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Growth – Inflation Relationship in Bangladesh: An Empirical Analysis for the Threshold Level of Inflation

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Abstract

It is of significant economic substance to investigate the relationship of the inflationgrowth nexus in Bangladesh, to recognize whether there is a relationship between the two macro variables. This can lead to the detection of the threshold level of inflation for Bangladesh. Accordingly, this research investigates the inflation-growth relationship in Bangladesh, using annual data from 1978 to 2018 fiscal year. Various econometric tests like augmented Dickey–Fuller test (ADF) tests, Breusch-Godfrey serial autocorrelation LM test etc. and Autoregressive Distributed Lag (ARDL) method are used for the growth equation. The results confirm significant structural break in per capita gross domestic product (GDP) growth rate when the inflation rate exceeds 6.5 per cent. However, This is an indication that any adverse effects of contemporaneous inflation are neutralized due to the significant positive effect of money supply (M2) and negative effects from the inflation lag of one and two years. Furthermore, the results are in favour of the view of maintaining inflation at low levels and thus, this study is important for policymakers, when implementing inflation targeting in Bangladesh in the future.

Keywords: Economic growth, per capita GDP growth, inflation threshold.

AMS Classification: 91B84.

1. Introduction

Most of the development strategy objectives of an emerging economy turn around achieving rapid and sustainable economic growth. However, when rapid growth is achieved, as a result of increasing pressure on inputs utilized by excess demand, prices can increase. Hence, supporting high growth requires that inflation be kept in control, if an increase in inflation causes negative effects on economic growth. The study of the inflation- growth nexus in developing countries is essential to understand the true scenario of the relationship between inflation and growth, as maintaining exceptionally low inflation can lead to high unemployment and diminished output. This can generate inadvertent consequences to economic growth in developing countries. In view of this, Pollin and Zhu (2006) recognized a positive nexus between Gross Domestic Product (GDP) growth and high inflation up to 15-18 per cent for 80 middle and low income countries, where they argue that targeting inflation at low levels of around 3-4 per cent may not be possible for emerging economies and doing so could spoil economic growth.

A number of empirical studies, which are discussed in detail under Section Two, have shown that high inflation can be costly and can affect the macroeconomic stability of the country. A study based on data from Latin American countries exposed that there is a negative relationship between inflation and GDP per capita growth (Gregorio, 1992). Barro (1991) shows that when inflation is greater than 10 percent, the per capita GDP growth rate reduces by 0.2 - 0.3 percentage points. A similar inflation threshold is evident in a study by Espinoza et al. (2012), where they conclude that for developing countries, a significant structural break in per capita GDP growth is caused by an inflation rate more than 10 percent.

A study that using data from 86 countries including Bangladesh, found a structural break in per capita GDP growth at 8 percent of inflation rate for emerging and developed nations and suggests that for a significant structural break for per capita GDP growth exists for a country, and the failure on the part of policymakers to take into consideration the same will impose a greater bias on the inflation effect towards GDP growth (Sarel, 1996). Additionally, Sarel emphasises that the existence of a structural break provides a numerical policy target for Central Banks to keep inflation below the structural break. He identify the detrimental effects of high inflation by taking into account the structural break in growth in GDP and points out that when the inflation rate doubles (for example, an increase in inflation from 10 to 20 percent), the growth rate declines by 1.7 percentage points.

One of the core objectives of Bangladesh Bank, the Central Bank of Bangladesh is to maintain economic stability by controlling inflation, which may be harmful to the economy. The lack of well-researched and published papers regarding the

20

threshold level of inflation for Bangladesh, which quantifies any significant structural break of GDP per capita growth in Bangladesh, creates a research gap in this field of studies. Motivated by the identified research gap and also by the findings of Sarel (1996), this study attempts to investigate whether such a structural break for per capita GDP growth exists in the Bangladesh context. Accordingly, this research explores the inflation-growth relation in Bangladesh using annual data. Principally, this paper addresses whether there is any inflation threshold that maximises per capita GDP growth for Bangladesh. If any, is the effect of inflation on growth in per capita GDP significantly different above the threshold level from what it is below the inflation threshold.

