
Determinants of inflation in Bangladesh: An econometric investigation

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To cite this article:

Samim Uddin, Md. Niaz Murshed Chowdhury, Dr. Mohammad Abul Hossain. Determinants of Inflation in Bangladesh: An Econometric Investigation. *Journal of World Economic Research*. Vol. 3, No. 6, 2014, pp. 83-94. doi: 10.11648/j.jwer.20140306.13

Abstract: Both the increase and the decrease of inflation rate (General Price level) are like a two side sharpened razor in an economy like Bangladesh. They both are harmful for an economy. Therefore, it has been attempted here to know about some experimented determinants of inflation. Moreover, in this respect a well-known econometric technique, namely, Autoregressive Distributed Lagged (ARDL) Model has been applied. By employing data series for 1972 to 2012, it has been indicated that the gross domestic product (GDP_t), money supply ($M2_t$), and interest rate (IR_t) of current year of Bangladesh as well as previous year's real exchange rate (RER_{t-1}) and interest rate (IR_{t-1}) have contributed to increase inflation in Bangladesh. It has also been noticed that current year's real exchange rate (RER_t) in Dollar and previous year's money supply ($M2_t$) have contributed to decrease the inflation rate. In our study, we emphasized on the significance of variables and availability of data because of which some important determinants like unemployment rate (U_t), remittance (REM_t) and oil price (PP_t) have been ignored in main model.

Keywords: ARDL Model, Diagnostic Test, Inflation Rate, Money Supply, Interest Rate, Real Exchange Rate

1. Introduction

Bangladesh, officially The People's Republic of Bangladesh, is a country in South Asia. It is bordered by India on all sides except for a small border with Myanmar to the far southeast and by the Bay of Bengal to the south. Different types of natural disasters have visited Bangladesh fluently. By some man created disasters like environment pollution, unemployment, lack of effective investment, inauspicious position of foreign trade and gradual increase of food and non-food goods and service prices people are awkward with their life. Inflation has materialized as a global phenomenon in recent months largely reflecting the impact of higher food and fuel prices and strapping demand conditions especially in the emerging economies. In line with global trends, Bangladesh also experienced rising inflation with the 12-month average CPI inflation touching 10.96 percent in February 2012 (Bangladesh bank, 2012). The present cycle of rising inflation is the longest in the history of Bangladesh persisting for seven consecutive years, which in earlier episodes, usually showed fluctuating movements with

the rising trend continuing for 2/3 years.

The economy of Bangladesh has been suffering from a double-digit inflation. A shortage of oil production or energy crisis world-wide, increase in energy prices and cost-of production in combination with a demand-pull inflation from expansionary economic policies have caused persistent inflation. Altogether, these have created a supply-side problem by decreasing the productivity. The situation of Bangladesh has been aggravated due to political problems and efforts for minimizing corruption and a lack of confidence in business and manufacturing. It is hard to assume that we can ever get back to the single digit inflation. It is almost clear that we have to live with this double-digit inflation. We must find out the avenue how to increase output and income, aggregate production and supply of goods and services in an effort to fight the inflation. The natural rate of inflation from four to five per cent is accepted in almost any developing country. Nevertheless, a double-digit inflation of more than ten percent must have some reasons. Consumers are worried about higher or increasing prices of their consumer goods as their real income, purchasing power and

their standard of living is going down. Producers, manufactures, businessmen and traders are overly concerned about increasing prices of raw materials, energies including electricity, gas and oil and the higher cost of production.

High rates of inflation distort economic performance, making it mandatory to identify the causing factors. Several internal and external factors, such as the printing of money by the government, a rise in production and labor costs, high lending rates, a drop in the exchange rate, increased taxes or wars, can cause inflation. This study aims at ascertaining the determinants of inflation of Bangladesh by applying the Autoregressive Distributive Lagged Model (ARDL).

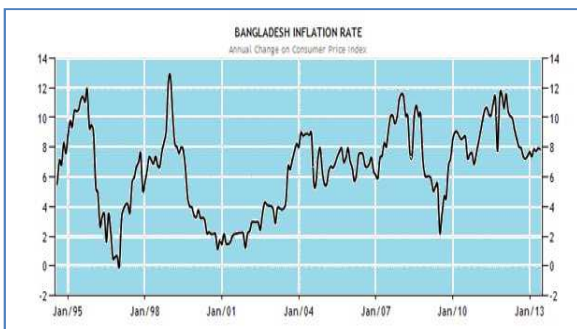


Figure 1.1. Fluctuation of Inflation Rate of Bangladesh (Jan '95-Jan '13)
Data Source: Bangladesh Bureau of Statistics.

The inflation rate in Bangladesh was recorded at 7.86 percent in May of 2013. The Bangladesh Bureau of Statistics reports the inflation rates in Bangladesh. Historically, from 1994 till 2013, Bangladesh's inflation rate averaged 6.60 Percent reaching an all time high of 12.71 Percent in December of 1998 and a record low of -0.02 Percent in December of 1996. In Bangladesh, the inflation rate measures a broad rise or fall in prices that consumers pay for a standard basket of goods.

The market intermediaries are the last agents to charge higher prices. Recently most of our economists think that devaluation or depreciation of the exchange rate of Taka is another cause of inflation, with whom the Governor of Bangladesh Bank (BB) disagreed. It matters little how the devaluation is related to inflation rate. We are in an economic stage of recession with lower output and income, higher unemployment and an unacceptably high instability in prices and inflation. We simply cannot afford to have a contractionary monetary policy to increase the exchange rate or value of Taka. On the other hand, contractionary monetary policy will further lower the output and income, increase unemployment and lower purchasing power and further aggravate the situation, and may not be able to decrease the cost-push inflation. Since independence, Bangladesh has been under a persistent inflationary pressure caused mainly by excess money supply as (Hossain, 2002). The popular judgment about the costs of inflation is that inflation makes everyone worse off by trading off the purchasing power of incomes, eroding living standards and adding, in many ways, to life's uncertainties (Lipsey *et al.* 1982). Broadly speaking, the primary effects of inflation are the redistribution of

income and wealth associated with unanticipated inflation, which is likely to affect economic activities and resource allocation of the country (Taslim, 1980).

