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Ali, Sharafat

Government Postgraduate College Kot Sultan District Layyah, Pakistan

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Cointegration Analysis of Exports and Imports: The Case of Pakistan Economy

SHARAFAT ALI
Government Postgraduate College Kot Sultan, District Layyah, Pakistan
E-mail: Rana.Sharafat@gc.edu.pk

Abstract
This paper analyzes the long run association between Pakistan's exports and imports from 1972 to 2012. The results of both the Engle and Granger (1987) and Johansen (1991, 1995) cointegration reveal a long run relationship between the two variables. The error correction model results demonstrate that both of the variables converge towards long run equilibrium. This specifies the effectiveness of macrocosmic policies in stabilizing the international trade balance.
Key Word: Exports, Imports, Cointegration, Budget Constraint
JEL Classification: C22, F14, F43

Introduction
International trade has been flourishing over the years since it offers different advantages to the trading economies of the globe. International trade makes it possible for the economies to set up economic relationship with the other economies of the globe. Liberalized trade has been the common observable fact for most of the national economies. The combined effects of the macroeconomic policies are reflected by the volume of international trade of an economy. One can understand the impacts of macroeconomic policies by analyzing the long run relationship between the exports and imports of the economy. A stable and long run relationship between exports and imports suggests that an economy is in obedience of the international budget constraint, Husted (1992). Husted (1992) examined the long run association between exports and imports of the U.S. Husted used quarterly data of trade for the U. S. economy. He concluded a long run relationship between the exports and imports and found that there was a tendency in U.S. exports and imports to converge in the long run.
Many researchers investigated, following Husted (1992), the long run relationship between exports and import both in developed and developing counters. Bahmani-Oskooee (1994) applied cointegration techniques to analyze the long-term association between the exports and imports of the Australian economy from 1960 and 1992. The study concluded long run association between the variables and also suggested the macroeconomic policies to be efficient for the sample period.
Keong *et al.* (2004) explored the long run relationship between exports and imports of Malaysia by using cointegration techniques. The study concluded that short run fluctuations between the imports and exports were not sustainable and the imports and exports would ultimately converge to towards long run equilibrium. Irandoust and Ericsson (2004) found cointegrating relationship between exports and imports of some developed economies for Germany, Sweden, and the US. But the study did not found any cointegrating association between the variables for the UK. The authors suggested that a long run relationship between the exports and imports that an economy was not in violation of international budget constraint. The authors also conclude that trade imbalances were short run phenomenon and macroeconomic policies, in these nations, had been effective to bring exports and imports into long run equilibrium. Irandoust and Ericsson (2004) also pointed that no cointegrating relationship between exports and imports designated key policy problems in the economy and the productivity gap.
Afzal (2008) explored and compared, by using the Engle-Granger cointegration test, the long run performance of imports and exports in Pakistan, India, Sri Lanka, Korea and Thailand. The study found trade disequilibrium to be a short run phenomenon. The author was of the view that the macrocosmic policies in the sample economies had been efficient to affect long run equilibrium between exports and imports.
Uddin (2009) evidenced a long run relationship between total imports and total exports of Bangladesh economy. The results of the cointegration analysis showed that long run bidirectional causality existed between nominal value of exports and nominal value of imports but unidirectional causality existed from imports to exports in the short run. The study concluded bidirectional causality between exports as percentage of GDP and imports as percentage of GDP both in short run and long run. Some of the studies focused on the equilibrium relationship between exports and imports of Pakistan economy. These studies concluded significant equilibrium association between exports and imports of Pakistan (Kemal and Qadir 2005, Naqvi and Kimio 2005, Badar 2006).
Hye and Siddiqui (2010) investigated the correlation between exports and imports of Pakistan economy by using the variance decomposing analysis and rolling window bound testing technique to find out cointegration between the variables. The study found that exports did not caused exports but imports caused exports effectively.

