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DO NATURAL DISASTERS AFFECT ECONOMIC GROWTH IN BANGLADESH?

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ABSTRACT

This paper investigates the relationship between natural disasters and economic growth in Bangladesh from 1960 to 2014. Moreover, the paper focuses on the long-run impact of natural disasters on economic growth in Bangladesh. As control variables, this study includes capital stock, trade openness, and population growth. In addition, the actual path and counterfactual path will be included to observe the path of economic growth. The autoregressive distributed lag (ARDL) model will be applied to examine the relationship between natural disasters and economic growth. The results of natural disasters have a negative relationship on economic growth in the long-run. Surprisingly, the result of the error correction term for the counterfactual path is significant at -1.13. This suggested an overcorrection of 13% in Bangladesh. The government of Bangladesh should reserve money to reconstruct their economic growth in the event that natural disasters occur.

Keywords: Natural disaster; Economic growth; ARDL; Bangladesh.

1. INTRODUCTION

One of the most significant currently discussed global issues is natural disasters. In recent years, the number of disasters has been growing throughout the world. It is important to look at the effect of these disasters because they can cause substantial loss of life, damage to assets and affect economic growth. According to McKenzie et al. (2005), a natural disaster can cause direct impacts, such as total or partial damage to assets, together with indirect impacts, such as, a drop in the production of goods and services. The issues have grown in importance in the light of recent natural disasters that have had an impact on macroeconomic activity (Sadeghi et al., 2009; Pelling et

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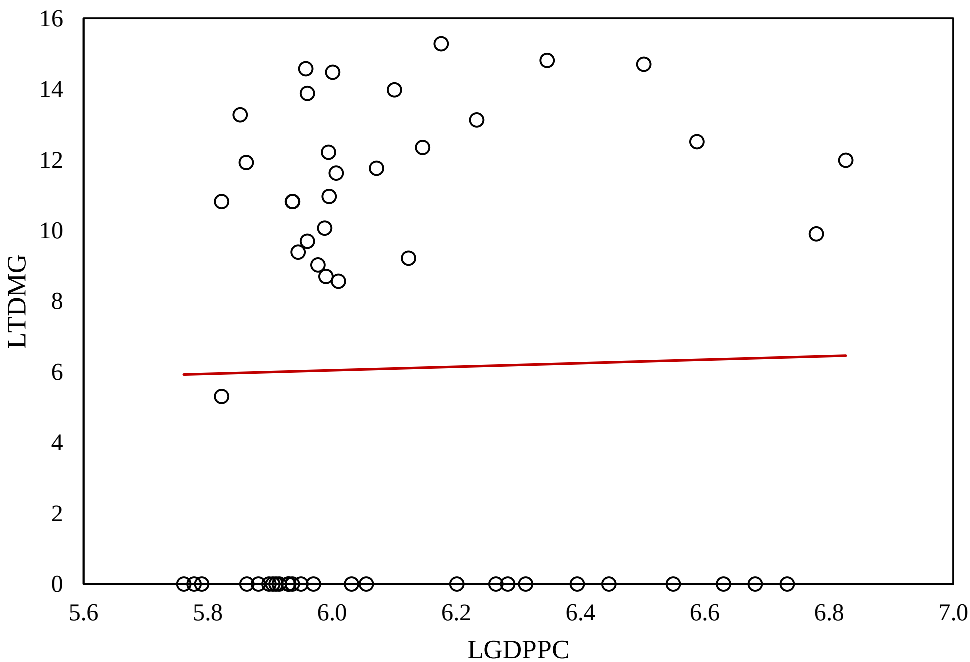
al.,2002). Moreover, this study investigates the impact of natural disasters on economic growth in Bangladesh. As Biswas (2013:86) notes, "Bangladesh is one of the largest deltas in the world and is highly vulnerable to natural disasters because of its geographical location". For example, Bangladesh is prone to flooding throughout the rainy period. According to Mahmood (2012), Bangladesh is one of the top 10 countries that face natural disasters. These natural disasters include storm, flood, extreme temperature, and others. Of the top causes of natural disaster in Bangladesh, storm was the main cause with a frequency of 52.8% followed by flooding with a 31.1% frequency while the third cause of natural disaster was extreme temperature with a frequency of 11.1% while other causes of natural disaster had a frequency of 5% during the period 1990-2014. According to the Emergency Events Database (EM-DAT), Bangladesh faced USD 285,400,000 of economic losses from 2005 until 2014 due to natural disasters. Figure 1 presents the scatter plot for the total damage natural disaster with economic growth during the period 1960 – 2014 in Bangladesh. Moreover, this study transforms the total damage (LTDMG) natural disaster and economic growth (LGDPPC) into natural logarithms.

