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Some Facts and Determinants of CPI Inflation in Bangladesh: Evidence from Post-Floating Exchange Rate Regime

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Abstract

This paper examines the determinants of the CPI inflation in Bangladesh particularly the impact of the exchange rate through import prices and some macroeconomic variables on the price level during the post floating exchange rate regime. An analysis of the CPI basket shows that the contribution of exchange rate depreciation through import prices is 0.14 percentage points out of 10.63 percent CPI inflation recorded in December 2011 with 13.7 percent depreciation of Taka against USD and 9.65 percent share of all imported commodities to the CPI basket. The contribution of exchange rate depreciation increases as high as to 0.49 percentage points when 100% import weight is considered.

The impact of domestic macroeconomic variables on CPI inflation is estimated by co-integration and vector error correction model (VECM) using monthly data during 2003:06-2011:09. The empirical results show that the price elasticity of the exchange rate is 0.23 implying that one percent increase in the exchange rate (i.e., depreciation) would increase the price level by 0.23 percent. The price elasticity with respect to broad money supply (M2), appear to be 0.32, while the spread between the lending rate and deposits rate has significant and negative influence on the price level in Bangladesh. The Vector Error Correction model shows that the speed of adjustment to the equilibrium is 0.41 which is significant and negative implying that if there is disequilibrium from the long run position of price level in the previous months, M2, real GDP, exchange rate and interest rate spread and inflation expectations adjust rapidly to reach to the long run equilibrium of the price level.

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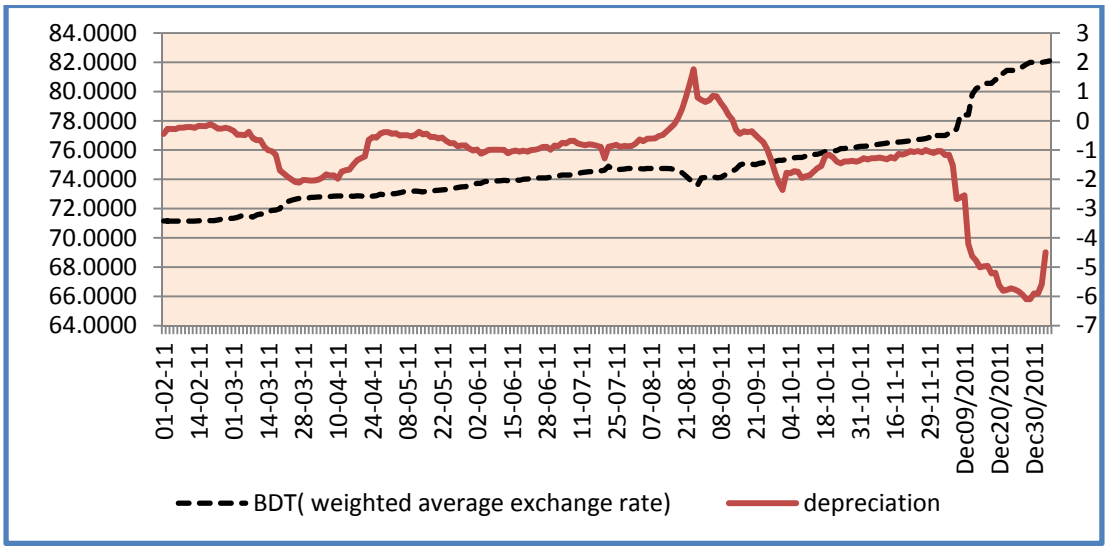
Some Facts and Determinants of CPI Inflation in Bangladesh: Evidence from Post-Floating Exchange Rate Regime

I.1 Background

The intention of this paper is to examine the determinants of CPI inflation particularly the impact of the nominal exchange rate depreciation on the price level of Bangladesh for the sample period from 2003:06 to 2011:09. It has been observed that Bangladesh Taka started to depreciate at relatively faster rate against US$ from the end of second quarter of FY11 raising the concern over the effective management of monetary and exchange rate policies in controlling the price level of Bangladesh. Since January 01, 2011 to December 31, 2011, the exchange value of Taka against the US$ depreciated about 14 percent. The decline in the value of the Taka is likely to have higher inflationary consequences by raising the cost of imports feeding into the higher consumer prices for an import dependent country like Bangladesh.

Chart: I.1.1 Trends of the daily exchange rate (Tk. /$) and depreciation/appreciation



Source: Economic Trends, Bangladesh Bank.

