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# Are Terms of Trade Improvement Inflationary?: An Investigation of Non-linear Terms of Trade-Inflation Nexus in Bangladesh

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*Bangladesh is a lower middle income country that has followed an export-led growth strategy to develop its economy over the years which signifies the importance of Terms of Trade (TOT) movements a crucial macroeconomic tool that can dictate its volume of trade. However, despite the fact that a TOT improvement is aimed to generate positive externality on various macroeconomic indicators, it is empirically acknowledged to trigger Inflation as well, mainly through movement in the exchange rates. The aim of this paper is to fill the gap in empirical literature by investigating the linearity relationship between TOT and inflation in context of Bangladesh. In addition, this paper also looks forward to identifying the causal association between TOT and inflation in Bangladesh using annual time series data from 1980 to 2014. A multivariate model was used in which inflation was expressed as a function of TOT and other controlled variables. Augmented Dickey-Fuller test is used to determine the stationarity of the variables considered in the model. Ordinary Least Squares method is also tapped to estimate the slope coefficients attached to the independent variables in the model. Chow Break-point test and CUSUM test are applied to identify possible structural breaks in the data set. In addition, Johansen Cointegration test is employed to understand the long run associations between the variables while the Granger Causality tests provide the causal associations as well. The results confirm an inverted-U shaped non-linear relationship between TOT and inflation in Bangladesh. Moreover, the transition of the country's exchange rate regime from a fixed to the flexible framework is unable to inflict significant influence on the TOT-inflation nexus. The causality tests reveal that TOT improvement in not inflationary in the long run.*

**Keywords:** inflation, terms of trade, Bangladesh, causality, structural break
**Field of Research**: Economics

## 1. Introduction

In the contemporary era, globalization seems to be a major macroeconomic tool that is tapped all over the world in quest of attaining economic development. Globalization can be viewed as a process of enhancing both economic and trade openness through multidimensional liberalization policies taken by governments worldwide, to which Bangladesh is no exception. Bangladesh is a lower middle-income country that has embraced globalization a long time ago which can be reflected in the fact that the nation has been following an export-led growth strategy for long. As a result, it has heavily banked on the export of its readymade garments to the developed countries and in the process has managed to attain positive impacts on its macroeconomic indicators. In

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addition, the nation has increased the magnitude of its trade openness index through its widespread engagement in international trade. Even though globalization is viewed as a means of attaining economic development, it sometimes can boomerang in triggering adversities on the economy which may then go on to question the justification of the globalizing policies being implemented worldwide. Trade openness is a subset of the numerous globalization tools that are at disposal of an economy that is willing to open up in order to boost its trade volumes, especially exports. Nevertheless, liberalizing trade can at times trigger imports at a faster rate than exports, leading to a net exports deficit. Under such circumstances, Terms of Trade (TOT) improvement is believed to be a relatively more stable globalization tool as compared to the enhancement of openness to trade. TOT improvement to a great extent can resolve this problem.

However, a TOT improvement does not always guarantee favorable impacts on the associated economy, as evidence have been found in the empirical literature suggesting that an improvement in TOT can at times trigger Inflation (INF) within the local economy. INF, although, plays a positive role in incentivizing investments required for catalyzing the domestic industrialization drives, it is generally viewed as a negative determinant of crucial socioeconomic indicators. For instance, rising rates of INF can erode the standard of living of the local people by reducing their purchasing capabilities. Moreover, inflation can also trigger the input prices for manufacturers, thus having a dampening effect on the overall investment in the economy. Rising input prices can also drive the price of exportable items up leading to a fall in the overall export volume whereby the net exports value is likely to be axed. Thus, the TOT-INF nexus has been a crucial field of research amongst academicians and policymakers all around the globe.

The ambiguous relationship between a country's TOT and INF is evident in existing literature as no unanimity is yet to be established regarding a particular nature of this relationship. It is often argued that TOT improvement can either instigate inflationary pressures on the local economy or, in contrast, it can also lead to a fall in the domestic INF rate as well (Gruen and Shuetrim, 1994). The authors argued that TOT improvement can trigger domestic INF in Australian economy if the increase in the country's Real Exchange Rate (RER) is less than at least half of the increase in the TOT and vice-versa. Thus, countries engaged in extensive bilateral and multilateral trade agreements are highly vulnerable to TOT shocks that can lead to the appreciation of their respective RER which in turn can stimulate domestic INF in their own economies. In contrast to the views suggesting TOT to be a determinant of domestic INF, some researchers have also opined on a reverse causal relationship between these two variables (Rotemberg, 1985; Tso, 1988). In a study by Tagliabue (2005), a rise in expected INF following an expansionary monetary policy adoption can reduce the demand for money and increase the demand for capital goods, leading to a deterioration of the local TOT. Similarly, a rise in INF can also reallocate the expenditure budget of the local people from consumption of goods and services to the non-consumption expenditure of people whereby an excess supply of exportable goods would, in turn, push down export prices leading to a decline in the local TOT as well.

The nature of the association between a country's TOT and INF is also believed to depend on the type of exchange rate regime followed. According to Stevens (1992), under a fixed exchange rate system followed in Australia, there was a positive relationship between TOT and INF as a rise in TOT was associated with a rise in the rate of INF and vice-versa. However, under a floating exchange rate arrangement, the relationship was not so pronounced and rather was reversed at a certain period of time. Thus, the author had concluded that the dynamics encompassing the TOT-INF nexus is somewhat determined by the local country's exchange rate arrangement. Thus, the investigation of the relationship between TOT and INF in context of Bangladesh is of great significance since Bangladesh historically followed a fixed exchange rate policy before making its transition in a floating exchange rate arrangement from May 2003 onwards. At present, Bangladesh practices a managed floating system whereby the equilibrium exchange rate is market-determined but the Bangladesh Bank does have some discretionary powers, if required, to intervene and tackle the nation's exchange rate volatilities.

Although there are a plethora of studies analyzing the effects of inflation on economic growth in Bangladesh (Hossain *et al., 2012*), to the best of my knowledge, there has been no previous study exclusively emphasizing on the nexus between TOT and INF in context of Bangladesh. This paper aims to fill this gap in the empirical literature by employing time series econometric methodology using relevant annual data from 1980 to 2014. In addition, this paper also attempts to test the linearity of the TOT-INF nexus and also attempts to shed light on the difference, if any, in the nature of the TOT-INF nexus resulting from the nation's decision to change its exchange rate from May 2003 onwards. Furthermore, cointegrating and causality analyses are also considered to check the robustness of the association between TOT and INF in Bangladesh. The following questions have been specifically addressed in the paper:

1. Does the relationship between TOT and INF exhibit linearity in context of Bangladesh?
2. Is there any cointegrating relationship between changes in TOT and INF in Bangladesh?
3. What is the form of causal association between TOT and INF in context of Bangladesh?
4. Does the nature of the TOT-INF nexus vary across the type of exchange rate regime followed in Bangladesh?

