

Estimating growth-inflation tradeoff threshold in Bangladesh

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Abstract

The objective of this study is to explore the inflation-economic growth linkage, if any, in Bangladesh. With this view, various tables and charts, correlation matrices, pair-wise Granger Causality tests and a quadratic regression equation estimated by OLS based on time series annual data covering the sample period from 1976 to 2012 are used. The results of all the data including regression analysis convincingly demonstrate that the relationship between inflation and growth is non-linear with an existence of a threshold level of inflation within the range of 7-8 percent. This implies that targeting too low an inflation level (relative to the threshold) would be hurtful for growth in terms of potential cost of forgone output and, at the same time, too high level of inflation would also impede economic growth. Thus, Government's inflation target of 7.5 percent set in FY12/13 budget seems to be reasonable as it stands within the estimated range of threshold levels of inflation found in the study. Despite recent moderating trends in inflation, current restrictive monetary policy stance of Bangladesh Bank seems to be in the right direction, as inflation is still running far beyond indicated threshold level. Besides, continuous coordinated efforts are required to contain inflation around the threshold band of 7-8 percent inflation for the sake of optimal economic growth in Bangladesh.

JEL Classification: C22 and E31

Keywords: Inflation, Growth, Threshold level of Inflation, Bangladesh Economy

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I. Introduction

Understanding the relationship between inflation and output growth is very crucial in setting the targets of policy goals, inflation in particular and formulating the policy framework. Several cross-country and single country studies on the issue indicate that the relationship between inflation and output growth is not linear and there exist a threshold level of inflation, up to which inflation appears to be helpful for economic growth and beyond which it appears to impede growth. This simply means that likewise the cost of high inflation, keeping too low inflation is also costly in terms of output loss. The objective of this study is to explore the inflation-economic growth linkage, if any, in Bangladesh, particularly identifying a reasonable threshold level, which is robust and not highly sensitive to changes in underlying assumptions. This would be very useful as guide for policy makers as the cost of wrong choice of threshold inflation level could be substantial in terms of forgone output and employment opportunities. There are few studies that tried to identify the threshold level of inflation in developing countries including Bangladesh but lack any consensus in determining the levels of threshold inflation. In this regard, the current study makes an attempt to examine the relationship between inflation and output growth to identify a realistic level of threshold level of inflation in Bangladesh.

The plan of the study is as follows: after the introduction in section-I, a review of the related literature is provided in section-II. While section-III analyzes the relationship between growth and inflation, section – IV outlines the model specification, methodology and the empirical estimation. Finally, the conclusions and recommendations are given in section-V.

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II. Review of literature on threshold effect of inflation on growth:

The debate whether inflation has inimical or helpful or no effects on growth were examined empirically in many studies. Some earlier empirical works, such as Fischer, (1993, 1996) and Bruno and Easterly (1995) generally accepted the views that there exists a negative relationship between inflation and economic growth at least at double-digit level of inflation supporting the idea of Phillip's curve. However, as Barro (1995) and Sarel (1996) do not find any clear negative relationship below 8 percent inflation, some uncertainties regarding this relationship remain at low level of inflation. Fischer (1993) examined the possibility of non-linearity in the relationship between inflation and economic growth in a panel of ninety-three countries. Using both cross-section and panel data for a sample of both developing and industrialized countries, his findings suggest a non-linear relationship between inflation and growth. Interestingly, by using break points of 15 percent and 40 percent in spline regression, Fisher showed not only the presence of nonlinearities in the relationship between inflation and growth, but also that the strength of this relationship weakens for inflation rates higher than 40 percent.

Barro (1995) using data for 100 countries covering 1960-1990 assessed the impact of inflation on economic performances. The regression results indicate that the growth rate of real per capita reduced by 0.2-0.3 percentage points per year for every 10 percentage points increase in inflation.