Figure 1: The scatter plot for the total damage (LTDMG) natural disaster with economic growth (LGDPPC) for the period 1960 – 2014 in Bangladesh



Based on Figure 1, this study employs total damage (LTDMG) to represent natural disasters in Bangladesh and the gross domestic product per capita (LGDPPC) to represent economic growth. Surprisingly, there is a positive relationship between natural disasters and economic growth in Bangladesh. In other words, there is increasing concern that natural disasters are good for economic growth in Bangladesh. Therefore, this relationship provides motivation for this study to investigate the relationship between natural disasters and economic growth in Bangladesh.

Another motivation of this study is that the impact of natural disasters on economic growth in Bangladesh is contradicted. Many researchers have concluded that there is a negative relationship between natural disasters upon economic growth (Skidmore & Toya, 2002; Rasmussen, 2004; Noy, 2009; Hochrainer, 2009; Loayza et al., 2012). In contrast, some researchers have indicated that there is a positive or no relationship between natural disasters upon economic growth (Albala-Betrand, 1993; Caselli & Malhotra, 2004; Raddatz, 2007; 2009). However, there is no reliable evidence on the outcome of natural disasters on economic growth. Thus, this study will examine the impacts of natural disasters on Bangladesh's economic growth in the long-run. The impact of natural disasters can be observed through the changes in a country's general level of economic activity over the long-run based on economic growth. To accomplish these objectives, this study applied the ARDL model to investigate the long-run impact of natural disasters on economic growth in Bangladesh from 1960 until 2014.

This paper is organised as follows. Section 2 contains the literature review and discusses the outcome of natural disasters on economics. Section 3 indicates the model, data and methodology used in this study and Section 4 presents the empirical results together with a discussion on the results. Section 5 contains the conclusion and policy recommendations.

2. LITERATURE REVIEW

There are two major strands of research in the existing literature of natural disaster economics. The first strand mainly examines how individuals (particularly households and firms) prepare and deal with the sudden unexpected risks that are associated with natural disasters and their ability to ensure against them (see, for example, Paxson, 1992; Hood et al., 2013). The second strand, which is more related to this study, primarily focuses on the short-run and long-run macroeconomic impacts of natural disasters. This section briefly describes previous studies that are directly relevant to this paper while a thorough review can be found in Dell et al., (2014), Cavallo & Noy (2011), and Chhibber & Laajaj (2008).

As pointed out by Strobl (2012), while recorded damages due to natural disasters are often enormous, the overall macroeconomic impact may not necessarily be quite that apparent especially in terms of economic output for several reasons. Firstly, natural disasters are most likely localized events and may thus only partially affect the whole economy (Horwich, 2000). Secondly, natural disasters primarily bring losses in physical capital in an economy, although there may also be losses in human capital. Since GDP is in principle measured as total national output, it can be higher due to the creation of replacement capital that comes from post-disaster rescue, relief, and clean-up activity (Horwich, 2000, p. 524). Hallegatte et al., (2007), Hallegatte & Dumas (2009) and Noy (2009) also argued that negative events such as natural disasters may open ways for reinvestment, capital replacement and technical advancement, which allow for a new flow of production and in turn can improve economic growth. Thirdly, the degree of total damages of natural disasters is largely associated with the level of economic development of the affected country, and often higher damages were observed in developing countries (Cavallo & Noy, 2011). For instance, Kahn (2005) found that while high-income countries do not experience fewer or less severe natural disasters, their casualties and damage are considerably lower. In 1990, a low-income country (per capita GDP lower than $2000) typically experienced average 9.4 deaths per million people per year, while a high-income country (per capita GDP higher than $14,000) would have experienced only 1.8 deaths. Such a phenomenon is not surprising as developed countries tend to spend a greater level of resources on natural disaster prevention and mitigation than developing countries. In fact, some of the policy interventions that have helped in ameliorating disaster impacts (including land-use planning, building codes and engineering interventions) are less common in developing countries (Freeman et al., 2003; Jaramillo, 2009).