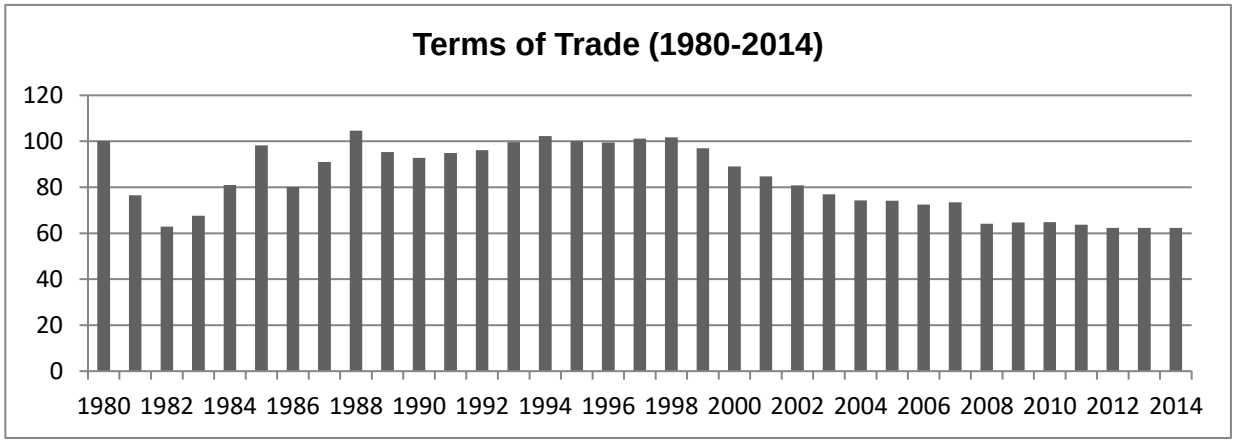
The remainder of the paper is structured as follows. Section 2 provides an overview of the trends in Bangladesh's TOT and INF indices. This is followed by a review of the existing literature, as presented in section 3, addressing the dynamics concerning the TOT-INF nexus. Section 4 gives the empirical model considered in the paper and also sheds light on the attributes of data used. Section 5 provides the methodological approach that is employed in the paper, while section 6 presents the estimated results from the various econometric tests performed. Finally, section 7 highlights the concluding remarks emphasizing the findings and their implications.

## 2. An Overview of TOT and INF Trends in Bangladesh

### 2.1 Bangladesh's TOT Stylized Facts:

Over the years, Bangladesh has experienced a more or less symmetric trend in its TOT value. Fig. 1 shows the trends in Bangladesh's TOT over the period 1980 to 2014.

**Figure 1: Bangladesh's TOT Trends between 1980 and 2014**




*Source: Bangladesh Economic Review (2015).*

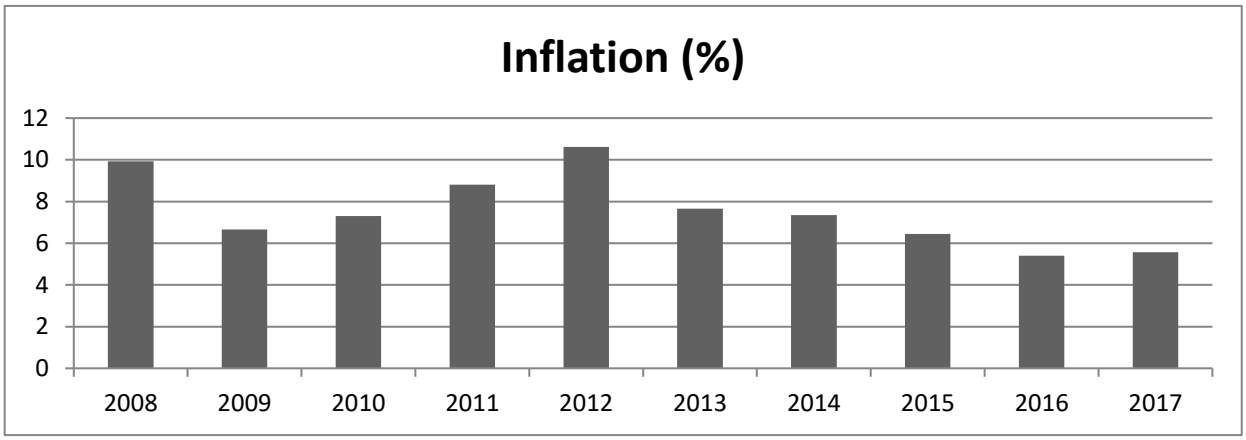
An important point to note here is the fact that the changes in Bangladesh's TOT do not imply volatility which implies that the country is yet to face a major TOT shock. The country recorded its highest TOT figure of 104.7 in the year 1998 however it could not be sustained which is evident from the fact that the TOT values experienced a declining trend over the next two years. Bangladesh's TOT ratio hovered around a touch more than 60 between 2008 and 2014 which is a concern for a nation like Bangladesh which is heavily reliant on its export sector. The low value of Bangladesh's TOT can be hypothesized to have occurred due to a rise in the country's domestic price level, pushing its relative export prices up.

### 2.2 Inflationary Rates in Bangladesh between 2008 and 2017

Historically, inflation was a problematic issue for Bangladesh ever since the country's independence in 1971. Bangladesh had experienced substantial fluctuations in its domestic INF rate over the years. However, the country managed to effectively curb the rate in recent times as reflected in the nation's average yearly rate of INF being 7.75% (Bangladesh Bureau of Statistics, 2017). Over the last decade, the nation experienced its worst INF rate scenario in 2012 as the rate went up to 10.62%. That was the time when Bangladesh recorded the highest rate of INF amongst the South Asian countries. Since then, the government of Bangladesh has managed to bring down the national INF rate by almost half the rate and as a result, the current rate of INF in Bangladesh is around 5.57% (as of July 2017). The country experienced its lowest INF rate of 3.37% in ten years in September 2016. Controlling the volatility in INF rate is crucial in order to maintain a

macroeconomic stability in the economy which in turn would enhance the investment climate within the nation. Thus, it can be said that Bangladesh has recently achieved an impressive feat in ensuring low INF rates but there is still scope to go one step further.

