated from the co-integration equations was included (denoted as ECM_t). The inclusion of the error term allows the integration of the short term dynamics with the long run equilibrium. The error correction term represents the short term response necessary to move the system back towards long run equilibrium[9].

Parsimony was achieved by removing the insignificant regressors and testing the validity of the reduction by an F - test. The parsimonious vector error correction (VECM) was subjected to a number of diagnostic checks, including stability, within equation residual serial correction, heteroscedasticity, and normality tests. The impulse dummy which was included to capture the adjustment program appeared insignificant. A possible explanation is that, though the adjustment program was introduced in 1980s, the policies were introduced slowly and to date some of the policies are still not fully implemented. This might not be unconnected with the political uprising due to loss of jobs and economic hardship that followed some of the policies implemented.

The estimation result is reported in Table 4. The deviations from the cointegrating relationships measured by ECM_t are statistically significant. The coefficients are correctly signed for all countries, which provide support to the validity of the co-integrating relationship estimated, which lies in a range 0.02 to 0.20.

[9] In estimating the VECM and to ensure that the parameters are consistent; it is germane that the optimal lag length is utilized. The Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Information Criterion (HQ) and likelihood ratio (LR) information criterion are used to select the optimum lag length for the VAR.

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

Table 4: The Estimates of the Adjustment to the Long Run Equilibrium Relationships

Guinea Bissau

Variable	*Coefficient*	*Std. Error*	*t-value*	*t-prob*
ΔM_1	0.6654	0.08945	1.976	0.0403
Δy_4	0.2536	0.07056	2.045	0.0356
ΔE_2	0.4349	0.17532	2.046	0.0237
Δr_1	0.2243	0.27864	1.989	0.0231
Δr*_3	0.0367	0.00876	2.487	0.0158
ΔPf_3	0.1766	0.00768	2.473	0.0147
ΔZ_1	0.0933	0.00678	1.879	0.7896
ECM_1	-0.0342	0.11276	-4.109	0.0001
Constant	0.0164	0.00746	1.342	0.1876

Diagnostics Tests: Auto-correlation 1.16(0.33); ARCH: 1.44(0.06); Het. 2.41(0.16)

Ghana

Variable	*Coefficient*	*Std. Error*	*t-value*	*t-prob*
ΔM_3	0.5645	0.08286	5.206	0.0000
Δy_1	0.2876	0.01302	2.346	0.0237
ΔE_1	0.6431	0.24467	2.463	0.0176
Δr_2	0.0756	0.08746	5.234	0.0001
Δr*_2	0.0523	0.00568	1.854	0.0411
ΔPf_1	0.0807	0.00634	4.675	0.0001
ΔZ_2	0.0823	0.00568	3.192	0.0017
ECM_1	-0.2064	0.04102	-5.022	0.0001
Constant	0.0323	0.00654	6.234	0.0000

Diagnostics Tests: Auto-correlation 2.07(0.07); ARCH: 1.34(0.20); Het. 1.07(0.12)

Gambia

Variable	*Coefficient*	*Std. Error*	*t-value*	*t-prob*
ΔM_2	0.4124	0.08734	2.543	0.0125
Δy_2	0.1753	0.05332	3.065	0.0075
ΔE_1	0.5467	0.23067	2.203	0.0211
Δr_1	0.2653	0.19863	3.066	0.0026
Δr*_2	0.0655	0.01268	2.078	0.0402
ΔPf_3	0.0189	0.01212	1.986	0.0721
ΔZ_1	0.1898	0.03254	2.148	0.0321
ECM_1	-0.0678	0.02587	-2.305	0.0023
Constant	0.0194	0.11378	1.881	0.0901

British Journal of Business Design & Education
ISSN (Print): 2222-7426, ISSN (Online): 2222-8412
Vol 06 No 02

Diagnostics Tests: Auto-correlation 0.85(0.51*); ARCH:* 1.49 [0.19*); Het.* 2.37(0.05)

Guinea

Variable	*Coefficient*	*Std. Error*	*t-value*	*t-prob*
ΔM_2	0.6784	0.27968	3.762	0.0005
Δy_1	0.1532	0.06329	2.078	0.0273
ΔE_1	0.4811	0.23632	1.986	0.0534
Δr_2	0.0764	0.06598	2.013	0.0655
Δr*_2	0.3856	0.02352	2.075	0.0427
ΔPf_2	0.6411	0.19468	3.243	0.0015
ΔZ_2	0.1967	0.00978	1.896	0.2213
ECM_1	-0.0454	0.08737	2.866	0.0329
Constant	0.0231	0.01259	1.998	0.0512

