

# **BIDPA Working Paper 36**

February 2013

## **Inflation Dynamics in Botswana and Bank of Botswana's Medium-Term Objective Range**

Haile Kebret Taye

**BOTSWANA INSTITUTE FOR DEVELOPMENT POLICY ANALYSIS**



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## **BIDPA**

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## **ABSTRACT**

This study is motivated by the high and unstable episodes of inflation in Botswana over the last 20 years or so. This is despite the Bank of Botswana's (BOB) concerted effort to keep inflation at its minimum and stable over time. More specifically, it has been attempting to bring down and keep inflation within the medium-term objective range of 3 to 6 percent. The objectives of this study are, therefore, to: (a) examine inflation dynamics in Botswana by identifying the factors that have determined its movements over time; and (b) assess the likelihood that the Bank of Botswana's medium-term objective range of 3 to 6 percent could be achieved in the short to medium-term (one and half to two years). To examine these objectives, the study used an Auto Regressive Distributed Lag (ARDL) estimation technique. A quarterly data ranging from the first quarter of 1990 to the fourth quarter of 2010 is used to estimate the model. And the results show that the identified variables are significant and have the theoretically expected signs. The main conclusions of the study are: (a) price inertia, real GDP, money supply and South African prices play a dominant role in determining inflation in Botswana; and (b) unless international deflationary environment prevails, the probability that the Bank of Botswana will achieve its medium-term objective range of 3 to 6 percent in the medium-term is very low, according to the policy simulation results in this study.

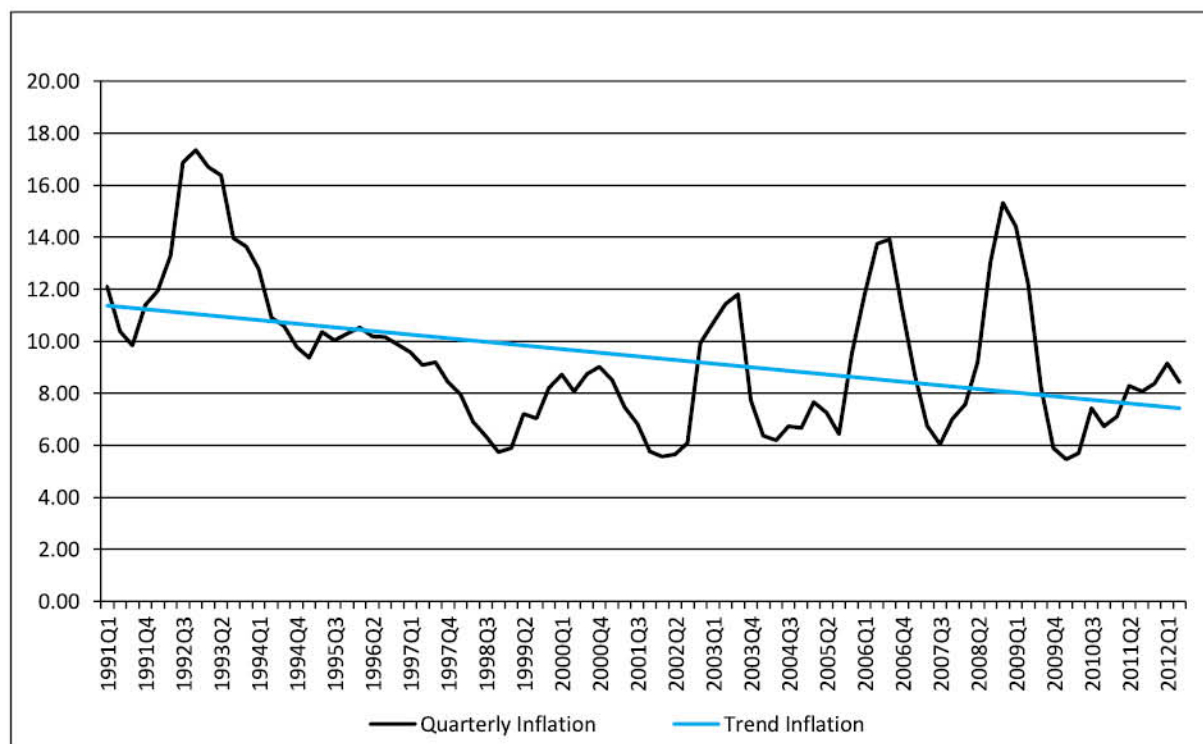
## 1. INTRODUCTION

Low and stable inflation, high economic growth and low unemployment rate are the three most important objectives of macroeconomic policy. Hence, central Banks put a significant amount of effort in monitoring and addressing trends and deviations of gross domestic product (GDP), employment and inflation compared to what is perceived to be full-capacity level. Like other central Banks, the Bank of Botswana (BOB) has also paid attention to the state of the above macroeconomic aggregates hoping to gauge their performance. In particular, the BOB has keenly followed the movements of inflation over time to ensure that its monetary policy is consistent with the desired level and stability of inflation. That is, as could be noted from its various policy statements, the BOB has attempted to monitor and in some instances influence inflation over time using various macroeconomic aggregates. The various aggregates through which the BOB monitors the macroeconomic health and stability of the economy in general and inflation in particular include various monetary policy tools (interest rates, and money supply) and policies of maintaining a stable exchange rate regime.

As clearly stated in the Bank's recent statement (BOB, 2012, p.2) “The bank's monetary policy objective is to achieve price stability, which is defined as sustained inflation within the medium-term objective range of 3-6 percent. Such a low and predictable level of inflation contributes towards the broader national objective of attaining sustainable economic growth.... (and) in pursuit of price stability, the Bank uses interest rates and open market operations to affect demand conditions in the economy and ultimately the rate of price increases”. The main focus or interest here is the Bank's objective range of achieving the 3-6 percent in the medium-term which is assumed to create the minimum economic distortion and foster positive economic growth. It has to be noted that this inflation objective is also in tandem with what the Republic of South Africa (Botswana's major trading partner and neighbour) has been attempting to achieve.

However, as could be seen from Figure 1, despite the effort, inflation in Botswana has hardly been within the desired range and unstable in recent years. It has reached a maximum of about 18 percent in the early 1990s and a low of about 5 percent around the end of 2009 and oscillated a lot from one quarter to another over the last 20 years. Despite its spike between 2006 and 2008, inflation in Botswana averaged about 8.5 percent over the last ten years (1999 to 2010). In general, despite the instability, inflation exhibited a downward trend over the period under consideration.

