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Is Trade Good for Environment? A Unit Root Cointegration Analysis

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I. INTRODUCTION

One of the most debatable issues surrounding globalisation is the concern that trade hurts the environment, both locally and globally. Economists argue that expanding trade from domestic market to international market not only increases market share of each country but also rising competition among the nations and improve efficiency of utilising scarce resources because each country produces those goods in which she has comparative advantages. But on the other hand, environmental economists have opposed global trade and argue that the costs of spreading trade to international markets are depleting natural resources and rising pollution emissions that ultimately deteriorates environmental quality. [Copeland and Taylor (2001), Antweiler, Copeland and Taylor (2001), Chaudhuri and Pfaff (2002), Schmalensee, Stoker and Judson (1996).]

There is a conflict among economists as environmental economists argue that pollution control and natural resource management issues are neglected in trade policy. Further, new scenario of economics raises competition among the nations and they encourage export led growth, privatisation, deregulation and free trade. All these factors have severe effect on social structure. It has led to the collapse of social systems; increased social inequities resulting in conflicts; displaced populations; and increased migration. It has shaped a development model of production and consumption with far reaching impacts on the physical environment worldwide [Bhagwati (1999)]. On the other hand, some economists claim that trade is beneficial for environment because trade raises competition by reducing trade barriers, improved quality of product and implementation of environmental regulations. Further, trade led growth improves standard of living of the developing countries as well as environmental quality. [Runge (1994); Helpman (1998); Daniel and Giradina (1998)].

One of the well-known environmental arguments against foreign trade is that it allows dirty industries[1] to be shifted from developed nations to developing nations. There are three reasons for such an action. First, firms that face regulations at home will use the threat of relocation to successfully lobby for special relieves from regulations at home. Second it is inappropriate to export our dirty industries to developing countries, and finally there is concern about pollution produced in less developed countries which carries back to developed nations.

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[1]"Dirty Industries" means transfer of bad technology.

There is much more empirical work to find out relationship between GDP growth and environmental degradation, which is known as environmental Kuznets curve (EKC). But still environmental Kuznets curve is a controversial issue in literature. Many believe that environment and per capital income hold same relationship as relationship between per capita income and income distribution which was found by Simon Kuznet in 1955.[2] They stated that at initial level of growth, environmental quality is worsen, while at later stage of growth it improves because people desire for better environment. [Grossman and Krueger (1991, 1995), Selden and Song (1994), Shafik and Bandyopadyay (1992), Stern, Common and Barbier (1996), Panaotou (1993) Antle and Heidebrink (1995), Dasgupta, Laplante, and Wheeler (2002), Eakin and Seldon (1995), Hettige, Mani and Wheeler (2000), Kuznet (1955)]. On the other hand, some economists have empirically proved that such relationship dose not hold between per capita income and environmental quality [Koop and Tole (1999), Dietz (2000)].

But there is not enough research work that has evaluated the impacts of global trade on environment. Therefore, the purpose of this study is to find out how trade deteriorates environmental quality and deplete natural resources. A unit root co-integration technique has been used for it. The sources of data are World Bank/World Development Indicators/Economic Survey of Pakistan.

The paper is organised in Section II and III which discuss methodological issue and procedure, Section IV provides empirical results and finally Section V presents concluding remarks.

II. DATA SOURCE AND METHODOLOGY

This study is designed to analyse impacts of foreign trade on domestic environmental quality. Recent empirical work suggests that there is either not enough research work to find out relationship between trade and environmental quality or if there is any study then it consists of cross sectional data. This study analyses if there is any long run relationship between trade and environmental quality.[3] The relationship between trade and environmental quality is simple; therefore, study explores the impact of trade indicators on the environment in Pakistan. As a beginning of empirical framework, two different indicators of environmental quality are used to examine impact of trade on environmental quality.[4] We estimate the following linear-trade environmental model for our study.

$$CO_2=\alpha_1+ \alpha_2 EX+ \alpha_3 PD+ \alpha_4 FDI+ \alpha_5 Y_+ \mu \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$LA= \beta_1 + \beta_2 EX+ \beta_3 PD+ \beta_4 FDI+ \beta_5 Y\mu \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

These two models consist of six variables, Arable Land (hectares in thousand) (*AL*), Carbon Dioxide Emissions (kt in thousand) CO_2, Exports (*EX*), Population Density

[2]Kuznets (1955) in his article "Economic Growth and Income Inequality" proposed inverted U-Shaped Curve for relationship between Growth and Inequality.