The structure of the paper is as follows. Section Two reviews the empirical literature and data description on the inflation-growth relationship. Section Three includes the methodology and estimation used in the study, followed by a summary of the results and analysis. Finally, Section Four discusses policy implications.

2. Literature Review & Data Description

A survey of the available theoretical- and empirical literature is carried out with an observation to enlighten policy makers on the ongoing debate of the inflationgrowth relationship and also to explore the threshold level of inflation, if any, for Bangladesh. Many previous empirical studies have analysed the inflation growth nexus in developing countries as well as developed countries and there is facts for both a positive and negative connection between inflation and growth. Previous studies have been categorized according to the nature of the inflation-growth nexus and salient features are briefly explained.

Latin American countries experienced high inflation along with moderate growth during the 1950s and 1960s, and Bruno and Easterly (1998) researched the behaviour of growth for pre, during and post high inflation periods. They found that there is no significant long run harm to growth from high inflation rates. A short run positive relationship between inflation and growth is recognized by the Keynesian and Neo Keynesian theories (Hayat & Kalirajan, 2009), whereas a long run positive relationship is established by Mallik and Chowdhury (2001) using error correction models for four South Asian countries Bangladesh, India, Pakistan, and Sri Lanka. The research implies that these countries needed inflation

for growth. However, these outcomes contrast with the discoveries of Hayat and Kalirajan for Bangladesh for the period of 1976 to 2005.

In the context of developed countries, Khan and Senhadji (2001) establish an 11 percent threshold for developing countries and 1 percent for industrialization based countries. According to Ghosh and Phillips (1998), the appropriate rate is 2.5 percent, whereas Judson and Orphanides (1999) conclude a two-digit inflation threshold. Moreover, the aggregate supply equation with imperfect information, sticky wages and sticky prices explains a positive relation between prices and output. According to the Phillips curve equation, low inflation is related with lower output or increased unemployment.

Several studies have explored the negative relationship between inflation and growth and according to the conventional neo-classical view, there is a negative relationship between inflation and growth (Barro, 2013). Uncertainty brings macroeconomic instability and in turn reduces the efficiency of the price mechanism and secondly, uncertainty reduces the investments in a country due to the high volatility in prices (Fischer, 1993).

According to the results of Espinoza et al.'s study (2012), which examined 165 countries over the period 1960–2007, it is evident that for developing countries inflation above a threshold of about 10 percent rapidly becomes unfavourable to growth, implying the need to take immediate policy actions to maintain inflation at a single digit level. However, in the context of advanced economies, threshold effect has not been proven and hence any level of inflation damages growth. Furthermore, by using panel data and the Panel Smooth Transition Regression (PSTR) method on the Southern African Development Community, Seletang et al. reveal an inflation threshold of 18.9 per cent, beyond which, there will be harmful effects on the economic growth (2013).

The rate of inflation in Bangladesh is measured by the change in the Consumer Price Index (CPI). The CPI is computed to indicate average changes in the prices of goods and services purchased by households. Bangladesh is considered as a potential and growing economy in the South Asian region. We may observe movements in economic growth and inflation in different decades of Bangladesh economy during the period FY1978-FY2018. After liberation up to the 1980s, GDP per capita growth rates of Bangladesh abnormally fluctuated from -11 to 34 percent while inflation rates followed the same pattern which showed up and

22

down from a negative figure of 2 to 18 percent. During two decades (1981-2000s), high inflation rate remained detrimental to economic growth. Data of the current decade (FY2011 to onward) showed that the average CPI inflation stood at 7 percent and GDP growth per capita was 10 percent. Here the important point is that the degree of relationship between GDP growth per capita and inflation depends on the threshold level inflation of a particular country. If the inflation rate is much lower compare to the threshold rate, the relation may be positive or weak and vice versa. It is a fact that actual conclusion could not be drawn through visual lookup but an inverse relationship between economic growth and inflation rate could be inferred throughout the period under the study.