Different schools of thought provide different views on what actually causes inflation. However, there is a general agreement amongst economists that economic inflation may be caused by either an increase in the money supply or a decrease in the quantity of goods being supplied. The proponents of the Demand Pull theory attribute a rise in prices to an increase in demand in excess of the supplies available. An increase in the quantity of money in circulation relative to the ability of the economy to supply leads to increased demand-fuelling prices. The case is of too much money chasing too few goods. An increase in demand could also be a result of declining interest rates, a cut in tax rates or increased consumer confidence. The Cost Push theory, on the other hand, states that inflation occurs when the cost of producing rises and the increase is passed on to the consumers. The cost of production can rise because of rising labor costs or when the producing firm is a monopoly or oligopoly and raises prices; cost of imported raw material rises due to exchange rate changes, and external factors, such as natural calamities or an increase in the economic power of a certain country. An increase in indirect taxes can also lead to increased production costs. A classic example of cost-push or supply-shock inflation is the oil crisis that occurred in the 1970s, after the OPEC raised oil prices. Now a days due to oil price being increased by importers of petroleum and reducing subsidy on imported oil Bangladesh economy experienced double-digit inflation in previous few years. Since oil is used in every industry and increasing demand of oil in Quick Rental Power plant of Bangladesh accelerate the oil price in domestic market, a sharp rise in the price of oil leads to an increase in the prices of all commodities.

The main purpose of the study is to identify the causes of inflation of developing countries like Bangladesh. Like other monetary authorities of developing countries, the central bank of Bangladesh and Bangladesh govt. are anxious with the policy types that may control the hyperinflation¹. As a result, the determinants of inflation play a vital rule to policy makers. A list of examined determinants may make easy to control inflation.

More specifically, the study hubs of the following objective

- To have more clear knowledge about the techniques, rules and standards of measurement of inflation;
- To assess out the current situation of Inflation in Bangladesh;
- To compare the inflation fluctuation and its impact on economy periodically;
- To compare the inflation fluctuation among neighbor countries;

¹ A very rapidly accelerating inflation is also known as runaway inflation or galloping inflation. This usually leads to the breakdown of the country's monetary system as the existing currency may have to be withdrawn and a new one introduced.

- To explore the implication of forecasting techniques in inflation of Bangladesh;
- To detect the causes relevant to inflation and fluctuation;

2. Literature Review

Numerous studies attempted to estimate short run and long run relationships between inflation rate and its determinants in different countries applying different theoretical and methodological constructs. In this section, some of these studies are summarized in terms of their methodologies and findings in the basis of publishing year. There have been very few studies on forecasting inflation in Bangladesh and other developing countries using time series techniques. 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 trends in Bangladesh. Thus, factors related to short-run and long-run inflation elasticities have not been adequately explored.

Mortaza and Rahman (2008) dissected the relationship between import and domestic prices in Bangladesh during 2000-2008. Using monthly data, they investigated the relationship between domestic supplies, pass through elasticity, and alleged that commodities with higher share of domestic supply face a lower pass-through elasticity of import prices on domestic prices. The results suggest that it is important for policies in Bangladesh to correctly align the exchange rate and trade related policies in the short run to domestic realities coupled with the long run policy of increasing domestic production as the most effective strategy to ensure domestic price stability. Ahmed and Mortaza (2005) attempt an assessment of empirical evidence through the co-integration and error correction models using annual data set of Bangladesh on real GDP and CPI for the period of 1980 to 2005. The empirical evidence demonstrated that there existed a statistically significant long-run *negative* relationship between inflation and economic growth for the country as indicated by a statistically significant long-run *negative* relationship between CPI and real GDP. In Thailand Tao Sun (2004) developed an approach for forecasting core inflation using monthly data from May 1995 to October 2003. The seasonally adjusted, monthly percent changes in Thailand's consumer price index after removing its raw food and energy components is used as the dependent variable. Hafer and Hein (2005) compared the relative efficiency of the widely used interest rate based forecasting model and univariate time series model based on monthly data from the United States, Belgium, Canada, England, France and Germany for the sample period from 1978 to 1986. Using monthly data on the Euro rates and the consumer price index (CPI) their results indicate that time series forecast of inflation model produces equal or lower forecast errors and has unbiased predictions than the interest rate based forecasts. Gavin and Kevin (2006) using Stock Dynamic Factor Models (DFM) forecast inflation and output with three alternative processes: a benchmark autoregressive model; a random walk; and a constant that presumes a fixed rate of growth of prices and

output over the forecast horizon 3, 12 and 24 months with the monthly data from January 1978 to December 1996.

Faisal (2012) suggests that the long-time lag between monetary policy announcement and policy action, it is difficult for policymakers to coordinate properly their strategies. Under such situation, forecasting future inflation can assist policymakers in formulating their strategies. Along with the time lag, in reality inflation is often multi causal and prime cause of inflation can vary from year to year. Raihan and Fatema (2007) reviewed a number of hypotheses put forward by the economists, policy makers and donor agencies, like IMF, World Bank and ADB, with regard to the causes of inflation in Bangladesh. They found 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. Kabundi (2011) tried to identify the main features underlying inflation in Uganda, both in the long -run and short-run, using monthly data from January 1999 to October 2010. The author ran a single-equation Error Correction Model (ECM) based on the quantity theory of money including both external and domestic variables. Finally, they concluded that evidence of inflation inertia which can be attributed to expectations of agents and/or inflation persistence. Totonchi (2011) attempted to review and analyze the competing theories of inflation. The theoretical survey in this research work yielded a six-blocked schematization of origins of inflation; monetary shocks, Demand side, supply-side (or real) shocks, structural and political factors (or the role of institutions). It appeared that inflation is the net result of sophisticated dynamic interactions of these six groups of explanatory factors. That is to say, inflation is always and everywhere a macroeconomic and institutional phenomenon.

