



Evaluating the Persistence of j Curve Phenomenon in the Bilateral Trade between Bangladesh and USA: The ARDL Bounds Testing Approach and Granger Causality Analysis

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Abstract

Most of the previously examined studies that investigated the repercussion of the trade balance to exchange rate mutation relied on the assumption that appreciation and depreciation behave symmetrically, recently several works have been conducted using the asymmetric analysis. In this work, we exhibited a model employing the disaggregated data (bilateral) of trade balance with the USA. In our pursuit, we endeavored to disclose a phenomenon of the J curve, is this pattern present in our trade balance and exchange rate bearing? In this article, first, we checked the stationarity of data set and discovered the stationary employing the Augmented Dickey-Fuller test, Phillips Peron then applying the ARDL bounds test of cointegration apropos to find out the long run co integrated equations and last of all, tried to investigate the short-run and long-run relationship among the variables, while we used the ECM (error correction model). The Toda-Yamamoto Procedure for Granger Causality in a VAR framework has been applied to detect the causal direction. In our model, we have blazoned the negative short-run rapport between the exchange rate and trade balance in the bilateral data, whereas we have remarked a discrepant bearing in the long run and we did receive the evidence of the appearance of j pattern in the relationship between exchange rate and trade balance. Dispensing the error correction model, we found domestic higher price level hinders the trade balance in the short run, did not find any evidence of foreign income stimulate the export. Toda-Yamamoto Procedure for Granger Causality reveals the unidirectional causal effect from exchange rate to trade balance of Bangladesh with the USA.

Keywords: Trade balance; Exchange rate; Inflation rate; ARDL bounds test; Granger causality test; Stability test.

1. Introduction

The cohesion between the trade balance and the exchange rate has a lingering history. In the venerable days, researchers sought conditions under which a devaluation or depreciation could ameliorate the trade balance. The upliftment does come but only after transgression of time and after completion of pass through of exchange rates to prices, hence the J-curve effect introduced by Magee (1973) and supported by empirical results by Bahmani-Oskooee (1995). Mostly exercised trade theory postulates that depreciation of the real exchange rate can stimulate the export demand of the particular country's product through the inducement and shifting the relative prices. If the export and import demand functions are elastic, then devaluation lowers the relative prices of exports and raises those of imports. The Marshall-Lerner condition simply asserts that devaluing or depreciating a real exchange rate will not boost the trade balance unless the absolute summation of the price elastic ties of export and import demands exceed one (Junz and Rhomberg, 1973). In the short-run, however, the effects of exchange rate devaluation on the trade balance are delayed, due to several adjustment lags (Mwito et al., 2015) The J-curve effect postulates the aftermath of the trade balance is that, it deteriorates in the short run and improves in the long run as a subsequent devaluation or depreciation of exchange rate (Magee, 1973). Historically though Bangladesh had been sustaining several pegged exchange rate regimes, now this is in the framework on the floating system from 2003 and continued to adhere to a managed float through intermittent intervention in the foreign exchange market. An appropriate management of the exchange rate always to be a critical part of the trade policy to make easy the competitiveness in the international market and to stimulate the economic growth. In this work, our concern the United States of America is one of the largest trading partners of Bangladesh and has turned out a robust enormity for the export destination of Bangladesh. Since independence, the volume of export to the US has increased and Bangladeshi Taka has also depreciated significantly. However, how much contribution this depreciation is associated to the export growth of Bangladesh is not yet clear. For the sake of identifying this, we have incorporated the bilateral trade

