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Short Run and Long Run Association between Real Exchange Rate and Trade Balance: Empirical Evidence from Bangladesh (Johansen Approach and Vector Error Correction Model)

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Subroto Dey [α], Subrata Saha [σ] & Roksana Akter [ρ]

Abstract- Several studies have tested the j curve phenomenon for Australia, Japan, South Korea, New Zealand and many other countries using non stationary time series data and have provided mixed results. They not only suffer from the aggregation bias problem but also the spurious regression problem. To overcome this problem, in this paper we investigate the short run and long-run effects of real depreciation of the Bangladeshi taka to the trade balance between Bangladesh and her trading partners. In this article first we check the stationary of data set and find the stationary applying the Augmented Dickey Fuller test, then applying the Johansen co integration test in order to find out the long run co integrated equations and last of all try to investigate the short run and long run relationship among the variables, while we use the VECM (vector error correction model) and found that there is long run associations among the variables, and short-run coefficients are statistically insignificant. But for Bangladesh j curve concept have not been tested yet. That's why we have chosen this topic, and we incorporated several others variables to test the linkages on trade balance such as GNI as a proxy of GDP, inflation rate, NODA (net officials development assistance, and we have given more priory on the variable real exchange rate.

I. Introduction

In the era of floating exchange rates, the effects of currency appreciations and depreciation on trade flows have been closely studied. One particular topic of interest is the so-called J curve effect, in which a country's trade balance might deteriorate in the short run after devaluation, before improving in the long run. Because depreciation should help increase a country's exports, while making its imports more expensive, it should, in theory, result in an improvement of the differences between the exports and imports. Because of time lag involved in adjusting contracts, however, the number of exports and imports are temporarily fixed. If the country is paying in foreign currency, it must give up more units of depreciated currency before the quantity can adjust, so the trade balance might briefly deteriorate. Improvement may come only after the passage of sometimes hence the J curve pattern. Due to lag structures, currency devaluations said to worsen the trade balance first and improve it later resulting in a pattern that resembles the latter J, hence, the J curve phenomenon. Since Magee introduced it in (1973, Brooking papers on the Economic Activity, 1, pp.303-25), a large number of studies have attempted to test the phenomenon using different techniques and different model specifications. There have been numerous papers examining the long run and short-run relationships between the terms of trade and trade balance. A deterioration of the terms of trade (devaluation) brings in a long run improvement in the trade balance that ML conditions explained. Since the short run elasticity is usually smaller than the long run elasticity, the trade balance may not improve in the short run. In fact, in the short run, the post-devaluation time path of the trade balance is theoretically ambiguous, as Magee (1973) notes. While there are reasons to believe that the J curve phenomenon characterizes the short-run dynamics, there are also reasons why it may not. Indeed the empirical evidence has been rather mixed or inconclusive.

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II. Literature Review

A country that is experiencing deterioration in her trade balance could rely upon currency devaluation or depreciation to reverse the situation. However, due to adjustment lags, currency devaluation or depreciation is said to worsen the trade balance first before improving it, hence the j curve. Ever since the introduction of the concept by Magee (1973) and its empirical counterpart by Bahmani-Oskooee (1995), researchers have tried to verify the concept by using data from individual countries. Bahmani-Oskooee, M., Xu, J., & Saha, S. (2017) distinguished the short run effects from long-run effects of changes in the real bilateral exchange rate on the trade balance of each of the 69 industries and found that the trade balance of 48 industries were affected by exchange rate changes in the short run, from long-run coefficients estimates, they gathered that there were 24 industries in which the real exchange rate carried a significantly positive coefficient for Korea and Japan. Nusrate Aziz (2008) in his article "The Role of the exchange rate in trade balance: Empirics from Bangladesh" estimated the effect of exchange rate on the balance of trade of Bangladesh. Using the Johansen technique and error correction mechanism he demonstrated that the real exchange rate has a significant positive influence 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. Boyd, D., Caporale, G. M., & Smith, R. (2001) used co integrating VAR, co integrating VECM and single equation ARDL model and found the considerable evidence that the real exchange rate does have a significant impact on the trade balance. Hsing, H. M. (2005) used the generalized impulse response function from the vector error correction model to examine whether the j curve effect exists for Japan, Korea and Taiwan. Both bilateral and aggregate cases were considered .this study found that japans aggregate trade is the only case that shows the traditional j curve phenomenon after real depreciation. DOROODIAN Sr, K. H. O. S. R. O. W., Jung, C., & Boyd, R. (1999) in their article examined the hypothesis of the j curve for the US US data for both agricultural and manufactured goods using the Shiller lag model and their statistical result supported the hypothesis that there is a j curve effect for agricultural goods and that the behavior of the trade balance in manufactured goods did not follow a j curve. Petrović, P., & Gligorić, M. (2010) introduced Serbian data, after the consecutive testing procedure they found that a real exchange rate depreciation has a significant positive long-run impact on the trade balance in Serbia and that in the short run trade balance first deteriorates before it later improves. Narayan, P. K. (2004) found that New Zealand's trade balance, Real exchange rate and the domestic income, foreign income are not co integrated, there is no long-run relationship among these variables and also found the existence of the j curve path for the New Zealand trade balance. Bahmani-Oskooee, M. (1991) using quarterly data over 1973-1988 period and applying the co integration analysis he found that the trade balance and the real effective exchange rate of some LDCs are co integrated into the long run. Onafowora, O. (2003) examined the short and long-run effects of real exchange rate changes on the real trade balance for three ASEAN countries-Thailand, Malaysia and Indonesia and cointegration analysis indicated that there is a long run steady state relationship among real trade balance, real exchange rate, real domestic income, and real foreign income.