Kozo & Ueda (2009) tried to investigate the determinants of households' inflation expectations in Japan and the United States. They estimated a vector auto-regression model in which the four endogenous variables are inflation expectations, inflation, the short-term nominal interest rate and the output gap, with energy prices and (fresh) food prices being exogenous. Short-term nonrecursive restrictions are imposed taking account of simultaneous codependence between realized inflation and expected inflation. They find, first, that responding not only to changes in energy prices and food prices but also to monetary policy shocks, inflation expectations adjust more quickly than does realized inflation.

Ratnasiri (2006) attempted to examine the determinants of inflation for Sri Lanka over the period 1980 – 2005 using VAR based co-integration approach. The findings indicate money supply growth and the increases in rice price are the most important determinants of inflation in Sri Lanka in the short run and long run. The effect of GDP growth and exchange rate depreciation on inflation has been found to be negligible and statistically not significant. The short-run effect of money growth, rice price and exchange rate effect on inflation is statistically significant. However GDP growth is not significant in short run too. It is obvious that the supply side effect on inflation in Sri Lanka is reflected through rice prices.

By using Johansen-Juselius cointegration methodology, Arif & Ali (2012) concluded that the GDP, broad money, government expenditure and import have a positive effect on the inflation in long run. On the other hand, government revenue and export have a negative effect. The government expenditure coefficient is 0.466 and the money supply coefficient is 0.337, implying a one percent increase in government expenditure and one percent increase in money supply elicit 0.466% and 0.337% increase in inflation respectively. In the short-run money supply has been found to be major factor influencing inflation in the country. Fatukasi Bayo (2005) investigates the determinants of inflation in Nigeria between 1981 and 2003. They concluded that all explanatory variables (fiscal deficits, money supply, interest and exchange rates) significantly and positively impacted on the rate of inflation in Nigeria during the period under review. Fashoyin (1984) in a study with respect to the impact of structural phenomenon on inflation in Nigeria identified ten structural variables (agricultural bottlenecks, industrial production, imports, exports, food import and production, trade union militancy, indirect taxation on companies, wage bill, government expenditure – deficit financing and money supply) responsible for inflation in Nigeria. Regressing the rate of inflation on the ten variables using the Ordinary Least Square (OLS) approach, the results indicated that money supply; wages, imports, exports, food import and indirect taxation had significant positive relationships with inflation. However, other variables provided inconclusive results due to unavailability of data for computation.

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. 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. Hossain and Zaman (2008) explored a positive feature of Bangladesh's inflation which is low and declining volatility. They found that there is conclusive evidence internationally of a negative correlation between the level of inflation and income growth for all but low inflation countries. Their attempt concluded with a reminder of the limitations of how much government can do to contain inflation when it is driven primarily by international price increases. In an early study, Taslim (1982) attempted to analyze the inflationary process in Bangladesh in light of the structuralist-monetarist controversy using the data for FY60 to FY80. The author systematically tested both the views in the context of Bangladesh as well as a hybrid model considering both views together. The findings clearly indicate that the rate of change of money supply and devaluation are the most significant explanatory variables. Ubide (1997) explain that the rate inflation in Mozambique was consistently high until 1995, and then plugged in 1996 to 17 percent from 70 percent in 1994. The authors tried to explain the behavior of inflation in

Mozambique though there different approaches. The first one decomposes inflation into three component: a trend that represents underlying inflation, a seasonal components that follows closely the agricultural season, and an irregular component. The second approach drives a theoretical model of inflation determination mechanism and estimates an inflation equation. The third analyzes the transmission mechanism embedded in the system by estimating a multivariate dynamic system. The policy implications of the results are discussed. Abidemi and Maliq (2010) analyzed the dynamic and simultaneous inter-relationship between inflation and its determinants in Nigeria between 1970 and 2007. They observed that the periods of high monetary growth (1988, 1990, 1992-1994), inflation surged accordingly, though with some lags. As the increase in narrow money rose from 4.1% in 1988, the inflation rate increased from 5.4 to 38.3% during the same period. Following the lag response of inflation to monetary growth, inflation peaked at 50.0% in 1989. Similarly, when the money supply growth increased substantially, inflation also accelerated. On the other hand, the decline in the monetary growth rate in 1994 led to a consequent decline in inflation rate. This confirmed that there is a strong link between increases in money supply and inflation. Sarel (1995) mentions that inflation rates were somewhat modest in most countries before the 1970s and after that inflation rates started to be high. Therefore, most empirical studies conducted before the 1970s show the evidence of a positive relationship between inflation and economic growth and a negative relationship between the two beyond that time period due to the severe inflation hike. Begum (1991) considers a detailed approach that concentrates both on aggregate supply and demand in contrast, in formulating a model of inflation for Bangladesh. The empirical test shows that the significant variables for inflation are agricultural and import bottlenecks, government expenditure, rate of interest, wage rate, bank credit and expected inflation. According to Akinnifesi (1984), factors such as changes in money supply, lagged changes in money supply, credit to government by the banking system, government deficit expenditure, industrial production and food price indices were the variable captured while changes in the annual data for 1960-1983 were used in empirical estimation. The study showed that changes in the above factors, jointly explained inflationary tendencies in Nigeria. His study however, emphasized that the increase in government expenditure financed by monetization of oil revenue and credit from the banking system were responsible for the expansion of money supply which in turn with a lagged-in-effect contributed immensely to inflationary tendencies.