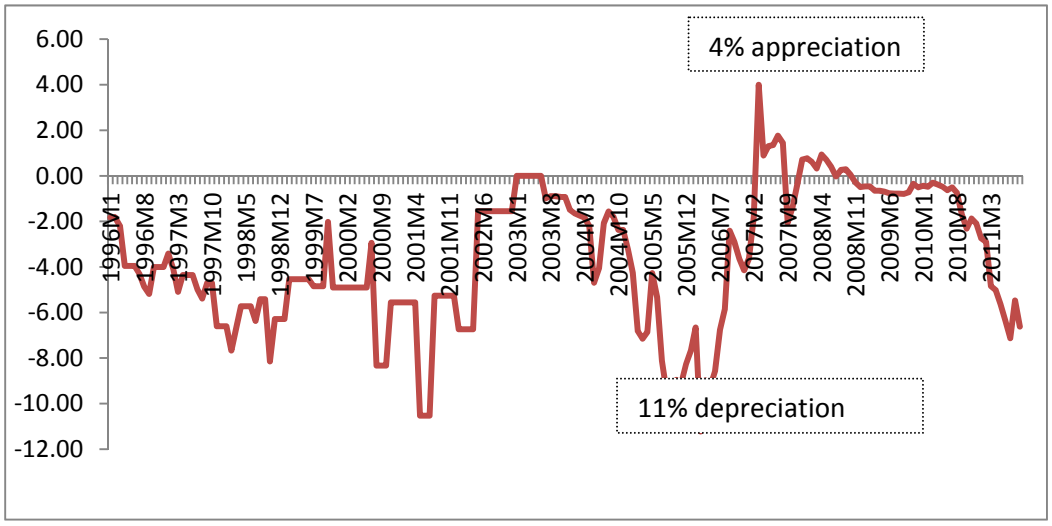
I.2 Bangladesh entered into the floating exchange rate regime at the end of May, 2003 with the objectives of increasing effectiveness of monetary policy and to avoid any crisis associated with the fixed exchange rate regime. Prior to the floatation of the exchange Bangladeshi Taka was pegged to a basket of hard currencies and the exchange rate was adjusted occasionally depending on the trend of appreciation/depreciation of the real effective exchange rate (REER) of Taka, originating from a relatively high rate of inflation in Bangladesh vis-à-vis its trading partners. The switch of the exchange rate regime from pegged to the floating regime occurred in an environment of balanced economic fundamentals. Taka remained relatively stable after the float. Thus, despite some concern, the transition turned out to be smooth. The monetary authority has gained greater control over monetary instruments. Therefore, the plan of the study is as follows: While Section-I contains the background of the study with some evidences

of exchange rate pass-through in Bangladesh, Section-II discusses the literature on the exchange rate pass-through and possible other sources of inflation in Bangladesh. Model specification, variables, methodology and empirical results have been discussed in Section-III followed by the conclusions and recommendations in Section-IV.

I.3 Bangladesh is practicing monetary targeting since her independence in 1971 under the different exchange rate regimes. Prior to 1990, policy was based on direct control of various instruments, such as volume and direction of credits and the interest rates. Since the adoption of Financial Sector Reform Program in 1990, the policy stance has shifted toward indirect control. The growth of broad money (M2) was maintained at levels consistent with the real output growth and stable & moderate inflation rate using indirect monetary instruments. Money supply (M2) grew a lower yearly average growth of 12.90 percent in the 1990s. The yearly average inflation rate declined to 5.69 percent during the same period. However, M2 grew at a comparatively higher rate of 15.11 percent during 2001-2003, while GDP grew by 5.01 percent during the same period compared to 4.81 percent in the 1990s keeping average inflation relatively lower to a rate at 3.04 percent.

I.4 A trend of depreciation of Taka against US$ exchange has observed since July 2003, that peaked of about 11 percent in mid-2006 following episodes of global commodity price hikes in FY06 (Chart-I.1.2) followed by the 4 percent appreciated in FY07. However, overall Taka/US$ has maintained reasonably stable path since the floatation of the exchange rate (Chart-I.1.2).

Chart I.1.2: Trends of the Exchange Rate Depreciation/Appreciation since 1996:08 to 2011:09



Source: Economic Trends, Bangladesh Bank

I.5 Given the recent sharp fall in the par value of Taka, it is worthwhile to examine how much of a risk on inflation is posed by such an exchange rate depreciation of the domestic currency? The answer of this question however depends on how much of the falling value of the currency is passed through by the import prices on overall consumer prices. As argued by Mishkin (2008) possibility of certain specific shocks and the responses to them may be associated with considerably higher pass-through than indicated by the average relationships exchange rate pass-through to consumer price inflation, the current study considers a wider platform to investigate the possible impact of exchange rate depreciation on CPI inflation.

II Literature on Pass-Through of Import Prices on the Price Level

II.1 Most of the literature examining the effects of exchange rates on prices focused on import prices at either an aggregate (index), sectoral, or industry level. For example, Marazzi and Sheets (2007) found that the average cumulative response of the U.S. import price index to an exchange rate shock declined from around 0.5 to around 0.2 in 1970-80s. In interpreting the evidence, Mishkin (2008), mentioned that it is useful to begin with the observation that low pass-through to import prices is not a prerequisite for low pass-through to consumer prices. Even if import prices react strongly to exchange rates, a monetary policy stance that is sufficiently reactive to inflation can insulate consumer price inflation from the effects of a shock that causes the exchange rate to depreciate. For example, although the United Kingdom experienced a very large increase in import prices of about 13 percent in the European exchange rate mechanism (ERM) crisis in 1992-93, which was nearly as large as the depreciation of its multilateral nominal exchange rate consumer price inflation, remained subdued.

II.2 We will now focus on the contribution of Taka/Dollar exchange rate on inflation based on the overall weights of the imported commodities and the magnitudes of depreciation. Table-II.1.1 contains calculated weights of the imported commodities in the CPI basket. The imports of rice and wheat are taken from FPMU by calculating a 6 year average trend. The data show that during the last six years the weights of imported rice and wheat are 3.25% and 76.23% respectively out of total domestic consumption (Table-II.1.1). For the other imported commodities the share of import is calculated on the basis local production trend.

Table-II.1.1: Weights of the imported commodities in the CPI Basket in Bangladesh

	Weights	Import*weights	Imports (%)
Rice	23.79	1.1895	5%
Wheat(Atta) best quality	1.94	1.55	80%
Musurdal- husked-best quality	0.78	0.78	100%
Ruhu-medium size(1-2) kg.weight	0.97	0.49	50%
Watermelon (Tarmuse)b/q.2-3 kg.	0.05	0.01	25%
Onion-best quality	0.67	0.34	50%
Ginger-best quality	0.03	0.02	50%
Garlic-best quality	0.20	0.10	50%
Turmeric-best quality	0.59	0.30	50%
Cumin seed-best quality	0.08	0.08	100%
Cardamon(Elachi)-small size	0.06	0.06	100%
Cinamon(Daruchini)	0.05	0.05	100%
Soyabean oil-white-best quality	0.77	0.77	100%
Dalda-Pakvan	0.07	0.07	100%
Powder milk (400 gr.Packet)	0.39	0.39	100%
Sugar-best quality-open market	0.41	0.33	80%
Kerosene-white	2.89	2.89	100%
Wrist watch	0.06	0.06	100%
Televison, phellips 20" size black & white	0.19	0.19	100%
Total weights of imported goods in the CPI Basket		9.65	
Contribution of Depreciation on Inflation:			
Inflation(10.63)*Import weights(9.65%)*Depreciation(13.7%) = 0.14			
Inflation p-t-p (December, 2011)-(Contribution of imports*Depreciation): 10.63-0.14 =10.49			

Source: BBS.