**Figure 1: Quarterly Inflation in Botswana**



Source: Statistics Botswana, formerly, Central Statistics Office

The objective of this study is, therefore, to: (a) examine inflation dynamics in Botswana by identifying the factors that have influenced its movements during the period of analysis; and (b) assess the likelihood that the Bank of Botswana's objective range of 3-6 percent inflation could be achieved in the medium-term, based on the model's estimates and the policy forecasts that followed. The remainder of the study is organized as follows. Section two briefly reviews the theoretical and empirical literature on the determinants of inflation. The third section specifies the model and discusses the estimation technique. The fourth section discusses the estimation results and assesses the likelihood of reducing inflation to the level of BOB's goal of 3-6 percent in the medium-term. And Section five concludes the study by highlighting the policy implications of the results.

## 2. BRIEF REVIEW OF THEORETICAL AND EMPIRICAL LITERATURE

Economic theory suggests that the sources of domestic inflation could be categorized into two broad groups: It might be caused by supply factors (cost push) or by excess demand pressures (demand pull). While some studies emphasize that the attendant economic structure of a country (supply gap) is the main determinant of inflation, others stress that inflation results from policy choices that trigger excess demand such as excess money supply. At an empirical level, most studies, however, follow an eclectic view in that inflation could be caused by either one or both factors.

In addition to the above generally accepted sources of inflation, some authors stress the need to focus on the specific features of a given economy. As such Botswana's attendant economic structure influences both the origin and the movements of inflation. As Huda (1987, p. 209), put it, “the nature and origin of inflation in Botswana has been somewhat different from those of other countries, mainly due to the peculiar character of the economy which relies primarily on exports for income generation and on imports for most of its consumer goods”. In what follows, therefore, the theoretical and empirical review will be brief. In particular, the theoretical background will be discussed in the context of the empirical studies reviewed.

In general, according to the theories on the demand side, the explanation of inflation hinges on the argument that as the demand for goods and services exceeds what is supplied inflation follows. This excess demand could be triggered by the provision of excess money supply or factors that are associated with it, like interest rates and exchange rates;

On the other hand, cost push explanations of inflation rely on factors that do not emanate from increases in aggregate demand. Most focus on price increases that are caused by or results in increases in cost of production, mark up prices, union wages and low productivity. In short, these explanations focus on the supply side as the sources of inflation. Consequently, many previous studies that have been conducted to assess the determinants of inflation used variables that have captured supply side, demand side or a combination of both factors.

At an empirical level, in line with what is described above, most authors followed an eclectic theoretical approach in identifying the determinants of inflation. These include: Atta et al (1999) for Botswana, Abidemi, et al (2010) for Nigeria, *Kandil. and Morsy* (2009) for the Gulf Cooperation Council (GCC) countries, *Khan. et al* (2007) for Pakistan, Leheyda (2005) for Ukraine, Ocran et al (2005), for Ghana, and Akinboade et al (2004) for South Africa, to name a few. Even though the emphasis slightly varied from one study to another, most used both supply side and demand side factors as determinants of inflation. Accordingly, many studies emphasized that inflation is caused by some demand pressures as triggered by excess money supply, government expenditure, availability of credit, movements in exchange rates and interest rate structures.

On the other hand, other studies focused on cost push factors such as labour productivity, wages, food and other prices, some measure of market structure (competitiveness) and an output gap in the economy. But in most of the studies, price inertia as measured by past values of the price movements is included to account for price expectations, irrespective of the emphasis on cost push or demand pull factors.



At an empirical level, what is emphasised and what turned out to be the most influential variable(s) varied across studies. For instance, Atta et. al. (1999) for Botswana and Dlamini et. al. (2001) for Swaziland used nominal money supply, nominal interest rate, nominal exchange rate, nominal wages and South African consumer price index as determinants of inflation. South African prices and US exchange rate pass through were important in Atta et. al.'s (1999) study; but real sector effects (GDP for instance) were more important in influencing inflation in the Dlamini et. al. (2001) for Swaziland than monetary variables like money supply and interest rates. Akinboade et. al. (2004) who followed a similar approach for South Africa reached the same conclusion.

On the other hand, Ocran et. al. (2005) found inflation persistence to be the most dominant determinant of inflation in Ghana. Similarly, Khan et. al. (2007) for Pakistan and Leheyda (2005) for Ukraine also found price inertia to be one of the most important variables in addition to money supply, wages and exchange rates in the short-run. Money supply, fiscal policy and exchange rates also played some role in all the above noted models in influencing inflation.

In terms of an estimation technique, all the studies noted above carefully addressed issues of data characteristics and applied recent techniques that included an error correction model and co-integration analysis to avoid spurious regression. For instance, the studies undertaken by Atta et. al. (1999), Moser (2005) and Kandil and Morsy (2009) estimated the determinants of inflation using an error correction model. Ratnasiri (2007) for Sri Lanka used a Vector Autoregressive (VAR) analysis. Despite the slight difference in approach most reached similar conclusions in that money supply growth and price increases (inertia) were among the most important determinants of inflation.

Lim and Papi (1997) for Turkey adopted a slightly different approach which uses a multi-sectoral model of the economy comprising of the goods, money, labour and external sectors. They also used various estimation techniques that ranged from instrumental variables to an Error Correction Model (ECM) and concluded that (p.20) “the econometric analysis supports an interpretation of Turkish inflation in which monetary variables (initially money, more recently exchange rate), play a central role in the inflationary process; inertial factors are quantitatively important; and public sector deficits are found to have an important direct effect on inflation.”

In Botswana, there have been four previous studies on the determinants of inflation that we are aware of. In addition to the previously noted study by Atta et. al. (1999), these include a study by Huda (1987), Leith (1991) and Ncube (1992). They all estimated a log-linear model of the price level with South African prices, the Rand to Pula exchange rate and with some variations in the lag structures of variables. The size of coefficients differed but all found that South African prices and the Rand to Pula exchange rate had positive influence on prices in Botswana.

This study also follows a modified version of the above approaches in that in addition to establishing the long-run relationship of the variables using a log-linear specification, a short-run model is estimated using the first difference of the variables. Additional variables like the money supply and real GDP were also included unlike in the above noted studies. The justifications for including the variables will be discussed following the specified model.

### 3. METHODOLOGY

#### 3.1 Model

The methodological approach adopted in this study is guided by searching for an approach that is most suited to the characteristics of the data at hand and that uses the general to specific modelling. There are many alternative and competing estimation techniques in that regard, but this study adopted an Autoregressive Distributed Lag (ARDL) Model, popularized by Pesaran, Shin and Smith (2001). This approach has three notable advantages over other competing estimation techniques (Shahbaz, 2009, P. 92). “First, unlike the Engel-granger and Johansen co-integration approaches, it can be used irrespective of whether the explanatory variables are only I(0), I(1), or a combination of the two. Second, in Monte Carlo studies it performs better than the above two noted approaches. Third, it handles structural breaks in data series”.