Source: Bangladesh Bureau of Statistics (BBS) (GDP per capita in USD)



This scatter diagram depicts the level of inflation rate and its corresponding GDP growth per capita. From the below figure 2, a non linear relationship between inflation and real GDP growth and the threshold level of inflation is clearly be seen which is between 6-9 percent.



Figure 2: GDP per capita growth vs inflation

The growth-inflation relationship could be easily understood through portraying their trends over time. Hence, we deconstructed the data for the period (FY1978-FY2018) within 5 grouped observations where we have estimated the average economic growth for each span of inflation (table 1).

Table 1: Inflation-GDP	per capita	growth	relationship	in Bangladesh,
	1978-20)18FY		

Sample Size	Inflation Range (%)	Average GDP per Capita Growth (%)
7	up to 4.00	1.65
6	4.01-6.00	6.46
11	6.01-8.00	9.15
10	8.01-10.00	4.35
7	Above 10.00	11.35

Source: Author's own calculation from BBS data

The groups show that when the inflation rate is ranging from 0 to 4 percent, it shows an average GDP per capita growth rate of 1.65 percent. As the inflation reaches the range of 4.01-6.00 percent and 6.01 to 8.00 percent, growth rate goes up gradually to 6.46 percent and 9.15 percent respectively. However, the next level shows a gradual decrease in growth which may indicates the negative

relationship between inflation and growth rate. It is clear from the above observation that when inflation is at the middle level ranged from 6.01 to 8.00 percent the growth is at the higher level considering outlier at the last level.

Accordingly, the null hypothesis to be tested in this study is that;

H0: the inflation rate and per capita GDP growth rate has a non-linear relationship and a threshold level of inflation exists for Bangladesh.

A similar approach to Sarel (1996) and Hayat and Kalirajan (2009) is used in this study to examine the threshold level of inflation in Bangladesh and to assess whether that threshold level is statistically significant.

Data for Inflation and GDP per capita growth are collected from Bangladesh Bureau of Statistics (BBS). The money supply (M2) data has been collected from Bangladesh Bank and also available in International Monetary Fund (IMF) database. Inflation and GDP related data also available in World Development Indicator (WDI) of the World Bank. Fiscal year 1977-78 to 2017-18 data has been used. Eviews 9.0 has been used during analysis.

3. Methodology and Estimation

3.1 Estimating the growth equation

To examine the inflation- growth relation in Bangladesh, this study uses the model based on the studies of De Gregorio (1992), Bruno and Easterly (1998), Singh and Kalirajan (2003), and Hayat and Kalirajan (2009). These empirical studies have emphasized inflation and money supply (M2) as the main determinants of growth, among others. This principle can also be adopted in a single country time series data, ensuring that the variables entering the regression are stationary (Singh and Kalirajan, 2003). The objective is to identify a model with higher explanatory power for analyzing the relationship between growth and inflation. Accordingly, the following simplified model has been applied to Bangladesh context.

$$GDP_CG_t = \alpha + \beta_1 INF_t + \beta_2 M2G_t + u_t \tag{1}$$

where GDP_CG=GDP per capital growth, INF=inflation, M2G= M2 growth at time period "t".

Since time series data are used in the study, it is necessary to examine whether the variables are stationary or non-stationary. Use of non-stationary data in regressions could produce spurious results through incorrect relationships. Therefore, the Augmented Dickey Fuller (ADF) test and Phillips-Perron test have been used to examine the presence of unit roots, as proposed by Engle and Granger (1987). First level variables were tested and if a unit root for a particular series was found, then they were tested again by taking the first difference level of the series. Table 2 presents the results of the unit root test.

