Decomposing the trade-environment nexus for Malaysia: What do the technique, scale, composition and comparative advantage effect indicate?

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Abstract: This paper investigates the impact of trade openness on CO_2 emissions using time series data over the period of 1970QI-2011QIV for Malaysia. We disintegrate the trade effect into scale, technique, composition and comparative advantage effects to check the environmental consequence of trade at four different transition points. To achieve the purpose, we have employed ADF and PP unit root tests in order to examine the stationary properties of the variables. Later, the long-run association among the variables is examined by applying ARDL bounds testing approach to cointegration. Our results confirm the presence of cointegration. Further, we find that scale effect has positive and technique effect has negative impact on CO_2 emissions after threshold income level and form inverted-U shaped relationship – hence validates the environmental Kuznets curve hypothesis. Energy consumption adds in CO_2 emissions. Trade openness and composite effect improve environmental quality by lowering CO_2 emissions. The comparative advantage effect increases CO_2 emissions and impairs environmental quality. The results provide the innovative approach to see the impact of trade openness in four sub-dimensions of trade liberalization. Hence, this study attributes more comprehensive policy tool for trade economists to better design environmentally sustainable trade rules and agreements.

I. Introduction

Today developed world is in favor of opening economies as well as for more trade openness, as trade openness has beneficial impact on economic growth. This rising level of trade openness has started the debate that changing trade pattern may bring environmental changes in the globe of world. Following standard Heckscher-Ohlin model of trade, a country having relatively low factor price ratio would be relatively environment abundant. Trade openness would increase specialization in pollution intensive products. This environment detrimental shift in the composition of output lies behind the popular concern. Yet, following the Stolper-Samuelson theorem, the price paid for using environment would be bid-up and all firms would shift to less pollution-intensive production techniques. In the standard Heckscher-Ohlin model, there would be no change in the overall use of environment (Khalil and Inam, 2006; Halicioglu, 2009; Managi et al. 2009; Baek et al. 2009). Grossman and Krueger, (1991) started the debate that trade openness has significant impact on environmental quality. The proponents of trade openness treat quality of environment as a normal good as the level of traded income rises, people attached with this income demand clean environment. The authorities discourage the old and outdated techniques of production. The proponents of trade openness suppose that trade openness creates win-win situation which improves the economy and environment as a whole. But on other hand, opponents of trade openness claim that trade openness stimulates economic activity and quality of environment is deteriorated if the techniques of production are unchanged. They suppose that if quality of environment is a normal good then firms in developing countries move towards lower standard of production due to relax rules and regulations of environment. This process may raise distribution of income at world level, trade openness favors growth of pollution-intensive industries in case of developing countries as developed countries enforce strict environmental regulations, thereby having a significant adverse effect on environmental quality (Copeland and Taylor, 1994, 2004; Copeland, 2005).

Although theoretical relationship between trade openness and environmental quality is not clear but developed countries have recently raised concerns over the dirty industries of developing countries as it changes the structure of comparative advantages. Firms in developed countries have to face strict domestic environmental regulations compared to developing countries. But on other hand, developing countries are concerned that trade liberalization will promote specialization in dirty industries, thus aggravating environmental damage (Dean, 1992). The modern world is now divided into trade blocks and trade openness has the potential to affect not only socio-economic well-being of the nations in trade block, but also environmental quality enjoyed by all states involved in the agreements; that such a trade-environment relationship exists is well-established and widely accepted (MacArthur 2001; Todaro and Smith 2002; Callan 2004; Baylis and Smith 2005). Such type of relationship is visible in trade liberalization agreements among countries with a marked developmental imbalance.

