International Journal of Economics and Management Sciences
Vol. 2, No. 3, 2012, pp. 01-09

MANAGEMENT JOURNALS
managementjournals.org

Determining Long Term Relationship & Response to Shocks for Imports Exports and GDP of Bangladesh

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ABSTRACT

This paper investigates causal relationship between exports, imports and economic growth (GDP) in Bangladesh over the period 1961-2009 using Cointegration, Error Correction Model, and VEC Granger causality. Bangladesh, a developing economy of the third world, contains trade imbalance from her very inception. This paper makes an effort to understand the time series behavior of the dynamic relationship among total imports, total exports and GDP of this country. Through unit root test we found that all three variables are non stationary. Johansen cointegration test reveled the existence of one long run equilibrium relationship among these variables. The analysis of short run dynamics of the vector error correction model found out though, total exports and GDP of Bangladesh is approaching in the right track, total imports is moving away from the equilibrium state with a significant speed. Again, impulse response analysis traced out the response of shocks in one variable to the other variables as well as to the same variable. The adequacy of the fitted model is also justified through residual analysis.

Keywords: *Exports; Imports; Economic growth; Granger causality; Vector error correction model*

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1. INTRODUCTION

With the introduction of globalization, international financial market has become wide open and the countries, specially the developing ones like Bangladesh is having a great opportunity to make some drastic positive change to its overall financial condition. Researchers are having great interest in analyzing the relationship between foreign trade and national income as both of them are very important components of economical growth of a country and a healthy balancing relationship should exist between them to make a country economically strong.

Whatever the condition of the economy of a country is, it always try to gain the trade balance, as well as to bring its national income to a balanced stage with the foreign trade. To investigate collective effect of many policies on international trade, one can look for the long-run equilibrium relationship between export and import. And if someone is interested in how the policies of in land economics is synchronizing with foreign trade policies to bring the county's overall economic status to a stable position, the analysis of long run equilibrium relationship among total exports, total imports and gross domestic product (GDP) might be of interest.

In this study the relationship between economic growth (GDP) and the components of foreign trade (total imports and total exports) is analyzed in context with long term relationship. We have tried to find whether these variables have long run equilibrium relationship or not and if they have, what are the nature of these relationship and how the short run dynamics are working. The response of shocks in one variable to the other variables are also analyzed and interpreted. Haydory Akbar Ahmed and Md. Gazi Salah Uddin (2009) investigates the causal nexus between export, import, remittance and GDP growth for Bangladesh using annual data from 1976 to 2005. The paper uses time series econometrics tools toinvestigate the relationship adding import and remittance in the model. Study finds limited support in favor of export-led growth hypothesis for Bangladesh as exports, imports and remittance cause GDP growth only in the short run. Mamun and Nath (2005) examine time series evidence to investigate the link between exports and economic growth in Bangladesh. Using quarterly data for a period from 1976 to 2003, the article finds that industrial production and exports are cointegrated. The results of an error correction model (ECM) suggest that there is long-run unidirectional causality from exports to growth in Bangladesh. Shirazi and Manap (2005) examine the export-led growth (ELG) hypothesis for five South Asian countries including Bangladesh using cointegration and multivariate Granger Causality tests. They found feedback effects between exports and GDP and imports and GDP for Bangladesh. Hossain and Salim (2009) addressed the short run dynamics of long run relationship between export and economic growth in Bangladesh using annual time series data and found that export led growth and growth led exports were both valid for Bangladesh. Islam and Zaman (1996) found no significant relationship between exports and growth. The results cast considerable doubt as the time series used in the study was non-stationary. By adopting standard econometric techniques to analyse time series data for the period 1969-1991, Islam (1998) examines the nature and direction of causation between export expansionand growth for 15 Asian countries including Bangladesh. The estimation results show that export granger causes economic growth positively but not *vice versa*, in both the bivariate and error correction models. However, the multivariate Granger test shows no causality between the two. This study uses quarterly data for the considered time period, but did not provide any explanation of data generating process for Bangladesh.

2. METHODOLOGY

2.1 *Data*

The variables used in this study of export, import economic growth (in terms of GDP) of Bangladesh are Exports of goods and services (constant 2000 US$), Imports s of goods and services (constant 2000 US$) and GDP (constant 2000 US$). The sample period covers annual data from 1960 to 2010. All the data is obtained from World Development Indicators, The World Bank.