balance data with USA in our methodology and try to explore the relationship between exchange rate and trade balance with USA. Early studies that attempted to test the phenomenon whereas used aggregate trade data between one country and rest of the world. According to many researchers as [Hossain and Alauddin \(2005\)](#), [Aziz \(2008\)](#) the main objectives of exchange rate changes in Bangladesh are to easing international competitiveness, encourage exports diversification, discourage imports growth, rearrange resources in import substitutes and export oriented sectors, encourage remittances inflow from expatriate wage earners, maintain stable internal price, and maintain a viable external account position. [Khatoun and Rahman \(2009\)](#), [Aziz \(2008\)](#), [Chowdhury and Younus \(2015\)](#), all they have tried to reveal the relationship between exchange rate change and trade balance in Bangladesh using the aggregated time series non stationary data and found the mixture in expected results (someone's findings is short run statistical significant positive effect, someone's is long run positive effect, other's is short and long run positive effect). our research work is different from others in the sense that we are going to employ the bilateral trade data of Bangladesh and united states of America and want to test the existence of j curve phenomenon in the trade balance and exchange rate relationship within this two country's data, for the sake of avoiding the aggregation bias problem we avoid the aggregate trade balance data of Bangladesh with its all trading partners. There is a great controversy whether a country like Bangladesh follows the consecutive way of devaluation of its own currency to increase balance of trade through healthy view of export or not. Because the exchange rate volatility has an immense spillover effects throughout the various macroeconomic indicators. Some researchers argue that the volatility of exchange rates would have an adverse effect on trade flows; the others argue that the volatility of exchange rates would encourage trade flows ([Altıntaş et al., 2011](#)). Many prominent economists believe that undervaluation promotes growth because it motivates firms to invest in high productivity tradable industries, which increases overall productivity rates ([Rodrik, 2008](#)).

2. Review of Literature and Theoretical Framework

Empirical findings on the J-curve phenomena have largely differed depending on the level of data aggregation and the estimation techniques used. A country that is perceiving deterioration in her trade balance could put trust on currency devaluation or depreciation to oversee the situation. However, due to adjustment lags, currency devaluation or depreciation is said to derange the trade balance first before promoting it, hence the j curve. The current account¹, measured in domestic output, can deteriorate sharply right after real currency depreciation because most import and export orders are placed several months in advanced. In the first few months after the depreciation, export and import volumes therefore may reflect buying decisions that were made on the basis of the old real exchange rate: the primary effect of the depreciation is to raise the value of the pre contracted level of imports in terms of domestic products. Because exports measured in domestic output do not change while imports measured in domestic output rise, there is an initial fall in the current account. Using the pooled mean group (PMG) under the both linear and the non linear ARDL framework, ([Mwito et al., 2021](#)) have found j curve effects in the seven bilateral trading partner (symmetries exchange rate effects) and j curve effects are evident in the thirteen countries (assuming asymmetries). [Iqbal et al. \(2020\)](#) investigate the response of the trade balance to exchange rate change using the non linear autoregressive distributed lag model (ARDL) employing the data of Pakistan and her eight trading partners and found the significant prove of the j curve effects when they used the non linear model and no evidence of j curve in the case of linear ARDL models. [Bahmani-Oskooee and Nouira \(2021\)](#), employ nonlinear models and estimate asymmetric J-curve effects for each of the 58 industries that trade between Italy and the United States. From the estimation of the linear and nonlinear models they found support for the J-curve effect in 12 industries. Applying an asymmetric model (non linear ARDL model) ([Bhat and Bhat, 2021](#)) report no evidence of J-curve phenomenon in case of India. Employing the time series data that of 1960 to 2016 of Nigerian trade whereas adopting the Non-linear ARDL bounds test and the [Bayer and Hanck \(2013\)](#) test [Nathaniel \(2020\)](#) is unable to confirm the existence of the J-curve Phenomenon. [Bahmani-Oskooee and Nasir \(2020\)](#), [Bahmani-Oskooee et al. \(2017\)](#), [Bahmani-Oskooee et al. \(2017\)](#), [Bawa et al. \(2018\)](#) have found better evidence of the existence of j curve in the case of non linear ARDL model instead of linear ARDL model for different countries. Using the Serbian trade data and applying the autoregressive distributed lag approach corresponding error correction models as well as impulse response functions, [Petrović and Gligorić \(2010\)](#) indicate the existence of j curve pattern. Examining the short-run and long-run effects of real exchange rate changes on the Nigeria's trade balance, ([Bawa et al., 2018](#)) reveal that real depreciation would lead to improvements in Nigeria's trade balance in the long-run. ([Bahmani-Oskooee et al., 2017](#)), individualize the short run effects from long run effects of changes in the real bilateral exchange rate on the trade balance of Korea and establish that the trade balance is influenced by the exchange rate variation in the short run as well as in the long run. Employing the Johansen technique and error correction mechanism ([Aziz, 2008](#)) exhibits that the real exchange rate has a cabbalistic positive dominance on Bangladeshi trade in both short and long run and the granger causality test suggests that the real exchange rate does granger causes the trade balance. Conducting with co integrating VAR, co integrating VECM and single equation ARDL model, ([Boyd et al., 2001](#)) trace the considerable indication that the real exchange rate does have a momentous impact on the trade balance. Employing the ARDL model and impulse response function ([Narayan, 2006](#)) investigates that no j curve pattern is present in the china's bilateral trade with USA in response to exchange rate change. Using both of ARDL and VAR techniques in an analysis of Malaysia's aggregate trade balance for the time period 1974 to 2003, ([Duasa, 2007](#)) suggests that other policies would be more effective than exchange-rate management in improving the overall economy. Applying the ARDL co