Another study by Sarel (1996) tested a structural break in the relationship between inflation and growth. Sarel (1996) used a panel data (1970-1990) of eighty-seven countries on population, GDP, consumer price indices, terms of trade, real exchange rates, government expenditures and investment rates for his study. He found evidence of a significant structural break at an annual inflation rate of 8 percent beyond which the relationship between inflation and growth is negative, which is statistically significant and extremely strong. Below that rate, however, inflation does not have any significant negative effect on growth rather comes with marginally positive effect.

Bruno and Easterly (1998) examined the determinants of economic growth using annual CPI inflation of twenty-six countries which experienced inflation crises during the period 1961-92. They considered inflation rate of 40 percent and over is as the threshold level for an inflation crisis. They found inconsistent or somewhat inconclusive relationship between inflation and economic growth below this threshold level when countries with high inflation crises were excluded from the sample.

Khan and Senhadji (2001) used an unbalanced panel data covering the period 1960-98 for 140 countries to estimate the threshold levels of inflation for industrial and developing countries. Using a non-linear least squares (NLLS) estimation method, they found that the threshold levels of inflation for industrial and developing countries are in between 1-3 percent and 11-12 percent respectively. For inflation rates above these threshold levels, there is a strong negative relationship between inflation and

growth for the respective group of countries. They also examined the relationship between inflation and growth at country-by-country basis using time series data to determine the threshold level.

In case of India, the outcomes of the studies on threshold levels of inflation provide differing views. For example, Chakarvarty Committee (1985) considered the acceptable rise in prices at 4 percent while Rangarajan (1998) judged it at 6–7 percent, which is supported by few other studies like Vasudevan et al. (1998), Kannan and Joshi (1998) as they found the threshold level to be around 6 percent. Results of Samantaraya and Prasad (2001) are also in similar line as they found the threshold level to be around 6.5 percent. In contrast, Singh and Kalirajan (2003) using annual data for the period of 1971–1998 provided argument against any threshold level for India. A more recent study by Singh (2010) which used both yearly and quarterly data found threshold level of inflation for India is at 6 percent. Another paper by Pattanaik and Nadhanael (2011) examined why persistent high inflation impedes growth in India. They identified three factors causing inflation to appear well above the threshold level. First, inflationary expectations, seen from RBI surveys, are above the headline inflation rates; second, the pace of increase in wages has also been much more than inflation and third, corporate finance data suggest that growth in staff costs in recent quarters have been higher than the rate of growth in earnings.

Using an annual data set for the period 1973-2000, Mubarik (2005) estimated the threshold level of inflation for Pakistan. He found an inflation rate beyond 9 percent is detrimental for the economic growth suggesting that an inflation rate below 9 percent is favorable for the economic growth of Pakistan. However, the study by Hussain (2005) based on the annual data covering 1973-2005 found no threshold level of inflation for Pakistan.

Lee and Wong (2005) estimated the threshold levels of inflation using quarterly data during 1965-2002 for Taiwan and 1970-2001 for Japan. Their estimation of the threshold models suggests that an inflation rate beyond 7.25 percent is detrimental for the economic growth of Taiwan. For Japan on the contrary, they found two threshold levels, which are 2.52 percent and 9.66 percent. This suggests that inflation rate below the estimated threshold levels is favorable to economic growth and beyond that threshold value, it is harmful for the economic growth.

A paper by Munir *et al.* (2005) re-examined the issue of the threshold effects in the relationship between inflation and growth using new econometric methods that provide appropriate procedures for estimation and inference based on yearly data during 1970-2005 for Malaysia. The empirical results strongly suggest the existence of one threshold value at 3.89 percent. This implies there is non-linear relationship between inflation and economic growth for Malaysia. The empirical results points to the fact that inflation may promote economic growth when it is below 3.89 percent and inflation exerts a negative effect on economic growth when it is higher than 3.89 percent.

Frimpong *et al.* (2010) empirically estimated the threshold effect of inflation for Ghana using threshold regression models designed to estimate the inflation thresholds based on data during 1960-2008. They found evidence of a threshold effect of inflation on economic growth in Ghana. The result indicates inflation threshold level of 11 percent. While above this threshold level, inflation would adversely affect economic growth and below the 11 percent level, inflation is likely to have a positive effect on economic activities. Therefore, they concluded that the current medium term inflation target of 6-9 percent annual average set by the Bank of Ghana and the Government respectively is in the right direction as it is well below the 11 percent threshold.