The reasons stated above seemingly explained why the existing literature has remained largely inconclusive to date, where some studies have reported negative effects (Skidmore & Toya, 2002; Rasmussen, 2004; Noy, 2009; Hochrainer, 2009; Loayza et al., 2012; Felbermayr & Gröschl, 2014, Baig et al., 2018), while others have indicated positive or insignificant effects (Albala-Betrand, 1993; Caselli & Malhotra, 2004; Raddatz, 2007; 2009) of natural disasters on economic growth. For instance, the seminal work of Albala-Betrand (1993) found that GDP increased by 0.4 % after a disaster event took place in 26 countries during the period 1960–1979. Skidmore and Toya (2002) examined the long-run impact of natural disasters on growth by considering the frequency of natural disasters and the average per capita GDP growth for the period 1960–1990. They found that climatic disasters are positively associated with long-run economic growth, while geological disasters are associated with lower growth. Similarly, Guo et al. (2015) showed that meteorological disasters promote economic growth through human capital reinvestment based on data of 577 recorded disasters in China from 1985 to 2011. However, Guo et al. (2015) also stressed that natural disaster had overall showed no impact on the economic growth from 1985 to 1998. By using a VAR framework, Raddatz (2007) investigated the role that natural disasters played on the short-run output dynamics in low-income countries and found that external shocks only accounted for 13.9 % of the total growth volatility. However, the cross-country study of Noy (2009) suggested that natural disasters caused a decrease in output of 9 % points in developing countries and that macroeconomic costs are almost entirely borne by them. Subsequently, Raddatz (2009) has extended his earlier study by investigating the short-run and long-run effect of different types of natural disasters on countries across different income levels. He concluded that small and low-income countries are more vulnerable to natural disasters, especially to climatic events. The more recent empirical evidence of Loayza et al. (2012) reconciled the findings of Raddatz (2007; 2009), Noy (2009), and Hochrainer (2009) where their dynamic GMM estimates indicated that disasters do, but not always, adversely affect economic growth, with effects that differ across types of disasters, economic sectors, and the level of development. This is further explained in Ward & Shively (2017), in which wealthier countries are less likely to experience climate-related disasters as compared to poor countries due to the higher resilience and adaptive capacity possessed in wealthier countries.

On the other hand, a strand of literature of natural disaster firmly argue for negative growth impact of natural disaster. For instance, the meta-regression analysis of Klomp & Valckx (2014) concluded that there exists a negative genuine effect of natural disasters on economic growth and the magnitude differs across the type of disaster and countries. In particular, climatic disasters in developing countries have the most significant adverse impact on economic growth. By using a self-constructed dataset, Felbermayr & Gröschl (2014) found robust and significant negative effect of disasters on growth, and that low-income countries are more affected by geophysical disasters while rich countries are more affected by meteorological events. Some recent studies also found evidence of negative growth effect. Lee et al. (2018) stated that natural disaster have a significant and negative impact on economics growth as the disaster will deteriorated the country's fiscal and trade balance. Lima & Barbosa (2018) concluded that economic growth decrease 7.6% after a flash flood occurred in Brazil. Finally, Baig et al. (2018) showed that natural disasters would hamper economic growth in Pakistan in the long run.