¹ In economics, a country's current account records the value of exports and imports of both goods and services and international transfers of capital. It is one of the three components of its balance of payments.

integration approach, (Rehman and Afzal, 2003) find the opposite sign in short run and long run coefficient and establish the existence in the j curve phenomenon in the Pakistani trade. Akbostanci (2004), who fails to find any evidence of a J-curve effect for Turkey's trade balance over the period from 1987 to 2000; and Singh (2004) who also shows no J-pattern for India over the period from 1975 to 1996.

3. Data and Methodology

Current study investigates the J-curve hypothesis of Bangladesh trade balance with USA². This hypothesis is incurred by using Bangladesh's trade balance with USA and exchange rate of taka in terms of USD, USA's Gross National Income and inflation rate of Bangladesh are also used as control variables. Time series data spanning from the period of 1989 to 2019 has been used. Data for Trade balance is collected from Direction of trade statistics, CD-ROM (IMF)³ and the other variables data source is the World Development Indicator (WDI, 2021) of the World Bank⁴. For empirical investigation we take natural logarithm for every variable except inflation.

3.1. Model Specification

We specify Bangladesh's trade balance with United States of America as a function of USA's gross national income, exchange rate of Bangladeshi taka in terms of US dollar and Bangladesh's inflation rate as follows. In order to demonstrate our model, we are encouraged by the: Goldstein and Khan (1985), Khan and Hossain (2010), Rose and Yellen (1989) and applied the slightly modified version that helps us to get the expected results.

$$\ln(TB_t) = \alpha_0 + \beta_1 \ln YF_t + \beta_2 \ln ER_t + \beta_3 IR_t + \varepsilon_t \quad (1)$$

Where \ln is natural logarithm, TB_t is a measure of Bangladesh's trade balance with USA defined as the total exports of Bangladeshi product in US market over its total imports from US market. YF_t is the US gross national income. ER_t is the exchange rate of taka in terms of US dollar and IR_t is the rate at which the value of taka is falling and consequently the general level of prices for Bangladeshi goods and services is rising. A priori, we expect β_1 to be positive ($\beta_1 > 0$) because an increase in US gross national income will increase the demand for Bangladeshi product in US market, consequently increase in Bangladesh's export in US. On the other hand, in normal sense it is assumed that a depreciation of domestic currency i.e. increase in ER_t will flourish the trade balance that means β_2 shall be positive ($\beta_2 > 0$) because a devalued currency means imports are more expensive and vice versa for export. But in J-curve hypothesis this is true only in the long run but in the short run β_2 will be negative. Other coefficient β_3 is expected as negative sign because inflation makes it expensive for Bangladeshi goods in US consumer, for this reason volume of export is expected to decrease which ultimately worsens the trade balance.