[3]Jeffrey and Rose (2002) sort out causality between trade and environmental quality. They Used CO_2 emission as air pollution and as air quality indicators, Seldon and Song (1994) also used CO_2 for air pollution.

[4]AL used for agriculture sector and CO_2 for industrial sector.

(*PD*), GDP per capita (*Y*), and Foreign Direct Investment (*FDI*). The data is obtained from the *World Development Series* and *Economic Survey of Pakistan.*

III. ECONOMETRIC PROCEDURE

There are three basic environmental issues; air pollution, water pollution and land degradation. This paper is confined to two environmental pollution areas, air and land. We analyse the impact of trade variables on environmental quality indicators both carbon dioxide emission (CO_2) and arable land (AL) separately. First Augmented Dickey-Fuller (ADF) test is used to examine whether the time series is unit root. Second, Johansson's maximum likelihood multiple co- integration test is used to find out long run relationship among the variables. Further if there is existence of long run relationship among variables then Error Correction test is applied to find out short-run relationship because there is possibility of disequilibrium in the short-run. Finally, Granger Causality Test is applied to investigate that whether these variables have causality or not.

The co-integration technique pioneered by Granger (1986), and Engle and Granger (1987) permit long-run components of variables to conform long-run equilibrium relationships to the short-run components having a flexible dynamic specification. In light of Shintani's (1994) finding that the Johansson method is more powerful than the Engle-Granger method, the multivariate co-integration framework that we intend to use here has now come to be established as a standard one for VAR systems. The procedure may be summarised as follows [see for example, Johanson (1988); Johansen and Juselius (1990)]. Unlike the Engle and Granger co-integration method, the Johanson procedure can find multiple cointegration vectors. For this approach, one has to estimate an unrestricted Vector Auto-Regression (VAR) of the following form:

Let Xt be an I(1) vector representing the n-series of interest. A VAR of length p for Xt, would then be of the form.

$$Xt = \sum_{j=1}^{p} \Pi_j X_{t-j} + \mu + \varepsilon \qquad t=1, 2, 3\ldots T$$

Where the Π_j are matrices of constant coefficients, μ is an intercept, ε is a Gaussian error term and T the total number of observations.

The ECM corresponding to Equation (2) is

$$\Delta X = \sum_{j=1}^{p} \Gamma_j \Delta X_{t-1} + \Pi X_{t-p} + \mu + \varepsilon$$

Where Δ is the first-difference operator and the expression for Γj and Π are as given in Johanson and Juselius (1990).

If Rank (Π) = $r(r<n)$ then co integration is indicated (with r co- integrating vectors present) and further, in this case Π may be factored as $\Pi=\alpha\beta$, with the matrix β comprising the r co-integrating vectors and α can be interpreted as the matrix of corresponding ECM weights. The matrix Π contains the information on long run relationship between variables, if the rank of $\Pi=0$, the variables are not co-integrated. On the other hand if rank (usually denote by 'r') is equal to one, there exist one co-integrating vector and finally if $1<r<n$, there are multiple co-integrating vectors.

[Johanson and Juselius (1990)] have derived two tests for co-integration, namely trace test and the maximum eigenvalue test. The first task in Johanson procedure is to choose an autoregressive order (p). There are tests for the choice of this appropriate lag length.[5] The ECM weights αi determine the short-run term error correction responses of the variables to deviations from long-run equilibrium values.

IV. EMPIRICAL RESULTS

There are two co-integration techniques to investigate long run relationship among the variables but the Johanson co-integration and error correction techniques are used to examine long run and short run relationship respectively.[6]

But before applying co-integration technique to establish long run relationship, it is imperative to make the series stationary and establish order of integration among variables. That is why, Augmented Dickey Fuller (ADF) method was carried out on the time series levels and first difference form. The results are presented in Table 1 and show that all variables are unit root (non-stationary) at levels and stationary at first difference. Therefore all Variables (CO_2, *PD*, *EX*, *Y*, *FDI*, *AL*) are integrated of order of one I (1).

