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Environmental Effects of Trade Liberalisation: A Case Study of Pakistan

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1. INTRODUCTION

Within today's global economy countries now trade more intensively and frequently than in the past. Trade has become an increasingly important global economic activity, with annual trade volumes increasing sixteen fold over the last fifty years and the ratio of world exports to Gross Domestic Product (GDP) now approaching twenty percent. With this recent acceleration of global trade, countries throughout the world have benefited from more investment, industrial development, and employment and income growth.

Other positive effects include increased mobility of capital, increased ease of movement of goods and services (and information) across national borders as well as the diffusion of global norms and values, the spread of democracy and international environmental and human rights agreements. Critics of trade liberalisation argue that these much-acclaimed advantages of trade liberalisation (and globalisation) often underrate the impact of globalisation on widening the economic gap between the North and the South. Over the years, attention has been given to the advantages of trade liberalisation and globalisation to the detriment of the disadvantages. The major disadvantage that is always swept under the rug is the environmental problem. Recently, however, there has been an increasing concern over the potential negative impacts of trade liberalisation, particularly on the environmental and natural resources of developing countries.

Since the middle 1970s, there has been considerable progress in trade reforms in most developing countries, turning from import substitution strategy to export-oriented approach. Pakistan's trade policy has also been moving towards more openness; fewer controls and steadily the tariff rates have tumbled down. Rapid expansion in industrial production and urbanisation have led to increased levels of waste water pollution, solid waste, and vehicle emissions that have resulted in serious health problems in many areas of the country. Like most developing countries, Pakistan faces serious environmental

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problems. Rapid population growth (averaged about 3 percent a year since the early 1970s) and impressive GDP growth (of about 6 percent a year) have put enormous pressure on the country's natural resource base and have significantly increased levels of pollution.[1]

The theoretical research in the relevant literature indicate that economic globalisation in the form of trade liberalisation can affect pollution in three ways—technique effects, composition effects and scale effects [Antweiler, *et al.* (2001)]. In the case of the latter, pollution or emissions are the by-product of production and consumption, and increases in the scale of economic activity may definitely affect pollution. Technique or method effects involve the use of different methods of production that have different environmental impacts due to the possibility of substitution between different inputs. Composition effects arisen from the fact that each good has its own polluting tendency. The composition of traded goods therefore can determine the extent of pollution in any given society.

The collection of empirical evidence on the relative impact of these effects as well as the gross effects of trade liberalisation on the environment is rare and largely limited to developed countries.[2] Furthermore, earlier research on the issue, which has largely been confined to cross-country investigations that were sensitive to the choice of pollutants and the countries included in the sample, has been unhelpful in offering guidance and sound policy advice to the developing countries.[3] In recent years, an increased emphasis is being placed on examining the experience of individual countries so that policy frameworks are suggested according to their unique circumstances and resources.

The present study focuses on the pollution effects of the scale, composition and techniques of trade liberalisation in Pakistan. It seeks to determine the extent of these effects and how they can be minimised in the case of Pakistan trade policies and in the wider developmental context. To the best of our knowledge, no empirical attempt has yet been made in Pakistan to study the relationship between economic globalisation in the form of trade liberalisation can affect pollution in three ways—technique effects, composition effects and scale effects by using the sophisticated econometric techniques.

The plan of the paper is as follows: Section 2 presents theoretical Issues of trade liberalisation and the environment, while methodology and data series are discussed in Section 3, analysis and empirical results in Section 4 and Section 5 presents concluding remarks.

2. THEORETICAL ISSUES OF TRADE LIBERALISATION AND THE ENVIRONMENT

The neoclassical factor endowment model known as the Hecksher-Ohlin theory of trade postulates that trade arises because of the differences in labour productivity—which they assume to be fixed—for different commodities in different countries. According to this theory, the basis for trade arises not because of inherent technological differences in

[1]The Environmental Sustainability Index (ESI) compiled by the Yale Centre for Environmental Law and Policy and the Centre for International Earth Science Information Network, ranked Pakistan as 137 out of 146 countries in 2005.

[2]Grossman and Krueger (1993), Lopez (1994), and Chua (1999).