There is a wide range of literature available that empirically investigates trade-emissions nexus; however, the findings have been conflicting (Shahbaz et al. 2013; Ahmed et al. 2015). For example: Managi (2004) explores the environmental consequence of trade liberalization and found positive elasticity for both developing and developed countries, but the later study of Frankel and Rose (2005) concludes that trade openness reduces emissions. Managi et al. (2009) argues that environmental repercussions of trade depend upon the economic structure of the country and pollutants. Hence, the literature reveals that in order to examine whether trade detriments environment, requires country specific study and CO_2 emissions is found with the highest concentration in the developing countries i.e. Malaysia. The recent study of Sbia et al. (2014) and Farhani and Ozturk (2015) indicate that environmental consequence of trade may also vary due to scale, technique and composition effects in a particular country. However, their theoretical statement is assessed in this study. Malaysia's emissions profile is influenced by several development indicators. For example; the results of Solarin (2013) concludes that tourists significantly contribute to pollution in Malaysia, Bekhet and Yasmin (2013) found energy consumption increases pollution both in long-run and short-run, Augus et al. (2014) conclude palm oil industry also increases pollution, Begum et al. (2015) found GDP growth leads to pollution intensity in long-run. However, trade openness has mixed results on environmental quality of Malaysia. Saboori et al (2012) conclude that trade openness is not the major contributing factor in Malaysia; whereas, Solarin (2013) found Malaysia's exports to Singapore has positive correlation with CO_2 emissions. Although ample literature has investigated the growth-environment nexus in case of Malaysia, but due to involvement of several development indicators, the country's emissions profile require further empirical investigations. The impact of trade liberalization mainly depends on the simultaneous growth in technical knowhow and institutional quality. Hence, Malaysian government claims substantial investment on research and development in order to control the potential environmental degradation cause by the industrialization. Hence, whether the government initiative is going in the right direction and has potential to accomplish desired environmental friendly sustainable development goal for Malaysia? This study explores the impact of trade openness on environment using decomposed EKC- hypothesis i.e. scale, technique and composition effects. Moreover, the comparative advantage effect as an additional exogenous factor.

The aim of this study is to examine the effect of trade openness on CO_2 emissions. As an individual country, level of income as well as the composition of traded commodities, level of emissions intensity, can give better understanding about the effect of trade openness on CO_2 emissions (Baek et al. 2009). This study is a healthy contribution towards respective literature by four folds: (i), it is pioneering effort investigating the relationship between trade openness and CO_2 emissions by adding scale, technique, composite and comparative advantage effects in CO_2 emissions function. (ii), The bounds testing approach is applied for checking the presence of cointegration between the variables along with test of unit root properties of the series. (iii), The long-run and short-run elasticities have been investigated by applying OLS and ECM approaches. Finally, cause and effect between trade openness and CO_2 emissions is examined by employing the VECM Granger causality test. We find that scale effect increases CO_2 emissions but technique effect reduces CO_2 emissions. Energy consumption adds in CO_2 emissions. The composition effect lowers CO_2 emissions. Trade openness (trade effect) lowers CO_2 emissions but comparative advantage effect increases CO_2 emissions. The causality analysis reports the bidirectional between energy consumption and CO_2 emissions. The composition effect, trade effect and comparative advantage effect cause energy consumption and hence CO_2 emissions.

II. Literature Review

The existing empirical literature on trade-emissions nexus has provided mixed results and a mutual consensus has not been developed yet. Initially, Grossman and Krueger (1991) started debate on the relationship between trade openness and environmental quality. Later on, Lucas et al. (1992) examined the impact of trade openness on growth of toxic intensity of output. They found that rapidly growing economies increased their trade openness which further reduces toxic intensity of output. Grossman and Krueger (1993) analyzed the relationship between trade openness and environmental quality in case of Mexico and its Northern neighbors. Their results showed that trade openness increases Mexican specialization in unskilled labor-intensive industries, which in turn causes a reduction in environmental pollution. Trade openness is helpful in improving quality of environment via income growth but strict regulations about environment quality increase efficiency and encourages innovations. This process further has positive affect for a firm's competitiveness and enhanced trade volume (Porter and van der Linde, 1995). Gale and Mendez (1998) investigated the linkages between trade openness, economic growth and environment quality and found that rising level of income has detrimental impact on quality of environment but trade openness has insignificant relationship with quality of environment. Dean (2002) analyzed the effect of trade openness on environment and noted that rising level of trade openness in international markets aggravates environmental damage via terms of trade, but mitigates it via income growth (Ang, 2008; Jalil and Mahmud, 2009; Menyah and Wold-Rufael, 2010; Ghosh, 2010; Change, 2010; Ozturk, 2010). Levinson and Taylor (2001, 2008) found that strict environmental regulations are associated with larger net imports. So foreign direct investment and quality of environment in case of developing countries has received less attention. There are numbers of other studies which investigate that CO_2 emissions and trade openness has long run relationship (Lee et al. 2009; Narayan and Narayan, 2010; Bhattacharyya and Ghoshal, 2010; Shahbaz et al. 2015).