**Figure 2: The INF trends in Bangladesh (2008-2017)**




*Source: Statistical Yearbook of Bangladesh, 2017, Bangladesh Bureau of Statistics (BBS).*

The Consumer Price Index (CPI) is often used as a proxy for INF in conventional literature. Table 1 provides an understanding of the overall INF situation in selected countries enlisted under the South Asian Association for Regional Cooperation (SAARC) via the associated CPIs of those countries between 1992 and 2012. It can be seen from the table that Bangladesh, in 2012, is just behind India in terms of its CPI while having a favorable CPI compared to the other SAARC countries included.

**Table 1: Consumer Price Indices of Selected Countries under the SAARC**

| Year | Bangladesh | India | Pakistan | Sri Lanka | Nepal | Bhutan |
|---|---|---|---|---|---|---|
| **2000** | 2.208256209 | 3.805865922 | 4.366664513 | 6.17627591 | 2.478820207 | 4.01099373 |
| **2001** | 2.007173742 | 3.76723848 | 3.148261446 | 14.1584558 | 2.688303735 | 3.410404624 |
| **2002** | 3.332564933 | 4.246353323 | 3.290344726 | 9.55103167 | 3.029399487 | 2.483430488 |
| **2003** | 5.668707734 | 6.145522388 | 2.914134701 | 6.314637871 | 5.707009319 | 1.566152408 |
| **2004** | 7.587536385 | 6.369996746 | 7.444624693 | 7.57592583 | 2.841811312 | (18.1086301) |
| **2005** | 7.046618162 | 8.351816444 | 9.06332737 | 11.6396861 | 6.836332659 | 5.311513063 |
| **2006** | 6.765261171 | 10.87739112 | 7.921084401 | 10.02018361 | 6.920335807 | 5.00045438 |
| **2007** | 9.106984969 | 11.99229692 | 7.598684411 | 15.84211149 | 5.745910312 | 5.156111388 |
| **2008** | 8.901944895 | 8.857845297 | 20.28612109 | 22.56449553 | 9.878396059 | 8.327160494 |
| **2009** | 5.423472362 | 9.312445605 | 13.64776506 | 3.464963221 | 11.07764508 | 4.361122191 |
| **2010** | 8.126676392 | 10.90764331 | 13.88113926 | 6.217648893 | 9.324000504 | 7.036383161 |
| **2011** | 10.7048046 | 6.353194544 | 11.91676947 | 6.716768436 | 9.271714177 | 8.848985699 |
| **2012** | 6.21818237 | 5.872426595 | 9.68505341 | 7.542913732 | 9.454180743 | 10.91965694 |

*Source: World Development Indicators (WDI), 2016, World Bank.*

## 3. Literature Review

This particular section has been divided into two sub-sections. At first, a conceptual framework is provided to explain the dynamics relating to the TOT-INF nexus. In the latter part of this section, empirical findings are given to shed light on the existing literature explaining the relationship between INF and its macro determinants.

### 3.1 Theoretical Background

A country's TOT refers to the price of its exports relative to the price of its imports. It is basically a ratio that is calculated by dividing a country's export prices by its import prices and then multiplying it by 100. Thus, a rise in TOT over 100 can be termed as an improvement in TOT while a fall in TOT below 100 can be remarked as the opposite. It is important to note here that, since TOT is a ratio of prices, a change in domestic INF rate within a country can easily affect its TOT. Thus, INF has often been expressed as a determinant of TOT in existing literature. However, in contrast, some studies have also concluded TOT to be effective in explaining changes in the domestic rate of INF as well. Thus, the ambiguity related to the nature of the TOT-INF nexus prevails.

#### 3.1.1 The ‘Neoclassical Two-Country, Two-Currency, Two-Goods Model’

It can ideally explain the mechanisms by which a monetary expansion induced INF can affect TOT within an economy. In case of both the demand and supply side channels, a rise in INF is believed to deteriorate a country’s TOT. According to the demand side economics, an increase in inflation can lead to speculative actions in people as they would expect the rate of INF to increase further in future. As a result, the demand for capital goods in the economy would increase leading to a rise in the associated prices, both locally and internationally. Thus, the import prices, *ceteris paribus*, would go up resulting in a decline in the country's TOT value. In contrast, according to the supply side economics, a rise in INF rate would reduce the purchasing powers of the local people whereby a budget reallocation from consumption expenditure to non-consumption expenditure can be expected. This, in turn, would result in an oversupply of exportables causing the price of exports to decline. As a result, the country’s TOT index is likely to deteriorate as well.

#### 3.1.2 The Factor-Reallocation Effect

The effect of a TOT improvement on domestic INF can be explained via the factor-reallocation effect mechanism which takes place when a rise in TOT induces a corresponding increase in the Real Exchange Rate (RER) of the local country. Following such an increase in the RER, the volume of exports is likely to increase which in turn would stimulate factor reallocation from production of non-traded goods to production of traded goods. Thus, the fall in supply of non-traded goods in the local market would drive their prices up, triggering INF in the local economy. Gruen and Dwyer (1995) made conclusions in support to the factor-reallocation effect of a TOT improvement by stating

that a rise in the TOT value in the Australian economy is inflationary if the associated rise in RER is below a threshold level.

### 3.2 Empirical Findings

There have not been many studies in existing literature that have directly investigated the relationship between TOT and INF. However, many researchers have attempted to comment on the TOT-INF nexus in light of growing globalization and its effects on the overall economy. In a study by Bowen and Mayhew (2008), the relationship concerning globalization, import prices and inflation was analyzed in the context of the United Kingdom (UK). The authors asserted that rising degree of globalization in the UK led to its TOT improvement in between the mid-1970s and mid-2000s mainly due to falling import prices. However, increased demand for raw materials and technology triggered domestic INF in the local economy which eventually off-set the improvement trends of TOT in the UK. Thus, a negative relationship between TOT and domestic inflationary rate in the UK was put forward. Their results corroborated to the conclusions made by Gruen and Dwyer (1995) in which an improvement in Australian TOT was referred to stimulate inflationary pressures if the associated rise in the country's real exchange rate was below a threshold level.

The negative association between TOT and INF was also put forward by Fatima (2010) who examined the effects of TOT in Pakistan incorporating time series data from 1990 to 2008. Net barter TOT and income TOT were the two forms of TOT considered in the paper. According to the findings, Pakistan experienced negative impacts on its GDP mainly due to its TOT deterioration which was attributed to the country's export price instability. In addition, Pakistan's persistent high rate of INF, reaching a double-digit in the financial year 2008-2009, was thought to be a decisive factor that had contributed to the nation's export price instability. Moreover, the country's occasional droughts driving agricultural goods' prices up exerted adverse impacts on the country's trade volume, further deteriorating its TOT.

