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Centre for Policy Dialogue (CPD)

12 March 2012

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Abstract: Inflation appears to have emerged as a perennial phenomenon in Bangladesh in the recent past. High inflationary trend that began to show up since the second quarter of FY2010 continued throughout FY2011 and FY2012. In this regard, an empirical examination to explore the major sources of inflation is necessary for effective policy suggestions towards curbing inflationary pressure, ensuring price stability and attaining the desired economic growth. This paper investigates major determining factors of inflationary trends in Bangladesh during the period FY1981 to FY2009. An unrestricted error-correction model (UECM) version auto-regressive distributed lag (ARDL) bounds F-test is employed to find out the short run and long run elasticities of the determinants of inflation. Empirical result reveals that domestic rice production affects inflation negatively in the short run to a significant extent. Conversely, domestic petroleum price and broad money (M2) supply have low but positive impact on inflationary trends. This suggests that increased domestic rice production and effective fiscal-monetary integration are the crucial policy options to curb the inflationary pressure in Bangladesh.

Keywords: Inflation, Bangladesh, ARDL bounds F-test.
JEL Classification: E31, C32.

1 INTRODUCTION

Inflation appears to have emerged as a perennial phenomenon in the economic landscape of Bangladesh in the recent past. It has started to increase since the second quarter of FY2010 and continued to rise throughout FY2011 and FY2012. As in most years, food inflation was higher than general inflation. Food inflation reached to 13.75% in September 2011 as opposed to 9.72% in September 2010 (CPD, 2011b). This is the highest inflation rate in the last decade. High food inflation had a knock on effect on non-food inflation as well, pushing it upward to settle at 8.77% in September 2011 from as low as 3.69% in September 2010. According to the Bangladesh Bureau of Statistics (BBS), point-to-point inflation rose to 11.97% in September 2011 and food inflation increased to a level more than what policy analysts had forecasted, due to higher food and oil prices. Such high food inflation contributed more to the overall national inflation (Table II). However, annual imported rice is likely to influence domestic food prices since it accounts for only 1% to 2% on an average of total domestic demand. Public food distribution system (PFDS), on the other hand, has an impact on the food price in Bangladesh. Therefore, it is important that policies are formulated taking these factors into consideration since inappropriate policy measures can worsen the situation and hamper price stabilization. Hence, an investigation into the source of inflation in Bangladesh can help design appropriate fiscal-monetary[1] policy measures to control inflationary pressure.

Based on long-term time series data this paper examines the determining factors of inflationary trend in Bangladesh. The current paper investigates the sources of inflation and respective elasticities using autoregressive distributed lag (ARDL) bounds F-test based on yearly consumer price index (CPI) data of Bangladesh.

The paper is organized in the following manner. The introductory section is followed by a brief review of relevant literature in Section 2. An analysis of the inflationary trend in Bangladesh is made in Section 3 in order to understand the magnitude of the problem. Description of data and methodology is presented in Section 4. This section briefly explains the ARDL bounds F-test estimation techniques, including the derivation of inflation equation. Empirical results of and discussions on the ARDL estimates and elasticities are presented in Section 5. The paper concludes by suggesting a few policy implications based on the results of the econometric model in Section 6.

2 REVIEW OF LITERATURE

In the literature, a number of economic theories have explained the factors associated with supply and demand which contributes to inflation. According to the earliest doctrine on inflation has been anticipated by the 'quantity theory of money'. It explains that the rate of change in the money supply is positively correlated with inflation, and negatively correlated with the growth in real income. Inflation is reviewed as a domestic monetary phenomenon which arises due to the monetary financing of fiscal deficits, or by extending credit to the private sector by central monetary authorities (Cagan, 1956; Bailey, 1956; Dornbusch and Fischer, 1993). On the other hand, according to the monetarist view pioneered by Milton Friedman inflation is caused due to an expansion in the money supply (Friedman, 1970). The third view holds that increase in aggregate demand in the source of demand-pull inflation. This is Keynesian theory of inflation which occurs in a situation when at an optimum or employment of output aggregate supply falls short of aggregate demand full (Keynes, 1936).

As opposed to demand-pull, the "cost-push' theory known also as 'New Inflation' argues that prices rise due to high cost of factors of production. Potential 'cost-push' causes of inflation are rise in wage level, increase in prices of imported raw material and/or depreciation of domestic currency and price

[1] Generally, the adjustment speed of monetary policy instruments takes relatively longer period than fiscal policy instruments. In such a case, short and/or medium term fiscal policy initiatives would be more helpful than inappropriate monetary policy stances. Most notably, success of fiscal measures will depend on the balance between the goals and objectives along with proper implementation.

(Humphrey, 1998). Another view explains id the result of structural adjustment in the economy. The 'structuralist'[2] theory distinguishes between structural inflationary pressure and the mechanism which transmit such pressure (Kirkpatrick and Nixson, 1987). According to this theory, inelastic supply of food grains, foreign exchange constraint and government's budgetary pressure are the key factors behind higher inflation. Yet, another school of thought postulates the "rational expectation theory" of inflation. Economic agents forecast inflation in the future rationally on the basis of full information of the past and present (Lucas, 1972; McCallum, 1980; Sargent and Hansen, 1980).

Non economic factors such as institutions, practical process and culture are also being considered as important factors for inflationary movements. In the contemporary world economic institution including inflation can very much influenced by the political situation of a country (Drazen, 2000). In Bangladesh, both economic and non-economic (e.g., monetary and non-monetary) factors can give rise to inflation. The 'purchasing power parity' theory of inflation explains that changes in exchange rate influence domestic prices through differences of inflation between home country and importing country (Agenor and Montiel, 1996). The expected foreign inflation, and changes in the nominal exchange rate can have an immediate 'pass through'[3] effect to the domestic price levels.