Diagnostics Tests: Auto-correlation 1.45(0.21*); ARCH:* 0.93(0.46*); Het.* 1.46(0.20*)*

Nigeria

Variable	*Coefficient*	*Std. Error*	*t-value*	*t-prob*
ΔM_3	0.5634	0.06579	5.307	0
Δy_2	0.1866	0.07696	3.421	0.0013
ΔE_1	0.4775	0.19761	3.762	0.0019
Δr_2	0.1635	0.01089	2.168	0.0184
Δr*_1	0.0187	0.01244	2.165	0.0237
ΔPf_2	0.3677	0.11856	2.434	0.0437
ΔZ_2	0.1986	0.01985	4.089	0.0002
ECM_1	-0.0729	0.03427	-3.018	0.0034
Constant	0.0176	0.00564	2.011	0.0041

Diagnostics Tests: Auto-correlation 1.84(0.011*); ARCH:* 0.69(0.62*); Het.* 1.79 (0.12*)*

Sierra Leone

Variable	*Coefficient*	*Std. Error*	*t-value*	*t-prob*
ΔM_4	0.4731	0.08676	2.047	0.0367
Δy_1	0.3245	0.20156	1.906	0.0549
ΔE_2	0.3312	0.16543	2.534	0.0054
Δr_2	0.0293	0.05487	2.911	0.0108
Δr*_2	0.3426	0.23198	2.231	0.0116
ΔPf_1	0.1986	0.27531	1.976	0.0598

ΔZ_2	0.1733	0.12648	-2.442	0.0071
ECM_1	-0.1891	0.01265	-5.486	0.0001
Constant	0.0288	0.01046	2.755	0.0064

Diagnostics Tests: Auto-correlation 0.79 [0.55]*; ARCH:* 0.87(0.49)*; Het.* 1.35(0.17)

In particular, we note that approximately 3 percent of previous disequilibrium is corrected each quarter in Guinea Bissau, while in Ghana about 20 percent of past disequilibrium is eliminated each quarter. Notably, the speed of adjustment is higher in Ghana.

For all the countries, the fitted values of the inflation rates from the error correction model track the cyclical nature of the actual price movements fairly well. For Guinea Bissau, Ghana, Gambia, Guinea, Nigeria and Sierra Leone, the results indicated that a 1 percent increase in the rate of money growth would yield 0.67, 0.56, 0.41, 0.68, 0.56 and 0.47 percent increases respectively in the rate of inflation. Also, for these countries a permanent 1 percent increase in exchange rate (depreciation) would lead to an increase of 0.43, 0.64, 0.54, 0.48, 0.48 and 0.33 percent respectively in inflation. As expected in some of the countries, improved rainfall reduces the level of inflation.

6 Concluding Remarks

This study examined the determinants of inflation in Guinea Bissau, Ghana, Gambia, Guinea, Nigeria and Sierra Leone. Using the Johansen technique and time series data between 1970q1 and 2010q4, our results indicated that money supply, exchange rate movements, income and foreign prices have significant influences on the inflation rate in the long run. Also, short run dynamics based on an error correction model indicated that money supply, exchange rate and income, and in some countries foreign prices have notable effects on inflation. Specifically, the paper found that for Guinea Bissau, Ghana, Gambia, Guinea, Nigeria and Sierra Leone a 1 percent increase in the rate of money growth would yield 0.67, 0.56, 0.41, 0.68, 0.56 and 0.47 percent increases respectively in the rate of inflation. In the same vein, for these countries a permanent 1 percent increase in exchange rate (depreciation) would lead to an increase of 0.43, 0.64, 0.54, 0.48, 0.48 and 0.33 percent respectively in inflation.

Also, our results confirms finding in some earlier studies that monetary expansion driven by expansionary fiscal policies, the depreciation of the exchange rate, and foreign prices account for the inflationary process in many West African countries.

The policy implications is that for any attempt to combat inflation in West African countries, the policy makers need to focus on reducing money supply and stabilizing the exchange rate vis-à-vis their trading partners, although the governments of these countries might not have control over foreign prices since they are price takers.