3.2. Autoregressive Distributed Lag Model (ARDL)

In regression analysis involving time series data, if the regression model includes not only the current but also the lagged values of the explanatory variables, it is called a distributed-lag model. On the other hand, if the model includes one or more lagged values of the dependent variable among its explanatory variables, it is called an autoregressive model. So the autoregressive distributed-lag model (ARDL) is the amalgamation of this two at once. An autoregressive distributed lag (ARDL) model is an ordinary least square (OLS) based model which is applicable for both non-stationary time series as well as for time series with mixed order of integration. An ARDL model takes the following form:

$$\Delta \ln(TB)_t = \alpha_0 + \sum_{i=1}^m \alpha_{1i} \Delta \ln(TB)_{t-i} + \sum_{i=0}^m \alpha_{2i} \Delta \ln YF_{t-i} + \sum_{i=0}^m \alpha_{3i} \Delta \ln ER_{t-i} + \sum_{i=0}^m \alpha_{4i} \Delta IR_{t-i} + \beta_1 \ln(TB)_{t-1} + \beta_2 \ln YF_{t-1} + \beta_3 \ln ER_{t-1} + \beta_4 IR_{t-1} + \varepsilon_t \quad (2)$$

Where Δ is a first difference operator, t is time; α_0 is an intercept term, α_{1i} to α_{4i} be the short run coefficients and β_1 to β_4 be the long run parameters of the model. The null hypothesis in the equation is that $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$, which means non-existence of long run relationship. For this conduct an ARDL bound test to examine the existence of long-run relationship. Pesaran *et al.* (2001), initiate the bounds tests in the unrestricted model or namely an ARDL model. They provide two critical values for the co-integration test. The lower critical bound assumes that all the variables are $I(0)$ while the upper critical bound assumes that all variables are $I(1)$. The decision criterion is that if the computed F-statistics falls below the lower bound critical values, the null hypothesis of no co-integration cannot be rejected. However, if the computed F-statistics lays above the upper bound critical values; the null hypothesis of no co-integration is rejected, implying the existence of co-integration amongst the variables in the model. If there was existed any co-integration among variables then ARDL long run model can be estimated as follows:

$$\ln(TB)_t = \beta_0 + \sum_{i=1}^m \beta_{1i} \ln(TB)_{t-i} + \sum_{i=0}^m \beta_{2i} \ln YF_{t-i} + \sum_{i=0}^m \beta_{3i} \ln ER_{t-i} + \sum_{i=0}^m \beta_{4i} IR_{t-i} + \varepsilon_t \quad (3)$$

Accordingly, the associated error correction model for above equation is specified as:

$$\Delta \ln(TB)_t = \beta_0 + \sum_{i=1}^m \beta_{1i} \Delta \ln(TB)_{t-i} + \sum_{i=0}^m \beta_{2i} \Delta \ln YF_{t-i} + \sum_{i=0}^m \beta_{3i} \Delta \ln ER_{t-i} + \sum_{i=0}^m \beta_{4i} \Delta IR_{t-i} + \varphi_1 \text{ect}_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta \ln(YF)_t = \delta_0 + \sum_{i=0}^m \delta_{1i} \Delta \ln(TB)_{t-i} + \sum_{i=1}^m \delta_{2i} \Delta \ln YF_{t-i} + \sum_{i=0}^m \delta_{3i} \Delta \ln ER_{t-i} + \sum_{i=0}^m \delta_{4i} \Delta IR_{t-i} + \varphi_2 \text{ect}_{t-1} + \varepsilon_t \quad (5)$$

² The J Curve is an economic theory that says the trade deficit will initially worsen after currency depreciation.

