Estimating growth-inflation trade off 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.

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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. Study identifying the threshold level of inflation in Bangladesh is scarce; therefore, 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.

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

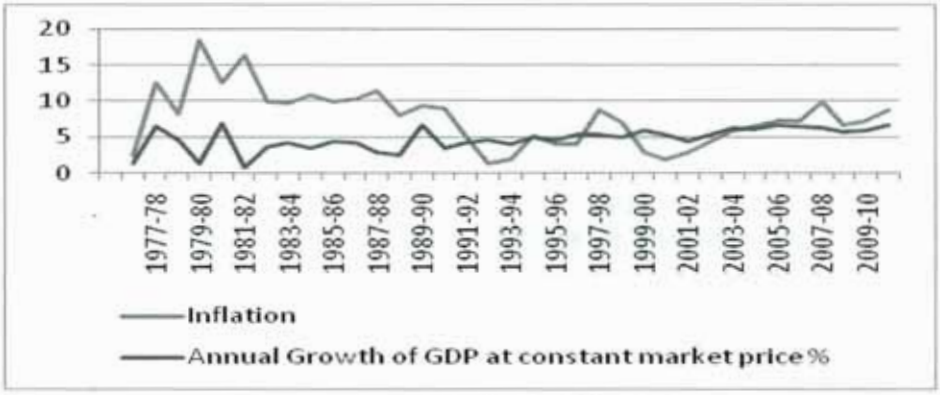
The debate whether inflation has inimical or helpful or no effects on growth were examined empirically in many studies. Some earlier empirical works, such as Fischer, (1993, 1996) and Bruno and Easterly (1995) generally accepted the views that there exists a negative relationship between inflation and 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. 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. The author 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. 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. 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) found the threshold level to be around 6 percent. In contrast, Singh and Kalirajan (2003) using annual data for the period of 1971–1998 provided argument against any threshold level for India. 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. 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 during the period from 1981 to 2012 are used.

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

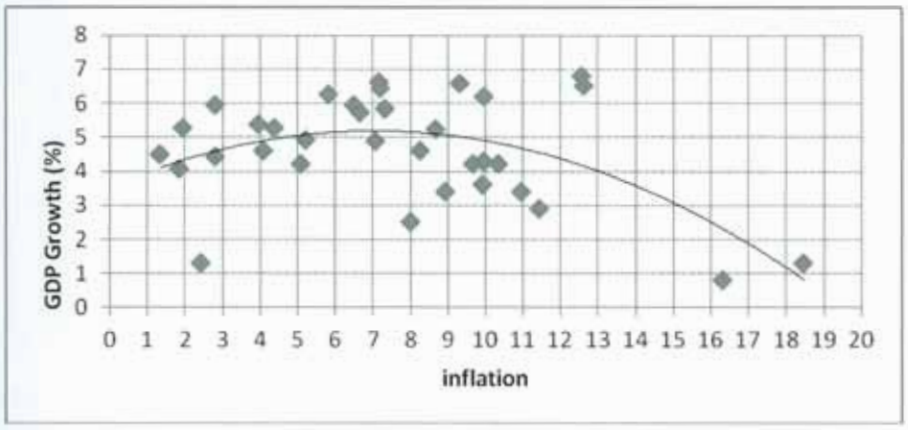
Sample size	inflation (percent)	Avg. GDP growth (percent)
6	up to 2.99	4.25
1	3.00-3.99	5.39
2	4.00-4.99	4.94
3	5.00-5.99	5.13
2	6.00-6.99	5.85
4	7.00-7.99	5.94
5	8.00-8.99	4.48
5	9.00-9.99	4.98
2	10.00-10.99	3.80
1	11.00-11.99	2.90
2	12.00-12.99	6.65
1	16.00-16.99	0.80
1	18.00-18.99	1.3

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 (Chat-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

A. 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.

B. 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.

[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.

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 (d2gry/d2inf) <0, the inverted U curve.

(d2gry/d2inf) 0.539016-2(0.03645)INF=0
or, INF = 0.539016/0.0729=7.394 percent

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.

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? 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.

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