The TOT-INF nexus can also be understood from the conclusions made by Kasirajan and Thirunavukkarasu (2015) that shed light on the relationships trends between exchange rates, inflation and terms of trade. The authors acquired historical data over the period 2000/01 to 2013/14 in context of India. In light of their concluding remarks, a negative relationship between India's TOT and INF can be understood due to exchange rates being positively and negatively related to INF and TOT. The historical statistics suggest that rises in INF rates in India were matched by increments in the country's exchange rates. As a result, India's exports experienced a falling trend while imports surged leading to deterioration in the local TOT values.

Desormeaux *et al.* (2009) probed the TOT, commodity prices and INF dynamics in the context of the Chilean economy using a Dynamic Stochastic General Equilibrium (DSGE) in order to predict the relationships from 2001 to 2008. According to the findings, an improvement in the TOT gains in Chile led to a one to one increase in the nation's government size, attributing to inflationary pressures in the Chilean economy. In addition,

INF in Chile, in the form of a cost-push INF framework, was also found to be determined by the oil price shocks faced by the nation.

In a study by Yoon *et al.* (2014), the effects of demographic changes on INF and macroeconomic indicators in the context of 30 OECD countries using annual data from 1960 to 2013. Dynamic panel estimation techniques were used to estimate results for the OECD panel while OLS method was tapped in context of Japan. TOT was considered as one of the demographic variables explaining the changes in INF, a macroeconomic variable. Results suggested that INF and TOT growth rate was negatively related in the cases of both Japan and OECD panel as the estimated slope coefficients of -0.145 and -0.169 respectively were statistically significant at 1% and 5% levels of significance.

The positive relationship between INF and the home country's TOT was explored by Carlin and Soskice (2006). According to the authors, a rise in the home country's INF compared to world INF will lead to a TOT improvement in the home country. This happens because the price of exports is determined at home while the home country has nominal power over the import prices and as a result, the price of exports relative to import prices are likely to rise. Thus, INF was concluded to be a variable that explains TOT changes in an economy. Their views were in contradiction to those by Kulish and Rees (2015) who asserted a reverse causal relationship between Australia's TOT and INF suggesting that a rise in the relative price of non-tradable can be accounted for due to shifts in the country's TOT index.

The relationship between TOT and domestic INF from the perspective of oil exporting countries was highlighted in the study by Karimili *et al.* (2016). The study emphasized on understanding the mechanism in which oil price shocks are translated into domestic INF in three oil exporting nations, Azerbaijan, Kazakhstan and Russia incorporating quarterly data from 2001Q1 to 2014Q4. Structural Vector Autoregression (SVAR) techniques were applied throughout the study. The results confirmed that negative oil price shocks in these countries led to the deterioration of their TOT which in turn resulted in the exertion of inflationary pressures. Thus, a negative relationship between TOT and INF in context of oil-exporting economies was put forward in this study. Their findings were in line with those by Ito (2008) for Russia and Adeniyi *et al.* (2012) for Nigeria.

The negative association between TOT and INF was also indirectly put forward by Bowdler and Malik (2005) who examined the nexus between openness and INF volatility in context of a panel of 96 countries, including the Chad and all the countries except for the four Gulf oil states used in the sample of Romer (1993). Dynamic panel data estimation techniques were employed to draw conclusions based on the test findings. According to Bowdler and Malik (2005), a rise in openness in the panel of the countries considered led to a worsening of the TOT index which in turn resulted in a fall in the rate of INF. Thus a negative association between TOT and INF was found to be statistically significant.

## 4. Empirical Model and Data

The model considered in this paper is an extension of the one used by Ramzan *et al.* (2013) in which TOT and other macroeconomic determinants of INF are augmented. Basically, in the model, INF is expressed as a function of TOT, controlling for the real fundamentals of triggering the inflationary rate in the economy of Bangladesh. Annual time series data of all the variables are incorporated from the year 1980 to 2014. The empirical linear regression model is as follows:

$$INF_t = \alpha_0 + \alpha_1 TOT_t + \alpha_2 RER_t + \alpha_3 M2_t + \alpha_4 GDP_t + \alpha_5 INT_t + \alpha_6 OPEN_t + \alpha_7 IMP_t + \alpha_8 EXP_t + \varepsilon_t \quad \ldots\ldots\ldots \text{(i)}$$

where INF and TOT are inflation and terms of trade figures of Bangladesh. The rate of inflation in Bangladesh is proxied by its consumer price index. RER represents the real exchange rate calculated by multiplying the nominal exchange rate by the ratio of consumer price indices of Bangladesh and the United States. M2 denotes broad money and it is used as a measure of money supply in the economy. The gross domestic product of Bangladesh is denoted by GDP which is considered to proxy for the level of economic growth in the country. Open refers to trade openness in the country which is used as a proxy to depict the magnitude of globalizing activities undertaken by the governments of Bangladesh over the years. IMP and EXP are the volumes if imports and exports in the country.

Moreover, in order to verify whether the TOT-INF relationship is linear or non-linear in nature, a second alternative regression model includes the squared term of the variable TOT (as $TOT^2$):

$$INF_t = \beta_0 + \beta_1 TOT_t + \beta_2 TOT^2 + \beta_3 RER_t + \beta_4 M2_t + \beta_5 GDP_t + \beta_6 INT_t + \beta_7 OPEN_t + \beta_8 IMP_t + \beta_9 EXP_t + \varepsilon_t \ldots \text{(ii)}$$

In order to capture whether the TOT improvement effect on INF could also be attributed to Bangladesh's transition from a fixed exchange rate regime to a flexible exchange rate regime**,** a dummy variable is introduced (DUM) into equation (i). Since the flexible exchange rate policy in Bangladesh was adopted from May of the financial year 2003/04, the dummy variable has a value of zero from 1980 to 2003 and a value of one from 2004 onwards. Thus, a third alternative regression model augments equation (i) with a new variable which is given as a multiple of TOT and DUM:

$$INF_t = \rho_0 + \rho_1 TOT_t + \rho_2 (TOT^* DUM)^2 + \rho_3 RER_t + \rho_4 M2_t + \rho_5 GDP_t + \rho_6 INT_t + \rho_7 OPEN_t + \rho_8 IMP_t + \rho_9 EXP_t + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(iii)}$$

Table 2 provides the sources and units of the variables included in the dataset.