The above Table (II.1.2) shows that in the consumption basket the contributions of the imported commodities are 9.65% out of total 33.99% weights. The contribution of imports weights due to 13.7% depreciation during January, 2011 to December, 2011 with the 10.63% point to point inflation in December, 2011 would be 0.14. This implies that the inflation would have been down to 10.49% in December 2011 should there no depreciation of the exchange rate.

Table-II.1.3: Trends of Rice and Wheat production and Imports in Bangladesh

(Million Metric Tons)

	2010-11	2009-10	2008-09	2007-08	2006-07	2005-06	Average
Aus	2.13	1.709	1.89	0.151	1.51	1.75	**1.52**
Aman	12.79	12.207	11.61	9.66	10.84	10.81	**11.32**
Borro	18.6	18.341	17.81	17.76	14.96	13.98	**16.91**
Total domestic production of Rice	**33.52**	**32.257**	**31.31**	**27.571**	**27.31**	**26.54**	**29.75**
Total domestic production of Wheat	**0.97**	**0.90**	**0.85**	**0.84**	**0.74**	**0.74**	**0.84**
Total food grain production	**34.49**	**33.157**	**32.16**	**28.411**	**28.05**	**27.28**	**30.59**
Total Imports of Rice	1.6	0.51	0.6	2.06	0.72	0.532	**1.00**
Total Imports of Wheat	3.79	2.89	3.03	3.46	1.7	2.03	**2.82**
Total Domestic Consumption of Rice	35.12	32.767	31.91	29.631	28.03	27.072	**30.76**
Total Domestic Consumption of Wheat	**4.76**	**3.79**	**3.88**	**4.3**	**2.44**	**2.77**	**3.66**
% share of Imports of Rice out of Total Consumption	4.56	1.56	1.88	6.95	2.57	1.97	**3.25**
% share of Imports of Wheat out of Total Consumption	79.62	76.25	78.09	80.47	69.67	73.29	**76.23**

Source: Food Planning and Monitoring Unit, Bangladesh Ministry of Food and Disaster Management

A worst case scenario has been visualized in Table-II.1.2 assuming 100% imports of rice and wheat and other commodities. The weights would be as high as 33.94% and the contribution with the 13.7 percent depreciation and 10.63% inflation would be 0.49. However, one should take this result carefully since there are some other commodities that might capture the indirect impact of price increase of certain commodities. For example, during FY11 and FY12 four times hike in the fuel prices may transmit in to the CPI basket through price increase of diesel, transportation fair, and energy prices which may cause the total effect larger than estimated by imports weights. Table I.2.4 shows a simulated outcome with the various ranges of exchange rate depreciations and its impact on the inflation as compared with the worst case scenario.

Table I.2.3: Weights of the imported commodities in the CPI Basket in Bangladesh

	Weights	Import*weights	Imports (%)
Rice	23.79	23.79	100%
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Ruhu-medium size(1-2) kg.weight	0.97	0.97	100%
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Sugar-best quality-open market	0.41	0.41	100%
Kerosene-white	2.89	2.89	100%
Wrist watch	0.06	0.06	100%
Televison, phellips 20" size black & white	0.19	0.19	100%
Total weights of imported goods in the CPI Basket	33.99	33.99	

Table- I.2.4: Estimated contribution to inflation due to various magnitude of exchange rate depreciation through Import Prices

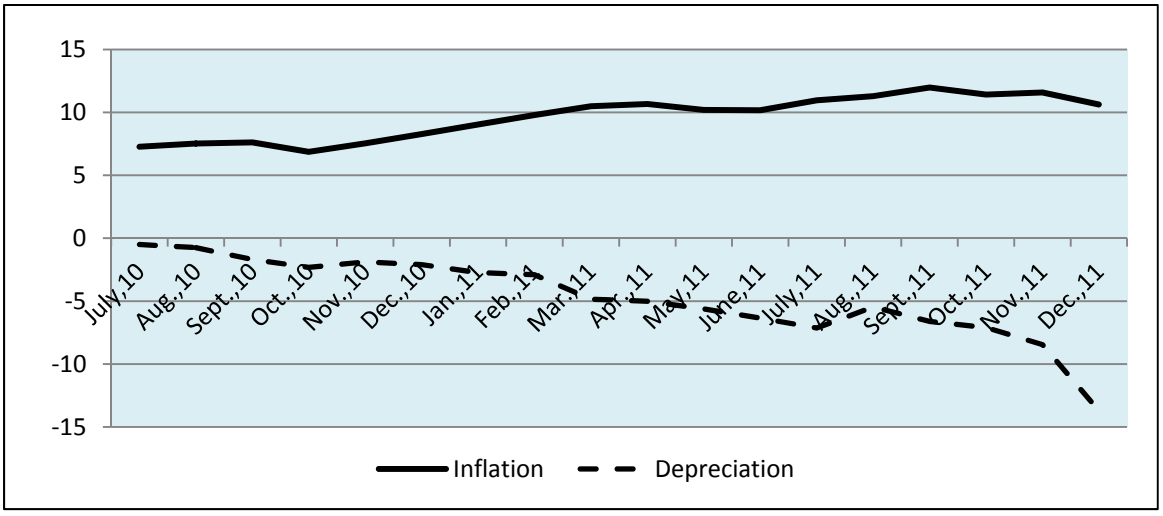
Calculated import weights(%) to CPI basket	Inflation Rate(ptp) December 2011	Rate (%) of Depreciation	Estimated contribution to Inflation due to various magnitude of exchange rate depreciation (Inf(10.63)*Imports	Estimated Inflation without and with exchange rate depreciation
33.99	10.63	0	0.00	10.63
33.99	10.63	1	0.04	10.59
33.99	10.63	2	0.07	10.56
33.99	10.63	3	0.11	10.52
33.99	10.63	4	0.14	10.49
33.99	10.63	5.47	0.20	10.43
33.99	10.63	6.62	0.24	10.39
33.99	10.63	7.09	0.26	10.37
33.99	10.63	8.46	0.31	10.32
33.99	10.63	9	0.33	10.30
33.99	10.63	10	0.36	10.27
33.99	10.63	11	0.40	10.23
33.99	10.63	12	0.43	10.20
33.99	10.63	13.7	0.49	10.14
33.99	10.63	14	0.51	10.12
33.99	10.63	15.09	0.55	10.08
33.99	10.63	16	0.58	10.05
33.99	10.63	17	0.61	10.02
33.99	10.63	18	0.65	9.98
33.99	10.63	19	0.69	9.94
33.99	10.63	20	0.72	9.91