Imports of Pakistan caused exports for the period of 2003 to over sample size but exports caused the imports for the period of 1994-2004.
Mukhtar and Rasheed (2010) looked into the relationship between imports exports and used cointegration and vector error correction procedures for the analysis. The authors used quarterly data for real exports, real imports and real exchange rate of Pakistan economy for the period of 1972-2006. The results of the study showed that exports and imports of Pakistan economy were cointegrated and there was no violation of international budget constraint. The long run relationship between the exports and imports of the economy was stable. Granger causality tests confirmed bidirectional causality between the variables.
Tiwari (2011) investigated the long term association between exports and imports of Chinese and Indian Economy. The author applied the latest time series econometric techniques such as unit root test in the presence of endogenous structural breaks and seasonal adjustments for the examination. The results of the Gregory-Hansen cointegration revealed that exports and imports of India were cointegrated but not for that of Chinese economy. The present study analyzes the long run relationship between the exports as percentage GDP and import as a percentage of GDP of Pakistan economy for the period of 1972-2012. In this analysis Engle and Granger two step method of cointegration and Johansen cointegration techniques to find out the association between the variables.

Theoretical Underpinnings

The present paper analyses, following Husted (1992), the existence of long run relationship between the exports and imports of Pakistan economy. If there exists a long run relationship between these variables then it would imply that exports and imports would not "drift too far apart"[3]. Husted (1992) provides theoretical motives to maintain his argument. Husted (1992) considers an individual consumer living in a small open economy with no government. The consumer can borrow and lend at predetermined interest rate in international market and maximizes utility given his budget limitations. The resources of the consumer comprise of an endowment of output and redistributed profits that he receives from the firms. The consumer uses his resources for consumption and saving. Husted (1992) started with the current period budget constraint as:

$$y_t = c_t + b_t - i_t - (1 + r_t)b_{t-1} \qquad (1)$$

Here y_t, c_t, and i_t are current output, current consumption, and investment level respectively. r_t and $(1 + r_t)b_{t-1}$ are current interest rate in international market and the debt of the last period corresponding to the economy's foreign debt.
Husted (1992) imposed a number of assumptions on equation (1) to derive an empirically testable equation as:

$$X_t = \beta_1 + \beta_2 M_t + e_t \qquad (2)$$

Where X_t is export and M_t is import. If there exists long term associate between exports and imports, it would imply that the economy would gratify its intertemporal budget constraint otherwise economy would not able to fulfill its foreign liabilities.

The Data and Methodology

The study is focused to probe long run relationship between the exports and imports of Pakistan economy for the period of 1972-2012. The data of exports and imports is taken from the Economic Survey of Pakistan (2011-12) issued by the Ministry of Finance Pakistan. The GDP data is taken from the World Development Indicators (WDI, 2012) of the World Bank. Author estimated the exports as percentage of GDP (X_t) and imports as percentage of GDP (M_t) for the analysis. The present study uses both the Engle and Granger (1987) two step method of integration and Johansen (1991, 1995) cointegration techniques for time series analysis. A prior examination about the level of integration of the variable has become routine. Unit root test has become very much popular as test of stationarity. A time series is conclude to be stationary if it has constant mean and variance over time and it's the covariance between the two times periods depend only the gap between two periods. A time series that is not stationary is called non-stationary. Granger (1986) suggests a unit root test as a pre-test to avoid spurious regression. We have two time series X_t and M_t, and:

$$X_t = \rho_1 X_{t-1} + u_{1,t} \ , \qquad -1 \le \rho_1 \le 0 \qquad (3)$$

$$M_t = \rho_2 M_{t-1} + u_{2,t} \ , \qquad -1 \le \rho_1 \le 0 \qquad (4)$$

If $\rho_1 = \rho_2 = 1$ then it is the case of unit root and the equations (3) and (4) would be random walk without drift and trend. It would imply that time series are non-stationary at their level. When we lag X_t and M_t for one time period, then the variables may become stationary. We formulate the time series as:

$$\Delta Y_t = \delta_1 Y_{t-1} + \epsilon_{1,t} \qquad (5)$$

$$\Delta M_t = \delta_2 M_{t-1} + \epsilon_{2,t} \qquad (6)$$

The unit root test suggested by Dickey-Fuller (1979) tests the null hypothesis that $\delta_1 = \delta_2 = 0$. If the null hypothesis is rejected then it is concluded that time series is stationary. Dickey-Fuller unit root test is based on the assumption that error terms in equation (5) and (6) are serially uncorrelated. When the error term is serially