3. DATA, MODEL AND METHODOLOGY

3.1. Data

The data about capital stock were obtained from the University of Groningen and the University of California, Davis (2017). Moreover, the GDP per capita (constant 2010 US $), trade openness (real exports plus real imports over real GDP), population growth data were obtained from the World Development Indicators (WDI), a database from World Bank (2018). Total damages from natural disasters data were obtained from the Emergency Events Database (EM-DAT), which is maintained by the Centre Research for Epidemiology of Disasters (CRED) (2018) from Université catholique de Louvain. This study includes earthquakes, floods and storms for the total damage of natural disasters. All of the data covers the period from 1960 to 2014. Moreover, the variables are transformed into natural logarithms.

3.2. Model And Methodology

This paper applies an autoregressive distributed lag (ARDL) model bounds testing (Pesaran et al., 2001) to determine the presence of co-integration among the variables. The ARDL bound test has been chosen in this study due to its advantageous over the small sample properties (Pesaran & Shin,1999; Panopoulou & Pittis, 2004). On the other hand, it is also because the test can be applied to the model with mixed order of integration of I(0) and I(1) for regressors as long as the order of integration for regressand is I(1) (Pesaran et al., 2001). To avoid the inclusion of the second order of integration, I(2) regressors in the test, this study conducts an Augmented Dickey-Fuller (ADF) unit root test (Dicky & Fuller, 1979) for each of the variables.
After the unit root test, we proceed to our ARDL model bounds test. If the F-statistic exceeds the upper critical bounds value, then this study concludes that the variables are co-integrated. Otherwise, the variables are not co-integrated. If the variables are co-integrated, this study will frame the ARDL equation. Moreover, this study includes both the base model and the base model with total damages from natural disasters. The several factors in the model, namely LGDPPC, LCS, LTO, LPOPG and LTDMG have been extensively used by previous researchers (Albala-Betrand, 1993; Skidmore & Toya, 2002; Caselli & Malhotra, 2004; Rasmussen, 2004; Noy, 2009; Hochrainer, 2009; Loayza et al., 2012; Baig et al., 2018). The ARDL equation for the base model is as follows:

$$\Delta \mathrm{LGDPPC_t} = \beta_0 + \emptyset_1 \mathrm{LGDPPC_{t-1}} + \emptyset_2 \mathrm{LCS_{t-1}} + \emptyset_3 \mathrm{LTO_{t-1}} + \emptyset_4 \mathrm{LPOPG_{t-1}} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta \mathrm{LGDPPC_{t-i}} + \sum_{i=0}^{q} \alpha_{2i}\, \Delta \mathrm{LCS_{t-i}} + \sum_{i=0}^{r} \alpha_{2i}\, \Delta \mathrm{LTO_{t-i}} + \sum_{i=0}^{s} \alpha_{3i}\, \Delta \mathrm{LPOPG_{t-i}} + \varepsilon_t \quad (1)$$

where LGDPPC is the log of gross domestic product per capita, LCS is the log of capital stock, LTO is the log of trade openness, LPOPG is the log of population growth, Δ represents the first difference operator and *ε* is the residuals that are normally distributed and white noise. The lag orders *p, q, r, s* are selected based on minimum Akaike's Information Criterion (AIC). The ARDL equation for the base model with total damages from natural disasters is as follows:

$$\Delta \mathrm{LGDPPC_t} = \beta_0 + \emptyset_1 \mathrm{LGDPPC_{t-1}} + \emptyset_2 \mathrm{LCS_{t-1}} + \emptyset_3 \mathrm{LTO_{t-1}} + \emptyset_4 \mathrm{LPOPG_{t-1}} + \emptyset_5 \mathrm{LTDMG_{t-1}} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta \mathrm{LGDPPC_{t-i}} + \sum_{i=0}^{q} \alpha_{2i}\, \Delta \mathrm{LCS_{t-i}} + \sum_{i=0}^{r} \alpha_{2i}\, \Delta \mathrm{LTO_{t-i}} + \sum_{i=0}^{s} \alpha_{3i}\, \Delta \mathrm{LPOPG_{t-i}} + \sum_{i=0}^{s} \alpha_{3i}\, \Delta \mathrm{LTDMG_{t-i}} + \varepsilon_t \quad (2)$$

4. EMPIRICAL RESULTS AND DISCUSSION

Table 1 indicates the results of the unit root tests. In addition, the unit root test result of LTDMG is I(0) and LGDPPC, LTO, and LPOPG are I(1). However, the unit root test result of LCS in the first difference is insignificant and constant without trend but significant and constant with trend. Overall, the ADF unit root tests indicate that the variables are not I(2). Hence, the ARDL model bounds test is applied to investigate the cointegration between the variables.