III. Evidence of Exchange Rate Pass-Through on Domestic Prices

III.1 Traditional monetary theory suggests that excessive money creation is a common source of instability in both the exchange rate and price level. In the presence of large monetary shocks, price inflation and exchange rate depreciation should, therefore, be closely linked.

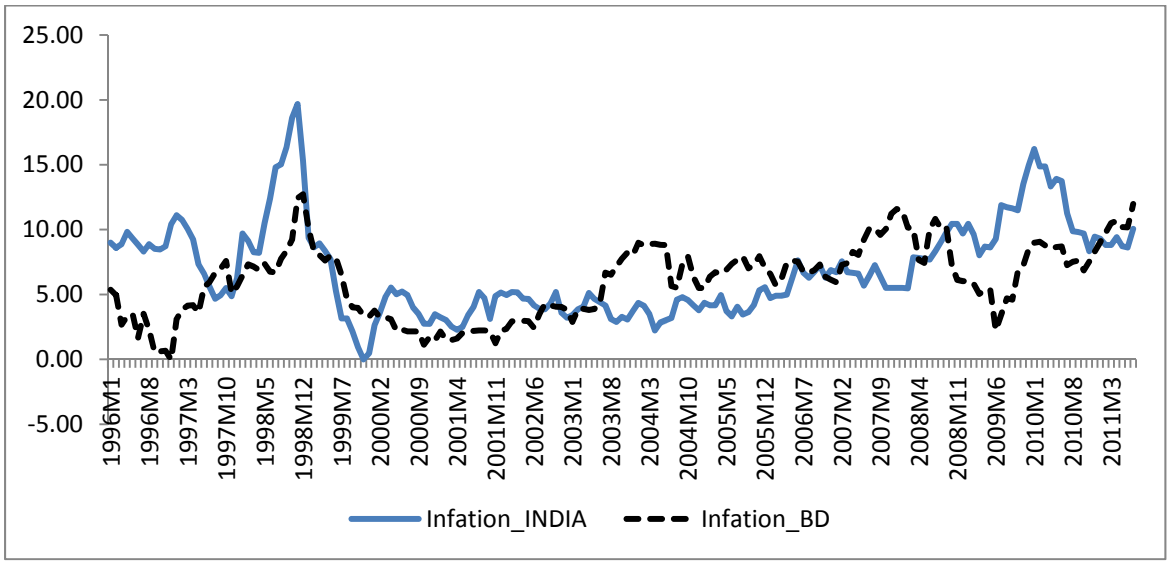
According to Mishkin (2008) the correlation between consumer price inflation and the rate of nominal exchange rate depreciation can indeed be high in an unstable monetary environment in which nominal shocks fuel both high inflation and exchange rate depreciation. But a salient feature of the data is that this correlation has been very low over the past two decades for a broad group of countries that have pursued stable and predictable monetary policies. Moreover, the evidence suggests that even countries in which inflation and exchange rate depreciation appear to have been fairly closely linked historically have experienced a sizeable decline in pass-through following the adoption of improved monetary policies.

Chart: III.1.1 Trends of Exchange Rate App./Dep. and CPI Inflation in Bangladesh



The above chart III.1.1 shows the trends of exchange rate movements and inflation in Bangladesh during July, 2010 to December, 2011. From the above chart-III.1.1, it is evident that the higher the value of inflation the lower the value of the exchange rate with some exceptions (although inflation decelerated to 10.63 percent in December, 2011 from 11.58 percent in November 2011.

Chart-III.1.2: Trends of CPI Inflation in India and Bangladesh



The above Chart-III.3 shows that the trends of inflation in India and Bangladesh for the sample period from 1996:01 to 2011:03. From the above chart-III.3, it is evident that the accelerating and decelerating trend in the India's inflation is clearly captured in the domestic inflation through import prices because India is our one of the major trade partners.