A review of the selected empirical studies on the determinants of inflation in Bangladesh reveals varied results. Most studies are based on qualitative analysis of the inflationary trend in Bangladesh. Thus factors related to short run and long run inflation elasticities have not been adequately explored. Osmani (2007) examines monetary and exchange rate policies to understand potential sources and the extent of inflationary pressure in Bangladesh. He finds that non-competitive market behavior (market syndicate) has insignificant impact on inflation. To explain the inflationary trend, Ahmed (2009) examines the sources of inflation in Bangladesh taking into account both demand-side and supply-side factors. He finds that inward remittance, government debt, inflation inertia, non-competitive market behavior, food and oil prices affect inflation to a large extent. Majumdar (2006) also points out some specific supply side factors of inflation such as wage/labor cost, import cost, exchange rate, oil price, market syndication and supply shortage of agricultural commodities. Raihan and Fatema (2007) find that both demand-side and supply-side factors such as price hike of food and non-food items have significant influence on the rising trend of inflation in Bangladesh. Mortaza (2006) estimates a vector autoregressive (VAR) model which reveals that money supply and exchange rate have positive and significant impact on inflationary spiral. In a recent study, devaluation was found to have insignificant impact on inflation in Bangladesh (Hossain, 2007).

At the global level, several country studies explored the determinants of inflation in the context of respective countries. Some of the relevant areas may be mentioned here. Quinn and Mawdsley (1996) find that a low inflation rate requires a firm exchange rate policy, stable wage rate and slow growth in the money stock in Ireland. According to Laryea and Sumaila (2001), parallel positive influence of exchange rate with respect to output and money plays a key role in determining the inflation rate. They suggest contractionary monetary policy and higher agriculture output to address the negative impact of inflation. DaCosta and Greenidge (2008) indicate that oil price and exchange rate are the determining for the movement of price level in the Caribbean economies. Khan *et al.* (2007) explored issues related to mismanagement in expansionary monetary and fiscal policies, imported inflation, administered prices of Pakistan. Their findings revealed that the contribution of fiscal policies to inflation was minimal but adaptive expectations, private sector credit and increased import prices were major sources of inflation in Pakistan. Kim (2001) also suggests a passive monetary policy to control this type inflationary trend in Poland.

Hammermann (2007) decomposes the non-monetary determinants of inflation in Romania using panel estimation which included fixed effect and random effect. The study suggests that structural gap gives

[2] The 'structuralists' argue that inflation is necessary for economic growth, whereas the 'monetarists' argue the opposite, that is, inflation as detrimental for economic growth (Mallik and Chowdhury, 2001).

[3] On the whole pass-through effect is the effect of changing economic conditions on the production cost passed through to the final retail price of the product.

rise to inflation in a country. Hassan (2008) uses non-technical analysis of inflationary trend, and explains some basic reasons for rampant inflation rate in Ethiopia. These include money supply, interest rate, exchange rate, oil prices, shortage of agriculture production, foreign reserve and foreign debt. Ndaferankhande (2006) pointed out that lagged inflation, food supply shocks, exchange rate, money supply and growth in the real income significantly influence the dynamics of inflation in Malawi. In order to understand the short-term determinants of inflation in Mali, Diouf (2007) investigates monetarist, structuralist and external views on Malian inflation. The paper suggests supply-side policy measures to reduce the inflationary pressure in Malawi. Holod (2000) also finds positive and significant influence of money supply and exchange rate on inflation in Ukraine.

3 INFLATION IN BANGLADESH

Bangladesh has been experiencing high food inflation during the recent period. [4] Such high level of inflation was observed in the 1980s which had moderated during the 1990s (Table I). On the other hand, the general inflation rate in Bangladesh was low during FY1990-2009. The reason for lower inflation rate was good macroeconomic performances and fiscal and monetary measures[5] to control inflationary pressure.

A widely discussed plausible cause of high inflation in Bangladesh is the impact of global price hike.[6] As a food and petroleum importing country, Bangladesh has to bear the brunt of global price hike of these items. Since the beginning of the current decade and up to 2008, global prices of fuel and food followed an increasing trend which got transmitted into the country's domestic economy. There has been some respite from high inflationary pressure towards the end of 2008 and 2009 due to the global meltdown and the resultant price fall of major commodities in the global market. With the turn round of the global economy from the recession towards the end of 2009 and beginning of 2010, inflation started to shoot up.[7] This trend was also observed in Bangladesh. The other major source of high inflation in Bangladesh is high food inflation in the domestic market. This is because, the weight of food items in the CPI commodity basket of Bangladesh is as high as 58.8%, of which the share of rice is 20.1%. Hence the rise in food inflation affects the overall inflation significantly. Based on BBS data, it has been estimated that the contribution of food inflation to the overall inflation was 63.43% in FY2012 (Table II).

In this section, the inter-linkages between inflation and major determining factors such as domestic rice production (RP), domestic petroleum price (PP) and domestic broad money supply (BM) have been explored. Graphical representation of these factors in Figure 1 (in log level) shows their fluctuations over the period. It is observed from Figure I that during FY1999-2009, rice production, petroleum price and broad money supply increased at a moderate level compared to the previous years.

[4] See: Bangladesh Bank's 'Monthly Economic Trends' for details.
[5] Major monetary indicators include domestic credit, broad money supply, foreign reserve, excess liquidity, disbursement of agriculture credit, net sale of NSD certificate and inward remittance flow.
[6] Inflation dynamics in Bangladesh is probably somewhat more complicated than the straightforward relationship between general inflation components in developing countries.
[7] The FAO Food Price Index (FFPI) averaged 225 points in September 2011, down 4.5 points from August 2011, though still higher than its September 2010 value of 195 points.