Mallik and Chowdhury examined (2001) the impact of inflation on the GDP growth for four South Asian countries (namely Bangladesh, India, Pakistan and Sri Lanka). Using annual data based on co-integration and error correction methods, the authors found the evidence of a long-run positive relationship between GDP growth and inflation rate for all the four countries though they did not identify any threshold effect or growth inflation tradeoff for these countries.

There are not enough studies on inflation-growth tradeoff in Bangladesh. However, one study by Ahmed and Mortaza (2005) is sort of in line with the objectives of current study. They empirically explored the relationship between inflation and economic growth in the context of Bangladesh using annual data on real GDP and CPI for the period of 1980-2005. The empirical evidence of co-integration and error correction models demonstrates that there exists a statistically significant long-run negative relationship between inflation and economic growth for Bangladesh. Their results, based on OLS estimation, also suggest a threshold level (i.e., structural break point) of inflation is at 6 percent. They suggested the level of inflation more than 6 percent would adversely affect the economic growth in Bangladesh.

To summarize the findings of the above studies it can be safely noted that there is relationship between inflation and economic growth, which is often non-linear in nature. Under a certain level of inflation, the relationship is positive and beyond that level of inflation, the relationship is negative. Simple implication of this kind of relationship between inflation and economic growth is that modest increase in the rate of inflation would not be harmful for the long-run real economic growth for the economies with initially low rates of inflation. But for economies with initially high rates of inflation, further increase in the inflation rate would have adverse effects on real economic growth.

III: An analysis of the growth-inflation relationship in Bangladesh

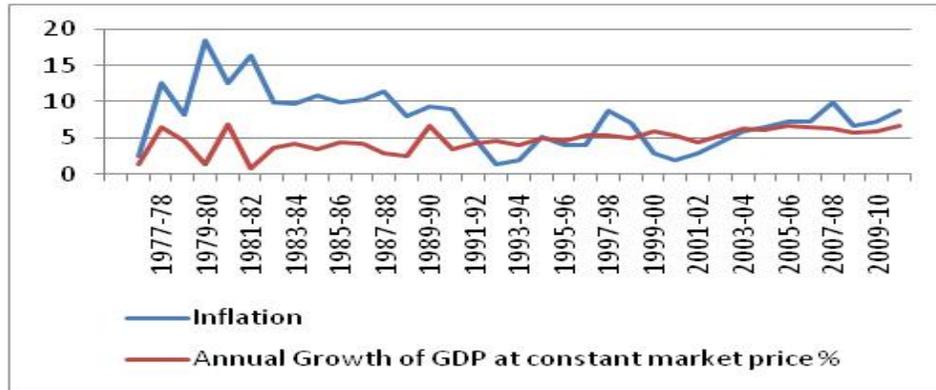
In view of visualizing the relationship between inflation and GDP growth in Bangladesh, several statistical tables and charts containing CPI inflation, real GDP and M2 growth during the period from 1981 to 2011 are used. The last row of Table-1 depicts the average inflation and growth of M2 and Real GDP for three decades. It is seen from the Table-1 that during the decade of FY81 to FY90, the inflation rate was around 10.84 percent, while the GDP growth was 3.93 percent and money supply (M2) growth was around 21.58 percent. During the decade of FY91 to FY00, the CPI inflation rate decreased significantly from around 11 percent to 5 percent, M2 growth decreased to 13 percent from 21.58 percent and the GDP growth increased moderately to 4.72 percent from 3.93 percent. During the decade of FY01 to FY10, however, the real GDP growth increased to around 6 percent, the CPI inflation also increased to around 6 percent as well and M2 growth increased to around 17.15 percent. From the table, it is evident that when money supply was the highest (i.e., 22 percent), the inflation rate was much higher with lower real GDP growth (i.e., around 4 percent). During the current decade, the state of inflation, M2 and real GDP growth deem to be optimal as the average CPI inflation and real GDP growth both appeared to be around 6 percent with a relatively low growth in M2 at around 17 percent.