The model that is specified to determine the long-run relationships and the short-run dynamics of the variables are presented below. As noted earlier, the model specified is similar to the previous studies used in Botswana and that adopted by Dlamini et. al. (2001) for Swaziland. The main rationales for following a similar approach is to compare results when applicable and use a slightly modified approach that takes into account the distributed lag structure of the data. More importantly, both the studies on Botswana and that of Swaziland took into account the unique structure of the respective economies. That is, both Botswana and Swaziland are heavily dependent on imports from South Africa and hence are likely to share some of the common influences on their respective economies.

The long-run relationships of the variables is specified as follows:

$$\text{Log}(CPIB_t) = \alpha_0 + \lambda_1 \text{Log}(CPIB_{t-1}) + \lambda_2 \text{Log}(CPISA_{t-1}) + \lambda_3 \text{Log}(BRM3_{t-1}) + \lambda_4 \text{Log}(RGDP_{t-1}) + \lambda_5 \text{Log}(BREER_{t-1}) + \lambda_6 \text{log}(NIR_{t-1}) + \lambda_7 D1 + \varepsilon_t \dots \dots \dots 1$$

Where:

- Log(CPIB) = log of Botswana CPI;
- LOG(BRGDP) = log of Botswana real GDP;
- LOG(BRM3) = log of Botswana real broad money supply;
- LOG(CPISA) = log of South African CPI
- LOG(BREER) = log of Real effective exchange rate (Foreign Currencies/Pula);
- LOG(NIR) = nominal Interest Rate in Botswana (prime rate is used);
- D1 = a dummy variable denoting 2005 and after =1, otherwise = zero;
- $\alpha_0$  is a constant;
- $\lambda_i$ 's are respective coefficients;  $\varepsilon$  is an error term and t=time subscript.

The Botswana inflation rate is measured by the growth of the Botswana consumer price index (CPIB). The coefficients for Botswana broad real money supply (BRM3) and South African consumer price index (CPISA) are expected to be positive. But the coefficients for Botswana real GDP (BRGDP), Botswana real effective exchange rate (BREER) and the nominal interest rate (NIR) are expected to be negative.

The economic rationale for this expectation are as follows. Real broad money supply (BRM3) is expected to be positive as theory suggests that excess money supply is one of the potential sources of inflation and hence its increase is expected to positively affect inflation. Similarly, South African CPI (CPISA) is expected to positively influence the price level in Botswana because most goods originate and pass through the Republic of South Africa.

Botswana's real GDP is expected to lower prices because of an increase in the availability of goods and services. It is, therefore, expected to be negatively related to inflation. But this conventional explanation must be interpreted in caution as GDP growth also increases imports and hence the degree of pass through. The Botswana real effective exchange rate is defined as the price of foreign currencies per unit of the local currency (the Pula). Hence, a decrease in the value suggests a depreciation of the local currency against the basket of currencies used in calculating the effective exchange rate.

The net effect of the real effective exchange rate on inflation is difficult to determine a priori as there are many channels through which it also affects the domestic prices level. For instance, due to its impact on imported prices in particular and aggregate demand in general it is likely to have some negative influence on prices; but due to price pass through, and the j-curve effect, and expectations, on the other hand, it also influences domestic prices positively depending on the elasticity of demand for commodities. Its net effect, is therefore difficult to sign a priori in an economy like that of Botswana where most basic commodities are imported from abroad. But on balance, it is expected to negatively influence inflation, assuming its impact on demand for goods and services dominates. The nominal interest rate is also expected to negatively affect prices via its assumed negative effect on spending and hence on aggregate demand.

Before proceeding with the estimation of the long-run relationships and the short-run effects, the first step is to establish whether there is a long-run relationship among the variables identified and inflation using model (2) below. This is accomplished by testing whether the variables are co-integrated or not by testing the hypothesis that  $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0$  in equation (2) below. The computed F-statistics is then compared with the critical values tabulated by Pesaran et. al. (2001) and later modified by Narayan (2005) to account for a shorter sample size, in what is called a Bounds Test. The decision rule is if the estimated F-statistics is greater than the tabulated values, we reject the null hypothesis of no long-run relationship between the variables of interest. Pesaran et. al. (2001) identified a case in which the estimated value falls between the lower and upper critical values. In that case the outcome is inconclusive. But if it is above the upper value, we reject the hypothesis of no long-run relationships.

The short-run and long-run (combined) representation of the model is presented below.

$$\begin{aligned} \Delta \log(CPIB_t) = & \alpha_0 + \sum_{i=1}^n \beta_1 \Delta \log(CPIB_{t-i}) + \sum_{i=1}^n \beta_2 \Delta \log(BRGDP_{t-i}) + \sum_{i=1}^n \beta_3 \Delta \log(BRM3_t) \\ & + \sum_{i=1}^n \beta_4 \Delta \log(CPISA_{t-i}) + \sum_{i=1}^n \beta_5 \Delta \log(BREER_{t-i}) + \sum_{i=1}^n \beta_6 \Delta \log(NIR_{t-i}) + \\ & \lambda_1 \log(CPIB_{t-1}) + \lambda_2 \log(BRGDP_{t-1}) + \lambda_3 \log(BRM3_t) + \lambda_4 \log(CPISA_{t-1}) + \\ & \lambda_5 \log(BREER_{t-1}) + \lambda_6 \log(NIR_{t-1}) + \varepsilon_t \dots \dots \dots (2) \end{aligned}$$

It is important to note that as Baek and Koo (2009, p.6) noted, 'the robust results for the ARDL model typically rely on the two assumptions of exogeneity of explanatory variables and the existence of a unique long-run relationship among the variables'. And this is ensured if the explanatory variables are exogenous and there is a co-integration among the variables.

In sum, therefore, the following steps are taken in this study before the final estimation of the model is done. First, a unit root test is carried out using an augmented Dickey Fuller test to ensure that the variables are stationary. Second, a co-integration test is performed using a Johansen approach to ensure that there indeed is a long-run relationship among the variables. Third, the ARDL bounds test is conducted to determine if it passes the F-test criteria to support the long-run relationship among the variables as initially specified by Pesaran et. al. (2001) and later modified by Narayan (2005) for a shorter sample size.