**Table 2: Informative Details of Variables Included in the Data Set**

| Variable | Units | Source |
|---|---|---|
| **INF** | Index | International Financial Statistics, IMF, 2015 |
| **TOT/TOT$^2$** | Index | Bangladesh Economic Review, 2015 |
| **RER** | BDT/USD | Statistical Yearbook of Bangladesh, 2017, Bangladesh Bank. |
| **M2** | Bangladeshi Taka | World Development Indicators, 2016, World Bank. |
| **GDP** | Current billion US$ | World Development Indicators, 2016, World Bank. |
| **INT** | Percentage | World Development Indicators, 2016, World Bank. |
| **OPEN** | Percentage (of GDP) | World Development Indicators, 2016, World Bank. |
| **IMP** | Current US$ | World Development Indicators, 2016, World Bank. |
| **EXP** | Current US$ | World Development Indicators, 2016, World Bank. |

## 5. Methodology

At first, all the variables in the entire data set were tested for unit roots, if any, using the Augmented Dickey-Fuller (ADF) test of stationarity. This was followed by the Ordinary Least Squares (OLS) method to estimate the unknown parameters in equations (i), (ii) and (iii), respectively. The results from the OLS provided the relationship between the dependent and the explanatory variables considered in the paper. Tests for structural breaks, using Chow break-point test and CUSUM test, were then conducted to identify possible impacts of break dates in the estimated results. In accordance to existing literature asserting that exchange rate regime in an economy affects its nature of TOT-INF relationship (Catao and Chang, 2013), a possible break-point date in this paper could be 2004, the time when Bangladesh made a transition from fixed to flexible exchange rate policy. Thus, the Chow break-point test was conducted using 2004 as the specified break date. Then the Johansen cointegration test, a prerequisite for conducting causality tests, was performed to understand whether, or not, the variables are related in the long run. Finally, the Granger causality test and the Vector Error Correction Model (VECM) approach were employed to deduce the long run and short run causal relationships between the variables in the paper.

### 5.1 Augmented Dickey-Fuller (ADF) Test

There are several ways of testing for the presence of a unit root. However, the popular test for unit roots is Augmented Dickey-Fuller (ADF) tests. The ADF test is run based on equation (iii) which is a modification of the DF test and involves augmenting the DF equation by lagged values of the dependent variable, and hence ensuring that the error process is residually uncorrelated.
It also captures the possibility that the dependent variable is characterized by a higher order autoregressive process.

$$\Delta Y_t = \alpha + (\beta - 1) Y_{t-1} + \delta \Delta Y_{t-1} + \Psi T + e_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(iv)}$$

In case of the ADF test the following testing procedure has been performed:

$H_0$: $\beta - 1 = 0$ [i.e. the $Y_t$ is non-stationary]

$H_1$: β—1≠0 [i.e. the $Y_t$ is stationary]

If the observed data exhibits an increasing or decreasing trend, it is very crucial to include the time trend in the unit root test procedure. Here it is mentionable that unit root tests have non-standard and non-normal asymptotic distribution which are highly affected by the inclusion of deterministic terms, e.g., constant, time trend etc. A time trend is considered an extraneous regressor whose inclusion reduces the power of the test. However, if the true data generating process were trend stationary, failing to include a time trend also results in a reduction in power of the test. In addition, this loss of power from excluding a time trend when it should be present is more severe than the reduction in power associated with including a time trend when it is extraneous.

We cannot rely upon the usual t-statistic since $Y_t$ can be non-stationary; rather we need to use specially tabulated McKinnon τ (tau) statistics values. If the computed value of τ is absolutely greater than the critical DF value, we may reject the null hypothesis of non-stationarity, with α level of significance and accept the alternative hypothesis of stationarity. Otherwise, we do not. One of the most important issues in conducting the unit root test is to select the appropriate lag length. One approach is to include a relatively long lag length and select the model by the usual t-test. If the t-statistics on lag p is insignificant at some specified critical value, the regression should be repeatedly estimated using a lag length p-1 until the lag is significantly different from zero.

### 5.2 Ordinary Least Squares (OLS) Estimation Method

In time series analysis, the OLS technique is a widely hired econometric tool that estimates the coefficients of unknown parameters in a linear regression model by minimizing the sum of squares (hence the name least squares) of the differences between the predicted coefficients and the actual coefficients in the data set. The OLS method basically predicts a regression line that best fits the data points in the sense that the estimated line is closest to the actual regression line. Under certain conditions, the OLS provides estimations of parameters having the minimum amount of variances and unbiased means. Some of the prerequisites for the OLS method to work include the explanatory variables to be exogenous to avoid the endogeneity problem. In addition, the error terms should not have heteroscedasticity and should definitely be serially uncorrelated. A basic OLS regression model is given by:

$$Y = a + bX \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(v)}$$

where Y and X are N number of paired observations, a is the intercept to be estimated and b is the slope coefficient which is to be estimated too. The estimated regression line (Y') is given by:

$$Y' = a + bX \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(vi)}$$

The ‘errors’ in prediction, denoted by ε, are to be minimized and can be given by:

$$\varepsilon = \sum_i (Y_i - Y_i')^2 = \sum_i [Y_i - (a + bX_i)]^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(vii)}$$

The values of a and b can then be estimated by taking the derivative of ε with respect to a and b and equating them to zero:

$$\frac{\partial \varepsilon}{\partial a} = 2Na + 2b\sum X_i - 2\sum Y_i = 0 \qquad \text{.....(viii)}$$

$$\frac{\partial \varepsilon}{\partial b} = 2b\sum X_i^2 + 2a\sum X_i - 2\sum Y_i X_i = 0 \qquad \text{..... (ix)}$$

Solving the two normal equations (viii) and (ix), the least squares estimates of a and b can be given by:

$$a = Y^{"} - bX" \qquad \text{..... (x)}$$

$$b = \frac{\sum(Y_i - Y^{"})(X_i - X^{"})}{\sum(X_i - X^{"})^2} \qquad \text{.....(xi)}$$

where Y" and X" are the means of the variables Y and X respectively.

### 5.3 Tests for Structural Breaks

In case of a regression model incorporating data from a large period of time, the variations in the dependent variable, explained by the regressors, can at times be attributed to a particular event that had occurred at a particular point within the entire period of study. These particular points are referred to a structural breakpoint. It is crucial to identify the location of any structural break, if any, within the data set in order to understand how the effects of those breaks are accommodated into the estimated parameters of the regression model. In simple terms, structural break tests are tapped to test whether an estimated regression model has the same predicted coefficients for different time periods. In this paper, two structural break tests are considered: Chow BreakPoint test and CUSUM test.