Variables	ADE tost	Phillips-	Critical		
	statistics	Perrontest	Value at 5%	Decision	
		statistic	Level		
GDP_CG	-5.335	-5.327	-2.937		
IMF	-3.649	-3.462	-2.937	No unit	
M2G	-3.568	-3.568	-2.937	1001	

 Table 2: Unit Root Test Results

The result shows that all the variables are stationary. According to the results of the unit root test, the Autoregressive Distributed Lags (ARDL) method developed by Pesaran and Shin (1999) and Pesaran (2001) is used in the study. Due to the relatively small size of the time series data, the order is decided on by using the Schwarz Bayesian Criterion (SBC) of model selection. A lag length of two is selected for GDP_CG, three is selected for inflation and four is selected for M2G. So, equation (1) can be modified as,

$$GDP_CG_t = \alpha + \beta_{11}GDP_CG(-1)_t + \beta_{12}GDP_CG(-2)_t + \beta_{21}INF_t + \beta_{22}INF(-1)_t + \beta_{23}INF(-2)_t + \beta_{24}INF(-3)_t + \beta_{31}M2G_t + \beta_{32}M2G(-1)_t + \beta_{33}M2G(-2)_t + \beta_{34}M2G(-3)_t + \beta_{35}M2G(-4)_t + \epsilon_t$$
(2)

The potential effect of current inflation has been tested using the ARDL in the most well specified model, having taken into consideration all the relevant significant explanatory variables. The impact of contemporaneous inflation along with three lags of inflation has been examined for equation (2) (Table 3). Accordingly, it can be seen that the inclusion of contemporaneous inflation along with other significant controlled variables has improved the goodness-of-fit to 58 per cent considering the lag values of the variables. It is noteworthy that the negative effect of lagged inflations (lag of one period and two periods) and

positive effect of money supply on the GDP per capita growth are statistically significant. It is important to analyze how lagged inflation and money supply must have affected the per capita GDP growth in Bangladesh.

3.2 Estimating threshold level of inflation

In this study, by following Sarel (1996), and Hayat and Kalirajan (2009) in particular to examine the threshold level of inflation for Bangladesh, the dummy variables are introduced to the basic model to incorporate the concept of extra inflation that is the effect caused by higher actual inflation above the threshold level. Accordingly equation (2) will be iterated with different threshold level of inflation (TLINF) i variables as follows,

 $GDP_CG_t = \alpha + \beta_{11}GDP_CG(-1)_t + \beta_{12}GDP_CG(-2)_t + \beta_{21}INF_t + \beta_{22}INF(-1)_t + \beta_{23}INF(-2)_t + \beta_{24}INF(-3)_t + \beta_{31}M2G_t + \beta_{32}M2G(-1)_t + \beta_{33}M2G(-2)_t + \beta_{34}M2G(-3)_t + \beta_{35}M2G(-4)_t + \gamma_1D_iTLINF_{it} + \epsilon_t$ (3)

Here, let INF* be the rate of inflation at the structural break. A dummy variable is defined as,

D_i= 1 if actual INF in period t>INF* and D_i=0 otherwise

A new variable for the excess inflation over INF* is termed as, $TLINF_i=D_i*(INF-INF*)$ where i is the value of INF* (i=4.5,5.0,...., 9.0 etc.).

When $D_i=1$, equation (3) appears as the following:

$$\begin{aligned} GDP_CG_t &= \alpha + \beta_{11}GDP_CG(-1)_t + \beta_{12}GDP_CG(-2)_t + \beta_{21}INF_t \\ &+ \beta_{22}INF(-1)_t + \beta_{23}INF(-2)_t + \beta_{24}INF(-3)_t + \beta_{31}M2G_t \\ &+ \beta_{32}M2G(-1)_t + \beta_{33}M2G(-2)_t + \beta_{34}M2G(-3)_t \\ &+ \beta_{35}M2G(-4)_t + \gamma_1TLINF_{it} + \epsilon_t \end{aligned}$$