III. Description about the Variables

While the nominal exchange rate tells how much we exchange foreign currency for a unit of domestic currency, the real exchange rate tells how much the goods and services in the domestic country can be exchanged for the goods and services in a foreign country. In this paper, our dependent variable is trade deficit, and independent variables are real exchange rate, inflation rate, Net official's development assistances, GNI as a proxy of GDP. We want to estimate the coefficients to justify the strength of the relationship, want to investigate the short run and long run association among the variables using the Johnsen cointegration test and VECM (vector error correction model). After that we may conclude about the existence of the j curve in trade balance and real exchange rate. Here our objective is to evacuate the relationship among variables if they are positively related or negatively related. Are they associated in the short run or the long run? That's why our research is unit free, and we have not given more concentrate upon the volume of the coefficient but the sign f the coefficient term.

Actually, in this paper, we want to clarify the determinant of trade balance and want to evaluate the existence of the J curve pattern between trade balance and real exchange rate. We used the time series data to investigate the relationship between the variables from 1983 to 2017.

IV. The Model

$$trade\ defecit_t = \beta_1 + \beta_2\ real\ exchange\ rate_t + \beta_3\ real\ exchange\ rate_t^2 + \beta_4 GNI_t + \beta_5 inflation_t + \beta_6 NODA_t + u_t$$

Where we used the GNI as a proxy of the national income. We know very much well that if a country's income increases then import demand also increases and trade deficit increases, so there is a positive relationship. Also we want to check is there any relationship between the inflation and trade. we, know very much well that if a country's inflation rate increases that means price of the product of her own country is now expensive and people will be reluctant to buy own country's product and import demand also increases and trade deficit increases. Here we also incorporate a new term NODA (net official development assistance), proxy as a foreign aid. From theoretical background, we realize that if foreign aid increases then there may be an impact on exchange rate whereas domestic currency may be appreciated, and import demand may be stimulated, and export may be decreased. Thus we may find a positive impact on trade deficit. Here we also amalgamated the most important independent variable that mostly affects the trade is real exchange rate If the real exchange rate increases that means the currency is depreciates, then foreign product becomes more expensive to people and domestic good becomes relatively cheaper. So there is the possibility to stimulate the export demand and reduction in the import demand.

So we may find a negative relationship with the trade deficit and real exchange rate.

V. Test for Unit Root

Before we precede our regression, we want to test the data set as they have a unit root or not. Regarding previous literature if the time series data are non stationary and we regress the model disregarding this, then we may find the spurious regressions if the time series data are non stationary then their first difference must be stationary if we want to find an acceptable result. We usually test the unit root by Augmented D K fuller test which is developed in (1979) and has been employed here. First we want to test the data of trade deficit from 1983 to 2017. The probable equations of ADF as follows:

$$\Delta trade\ deficit_{t} = \alpha + \beta t + \gamma trade\ deficit_{t-1} + \delta_i \sum_{i=1}^{n} \Delta\ trade\ deficit_{t-1} + u_t \ldots\ldots (1)$$

(This equation involve trend and intercept).we may use the following equations for respective variables.)

$$\Delta inflation_{t=} \delta inflation_{t-1} + u_t \ldots\ldots (2)$$

$$\Delta real\ exchange\ rate_t = \gamma real\ exchange\ rate_{t-1} + u_t \ (3)$$

$$\Delta NODA_t = \theta NODA_{t-1} + u_t \ldots\ldots (4)$$

Here the null hypothesis in equation (1) is that the data is non stationary, which can be rejected if the computed γ is statistically significant and different from zero. we may conclude that the data is strationary but if the γ coefficient will not be different from zero, then the data set is not stationary. If a time series data set is non stationary, then we take the first difference to make it stationary. Augmented Dickey Fuller follows this procedure. Here the first difference is taken. We check all of my variables like the above- mentioned equation.