2.2 *Data Description*

Exports of goods and services represent the value of al goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in constant 2000 U.S. dollars.Imports of goods and services represent the value of all goods and other market services received from the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments. Data are in constant 2000 U.S. dollars.GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2000 U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 2000 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

2.3 *Unit Root Test*

Since macroeconomic time-series data are usually non-stationary (Nelson and Plosser, 1982) and thus conducive to spurious regression, we test for stationary of a time series at the outset of cointegration analysis. For this purpose, we conduct an augmented Dickey-Fuller (ADF) test, which is based on the t-ratio of the parameter in the following regression.

$$\Delta x_t = \kappa + \emptyset + \Theta_i X_{t-i} + \sum_{i=1}^{n} \varphi_i \Delta X_{t-i} + \varepsilon_t \qquad (1)$$

where X is the variable under consideration, Δ is the first difference

It is essential at the onset of cointegration analysis, that we should solve the problem of optimal lag length because multivariate cointegration analysis which we are going to conduct in the study is very sensitive to lag length selection.

The most commonly used lag length selection criteria are the Final prediction error *(*FPE*)*, Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (*SC*), Hannan-Quinn Criterion (HQ)(Reference)

2.4 *Cointegration Test*

The econometric framework used for analysis in the study is the Johansen (1998) and Johansen and Juselius (1990) Maximum- Likelihood cointegration technique, which tests both the existence and the number of cointegration vectors. This multivariate cointegration test can be expressed as:

$$Z_t = K_0 + K_1 \Delta Z_{t-1} + K_1 \Delta Z_{t-1} + \dots\dots\dots.. + K_p \Delta Z_{t-p} + \prod Z_{t-p} + \mu_t \qquad (2)$$

Where

$Z_t = (EX, IM, GDP)$

Z_t = a 3 x 1 vector of variables that are integrated of order one [i.e. I (1)]

EX, IM and GDP are exports, imports and real gross domestic product respectively

K = a 3 x 3 matrix of coefficients

Π = 3 x 3 matrix of parameters and

μ_t = a vector of normally and independently distributed error term.

The presence of r cointegrating vectors between the elements of Z implies that Π is of the rank $r(0 < r < 2)$.(less than equal)

To determine the number of cointegrating vectors, Johansen developed two likelihood ratio tests: Trace test (λ_{trace}) and maximum eigenvalue test (λ_{max}.).If there is any divergence of results between these two tests, it is advisable to rely on the evidence based on the λ_{max} test because it is more reliable in small samples (see Dutta and Ahmed, 1997 and Odhiambo, 2005).

2.5 *Granger Causality*

If we exploit the idea that there may exist comovements among exports, imports and gdp and possibilities that they will trend together in finding a long run stable equilibrium, by the Granger representation theorem (Engle and Granger 1987), we may posit the following testing relationships, which constitute our vector error-correction model:

$$\Delta EX_t = \alpha_1 + \sum_{i=1}^{l} \beta_{1i} \Delta EX_{t-1} + \sum_{i=1}^{m} \gamma_{1i} \Delta IM_{t-1} + \sum_{i=1}^{n} \delta_{1i} \Delta GDP_{t-1} + \sum_{i=1}^{r} \theta_{1i} ECT_{r,t-1} + \xi_{1t} \qquad (3)$$

$$\Delta IM_t = \alpha_2 + \sum_{i=1}^{l} \beta_{2i} \Delta EX_{t-1} + \sum_{i=1}^{m} \gamma_{2i} \Delta IM_{t-1} + \sum_{i=1}^{n} \delta_{2i} \Delta GDP_{t-1} + \sum_{i=1}^{r} \theta_{2i} ECT_{r,t-1} + \xi_{2t} \qquad (4)$$

$$\Delta GDP_t = \alpha_3 + \sum_{i=1}^{l} \beta_{3i} \Delta EX_{t-1} + \sum_{i=1}^{m} \gamma_{3i} \Delta IM_{t-1} + \sum_{i=1}^{n} \delta_{3i} \Delta GDP_{t-1} + \sum_{i=1}^{r} \theta_{3i} ECT_{r,t-1} + \xi_{3t} \qquad (5)$$

Where EX ,IM,GDP have been explained in section IV, Δ is a difference operator, ECT refers to the error-correction term(s) derived from long run cointegrating relationship via the Johansen maximum likelihood procedure, and ζ_{it}'s (for i = 1, 2, 3) are serially uncorrelated random error terms with mean zero. In our case, equation 3 will be used to test causation from imports and GDP to exports. Equation 4 will be used to test causality running from exports and GDP to imports whereas equation 5 will test causality running from exports and imports to GDP. A consequence of relationships described by equations 3 to 5 is that either ΔEX_t, ΔIM_t, ΔGDP_t or a combination of any them must be caused by ECT_{t-1} which is itself a function of EX_{t-1}, IM_{t-1}, and GDP_{t-1}.