Table 1. Unit Root Tests

	ADF	
	Level	
Variables	**Constant Without Trend**	**Constant With Trend**
$LGDPPC_t$	3.214	-0.592
LCS_t	1.511	-1.362
LTO_t	-0.610	-1.219
$LPOPG_t$	1.093	-4.753***
$LTDMG_t$	-7.855***	-7.781***
	First Difference	
$\Delta LGDPPC_t$	-4.173***	-5.334***
ΔLCS_t	-1.601	-4.710***
ΔLTO_t	-5.273***	-5.530***
$\Delta LPOPG_t$	-9.733***	-3.510*
$\Delta LTDMG_t$	-9.188***	-9.10***

***Notes*:** *, **, *** denote significant at the 10%, 5%, and 1% significance level respectively.

The results of the ARDL bounds test for the base model and the results of the ARDL bounds test for the base model with total damage natural disasters are presented in Table 2 and Table 3 respectively. The lag selection is based on the Akaike Information Criterion (AIC). Additionally, the F-statistic is more than the upper bound at the 1% significance level in Table 2 and Table 3. These results conclude that cointegration exists between the variables.

Table 2: The ARDL Bounds Test Results for the base model

Bounds testing approach to co-integration		
	F(LGDPPC,LCS, LTO, LPOPG)	
Optimal lags	(2, 4, 4, 1)	
F-statistics	6.142***	
	Critical values (k=3, T=51)	
Significance level (%)	**Lower bounds I(0)**	**Upper bounds I(1)**
1	3.65	4.66
5	2.79	3.67
10	2.37	3.20
Diagnostic tests	**F-statistic**	**Probability**
Serial correlation	0.908	0.347
Heteroskedasticity test	1.634	0.117

Notes: *, **, *** denote significant at the 10%, 5%, and 1% significance level respectively.

Table 3: The ARDL Bounds Test Results for the base model with total damage natural disasters

Bounds testing approach to co-integration		
	F(LGDPPC,LCS, LTO, LPOPG, LTDMG)	
Optimal lags	(2, 4, 4, 3,4)	
F-statistics	7.101***	
	Critical values (k=4, T=51)	
Significance level (%)	**Lower bounds I(0)**	**Upper bounds I(1)**
1	3.29	4.37
5	2.56	3.49
10	2.20	3.09
Diagnostic tests	**F-statistic**	**Probability**
Serial correlation	0.214	0.647
Heteroskedasticity test	1.545	0.137

Notes: *, **, *** denote significant at the 10%, 5%, and 1% significance level respectively.

Next, the long-run results for the base model and the base model with total damage natural disasters are indicated in Table 4 and Table 5 respectively. In addition, Table 4 can be the actual path (base model) and Table 5 can be the counterfactual path (base model with total damage natural disasters).

Table 4: The long-run elasticity for the base model

Dependent variable = $LGDPPC_t$				
Long-run elasticity				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**p-value**
LCS_t	0.464***	0.026	17.926	0.000
LTO_t	2.263***	0.129	17.578	0.000
$LPOPG_t$	2.037***	0.271	7.510	0.000
ECT_{t-1}	-0.881***	0.151	-5.841	0.000

Notes: *, **, *** denote significant at the 10%, 5%, and 1% significance level

Table 5: The long-run elasticity for the base model with total damage natural disasters