VI. Johansen Cointegration test and the Vector error Correction Model(vecm)

We can check the cointegration between the time series by using Johansen test which is developed by Johansen (1988,1991) and Johansen and Huselius if both series are integrated of order one. We estimate the following equation in Johansen multivariate framework. The method starts with a VAR representation of the variables (economic systems we like to investigate. We have a pp-dimensional process, integrated of order d,xt~I(d)d,xt~I(d), with VAR representation.

$$x_t = \text{v} + A_k x_{t-1} + \epsilon_t$$

By using the difference operator Δ=1−L Δ=1−L, or L=1−ΔL=1−Δ, the VAR in levels can be transformed into a vector error correction model (VECM).

$$\Delta x_t = \text{u} + \rho_1 \Delta x_{t-1} + \ldots\ldots + \rho_{k-1} \Delta x_{t-k-1} + \pi x_{t-1} + \epsilon_t$$

After transforming the model, using L=1−ΔL=1−Δ, we lose one lag at the end, leading to k−1k−1 lags in VECM. The more compact for the VECM becomes:

$$\Delta x_t = v + \sum_{i=1}^{k-1} \rho_1\, \Delta x_{t-1} + \pi x_{t-1} + \epsilon_t$$

The number cointegrating vectors are identical to the number of stationary relationship in the π matrix. If there is no cointegration π, all row in must be filled with zeros. If there are stationary combinations, or stationary variables, some parameter in π will be nonzero. The rank of π matrix determines the number of independent rows in, and the number of co integrated vectors. The rank of π is given by the number of significant Eigen values found in π.Each significant eigenvalue represents a stationary relation. Johansen derived two tests, the λ−max λ−max (or maximum eigenvalue) and the λ−trace−trace (or trace test.)

$$\mu_{trace}\ (\text{r}) = \text{-T} \sum_{i=r+1}^{g} log(1\text{-}\mu_i)$$

$$\mu_{max}\ (\text{r,r+1}) = \text{-T log } (1\text{-}\mu_{t+1})$$

μ is the ordered Eigen value of matrices π and T is the available observations. Both procedures test the null hypothesis of at most r cointegrating vectors against the unspecified or general alternative hypothesis of having more than one cointegrating vector (BROOKS 2008).

Where Δthe first difference operator, x is is the vector of variables, u is the drift parameter, ρ_1 and ρ_{k-1} are coefficient matrices. To determine the rank of the metrics π is an important task in Johansen cointegration test. We actually amalgamate this Johansen cointegration test and VECM in my article in order to verify the co integrated equations and find the short run and long run relationship among the variables. And before doing that we tested the unit root test and finds that the variables are nonstationary at level, but if we take the first difference they become stationary.

a) Linear Regression

Trade deficit	Coefficient	Standard error	T value	P value	95% confidence interval
Real exchange rate	-.2002137	.0559469	-3.58	0.001	-.3141737 to -.0862536
Real exchange rate^2	.0019778	.0005561	3.56	0.001	.0008451 to.0031106
GNI	.0043303	.000193	22.43	0.000	.0039371 to .0047236
NODA	.043591	.0354123	1.39	0.173	-.0227735 to .1214917
Inflation	.2315748	.0800665	2.89	0.007	.0684846 to .394665
Constant	-2.180341	1.371052	-1.59	0.122	-4.973082 to .6124001

R Squared value =.9448
F (5,32)=157.68

Estimated from stata, time series from 1983 to 2017

Result Explanation: In this regression model we have amalgamated five independent variables, and we have found the expected coefficient sign. Here, the real exchange rate has a positive impact on trade balance and negative impact on the trade deficit, and furthermore, we have found the negative coefficient. Then we used the gross national product as a proxy of gross domestic product. If a country's income increases then the import demand increase and trade deficit will be increased we have found the expected positive sign. NODA (net official development assistance), we incorporate this variable here as foreign aid. If foreign aid increase, then there may be an impact on currency valuation, currency may be appreciated, import demand may be increased and o found here the positive coefficient sign. If the domestic price increases then foreign product will be relatively cheaper to people. Thus if inflation rate increases then foreigner also faces a relatively higher price of your product so export will be decreased. According to the theoretical background, we have found here the expected sign for every variable.