### **3.2. Unit Root, ARDL Bounds Test and Co-integration**

Dickey Fuller test results show (Appendix 1) that all the variables (except CPIB) are non-stationary in levels but become stationary after differencing once, suggesting that they are I(1). The Botswana CPI is stationary at 5% and it is non-stationary at 1%. As noted above, as long as the variables are either I(0) or I(1), we can proceed to establish the existence (or lack thereof) of any long-run relationship by applying unrestricted co-integration test on equation (2). The test indicates (see Appendix 2) that there is one co-integrating vector on the basis of an Eigenvalue test and the trace statistics.

An ARDL bounds test was also conducted using the unrestricted Vector Error Correction (UVEC) version of a VAR model to ensure that the variables are co-integrated. The results show (Appendix 3) that the computed F- value is greater than the critical values tabulated by Pesaran et. al. (2001) and Narayan (2005) which suggests that we should reject the hypothesis that there is no long-run relationship between the variables in the estimated model.

It is therefore clear that, the specified model suggests that the variables have a meaningful relationship, as demonstrated by the unit root, co-integration, and bounds tests. The model could therefore be used to examine the long-run relationships and short-run dynamics using an error correction representation. In what follows, models that show both the specific long-run relationships and short-run coefficients are discussed to help us analyses the earlier stated objectives of the study.

## 4. ESTIMATION, DATA AND VALIDATION OF RESULTS

### 4.1. Estimation

Equation (1) is estimated to explore the long-run relationships of the variables. All the variables, except the nominal interest rate (NIR), are significant and almost all have the theoretically expected signs (appendix 4). The only (arguably ambiguous sign) is that of the Botswana real effective exchange rate (BREER). But since the purpose of the long-run equation is only to establish the existence of a long-run relationships of the variables and to facilitate the presentation of the error correction model, no further analysis of model results will be discussed. Instead the focus is on the short-run dynamics (or ECM) version of the model.

The data used to estimate equations (1) and (2) is a quarterly time series ranging from the first quarter of 1990 to the fourth quarter of 2010. The data for the different variables have been collected from Bank of Botswana Statistical Reports (Botswana Financial Statistics), Central Statistics Office, Ministry of Finance and Development Planning and Reserve Bank of South Africa. All the variables are used in logs in the long-run relationships while their first differences is used in the short-run equation.

Hence, the error correction term is derived from the long-run equation and is tested for stationarity before it is included in the short-run model. After the error term is found to be stationary in levels, it is combined with the first difference of the variables in estimating the short-run or the error correction model. As reported in Table 1, all the short-run coefficients are significant including the nominal interest rate (NIR) which was not significant in the long-run equation. And all have the theoretically expected signs including the real effective exchange rate (BREER), which was described as likely to capture both negative and positive influences. But the dummy variable was not significant in the short run.

**Table 1: Estimation of Short Run Model (ECM)**

Variable	Coefficient	t-Statistic	Prob.
C	0.002075	0.566683	0.5727
$\Delta$ (LOG(CPIB(-1)))	0.769788	4.703762***	0.0000
$\Delta$ (LOG(BRGDP(-1)))	-0.028974	-2.175663**	0.0329
$\Delta$ (LOG(BRM3))	0.147500	1.761266*	0.0824
$\Delta$ (LOG(CPISA(-1)))	0.149878	1.605182*	0.1128
$\Delta$ (LOG(BREER(-1)))	-0.099896	-1.898942*	0.0616
(NIR(-1))	-0.002408	-3.027317***	0.0034
D1	-0.000133	-0.068799	0.9453
ECM_REV(-1)	-0.835200	-4.379413***	0.0000

\* $\Delta$  indicates first difference.

R<sup>2</sup> = 0.490987 S.E. = 0.007485; F = 8.681270; DW = 2.0178; RSS = 0.004033.  
Information Criteria: SC = -6.581443; Akaike = -6.847493; HQ = -6.740750;

The coefficients in the short-run model suggest the variables that have the greatest influence on Botswana prices are the lagged value of the dependent variable (CPIB), South African CPI (CPISA), and broad money (BRM3). The variables that seem to have the least impact on prices in Botswana, on the other hand, seem to be nominal interest rates (NIR), real GDP (BRGDP) and real effective exchange rate (BREER). The possible explanation why the lagged value has the greatest impact could be it probably is capturing any potential omitted variables and likely price expectations. The impact of the other variables could be easily explained by standard economic arguments and by the fact that the Botswana economy is an export dependent economy that imports most of the goods that are used in production and consumption.

Though not crucial, it is worth noting that the explanatory power of the short-run model is around 50 percent. Differenced data usually has a low R-squared. This was also the case in some of the studies reviewed. For instance, Abidemi et. al. (2010) for Nigeria, Siebrits and Wambach (2004) for South Africa, and Dwyer and Leong (2001) for Australia reported about the same or lower explanatory powers of estimated ECM models. But this was not comparable to the studies in Botswana as all the estimated equations were in log linear form.

Further, the sign and the magnitude of the error correction term (ECM\_rev) is also worth highlighting. It is statistically significant, has the right sign and the magnitude of the coefficient suggests that about 80% of any deviation is corrected within the period. Admittedly, the speed of adjustment seems to be on the high side since it suggests that any deviation from equilibrium will adjust in less than six months.

Before the model is used to examine the objectives stated at the beginning, appropriate diagnostic tests were carried out so that the results are not affected by detectable biases. For instance (as noted in Appendix 5), formal tests for serial correlation using LM test, Ramsey Reset test for correct model specification, ARCH and White tests for Heteroskedasticity were conducted. In all the cases, no detectable problem was found and the respective null hypotheses cannot be rejected using appropriate tests.

#### **4.2. Validation of the Model**

In addition to the tests at a coefficient level, and any possible violations at an equation level, a validation process that includes both within and outside sample forecasts was undertaken to examine the extent to which we can rely on the estimates to evaluate policy using the model. In particular, it would help us assess the extent to which it could be used to forecast future values of inflation.

Accordingly, an overall validation was conducted to examine the extent to which the model forecasts inflation compared to actual values. To be specific two validation processes of the model, namely, within sample and outside sample tests were conducted. First, the model was tested using data for the first quarter of 1990 to the fourth quarter of 2010 to test the extent to which the model mimics the historical data (within sample forecasts, Appendix 6).

Second, as part of the within sample forecast based on  $\pm 2$  standard deviations was conducted to track deviations from the real values (Appendix 7).