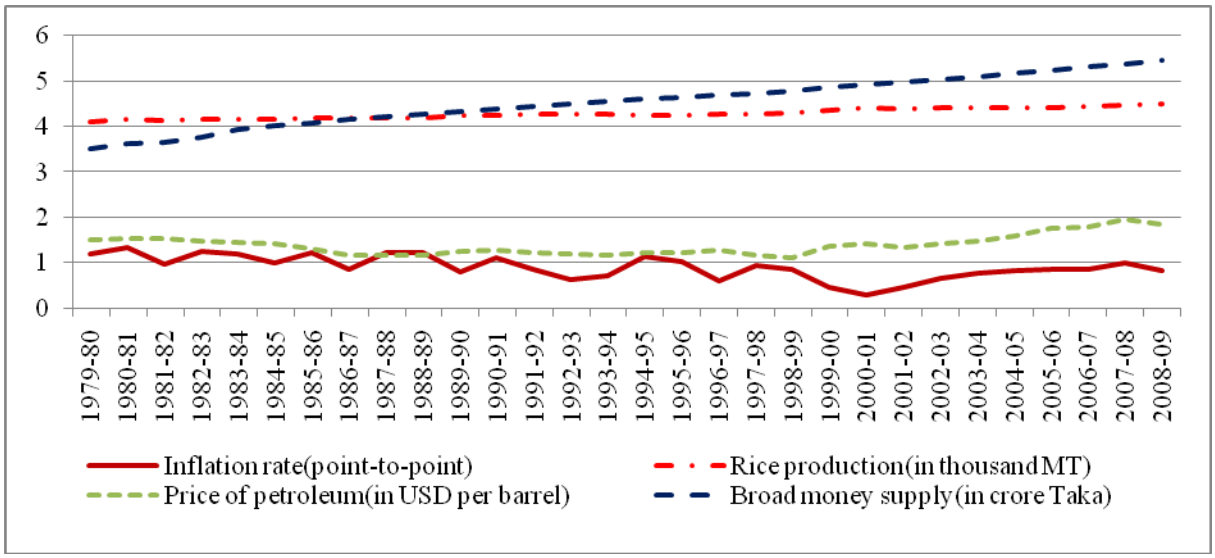


Figure 1. Trends of major determining factors of inflation (in log level)
Source: Statistical Year Book of Bangladesh, BBS (2010).

A disaggregated analysis of the inflation rate in Bangladesh reveals that during FY1990 to FY2009 inflation rate saw a fluctuating trend. The point-to-point inflation rate decreased significantly from 8.77% in FY1995 to 1.94% in FY2001. This fall was partly attributed to the decline in prices of different food items. The point-to-point food inflation showed a steady rise since FY1994 and reached its highest at 10.46% in FY1998. By the end of FY2000, this rate declined to 2.68%. Table I shows the growth rate of CPI and major determinants of inflation. The contribution of food and non-food inflation to the overall inflation in Bangladesh is shown in Table II. Figure I depicts the deflated rice production, petroleum price and broad money supply.

The significance of rice production in explaining the major determinants of inflation is two-fold. Firstly, sufficient production of rice can reduce demand-push inflation. It can minimize import price shocks. Empirical evidence indicates that higher rice production lowers the transmitted shocks from the international market which consequently decreases the rice price-led inflation. From FY1900, the growth of rice production was rising compared to the previous years, and the contribution to food inflation to the overall inflation was also small. Table I and II show the increasing trend of food inflation and its contribution to the overall inflation. Secondly, higher petroleum prices have always been an important factor for higher inflationary pressure in Bangladesh. From FY2003, the growth of petroleum price was higher than previous fiscals in most cases. The CPI growth was also high during this period. Another important factor is the broad money supply. Table I and Figure I indicate that broad money supply shows positive and increasing trend in growth. The response of broad money supply to inflation is an indicator of future inflation (Kahn and Benolkin, 2007). From Table I and Figure I, it is evident that inflation and money supply have been following almost a similar path. However, the recent trend also indicates that acceleration in money supply caused higher inflation by generating disproportionate stress on domestic demand (Osmani, 2007). Moreover, there have been wide fluctuations in the growth of broad money supply, particularly between 1994 and 1999 compared to previous year. Since FY2002, increasing inflation has generally been associated with the growth rate of broad money supply in Bangladesh. The relatively fast growth of broad money supply (on average 17.12% during FY2004-2009) had bearing on the national price level. Another decisive factor is the lagged inflation that is the extent to which inflation persists on its lagged or past inflation. Consequently, reducing high inflation has usually involved breaking the linked channel between these two variables that gives inflation its own momentum (Sargent, 1982).

In general, food inflation increases at a faster rate than non-food inflation in Bangladesh. This was observed during FY2001-2007. The inflationary trend in Bangladesh has two major features. The first one is the high inflation rate since FY2002, and the second one is the incremental contribution of food inflation on the general inflation (Table II). Over the past three decades the average contribution of

food inflation to the overall inflation has increased. For example, in FY1990, contributions of food and non-food inflation to overall inflation were 39.23% and 68.17%, respectively. However, the contribution of food on national inflation started to increase afterwards with a peak in FY1999. In FY2009, the contributions of food and non-food inflation were 63.43% and 36.52%, respectively. The prevailing situation therefore indicates that domestic food prices have been influencing the overall inflationary pressure in the recent years.

4 DATA AND METHODOLOGY

4.1 Derivation of Inflation Equation

The study explores the long run and short run effects (lagged values of key determinants) using unrestricted error correction model (UECM) version of the ARDL model. Data for the period from FY1980 to FY2009 have been collected from Bangladesh Bureau of Statistics (BBS, 2010). It is assumed in the study assumes that inflation in Bangladesh, in terms of consumer price index (CPI), is a function of domestic rice production (hereafter rice production), domestic petroleum price (hereafter petroleum price), and broad money (M2) supply.