Liddle (2001), Antweiler et al. (2001) and Frankel and Rose (2005) found that trade openness is good for environmental quality in case of developing and developed nations. On contrary, Kukla-Gryz (2009) supported that trade openness increases the level of air pollution in case of developing nations at first stage of economic growth. Moreover, Low and Yeats (1992), Mani and Wheeler (1998), Dinda (2006), and Baek et al. (2009) mentioned that free trade may have detrimental impacts on environment in case of developing countries, but trade openness may increase environmental quality in developed countries. Managi et al. (2009) examined the relationship between trade openness, economic development and environmental quality using the instrumental variables for OECD and non-OECD countries. They found that trade openness is beneficial for environmental quality via lowering CO_2 emissions in OECD countries but increases CO_2 emissions in non-OECD countries. But, Iwataa et al. (2012) reported that trade openness affects CO_2 emissions in OECD countries insignificantly. Halicioglu (2009) investigated the causal relationship between CO_2 emissions, energy consumption, economic growth and trade openness using Turkish data. The results indicated that trade openness leads CO_2 emissions and, economic growth and energy consumption are also contributing factors to CO_2 emissions. But Cole (2004) noted that developing countries do not follow rules and regulations of WHO and in resulting, trade openness reduces quality of environment there. Takeda and Matsuura, (2006) exposed how quality of environmental is affected by trade openness of 'dirty' goods in case of East Asian countries over the period of 1988-2000. Their empirical findings indicate that increasing exports in 'dirty' industries to Japan and domestic industrialization in East Asia tend to raise CO_2 emissions in East Asian countries, while 'dirty' imports from Japan and the USA do not affect CO_2 emissions in the area. Temurshoev, (2006) analyzed the relationship between trade openness and quality of environment in developing economies. The results indicated that correlation between capital intensity and pollution intensity of production was small, and thus raised doubts about the existence of factor endowment hypothesis. But other studies found that differences in environmental regulations across countries are a significant determinant of trade flows (Van Beers and Van den Bergh 1997, Harris et al. 2002, Busse 2004).

Baek and Koo, (2008) examined that FDI inflow impacts environmental quality in China. Cole et al. (2011) used Chinese cities data and concluded that the environmental effect of FDI inflows from Hong Kong, Macao and Taiwan and other foreign economies could be beneficial, detrimental or neutral, depending on the pollutants being considered. Naranpanawa, (2010) examined the causality between trade openness and CO_2 emissions in case of Sri Lanka. The empirical results reported the presence of cointegration between the series. The causality analysis unveiled that trade openness is Granger cause of CO_2 emissions in long run but in short run, trade openness Granger causes CO_2 emissions. For Tunisian economy, Chebbi et al. (2010) examined the relationship between trade openness and CO_2 emissions. They found that trade openness increases CO_2 emissions and the unidirectional causal relation exists running from trade openness to CO_2 emissions.