#### 5.3.1 Chow Break-Point Test

The Chow-Break Point (Chow, 1960) Test is conventionally applied in the time-series analysis to test the statistical significance of a known break date. It basically validifies the presence of a structural break, if any, from a certain time onwards which is assumed to be known beforehand (*a priori).* In econometric terms, this test is used to determine whether the impacts of regressors on the dependent variable are different across a couple of samples drawn on the basis of the known macroeconomic event date. The basic model considered for the test is given by:

$$Y_t = \partial_0 + \partial_1 X_t + \varepsilon_t \qquad \text{.....} \quad \text{(xii)}$$

where Y is the dependent variable, X is the regressor and ε is the error term. The time trend is shown by t. The known structural break date then needs to be added to the model in the form of a dummy variable,$_t$ with a value of 0 and 1 before and after the date respectively. The revised model is given by:

$$Y_t = \partial_0 + \partial_1 X_t + \beta_0 A_t + \beta_1 X_t A_t + V_t \qquad \text{.....(xiii)}$$

The null and the alternative hypothesis considered in the test are as follows:

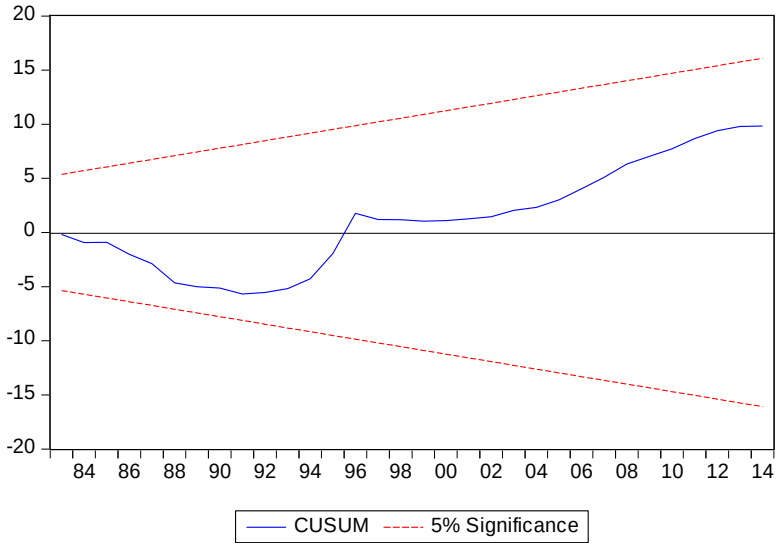
$H_0$: $\beta_0=\beta_1=0$ [i.e. no break-point at specified date]
$H_1$: At least one is equal to zero [i.e. there is existence of break-point at specified date]

Following the regression of equation (xiii), if the estimated F-statistic is large and has a probability value of less than 5%, then the null hypothesis can be rejected implying a statistical significance of the existence of the structural break at the specified date. In case of the model in this paper, a possible structural break-point in the data set could be in the year 2003, the time when Bangladesh made a transition from a fixed exchange rate regime to a flexible exchange rate regime.

### 5.3.2 The Cumulative Sum (CUSUM) Test

The CUSUM (Page, 1954) structural break test is appropriate under the circumstance when the exact point of structural break in the data set is unknown. Thus, this test aids in identifying the possible existence of unknown structural breaks. Location of break-point at unspecified date under the CUSUM test is estimated via the recursive least squares estimation technique (Brown *et al.*, 1975). It is basically a stability test which shows whether regression of a model is stable over a disaggregated time period of study. The stability is viewed in the sense that the estimated value of the coefficients across different subsamples is equal. The CUSUM output is basically provided in the form of a chart in which if the estimated regression graph lies in between the upper and lower limits (usually set at 95% confidence interval) then the dependent variable is said to be stable; implying no existence of a structural break in the data set (vice-versa). An example of a CUSUM is given in **figure 3.**

**Figure 3: An example of a CUSUM Chart**



### 5.4 Johansen Test for Cointegration

Furthermore, the Johansen procedure was applied to test for cointegration, which is known to provide a unified framework for estimation and testing of cointegration relations in the context of VAR error correction models. An Unrestricted Vector of Autocorrelation of the following form is estimated for this purpose:

$$\Delta x_t = \alpha + \theta_1 \Delta x_{t-1} + \theta_2 \Delta x_{t-2} + \theta_3 \Delta x_{t-3} + \cdots\cdots + \theta_{k-1} \Delta x_{t-k+1} + \theta_k \Delta x_{t-k} + u_t \quad \ldots\ldots\ldots\ldots \text{(xiv)}$$

where $\Delta$ is the difference operator; $x_t$ is a (n x 1) vector of non-stationary variables (in levels); and $U_t$ is the (n x 1) vector of random errors. The matrix $\theta_k$ contains the information on the long run relationship between variables, for instance, if the rank of $\theta_k = 0$, the variables are not cointegrated. On the other hand if rank (usually denoted by r) is equal to 1, there exists one cointegrating vector and finally if $1 < r < n$, there are multiple cointegrating vectors. Johansen (1988) derive two tests for cointegration, namely the trace test and the maximum Eigenvalue test. The trace statistic test evaluates the null hypothesis that there are at most r cointegrating vectors whereas the maximum Eigenvalue test, evaluates the null hypothesis that there are exactly r cointegrating vectors in $x_t$.

### 5.5 Granger Causality Test

According to cointegration analysis, when two variables are cointegrated then there exists at least one direction of causality. Granger-causality, introduced by Granger (1969), is one of the important matters that have been much studied in empirical macroeconomics and empirical finance. The presence of non-stationarity can lead to ambiguous or misleading conclusions in the Granger causality tests (Engel and Granger, 1987). Only when the variables are cointegrated, it is possible to deduce that a long run relationship exists between the non-stationary time series.

When we take y and x as the variables of interest, then the Granger causality test (Granger, 1969, 1988) determines whether past values of y add to the explanation of current values of x as provided by information in past values of x itself. If previous changes in y do not help explain current changes in x, then y does not Granger cause x. In a similar way, we can examine if x Ganger causes y just be interchanging them and carrying out this process again. There could be four probable outcomes: (a) x Granger causes y (b) y Granger causes (c) Both x and y granger causes the other and (d) neither of the variables Granger causes the other.

In this paper, the causality tests among all the concerned variables are conducted. For this the following set of equations are estimated:

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots\cdots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \cdots\cdots + \beta_l y_{t-l} + u_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(xv)}$$

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots\cdots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \cdots\cdots + \beta_l x_{t-l} + v_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(xvi)}$$

This paper considers the above set of equations for all possible pairs of (x, y) series in the group. The reported F-statistics are the Wald statistics for the joint hypothesis. After

confirming the long run causalities between the variables considered in the model, the VECM approach provides the short run causal relationships.