To avoid general time series estimation problem due to omitted variable problem of a bivariate model, following Ozturk and Acaravci (2010), a multivariate model is used to investigate the long run equilibrium relationship between inflation (CPI), rice production (RP), petroleum price (PP), and broad money supply (BM). This study uses yearly time series data for the period from FY1981 to FY2009. This can take the following functional form.

$$Inflation,\ \Pi_t = f\ (RP_t,\ PP_t,\ BM_t) \tag{1}$$

Eq. (1) can be rearranged in logarithmic[8] form, where, X_t represents all determinants considered in the model and β_t is the respective coefficient.

$$ln.\Pi_t = \alpha + ln \sum_{t=1}^{k} \beta_t X_t + \varepsilon_t \tag{2}$$

Eq. (2) can be rewritten as:

$$ln.CPI_t = \alpha + \beta_1\, ln.X_1 + \beta_2\, ln.X_2 + \beta_3\, ln.X_3 + \varepsilon_t \tag{3}$$
$$ln.CPI_t = \alpha + \beta_1\, ln.RP_t + \beta_2\, ln.PP_t + \beta_3\, ln.BM_t + \varepsilon_t \tag{4}$$

In Eq. (3), log of CPI (ln.CPI) is a dependent variable, $\sum X_t$ is the vector of independent variable of inflation determinant and ε_t is the serially uncorrelated error term of the model. In Eq. (4), log of rice production (ln.RP), log of petroleum price (ln.PP) and log of broad money supply (ln.BM) are considered as explanatory or independent variables.

This paper explores the existence and directions of short run and long run inflation elasticity for Bangladesh which is expressed mathematically in Eq. (4). The ARDL bounds F-test procedure require step-by-step estimations in the following manner: i) perform stationarity (unit root) test[9] to avoid any spurious relationship between the series (model variables); ii) selection of the optimal lag length using different information criteria (this study uses AIC); iii) estimation of UECM version ARDL model with appropriate post-estimation diagnostic tests; iv) investigation of long run cointegration equilibrium relationship test using ARDL bounds F-test; v) estimation of the short run and long run elasticities from ARDL estimates; and vi) examination of the stability of the model through CUSUM test and CUSUMSQ test (Brown *et al.,*1975).

[8] Variables used in the inflation model are expressed in logarithmic forms in order to reduce the heteroscedasticity problem as well as to interpret the estimated coefficients as its own elasticity.
[9] Though it is not required for ARDL bound F-test, it shows the same order of integration.

4.2 Autoregressive Distributed Lag (ARDL) Bounds F-test

According to Pesaran *et al.* (2001) and Pesaran and Shin (1997) the augmented ARDL model can be expressed in the following form:

$$y_t = \alpha_0 + \sum_{i=1}^{k} \beta_i x_{it} + \varepsilon_t \quad (5)$$

In Eq. (5), y_t is the dependent variable, α_0 is the constant term, and x_{it} is the independent variable. Rearranging Eq. (5), UECM version of the ARDL model can be obtained in terms of the lagged levels and first difference as follows:

$$\Delta y_t = \alpha_0 + \alpha_{1t} + \lambda_{yx} v_{t-1} + \sum_{i=1}^{p-1} \theta_i \Delta y_{t-i} + \sum_{i=0}^{p-1} \theta_i \Delta x_{t-i} + \varepsilon_t \quad (6)$$

In Eq. (6), Δ, t and θ_i represent first difference operator, time trend and short run movements of the 'inflation' model. If the model variables show a linear trend and no quadratic trend,[10] it can specify the UECM version of the ARDL equation as follows:

$$\Delta y_t = \alpha_0 + \lambda_{yy} y_{t-1} + \lambda_{yxx} x_{t-1} + \sum_{i=1}^{p-1} \theta_i \Delta y_{t-i} + \sum_{i=0}^{p-1} \theta_i \Delta x_{t-i} + \varepsilon_t \quad (7)$$

ARDL bounds F-test approach following Pesaran and Shin (1997) and Pesaran *et al.* (2001) has some specific advantages in contrast with other typical cointegration methods such as Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990). The ARDL procedure does not require all the series in the model to be of equal order of integration; it allows different optimal lags[11] of the series. It is irrespective of whether the regressors are mutually cointegrated, or it is I (0) and I (1). Moreover, it provides efficient estimator even if samples are small/finite and some of the regressors are endogenous.[12] It also allows the 'single reduced form equation'.

The ARDL cointegration approach requires two-step estimation method to explore the relationships between the model variables (series) both in the long run and in the short run. The first step is to examine the existence of long run equilibrium relationship among the series of the model. To do so, following Pesaran *et al.* (2001), the UECM specification of the ARDL model of long run relationship between rice production (ln.RP), petroleum price (ln.PP), broad money supply (ln.BM), and inflation (In. CPI) can be expressed as follows:

$$\begin{aligned} &\Delta ln.CPI_t = \\ &\alpha_1 + \sum_{i=1}^{a1} \omega_{1i} \Delta ln.CPI_{t-i} + \sum_{j=0}^{b1} \beta \Delta ln.RP_{t-j} + \sum_{k=0}^{c1} \gamma \Delta ln.PP_{t-k} + \sum_{l=0}^{d1} \theta \Delta ln.BM_{t-l} + \\ &+\lambda_1 \Delta ln.CPI_{t-1} + \lambda_2 \Delta ln.RP_{t-1} + \lambda_3 \Delta ln.PP_{t-1} + \lambda_4 \Delta ln.BM_{t-1} + \varepsilon_{1t} \end{aligned} \quad (8)$$

In Eq. (8), Δ and ε_{1t} are the first difference operator and the 'white noise error term',[13] respectively. An appropriate lag length selection based on Akaike Information Criterion (AIC) is applied here. The ARDL bounds test procedure is based on the joint F-statistic (Wald statistic) which tested the null of no cointegration against the alternative hypothesis:

$$H_N: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0 \text{ vs. } H_A: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$$

[10] Existence of trend can be retrieved from graphical presentation of the series.
[11] Most of the studies use Akaike Information Criteria (AIC) or Schwarz Bayesian Criteria (SBC) to get the optimum lag-length of respective variables.
[12] 'Endogeneity' refers to correlation between the variable and the error term. This arises due to simultaneity, omitted variables, measurement errors and sample selection errors. Generally, a causality between the regressor and regressand of an econometric model leads to endogeneity.
[13] 'White noise error term' is derived from residuals of the estimated cointegration and measure the magnitude of the past disequilibrium.