And, third, forecasts were made for the 1<sup>st</sup> quarter of 2011 to the 3<sup>rd</sup> quarter 2012 and beyond and compared with the actual values (outside sample forecasts, appendices 8 and 9 for the long-run and short-run models). As could be seen from the tracking performance, the model closely mimics both the within sample and outside sample values. In short, all the econometric results as examined by the various tests and the within and outside sample forecasts suggest that the model mimics the actual values of inflation and can, therefore, be used for policy simulation and forecasting future path of inflation in Botswana. After the thorough validation process and being satisfied with the forecasting ability of the model, therefore, the next step is to use the model for policy analysis and evaluation.

## 5. POLICY DISCUSSIONS

As noted earlier, the objective of the paper is to (a) identify the dynamics of inflation in Botswana, and (b) assess whether the Bank of Botswana will meet the goal of lowering and keeping inflation at its objective range of 3-6 percent. The above discussions addressed the first objective (i.e. identifying the determinants of inflation that influence its movements). What is left is the second objective of examining the likelihood that the BOB reduces and keeps inflation within the 3-6 percent objective range.

As noted, earlier, it has to be re-emphasized that the extent to which the BOB can lower and keep inflation within its objective range of 3-6 percent depends on: (a) its ability to influence the determinants of inflation; (b) the magnitude of the estimated coefficients of the variables under the control of the BOB (like the money supply, interest rates etc); and /or (c) the extent to which variables outside of the BOB's influence play a role in domestic inflation.

In addition to the above general observations, the following stylized facts are also important in determining the extent to which the BOB influences inflation in Botswana: First, as an open and small importer of most of its goods (the small open economy assumption), Botswana's ability to influence external prices is limited (i.e. is a price taker). Second, in an economy that uses an indirect (as opposed to direct) approach in conducting monetary policy, its ability to control money supply is limited; this limitation emanates from the fact that money supply is influenced by the behaviour of the non-bank public and the behaviour of the commercial banks, in addition to the behaviour of the central bank that uses its monetary policy instruments. Or put differently "Central banks don't directly control inflation, nor do their policy actions have effects on real economic activities that are always easy to determine" (Walsh, 1998, p.386).

Given the above observations, if we look at the determinants of inflation in Botswana, the BOB can only (with unguaranteed success) influence domestic inflation via, say, money supply, interest rates, and exchange rates. The remaining variables are outside of its control, short of engaging in administrative measures or what is called 'moral persuasion'.

But as the results of the short-run model show, the three most important variables (as measured by the size of their coefficients) are the inflation inertia and /or expectations captured by the lagged value of prices, South African prices, and the money supply (see Table 1). The interest rate and the real effective exchange rates have relatively marginal influence.

To examine the extent to which the BOB is likely to achieve its goal of lowering inflation to its objective range of 3-6 percent and keep it in that range in the medium-term, therefore, a policy simulation exercise is conducted as follows:

First, the average growth rates of the variables of interest (money supply, the exchange rate and the interest rates) are calculated for the last 10 years; and Second, the exercise, then, assumed, as a best case scenario, that the BOB could reduce inflation from its predicted (base-run) value by the sum of the average growth rates of the variables of interest multiplied by 5 Percent of their respective coefficients. This leads to, an average combined reduction of inflation by about 0.091832 or (9.1832 percent) of the base run.

Admittedly, different people may propose different order of magnitude by which the BOB can influence the variables of interest (on the margin) and, hence, may design the policy exercise differently. But we believe that this is a more realistic assumption as it is not only the lack of ability to reduce the variables which is the problem (as argued above) but also the fact that the BOB is likely to be constrained by other economic considerations when intervening to influence the magnitude of the above variables.

At any rate, assuming the above magnitude reasonably reflects by how much the BOB is willing and in a position to reduce inflation in the medium-term, the combined effects of the exercise is depicted in Fig. 2.

Forecasts based on the above assumption show that the earliest time that inflation will decline to 6% (or touches the upper bound of the objective range) is in the first quarter of 2014. After that it will only marginally decline in the following quarters. According to the simulation results, other things being equal, inflation will decline to about 5.7% by the fourth quarter of 2015.

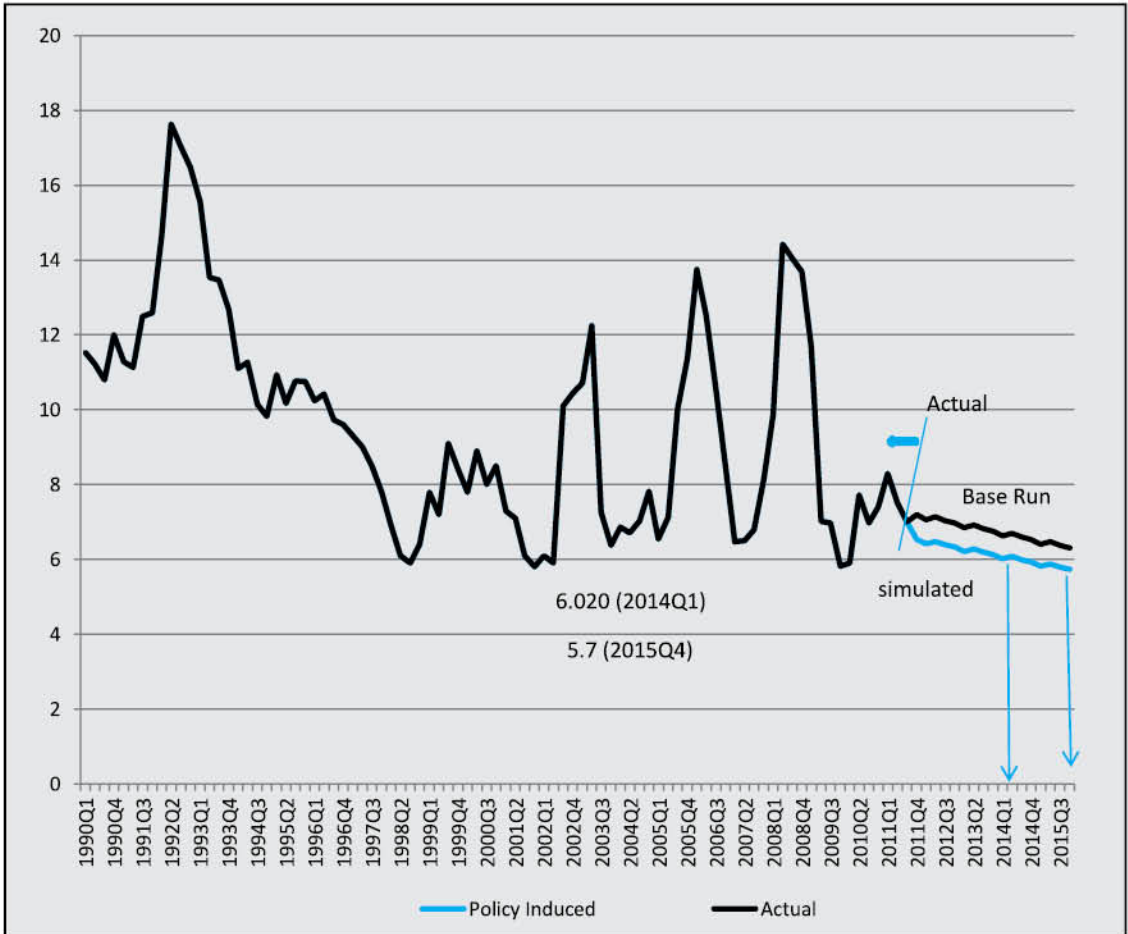
It is worth noting that the simulation incorporated the recent downward movements of inflation in Botswana since the base line forecast values showed a downward trend. To such an extent the results captured the most optimistic scenario regarding the likely future movements of inflation. The important questions are, then, the following. (a) Will and Could the BOB exert the pressure that this exercise assumed to reduce inflation? (b) Will the downward trend observed in the last year or so continue? In particular, will the global deflationary trends persist such that it is a conducive environment for prices to continue falling as they did over the last year or so? The answer to these questions will influence the extent to which the simulation results will hold and the BOB could reach the upper bound of its inflation goal of 3-6 percent in the medium-term.