Table-1 Trends of real GDP growth, CPI inflation and M2 growth (in percent)

Year	GDP_growth	CPI_Inflation	M2_growth	Year	GDP_growth	CPI_Inflation	M2_growth	Year	GDP_growth	CPI_Inflation	M2_growth
FY81	6.8	12.54	27.5	FY91	3.4	8.94	12.1	FY01	5.27	1.94	16.6
FY82	0.8	16.29	10.0	FY92	4.2	5.09	14.1	FY02	4.42	2.79	13.1
FY83	3.6	9.93	29.7	FY93	4.5	1.33	11.4	FY03	5.26	4.38	15.6
FY84	4.2	9.67	42.2	FY94	4.08	1.83	14.1	FY04	6.27	5.83	13.8
FY85	3.4	10.94	25.6	FY95	4.93	5.2	16.5	FY05	5.96	6.48	16.7
FY86	4.3	9.95	17.1	FY96	4.62	4.07	8.2	FY06	6.63	7.16	19.3
FY87	4.2	10.35	16.3	FY97	5.39	3.96	10.8	FY07	6.43	7.20	17.1
FY88	2.9	11.42	14.3	FY98	5.23	8.66	10.4	FY08	6.19	9.94	17.6
FY89	2.5	8	16.3	FY99	4.87	7.06	12.8	FY09	5.74	6.66	19.2
FY90	6.6	9.3	16.9	FY00	5.94	2.79	18.6	FY10	5.83	7.31	22.4
AVG.	3.93	10.84	21.58		4.72	4.89	12.90		5.80	5.97	17.15

Source: Economic Trends (various issues), a Bangladesh Bank publication

Chart-1: Inflation and Real GDP Growth



Source: Economic Trends, Bangladesh Bank

Chart-1 shows the relationship between the CPI inflation and real GDP growth for the period 1977-78 to 2009-10. It is evident from the chart that during the late 80s to late 90s, when the rates of inflation were higher, the corresponding average GDP growth was relatively lower. During 1990s and 2000s, however, inflation and growth maintained some sort of neutral relationship. Although from FY04 onward matching with the period of flexible exchange rate regime, the real GDP growth was relatively higher corresponding to relatively lower rates of inflation. It can also be noted from the chart that the relationship between inflation and growth is not linear that might go through some structural breaks requiring further investigation.

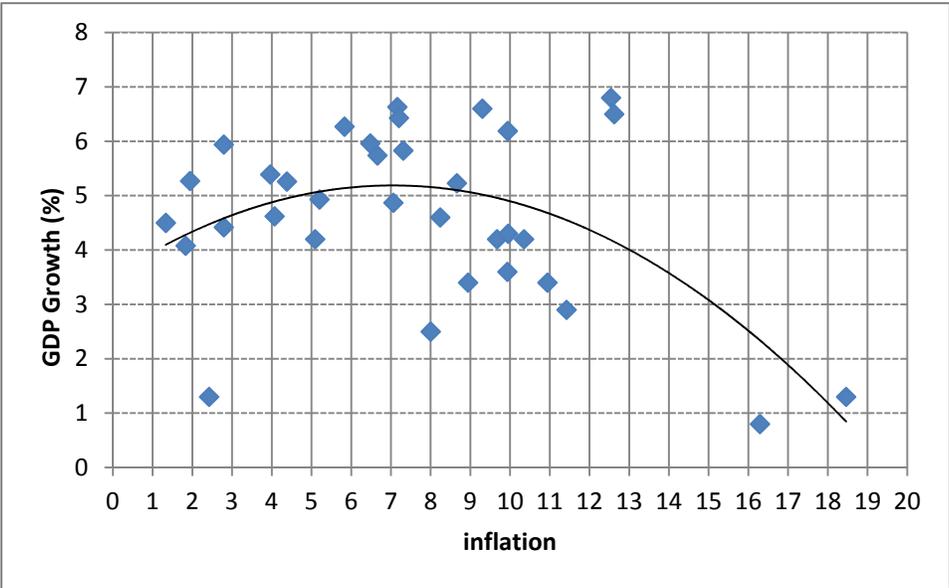
Table-2: Evidence from historical data: inflation-growth