## 6. Results

The results from the ADF unit root test suggest that all the variables, in common, are stationary at their at their first difference forms, I (1). Thus, the possibility of the regressions being spurious is nullified.

**Table 3: ADF Unit Root Test Results**

| Var. | ADF Stat.[a] | ADF Stat.[b] | Decision on Stationarity |
|---|---|---|---|
| **First Difference I (1)** | | | |
| **INF** | -9.112 | -8.984 | Stationary considering both constant and constant and trend |
| **TOT** | -5.884 | -5.944 | Stationary considering both constant and constant and trend |
| **$TOT^2$** | -6.209 | -6.247 | Stationary considering both constant and constant and trend |
| **RER** | -4.105 | -4.394 | Stationary considering both constant and constant and trend |
| **M2** | 6.556 | 2.140 | Stationary considering constant and Non-Stationary considering constant and trend |
| **GDP** | 3.564 | -2.445 | Stationary considering constant and Non-Stationary considering constant and trend |
| **INT** | -4.198 | -4.183 | Stationary considering both constant and constant and trend |
| **OPEN** | -3.593 | -4.495 | Stationary considering both constant and constant and trend |
| **IMP** | -1.166 | -6.258 | Non-Stationary considering constant and Stationary considering constant and trend |
| **EXP** | -0.839 | -6.084 | Non-Stationary considering constant and Stationary considering constant and trend |
| **DUM** | -5.745 | -5.725 | Stationary considering both constant and constant and trend |

| **Table: Mackinnon Critical Values for Rejection of Hypothesis of a Unit Root** | | | | |
|---|---|---|---|---|
| **Level of Significance** | **Level I (0)** | | **First Difference I (1)** | |
| | **Only Constant** | **Constant and Trend** | **Only Constant** | **Constant and Trend** |
| **5%** | -2.951 | -3.548 | -2.954 | -3.553 |

*Notes: (a) Considering only constant; (b) Considering both constant and trend; Critical Values are given at 95% level.*

Results from the OLS estimations are represented in Table 4. According to the OLS estimations of equation (i), a positive relationship between TOT and INF is found as the slope coefficient of TOT is estimated to be 0.119. Moreover, IMP is also observed to have positive impacts on INF while INT and EXP are negatively related to INF. Results also confirm that the positive relationship between TOT and INF does not sustain when the squared term of the variable TOT is introduced in equation (ii). The OLS estimations of equation (ii) provide positive and negative slope coefficients for TOT and $TOT^2$, implying a non-linear relationship between TOT and INF. Thus, this finding forms the base of concluding an inverted-U nexus between TOT and INF in context of Bangladesh. The $R^2$ in equation (ii) increases marginally implying a slightly better fit. Furthermore, the inclusion of the dummy variable to capture the effect of a change in exchange rate regime in the country does not inflict a significant change in the TOT-INF relationship in Bangladesh. This is evident from the fact that the results from OLS estimations of equation (iii) reveal that a transition from a fixed to flexible exchange rate policy increases the slope coefficient attached to TOT by a meager 0.004 units; thus making no significant impact on the overall TOT-INF relationship in Bangladesh.

**Table 4: The OLS Estimation Results (Dependent Variable: INF)**

| Regressors | OLS of equation (i) | OLS of equation (ii) | OLS of equation (iii) |
|---|---|---|---|
| **TOT** | 0.119<br>(0.379)* | 0.204<br>(0.228)* | 0.121<br>(1.610)* |
| **$TOT^2$** | - | -0.001<br>(-0.095)** | - |
| **TOT*DUM** | - | - | 0.004<br>(0.110)* |
| **RER** | 0.006<br>(0.028) | -0.001<br>(-0.004) | 0.005<br>(0.023) |
| **M2** | 2.29E-12<br>(0.660) | 2.29E-12<br>(0.648) | 2.18E-12<br>(0.597) |
| **GDP** | -0.023<br>(-0.152) | -0.022<br>(-0.147) | -0.026<br>(-0.167) |
| **INT** | -1.215<br>(2.437)* | -1.212<br>(-2.378)* | -1.214<br>(-2.386)* |
| **OPEN** | 0.129<br>(0.377) | 0.135<br>(0.381) | 0.115<br>(0.308) |
| **IMP** | 6.12E-9<br>(3.386)* | 6.13E-9<br>(3.320)* | 6.11E-9<br>(3.312)* |
| **EXP** | -8.62E-09<br>(-3.157)* | -8.64E-9<br>(-3.096)* | -8.56E-9<br>(-3.021)* |
| **Goodness of Fit** | **$R^2$=0.553**<br>**Adjusted $R^2$=0.416** | **$R^2$=0.554**<br>**Adjusted $R^2$=0.393** | **$R^2$=0.554**<br>**Adjusted $R^2$=0.393** |

*Notes: The figures in the parenthesis are the t-statistics. * and ** denote the statistical significance of the t-statistics at 10% and 5% levels of significance, respectively.*

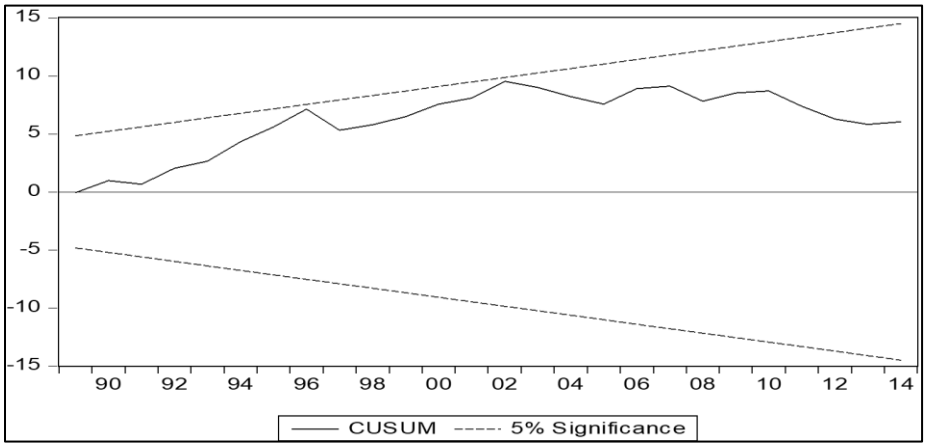
According to the Chow break-point test results, shown in table 5, the assumption of a possible structural break in the data set in the year 2004 could not be proved as the estimated F-statistic is found to be statistically insignificant at 10% level of significance.