Adeyeye and Fakiyesi (1980) estimated and tested the hypothesis that government expenditure is the main factor responsible for price instability and inflationary tendencies in Nigeria. According to their study,, they concluded significant positive relationship between inflation rate and money supply, government expenditure and bank credit was established but the relationship of inflation rate with growth of government

revenue was unclear. Ahmed (2009) examines the sources of inflation in Bangladesh taking into account both demand-side and supply-side factors to explain the inflationary trend. He finds that inward remittances, government debt, inflation inertia, non-competitive market behavior, food and oil prices affect inflation to a large extent. Mallik and Chowdhury (2001) have examined the short-run and long-run dynamics of the relationship between inflation and economic growth for four South Asian economies: Bangladesh, India, Pakistan, and Sri Lanka. Applying co-integration and error correction models to the annual data retrieved from the International Monetary Fund (IMF) and International Financial Statistics (IFS). They found two motivating results. First, the relationship between inflation and economic growth is positive and statistically significant for all four countries. Second, the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates. Judson and Orphanides (1999) have estimated a non-linear relationship and discovered structural breaks for many developing countries including Bangladesh. These varied findings, therefore, deserve further investigation for policy implications. Besides, it is argued that an individual country study should provide more reliable estimates than cross-country studies as country-specific relevant variables can be controlled properly and homogeneity can also be maintained. Different demand and supply responses for policy changes in different countries might result in different economic outcomes and provide misleading results under cross-sectional data. Temple (2000) pointed out that in cross-country studies comprising relatively dissimilar developing countries, inflationary impacts might differ and therefore, extrapolation requires more caution. He further argued, citing findings of several studies that the detection and significance of some relationships change when cross-section instead of annual panel data is used or if the time-horizon is altered. Bangladesh is under pressure from the international lending agencies (IMF, the World Bank and ADB) to reduce its inflation rates in order to boost economic growth.

3. Data

This analysis is mainly based on secondary information. It is suggested that combining secondary data from various sources may increase the validity of the information. Secondary data have been collected mainly from official sources. Suitable data have been extracted, organized, analyzed, illustrated and interpreted in the study with proper reasoning, analytical judgment, clarification and explanation. Research has been conducted on the basis of 1972-2012 inflation data frame in the context of Bangladesh. A time series model is useful in examining the dynamic determinants of economic series. The basic underlying assumption in time series forecasting is that the set of casual factors (Macroeconomic fundamentals) that operated on the dependent variable in the past will exhibit similar influence in some repetitive fashion in the future. In this research historical yearly national consumer price indices (general)

data from (1972-2012) of Bangladesh will be analyzed. In some previous studies of inflation forecasting of Bangladesh, emphasis has been given on testing economic theory and on empirical analysis. Even though some of these studies have been used as an input into the forecasting process, they have not been subject to rigorous forecast evaluation techniques. This paper set out to redress this deficiency and explicitly use time series techniques solely for forecasting purposes. All the figures that were used in this study were collected from the following publications. Bangladesh Bank Annual Report, published by Bangladesh Bank. Bangladesh Economic Survey, various issues, published by the Ministry of Finance. Economic Trends (monthly), published by the Statistics Department of the Central Bank of Bangladesh, official website of the Central Bank, Ministry of Finance and Export Promotion Bureau of Bangladesh. The World Economic Outlook 2012, published by The International Monetary Fund. Asian Development Bank (ADB) database. World Bank databank (World Development Indicator, WDI). Official website of World Bank. I have also checked published books on economic issues, working papers, reports, research monographs, journals and research works that are relevant to the study.

The central objective of the ARDL approach to modeling is to assess the inflationary potential of an economy through evaluating the characteristics of its monetary conditions. The ARDL type of models is based on the combination of long-term determinants of the price level with short-term changes in inflation in the economy.

In time series models, a substantial period of time may pass between the economic decision-making period and the final impact of a change in a policy variable. One can say that it is the nature of economic relationships that the adjustment of Y to changes in X is distributed widely through time. If the appropriate decision and response period is sufficiently long, lagged explanatory variables should be included explicitly in the model.

One way to model the dynamic responses is to include lagged values of X on the right hand side of the regression equation; this is the basis of the distributed lag model, in which a series of lagged explanatory variables account for the time adjustment process. The (finite) distributed-lag model takes the form:

$$y_t = \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \dots + \beta_k x_{t-k} + \gamma_1 y_{t-1} + \varepsilon_t$$

Given the above model, if the explanatory (input) variable x undergoes a one *unit change (impulse)* in some period t ; then the immediate impact on y is given by β_0 ; β_1 is the impact on y after one period, β_2 is the impact after two periods, and so on. The final impact on y is β_k and it occurs after k periods. So speaking, it takes k periods for the full effects of the impulse to be realized. The sequence of coefficients $\{\beta_0; \beta_1; \beta_2; \dots; \beta_k\}$ constitutes the impulse response function of the mapping from X_t to Y_t . Furthermore, the dynamic behavior of an economy can reveal itself through a dependence of the current value of an economic variable on its own past values. Specifically, models of how

decision makers' expectations are formed, and how they react to changes in the economy, result in the value of y_t depending on lagged Y 's. Therefore, an alternative way to capture the dynamic component of economic behavior is to include lagged values of the dependent variable on the right-hand side of the regression together with the exogenous variable.

In time-series econometric modeling, a dynamic regression will usually include both lagged dependent and independent variables as regressors:

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \beta_3 x_{t-2} + \dots + \beta_k x_{t-k} + \gamma_1 y_{t-1} + \varepsilon_t$$

The above model is called the autoregressive distributed-lag model, abbreviated as ARDL(p, k). ARDL of order 1 in autoregression and order 1 in distributed lags:

ARDL(1,1) model is defined as M1. The values of p and k (i.e. how many lags of Y and X will be used) are chosen (i) on the basis of the statistical significance of the lagged variables, and (ii) that the resulting model is well specified (e.g. it does not suffer from serial correlation).

As mentioned earlier, the motive is to find out the determinants of inflation in Bangladesh. For this purpose, several steps have been undertaken in the model specification. We have completed the Stationary Test of all data series and the results are presented below. However, many factors have effect on inflation. Due to failure in stationary test and insufficient data series, we have to ignore some important factors like unemployment etc. In addition to this, we have considered some proxy variables that are highly correlated with considered variables. A brief is mentioned before those

are being considered as tested determinants of inflation.