When $D_i=0$, equation (3) appears as the following:

$$\begin{split} GDP_CG_t &= \alpha + \beta_{11}GDP_CG(-1)_t + \beta_{12}GDP_CG(-2)_t + \beta_{21}INF_t \\ &+ \beta_{22}INF(-1)_t + \beta_{23}INF(-2)_t + \beta_{24}INF(-3)_t + \beta_{31}M2G_t \\ &+ \beta_{32}M2G(-1)_t + \beta_{33}M2G(-2)_t + \beta_{34}M2G(-3)_t \\ &+ \beta_{35}M2G(-4)_t + \epsilon_t \end{split}$$

By prior expectation we expect $\beta_{21}>0$ and $\gamma_1<0$ because extra inflation has a negative effect on GDP per capital growth. For determination of the threshold

level, the magnitude of γ_1 must be so large so that the sum of the coefficients of both inflation and extra inflation must be negative i.e. $(\beta_{21} + \gamma_1) < 0$.

In search of the threshold level of inflation the OLS regression will be applied iteratively with different assumed structural break (INF*) values. The structural break INF* ranges/takes values from 4.5 to 9. There are few observations below 3 or above 9 percent inflation rate. Estimating regression taking different structural values (INF*) will generate a series of regression estimates.



Figure 3: Residual Sum of Square

Among the series of regression estimates, we determine the threshold level of inflation INF* at which a structural break is suspected with the highest R^2 or minimum residual sum of squares (RSS) along with the sum of the coefficients of both the level of inflation and extra inflation which is negative and statistically significant. It means a one unit increase in inflation above the threshold level results lower the growth. Extra inflation more than the threshold level harms GDP per capita growth. Inflation below the threshold level is tolerable and higher GDP growth is possible by allowing inflation up to this threshold level. To detect the threshold level, we will compare the above 10 estimated equations with maximum R^2 (figure 3).

	Current year	Threshold le	Threshold level of Inflation		
Variable	inflation	for 6.0	for 6.5		
	GDP_CG				
C	-7.030	-2.626	-1.445		
C	(4.25)	(5.35)	(5.05)		
CDD CC(1)	0.408**	0.911***	0.900***		
$ODP_CO(-1)$	(0.17)	(0.31)	(0.32)		
CDP CC(2)	0.347*	0.296*	-0.288		
$GDP_CG(-2)$	(0.19)	(0.17)	(0.17)		
INE	-0.174	2.333**	1.952**		
IINF	(0.47)	(1.02)	(0.94)		
INE(1)	-0.826*	0.064	0.130		
IINF(-1)	(0.42)	(1.38)	(1.37)		
$\mathbf{NE}(2)$	-0.913**	0.010	0.031		
IINF(-2)	(0.35)	(1.17)	(1.17)		
INE(2)	-0.536	0.014	0.019		
IINF(-3)	(0.40)	(0.37)	(0.37)		
Mac	0.708***	-0.191	-0.179		
M2O	(0.21)	(0.49)	(0.49)		
M2C(1)	0.268	0.128	0.069		
M2G(-1)	(0.23)	(1.04)	(1.04)		
M2C(2)	-0.161	-0.351	-0.288		
M2G(-2)	(0.19)	(1.35)	(1.35)		
MOC(2)	0.069	0.194	0.161		
M2O(-3)	(0.19)	(0.87)	(0.87)		
M2C(A)	0.683***	-0.039	-0.033		
M2G(-4)	(0.20)	(0.22)	(0.22)		
INEC O		-2.965**			
ПАРО.0		(1.08)			
INE6 5			-2.697**		
IINF0.J			(0.98)		
R squared	0.577	0.672	0.672		
Adjusted R squared	0.39	0.507	0.508		
DW stat	1.707	0.815	0.859		

Table 3: Growth equation (Current year and Threshold)
estimation

Note: Values in parenthesis are standard errors.