As Rule of thumps according to the t statistics and P value all the variables are statistically significant except the NODA. According to the R squared value this model is able to explain the 94% variation of trade deficit so the incorporated variables are able to explain the trade deficit significantly.

b) Augmented D K Fuller Test for Variable Trade Deficit

Now we want o test the individual data set has unit root or not. If the time series data are non stationary then the regression result will be spurious. For the sake of that we have to test:

$$\textit{Null hypothesis}: \textit{Data is non strationary}$$

$$\textit{Alternative hypothesis}: \textit{Data is strationary}$$

We may decide according to the value of test statistics and critical value comparison. If the test statistics is greater than the critical value, we may reject the null hypothesis and may accept the alternative hypothesis. So, in the level form trade deficit data are non stationary and if we take its first difference the found that they are stationary.

		Test statistics	1% *critical value*	5%*critical value*	10% *critical value*
For level form	Z(t)	-2.403	-4.260	-3.548	-3.209
For first difference form	Z(t)	-3.648	-4.260	-3.548	-3.209

Source: author, results from Stata, time series

c) Augmented D K Fuller test for variable real exchange rate

According to the T test statistics and critical value we found that the level form of real exchange rate is nonstationary and if we take the first difference then at the 5 % significant level they will be stationary.

		Test statistics	1%*critical value*	5%*critical value*	10%*critical value*
For level form	Z(t)	-2.350	-4.316	-3.572	-3.223
For first difference form	Z(t)	-3.501	-4.325	3.576	-3.226

Source: Author, results from stata, time series

d) Augmented D K fuller test for variable GNI

According to the t test statistics and critical value we found that the level form of GNI is nonstationary and if we take the first difference then at the 10% significant level they will be stationary.

		Test statistics	1%*critical value*	5%*critical value*	10%*critical value*
For level form	Z(t)	-2.670	-4.316	-3.572	-3.223
For first difference form	Z(t)	-4.423	-4.325	-3.576	-3.226

Source: Author, results from strata, time series

e) *Augmented Dickey fuller test for unit root, variable, inflation rate*

According to the t-test statistics and critical value we found that the level form of inflation rate is nonstationary and if we take the first difference then at the 1% significant level they will be stationary.

		Test statistics	1%*critical value*	5%*critical value*	10%*critical value*
For level form	Z(t)	-2.206	-4.288	-3.560	-3.216
For first difference form	Z(t)	-5.237	-4.297	-3.564	-3.218

Source: Author, results from strata, time series

VII. Johansen Test for Cointegration

Trend: constant number of observations 36
Variable: 1982-2017 lags 2

a) *Trace statistics*

Maximum rank	Parma	LL	Eigen value	Trace statistics	5%critical value
0	42	-17.960909		110.3526	94.15
1	53	4.2704517	0.70919	65.8899	68.52
2	62	17.103814	0.50981	40.2232	47.21
3	69	25.300323	0.36578	23.8302	29.68
4	74	31.309343	0.28385	11.8109	15.41
5	77	36.206296	0.23816	2.0182	3.76
6	78	37.215404	0.05452		

b) *Max statistics*

Maximum rank	Parma	LL	Eigen value	Max statistics	5%critical value
0	42	-17.960909		44.4627	39.37
1	53	4.2704517	0.70919	25.6667	33.46
2	62	17.103814	0.50981	16.3930	27.07
3	69	25.300323	0.36578	12.0192	20.97
4	74	31.309343	0.28385	9.7927	14.07
5	77	36.206296	0.23816	2.0182	3.76
6	78	37.215404	0.05452		

Here we tested the Johansen cointegration criteria to find out is there any log run association ship among the variables or not. Software has given me the two criteria one is Max statistics, and another is trace statistics. For trace statistics 0 means there is no cointegration that means null hypothesis is there is no cointegration among the variables and the alternative hypothesis is there is cointegration among the variables .We have to compare the trace statistics and the critical value .if the trace is greater than the critical value then I have to reject the null hypothesis and accept the alternative hypothesis. As the trace statistics 110 is greater than critical value94, then we have rejected the null and decide that they are coinegreted. Now we mean they have one cointegrated equation so, the null hypothesis is the variables that we have incorporated in this model have one cointegration .And we cannot reject this hypothesis. So, our decision is the variables trade deficit, real exchange rate, gross domestic income, inflation all are co integrated into one and they have log-run association and they move together in the long run. As all the variables are nonstationary at level form and stationary at first difference, we can run the co integration test. And as they are coitegrated in one and they have long-run relationship now, we can test the VECM model (vector error correction model).And here the max statistics and the trace statistics have given us the same results and that is the incorporated variables are moving together in the long run.