2.6 *VEC model*

In a VAR model I have to include the variables which have bilateral causality with each other. A VAR model consists of a set of variables $Y_t = (Y_1, Y_{2\dots} Y_{Kt})$ which can be represented as:

$$Yt = \alpha + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + u_t \qquad (6)$$

With A_i are (K×K) coefficient matrix for i=1, 2….p and u_t is a K dimensional process with E(u_t) = 0 and covariance matrix $E\,(ut\, ut^T) = \Sigma_u$ .If Yt 's are cointegrated the VAR model can be rewritten as VECM:

$$\Delta Y_t = \Pi Y_{t-p} + \Sigma\, \Gamma_i\, \Delta Y_{t-i} + u_t \qquad (7)$$

where

$\Pi = -(I - A_1 - A_2 \dots A_p)$ and $\Gamma_i = -(I - A_1 - A_2 \dots A_i)$.If the coefficient matrix Π has reduced rank r < k, then there exist k × r matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' Y_t$ is stationary. r is the number of cointegrating relations and each column of β is the cointegrating vector.

2.7 *Impulse Response Function*
The impulse response function of VEC is to analysis dynamic affects of the system when the model received the impulse. As our VER model, we have three variables. We can work the response between these variables.

3 RESULT AND DISCUSSIONS

3.1 *ADF Unit Root Tests:*
Plots of the logarithms of the three time series are shown in Figure 1. From Figure 1 it is clear that exports, imports and GDP shows an upward trend and they have a tendency to move together, implying that they are causally linked to each other.

The ADF test of unit root for the three variables of our concern, at suggested lag length three is presented below-

From the results shown in the above table 1 we can say that all the three variables are non stationary as we fail to reject the null hypothesis of non stationary even at ten percent level of significance.

As the original variable are found to be non stationary, we difference them at order one and do ADF test again, the results are shown below in table 2-

The results show that even after first differencing the variables remain non stationary. So, we difference them again (at order tow). The results of ADF test at suggested lag length 3, on the second differenced variables are given below in Table 3-

We can see that the null hypothesis that the variables are non stationary can now be rejected even at 1 percent level of significance for GDP and export and at 2 percent level of significance for the variable import.

3.2 *VAR Lag Order Selection*
Before fitting the model, we have to select the appropriate lag length of the vector error correction model. The value of different information criteria of the model at different lag length are given below-
The above table 4 shows us that, both AIC and FPE are at their smallest values if we fit the model at lag 5, while HQ gives smallest value at lag 3 and SC at lag 1. As FPE is considered as a more robust information criteria than the others, we consider the model to be fitted best at lag 5.

3.3 Johansen Co-integration Test
Johansen cointegration test is conducted to check the existence of cointegration which is shown below in Table 5 and Table 6-
From the above two table we can see that the null hypothesis that there is no cointegration relationship among the variables is rejected even at 1% level of significance and we fail to reject the null hypothesis that there is at most one conintegration relationship among the variable is failed to reject at 5% level of significance. Though we also fail to reject the null hypothesis about two such relationship inside the system, we ultimately come to the decision that the three variables of our concern has one cointegration relationship.

3.4 Long Run Relationship:
The estimated value of conintegration vector β (normalized to the first variable) is presented in the following table-

According to the above table 7 we can establish a equation among the three variables as-
GDP=.051 x Import-.69 x Export

This equation gives us a clear indication that one unit increase in total imports of Bangladesh causes GDP of Bangladesh to increase by .051 unit on an average and one percent increase in total Export of Bangladesh causes GDP to decrease by .69 unit on an average.

3.5 Short Run Analysis
The value of the error correction terms of the vector error correction model is presented in the following table-

From the above table 8 it can be seen that the error correction term for the equation GDP is negative and statistically significant, that means the GDP of Bangladesh responds to deviations of the system in a balancing manner. A value of -.098 for the coefficient of error means the Bangladeshi economy will converge towards its long run equilibrium by a slow pace (9.8% per year) after any shock occur in the system.

The error correction term for the equation of exports is also negative and highly significant which suggests total exports of Bangladesh will converge to the equilibrium position at 49% per year after the system faces any deviation.