Although identifying the causes of recent episode of the exchange rate depreciation in Bangladesh is not the intention, an analysis of some of the macroeconomic variables may be useful to identify the reasons that may cause exchange rate to depreciate. For example, higher government borrowings from the central bank resulting from lower external borrowing, fiscal and current account deficits may trigger the exchange rate to depreciate. In addition, according to Taylor (2000) higher inflation in the country may lead to higher exchange rate pass through because of its direction of causality between inflation and depreciation especially when inflation is high and also exchange rate is depreciating (Kenen and Pack, 1980:3). However, under a flexible exchange rate system, a persistent depreciation of the exchange rate is likely to raise inflation and it is equally likely that inflation would induce a depreciation of the exchange rate (Hossain, 2000). Hossain (2000) mentioned that in the literature there is a big debate over the difference between primary factors that generate inflation and secondary factors that propagate the inflationary process. One key question is whether devaluation should be considered primary sources of inflation? Most economists tend to believe that devaluation is at the most a secondary source of inflation. For example, "Agenor and Montiel (1996:305-306) have clarified the role of devaluation in the inflationary process by making a distinction between the immediate and the ultimate causes of inflation.

It can be stated as quoted from Hossain (2000) that, "If the fiscal deficit is financed through credit creation by the central bank, as is often the case in developing countries, the monetary expansion will lead to an increase in prices and progressive erosion of foreign reserves, which will eventually trigger

devaluation if the central bank has limited access to borrowing in international capital markets. A devaluation-inflation spiral may develop, in the absence of corrective measures aimed at reducing the deficit. Thus, while the proximate cause of inflation may appear to be exchange rate adjustment, the ultimate factor responsible for both inflation and exchange rate depreciation may stem from fiscal rigidities".

IV. Literature Review

Bangladesh switched from pegged exchange rate system to flexible exchange rate regime in May 2003. After that the volatility of the exchange rate is minimized through periodic intervention in the foreign exchange market by the central bank. The empirical evidences examining the relationship between inflation and the exchange rate depreciation or the pass through provides mixed results and varies country to country as well as in Bangladesh. For example, Hossain (2000) based on annual data from 1975-1996 on Bangladesh found that there is a positive impact of exchange rate depreciation on inflation in Bangladesh. The empirical results by using ordinary Least Square (OLS) method show that one percent depreciation of Taka/$ would result in 0.2 percent increase in inflation.

In contrary, Chowdhury and Siddique (2006) estimated the extent of exchange rate pass through on domestic inflation in Bangladesh based on McCarthy's (1999) approach of a recursive VAR model using data from July, 1997 to March, 2005. The Impulse Response Functions (IRF) and Variance Decompositions (VDCs) show that the exchange rate fluctuation does not have any significant effect on WPI or CPI in Bangladesh.

On the other hand, Mortaza (2006) attempts to analyse the sources of inflation in Bangladesh during FY90 to FY06.Using quarterly data from July-September, 1989 to April-June, 2006, the author empirically explores the relationship between inflation and its sources under the unrestricted vector autoregressions (VARs) system. The empirical evidence demonstrates that money supply and exchange rates have a significant positive influence on inflation. In addition, the paper identifies a significant negative relationship between deposit rate of interest and inflation.

Younus and Chowdhury (2006) assessed the experience of the exchange rate regimes gained by Bangladesh, and also evaluated the impact of the exchange rate regime on macroeconomic variables. An analysis of the macroeconomic variables under different exchange rate regimes shows that like other studies output growth in Bangladesh performed well in the intermediate and floating exchange rate regimes. Unlike other studies, inflation is lower in the intermediate regime despite higher money supply and exchange rate depreciation. There is also evidence that currency depreciation boosted exports growth in the floating regime, though not in the prior contexts.

Akhtaruzzaman (2005) employed Co-integration and Vector Error Correction Model (VECM) to identify the variables, which are believed to generate inflation in Bangladesh for the sample period of 1973:01 to 2002:02. Akhtaruzzaman's (2005) study supports that inflation is negatively related with real income, the level as well as the rate of depreciation of exchange rate, growth of money supply (m1),

deposit interest rate (DEPOINT); each has statistically significant role in explaining the inflationary process of Bangladesh.

Choudhri and Hakura (2001) tests a hypothesis suggested by Taylor (2000) that a low inflationary environment leads to a low exchange rate pass-through to domestic prices. A sample period from 1979-2000 for 71 countries is used to estimate new open economic macroeconomic models. They found a strong evidence of a positive and significant association between pass through and the average inflation rate across countries and periods.

Younus (2005) examine empirically the impact of monetary policy on exchange market pressure (EMP) of Bangladesh. Because Bangladesh is a small open economy and the U.S. and India are the major trading partners of Bangladesh. BDT/USD and BDT/INR nominal exchange rates are used to estimate separate EMP models. The percentage change in the consumer price index of the U.S. and India are used as the foreign inflation rates. Quarterly data from 1976:2 to 2003:1 are used to examine Girton and Roper's (1977) monetary model of EMP. Engle and Granger's (1987) two-step single-equation error correction model (ECM) and Impulse Response Functions (IRFs) and Variance Decompositions (VDCs) derived from a vector error correction model (VECM), are used to examine the model. The estimated coefficient of domestic credit derived from the ECM shows that domestic credit has a significant and negative impact on EMP. The IRFs and VDCs derived from the VECM also indicate that monetary policy, measured by domestic credit, has a significant and negative impact on EMP implying that the monetary authority in Bangladesh may reduce the exchange market pressure by either reducing foreign reserves or depreciating domestic currency.

V. Model Specification, Methodology and Empirical Results

This study employed the monetary model of Herberger (1963) for Chili by Hossain (1994) and Akhtaruzzaman (2005) for Bangladesh to see the impact of stock of money supply (M1, M2), real income, inflation expectations, the spread (difference between the lending rates and deposits rates), exchange rates and world food price index on inflation for the period from 2003:06 to 2011:09 in Bangladesh. It can be noted here that Akhtaruzzaman (2005) tested the monetary model along with the output gap model for the sample period from 1973:1 to 2002:2 i.e., pre-floating exchange rate regime. This paper uses the data of post-floating exchange rate era (2003:06 to 2012.09) to capture the impact of exchange changes on CPI inflation.