Table 1

Test of the Unit Root Hypothesis

	Level		First Difference	
Variables	t-statistics	K	t-statistics	K
AL	–3.01	4	–4.83*	1
CO_2	–2.85	1	–3.36**	1
PD	–1.36	3	–4.81*	2
FDI	–0.2	4	–4.28*	3
Y	–2.61	3	–2.8***	1
EX	0.2	4	–2.68***	2

Note: The t-statistic reported in is the t-ratio on γ_1 in the following regression.
The optimal lags (k) for conducting the ADF test were determined by AIC (Akaike information criteria).
, * and * indicate significance at the 5 percent, 1 percent and 10 percent levels, respectively.

$$\Delta X = \gamma_O + \gamma_1 X_{t-1} + \sum_{i=1}^{p} \beta \Delta X_{t-i} + \gamma_3 T + u_t$$

To establish order of integration, in next step, Johansen maximum likelihood co-integration method of E(1) and E(2) is used to investigate the presence of long run relationship among environmental and trade variables. Two separate environmental indicators are used to examine possible effect of trade variables on environmental quality,

[5]Akaike Information Criteria and Schwarz Criterion ets.
[6]The Johansen-Juselius (1990) can find multiple cointegrating vectors; Engle-Granger approach has several limitations in the case of more than one cointegration vector.

Carbon Dioxide (CO_2) is an indicator of air pollution while arable land (AL) measures quality of land. First, this study observes impact of trade on air Quality. The results of co-integration among CO_2, Ex, PD, Y and FDI are presented in Table 2.

Table 2

Johansen's Test for Multiple Cointegration Vectors

		Co-Integration Test Among [CO_2 Y, FDI, EX, PD]				
H0:	H1:	Tests Statistics	95%Critical values	99%Critical values		
λtrace		λtrace				
r = 0	*r > 0*	92.71*	76.07	84.45		
r ≤ 1	*r > 1*	51.79	53.12	60.16		
r ≤ 2	*r > 2*	26.79	34.91	41.07		
λmax values		λmax alues				
r = 0	*r = 1*	40.92*	25.54	30.34		
r = 1	*r = 2*	14.13	18.96	23.65		
r =2	*r = 3*	1.6	12.25	16.26		
Cointegrating Vector		*CO_2*	*EX*	*PD*	Y	FDI
		–1	*0.09*	*1.13*	0.68	0.06

*Indicates significance at the, 1 percent levels.

Starting with null hypothesis of no co-integration(r=0) among the variables, the trace statistic is 92.71 which exceeds the 99 percent critical value of the λtrace statistic (critical value is 84.45), it is possible to reject the null hypothesis (r=0) of no cointegration vector, in favour of the general alternative r≥1. As evident in Table 2, the null hypothesis of r≤1 r≤2 cannot be rejected at 5 percent level of significance. Consequently, we conclude that there is one cointegration relationship involving variables CO_2, EX, Y, FDI and PD.

On the other hand, λmax statistic reject the null hypothesis of no cointegration vector(r=0) against the alternative (r=1) as the calculated value λmax(0,1)=40.92 exceeds the 99 percent critical value(30.34). Thus, on the basis of λmax statistic there are also only one co-integration vector. The presence of cointegration vector shows that there exists a long run relationship among the variables. The long run elasticities of PD, Y, EX and FDI are 1.13, 0.68, 0.09 and 0.06 respectively.

Similarly, Johansen co-integration test is applied to check the long run relationship among arable land and trade variables (AL, PD, EX, Y and FDI). The results are presented in Table 3.

Table 3

Johansen's Test for Multiple Cointegration Vectors

Co-Integration Test Among [AL,Y FDI,EX,PD]						
H0:	H1:	Tests Statistics	95%Critical Values	99%Critical Values		
λtrace		λtrace				
r = 0	*r > 0*	86.05	76.07	84.45		
r ≤ 1	*r > 1*	45.8	53.12	60.16		
r ≤ 2	*r > 2*	22.97	34.91	41.07		
λmax values		λmax values				
r = 0	*r = 1*	40.25	25.54	30.34		
r = 1	*r = 2*	17.28	18.96	23.65		
r =2	*r = 3*	6.88	12.25	16.26		
Cointegrating Vector		*LA*	*EX*	*PD*	*Y*	*FDI*
		–1	*0.027*	*0.74*	0.20	0.029

* Indicates significance at the, 1 percent levels.

Table 3 shows that null-hypothesis of no cointegration(r=0) among the variables is rejected because the trace statistic 86.05 exceeds the 99 percent critical value of the λtrace statistic (critical value is 84.45), therefore, present study rejects the null hypothesis (r=0) of no cointegration vector, in favor of the general alternative r≥1. As evident in Table 3, the null hypothesis of r≤1 r≤2 cannot be rejected at 5 percent level of significance. Consequently, we conclude that there is one cointegration relationship involving variables AL, EX, Y, FDI and PD.

On the other hand, λmax statistic reject the null hypothesis of no cointegration vector(r=0) against the alternative (r=1) as the calculated value λmax (0,1)=40.25 exceeds the 99 percent critical value(30.34). Thus, on the basis of λmax statistic there are also only one co-integration vector. The presence of cointegration vector shows that there exists a long run relationship among the variables.