The study uses limited range of time series data (29 years) for estimating the model. The traditional critical values are not suitable for such limited data series because they are based on large sample sizes. Narayan (2005) regenerated the set of critical values for the limited data ranging from 30 to 80 observations by using the method of Pesaran *et al.* (2001). This study employs the critical values of Narayan (2005) for the bounds F-test rather than that of Pesaran *et al.* (2001).

The second step is to estimate the long run and short run elasticities after checking the evidence of cointegration (long run equilibrium relationship) between these series using least-square regression technique where the selection of appropriate lag of each independent variable is based on AIC. Long run elasticities are calculated from the estimated respective coefficients of the one lagged level explanatory (independent) variables divided by the coefficient of the one lagged level dependent variable and then multiplied by -1 (Bardsen, 1989; Hoque and Yusop, 2010). Short run elasticities are retrieved from the estimated coefficients of the respective first differenced variables.

Finally, relevant post-estimation diagnostic tests such as JB test, LM test, ARCH test and Ramsey RESET test are performed to check the goodness of fit of the estimated ARDL model of inflation. Stability tests i.e. CUSUM and CUSUMSQ are also employed to check the stability of the estimated coefficients over the time period from FY981 to FY2009.

5 EMPIRICAL RESULTS AND DISCUSSIONS

5.1 Results from Unit Root Tests

Following Enderrs (1995), ADF and PP unit root tests are performed to check the stationarity of the series as the selection of appropriate unit root test (stationarity) is complicated in general. The unit root tests are employed at levels and at first difference for both cases: i) without trend (intercept) and, ii) with trend (intercept and trend). The optimum lag was selected by using the AIC. Results of the unit root tests indicate the fact that inflation (In. CPI), rice production (ln.RP), petroleum price (ln.PP) and broad money supply (ln.BM) are non-stationary at level but stationary at first difference, i.e. I(1). Summery findings of the unit root tests (ADF and PP) results are presented in Table 1. Although the series of the model is integrated in order one, this study uses ADRL bounds test of cointegration to minimize the common time series estimation problem.

Table 1. Unit root tests

Variable	Augmented Dickey–Fuller (ADF)		Phillips–Perron (PP)		Order of integration
	Intercept	Intercept and trend	Intercept	Intercept and trend	
ln.CPI	1	1	1	1	I (1)
ln.RP	1	1	1	2	I (1)
ln.PP	1	1	1	2	I (1)
ln.BM	1	1	1	1	I (1)

Notes: For PP spectral estimation method is default (Bartlett kernel) and bandwidth is selected based on Newey-West procedure. Following Pessaran and Shin (1997), optimum lag-length of ADSF test is based on Schwartz Information Criteria (SIC).

5.2 Results from ARDL Estimations and Elasticities

A UECM version of the ARDL model with three lags[14] of Eq. (8) is estimated to find out the elasticities of the inflation model. Then Hendry's (1995) 'general-to-specific' modeling approach is selected for the equation using AIC. Results of Eq. (8) are presented in Table 2. The validity of the estimated equation is confirmed by employing relevant post-estimation diagnostic tests. Jarque–Bera test statistic confirmed the normality of the estimated residual of the equation. The Breusch–Godfrey LM test statistic rejected the first, second and third order serial correlation for Eq. (8). The ARCH test statistics explains that the residuals are homoscedastic in Eq. (8). RESET (specification) test confirms the correct functional form of the model. CUSUM and CUSUMSQ tests confirm the stability of the parameters over the period. CUSUM and CUSUMSQ test results are presented in Figure 3. This

[14] Akinboade *et al.,* (2008) suggested three lags for initial ARDL estimation.

cointegration test based on bounds F-test finds the evidence of a long run equilibrium relationship between consumer price index, rice production, petroleum price, and broad money supply at 5% level of significance. The ARDL cointegration test gives 4.88 as the F value that is significant at 5% level.[15]

Table 2. Estimated ARDL (1, 2, 2) model based on equation (6)

Variable	Coefficient	Standard Error	t-statistic
ln.li (-1)	-1.11	0.2859	-3.88
ln.RP (-1)	-2.77	2.6986	-1.03
ln.PP (-1)	0.93	0.4380	2.12
ln.BM (-1)	0.11	0.4616	0.25
D.ln.RP (-1)	-2.92	2.5436	-1.15
D. ln.PP (-1)	-0.20	0.6897	-0.29
D.ln.PP (-2)	-0.46	0.6102	-0.75
D.ln.BM (-1)	-0.62	2.2686	-0.28
D.ln.BM (-2)	-1.129	2.2535	-0.50
Constant	25.73	21.5843	1.19
R-square: 0.54			
Adj. R-square: 0.30			
F (9,17): 2.24			
Prob.>F: 0.07			
J-B Normality: 1.42[0.28]			
Breusch-Godfrey serial correlation LM test: LM-1: 0.819[0.37]; LM-2: 2.582[0.28]; LM-3: 4.081[0.25]			
ARCH test: ARCH-1:0.633[0.43]; ARCH-2: 1.043[0.60]; ARCH-3: 1.080[0.78]			
Ramsey RESET: 1.12[0.28]			
Durbin-Watson d-statistics: 2.08			

Table 3 represents the long run and short run elasticities of the inflation model. Long run elasticities of the model variable for inflation are calculated from the estimated coefficients of the respective lag one of independent variables divided by one lagged coefficient of CPI (dependent variable) of the respective equations and multiplied by a negative sign using the estimations presented in Table 2.