[3]See Vincent (1997) and Stern, Common, and Barbier (1997).

labour productivity for different commodities between different countries but because countries are endowed with different factor supplies. Given relative factor endowments, factor prices will differ (for instance, labour will be relatively cheap in labour-abundant countries) and so too will domestic commodity price ratios and factor combinations. The above theory therefore explains why resource-abundant (for instance, labour-abundant) LDCs are into the production and export of labour-intensive commodities in return for imports of capital-intensive goods because of their relative cost and price advantage enhanced by international specialisation. Trade therefore serves as an engine for a nation to capitalise on its abundant resources through more intensive production. What this theory suggests is nothing short of free trade, which was equally elicited in the Hecksher-Ohlin-Samuelson (H-O-S) model, which is a development of the H-O principle. This model shows how an increase in the price of a commodity can raise the income of the factors of production used most intensively in producing it. Samuelson's factor price equalisation theorem postulates the conditions under which free trade in commodities narrows differences in commodity prices between countries, and in doing so the incomes of the factors of production are also brought in line. In other words, free trade offers a substitute for the free mobility of factors of production. Based on the H-O-S model, free mobility of factors can lead to national resource movement from places of excess to places of relative scarcity, and the movement of polluting industries from their home countries to developing countries where environmental regulation is a matter of formality (the pollution haven hypothesis).

Antweiler, *et al.* (2001) made a much clearer extrapolation of the original HO model of trade. They decomposed the full impact of openness or trade liberalisation on environment into composition, scale and technique effects. Their approach involves both mathematical and geometrical illustrations. In their geometrical exposition, they derived the condition under which trade liberalisation for a dirty good leads to less pollution, if the technique effect (which for them is always beneficial to the environment) can overwhelm the combined scale and composition effects (which for them are always harmful to the environment). In this model, trade liberalisation (or reduction in trade barriers) produces the three trade-induced effects, which interact to determine the environmental effects of trade. When there is a decline in trade barriers, the HO-S model that prices are brought in line due to reduction in barriers applies. The result is that domestic price approaches the world price and production is enhanced as it moves to a point where revenue increases and real income rises and there is a change in the production techniques. The issues raised by most theories of the linkages between trade and environment include the following: if trade openness improves income levels and improves the access of developing economies to less polluting/cleaner techniques, why is there such an overwhelming negative impact of trade on pollution in many countries with these conditions? What is the extent of the technique effects of trade and is this variable only determined by income growth? If the technique effects of trade openness on environment are real, then how do we explain the dumping of especially old and obsolete technology on developing economies? What determines the direction of the composition and scale effects of trade? Are their effects on pollution always the same irrespective of whether it is a developing economy or a developed economy? Lastly, what is the impact of trade liberalisation on resource exhaustibility? Is the current wave of excessive trade openness good for the optimal utilisation of non-renewable resources? In light of these issues, the present study investigates the impact of trade openness on pollution and resource depletion in Pakistan.

3. DATA AND METHODOLOGY

The model to be employed in this analysis is similar to the one utilised by Antweiler, *et al.* (2001). Trade intensity or 'openness' is considered to be equal to imports plus exports in year t divided by GDP in year t thus: $(IMt + EXt) / GDPt$ = Trade intensity. The composition effect is captured by Kt / Lt, Where Kt is capital in year t and Lt is labour in year t. Capital is measured as the Gross fixed capital formation, while labour is derived as the product of total labour force. Scale of economic activity is measured in terms of real gross domestic product per square kilometre (i.e. real GDP/Area). Therefore, we measure the technique effect by the real gross national product (real GNP). Our models are specified as:

Model: 1 $$AP_t = \beta_1 + \beta_2 OT + \beta_3 CE + \beta_4 SE + \beta_5 TE + \mu_t$$

Model: 2 $$WP_t = \alpha_1 + \alpha_2 OT + \alpha_3 CE + \alpha_4 SE + \alpha_5 TE + \mu_t$$

OT = (Import+Export to GDP) [Economics openness or Trade intensity]
CE = K/L [Composition Effect]
SE = RGDP/Area [Scale Effect]
TE = RGNP [Technique Effect]
AP = (CO2 (carbon dioxide emissions (*kt*)) [proxy for Air Pollution]
WP = (Water pollution, textile industry (% of total BOD emissions).[4]

Above two models consist six variables; the models examine impact economics openness or trade intensity (OT), Composition Effect (CE), Scale Effect (SE) and Technique Effect (TE) on Air population (AP) and Water Pollution (WP), respectively. All the data were obtained from *World Development Series* and *Economic Survey of Pakistan*.