³ <https://data.imf.org/>

⁴ <https://data.worldbank.org/>

$$\Delta \ln(ER)_t = \rho_0 + \sum_{i=0}^m \rho_{1i} \Delta \ln(TB)_{t-i} + \sum_{i=0}^m \rho_{2i} \Delta \ln YF_{t-i} + \sum_{i=1}^m \rho_{3i} \Delta \ln ER_{t-i} + \sum_{i=0}^m \rho_{4i} \Delta IR_{t-i} + \varphi_3 ect_{t-1} + \varepsilon_t \tag{6}$$

$$\Delta \ln(IR)_t = \lambda_0 + \sum_{i=0}^m \lambda_{1i} \Delta \ln(TB)_{t-i} + \sum_{i=0}^m \lambda_{2i} \Delta \ln YF_{t-i} + \sum_{i=0}^m \lambda_{3i} \Delta \ln ER_{t-i} + \sum_{i=1}^m \lambda_{4i} \Delta IR_{t-i} + \varphi_4 ect_{t-1} + \varepsilon_t \tag{7}$$

Where φ is the speed of adjustment parameter or error correction term, the term error-correction relates to the fact that last-period's deviation from a long-run equilibrium, the error, influences its short-run dynamics. Thus ECMs directly estimate the speed at which a dependent variable returns to equilibrium after a change in other variables. This error correction term exist only when we find all the variables are co-integrated in ARDL bound test approach, otherwise they only have short run relationship.

4. Empirical Results

4.1. Unit Root Test

It is not necessary that a variable become stationary at level when we run an autoregressive distributed lag model. A mixture of stationary and non-stationary variable can be used in this model. Thereafter, we want to check stationary for all variables. For this purposes we use two well known statistical methods namely Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test of stationary.

Table-1. Unit root test

Variable	Augmented Dickey Fuller (ADF)		Phillips-Perron (PP)	
	Level	First Difference	Level	First Difference
lnTB _t	-4.647 ***	-3.356 **	-5.053 ***	-3.304 **
lnYF _t	-2.091	-3.356 **	-1.939	-3.304 **
lnER _t	-2.197	-4.009 ***	-2.313	-3.891 ***
IR _t	-4.260 ***	-7.389 ***	-4.218 ***	-8.140 ***
Critical Values for both ADF and PP Tests				
	Level		First Difference	
10% critical value	-2.624		-2.625	
5% critical value	-2.986		-2.989	
1% critical value	-3.716		-3.723	

* Significance at 10 per cent level, ** Significance at 5 per cent level, *** Significance at 1 per cent level

we see in the above table that the variable trade balance (TB_t) and inflation rate (IR_t) are stationary at level from both of the method used but partner countries national income (YF_t) and exchange rate (ER_t) are not stationary at level .But when we convert the entire variable at first difference then all of them become stationary because their associated test statistics is greater than 5% critical value or even 1% (ER_t and IR_t) value.

4.2. ARDL Bounds Test

For investigating the long run associations among variables in this study we conduct ARDL bound test approach which was first introduce by M. H. Pesaran a British-Iranian economist. [Pesaran et al. \(2001\)](#), employed the bounds tests in the unrestricted model or namely an ARDL model and secondly adopt the ARDL approach to the estimation of the level relations. We test the following hypothesis from equation 2:

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$$

$$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$$

Table-2. ARDL bounds test results

F-test result		
Significance Levels	Bound critical values(Unrestricted intercept and no trend)	
	Lower bound I(0)	Upper bound I(1)
10% critical value	2.72	3.77
5% critical value	3.23	4.35
2.5% critical value	3.69	4.89
1% critical value	4.29	5.61
F-statistics	5.070	
k	3	

K: # of non-deterministic regressors in long-run relationship

Now on the basis of above hypothesis, we can see that the estimated F-statistics which is mentioned in [table 2](#) is greater than the upper bound critical value at 5% significance level which strikes that we don't accept the null hypothesis that the variable have no long run relationship. Conducting the bounds test and demonstrating the results we can reach in the conclusion that there has strong long run relationship among variables.