Sample size	inflation (percent)	Avg. GDP growth (percent)
6	up to 2.99	4.25
1	3.00-3.99	5.39
2	4.00-4.99	4.94
3	5.00-5.99	5.13
2	6.00-6.99	5.85
4	7.00-7.99	5.94
5	8.00-8.99	4.48
5	9.00-9.99	4.98
2	10.00-10.99	3.80
1	11.00-11.99	2.90
2	12.00-12.99	6.65
1	16.00-16.99	0.80
1	18.00-18.99	1.3

Source: Author's own calculation

Table-2 contains the data on inflation and real GDP growth in Bangladesh for the last 35 years (1975-76 to 2011-12) in a way that various levels of GDP growth are recorded against a low-to-high sequence of inflation levels. The recorded data show that when the rates of inflation are below 3 percent the corresponding average GDP growth is 4.25 percent for six different years. It is also seen from the table that when inflation rates are between 3 to 3.99 percent, the real GDP growth is 5.39 percent. While inflation rates are in between 7 to 7.99 percent, the corresponding average real GDP growth rate is one of the highest at 5.94 percent for 4 different years. Beyond the 7.99 percent inflation, the average real GDP growth started to moderate. Thus the above bi-variate relationship between inflation and GDP growth indicates some sort of non-linearity with a structural break or inflexion point when the relationship between inflation and GDP growth switched.

**Chart 2: Average actual GDP growth against various level of inflation:
Scatter diagram of real GDP with polynomial (degree=2) of inflation**



The above scatter diagram (Chart-2) shows various levels of inflation and its corresponding real GDP growth. From the above chart of real GDP and polynomial (degree=2) of inflation it is seen that the relationship between inflation and real GDP starts changing while inflation level is between 7-8 percent.

IV: Model specification, methodology and empirical results

Data Analysis

Before estimating the model, it is necessary to examine the stationarity properties of the series. Inflation and GDP growth are found to be stationary at the level using both the Augmented Dickey-Fuller (1979) and Phillips-Perron (1998) tests. In order to see whether inflexion point exists in the inflation growth relationship two correlation matrices are estimated. A correlation-matrix with the inflation level less than 7.31 percent shows a positive correlation, while another correlation-matrix with more than 7.31 percent inflation shows a negative correlation between inflation and GDP growth. Therefore, from the two correlation matrices, we can assume that the relationship between inflation and growth is non linear with the existence of at least one break point. The relationship is positive at some level and after that level the relationship become negative. Historical data guided us to choose 7.31 percent level of inflation as one of the break point (Chart-2).

Correlation matrix for inflation less than 7.31 percent

	Inflation	GDP growth
Inflation	1	-
GDP Growth	0.54	1

Correlation matrix for inflation higher than 7.31 percent

	Inflation	GDP growth
Inflation	1	-
GDP Growth	-0.49	1

Pair-wise granger causality tests

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
GRY does not Granger Cause INF	33	0.62	0.54
INF does not Granger Cause GRY		3.56	0.04

As the correlation matrices stated above do not let us decide the direction of the relationship, Granger (1969) approach is used. It would allow us to see how much of the current GDP could be explained by past values of inflation and then to see whether adding lagged values of inflation could improve the explanatory power of inflation. Based on minimum Akaike Information Criteria (AIC) both the variables up to second lags are used in Granger Causality test and it is found that the causality runs from inflation to growth, which is statistically significant at 5 percent level.