[3] Husted (1992)

correlated then Augmented Dickey-Fuller (1979) unit root test is used to test order of integration of the time series. In ADF test, with the assumption of no drift and trend in the date, following regressions are estimated:

$$\Delta X_t = \delta_1 Y_{t-1} + \theta_{1,i} \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_{1.t} \quad (7)$$

$$\Delta M_t = \delta_2 M_{t-1} + \theta_{2,i} \sum_{i=1}^{m} \Delta M_{t-i} + \varepsilon_{2.t} \quad (8)$$

In regressions (7) and (8), $\varepsilon_{1.t}$ and $\varepsilon_{1.t}$ are white noise error terms. The ADF test also tests the null hypothesis that$\delta_1 = \delta_2 = 0$. The ADF test is better test than the DF test since it takes into account the presence of the correlation between the error terms by adjusting the one time differenced terms of the dependant variables.

Another unit root test suggested by Phillips & Perron (1988). In the Phillips & Perron (1988) test the correlation between the error terms is taken care of by using non-parametric statistical techniques. Both ADF test and Phillip-Perron unit root tests are applied on X_t and M_t, on level and first difference without intercept and no trend in the data, to check their order of integration.

Engle & Granger Cointegration and Error Correction Mechanism (ECM)

The present study utilizes the Engle & Granger (1987) two step procedure of cointegration and Jahansen (1991, 1995) cointegration technique. If two time series that are non-stationary separately but their linear combination is stationary are concluded to be cointegrated, Engle & Granger (1987). Cointegration techniques concern with long run behavior between the constituents of partially non-stationary variables that is sign of common trend. If the variables show common trend then the variables are supposed to move towards a long run or equilibrium association. We used Engle & Granger or Augmented Engle-Granger (AEG) test of cointegration. For this, I regressed X_t on M_t and error term is estimated by using Ordinary Least Squares (OLS) method as:

$$X_t = \beta_1 + \beta_2 M_t + e_t \quad (9)$$

And we estimated the error term of the model (9):

$$\hat{e}_t = X_t - \hat{\beta}_1 - \hat{\beta}_2 M_t \quad (10)$$

If the variables X_t and M_t are non-stationary but the error term $\hat{e}_t$ is stationary at its level then the variables are cointegrated, Engle & Granger (1987). It implies that there is an equilibrium relationship between the variables, that is, X_t and Mt are cointegrated. As first step of Engle & Granger cointegration process I estimated equation (9) by using OLS regression. As a second procedure, the study estimates the error term from the regression and test its order of integration of this error term at level. The author applied ADF test, with drift and trend, to examine order of integration of the error term of equation (10). The critical values generated by Davidson and MacKinnon (1993) are used for the rejection of unit root of error term. If the ADF test statistic is more negative than the Davidson and MacKinnon critical values at chosen level of significance then it is concluded that the error term is I (0). If the error term is concluded to be stationary, then the regression (9) would be called cointegrating regression and parameters β_2 is called cointegrating parameter.

When I (1) time series are cointegrated then the error term in the equation (10) can be treated as the equilibrium error. The two non-stationary variables X_t and M_t having long run association between them can be expressed as ECM, as:

$$\Delta X_t = A_0 + A_1 \Delta M_t + \sigma e_{t-1} + \vartheta_t \quad (11)$$

Where ϑ_t white noise error is term and e_{t-1} is the lagged value of the error term in regression (10). In equation (11), σ is expected to be negative. So ΔX_t also be negative to restore the equilibrium. If X_t is above its equilibrium value, it would start declining in next period t. if σ is positive then X_t would be below the equilibrium value then ΔX_t would be, and X_t would rise in period t.