Table 3. Short run and long run elasticities of inflation

Variables	Elasticity (η)	
	Short run (η_{sr})	Long run (η_{lr})
ln.RP (-1)	-2.92*	-2.50
ln.PP (-1)	0.30*	0.84**
ln.BM (-1)	0.09*	0.10

In the long run, rice production indicates higher and negative elastic (η_{RPlr}= -2.50) impact on overall inflation. It implies that a 1% increase in the rice production could lead to a decrease in the inflation by 2.50%. In the short run, rice production also indicates higher and negative elastic (η_{RPsr}=-2.92) impact on inflation implying that a 1% increase in the rice production could lead to a decrease in the inflation by 2.92%. Petroleum price, on the other hand, also indicates inelastic and positive impact (η_{PPlr}=0.84) on inflation, as expected, in the long run and indicates that a 1% increase in the petroleum price could lead to an increase in the inflation by 0.84%. In the short run, petroleum price indicates inelastic and positive impact (η_{PPsr}=0.30) on inflation which implies that a 1% increase in the petroleum price could lead to an increase in the inflation by 0.30%.

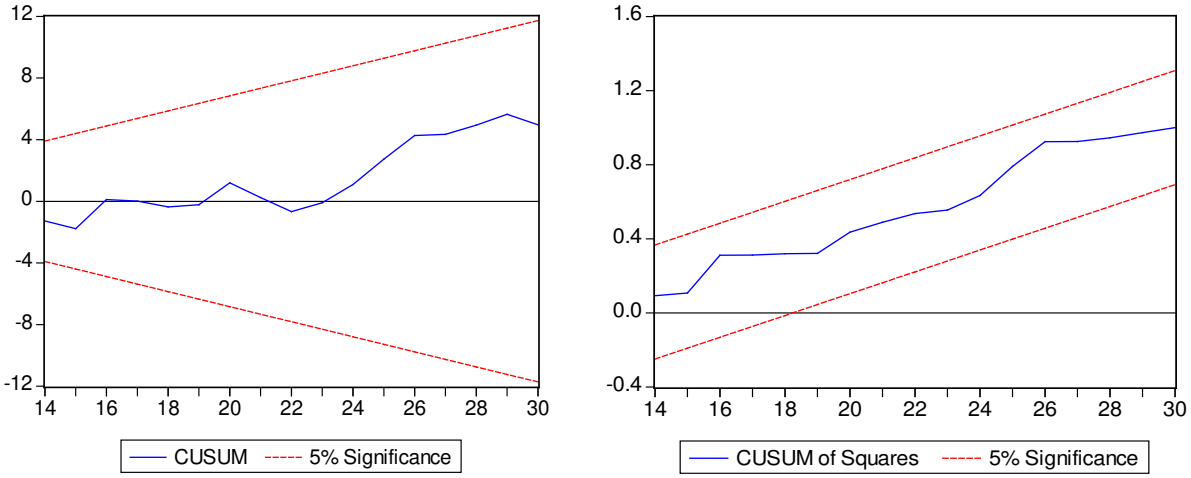
In the long run, broad money (M2) supply indicates inelastic and positive (η_{BMlr}= 0.10) impact on inflation. It implies that a 1% increase in the broad money supply could lead to an increase in the inflation by 0.10%. In the short run, broad money supply indicates inelastic and positive (η_{BMsr}=0.09)

[15] The critical values for the lower I (0) and upper I (1) bounds are 3.164 and 4.194 for 5% significance level, respectively (Narayan, 2005).

impact on inflation indicating a 1% increase in the broad money supply could lead to an increase in the inflation by 0.09%.

5.3 Post-estimation Diagnostic and Stability Tests

The unit root (stationarity) tests exhibit the fact that rice production, petroleum price and broad money supply are non-stationary at level but stationary at first difference. In addition, essential post-estimation diagnostic tests e.g., Jarque–Bera (JB) normality test, Breusch–Godfrey serial correlation LM test, ARCH test for heteroscedasticity, Ramsey RESET test for model specification and CUSUM with CUSUMSQ[16] stability tests are employed to check the validity and the robustness of the estimated model. The diagnostic test statistics suggest that the estimated model has fulfilled the standard econometric properties. The JB test statistic confirmed the normality behavior of the estimated residual series of the model. The Breusch–Godfrey LM test statistic rejected the first, second and third order serial correlation of the model. The ARCH test also confirms that the residuals are homoscedastic at first, second and third order of the estimated model and lastly, the Ramsey RESET test confirms the correct functional form (specification) of the inflation model.



3a. Plot of CUSUM test

3b. Plot of CUSUMSQ test

Figure 3. Plot of CUSUM and CUSUMSQ test

The structural stability of the inflation equation is examined by employing CUSUM and CUSUM-square (CUSUMSQ) tests which detects systematic change in the regression coefficients (Brown *et al.,* 1975). Figure 3 presents the plot of CUSUM and CUSUMSQ test statistics. These falls within the critical bound lines (red and dashed) at 5% level of significance that means that estimated coefficients in the UECM based ARDL model are stable over the sample period of FY1981-2009. Therefore, evidences revealed from the estimated model can be used for practical policy-making purposes.

6 CONCLUSIONS AND POLICY IMPLICATIONS

This study finds that rice production, petroleum price and broad money supply influence the inflationary trends in Bangladesh both in the short run and long run. Rice production has a positive, while petroleum price and broad money supply, both have a negative impact on the overall inflation. Keeping in mind that inflation in Bangladesh has arisen due to excess aggregate demand and inflationary expectations along with some sort of external price shocks, a number of policy recommendations can be drawn based on econometric estimations.

[16] CUSUM and CUMSUMSQ tests are based on the cumulative sum of the recursive residuals that incorporate the short run dynamics to the long run through residuals that restructured recursively and plotted against the break points of the estimated model (Brown *et al.,* 1975). These tests plot the cumulative sum with critical bounds lines at 5% significant level. These tests detect parameter instability if the cumulative sum goes outside the area between the two critical bounds lines.