Model specification:

The issue of non-linear relationship between variables in the areas of the social and behavioral sciences are not uncommon. Numerous theories as well as econometric approaches are there to handle such nonlinear relations among variables. As noted by Wang, Houshyar, and Prinstein (2006), the most-often investigated nonlinear effects are interaction and quadratic effects (the inverted U effect). A *quadratic effect* implies that predictor variables interact with themselves. Based on the analyzed non-linear relationship between inflation and growth, a quadratic equation of inflation and growth has been estimated by OLS to determine the threshold level of inflation using annual data during 1976-2012 for Bangladesh. Although, it is reasonable to argue that growth-inflation regression needs to include other plausible determinants of growth but considering argument of Ghosh et al. (1998)² and objective of the paper no other variable is included in model. Therefore, this study estimates bivariate model to gauge the relationship between inflation and growth.

$$\text{Equation: } Gry = C + \beta_1 Inf + \beta_2 D(Inf) * (Inf) + u$$

Where, *Gry*=Real GDP growth, *Inf*=lower Inflation *inf***inf*=higher inflation

Estimated results: Ordinary Least Square Method(OLS)		
Dependent variable: real GDP growth		
Explanatory variables	Coefficient	Prob.
C	3.268858	0.00***
INFLATION	0.539016	0.00***
INFLATION*INFLATION	-0.036450	0.02**
R-squared	0.31	
DW	1.75	

*** implies significant at 1 percent level while ** implies significant at 5 percent level

The above quadratic equation has been used to estimate the threshold level of inflation. The estimated results obtained from OLS using only inflation and its square to right hand side gives us a threshold level of inflation for Bangladesh. As per simple rule of optimization (setting first differentiation=zero and solving the equation), we get the threshold level of inflation at about 7.394. This equation also satisfies the second order condition (SOC) of growth maximization with respect to inflation implying $(d^2gry/d^2inf) < 0$, the inverted U curve.

$$(d^2gry/d^2inf) 0.539016 - 2(0.03645)INF = 0$$

$$\text{or, } INF = 0.539016 / 0.0729 = 7.394 \text{ percent}$$

² Ghosh et al. (1998) argued that inflation growth findings might not be robust once “conditioning” variables are included in the regression analysis. Besides, conditioning variables may themselves be functions of the inflation rate. Inclusion of these variables in a growth regression may reduce apparent effect of inflation.

The estimated quadratic equation for the sample period from 1976 to 2012 give a threshold level of inflation at 7.39 percent and up to this level of inflation, the impact of inflation on GDP growth remains positive in Bangladesh. After that level, any rise in inflation would hurt GDP growth. Various diagnostic tests are applied to the above estimated model to see whether it passes all the required diagnostic tests. First, the Jarque-Bera statistic for testing normality. If the residuals are normally distributed, the histogram will be bell-shaped and the Jarque-Bera statistic should not be significant. It has been found that the histogram is bell-shaped and Jarque-Bera statistic is insignificant (probability=0.6819 and Jarque-Bera test statistics=0.7655) implying that the residuals are normally distributed.

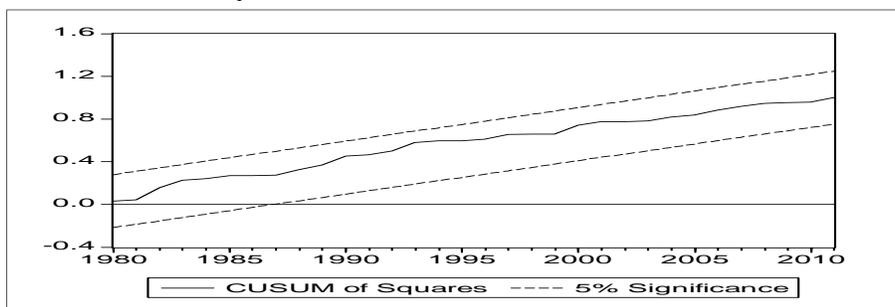
Second, the white noise Residual Test. The correlogram of Q-statistics shows that all the residuals are insignificant and white noise implying that there is no serial correlation or information left in the residuals. The LM test for higher order serial correlation test confirms no serial correlation as well. Besides, the stability test shows that the residual are within the band, implying no structural break in the estimated residual.