The model can be specified as follows:

$$Log\ (CPI)t = f\ (Log\ M2_t\ \ Log\ Y_t,\ \Delta Log\ CPI_{t-1},\ Log\ EXR_t,\ Log\ WFPI_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The above equation states that any increase in log of nominal money stock (M2), log of real GDP, expected rate of inflation, the log of the exchange rate, and log of world food price index lead to an increase in prices in period (t). Again, an increase in the spread that is, a rise in the difference of the nominal interest rate and cost of borrowing are used to capture the impact of interest rates on the

price level, while the real GDP (Y_t) variable is included in the model to see the impact of real income on the price level which is expected to a decline in prices. The co-integration and vector error correction method (VECM) are used in estimating the econometric models. All the variables used are in log forms except for the spread. The dependent variable is consumer price index (CPI). All the statistical figures except GDP are taken from the IMF data file 'International Financial Statistics (IFS).

Model variables:

LCPI= log of Consumer Price Index in Bangladesh (Base: 2005=100)
LM2= log of Money Supply (M2) (Taka in crore)
LEXR=Log of nominal exchange rate (Tk/US$)
LWFPI= Log of World food Price Index (Base: 2005=100)
Logy= Log of Real GDP (Tk. in crore)
Spread=the difference between the lending rate and the deposits rate

Stationary of the Time Series Data

The empirical analysis involves a number of steps. The finding that many macro time series may contain a unit root has spurred the development of the theory of non-stationary time series analysis. Non-stationarity in Time Series (TS) generally arises due to the presence of trends in the data which is stochastic in nature (random walk process) and it confirms that the data has a unit root process. Any regression results with non-stationary TS provide spurious relationships between variables and therefore, provide misleading implications of the relationship. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be co-integrated. The stationary linear combination is called the co-integrating equation and may be interpreted as a long-run equilibrium relationship among the variables. The purpose of the co-integration test is to determine whether a group of non-stationary series is co-integrated or not. If a series of non-stationary variables are co-integrated they form the basis for Vector Error Correction Model (VEC).

Unit Root Test Results

To see whether the variables included in the model are non-stationary a series of Unit Root tests are performed with time trend and intercept and spread without trend and intercept.

Table V.1: ADF and PP Tests for Unit Root

Variables	ADF	PP	Variables	ADF	PP
LCPI	0.15	-2.26	ΔLCPI	-4.18***	-4.26***
LEXR	-0.64	-0.58	ΔLEXR	-6.19***	-6.15***
LM2	-2.14	-2.47	ΔM2	-4.99***	-10.37***
Logy	-2.05	-1.77	ΔLY	-12.05***	-9.00***
L WFPI	-2.17	-1.74	Δ lWFPI	-3.95***	-3.96***
LR	-2.18	-2.21			
DR	-2.32	-1.79			
Spread	2.86	-0.04			

*** implies significant at the 1 percent level.

The estimated results using Augmented Dickey-Fuller (1979) and Phillips-Perron (1998) tests show that the null hypothesis, $H_{0,}$ (has a unit root) cannot be rejected for all the variables have been performed. According to the ADF and PP tests, Lcpi, Lexr, Lm2, Logy, lr, dr, spread, and Lwfpi have unit root in levels, while they are stationary in the first differences. Therefore, these variables fit the basis to test for co-integration. The idea of co-integration is to determine if the stochastic trends in all the variables that contain unit roots have long-run co-integrating relationship between them. Johansen co-integration tests are performed among the non-stationary series allowing linear deterministic trend in the data.

Estimation Results of Co-integration

In our empirical estimation we have applied the Johansen (1991 and 1995) and Johansen and Juselius (1990, 992) multivariate co-integrating methodology which jointly determine empirically the number of *r* (maximum *k-1*) co-integrating vectors from a vector of *k* endogenous variables in the model along with coefficients of the variables and the adjustment parameters to a 8th order VAR (with maximum lags eight) to test for co-integration. In our deterministic trend component specification in co-integrating equations we choose case-3 (linear trend assumption) that is, we assumed that the level series of endogenous variables have linear deterministic trends but the co-integrating equations have only intercepts (constants). The results are presented in Tables- III.2 to III.4.

Table V.2: Co-integration Analysis of Price Level *CPIt* with real GDP, inflation Expectations, exchange rate, and Broad Money Supply(M2)

Eigen values	**0.67**	**0.64**	**0.49**	**0.38**	**0.23**
Hypotheses	**r = 0**	**r ≤ 1**	**r ≤ 2**	**r ≤3**	**r ≤4**
Trace Statistics	**295.35***	**206.37***	**122.60***	**67.43***	**28.44**
95% Critical Values	**124.24**	**94.15**	**68.52**	**47.21**	**29.68**

Trace test indicates 4 co integrating equation(s) at both 5% and 1% levels

Maximum Eigen-Statistic	**88.98***	**83.77***	**38.99***	**5.97**		
		55.17*	**1.52***			
95% Critical Values	**45.28**	**39.37**	**33.46**	**27.07**	**20.97**	**14.07**

Max-eigenvalue test indicates 4 co-integrating equation(s) at the 1% level

Table-V.3: Standardized Co-integrating Coefficients (or Eigenvectors) 1 Cointegrating Equation(s)

Log CPI	*log M2*	*log gdp*	*inf_lag*	*Log EXR*	*spread*	*Log WFPI*	*c*
1.00	0.32	.24	-0.001	0.23	0.03	0.06	1.88
	(6.18)	(1.08)	(-0.001)	(2.23)	(2.75)	(1.60)	

(t-value in parentheses)

According to the pure monetary model of inflation there may exists a co-integrating (or long-run) relationship between prices, real money holdings, nominal exchange rate, price expectations, the level of real income and the opportunity cost of alternative asset holdings. In the estimated co-integrating relationships, the critical values of the maximal eigen-value statistics and trace statistics easily (strongly) reject the null hypothesis of no (zero) co-integrating vector in favor of a four co-integrating vector in each case at the 1% and also at 5 % levels. The existence of co-integrating relations implies that there were long run equilibrium relationships between price level and each of the variables in interest separately such as *logM2, logy, $\Delta logcpi_{t-1}$ logexr*, spread, logwfpi.