4. Empirical Result

4.1. Testing for Stationarity in Data

A random time series is said to be stationary if its mean and variance constant over time and the value of covariance between two time periods depends only the distance between the two time periods and not on the actual time at which the variance is computed (Gujarti, 1995). In order to check for the time series properties stationary of the variables, the widely applied unit root test such as Augmented Dickey – Fuller (1981) and Philips-Perron (1988) tests have been used. One way of removing non-stationarity is through the method of differencing. Unit Root test has been conducted to find out the stationarity of the considered series like GDP, interest rate, real exchange rate etc. The Augmented Dickey Fuller Test (ADF) and Philips-Perron have been used to check the existence of unit root of GDP series of Bangladesh the method. The null and the alternatives are:

H_0 : Consumer Price Index series have unit root;

H_a : Consumer Price index series do not follow unit root

Here, if and only if the P-value from ADF test is greater than 0.05 or 5%, the null hypothesis (H_0) is accepted. Otherwise, the null hypothesis will be rejected.

Table 4.1. The Results of the Stationary Test of the Data Series

Variable	Augmented Dickey Fuller Test		Philips Perron Test	
	Level I(0)	First difference I(1)	Level I(0)	First difference I(1)
GDP	2.825	-13.692	2.522	-11.352
M2	-0.545	-5.670	-1.075	-7.467
RER	-1.544	-6.464	-1.755	-5.432
IR	-2.550	-3.728	-2.200	-3.312
PP	-1.920	-6.436	-1.914	-6.439
REM	-0.246	-3.921	-2.162	-5.974
INF	-4.305	-4.773	-7.986	-4.827

Note: MacKinnon (1996) one-sided p-values t statistics 5% level of critical value is -2.936942

We test the stationarity of the first difference of these series by applying the ADF test on the first difference series. The results are presented in Table 4.1. As can be seen, the results show that these series are stationary in their first difference form. This means all series are I(1) and inflation rate is I(0). Even if the variables series, individually are I(1), it may be possible that a linear combination of the nine variables may be stationary. If I try to model a linear relationship among the variables series, even if each of them individually is non-stationary (i.e. I(1)), as long as they are co-integrated, the regression involving the series may not be spurious. Thus, we investigate whether the series are co-

integrated and have a long run equilibrium relationship.

4.2. Model Specification

At first, taking all considered variables and their lags along with lag of inflation series a simple Autoregressive Distributed lagged equation has been estimated alike the following form

$$\ln INF_t = \beta_1 + \beta_2 \ln GDP_t + \beta_3 \ln M2_t + \beta_4 \ln RER_t + \beta_5 \ln IR_t + \beta_6 \ln REM_t + \beta_7 \ln PP_t + \gamma_1 \ln INF_{t-1} + \sum_{i=2}^6 \gamma_i X_{t-1}$$

(Disturbance term disappears since it is an estimated model. I assume that all disturbance terms that follow the assumptions of Classical Linear Regression Model are independently and normally distributed)

Table 4.2. The Result of the Model 1

Model 1				
Dependent Variable: LNINF				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob
Q				
C	0.368125	0.637180	0.577741	0.5688
lnGDP	0.455236	0.127940	3.558209	0.0016
lnM2	0.205555	0.150070	1.369728	0.1835
lnRER	-0.718450	0.245366	-2.928080	0.0074
lnREM	-0.040405	0.056343	-0.717118	0.4802
lnPP	-0.037593	0.031693	-1.186144	0.2472
lnIR	0.110078	0.083417	1.319615	0.1994
lnINF(-1)	0.852799	0.082249	10.36854	0.0000
lnGDP(-1)	-0.210973	0.133108	-1.584974	0.1261
lnM2(-1)	-0.133539	0.159218	-0.838719	0.4099
lnRER(-1)	0.263103	0.185547	1.417983	0.1691
lnREM(-1)	0.028007	0.046537	0.601818	0.5529
lnPP(-1)	0.015886	0.028008	0.567191	0.5759
lnIR(-1)	-0.020240	0.090107	-0.224623	0.8242
R-squared	0.997993	Mean dependent var		4.190609
Adjusted R-squared	0.996906	S.D. dependent var		0.777228
S.E. of regression	0.043234	Akaike info criterion		-3.167062
Sum squared resid	0.044861	Hannan-Quinn criter.		-2.952404
Log likelihood	74.17417	Durbin-Watson stat		1.429291
F-statistic	917.9708	Prob(F-statistic)		0.000000

Here, all variables and their 1 year lagged variables are taken as determinants of inflation. We identify this as Model 1. Table 4.2 presents all beta values, t-stat, and P-values of all variables, adjusted R², Durbin Watson with its P-value and F-statistics with its P-value. Beta coefficient shows the tendency of an independent variable to respond against dependent variables. Therefore, greater value of beta indicates the larger influence on dependent variable and vice versa.