4.2.1. ARDL Long-run Model and Short-run Model

The estimated long-run equilibrium relationship among the variables using the ARDL (4, 4, 4, 4) suggested by AIC criteria (the optimum lag length) approach is given in the following table:

Table-3. ARDL long-run Estimation

Dependent Variable is $\ln(TB_t)$			
Variable	Coefficient	Standard Errors	P-values
$\ln YF_t$	-2.774876*	1.188043	0.052
$\ln ER_t$	5.520765***	1.483135	0.007
IR_t	0.1003114***	0.0235155	0.004

* Significance at 10 per cent level, ** Significance at 5 per cent level, *** Significance at 1 per cent level

Result shows that in the long run foreign income has negative impact on the trade balance. Exchange rate change has positive impact on Bangladesh's trade balance with USA. This result sticks to the J-curve hypothesis that the exchange rate has positive impact on trade balance in the long run.

Table-4. ARDL short-run model Estimation

Dependent Variable is ΔTB				
Variable	Coefficient	Standard Errors	P-values	
ECT_{t-1}	-0.8944321***	0.2425977	0.008	
TB_t	$\Delta \ln TB_{t-1}$	0.2661741	0.2441316	0.312
	$\Delta \ln TB_{t-2}$	-0.1957448	0.2177859	0.399
	$\Delta \ln TB_{t-3}$	-0.2890197*	0.1479879	0.092
YF_t	$\Delta \ln YF_t$	0.9353082	1.749751	0.610
	$\Delta \ln YF_{t-1}$	1.935095	1.799441	0.318
	$\Delta \ln YF_{t-2}$	-0.216712	1.681641	0.901
	$\Delta \ln YF_{t-3}$	3.074534	1.904701	0.151
ER_t	$\Delta \ln ER_t$	-2.616707*	1.29805	0.084
	$\Delta \ln ER_{t-1}$	-2.18826	1.346109	0.148
	$\Delta \ln ER_{t-2}$	-1.326413	0.9912579	0.223
	$\Delta \ln ER_{t-3}$	-0.8625911	1.110217	0.463
IR_t	ΔIR_t	-0.0752981***	0.0182612	0.004
	ΔIR_{t-1}	-0.0560657***	0.0154621	0.008
	ΔIR_{t-2}	-0.0407794**	0.0138407	0.022
	ΔIR_{t-3}	-0.0368833***	0.0086266	0.004
Constant	60.70131**	24.88738	0.045	

* Significance at 10 per cent level, ** Significance at 5 per cent level, *** Significance at 1 per cent level

To ascertain the existence of the J-curve hypothesis in Bangladeshi trade balance with USA, the sign of the coefficient on exchange rate should be negative in the short run. Empirical results from the short run ARDL model as presented in table 4, which shows that the coefficient of the exchange rate is negative in the short run. From that we see all the lag coefficient of inflation variable has negative and statistically significant as their associated p-value is quite low which is compatible to our prior assumption. Other variables, partner countries national income has expected positive sign as Bangladesh's export increase with the increase in partner's national income but statistically significant results reveals no strong evidence that foreign income stimulates export demand. Table 4 also reveals an error correction term as ECT which has a negative sign and it is very significant even at 1% level. This represents that there exists a long-term relationship between the dependent variable and the explanatory variables. In addition, the value of ECT coefficient is - 0.894, which signifies strong and a faster speed of adjustment to equilibrium. Thus nearly 89% of the disequilibrium converges back to the long-term equilibrium within one period. These findings, therefore, indicate that exchange rate policies can be used to target Bangladesh's trade balance in the long-run since there is evidence of a stable relationship. However, this has to be conducted bilaterally.