As noted by the BOB's recent observation (August 2012), the slowing of the domestic economy contributed to the decline in recent inflation. But it is possible to visualize a scenario in which the international environment that is currently putting a downward pressure on inflation, and hence the domestic economy, is unlikely to persist for long. In particular, as the global economy starts to fully recover, fuel prices are likely to increase, and as global income increases (for instance in countries like china and India), world food price will also likely increase, particularly in import dependent countries like Botswana.

Based on the simulation results and the thus far outlined observations, therefore, the conclusions of this study are as follows; (a) The likely impact of monetary policy initiatives in reducing inflation seem to be negligible according to the simulation exercise in this study. The best case scenario is for inflation to reach the upper bound in the medium-term with some policy interventions. But (b) as the world economy starts to fully recover, even the downward movement observed in Botswana in the last year or so is unlikely to continue. Instead, the trend is likely to reverse. Hence, based on these observations, the conclusion of this study is that the probability that the BOB can lower and keep inflation within the objective range of 3-6 percent in the medium-term is very low.

**Figure 2: Likely Effects of Policy Induced Inflation In the Medium-term**



## 6. CONCLUSIONS

The study had two interrelated objectives. First it examined the dynamics of inflation in Botswana by identifying its most likely determinants. Second, it addressed the likelihood that the BOB would lower inflation to its objective range of 3-6 percent in the medium-term.

In terms of the determinants of inflation, both domestic and international factors were found to be relevant in influencing inflation in Botswana. On the whole, the small open economy assumption holds for Botswana. Hence, price inertia or expectations, the price pass through (as measured by the exchange rate and South African prices), Botswana's real GDP, broad money supply and the interest rate play crucial roles in influencing domestic inflation. Price inertia or expectations, South African prices and money supply have the greatest influences (in that order) as measured by the magnitude of their respective coefficients (or short-term elasticity).

This is understandable for the following reasons. First, majority of imports both originate and pass through South Africa. Second, as a small open economy, the direction of causality between South Africa and Botswana is almost unidirectional in terms of price influence. Hence while Botswana's prices have very limited influence, that of South Africa will continue to exert its pressure on price movements in Botswana.

The main conclusion of this study, in addition to the above discussed determinants of inflation, is that even in the relaxed assumption that the BOB pursues an active monetary policy to reduce inflation, the simulation results only show a reduction to about the upper range of the objective range in about two years time. Further, as the global economy starts to fully recover, fuel prices are likely to increase, and as global income increases, world food price is likely to increase. Under such an environment, the likelihood that the Bank of Botswana will manage to reduce inflation will be weak. Hence, according to the simulation results in this study and the impact of the likely prospects of the global economy, the goal of lowering inflation to the objective range of 3-6 percent and keep it in that range in the medium-term is likely to be a daunting task.

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## APPENDIXES

### Appendix 1: Unit Root Test of Variables

		Critical values	1% level	-3.512290
			5% level	-2.897223
			10% level	-2.585861
Variable	In levels	1 <sup>st</sup> difference	Decision	
LOG(CPIB)	-3.179760	-4.405756	I(0)	
LOG(BRGDP)	0.276814	-10.78	I(1)	
LOG(BRM3)	-1.086390	-9.982591	I(1)	
LOG(CPISA)	-2.100722	-3.298043	I(1)	
LOG(BREER)	-1.106358	-7.566489	I(1)	
NIR	1.729744	-7.456595	I(1)	

### Appendix 2: Unrestricted Co-integration Test

Hypothesized	Trace	0.05		
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.659994	153.2085	95.75366	0.0000
At most 1	0.318990	66.90520	69.81889	0.0835

#### Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized	Max-Eigen	0.05		
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.659994	86.30329	40.07757	0.0000
At most 1	0.318990	30.73423	33.87687	0.1134

Trace test indicates 1 co integrating eqn(s) at the 0.05 level

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Appendix 3: Bounds Test for Co-integration Analysis

Statistics	F-Value	Comment
Computed F-statistics:	4.332174	(lag: K=4)
Critical F-statistics at 5% (based on Narayan 2005)	Lower: 2.750 upper: 3.755	For 9 regressors and 65 observations
Critical F-statistics at 5% (based on Pesaran et al -2001)	lower: 2.86 upper: 4.01	For 9 regressors

Note: In both cases Critical Values are for unrestricted intercept and no trend, Narayan (2005, p. 1988) for 65 observations and Pesaran et al. (2001, p. 300), Table CI (iii), Case 111.