***significant at 1% level, ** significant at 5% level, *significant at 10% level.

From figure 3, we can easily see that the threshold level might be at a rate of inflation of 6 percent or 6.5 percent among the 10 estimated equations where R2 is maximized. We made diagnostic tests for estimation equation at this level of inflation threshold.

From the diagnostic tests summarized in table 4 we found that the there are no serial autocorrelation and heteroskedastic problem in the residual distribution and the residuals are also normally distributed for 6.5%.

	Test statistics			
Test name	Current year inflation	For 6.0% threshold level	For 6.5% threshold level	Decision
Normality (Jarque-Bera test)	0.05 (0.97)	1.35 (0.51)	1.25 (0.54)	Residuals normally distributed
Serial Correlation (Breusch-Godfrey LM test)	0.54 (0.59)	4.05 (0.01)	1.98 (0.11)	Serial correlation exists for 6.0%
Heteroskedasticity (Breusch-Pagan- Godfrey)	1.13 (0.38)	0.73 (0.71)	0.67 (0.76)	No heteroscadasticity error

 Table 4: Diagnostic tests

Note: Values in parenthesis are probabilities

In order to examine whether there is any structural break for GDP per capita growth in Bangladesh, equation 3 has been chosen as the basic model due to its highest explanatory power and also due to the statistical and economical significance of the variables. From Table 3, it can be seen that the inclusion of threshold level of inflation for 6.5 along with other significant controlled variables has improved the goodness-of-fit from 58 percent to 67 percent allowing for the lag values of the variables. From table 3, we can notify the evidence that threshold level of inflation 6.5 is statistically significant and the study suggests that there is positive effect of inflation towards GDP per capita growth while threshold level itself shows statistically negative effect and no other lagged variable is statistically significant. It is notable that the significant positive effect of inflation is neutralized by the significant negative effects of the threshold level of inflation 6.5.

4. Conclusion

The study paper has examined the relationship between inflation and economic growths per capita and determined a threshold level of inflation in the case of Bangladesh. In this paper, various threshold equations have been used to diagnose

empirically the relationship in Bangladesh. The empirical results have indicated that the inflation and growth are negatively related according to the historical data. Second, the sensitivity of inflation to changes in growth rates is larger than that of growth to changes in inflation rates. That's why the policymakers should note that any increase in inflation from the previous period at any level has a negative effect on economic growth.

Empirical results based on time series annual data containing the full sample period (FY1978-2018) show that statistically significant structural break is exists in relation between growth and inflation at 6.5 percent which is higher than the targeted level of inflation (5.6 percent) for FY2018. As suggested by Sarel (1996), the existence of such a structural break is suggestive of an exact numerical target for monetary policy conduct by keeping inflation targets below the structural break point. Here the important point is that macroeconomic stability along with sufficient infrastructural facility is the main prerequisite for sustained growth and a vital window is the effect of inflation on investment which can affect growth. Due to the lack of data of quarterly GDP data, this study could not incorporate yearly seasonal variation in Bangladesh. Thus, this is an important area for further research. Since quarterly data of GDP, inflation and money supply is more volatile and can be expected to a greater extent for recent situation of inflation, the results may be different compare to yearly data.

However, the question of which level of inflation we should maintain to accelerate optimum growth in Bangladesh, has been empirically answered. The results of the study have important implications for monetary policy conduct for Bangladesh. The study recommends that the Bangladesh Bank should continue pursuing the cautious and growth-supportive monetary policy framework by keeping inflation target below 6.5 percent otherwise Bangladesh's growth prospects may be in a weak position. However, the recent trend of inflation shows downward and GDP growth is expected to be higher in the upcoming years. As a result, threshold may be lower.

Since, Bangladesh is an emerging economy, it is important to maintain inflation at a moderate level and prevent adverse effects to the economy through lower inflation rates. Thus, it suggests that maintaining inflation at a stable lower level is prudent and in line with the Central Bank's objective of maintaining economic and price stability.

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