**Table 5: Chow Break-point Test Results**

| Specified Break Date | Null Hypothesis | F-Statistic | P-value |
|---|---|---|---|
| 2004 | No break-point at specified date | 0.851 | 0.582 |

Since the exact location of possible structural breaks in the dataset is unknown, the CUSUM test is applied to determine the stability of the regression. Results of the CUSUM test are shown in figure 4. It is seen that from the CUSUM chart that the regression line fit within the two limits (95% confidence interval) which implies the absence of any structural break affecting the relationships between the dependent and the independent variables considered in the paper.

**Figure 4: CUSUM Test Results**




*Source: Computed from EViews7.1*

The Johansen test of cointegration forms the backdrop of further causality tests. Thus, in order to deduce possible long-run associations between the variables in the paper the Johansen cointegration test is done and the associated results are provided in table 6. According to each of the trace and maximum Eigen value tests under the Johansen cointegration framework, it is seen that at least 3 cointegrating relationships are found to be existing. Thus, it implies that all the variable in the paper are associated in the long run and this allows us to proceed towards performing causality tests.

**Table 6: Johansen Test of Cointegration (Lag=2)**

| Trace Test | | | | |
|---|---|---|---|---|
| **Null** | **Alternative** | **Trace Statistic** | **95% Critical Value** | **Conclusion** |
| **r = 0** | **r = 1** | 412.386 | 197.370 | 3 cointegrating equation |
| **r<=1** | **r = 2** | 268.606 | 159.530 | |
| **r<=2** | **r = 3** | 168.190 | 125.615 | |
| **r<=3** | **r = 4** | 111.509 | 95.754 | |
| **r<=4** | **r = 5** | 68.440 | 69.819 | |
| **Maximum Eigen Value Test** | | | | |
| **Null** | **Alternative** | **Max-Eigen Statistic** | **95% Critical Value** | **Conclusion** |
| **r = 0** | **r = 1** | 143.780 | 58.434 | 3 cointegrating equation |
| **r<=1** | **r = 2** | 100.417 | 52.363 | |
| **r<=2** | **r = 3** | 56.680 | 46.231 | |
| **r<=3** | **r = 4** | 43.068 | 40.078 | |
| **r<=4** | **r = 5** | 26.030 | 33.877 | |

*Notes: Selection of the lag is based on Schwartz Information Criterion (SIC). EViews 7.1 software automatically selects the most significant lag length based on this criterion.*

The Granger causality test provides long-run causal relationships between the variables considered. Results from this causality test are given in table 7. According to the estimates, there is no long-run causal association between INF and TOT in context of Bangladesh since the associated F-statistic is not statistically significant at 10% significance level. This implies that in the long run, a TOT improvement may not lead to

a change in the country's rate of INF. Moreover, the other explanatory variables are also ineffective in inflicting causal stimulations on INF.

**Table 7: Granger Causality Test (Lag=2)**

| Null Hypothesis | F - Statistic | P-Value | Decision on Causality |
|---|---|---|---|
| TOT does not Granger Cause INF | 0.511 | 0.605 | |
| INF does not Granger Cause TOT | 0.773 | 0.471 | No Causality |
| RER does not Granger Cause INF | 1.249 | 0.302 | |
| INF does not Granger Cause RER | 1.045 | 0.365 | No Causality |
| M2 does not Granger Cause INF | 0.069 | 0.933 | |
| INF does not Granger Cause M2 | 0.139 | 0.871 | No Causality |
| GDP does not Granger Cause INF | 0.201 | 0.819 | |
| INF does not Granger Cause GDP | 0.011 | 0.989 | No Causality |
| INT does not Granger Cause INF | 0.796 | 0.461 | |
| INF does not Granger Cause INT | 1.815 | 0.182 | No Causality |
| OPEN does not Granger Cause INF | 0.149 | 0.862 | |
| INF does not Granger Cause OPEN | 0.881 | 0.425 | No Causality |
| IMP does not Granger Cause INF | 0.340 | 0.715 | |
| INF does not Granger Cause IMP | 0.203 | 0.817 | No Causality |
| EX does not Granger Cause INF | 0.120 | 0.888 | |
| INF does not Granger Cause EX | 0.001 | 0.989 | No Causality |

*Note: The estimated F-Statistics are tested to be statistically significant at 10% level of significance.*

## 7. Conclusions

Globalization in the form of widespread engagements in international trade agreements is a crucial macroeconomic policy tool that can be utilized in enhancing the pace of economic development within an economy. Similarly, for Bangladesh and other countries pursuing export-led growth strategies, TOT improvement is extremely important when it comes to the enhancement of their export volumes at a faster rate than their import volumes. Thus, TOT improvement goes hand in hand with policies aimed at ensuring a favorable current account balance in these economies. As a country's TOT improvement means that the country can purchase more units of imported items for each unit of its export, thus, benefit the economy as a whole. However, such improvement in TOT can lead to domestic cost-push inflation whereby there could be a dampening effect on export volumes and deterioration of the balance of payments. Therefore, in accordance to meeting Bangladesh's national goal of leapfrogging into the elite group of upper-middle-income countries in near future, TOT improvement along with other trade liberalization policies are of utmost importance for the nation provided such policy actions do not trigger its domestic rates of INF.

The focal point of this paper was to investigate Bangladesh's TOT-INF nexus from a multidimensional framework using relevant annual time series data from 1980-2014. According to the findings, a non-linear relationship between TOT and INF is found suggesting an inverted-U shaped association between the variables. This is an important contribution to existing literature as most studies do not explore the linearity of the TOT-INF nexus. The results imply that in Bangladesh, an improvement in the TOT value although is inflationary at first but the effect does not sustain with time as the relationship, later on, becomes negative corroborating to the conclusions made by Desormeaux (2009)

for Chile and by Kasirajan and Thirunavukkarasu (2015) for India. In addition, the transition from a fixed to a more flexible exchange rate regime in Bangladesh is not found to inflict any substantial alteration to this relationship. Furthermore, following a robustness check concerning the TOT-INF causal relationship, no causal association between is found to exist in the long run. Thus, the results of this study imply that any policy aimed at improving the country's TOT can be welcomed without the fear of initiating volatility in the domestic rates of INF over a longer time period. As a result, TOT improvement can ideally be associated with attributing to the development of the macroeconomic indicators in Bangladesh.

A major limitation faced was data inadequacy whereby the data set could not be disaggregated into quarterly or monthly data which could have added to the robustness of the findings. Moreover, due to the aforementioned constraint, uniformity of the sources of data could not be ensured which may have had some impact on the estimated results in the paper. As part of future research scope, the study can be conducted in panel framework incorporating relevant data in the context of the neighboring countries in South Asia which would add to the finding in a more elaborative manner. Cross-sectional studies can also be an option provided the required data is available.

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