Several important remarks could be developed from the results of the normalized co-integrating relation for CPI.

- ✓ The elasticity between *M2, real GDP, inflation expectations ($\Delta logcpi_{t-1}$) exchange rate, spread and world food price index and the price level are* 0.32, 0.24, 0.00, 0.23 0.03 0.06 respectively.
- ✓ As opposite to the earlier study by Akhtaruzzaman (2005), this study finds strong and positive relation between M2 and the price level implying that in post-floating exchange rate regime, M2 is effective in influencing the price level in Bangladesh.

- ✓ Unlike previous study, this study does not find any significant and negative co-integrating relation with real GDP and the price level meaning that an increase in real GDP will not reduce the price level during the period from 2003:06 to 2011:09.
- ✓ The role of the log level of exchange rate in price inflation is important as seen from the coefficient values in co-integrating relation for inflation model.
- ✓ The spread between the lending rate and the deposits rate are found to be significant and negative implying that an increase in the spread helped to reduce the price level in Bangladesh.
- ✓ The log of world food price index did not have significant co-integrating relation with the price level. This is may be due to the exchange rate variable which captures the impact of foreign price variable.

Furthermore, the adjustment coefficients or feedback parameter values of different co-integrating variables gives an indication of whether the feedback parameter values were sufficiently strong to determine the variables of interest such as *logM2, logy, Δlogcpi$_{t-1}$ logexr*, spread, logwfpi in a endogenous fashion. From Tables-V.4, it can be seen that the dependent variable, the price level, is likely to be endogenously determined by its direct determinants. The implication of the high error correction values is that the fluctuations of the price level have been corrected by the appropriate adjustments of *logM2, logy, Δlogcpi$_{t-1}$ logexr*, spread, logwfpi which means that any adjustment policy through changing those variables on behalf of the central bank has important impact in inhibiting the price rise than the automatic correction of price itself by its past values.

Vector Error Correction (VEC) Models

A vector error correction (VEC) model is deployed to see the short run dynamics since the variable are integrated in order one I(1) and they are co-integrated. VEC is a restricted VAR representation. The co-integrating relationships reveal the factors that affect the long run level of demand for money. However, in the short run, deviations from these relations could occur as a result of shocks to any of the relevant endogenous variables. Thus, after testing for co-integration, a VECM is estimated conditional on co-integrating vectors specified as to regress the first (time) difference of each non-stationary endogenous variable at time-t with one period lag of the co-integrating equation/vector. In fact, when we impose number of co-integrating vectors as restrictions among the endogenous variables in the VAR, we move to VEC model whose general form is as follows:

$$\Delta \boldsymbol{x_{t=}} \boldsymbol{c_o} + \sum_{\boldsymbol{i=0}}^{\boldsymbol{p-1}} \boldsymbol{\gamma_i}\, \Delta \boldsymbol{x_{t-i}} + \boldsymbol{\delta_i ECT_{t-i}} + \boldsymbol{\omega_t}$$

In our case of inflation model the forms of VECs will be as follows:

Monetary Model: $\Delta cpi_t = c_0 + \sum_{i=0}^{p-1} \gamma 1_i \, \Delta m2_{t-i} + \sum_{i=0}^{p-1} \gamma 2_i \, \Delta(Inf\ lag) + \sum_{i=0}^{p-1} \gamma 3_i \, \Delta y_{t-i} + \sum_{i=0}^{p-1} \gamma 4_{t-i} \, \Delta exr_{t-i} + \sum_{i=0}^{p-1} \gamma 5_i \, \Delta wfpi_{t-i} + \sum_{i=0}^{p-1} \gamma 6_i \, \Delta r_{t-i} + \delta_i ECECp_{t-i} + \omega 1_t$

Where EC is the error correction term (generated from the co-integrating equation) capturing the disequilibrium or deviation that arise between the level of money supply and money demand in monetary model of inflation, The parameter δ is the speed of adjustment (in case of short-run imbalances) in bringing about the equilibrium that is, removing the deviation. The estimated results from VEC model we can draw several important conclusions; first, the error correction term is significant (at the 1-percent error level) as implied by the Granger representation theorem. The VEC is performed using eight period lags which are confirmed by the Log likelihood test, Akaike Information Criteria and also by Final Prediction Error. The error correction term found negative and significant for D (lcpi_bd) with a high speed of adjustment 0.41 implying very quick re-establishment long run equilibrium if there is any short-run disequilibrium occurs.

In the present context Granger representation theorem would imply that if there was any short-run deviation of money demand from money supply (long-run equilibrium in the money market), it would be automatically removed by appropriate change or adjustment of *m2t, gdp_t, Δcpi_t, exr_t, spread and wfpi*. In more general terms, the significance of EC terms implies that the error-correction mechanism works effectively to reduce the disequilibrium between the money supply and money demand (for monetary model) so that the price level will adjust to the new equilibrium. However, there are several features to be analyzed. Some of the adjustment coefficients of lagged values of explanatory variables were not significant (see Table-V.4 in the appendix). The value of adjusted R^2 is reasonably good (0.81).