References

[1] P.R Agenor and P.J. Montiel, *Development Macroeconomics*, Princeton, New Jersey, Princeton University Press, 1996.

[2] O.C. Akçay, C.E. Alper and S. Özmucur, *Debt Sustainability: Evidence from Turkey* (1970-2000), in: A. Kibritcioglu, L. Rittenberg, F. Selcuk, (eds.), Inflation and Disinflation in Turkey, Aldershot, U.K., Ashgate, pp.77-96, 2002.

[3] Regis Barnichon, and Shanaka J. Peiris, Sources of Inflation in Sub-Saharan Africa, *Journal of African Economies*, **17**(5), (2008), 729-746.

[4] M. Bawumia, and J. Atta-Mensah, A simple vector-error-correction forecasting Model for Ghana, *Working Paper*, *MAFSD*, Bank of Ghana, (February, 2003).

[5] E. Canetti and J. Greene, *Monetary Growth and Exchange Rate Depreciations as Causes of Inflation in African countries: An Empirical Analysis.* Mimeo, IMF, Washington, 1992.

[6] Prakash Loungani and Phillip Swagel, Sources of Inflation in Developing Countries, unpublished, *International Monetary Fund*, (December, 1996a).

[7] Prakash Loungani and Phillip Swagel, Supply-Side Sources of Inflation: Evidence from OECD Countries, *International Finance Discussion Paper*, **515**, Federal Reserve Bank, (October, 1996b).

[8] P. Montiel, Empirical Analysis of High-Inflation Episodes in Argentina, Brazil and Isreal, *IMF Staff Papers*, 36(3), (1989), 527-549.

[9] G.G. Moser, The Main Determinants of Inflation in Nigeria, *IMF Staff Papers*, **42**(2), (1995), 270-289.

[10] N. Liviatan and S. Piterman, *Accelerating Inflation and Balance of Payments Crises*, 1973-1984, in The Isreali Economy, ed. By Yoram Ben-Porath, Cambridge, Harvard University Press, pp 320-346, 1986.

[11] B. Pinto, Nigeria during and after the oil boom: A policy comparison with Indonesia, *World Bank Economic Review*, **1**(3), (1987), 419-445.

[12] B. Pinto, Black market premia, exchange rate unification, and inflation in Sub-Sahara Africa, *World Bank Economic Review*, **3**(3), (1989), 321-338.

[13] S. Johansen, Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control*, **12**(2/3), (1988), 231-254.

[14] S. Johansen and K. Juselius, Maximum Likelihood Estimation and Inference on Cointegration--With Applications to the Demand for Money, *Oxford Bulletin of Economics and Statistics*, **52**(2), (1990), 169-210.
[15] J. Fedderke and E. Schaling, Modeling Inflation in South Africa: a Multivariate Cointegration Analysis, *South African Journal of Economics*, **73**(1), (2005), 79-92.
[16] J. Thornton, Inflation and inflation uncertainty in Argentina, 1810-2005, *Economic Letters*, **98**, (2008), 247-252.
[17] S.B. Kamin, A multi-country comparison of the linkages between inflation and exchange rate competitiveness, *BIS Working Papers*, **45**, (1997).
[18] S. B. Kamin and M. Klau, Some multy-country evidence on the effects of real exchange rates on output, *BIS Working Papers*, **48**, (1997).
[19] T. Mukhtar and M. Zakaria, Budget Deficit, Money Supply and Inflation: The Case of Pakistan, Privredna kretanja i ekonomska politika, (2010).
[20] Olajide Oladipo, Exchange rate pass through: a case study of a small open economy, *Global Economy Journal*, **7**(3), Article 4, (2007), 1-24.
[21] Pahlavani and Rahimi, Sources of Inflation in Iran: An Application of the ARDL Approach, *International Journal of Applied Econometrics and Quantitative Studies*, **6**(1), (2009).
[22] N.K. Sowa and J.K. Kwakye, Inflationary trends and control in Ghana, *final research report presented at the African Economic Research Consortium Workshop*, Nairobi, Kenya, (May, 1991).
[23] T.K. Vu, The Causes of Inflation in Vietnam: Evidence from VAR with Sign Restrictions, *Memo*, (2011).
[24] P.J. Quirk, Fixed or Floating Exchange Regimes: Does It Matter for Inflation?, *IMF Working Paper*, **94/134**, (1994).