Johansen maximum likelihood co-integrated vector techniques indicate that there is a long run relationship among variables. Once long run relation is established, Error correction model can be used to examine short run distortion (shocks) in the model. Our study consists of two separate environmental problems, that is why we estimate two separate error correction model (ECM) for response of CO_2 and AL to determine short run dynamics of the system. To estimate the short run error correction model, we used general to specific approach [Hendry (1979)].

Using Hendry general to specific approach, initially, two lags of the explanatory variables and one lag of the error correction term are incorporated. Later, insignificant variables are gradually eliminated. The estimated results of Error Correction Model (ECM) are presented in Table 4 and Table 5.

Table 4

Estimated Error Correction Model-I

Dependent Variable=ΔAL Regressors	Estimated Coefficients
Constant	0.775^{**}
ΔAL (-1)	3.63^{**}
ΔPD (-1)	3.330^{*}
ΔFDI	0.006
ΔY	0.093
ΔEX(-1)	0.029
RES(-1)	-0.025^{**}
Diagnostic Tests	
Serial Correlation	0.85
Heteroscedasticity	1.25
Functional Form	0.65
Normality	0.31

, * and * indicate significance at the 5 percent, 1 percent and 10 percent levels, respectively.

Table 5

Estimated Error Correction Model-II

Dependent Variable=ΔCO_2 Regressors	Estimated Coefficients
Constant	0.044^{**}
ΔCO_2 (-1)	0.003^{**}
ΔPD(-1)	0.769
ΔFDI(-2)	0.070^{***}
ΔY(-1)	0.017^{**}
ΔEX(-1)	0.030
RES(-1)	-0.02^{**}
Diagnostic Tests	
Serial Correlation	0.75
Heteroscedasticity	1.14
Functional Form	0..60
Normality	0.49

, * and * indicate significance at the 5 percent, 1 percent and 10 percent levels, respectively.

The coefficients of error correction model (ECM) have correct negative sign and statistically significant at 5 percent level.[7] It suggests the validity of long-run equilibrium relationship among the variables in Table 2 and Table 3. Thus, ECM is not only valid but also there is significant conservative force tendency to bring the model back into equilibrium whenever it strays too far. The results of diagnostic test indicate that both equations passes the test of serial correlation, functional form, normality and heterodasticity. The small sizes of coefficient of error-correction terms indicate that speed of adjustment is rather slow for equation to return to their equilibrium level once it has been shocked.

Since all variables are measured in logarithms, therefore, the regression coefficients can be directly interpreted as elasticities. Estimated results of error correction model of response variable CO_2 is presented in Table 4 and indicate that except export both GDP per capita (y) and foreign direct investment (FDI) have significant positive impact on environment quality. For example long run elasticity of Y is 0.68 which indicates that a one percent increase in Y result in 0.68 percent increase in CO_2 emission in the air while long run elasticity of FDI is 0.06 which indicates that a one percent increase in FDI would raise CO_2 emission by 0.06 percent. On the other hand, in Table 5 none of the trade variable has significant impact on environment while, population density has significant positive impact on environment as it is expected. It suggests that a one percent increase in PD raises AL by 0.74 percent.

V. CONCLUSION

During the last few decades, trade led growth is supposed to be prerequisite for economic development. Economists argue that expanding trade from domestic market to international market not only increases market share of each country but also raise competition among the nations and improve efficiency of utilising scarce resources. On the other hand, environmental economists are opposed to such argument and they claim that real cost of spreading trade among the nations is depleting natural resources and deteriorate environmental quality.

In this study, we used Johansen-Juselius co-integration technique for valid long run relationship among the variables and error correction models to determine the short run dynamics of system to time series data for Pakistan's economy, over the period 1972-2002.

A valid long run relationship was found among the variables indicating that spreading trade on global level is harmful for environmental quality for developing countries because developed countries transfer their worse technology to the developing nations. Both CO_2 emission and arable land (AL) have significant long run relationship, but we could not find any significant relationship among arable land (AL) and trade variables. On the other hand, there is a significant short run relationship among CO_2 emission, per capita income and foreign direct investment (FDI).

The results indicate that we need to design appropriate economic policies to protect environment. These policies are to be based on sound macro-and micro economic management, couple with good governance aimed at regulating laws to protect

[7]The error-correction term was calculated from the Maximum Likelihood Estimates of cointegrating vector.

environment and promoting sustained economic growth. Further, this study provide an idea for research in determining the impacts of environmental laws on economic growth.

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