But the coefficient of the error correction term for total imports is positive and statistically significant, that means due to any disturbance in the system, divergence from equilibrium will take place at a very rapid pace (39.5% per year) and the system will be unstable.

3.6 Granger Causality Test
The result of multivariate Granger causality test of the three variables of our concern is given below in Table 9-

We can see that all the three variables granger causes each other at the system of our concern.

From the above Figure 2 we can see that shocks in total yearly imports of Bangladesh have high positive impacts on current and future values of total imports, a moderate to low positive impact on total exports and a very low but positive impact on current and future values of GDP.

Again from the figure 3 we can see that total imports of Bangladesh has no immediate reaction to the shock occurring in total exports, though it will response positively in the future and the response will be highest three and nine years after the shock. Total exports generally responses positively to one unit shock occurring in it and the response is quite high and GDP responses very low and positively to the same shock.

From the above figure 4 we can see that one standard deviation shock in GDP will cause immediate positive response in total imports but it will eventually decrease. Total exports will have low positive response at beginning but it will decrease and will remain almost zero up to the following three years and then will start responding negatively and GDP will have a little positive response at the beginning but very soon (after seven years) the effect of the shock will neutralize.

3.7 Diagnostic Checks
3.7.1 Portmanteau test
To check the adequacy of the model, the multivariate Portmanteau tests are conducted. Here the null hypothesis is the residuals of the model are white noise. The value of the test statistic at lag 16 (about one third of the length of the data set) and the corresponding P value are given below in Table 10-

So, we fail to reject the null hypothesis even at ten percent level of significance. So, we can conclude that the errors of the VECM is not auto correlated

4. CONCLUSION AND POLICY IMPLEMENTATION

The long run relationship between total exports and total imports is of significant importance due to fact that it reflects the sustainability of foreign tradesituation of a country. The main objective of the study is to investigatethe long run relationship between Bangladesh’s exports, imports and GDP byapplying cointegration and vector error correction model techniques. We have used annual data for total exports, total imports and GDP for the period 1960 to 2010.

The results of the ADF unit root tests demonstrate that all series are non-stationary at their levels and become stationary after they are differenced at order one twice i.e. they all are I(2)(integrated of order two). Then we move forward by applyingthe Johansen multivariate cointegration test in order to investigating the long run relationship among exports, imports and GDP. The results indicate the existence of one cointegrating relationship among these variables. The cointegrating vector shows that total imports positively affect GDP while the effect of exports is negative.

Furthermore, we have tested the stability of the equilibrium using VECM. The results indicate that the coefficient of the error-correction term of export and GDP have the right sign (negative) and are statistically significant even at 0.1 percent level of significance. The value of coefficient of the error correction term of total exports is -0.49, that means in any case of disequilibrium in every year there will be 49 percent convergence for restoring the long run equilibrium position. The coefficient of the same term for GDP is -.098 which indicates almost 10 percent convergence every year to the long run equilibrium in case of any type of disturbance in the system. The coefficient of the error correction term of imports has positive sign and statistically significant even at 0.1 percent level of significance and depict divergence from the long run equilibrium in the system.

Multivariate Granger causality test shows that these three variables granger cause each other at our model and multivariate adjusted portmanteau test indicates the independence of the error terms of the model i.e. the adequacy of it.

The plots of impulse response function indicate shocks in total imports and exports affects positively on each other and also on themselves and the effects are moderate to high. These same shocks have positive but very low effect on GDP. Shocks in GDP have low positive effect on itself, moderate to high effect on imports and low positive effect at beginning but negative after three years on exports.