3.1. Econometric Procedure

In this paper, the impact of globalisation (through trade liberalisation) on environmental degradation is examined in the following ways:

(1) To examine whether a time series have a unit root, this paper has used Augmented Dickey-Fuller (ADF) unit root test.
(2) To find the long run relationship among the variable, this study has applied the Johanson's multiple cointegration test.
(3) Once the variables are found cointegrated, that is long run equilibrium relation between them, of course, in short run there may be disequilibrium. Therefore, we estimated an error-correction model (ECM) to determine the short run dynamic of system.

[4]World Resources Institute (2003) the percentage increase in CO2 emissions in world emissions during 1990-98 was 8 percent, it was 43 percent in Pakistan. Similarly, approximately 40-50 percent of total deaths in Pakistan are the result of water borne diseases [Pakistan-IUNC (1992)]. Therefore, AP and WP are used in our analysis for environmental degradation.

The cointegration and error-correction modelling techniques are now well-know and widely used in applied econometrics.

The cointegration technique pioneered by Granger (1886), and Engle and Granger (1987) allows long-run components of variables to obey long-run equilibrium relationships with the short-run components having a flexible dynamic specification. In light of Shintani's (1994) finding that the Johanson method is more powerful than the Engle-Granger method. The multivariate cointegration framework that we propose 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 cointegration method the Johanson procedure can find multiple cointegration vectors. For this approach one has to estimate an unrestricted Vector Autoregression (VAR) of the 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.

$$Xt = \sum_{j=1}^{\rho} \Pi_j X_{t-j} + \mu + \varepsilon$$

t=1, 2, 3,.....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 (2) is

$$\Delta X = \sum_{j=1}^{p} \Gamma_j \Delta X_{t-1} + \Pi X_{t-p} + \mu + \varepsilon \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (2)$$

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 cointegration is indicated (with r cointegrating vectors present) and further, in this case Π may be factored as Π=aß, with the matrix ß comprising the *r* cointegrating vectors and a 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 Π=0,the variables are not cointegrated. On the other hand if rank (usually denote by 'r') is equal to one there exist one cointegrating vector and finally if 1<r<n there are multiple cointegrating vectors. Johanson and Juselius (1990) have derived two tests for cointegration, namely trace test and the maximum eigen value 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 ai determine the short-run term error correction responses of the variables to deviations from long-run equilibrium values.

4. EMPIRICAL RESULTS AND ANALYSIS

The Johansen co-integration method and error-correction model technique has been used in order to examine the long run and the short run dynamic of system respectively.[6]

[5]Kaike Information Criteria and Schwarz Criterion etc.

[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.

Priory to testing the long run co-integration relation, it is necessary to establish the order of integration presented. To this end, an Augmented Dickey Fuller (ADF) was carried out on the time series levels and difference forms. The results are given in table (see Table 2 in Appendix) and as this table shows, all the variables have a unit root in their levels and are stationary in their first difference. Thus all variables (OT, SE, CE, TE, AP, WP) are integrated of order one I(1).

In the next step, the data series are further check for presence of cointegration using Johansen maximum likelihood co-integration test of variables. Firstly, present study examines long run relationship among (AP, OT, SE, CE, TE) have been estimated and reported in (see Table 3 in Appendix). Starting with null hypothesis of no cointegration (r=0) among the variables, the trace statistic is 120.2 exceeds the 99 per cent critical value of the λtrace statistic (critical value is 96.6), it is possible to reject the null hypothesis (r=0) of no cointegration vector, in the favour of the general alternative r=1. As is evidence in Table 3, the null hypothesis of r=1 r=2, cannot be rejected at 5 percent of level of significance. Consequently, we conclude that there is one cointegration relationship involving given variables of AP, OT, SE, CE and TE.