First, increased import of food grain items[17] and petroleum products[18] are matters of concern for the economy. As inflation is negatively related to rice production (and productivity), increase in rice production can ease the inflationary pressure.[19] A minimum rice and other food grain stocks are essential for pursuing price stabilization policy during the high inflationary periods. Moreover, market price of most essential commodities such as rice, wheat, sugar and edible oil should be kept 'reasonable' by intervening the market[20] through different regulatory policies. In this regard, state-owned Trading Corporation of Bangladesh (TCB) should be strengthened to rein price-spiral and to curtail the oligopolistic behavior of limited private suppliers.

Second, as petroleum price affects inflation positively in the short and long run to a significant extent, rationalization of petroleum price is necessary. Price volatility in international oil market and the pass-through effect of exchange rate[21] influence food and non-food inflation simultaneously. Bangladesh government gives subsidy for petroleum oil at the end-user level. This causes huge fiscal burden and consequent pressure on the balance of payment (BoP) of the country. Rationalizing fuel oil price and power tariff in line with the actual buying or production price could reduce the unfavorable BoP position.

Lastly, monetary policy[22] of Bangladesh Bank (BB) should also be integrated and fine tuned in view of the trend in movement of broad money supply, exchange rate, foreign reserve, sluggish implementation of annual development program (ADP) and growth of investment. The central bank of Bangladesh has been pursuing an 'accommodative' monetary policy to achieve growth and reduce price level. However, given the persistent nature of high inflation Bangladesh Bank increased cash reserve ratio (CRR), repurchase agreement (repo) and reverse repo a number of timers. However, such contradictory policy has not been effective to curb the demand-led inflation. Hossain (2010) argues that inflation instability in Bangladesh is an outcome of wrong monetary policy design and implementation of monetary targeting in an unstable political environment.[23] Given the nature of inflation in Bangladesh it is important that policy makers integrate monetary and fiscal policies to reduce inflationary pressure so that economic growth can be sustained.

DISCLAIMER

Views expressed in this paper are those of the authors alone and do not necessarily reflect the views of their employer. Other usual disclaimers apply.

[17] See: 'Bangladesh Food Situation Report' for details at: http://www.nfpcsp.org/agridrupal/bangladesh-food-situation-report
[18] See: World Bank Pink sheet at http://econ.worldbank.org
[19] In this fiscal, reduced agricultural subsidy and more increased fuel subsidy are other driving forces that cause higher fiscal burden. Financing fiscal deficit has its specific impacts and consequent adverse implications for monetary policy.
[20] Market intervention was increased by 3.4 times (1.18 MMT in FY2010-11 against 0.28 MMT in FY2009-10) through Open Market Sale (OMS) and Fair Price Card (FPC) channels.
[21] Though US dollar is depreciating against other major currencies in the recent time, in Bangladesh it is appreciating due to higher market demand for importing capital machinery as well as lower foreign reserve.
[22] Hoehn (1988) argues that monetary policy can stabilize inflation indirectly, by keeping the output and employment level stable. CPD (2011a) observes that the MPS for the period July to December Bangladesh Bank targets "for an inflation rate of 7.5% by the end of FY2011 through discouraging credit flow to unproductive sectors. At the time of the announcement of the MPS, monetary aggregates were already on increasing trends. But the MPS declared only an 'accommodative' policy for productive economic activities without any specific measures to control money supply." Table IV shows recent monetary policy stances taken by the Bangladesh Bank.
[23] Jongwanich and Park (2009) empirically reveal that 'monetary targeting' through a combination of monetary policy instruments will remain appropriate policy stances for Bangladesh. Appropriate design and implementation of monetary targeting through policy instruments would be beneficial to unfold the barriers of short and long term economic development. Based on all traditional inflation theories, Bangladesh Bank should have specific policies to minimize inflationary pressure (and inflation expectation) from gaining a perpetual hold. Malfunction of policy instruments, all inflation theories predict that any adverse shock can trigger a soar in inflation expectation, which then turns into high inflation permanently.

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APPENDIX

Table I. Year-on-year growth of CPI inflation (point-to-point) and major determinants

Year	CPI	Rice production (RP)	Petroleum price (PP)	Broad money supply (BM)
FY81	42.88	10.72	6.81	27.50
FY82	-56.04	-1.82	-5.83	10.01
FY83	85.20	4.30	-8.42	29.63
FY84	-11.23	2.05	-7.06	42.18
FY85	-37.88	0.79	-4.04	25.61
FY86	68.41	2.87	-26.71	17.13
FY87	-57.36	2.43	-24.08	16.33
FY88	138.36	0.04	0.47	14.32
FY89	-2.36	0.85	-4.11	16.27
FY90	-62.42	14.88	25.03	16.88
FY91	115.16	-0.03	2.32	12.14
FY92	-45.10	2.24	-8.84	14.09
FY93	-40.17	0.49	-4.68	10.55
FY94	20.05	-1.64	-11.42	15.43
FY95	170.68	-6.70	13.64	15.96
FY96	-25.04	5.08	0.22	8.24
FY97	-62.11	6.75	18.98	10.81
FY98	118.69	-0.11	-22.30	10.35
FY99	-18.48	5.53	-14.16	12.81
FY00	-60.48	15.89	77.95	18.62
FY01	-30.47	8.75	12.58	16.60
FY02	43.81	-3.13	-16.19	13.13
FY03	56.99	3.65	19.77	15.59
FY04	33.11	3.98	12.22	13.80
FY05	11.15	-3.95	38.10	16.75
FY06	10.49	5.46	43.73	19.30
FY07	0.56	2.97	5.60	17.06
FY08	38.06	5.90	48.49	17.63
FY09	-33.00	8.25	-25.15	19.17

Source: Statistical Year Book of Bangladesh (various issues), BBS.