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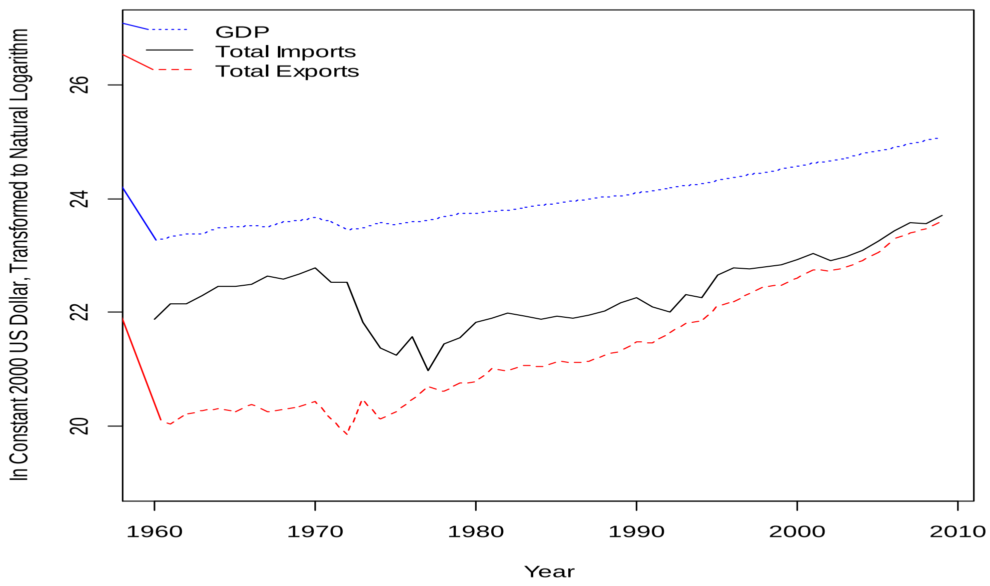