By the information of the Table 4.2, we can realize that there are direct impacts of gross domestic product, money supply and interest rate of current year and consumer price index, real exchange rate, petroleum price of the previous year. In addition, inflation of the current year is influenced negatively by the real exchange rate, remittances from abroad and petroleum price of current year and gross domestic product, money supply and interest rate of the previous year. Here, some coefficients of the variables show these types of result that are contrary to economic theory. Moreover, Prob series of the table indicates that all variables are insignificant except GDP and real exchange rate of the current year and consumer price index of the previous year. To solve this problem, I have run a number of equations. After long attempt, I have an efficient model whose maximum numbers of variables are significant at 1% level of significance.

$$\ln INF_t = \beta_1 + \beta_2 \ln GDP_t + \beta_3 \ln M2_t + \beta_4 \ln RER_t + \beta_5 \ln IR_t + \beta_6 \ln INF_{t-1} + \beta_7 \ln RER_{t-1} + \beta_8 \ln M2_{t-1}$$

According to Gujarati, D. N., (2003), OLS estimator (and forecasts based on them) is unbiased and consistent even if the error terms are serially correlated. The problem is with the efficiency of the estimates. In the proof of the Gauss-Markov Theorem that established efficiency, one of the steps involved minimization of the variance of the linear combination $\sum a_t \varepsilon_t$

$$Var(a_t \varepsilon_t) = \sum a_t^2 \delta_s^2 + \sum_{t \neq s} \sum a_t a_s cov(\varepsilon_t, \varepsilon_s)$$

Where, the summation is over all t and s that are different. If $Cov(\varepsilon_t, \varepsilon_s) \neq 0$, the second term on the right-hand side will not vanish. Therefore, the best linear unbiased estimator (BLUE) that minimizes $Var(a_t \varepsilon_t)$ will not be the same as the OLS estimator. That is, OLS estimates are not BLUE and therefore inefficient. Thus, the consequences of ignoring autocorrelation are the same as those of ignoring heteroskedasticity, namely, the OLS estimates and forecasts are unbiased and consistent, but are inefficient.

Considering the consequences, we have conducted a new model of which is symbolized as Model 3. The Model 2 that we have got ignoring the term and consequences mentioned by Gujarati is available in appendix section but diagnostic test of the Model 2 has been referred in our main discussion. In presence of autocorrelation, Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors or Newey-West approach can be applied to obtain the correct standard error. HAC standard errors are rather larger than the incorrect standard errors. This implies that if autocorrelation were not taken into account, the reliability of usual least square estimates would be observed.

The model result and explanations that we have got applying Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors is given below

Table 4.3 presents results obtained by running multiple regression analysis with the help of E-Views. The table consists of the following beta values, t-stat, P-values and elasticity at means of all variables and represents model's adjusted R², Durbin Watson with its P-value and F-stat with its P-value. Beta coefficient shows the tendency of an independent variable to respond against dependent Variables. Therefore, greater value of beta indicates the larger impact on dependent variable and vice versa. The results reveal that money supply, GDP, interest rate, previous- year inflation and previous-year real exchange rate are directly related to the price level in case of Bangladesh. The coefficient having positive sign is statistically significant suggesting that 1 percent increase in money supply leads to 0.26 percent increase in consumer price index on the average in the long run. The result is conforms to macroeconomic phenomenon of classical economists given in quantity theory of money as increase in money supply that leads to higher price levels. Due to higher money supply, more funds will be available to invest in the economy, investment will be taken place, aggregate demand accompanied by higher employment will be an increase, and finally there will be increased in consumer price index. It affects price level through demand

side. GDP is inducing consumer price index at 1 percent level of significance implying that consumer price index will increase by 0.23 percent due to 1 percent increase in gross domestic product on the average in the long run. In the same manner, if interest rate rises by 1 percent, price level will increase by 0.09 percent on the average in the long run. The results show that real exchange rate and previous year's

money supply is found to be inversely related to the price level in case of Bangladesh. The coefficient having negative sign is statistically significant suggesting that 1 percent decrease in the previous-year money supply and real exchange rate leads to 0.25 percent and 0.89 percent increase respectively in consumer price index on the average in the long run.

Table 4.3. The Result of Model 3

Model 3					
Dependent Variable: $\ln INF$					
Method: Least Squares					
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)					
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Elasticity at means
C	0.418307	0.338900	1.234307	0.2264	0.101345
$\ln GDP$	0.233002	0.102866	2.265101	0.0306	0.362589
$\ln M2$	0.261307	0.065379	3.996801	0.0004	0.201729
$\ln RER$	-0.889101	0.119964	-7.411385	0.0000	-0.757384
$\ln IR$	0.093841	0.031729	2.957587	0.0059	0.048740
$\ln INF(-1)$	0.896708	0.035797	25.04984	0.0000	0.876818
$\ln RER(-1)$	0.423793	0.084754	5.000293	0.0000	0.360806
$\ln M2(-1)$	-0.256595	0.088657	-2.894257	0.0069	-0.194642
R-squared	0.997908		Mean dependent var		4.127570
Adjusted R-squared	0.997436		S.D. dependent var		0.862074
S.E. of regression	0.043651		Schwarz criterion		-2.903255
Sum squared resid	0.059068		Durbin-Watson stat		1.357266
F-statistic	2112.889		Prob(F-statistic)		0.000000

*** Highly significant at 1% level of significance ** Significant at 5% level of significance * Significant at 10% level of significance

It is a common phenomenon that previous year consumer price index has positive impact on consumer price index. Consumer price index of Bangladesh increases by 0.89 percent due to increase of one percent increase of consumer price index of previous year.

In the table, column label Prob shows that all variables' P-values are <0.01 except GDP; i.e., gross domestic production (GDP) has (0.0306), money supply (M2) has (0.0004), real exchange rate (ER) has (0.000), interest rate (IR) has (0.0059) and lagged of consumer price index, real exchange rate and money supply have (0.0000), (0.0000) and (0.0069) respectively therefore all variables are significant.

Table 4.3 shows the value of adjusted R square as 0.9974 or 99.74% that indicates that model is 99.74% accurate or best fitted. Durbin-Watson test is used to test autocorrelation among the data (error term). In Durbin-Watson test, null hypothesis indicates that autocorrelation does not exist in error term and alternative hypothesis depicts that autocorrelation exists in error term. Since the regression model has assumption of uncorrelated error term, therefore it must be fulfilled to run regression analysis.