4.2.2. Autocorrelation Test

Autocorrelation is a mathematical representation of the degree of similarity between a given time series and a lagged version of itself over successive time intervals. Autocorrelation exists if residuals in one time period are related to residuals in another period. In Breusch-Godfrey test we assume the null hypothesis that there have no serial correlations. As the calculated Chi square value is not statistically significant at five percent then we can accept the series have no serial correlation.

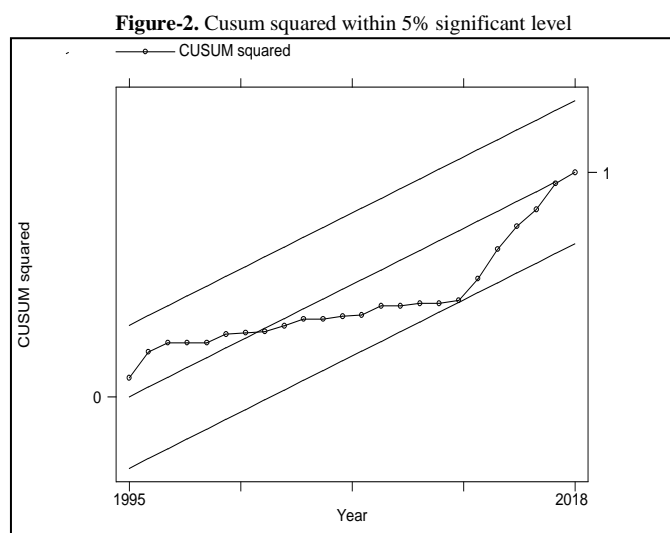
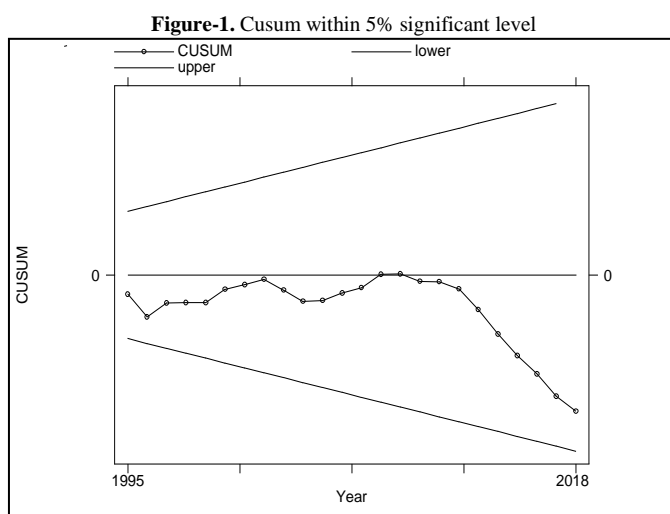
Table-5. LM test for autocorrelation

Breusch-Godfrey LM test for autocorrelation			
Lags	Chi square	df	P-Value
1	3.190*	1	0.0741

Not significant at five percent

4.2.3. Stability of the Model

For checking stability in the above model, we use cumulative sum (CUSUM) of recursive residuals and the CUSUM of square (CUSUMSQ) tests to assess the parameter stability as suggested by Peseran and Peseran (1997). A graphical representation of CUSUM and CUSUMSQ statistics are provided in Figure 1 and 2 mentioned below.



The cumulative sum test identifies systematic changes in the regression coefficients, while the cumulative sum of squares test detects sudden changes from the constancy of the regression coefficients. Figure 2 and 3 plots the results for CUSUM and CUSUMSQ tests. The results indicate the absence of any instability of the coefficients because the plots of the CUSUM and CUSUMSQ statistics fall inside the critical bands of the 5 per cent confidence intervals of parameter stability. Therefore, these statistics confirm the model stability and that there is no systematic change identified in the coefficients at 5% significance level over the study period.