Table II. Contribution of food and non-food inflation to general CPI inflation (point-to-point)

Year	National Inflation					Rural Inflation					Urban Inflation				
	G	F	FC	NF	NFC	G	F	FC	NF	NFC	G	F	FC	NF	NFC
FY90	3.81	2.54	39.23	6.31	68.17	3.43	1.98	36.34	6.55	70.73	4.21	4.05	46.95	4.44	54.00
FY91	8.19	7.97	57.26	8.61	43.27	8.76	8.58	61.67	9.14	38.65	6.43	6.17	46.83	6.8	54.15
FY92	4.51	4.13	53.88	5.2	47.46	4.3	3.8	55.64	5.33	45.91	4.86	5.12	51.41	4.5	47.41
FY93	2.71	1.84	39.95	4.27	64.85	2.32	1.52	41.25	4.61	73.60	2.9	2.76	46.44	3.1	54.73
FY94	3.24	2.91	52.85	3.86	49.04	3.47	2.92	52.98	3.9	41.63	3.11	2.89	45.35	3.4	55.97
FY95	8.77	9.15	61.39	8.07	37.87	9.3	9.75	66.01	8.42	33.54	7.63	7.52	48.10	7.79	52.27
FY96	5.53	5.86	62.35	4.67	34.76	5.82	5.77	62.42	5.91	37.61	4.99	6.25	61.12	3.3	33.86
FY97	3.96	3.67	54.53	4.47	46.46	3.67	3.32	56.96	4.53	45.72	4.5	4.53	49.13	4.46	50.74
FY98	8.66	10.46	71.07	5.99	28.47	9.22	11.03	75.32	6.18	24.83	7.25	9.06	60.98	5.54	39.12
FY99	7.06	9.3	77.51	3.95	23.03	7.29	8.96	77.38	4.33	22.00	6.54	10.13	75.59	3	23.49
FY00	2.79	2.68	56.52	3.08	45.44	2.41	2.1	54.86	2.99	45.95	3.69	4.09	54.09	3.28	45.51
FY01	1.94	1.38	41.86	3.04	64.50	2.12	1.18	35.04	3.83	66.92	1.52	1.89	60.68	1.13	38.06
FY02	2.79	1.63	34.38	4.61	68.01	2.56	1.44	35.42	4.57	66.12	3.36	2.09	30.35	4.7	71.62
FY03	4.38	3.46	46.48	5.66	53.19	3.46	4.05	73.70	2.09	22.37	3.52	2.09	28.98	5	72.73
FY04	5.83	6.92	69.84	4.37	30.85	5.44	6.55	75.81	3.18	21.65	5.99	7.8	63.55	4.14	35.39
FY05	6.48	7.91	71.82	4.33	27.50	6.62	7.99	75.99	4.27	23.89	6.14	7.71	61.28	4.49	37.44
FY06	7.17	7.76	63.68	6.4	36.74	7.36	7.62	65.18	6.9	34.73	6.68	8.09	59.10	5.14	39.40
FY07	7.22	8.12	66.17	5.9	33.63	7.3	7.96	68.65	6.1	30.95	7.02	8.53	59.30	5.34	38.95
FY08	9.93	12.28	72.76	6.32	26.20	9.99	11.94	75.25	6.41	23.77	9.8	13.07	65.08	6.06	31.66
FY09	6.66	7.18	63.43	5.91	36.52	6.83	7.09	65.36	6.33	34.33	6.24	7.43	58.11	4.8	39.38

Notes: i) Base year: 1995-96 = 100. G = General inflation, F= Food inflation, FC= Contribution of Food, NF = Non-food inflation, C = Contribution of NF; ii) Weight: National (General = 100, Food = 58.84, Non-food = 41.16); Rural (General = 100, Food = 62.96, Non-food = 37.04); Urban (General = 100, Food = 48.80, Non-food = 51.20); iii) Contribution of food/non-food is calculated as the share (weight) of food/non-food in general CPI multiplied by food/non-food inflation divided by general inflation rate.
Source: Monthly Economic Trends (Various Issues), Bangladesh Bank.

Table III. Descriptions and summery statistics of the model variables

Var.	Description (expected sign)	Unit	Obs.	Mean	Std. Dev.	Min.	Max.	Var.	Skew.	Kurt.
CPI	Consumer price index (n.a)	Index	30	9.32	5.16	1.94	21.53	26.60	0.61	2.36
RP	Domestic rice production (-)	'000 MT	30	19680	5239.34	12539	31317	2.75e7	0.60	2.14
PP	Domestic petroleum price (+)	USD/Barrel	30	28.53	18.32	12.87	90.39	335.45	1.88	6.08
BM	Broad money (M2) supply (+)	Crore BDT	30	69776.97	77866.83	3244	296500	6.06e9	1.48	4.31

Table IV. Monetary policy stances in Bangladesh

Period	Major issues
Jan-Jun 2009	***Accommodative;***[24] priority is given to providing credit support for creation and expansion of output capacities rather than for stoking of demand pressures.
Jul-Dec 2009	***Accommodative;*** greater directional emphasis on the credit needs of sectors like agriculture and SME typically under-served by the market
Jan-Jun 2010	***Accommodative;*** special attention to programmes pursuing fuller financial inclusion of the economic activity segments (including agriculture and SMEs) and population segments under-served by the markets, towards fostering inclusiveness of economic growth.
Jul-Dec 2010	***Accommodative;*** special attention to financial inclusion of agriculture, SMEs, renewable
Jan-Jun 2011	***Accommodative;*** in support of the government's goals of faster inclusive economic growth and poverty reduction besides maintaining monetary and price stability.
Jul-Dec 2011	***Restraining;*** in the context of unfolding near term development and ensuring adequate credit flows.

Source: CPD (2011b).

[24] Though, high growth and low inflation allowed monetary policy to be accommodative (Jongwanich and Park, 2009), but Bangladesh Bank continues this monetary policy stance in absence of these criteria.