### Appendix 4: Estimation of Long Run Relationship

Dependent Variable: LOG(CPIB)

Included observations: 81 after adjustments

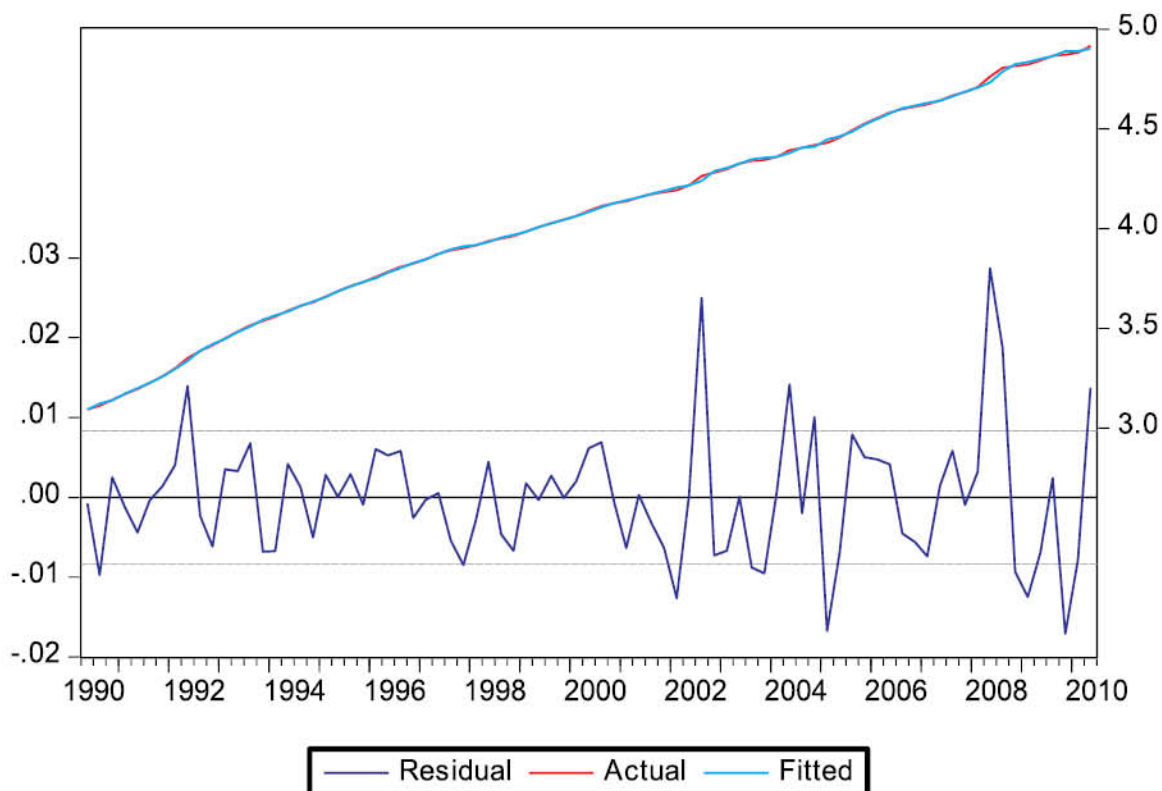
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.134521	0.120781	-1.113762	0.2690
LOG(CPIB(-1))	0.886062	0.041307	21.4506***	0.0000
LOG(BRGDP(-1))	-0.035867	0.017276	-2.07617**	0.0414
LOG(BRM3)	0.119893	0.072174	1.661161*	0.1010
LOG(CPISA(-1))	0.097855	0.048234	2.02876**	0.0461
LOG(BREER(1))	0.059712	0.028629	2.0858**	0.0405
NIR(-1)	-0.000626	0.000560	-1.119359	0.2667
D1	0.023374	0.006335	3.689836***	0.0004
R-squared	0.999755	Mean dependent var	4.066372	
Adjusted R-squared	0.999732	S.D. dependent var	0.509288	
S.E. of regression	0.008338	Akaike info criterion	-6.642491	
Sum squared resid	0.005075	Schwarz criterion	-6.406002	
Log likelihood	277.0209	Hannan-Quinn criter.	-6.547608	
F-statistic	42629.26	Durbin-Watson stat	1.652017	
Prob(F- statistic)	0.000000			

Note:\*\*\*, \*\*, \* denotesignificance at 1, 5 and 10 percent.

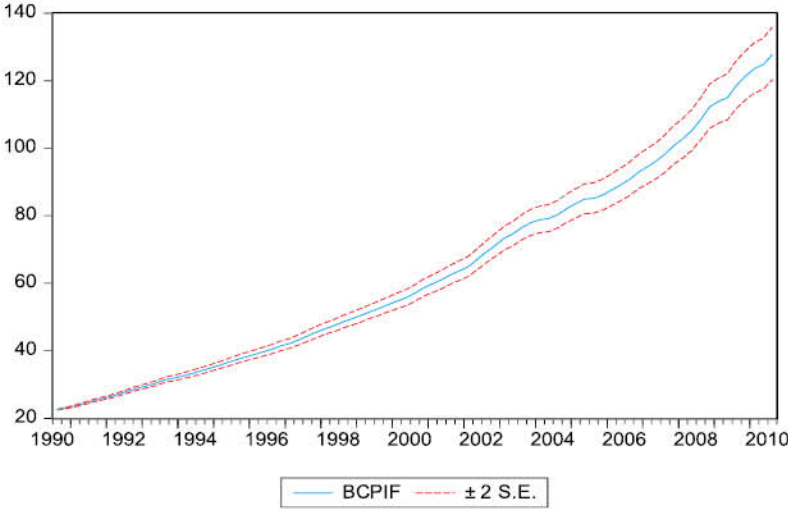
## Appendix 5: Diagnostic Tests for the Short Run Model

Diagnostic Test	A: Test Statistics	B: Critical Value	Decision Rule	Conclusion
LM Serial Correlation H0: No Serial Correlation	0.10	1.66	Reject H0 if A>B	Cannot reject the null hypothesis
Ramsey Reset Test H0: Model is correctly specified	0.03	4.00	Reject H0 if A>B	Cannot reject the null hypothesis
ARCH Heteroskedasticity H0: Homoskedasticity	0.44	7.88	Reject H0 if A>B	Cannot reject the null hypothesis
White Heteroskedasticity H0: Homoskedasticity	42.3	63.69	Reject H0 if A>B	Cannot reject the null hypothesis