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)=59.7 exceeds the 99 per cent critical value (42.4). 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.

Similarly, we examine the long run relationship among (WP, OT, SE, CE, TE) have been estimated and reported in (see Table 4 in Appendix). Both λtrace statistic and λmax statistic show the there are also only one co-integration vector. The presence of cointegration vector shows that there exists a long run relationship among the variables.

We estimated separately the error-correction model (ECM) for response variable AP and WP each to determine the short run dynamic of system. To estimate the short run error correction model, we used general to specific approach [Hendry (1995)].

Following Hendry's (1979) general to specific modeling approach, we first include 2 lags of the explanatory variables and 1 lag of error correction term, and then gradually eliminate the insignificant variables. Once a cointegrating relationship is established, then an ECM can be estimated.

The coefficient of error-correction terms of both models have correct sign (negative) and statistically significant at 1 percent.[7] It suggests the validity of long-run equilibrium relationship among the variables. Meaning not only that the ECM is valid but also that 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.

Results reveal that air pollution is positively related to trade intensity and scale effect, thus making the scale effect of trade intensity negatively related to environmental pollution (see Table 5 in Appendix). Long run coefficients of trade intensity and scale

[7]The error-correction term was calculated from the Maximum Likelihood Estimates of cointegrating vector (see Table 5 and Table 6 in Appendix).

effect are significantly related to air pollution. The air pollution indirectly will affect the public health and agriculture sector in long run.[8] The composition effect and technique are negatively related to pollution. The model 2 results indicate that trade intensity; scale effect and technique effect are positively related to water pollution. Thus indicating that the technique, scale and total effects of liberalisation are detrimental to the environment. The composition effects of trade liberalisation on natural resource utilisation are however beneficial. Trade intensity and the technique effects of liberalisation do however significantly explain resource utilisation.

5. CONCLUSION

In this paper we have applied Johanson-Juselius cointegration technique for valid long run relationship among the variables and error correction model to determine the short run dynamics of the system by using the time series data for Pakistan economy, over the period of 1972-2001. The paper finds the existence of a cointegrating vector, indicating a valid long run relationship among the trade liberalisation and environmental indicators. This finding suggests that in long run trade liberalisation causes to increase air and water pollution. Moreover, there is a significant effect in short run. The results supports that trade liberalisation have a negative impact on environmental indicators. The emission of greenhouse gases are increasing with alarming rates, particularly carbon dioxide that is the cause of many diseases and adversely affecting the health of poor peoples. It is highly desirable to introduce environment friendly innovations, which will contribute in our sustainable development. International emission standards must be followed to protect the domestic environment and poor segments of society, which are directly dependent on environment for their livelihood.

We recommend the following government should examine carefully the challenges, opportunities and constraints they will face in participating in any further trade liberalisation. In other words, Pakistan should be ready to participate actively in future negotiations so as to ensure that decisions on areas where Pakistan exhibits comparative advantage are not compromised. In addition, government should ensure that any trade agreement does not contain provisions that jeopardise its environment.

To maximise the gains from liberalisation, and to achieve a sustainable and high-quality growth path, Pakistan must minimise the environmental costs associated with its industrial development. It is important to recognise that even if the composition effect is held constant, the scale effect induced by growth implies an increase in output and an increase in total industrial pollution. To keep the scale effect in check, the pollution intensity of industrial activity must be decreased. This is possible through the transfer of cleaner technology if sectoral pollution is a function of the vintage of technology and through the enforcement of environmental regulation where pollution depends on end-of-pipe treatment, as in the paper, leather and textiles industries [Gallagher (2000)]. In industries where pollution is the result of inefficient management of resources, awareness and capacity building may play an important role in reducing the environmental footprint (for example, according to estimates, the industrial sector could save approximately 22 percent of its total energy consumption without any loss of output if it utilises the inputs more efficiently [Pakistan (2000-01)].

[8]According to survey conducted by national and international agencies, air pollution has severely damaged production of wheat and rice in many areas of Pakistan [Moss (2001)].