Dependent variable = $LGDPPC_t$				
Long-run elasticity				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**p-value**
LCS_t	0.474***	0.020	23.318	0.000
LTO_t	2.106***	0.122	17.319	0.000
$LPOPG_t$	1.678***	0.287	5.839	0.000
$LTDMG_t$	-0.004**	0.002	-2.289	0.030
ECT_{t-1}	-1.129***	0.159	-7.068	0.000

Notes: *, **, *** denote significant at the 10%, 5%, and 1% significance level

The results for the variables such as capital stock, trade openness, and population growth are the same in Table 4 and Table 5. All estimated coefficients are statistically significant and have the expected sign in the long-run. A 1% increase in capital stock contributes to a 0.464% increase in economic growth in Table 4. This suggested that capital stock contributes to economic growth. Moreover, when the base model includes total damage natural disasters, a 1% increase in capital stock contributes to a 0.474% increase in economic growth in Table 5. The results of capital stock in Table 5 are greater than in Table 4, this indicates that when total damage natural disasters occur more capital stock is induced to Bangladesh. Thus, the counterfactual path induces more capital stock in Bangladesh.

The results of trade openness indicate that trade contributes to economic growth and this supports the trade-led growth hypothesis in Table 4 and Table 5. These results show that international trade plays an important role in Bangladesh. In addition, a 1% increase in trade openness leads to about a 2.263% and 2.106% increase in economic growth in Table 4 and Table 5 respectively. These results from Table 4 (actual) and Table 5 (counterfactual) indicate that trade openness reduces from 2.263% in Table 4 to 2.106% in Table 5 when Bangladesh encounters a natural disaster.

Moreover, population growth is positively significant with economic growth in Table 4 and Table 5 respectively. A 1% rise in population growth increases economic growth by 2.037% and 1.678% in Table 4 and Table 5 respectively. This shows that a larger labour force in Bangladesh contributes to higher economic growth. From the results of population growth in Table 4 and Table 5, we can conclude that total damage natural disaster in Bangladesh induces the population growth decrease from 2.037% to 1.678% respectively.

An increase in total damage natural disasters contributes to a negative relationship with economic growth in the long-run. This means that natural disasters destroy physical capital and decrease economic growth. Furthermore, these results are similar to the previous studies by (Loayza et al., 2012; Hochrainer, 2009). The coefficient of the error correction term (ECT) is statistically significant at -0.881 in Table 4. This indicates that an 88.1% adjustment to the long-run equilibrium in a year which showed that Bangladesh needed more than one and a quarter years to adjust to the long-run equilibrium before the natural disaster. The ECT is statically significant at -1.13 in Table 5 and this indicates that an overcorrection of 13% error in each time period in Bangladesh. This may be due to the fact that during the stage of renovation, a period arose after natural disasters that gave some immediate reconstruction for physical capital at least in the short-term period. Thus, the country may have an opportunity to adopt new technologies and update the damaged physical capital which may contribute the country recover quickly and growth over the potential rate (Sadeghi et al.,2009; Skidmore & Toya, 2002). The estimation results of the serial correlation and heteroskedasticity are not rejected at the 5 %significance level. In addition, the results of CUSUM for the base model and base model with total damage natural disaster are within the critical region at the 5 %significance level. Therefore, these results indicate that the model was stable during the sample period.

Figure 2: CUSUM for the base model.