## Appendix 6: Within Sample Tracking Performance (1990Q1-2010Q4)

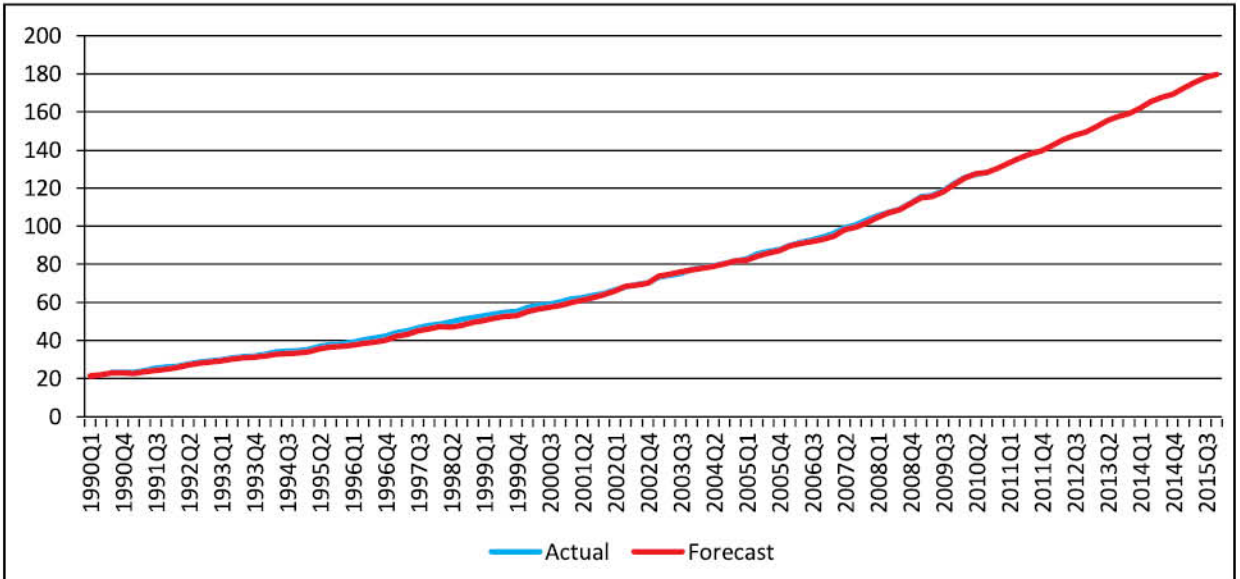


## Appendix 7: Dynamic Forecast of the Short-Run Model ( $\pm 2$ Standard deviations)



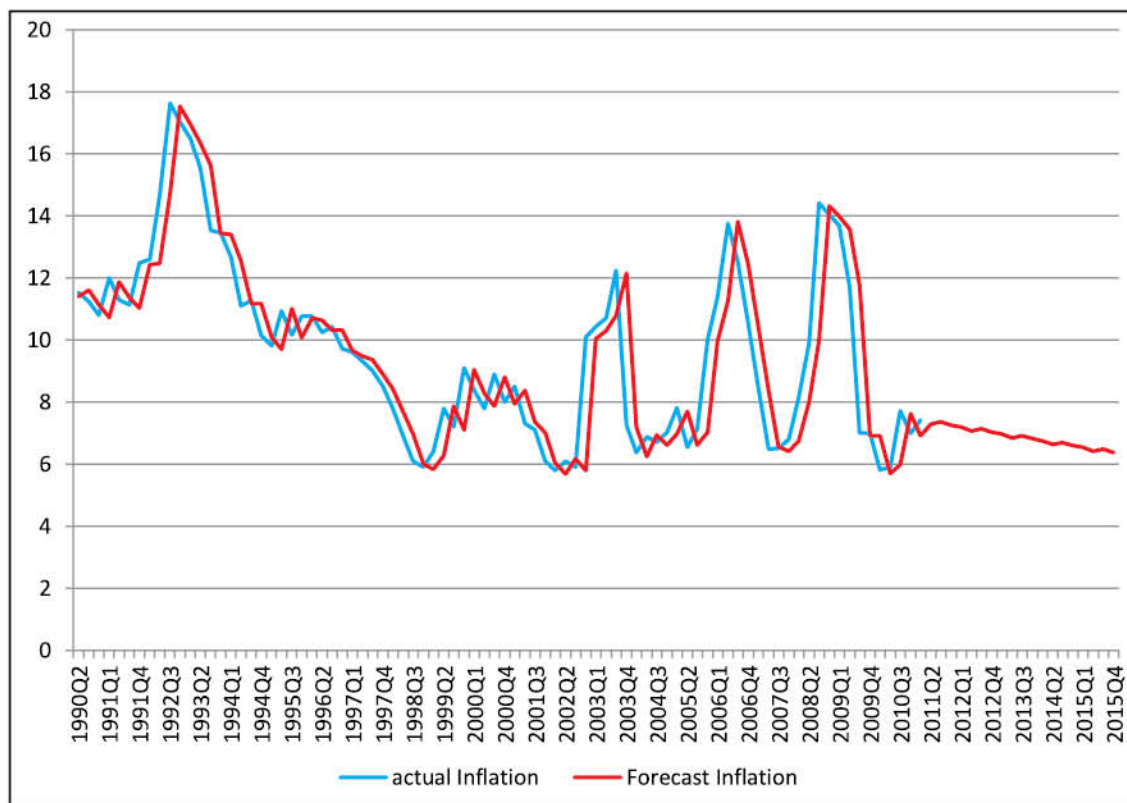
Forecast:	BCPIF
Actual:	BCPI
Forecast sample:	1990Q1 2010Q4
Adjusted sample:	1990Q3 2010Q3
Included observations:	81
Root Mean Squared Error	0.594554
Mean Absolute Error	0.467323
Mean Abs. Percent Error	0.965673
Theil Inequality Coefficient	0.004239
Bias Proportion	0.005232
Variance Proportion	0.640732
Covariance Proportion	0.354036

## Appendix 8: Out-side sample Tracking Performance





## Appendix 9: Outside Sample Tracking Performance of the Short-Run Model



## END NOTES

<sup>i</sup>It has to be noted that all additional results and tests are reported in an appendix to save space and are only referred in the main text.

2. This is partly due to recent economic slowdown both at a global level and in the domestic economy following the crisis in Europe. As the BOB noted in August 2012 and the data shows, inflation has, on average declined in recent quarters. But this is unlikely to last.

<sup>ii</sup>Bank of Botswana “Monetary Policy Statement 2012”, February, 20, p.2.

<sup>iii</sup>Indirect approaches to conducting monetary policy include: open market operations, reserve requirements, public sector deposits, credit auctions, and primary and secondary market sales of T-bills. Direct controls, on the other hand, are no longer widely used (even in Africa) but may include: interest rate control, credit ceilings, statutory liquidity ratios, credit rationing and bank-by-bank rediscount quotas.

<sup>iv</sup>Note that the weight assigned for each variable differed because of variations in the size of the variables, their coefficients and the ability of the BOB in influencing them. Both because of the size its coefficients and the direction of causality, broad money supply is (BRM3) is given the biggest weight.



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