Overall significance of regression model is identified by the F-value. It is actually the explained variance divided by unexplained variance (mean error). In table 5.5,

F-stat shows the value (2112.889) and it is Prob (F-statistic) (0.000). The Regression equation for model 3 is exposed as follows.

$$\ln INF_t = 0.418 + 0.233 \ln GDP_t + 0.261 \ln M2_t - 0.889 \ln RER_t +$$

$$0.094 \ln IR_t + 0.897 \ln INF_{t-1} + 0.423 \ln RER_{t-1} - 0.267 \ln M2_{t-1}$$

4.3. Spurious Relationship Test of the Model

In 1926, Georges Udny Yule wrote a paper in the Journal of the Royal Statistical Society called "Why Do We Sometimes get Nonsense Correlations between Time-Series?" In econometrics, a spurious relationship (sometimes, spurious correlation) is a mathematical relationship in which two events or variables have no direct causal connection, yet it may be wrongly inferred that they do, due to either coincidence or the presence of a certain third, unseen factor (referred to as a "confounding factor" or "lurking variable"). It is very common to see in time series regression equations with an apparently high degree of fit, as measured by the coefficient of multiple correlation R^2 or the corrected coefficient R^2 , but with an extremely low value for the Durbin-Watson statistic. By the way, we can easily define that a econometrical model will be spurious if the adjusted R^2 is greater than Durbin-Watson statistic. Though, it is said that Higher R^2 indicates higher goodness of fit. Sometimes, adding an irrelevant variable in model can increase the value of adjusted R^2 . we have executed the spurious test and the test result of spurious relationship of my model is given below.

Table 4.4. Test Results of Spurious Relationship of the Model

Model	R-Square	Durbin-Watson
Constant and trend	0.997908	1.357266
Conclusion	The model is not spurious	

The results reveal that the regression model is free from spuriousness that indicates the considered variables have direct casual connection and there is no third unseen factor.

4.4. Test for Co-Integration

To be sure, whether the non-stationary times series produce a spurious regression with another non-stationary time series, a co-integration test is necessary to check in this regard. Here, it is used the Engle- Granger (EG) or Augmented Engle-Granger (AEG) test to see the relationship. Granger causality test is appropriate to see the bilateral causality among the variables and VAR model is used for the multivariate model. To perform this test one should first find

out the residual of model and then check the Augmented Dickey-Fuller (ADF) unit root test to see whether the residual contains unit root or not. In this analysis, the variables are co-integrated if and only if the calculated value of the residual (U_i) is greater than the critical value at 5% level of significance. As the variables are co-integrated, OLS technique can be used to estimate the model.

Therefore, the null and alternative hypotheses in this regard are:

H_0 : The residual series has a unit root.

H_0 : The residual series has no a unit root.

Table 4.5. Test Results of Co-integration of all Considered Variables' Series

Model Residuals	Data based value of the test statistic	Critical value at 5% level	Results
Constant and trend	-5.2383	-2.94327	Reject H_0
Conclusion	The residuals series does not have a unit root. Hence, considered variables are co-integrated.		

Rejection of the null hypothesis would mean that the considered variables are co-integrated with consumer price index.

We have considered the White test including White Cross

Terms and Null and Alternative Hypothesis are given below

H_0 : There is no heteroskedasticity

H_1 : There is heteroskedasticity

Table 4.6. Test Results of Heteroskedasticity

Model	Obtained χ^2 ($n \cdot R^2$)	Critical value at 5% significant level.	Decision
Constant and trend	38.91611	48.6024	Accept H_0
Conclusion	Obtained $\chi^2 <$ Critical value of χ^2 . So, our model is free from at 10%, 5%, 2.5% and 1% level of significance. Finally, we can conclude that there is no Heteroskedasticity.		

Table 4.7. The Result of Lagrange Multiplier Test for Autocorrelation

Model	F-Calculated value	Critical value at 5% level, $F_{(1,30)}$	Results
Constant and trend	3.3640	4.17088	Accept H_0
Conclusion	Therefore, F-critical > F-calculated. Evidence does not support to reject the null hypothesis, thus we can say that null hypothesis of "there is no serial autocorrelation" is accepted. That is there is no serial autocorrelation in our model.		

4.5. Histogram for the Normality Test

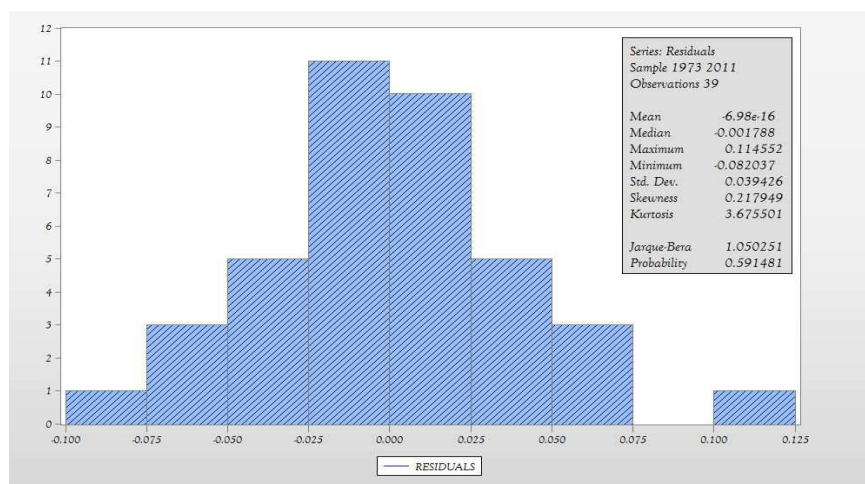


Figure 4.1. E-Views output residuals histogram and summary statistic.

The sample size in my work is rather small. Hence, strictly

speaking one should not use the JB statistic. By adopting E-

views, we got the skewness and kurtosis of the Model 2 are 0.2179 and 3.676. If we mechanically apply the JB formula to work, the JB statistic turns out to be 1.05. The p value of obtaining such a value from the chi-square distribution with 2 df (degrees of freedom) is about 0.59, which is quite high. In other words, we may not reject the normality assumption for my model, as critical value is 5.99146. Of course, we bear in mind the warning about the sample size.