The study also uses Johansen (1991, 1995) test of cointegration to recognize the existence of cointegrating association between the X_t and M_t. two non-stationary time series may share common trend. It implies that two time series are cointegrated if there exist a long run equilibrium association between them. Johansen cointegration procedure is based on the Vector Autoregressive (VAR) regression as:

$$X_t = B_t X_{t-1} + \ \dots \ + B_2 X_{t-p} + BM_t + \mu_t \quad (12)$$

In equation (12) y_t is a k-vector of non-stationary variables, x_t is a d-vector of deterministic time series variable and μ_t is a vector of error term. The VAR can be expressed as:

$$\Delta X_t = \pi X_{t-1} + \sum_{i=1}^{p-1} \varphi_i \Delta X_{t-1} + BM_t + \mu_t \quad (13)$$

Where $\pi = \left(\sum_{i=1}^{p} B_i\right) - I$ and $\varphi_i = -\sum_{j=i+1}^{p} B_j$

If the coefficient matrix π has reduced rank *r* < *k,* there would exist *k*×*r* matrices T and Λ each with rank *r* such that $\pi = T\Lambda'$ and $\Lambda' y_t$ is stationary. Where *r* is the number of cointegrating relations and each column of Λ is the cointegrating vector. Johansen (1991, 1995) test of cointegration estimated two different likelihood ratio tests trace teas and the maximum eigenvalue test as:

$$\Gamma_{trace} = -N \sum_{i=r+1}^{k} log\,(1 - \lambda_i) \quad (14)$$

$$\Gamma_{max} = -N \log\,((1 - \lambda_{r+1}) = \Gamma_r - \Gamma_{r+1} \quad (15)$$

Where N is the sample size and λ_i is the *i*-th largest eigenvalue. The trace statistic examines the null hypothesis of *r* cointegrating vectors against the alternative hypothesis of *k* cointegrating vectors. The maximum eigenvalue statistic tests the null hypothesis of *r* cointegrating vectors against the nil of *r+1* cointegrating vectors.

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When the variables integrated of order I(1) are cointegrated then the relationship between the variables can be expressed as the Error Correction Mechanism, Granger (1988), as:

$$\Delta X_t = H_0 + \sum_{i=1}^{4} H_i \Delta X_{t-i} + \sum_{j=1}^{4} H_j \Delta M_{t-j} + \phi E_{t-1} + v_t \quad (16)$$

In equation (15), E is the error is ECM term. The E_{t-1} is one year lagged value of the error term of the cointegrating regression. If there exists a long run equilibrium association between the variables, then there can be disequilibrium in the short run.

Results and Discussions

The study applies ADF test and Phillips-Perron unit tests, without drift and trend, to test the order of integration at level and first difference of the variables. The results of the unit root test, given in the Table 1, show that both of the variables are non-stationary at their levels but stationary at their first difference.

Table 1: Unit Root Test Results

Unit Root Test	**Level**	X_t`	M_t
ADF Test	Level	-0.0686 (0.6537)	-0.0996 (0.6417)
	1st Difference	-10.7901 (0.0000)*	-2.58163 (0.0116)**
Phillips-Perron Test	Level	0.0034 (0.6679)	-0.2235 (0.5995)
	1st Difference	-17.6244 (0.0000)*	-15.0834 (0.0000)*

Note: Values in the parentheses are MacKinnon (1996) one- sided p-values for the rejection of a unit root.
*(**) MacKinnon (1996) one-sided p-values for the reject hypothesis of unit root at 1%(5%) significance level.

When the time series are non-stationary at level but stationary at their first difference and if the error term is stationary at its level, then the variables are cointegrated, Engle & Granger (1987). The author estimated the regression (9) then the error term was obtained. The estimated error term was considered to be stationary for regression (9) to be considered as cointegrated regression. The order of integration of the estimated error term was examined by using ADF test. ADF test results are given in Equation (10). ADF test statistic value is compared with the Davidson and MacKinnon (1993) critical values (from Table 20.2, pp. 722).