Forslid et al. (2011) explained that how international trade affects environmental quality? They argued that international trade eases the firms to shift their economic activities to those countries where environmental regulations are relaxed. Their empirical evidence reported that competitive firms invest more in energy efficient technologies and emit very less energy pollutants which save environment from degradation. Hoa, (2012) applied economic integration model to examine the relationship between trade liberalization and CO_2 emissions for Chinese economy. The results show that economic growth is detrimental to environment but trade openness benefits it. Similarly, Gu et al. (2013) reported that trade openness Granger CO_2 emissions. Kohler, (2013) examined the relationship between trade liberalization, energy consumption, economic growth and CO_2 emissions for South Africa. The results confirmed the presence of cointegration between trade openness and CO_2 emissions and the bidirectional causality is validated between trade openness and quality of environment. In case of United Arab Emirates, Shahbaz et al. (2014c) used CO_2 emissions function and reported that exports has positive impact on CO_2 emissions while the feedback effect exists exports and CO_2 emissions.

In case of Malaysia, various authors partially examined the effect of trade openness on CO_2 emissions and listed down ambiguous empirical evidence. For example, Shahbaz et al. (2013) investigated whether trade openness affects CO_2 emissions. They found that trade openness deteriorates CO_2 emissions. Later on, Lau et al. (2014) examined the causal relationship between trade openness and CO_2 emissions. They noted that the variables are cointegrated for long run and trade openness Granger causes economic growth and hence CO_2 emissions. In other Asian countries such as Thailand, Arouri et al. (2014) reported that trade openness impedes environmental quality and the bidirectional causal relationship exists between both the variables. Shahbaz et al. (2014a, b) unveiled that trade openness increases CO_2 emissions but the neutral effect exists between trade openness and CO_2 emissions in case of Bangladesh and Tunisia. Similarly, Tiwari et al. (2013) reported the positive impact of trade openness on CO_2 emissions and feedback effect between both the variables. Shahbaz et al. (2012) and Ahmed and Long,

(2013) noted that trade openness lowers CO_2 emissions but, Nasir and Rehman, (2011) reported that trade openness deteriorates environmental quality in Pakistan[1]. Shahbaz et al. (2015a) exposed the relationship between trade openness (measuring by globalization index) and environmental degradation for Indian economy and they noticed that trade openness harms environmental quality in India[2]. Recently, Ibrahim and Law (2015) incorporated the role of institutions in trade-emission nexus for Sub-Saharan African countries. They found that trade-emission nexus is sensitive with institutional quality i.e. countries where institutional quality is good, trade is less harmful for environmental quality and vice versa.

III. Empirical Modelling and Estimation Strategy

The objective of present paper is to test the effect of trade openness on CO_2 emissions via scale, technique, composite and comparative advantage effects. Keeping in view of Malaysia's export led growth economic structure, we assume energy consumption has a significant role to play in such scenario. However, trade openness does not only increase energy consumption, but sufficient liberalization enhances energy efficiency through spillover effect of technological change in an economy. Similarly, the environmental impact of economic growth and trade openness changes as economy passes transition phase. In this regard EKC hypothesis provides standard tool to check inverted-U relationship between growth and environment. Considering the trade openness as exogenous variable, Cole (2006) suggests that trade openness induce energy efficient technology transfer, mass awareness to demand for clean environment and government policy direction towards environmental friendly economic policies. The environmental consequence of trade through energy consumption is varied through *income effect*, *technique effect* and *composition effect* (Jena and Grote, 2008). The effect of comparative advantage on environment depends upon combined effect of overall composition of trade of a country. Following Cole (2006), the general functional form of model is given below:

$$C_t = f(Y_t, Y_t^2, E_t, K_t, O_t, K_t.O_t) \tag{1}$$

We have transformed the variables into logarithmic form and empirical form of model is given as following:

$$\begin{aligned} \ln C_t = \alpha_1 + \underbrace{\alpha_2 \ln Y_t + \alpha_3 \ln Y_t^2}_{\text{Scale Effect and Technique Effect}} + \underbrace{\alpha_4 \ln E_t}_{\text{Energy Effect}} + \underbrace{\alpha_5 \ln K_t}_{\text{Composite Effect}} + \underbrace{\alpha_6 \ln O_t}_{\text{Trade Effect}} \\ + \underbrace{\alpha_7 \ln K_t.O_t}_{\text{Comparative Advantage Effect}} + \underbrace{\mu_t}_{\text{Residual Effect}} \end{aligned} \tag{2}$$