Equilibrium Log of the price level

An attempt has been made to calculate the equilibrium relationship of the price level with its macroeconomic fundamental variables. Therefore, the estimated long-run relationship of the price level and macroeconomic variables is used to examine the equilibrium price level from VECM specifications. The long-run elasticity's have been applied to the actual values of the macroeconomic variables in each period and an equilibrium series of price level is calculated.

Chart: V.1: Actual and Equilibrium CPI

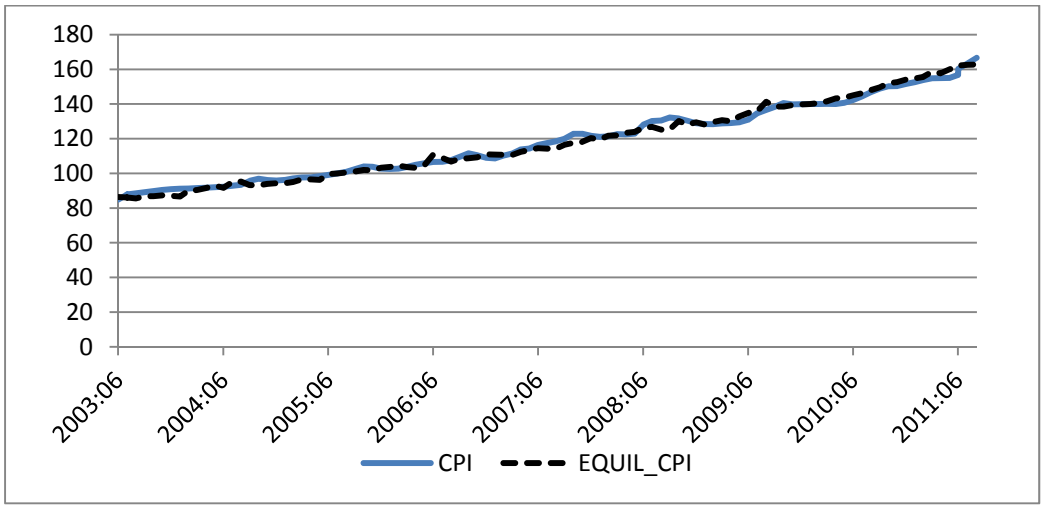


Figure III.1 show that there actual price level remains very close to the equilibrium price level supporting that the monetary model used in this study that rightly identifying the process through which inflation is generated in Bangladesh during the period from 2003:06 to 2011:09.

Vi. Conclusion and Policy Implications

The purpose of the present study was to demonstrate the actual inflationary process and to identify the determinants of CPI inflation in the economy of Bangladesh for the sample period from 2003:06 to 2011:10. The current study examines the factors affecting price levels particularly the exchange rate through import prices and domestic factors in Bangladesh. An analysis of the consumer price index basket show that the total weights of imported commodities is 9.65 percent and the contribution of the exchange rate depreciation is 0.14 passes through the import price. This number increased to as high as 0.49 when 100% import weights is considered.

The estimated results of the inflation model established the fact that the monetary factors like the broad money supply (M2), exchange rate, and the interest rate spread are the factors responsible the current inflationary process in Bangladesh. Error correction model has strongly represented the short run adjustment dynamics in the price adjustment process in Bangladesh with both the level and lagged coefficient values of different variables of interest with high statistical significance with high speed of adjustments. To conclude, a continuously rising money growth and exchange rate depreciation can provoke a price spiral in the long run. This should be taken seriously while setting the monetary targets. The findings of the empirical study using co-integration and vector error correction model can contribute effectively in the formulation of monetary policy.

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Appendix

Table- III.4: Vector Error Correction (VEC) Model: Short-run Adjustments for the Price movement, by real GDP, Broad money supply (M2), inflation expectation, deposit interest rate and exchange depreciation.

Co-integrating terms And Determinants of the Price Behavior	Δ CPI$_t$
ECT(CPI)$_{t-1}$	**-0.41(-1.96)**
$\Delta Lcpi_{t-1}$	**0.88(3.43)**
$\Delta Lcpi_{t-2}$	**-0.43(-1.03)**
$\Delta Lcpi_{t-3}$	**0.60(1.41)**
$\Delta Lcpi_{t-4}$	**0.42(0.83)**
***Δ m2*$_{t-1}$**	**-0.21(-1.05)**
***Δ m2*$_{t-2}$**	**-0.39(-1.74)**
***Δ m2*$_{t-4}$**	**-0.25(-0.95)**
***Δ m2*$_{t-5}$**	**-0.56(-2.14)**
***Δy*$_{t-1}$**	**-1.28(-0.74)**
***Δy*$_{t-2}$**	**-1.03(-0.60)**
***Δy*$_{t-3}$**	**-1.08(-0.62)**
***Δy*$_{t-4}$**	**-2.44(-1.34)**
***Δexr*$_{t-1}$**	**-0.31(-2.08)**
***Δexr*$_{t-3}$**	**-0.15(-1.04)**
***Δexr*$_{t-6}$**	**-0.09(-0.62)**
***Δexr*$_{t-8}$**	**-0.15(-0.98)**
***Δspread*$_{t-1}$**	***0.02(1.95)***
***Δspread*$_{t-2}$**	***0.01(1.70)***
***Δspread*$_{t-3}$**	***0.02(2.06)***
***Δspread*$_{t-4}$**	***0.01(1.25)***
***Δwfpi*$_{t-1}$**	**-0.08(-1.41)**
***Δwfpi*$_{t-2}$**	**-0.08(-1.47)**
Δ wfpi$_{t-5}$	**0.06(1.86)**
Constant	**0.05(1.52)**
R^2	0.81
S.E	0.01
F-Statistics	1.67