c) *Vector error correction model*

If the time series data are nonstationary at the level form and stationary at first difference and if they are co integrated into the long run by Johansen co integration test, then we can easily apply the Vector error correction model. We also use this model in to differentiate the short run causality and long-run causality. Here in this paper, we have tried a little bit to discover the short run and long run dependency among the variables. We found that all our incorporated variables are stationary at first difference and cointegrated in the long-run, for the sake of that we applied the vector error correction model as follows:

$$\Delta trade\ deficit_{t} = \alpha + \sum_{i=1}^{k-1} \beta_i\, \Delta trade\ deficit_{t-i} + \sum_{j=1}^{k-1} \gamma_j\, \Delta real\ exchange\ rate_{t-j} + \sum_{m=1}^{k-1} \delta_m \Delta GNI_{t-m} + \sum_{s=1}^{k-1} \varepsilon_s \Delta Net\ officials\ development\ assistance_{t-s} + \sum_{n=1}^{k-1} \theta_n\, \Delta inflation\ rate_{t-n} + \pi_1 ECT_{t-1} + u_{1t}$$

NOTES:

- K-1 =the lag length is reduced by 1.
- $\beta_i, \gamma_j, \delta_m, \varepsilon_s, \theta_n$ =Short run dynamic coefficients of the models adjustment long-run equilibrium.
- π_i =speed of adjustment parameter with a negative sign
- ECT_{t-1} =The error correction term is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable on the regressors. Contains long-run information derived from the long run co integrating relationship.
- u_{it} =residuals

d) *Vector error correction model*

Sample 1983-2017

Number of observation 35

Beta	Coefficient	Standard error	Z statistics	P value
D_1 trade deficit _ce1 L1	-.2564798	.1166557	-2.20	.028
1 trade deficit				
LD	-.1700934	.1957509	-.87	.385
L2D	.0259511	.1820158	.14	.887
1 rer				
LD	-.1637177	.7614941	-.21	.830
L2D	-.3026621	.679326	-.45	.656
1GNI_PC				
LD	.5141596	1.523708	.34	.736
L2D	3.122934	2.455098	1.27	.203
1noda_pc				
LD	.2370135	.2345446	1.01	.312
L2D	-.1084151	.2246564	-.48	.629
INF				
LD	.013794	.0227982	.61	.545
L2D	.0144075	.0192543	.75	.454
_cons-	-.0221602	.0889259	-.25	.803

e) *Johansen normalization restriction imposed*

Beta	Coefficient	Standard error	Z statistics	P value
_ce1 1trade deficit	1			
1rer	.4240321	.5282523	.80	.422
1gni_pc	-8.763669	1.121287	-7.82	.000
1noda_pc	1.237545	.3438836	3.60	.000
Inf	-.0570974	.0500508	-1.14	.254
_cons	53.73079			

From the above-mentioned table, it specified that the c_1 coefficient is statistically significant and that is the long run effect and error correctionion term, on the other hand the LD and L2D for several variables are short run coefficient, and results show that they are statistically insignificant. Johansen normalization table shows the long run relationship among trade deficit, real exchange rate, GNI, NODA, and inflation rate.

VIII. Conclusion

The link between the trade balance and the exchange rate has a long history. In the old days, researchers sought conditions under which a devaluation or depreciation could improve the trade balance.8 Countries continued to experience deterioration in their trade balance despite repeated devaluations. Improvement did come but only after the passage of time and after completion of pass-through of exchange rates to prices, hence the J-curve effect. Since it is shown that import and export prices adjust to exchange rate changes in an asymmetric manner (Bussiere, 2013), there is no reason not to believe that trade flows will not follow the same. As argued by Bahmani- Oskooee, and Fariditavana (2015, 2016) traders' expectations change when a currency appreciates versus when it depreciates. Therefore, trade balance likely reacts in an asymmetric manner to exchange rate changes. Another factor that could contribute to asymmetric effects is the fact that imports and exports originate from two different countries that are subject to different sets of trade rules, policies, and regulations. In other words, for countries with more bureaucratic red tape, the adjustment lags will be longer, which can contribute to asymmetric effects (Bahmani-Oskooee & Aftab, 2017). Currency depreciation is said to worsen the trade balance first before improving it, resulting in a pattern of movement that labeled the j curve phenomenon. Several studies have employed aggregate trade data and have suffered from the aggregation bias problem. The problem is that a favorable effect of currency depreciation against one country could be offset by its unfavorable effect against another one resulting in a conclusion that depreciation is ineffective .but in my article we have incorporated the stationary time series data and using the Johansen cointegration test and error correction modeling find the long-run association among the variables.

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