where, $\ln C_t$ is natural log of CO_2 emissions per capita, $\ln Y_t$ ($\ln Y_t^2$) is natural log of real GDP per capita (square term of real GDP per capita), $\ln E_t$ is natural log of energy consumption per capita, $\ln K_t$ is natural log of capital-labor ratio, $\ln O_t$ is natural log of real trade openness (real exports + real imports), $\ln K_t.O_t$ is natural log of interaction between capital-labor ratio and trade

[1] Later on, Khalid et al. (2014) confirmed the findings by Shahbaz et al. (2012)

[2] Shahbaz et al. (2015b) examined the validity of EKC for African countries. Their analysis indicated the presence of EKC and the feedback effect is noticed between economic growth and CO_2 emissions.

openness. The μ_t is error term with normal distribution. The data on CO_2 emissions (metric tons), real GDP, energy consumption (kt of oil equivalent), gross fixed capital formation, labor force, real exports and real imports is collected from World Development indicators (2014). We have employed population series to convert all the variables into per capita units. The study has used the time period of 1970QI-2011QIV[3].

In order to investigate the long-run association among the variables, this study adopts the dynamic time series econometric technique using ARDL bounds testing approach to cointegration developed in Pesaran et al. (2001). The bounds testing approach is superior to previously used cointegration techniques (i.e. two step residual based approach of Engle and Granger (1987) and system based reduced ranked regression approach of (Johansen, 1995) in two ways. (i) It has an ability to determine the long-run relationship between underlying vectors when it is not sure whether the series is trend or first differenced stationary (Pesaran et al. 2001). (ii), The ARDL bounds testing procedure is also appropriate for small sample size (Shahabaz et al. 2012). (iii), This approach provides short-run as well as long-run empirical evidence simultaneously without losing information of long-run results. The bounds testing approach to cointegration is restricted provide efficient results once single cointegration relation prevails between the series. This cointegration approach automatically solves the issues of serial correlation and endogeneity (Shahbaz et al. 2015a). The decision to reject null-hypothesis of no-cointegration is based on the two sets of asymptotic critical bounds[4] (include upper and lower critical bound values) regardless of regressors are $I(0)$ or $I(1)$. Thence, the ARDL bounds testing approach to cointegration is considered as the robust technique to empirically investigate the long-run relationship between trade openness and CO_2 emissions in case of Malaysia. Furthermore, the ARDL test equation is derived using dynamic unrestricted error correction model (UECM), which is as follows:

$$\begin{aligned}\ln C_t &= \beta_0 + \beta_1 T + \beta_2 \ln Y_{t-1} + \beta_3 \ln Y_{t-1}^2 + \beta_4 \ln E_{t-1} + \beta_5 \ln K_{t-1} + \beta_6 \ln O_{t-1} + \beta_7 \ln K_{t-1}.O_{t-1} \\ &+ \sum_{k=1}^{p} \alpha_i \Delta \ln C_{t-i} + \sum_{j=0}^{p} \alpha_j \Delta \ln Y_{t-j} + \sum_{k=0}^{p} \alpha_k \Delta \ln Y_{t-k}^2 + \sum_{l=0}^{p} \alpha_l \Delta \ln K_{t-l} + \sum_{m=0}^{p} \alpha_m \Delta \ln O_{t-m} \\ &+ \sum_{n=0}^{p} \alpha_n \Delta \ln K_{t-n}.O_{t-n} + \mu_t\end{aligned} \quad (3)$$

Here Δ represents the first difference operator, T denotes deterministic time trend and μ_{it} are the residual term. The lag length selection is an important procedure. Therefore following Shahbaz et al. (2013), order of lag length is selected based on the Akaike Information Criterion (AIC). Pesaran et al. (2001) suggests joint significance F-test on the coefficients of the lagged level variables to conclude the long-run relationship. The null hypotheses of no cointegration in equation-3 is defined as; $H_0: \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$, against the alternative hypotheses of cointegration $H_a: \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq 0$. The null-hypothesis of no-cointegration is rejected if the calculated F-statistic exceeds the upper critical bound limit and it confirms the long-run