Figure 1: Natural Logarithms of Exports, Imports and GDP

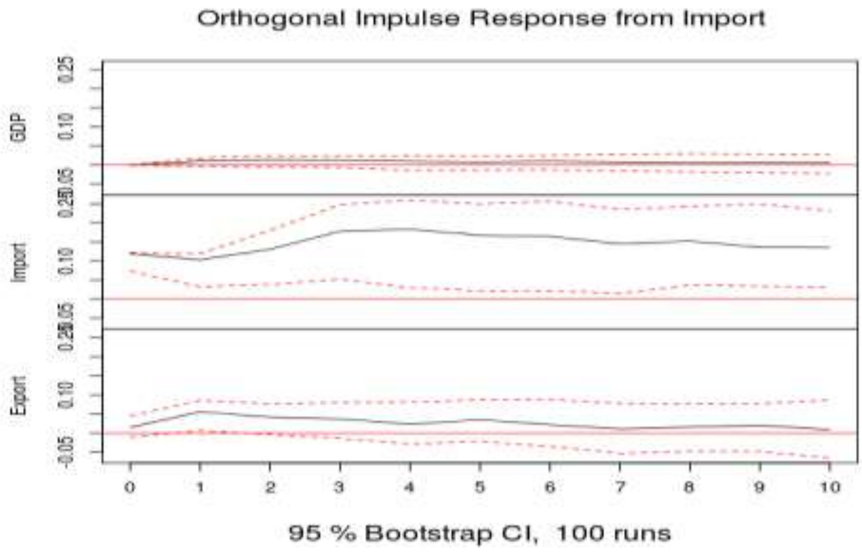

Figure 2: Impulse response function for import in Bangladesh, 1961-2010

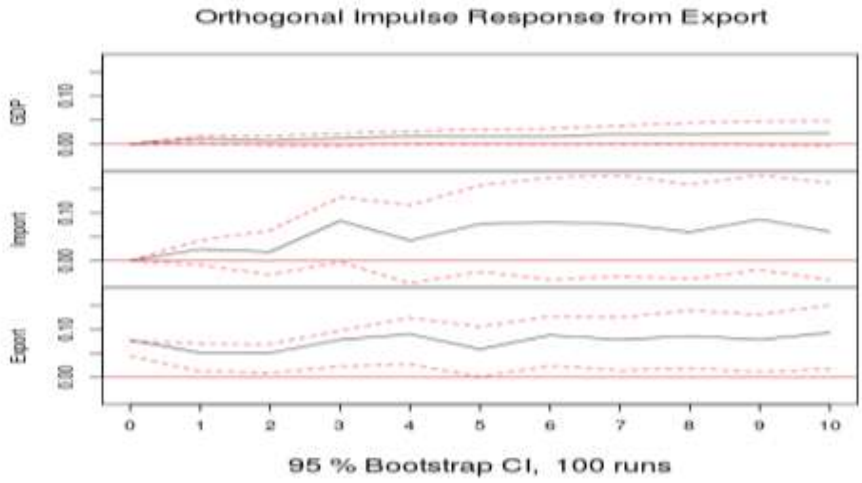

Figure 3: Impulse response function for Export in Bangladesh, 1961-2010

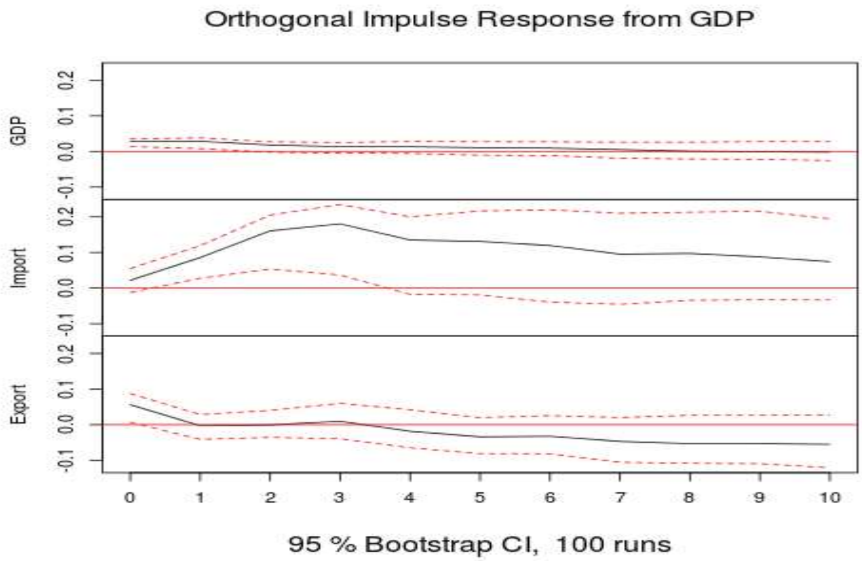

Figure 4: Impulse response function for GDP in Bangladesh, 1961-2010

Table1: Augmented Dickey Fuller (ADF) Unit Root Tests

Variable	**D statistic**	**P value**
GDP	-0.4394	0.98
Import	-1.699	0.82
Export	-1.3918	0.70

Table 2: ADF tests after first difference

Variable	**D statistic**	**P value**
GDP (diff1)	-3.3209	0.08
Import (diff1)	-3.4403	.06
Export (diff1)	-2.8062	.252

Table 3: ADF tests after second difference

Variable	**D statistic**	**P value**
GDP (diff2)	-5.9131	<0.01
Import (diff2)	-4.0381	0.015
Export (diff2)	-6.1316	<0.01

Table 4: Lag Length Criteria

IC	**Lag 1**	**Lag 2**	**Lag 3**	**Lag 4**	**Lag 5**	**Lag 6**
AIC	-13.96	-14.17	-14.65	-14.54	-14.80*	-14.72
HQ	-13.78	-13.85	-14.20*	-13.96	-14.08	-13.87
SC	-13.47*	-13.31	-13.43	-12.96	-12.85	-12.41
FPE	8.69	7.10	4.45	5.09	4.14*	4.83*

*Indicates lag order selected by criterion

Table 5: Result of Johansen Contegration Test Based on Trace Statistics

Null Hypothesis	**Test Statistics**	**Critical Value at 10%**	**Critical Value at 5%**	**Critical Value at 1%**
r<=2	8.07	7.52	9.24	12.97
r<=1	19.84	17.85	19.96	24.60
r=0	57.17	32.00	34.91	41.07

Table 6: Result of Johansen Contegration Test Based on Maximum Eigen Value Statistics

Null Hypothesis	**Test Statistics**	**Critical Value at 10%**	**Critical Value at 5%**	**Critical Value at 1%**
r<=2	8.07	7.52	9.24	12.97
r<=1	11.76	13.75	15.67	20.20
r=0	37.34	19.77	22.00	26.81

Table 7: Estimating Long run Relationship

Variable	**Cointegration Coefficient**
GDP	1.00
Import	0.051
Export	-0.69

Table 8: Summary result form VECM

Error Correction Term	**Estimated Value**	**t statistic**	**P Value**
For the equation of GDP	-.098	-3.235	0.00283 **
For the equation of Import	.395	3.010	0.00507 **
For the equation of Export	-0.493	-4.674	5.11e-05 ***

**** Significant for 1% level of significance**
***** Significant for 0.1% level of significance**

Table 9 : Results of Ganger causality test

Null Hypothesis	**F-Statistic**	**P-value**
GDP doesn't Granger cause Import and Export	4.1166	0.000116
Import doesn't Granger cause GDP and Export	1.9703	0.0463
Export doesn't Granger cause GDP and Import	3.1995	0.001527

Table 10: Results of diagnostic checking

Type of the test	**Lag used**	**Value of the test statistic**	**DF**	**P value**
Adjusted	16	118.67	102	0.124