APPENDIX

Table 1

CO_2 Emission in World Share

Countries	CO_2 Emission (Per Capita) 1980	2000	World Share 2000s	Rank 2000s
Bangladesh	0.1	0.3	0.1	62
China	1.5	2.7	12.1	2
India	0.5	1.2	4.7	5
Indonesia	0.6	1.2	1.2	20
Pakistan	0.4	0.7	0.5	27
Japan	7.9	9.4	5.4	4

Source: Human Development Report (2005).

Table 2

Test of the Unit Root Hypothesis

Variables	Level		First Difference	
	t-stat	*k*	*t*-stat	*k*
OT	–2.01	3	–5.83*	2
AP	–2.85	1	–3.16**	1
WP	–1.67	1	–3.80*	1
CE	–1.32	2	3.04**	1
SE	–1.02	1	4.01*	1
TE	–2.05	2	–5.12*	1

Note: The *t*-statistic reported in is the t-ratio on in the following regression.
…** and * indicate significance at the 5 percent and 1 percent levels, respectively.

Table 3

Johansen's Test for Multiple Cointegration Vectors
Cointegration Test among [AP, OT, SE, CE, TE]

H0:	H1:	Tests Stat	95% Critical Value	99% Critical value
λtrace	**λtrace**			
r = 0	*r > 0*	120.2	87.3	96.6
r = 1	*r > 1*	60.5	62.9	70.1
r = 2	*r > 2*	31.3	42.4	48.5
r = 3	*r > 3*	8.6	25.3	30.5
r = 4	*r > 4*	2.5	12.3	16.3
λmax values	**λmax values**			
r = 0	*r = 1*	59.7	37.5	42.4
r = 1	*r = 2*	29.2	31.5	36.7
r =2	*r = 3*	22.7	25.5	30.3
r =3	*r = 4*	6.1	18.9	23.7
r =4	*r = 5*	2.5	12.3	16.3

Table 4

Johansen's Test for Multiple Cointegration Vectors
Cointegration Test among [WP, OT, SE, CE, TE]

H0:	H1:	Tests Stat	95% Critical Value	99% Critical value
λtrace	**λtrace**			
r = 0	*r > 0*	110.2	87.3	96.6
r = 1	*r > 1*	52.5	62.9	70.1
r = 2	*r > 2*	28.3	42.4	48.5
r = 3	*r > 3*	9.6	25.3	30.5
r = 4	*r > 4*	1.5	12.3	16.3
λmax values	**λmax values**			
r = 0	*r = 1*	**57.7**	37.5	42.4
r = 1	*r = 2*	**24.2**	31.5	36.7
r =2	*r = 3*	**18.7**	25.5	30.3
r =3	*r = 4*	**8.1**	18.9	23.7
r =4	*r = 5*	**1.5**	12.3	16.3

Table 5

Error Correction Model Result

Dependent Variable=ΔAP		
Explanatory Variables	Estimated Coefficients	Long Run Coefficients
Constant	8.62*	
ΔAP (–1)	0.51**	
Δ (OT) [Trade Intensity]	5.11**	6.23*
ΔCE(–1) [Composition Effect]	–0.23**	–0.15
ΔTE[Technique Effect]	–0.62	–0.89
ΔSE [Scale Effect]	1.72***	2.51**
RES (–1)	– 0.18*	
Diagnostic Tests		
Serial Correlation	0.25	
Heteroscedasticity	0.32	
Functional Form	0.41	
Normality	0.63	

Table 6

Error Correction Model Result

Dependent Variable=ΔWP		
Explanatory Variables	Estimated Coefficients	Long-run Coefficients
Constant	1.22*	
ΔWP (–2)	0.51**	
Δ (OT) [Trade Intensity]	1.21**	2.23*
ΔCE(–1) [Composition Effect]	–0.73**	–0.65
ΔTE [Technique Effect]	–0.82	–0.19*
ΔSE [Scale Effect]	1.52***	4.31**
RES (–1)	–0.12*	
Diagnostic Tests		
Serial Correlation	1.14	
Heteroscedasticity	0.02	
Functional Form	1.01	
Normality	0.83	

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