[3] We have converted annual data into quarter frequency using quadratic-match-sum method (see for more details, Shahbaz et al. 2014c).
[4] For more details see (Pesaran et al. 1999, 2001)

relationship. However, if the calculated F-statistic falls below the lower critical bound value, the null-hypothesis of no cointegration is accepted and it concludes that there no long-run relationship among the variables. The F-statistic is between upper and lower bound values reflects that the results are inconclusive.

Subject to the existence of cointegration relationship, the causality analysis is an important component that explores the causal link among the variables. In such thrust, we apply Granger causality test in a lagged error correction model (VECM). The test equation of the VECM Granger causality approach is as follows:

$$(1-L)\begin{bmatrix} \ln C_t \\ \ln Y_t \\ \ln Y_t^2 \\ \ln K_t \\ \ln O_t \\ \ln K_t.O_t \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ \alpha_5 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} b_{11i}\, b_{12i}\, b_{13i}\, b_{14i}\, b_{15i}\, b_{16i} \\ b_{21i}\, b_{22i}\, b_{23i}\, b_{24i}\, b_{25i}\, b_{26i} \\ b_{31i}\, b_{32i}\, b_{33i}\, b_{43i}\, b_{53i}\, b_{36i} \\ b_{41i}\, b_{42i}\, b_{43i}\, b_{44i}\, b_{45i}\, b_{46i} \\ b_{51i}\, b_{52i}\, b_{53i}\, b_{54i}\, b_{55i}\, b_{56i} \\ b_{61i}\, b_{62i}\, b_{63i}\, b_{64i}\, b_{65i}\, b_{66i} \end{bmatrix} \times \begin{bmatrix} \ln C_{t-1} \\ \ln Y_{t-1} \\ \ln Y_{t-1}^2 \\ \ln K_{t-1} \\ \ln O_{t-1} \\ \ln K_{t-1}.O_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha \\ \beta \\ \delta \\ \theta \\ \vartheta \\ \phi \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix} \quad (4)$$

Besides the variables in above equation, $(1-L)$ denotes difference operator and ECT_{t-1} represents lagged error-correction term taken from the long-run relationship. The terms $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}, \varepsilon_{5t}$ and ε_{6t} are the residuals. These stochastic terms are assumed to be homoscedastic. The statistical significance of the coefficient of lagged error term i.e. ECT_{t-1} shows the long run causal relationship causal relationship between the variables. The statistical significance of F-statistic via Wald-test including differences and lagged differences of independent variables incorporated in model confirms the short-run causality. The joint long-run and short-run causality is confirmed by the statistical significance of the lagged error term with differences and lagged differences of the variables incorporated in model. For instance, $b_{12,3,i} \neq 0 \forall_i$ implies that scale and technique effects Granger-cause CO_2 emissions and scale and technique effects are Granger cause of CO_2 emissions shown by $b_{21,3,i} \neq 0 \forall_i$.

IV. Results and their Discussion

Table-1 explains the descriptive statistic analysis. We find that variations are high in trade openness compared to CO_2 emissions. Economic growth's variations are less compared to capitalization and energy consumption is more volatile compared to economic growth. Furthermore, the Jarque-Bera statistics confirm the normality of trade openness, economic growth, energy consumption, capitalization and CO_2 emissions. This shows that all the series are suitable for further empirical analysis.

The next step is to test either unit root problem exists between the variable before applying the cointegration approach for long run. We have overcome this issue by employing ADF and PP unit root tests. The results are shown in Table-2. The results of ADF test indicate that all the series are found non-stationary at level accommodating intercept and trend. After first differencing, CO_2 emissions ($\ln C_t$), economic growth ($\ln Y_t$), energy consumption ($\ln E_t$), composite effect ($\ln K_t$) and trade openness ($\ln O_t$) have been stationary. It reveals that the variables are integrated at I(1). The PP unit root test also confirms these findings.