Table 2: Engle-Granger Cointegration Test

Variable	**Coefficient**	**Standard Error**	**t-Statistics**	**Prob.***
Constant	1.5729	0.1113	14.1346	0.0000
M_t	0.6312	0.0387	16.2978	0.0000

R^2 = 0.8720 Adjusted R^2 = 0.8686
F-Statistic = 265.6172 Prob.(F-Statistic) = 0.0000
Akaike AIC = -1.2131 Durbin-Watson Statistic = 1.3503

*Mackinnon-Haug-Michelis (1999) p-values

Table 3: ADF Unit Root Test for Engle-Granger Cointegration Approach

$$\Delta\hat{u}_t = -0.0955 + 0.0048t - 0.9530\hat{u}_{t-1}$$
$$\tau = \quad (-2.2361) \quad (2.5419) \quad (-5.4454)$$

R-Squared = 0.4488 Adjusted R^2 = 0.4191
Durbin-Watson d = 1.8037 Prob. (F-statistic) = 0.0000

The results of the ADF test, given in Table3, show that the ADF tau value (-5.4454) is more negative than the Davidson and MacKinnon (1993) critical values of -5.25 and -4.43 at 0.01 and 0.05 significance level respectively. So the null hypothesis of unit root test at level is rejected for the estimated error term from the regression (9). So it is concluded that the linear combination of the I(1) time series X_t and M_t is stationary at level.

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Table 4: Engle-Granger Error Correction Model

Variable	Coefficient	Standard Error	t-Statistics	Prob.*
Constant	0.0034	0.0195	0.1768	0.8606
ΔM_t	0.6130**	0.0269	22.8070	0.0000
e_{t-1}	-0.6898**	0.1553	-4.4403	0.0001
R^2 = 0.9343 Adjusted R^2 = 0.9308 F-Statistic = 263.0996 Prob.(F-Statistic) = 0.0000 Akaike AIC = -1.2828 Durbin-Watson d = 2.0034				

*Mackinnon-Haug-Michelis (1999) p-values
**Significant at 0.01 significance level.

The stationarity of the error term at level implies that there exists a long run or equilibrium relationship between the X_t and M_t. In this case the regression (9) is concluded to be cointegrating regression. The cointegrating coefficients (given in Table 2) are statistically and significantly different from zero at 1 percent level of significance. Exports as percentage of GDP and imports as percentage of GDP, in Pakistan, are cointegrated. Import elasticity of exports is 0.6312 and it shows that imports have positive impact on the exports of Pakistan.

Johansen Cointegrating Test

Cointegration association between X_t and M_t has been analyzed by using Johansen technique of cointegration. The results of the Johansen cointegration method of maximum likelihood method are reported in Table 5. The null hypothesis of no cointegrating vector is rejected against the alternative hypothesis both by the trace statistic and maximum eigenvalue statistic at 5 percent significance level. The null hypothesis of at least 1 cointegrating vector cannot be rejected in favor of alternative hypothesis of 2 cointegrating vectors both by trace statistic and maximum eigenvalue statistic. Both trace statistic and maximum eigenvalue statistic suggest at least one cointegrating vector between X_t and M_t at 95 percent confidence level.

Table 5: Johansen Cointegration Test Results

Null Hypothesis	Alternative Hypothesis	Eigen Value	Trace Statistic	Critical Value	
				5%	P-values**
H_0: $r = 0$	$H_1 : r = 1$	0.6231	37.2016*	20.2618	0.0001
H_0: $r = 1$	$H_1 : r = 2$	0.056	2.0752	9.1645	0.7627
Null Hypothesis	**Alternative Hypothesis**	**Eigen value**	**Max-Eigen Statistics**	**Critical Value**	
				5%	**P-values****
$H_0 : r = 0$	$H_1 : r > 0$	0.6231	35.1265*	15.8921	0.0000
$H_0 : r \leq 1$	$H_1 : r > 1$	0.056	2.0752	9.1645	0.7627

Normalized cointegrating coefficients
(t-value in parentheses)

$$X_t = -3.7274 + 2.4762M_t$$
$$t = (-5.0435)^{***} \quad (9.6028)^{***}$$

Note: Trace test & Max-eigenvalue test indicate 1 cointegrating equation at the 0.05 level of significance.
*Denotes rejection of the hypothesis at the 0.05 level.
** Mackinnon-Haug-Michelis (1999) p-values
***Indicates the rejection of the null hypothesis at 0.01 level.