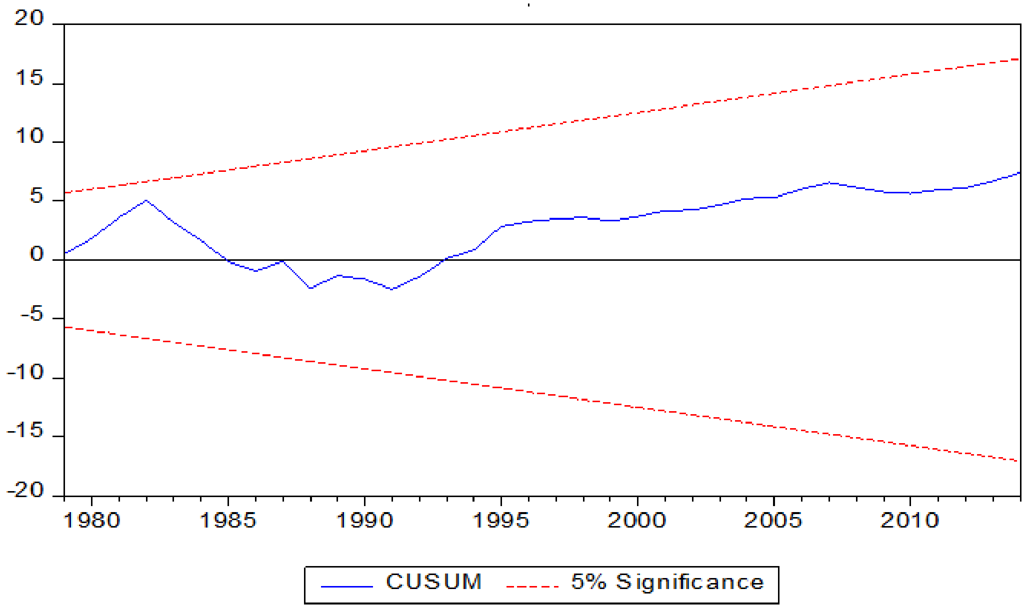
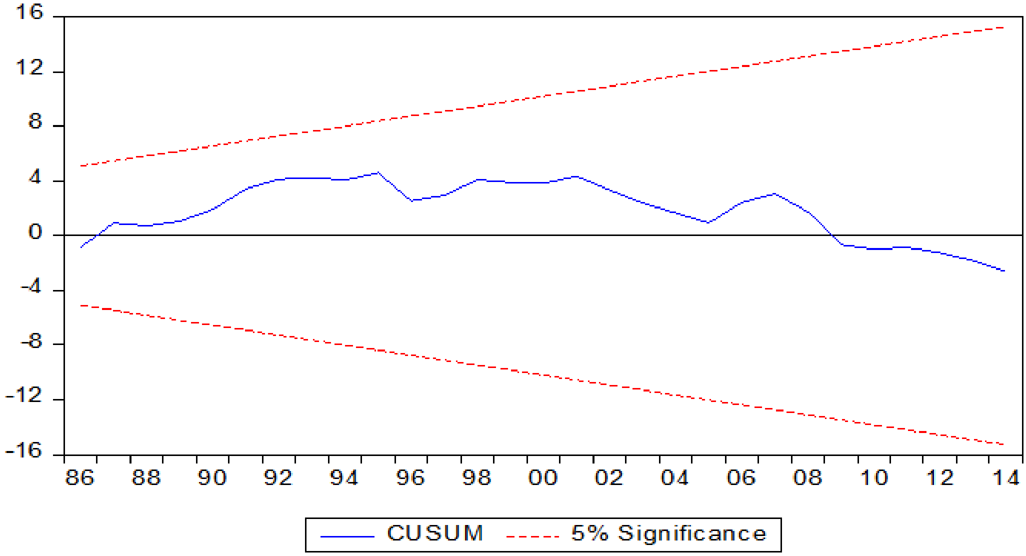


Figure 3: CUSUM for the base model with total damage natural disasters.



5. CONCLUSION

Due to its demographic location, Bangladesh is a country that has a high tendency to experience natural disasters. Hence, it is interesting to investigate the relationship between natural disasters and economic growth in Bangladesh. The results from this study indicated that natural disasters had a negative relationship with economic growth in the long-run. This study is consistent with previous studies where there is also a negative relationship between natural disasters and economic growth (Baig et al., 2018; Loayza et al., 2012; Hochrainer, 2009). According to Raddatz (2009), smaller and poorer countries may experience a larger impact on economic growth when hit by natural disasters. This was supported by Klomp & Valckx (2014), where their study indicated that developing countries experience the most significant negative impact on economic growth caused by natural disasters. Thus, the government of Bangladesh should reserve money in order to reconstruct their economic growth in the aftermath of natural disasters.

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