Table-1: Descriptive Statistics Analysis

Variables	$\ln C_t$	$\ln Y_t$	$\ln E_t$	$\ln K_t$	$\ln O_t$
Mean	1.2789	9.2689	7.1851	8.3174	9.5405
Median	1.3327	9.2889	7.2741	8.4737	9.6528
Maximum	2.1650	9.9270	7.9385	9.2080	10.535
Minimum	0.3996	8.4043	6.2271	7.1387	8.1021
Std. Dev.	0.5893	0.4578	0.5388	0.5482	0.8190
Skewness	-0.0431	-0.2027	-0.2979	-0.4330	-0.2870
Kurtosis	1.4946	1.7759	1.8275	2.1174	1.6544
Jarque-Bera	3.9785	2.9096	3.0270	2.6760	3.7449
Probability	0.1367	0.2334	0.2201	0.2623	0.1537

Table-2: Unit Root Analysis

Variables	ADF Test		PP Test	
	T-statistic	P.value	T-statistic	P.value
$\ln C_t$	-2.5548 (5)	0.3017	-2.2050(3)	0.4832
$\ln Y_t$	-1.5383(4)	0.8124	-1.9084(3)	0.6457
$\ln E_t$	-2.6073(3)	0.2777	-2.2702(3)	0.4474
$\ln K_t$	-2.6090(2)	0.1315	-1.7871(3)	0.7068
$\ln O_t$	-0.3806(2)	0.9875	0.1391(3)	0.9974
$\Delta \ln C_t$	-4.8703(4)*	0.0005	-6.9816(3)*	0.0000
$\Delta \ln Y_t$	-4.7749(5)*	0.0008	-6.7654(3)*	0.0000
$\Delta \ln E_t$	-11.0829(2)*	0.0000	-8.0117(3)*	0.000
$\Delta \ln K_t$	-4.7040(3)*	0.0010	-5.9635(3)*	0.0000
$\Delta \ln O_t$	-7.2535(2)*	0.0000	-6.4370(3)*	0.0000
Variables	**ZA Test at Level**		**ZA Test at 1st Difference**	
	T-statistic	Break Year	T-statistic	Break Year
$\ln C_t$	-4.772 (3)	$1989Q_2$	-12.913 (2)*	$1995Q_4$
$\ln Y_t$	-4.311 (2)	$1991Q_2$	-8.271 (3)*	$1986Q_3$
$\ln E_t$	-4.704 (3)	$1993Q_3$	-12.317 (1)*	$1978Q_3$
$\ln K_t$	-4.700 (2)	$1997Q_1$	-7.332 (2)*	$1997Q_2$
$\ln O_t$	-3.231 (3)	$1992Q_2$	-8.534 (4)*	$1987Q_3$

Note: * indicates significant at 1% level of significance. Lag length and bandwidth of variables is shown in small parentheses for ADF, PP and ZA unit root tests.

The results provided by ADF and PP may be ambiguous because these tests are unable to capture the information of structural breaks occurring in the series which may be cause of unit root problem. We have solved this issue by applying Zivot and Andrews, (1992) that accommodates the information for single unknown structural break in the time series data. The results are reported in Table-2. We noted that CO_2 emissions, economic growth, energy consumption, capitalization and trade openness contain unit root problem at level in the presence of structural breaks. These structural breaks in CO_2 emissions, economic growth, energy consumption, capitalization and trade openness are occurred in 1989Q_2, 1991Q_2, 1993Q_3, 1997Q_1 and 1992Q_2 respectively. The Malaysian government implemented numerous economic policies such as environmental auditing in 1989, sixth five year plan i.e. 1991-1996, electricity reforms in 1993, liberalization and privatization sector reforms for improving capital infrastructure in 1997 and ASEAN free trade agreement (AFTA) in 1992 respectively to improve the performance of Malaysian economy. The variables contain stationarity at first difference by accommodating structural breaks in CO_2 emissions, economic growth, energy consumption, capitalization and trade openness.