4.3. Granger Causality Test

As the long run cointegration exists among the concerned variables from the ARDL bounds test results, we easily can ascribe the granger causality to detect the unidirectional or bidirectional causal relation between the variables. Here in our model we amalgamated the Toda Yamamoto procedure that is not conventionally used. We examine the causal relationships between trade balance, exchange rate, inflation rate and foreign income in Bangladesh within an augmented VAR framework following (Toda and Yamamoto, 1995) procedure. Following table shows the short-run Granger Causality among the variables.

Table-6. Granger causality wald test

Independent variables					
Dependent variables	Trade balance	Foreign income	Exchange rate	Inflation rate	Relationship
Trade balance	-	11.626 (0.020)	17.297 (0.002)	49.128 (0.000)	$\ln TB_t \leftrightarrow \ln YF_t$
Foreign income	17.477 (0.002)	-	4.7372 (0.315)	6.6903 (0.153)	$\ln TB_t \leftarrow \ln ER_t$
Exchange rate	8.0674 (0.089)	13.784 (0.008)	-	1.4781 (0.831)	$\ln TB_t \leftrightarrow IR_t$
Inflation rate	18.217 (0.001)	9.3428 (0.053)	9.5231 (0.049)	-	

P-value shows in the parenthesis

We have traced the existence of the unidirectional causality running from the exchange rate to the trade balance and bidirectional causal relationship between the trade balance and foreign income. We also ascertain that VAR is well specified; that is VAR does not contain serial correlation in the residuals.

5. Conclusion

In this work, we presumed no asymmetric relationship exists and we used Pesaran *et al.* (2001) linear ARDL approach to investigate the symmetric response instead of using nonlinear ARDL approach by Shin *et al.* (2014). We employed the trade balance data with USA (bilateral) as a dependent variable and exchange rate, inflation rate, USA's GNI as independent variable to clinch the consecutive j curve effect is impending or not. In the case of bilateral data, we have received the short run discrepant relationship between exchange rate and trade balance that connotes, if the exchange rate increases (depreciation) then the trade balance will be attenuated in that particular year. For a specific country, if policymakers use the exchange rate as a policy tool to invigorate its export and devalue its currency, it is not obviously true that the particular country's trade balance will be improved immediately. The other macroeconomic variables that we have behaved here as independent variables like as inflation rate blazoned a proper sign of its coefficient in the short run. If a country's price level increases, then customer of foreign country found it expensive, then downward pressure toward export in the other hand domestic people will try to import foreign product due to comparatively lower price of foreign product. We found the negative coefficient of inflation rate which is compatible with macroeconomic theory. In terms of policy implications, the results show that exchange rate can be used as a crucial tool to ameliorate the trade balance in the long run (the statistical significant long run coefficient consolidates that). Adopting the Toda-Yamamoto (Toda and Yamamoto, 1995) procedure for Granger Causality in an augmented VAR frame-work, the unidirectional causal relation is established from exchange rate to trade balance. We can make our epilogue in the manner that Bangladeshi trade balance with USA will be meliorated in the long run if exchange rate depreciates but not immediately; short run negative coefficient corroborates that. The results seem the existence of the j curve effect in the USA and Bangladesh trade relationship due to change in the exchange rate, negative significant error correction term approves the models validity, post estimation diagnostic test such as Breusch-Godfrey Serial Correlation LM test and cusum test suggested by Pesaran *et al.* (2001) reveal that there is no autocorrelation and model to be stable. An appropriate management of the exchange rate should be a critical part of trade policy to stimulate export performance and high economic growth through others macroeconomic channels. The findings also reveal that a devaluation policy does not work immediately and that the bilateral trade balances worsen initially before improving after passage of sometime. If we gathered the commodity level and industry level country wise bilateral data and released the assumption of symmetric analysis of exchange rate and could apply the NLARDL model then it would give different results regarding exchange rate and trade balance relationship.

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