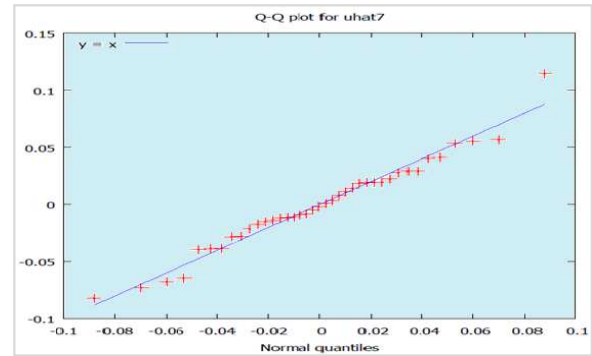


Figure 4.2. Normal P-P Plot of Regression Standardized Residual

Table 4.8. The Result of the Ramsay's RESET test

Model	F-Calculated value	Critical value at 5% level, $F_{(1,30)}$	Results
Constant and trend	32.66403	4.17088	Reject H_0
Conclusion	Therefore, F-critical < F-calculated. Evidence does not support to accept the null hypothesis, thus we can say that null hypothesis of "there is no specification error" is rejected. That is there is specification error in our model.		

For this new model, δ_1 is statistically significant. Therefore, we can say that this model contains serious problem of functional form and omitted variable. If we consider square of fitted $\ln INF$ is omitted and it ought to be a non-linear model. The findings after including square of fitted $\ln INF$ are noted below.

Table 4.9. The Results of Model 4

Model 4				
Dependent Variable: $\ln INF$				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.273321	0.524359	-4.335430	0.0002
$\ln GDP$	0.752294	0.106021	7.095678	0.0000
$\ln M2$	0.212400	0.081618	2.602370	0.0142
$\ln RER$	-1.248403	0.084485	-14.77668	0.0000
$\ln DI$	0.102045	0.025339	4.027155	0.0004
$\ln INF(-1)$	1.424191	0.095686	14.88402	0.0000
$\ln REX(-1)$	0.629953	0.068244	9.230952	0.0000
$\ln M2(-1)$	-0.383336	0.074035	-5.177771	0.0000
$FITTED^2$	-0.095659	0.016737	-5.715245	0.0000
R-squared	0.998999	Mean dependent var		4.127570
Adjusted R-squared	0.998732	S.D. dependent var		0.862074
S.E. of regression	0.030702	Akaike info criterion		-3.929807
Sum squared resid	0.028278	Hannan-Quinn criter.		-3.792067
Log likelihood	85.63124	Durbin-Watson stat		1.508421
F-statistic	3741.241	Prob(F-statistic)		0.000000

After long attempt, we have a model that has no specification error. Moreover, after long diagnostic tests the model 4 is free from all types of econometrical obstacle like heteroskedasticity, spurious modeling, and serial correlation and so on. In the final model (Model 4), all signs of betas are same as in model 3 but their magnitudes have been changed. In model 4 another variable called $fitted^2$ has been introduced and it has negative effect on $\ln INF$. By the prob value of the $fitted^2$, we can say there is a significant effect of $fitted^2$ and we cannot ignore this. Prob (f-statistics)

denotes that there is overall significant of model. All considered variables could explain 99.87% dispersion of $\ln INF$.

5. Concluding Remarks

The main purpose of the paper was to identify the causative factors of inflation in Bangladesh by estimating an appropriate inflation function. The important conclusion of this study can briefly be summarized as follows. An economic variable is not only influenced by the factors of the present period but also factors from the previous periods. This study applies Autoregressive Distributed Lagged Model (ARDL) to identify the factors that may influence the consumer price index of Bangladesh. The findings are also identical with the prevailing economic theory.

It is true that inflation is like a two-side sharpened razor without doubt. Increase and decrease the rate of inflation both are harmful to an economy. As a result, to identify determinants of inflation is always a topical issue. These determinants are multi dimensional and dynamic. Therefore, the government should pursue with vigor, policies that will enhance the reduction of the general price level but enhance increased productivity of goods and services. Such policies may include wage control/freeze, monetary policy (reduction in money supply), fiscal policy (increase in personal income tax and reduction in government in government expenditure), total ban on importation of some goods, increase in output of goods and services, over hauling distribution system, government intervention to check excessive bidding or depreciation of the taka among other things. Failure to control may lead to macroeconomic instability and reduce the rate of economic growth. The research work revealed some important facts about the general determinants of inflation in Bangladesh for the period 1972 to 2011.

The explanatory variables that significantly influence the consumer price index are Gross Domestic Product (GDP),

Money Supply (M2), Real Exchange Rate (RER) and Interest Rate (IR) of the current year and Inflation Rate, Real Exchange Rate and Money Supply of the previous year. Due to lack of data and insignificance in Model, I had to ignore some important variables as determinants of inflation like Unemployment rate (necessary to explain the nature of Phillip's Curve in Bangladesh) remittance and Petroleum Price (proxy of oil price). All considered variables except real exchange rate help to increase inflation positively. These explanatory variables combined to influence significantly the rate of inflation in Bangladesh as much as 99% while the stochastic error term (U1) captures 1%. At 5 percent level of significance, they all influenced the rate of inflation during the period.

Here sample size is only 39. Moreover, a specific estimation method has been used. Lack of time prevented me from taking other estimate methods. So the results obtain here could be improved in many ways. There is thus a scope for further research on the topic.

6. Acknowledgements

We owe a great deal of gratitude to our honorable teacher and research supervisor **Professor Dr. Mohammad Abul Hossain**, Economics Department, University of Chittagong. He offered us constant guidance and many insightful and constructive observations throughout the study. His support, encouragement and availability to discuss ideas and problems have contributed much in completing this work. He always kept us on task and pointing out us back to our research paper objectives. We really appreciate for his patience and high efficiency in guiding us in a proper way in conducting this research. His friendly guidance and cooperation which is very rare inspired us to successfully complete the whole work.

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