Normalized cointegrating coefficients are given in lower panel of Table 5. Since the variables are logarithmic, we can interpret the coefficient of M_t as imports elasticity of exports. The results show that 1 percent increase/decrease in imports is associated with 247.62 percent decrease/increase in exports. After finding out the non-stationary variables at level we vector error correction model is estimated with lag 4 (given in Table 6). The coefficient of error correction term is significant at 1 percent level of significance. The speed of convergence is 68.13 percent. The value of the speed of adjustment shows that exports are adjusted by 68.13 percent of the deviation of the last year from equilibrium. This shows that speed of adjustment is very fast. The coefficient of one year lagged value of exports is 2.47 and it is significant at 1 percent significance level. It shows that last year exports have positive and significant effects on exports in next year. One year and four year differenced value of

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imports affects exports significantly at 5 percent and 10 percent significance respectively. This shows that, in short run, imports also affect exports of Pakistan economy.

Table 6: Error Correction Mechanism Results

Variable	Coefficient	Standard Error	t-Statistic
Constant	0.0235	0.0585	0.4014
X(-1)	2.4694*	0.2619	9.4280
D(X(-1))	-0.8382	0.6572	-1.2755
D(X(-2))	-0.5576	0.7685	-0.7256
D(X(-3))	-0.1859	0.8513	-0.2184
D(X(-4))	-1.3456	0.9976	-1.3488
D(M(-1))	1.0985**	0.4936	2.2255
D(M(-2))	0.9140	0.5560	1.6440
D(M(-3))	0.6456	0.6064	1.0647
D(M(-4))	1.1411***	0.6913	1.6507
E_{t-1}	-0.6813*	0.2304	-2.9574
R^2 = 0.6216 Adjusted R^2 = 0.5000 F-Statistic = 4.7453 Akaike AIC = 0.8893			

*Significant at 0.01 significance level
**Significant at 0.05 significance level
***Significant at 0.10 significance level

It is apparent from the results of Engle & Granger two step cointegration test and Johansen cointegration test that exports and imports of Pakistan are cointegrated, which is, there exists a long run equilibrium relationship between them. These results show the observance of Pakistan economy to international constraint. The existence of cointegrating association between exports and imports is the necessary condition for the adherence of an economy to the international budget constraint, Husted (1992).

The long run relationship between exports and imports of Pakistan economy is very important due to the fact that imports play very important role in the process of growth of the economy through multiple channels. Imports of necessary raw material and indispensable modern technology increase the productive capacity of the economy in the long run. This increased productive capacity augments the rate of growth of economy, Shirazi and Manap (2004). Not only imports may increase the productive capacity but may also help generating the conduct and transportation sectors in the whole sale and retailing sector. These sectors also play very important role in the growth and development of the economy. Though unwarranted inflows of consumer goods into the economy may substitute the domestically produced goods and can cause lay off of the workers. But inflows of imported raw material, capital goods, machinery and modern technology help the economy to growth and boost the exports of the economy. Higher exports in turn improve the growth rates of the economy and make possible for the economy to access into the liberalized world markets. Excessive exports help to earn higher foreign exchange earnings. The adoption of the liberalized trade policy would help the economy to import essential raw material and intermediate goods for value addition, import of modern and efficient technology to develop the capacity and productivity of the economy.

Conclusion

The foremost aspire of the study is to look into the long run equilibrium relationship between Pakistan's exports and imports by using Engle and Granger (1987) two step approach of cointegration and Johansen (1991, 1995) for the period of 1972-2012. Both of both of the cointegration approaches conclude a long run equilibrium relationship between the exports and imports of Pakistan. It also found that the short term discrepancy between exports and imports are not sustainable in the long run as Pakistan's exports and imports converge in the long run. This long run relationship between the export and imports designates that, in Pakistan economy, macroeconomic policies have been implemented effectively. This implies that Pakistan economy is in obedience of international budget constraint.

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