The correlogram of Residual

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
. .	. .	1	0.042	0.042	0.0682	0.794
. * .	. * .	2	0.181	0.180	1.3555	0.508
. *** .	. *** .	3	0.361	0.359	6.6243	0.085
. .	. .	4	0.060	0.030	6.7764	0.148
. * .	. * .	5	0.178	0.066	8.1412	0.149
. ** .	. * .	6	0.240	0.125	10.721	0.097
. * .	. * .	7	0.119	0.079	11.379	0.123
. .	. ** .	8	-0.042	-0.205	11.463	0.177
. .	. * .	9	0.049	-0.144	11.580	0.238
. .	. .	10	0.027	-0.034	11.619	0.311
. * .	. .	11	-0.066	-0.038	11.856	0.375
. * .	. .	12	0.087	0.064	12.283	0.423
. ** .	. ** .	13	-0.247	-0.284	15.868	0.256
. .	. .	14	-0.025	0.029	15.907	0.319
. * .	. .	15	-0.108	-0.038	16.659	0.340
. * .	. .	16	-0.127	0.053	17.766	0.338

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.60	Probability	0.55
Obs*R-squared	1.36	Probability	0.50

Stability test also show that the residual are stable



V. Conclusion

The objective of this study is to explore the nature of relationship between inflation-economic growth in identifying two things: first, is the relationship non-linear and second, if so at what level of inflation the relationship breaks? We may call the break point as the expected threshold level of inflation. In doing so, this study uses various tables and charts, correlation matrices, pair-wise Granger Causality tests and a quadratic regression equation estimated by OLS using time series annual data covering the sample period from 1976 to 2012. The outcomes of all the data analysis including regression convincingly exhibit that the relationship between inflation and growth is non-linear with an existence of a break point. Historical data as depicted in several tables and charts show that average economic growth reaches its peak when inflation rates are in between 7-8 percent in Bangladesh. Correlation matrices also support this range in the sense that the inflation-growth correlation is positive when the rate of inflation is less than 7.31 percent which turns into negative at the rate of inflation higher than 7.31 percent. Besides, Granger Causality test confirms that the causality runs from inflation to growth allowing a regression analysis to see the threshold effect of inflation on economic growth. Accordingly, a quadratic equation by OLS is estimated generating a threshold level of inflation at 7.39 percent in Bangladesh, standing within the range of 7-8 percent.

In general, the findings of this study are very much in line with the results found by the other studies as discussed earlier although one of earlier study (Ahmed and Mortaza, 2005) on Bangladesh indicated the threshold level of inflation to be at 6 percent. The deviation of the threshold levels of inflation in the present study from the previous one might be due to data coverage and difference in the methodology of threshold determination. The earlier study barely covers the flexible exchange rate regime while the current study covers most recent data when inflation is running above single digit level in Bangladesh. Besides, the previous study considered the maximum inflation to be at 8 percent, which forced them to use some sort of truncated data set generating a relatively low outcome of 6 percent threshold level. Therefore, obtaining a different measure of inflation threshold within the range of 7-8 percent in this study is quite reasonable.

We know that government sets the target of inflation levels in Bangladesh, not the central bank as it does not have the goal independence. The inflation target set in GOB's FY12/13 budget is 7.5 percent. This target level is within the band of the threshold level of inflation found in this study. Inflation in Bangladesh persisted at double-digit levels in GY11 and during most of FY13. While this study demonstrates that such high levels of inflation may jeopardize growth. It also shows that targeting too low an inflation level (say, in lower single digit) for Bangladesh may be hurtful for growth, with potential cost in forgone output. Despite recent moderating trends in inflation, current restrictive policy stance of

Bangladesh Bank seems to be in the right direction, as inflation is still running far beyond indicated optimal threshold level. Besides, continuous coordinated efforts are required to contain inflation around the threshold levels of 7-8 percent for the sake of optimal economic growth in Bangladesh.

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