The unique order of integration of the variables leads us to employ the bounds testing cointegration approach for examining long run relationship between the variables while accommodating information about structural breaks in the series. Furthermore, the selection of appropriate lag does matter while investigating the cointegration between the series. We have used Akaike information criterion (AIC) for lag length selection due its superior properties and explanatory power. The results are reported in second column of Table-3[5]. For cointegration, we employed the ARDL bounds testing approach and results are reported in Table-3. While using CO_2 emissions and energy consumption as dependent variables, bounds testing F-statistics are higher than critical upper bound at 5% and 1% levels respectively. This leads us to reject the hypothesis of no cointegration. We cannot reject the null hypothesis of no cointegration as we used economic growth, composite effect, trade openness and comparative advantage effect as dependent variables. We note the presence of cointegration between trade openness and CO_2 emissions by incorporating economic growth, energy consumption, composite effect and comparative advantage effect for Malaysian economy.

Table-3: The Results of ARDL Cointegration Test

Bounds Testing to Cointegration				Diagnostic tests			
Dependent Variable	Optimal lag length	F-statistics	Break Year	χ^2_{NORMAL}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{SERIAL}
$F_C(C/Y,Y^2,E,K,O,K.O)$	6, 5, 6, 5, 6, 6, 5	4.289**	1989Q_2	0.9060	1.724	0.9300	0.5702
$F_{Y,Y^2}(Y,Y^2/C,E,K,O,K.O)$	6, 6, 6, 6, 5, 5, 6	2.991	1991Q_2	0.6402	3.5452	0.2910	2.7743
$F_E(E/C,Y,Y^2,K,O,K.O)$	6, 5, 5, 5, 6, 6, 5	5.346*	1993Q_3	0.2188	0.0900	0.6009	0.8473
$F_K(K/C,Y,Y^2,E,O,K.O)$	6, 6, 6, 6, 6, 6, 6	2.900	1997Q_1	0.4461	2.4400	2.8571	1.9556

[5] We have inserted dummy variable for each variable while considering it as dependent variable.

$F_O(O/C,Y,Y^2,E,K,K.O)$	6, 5, 5, 5, 5, 6, 5	2.250	$1992Q_2$	0.2744	2.9888	0.7766	1.3690
$F_{O.K}(O.K/C,Y,Y^2,E,K,O)$	6, 5, 5, 5, 6, 6, 6	2.600	....	0.3627	2.6900	1.8160	1.6500
Significant level	Lower bounds $I(0)$	Upper bounds $I(1)$					
1 per cent level	3.60	4.90					
5 per cent level	2.87	4.00					
10 per cent level	2.53	3.59					
Note: The asterisks *, ** and *** denote the significant at 1, 5 and 10 per cent levels, respectively. Critical values are collected from Pesaran et al. (2005).							

We have reported the long run results in Table-4 after confirming the cointegration between the variables. We find that scale effect has positive and technique effect has negative impact on CO_2 emissions. At 1% level of statistical significance, the results show that while attaining the economies of scale, 1% increase in income casts 2.26% of CO_2 emissions. However, when economic transition shifts due to technological change is considered, the positive effect turns into negative where 1% increase in income reduces CO_2 emissions by 0.17%. It shows that the relationship between linear (scale effect) and non-linear (technique effect) in terms of real GDP per capita and CO_2 emissions is inverted U-shaped which further confirms the existence of Environmental Kuznets Curve (EKC) hypothesis. The results are similar to Copeland and Tylor (1994) who study the environmental effect of North-South trade, and contrasting to Cole (2006) who found that trade openness boosts energy consumption that ultimately degrade environmental quality in long-run. Our empirical results suggest that increased in economic activity does not pare down environmental quality because income effect encourages newer technology adoption and leads to cleaner production in Malaysia. Furthermore, the empirical presence of the EKC is supported by the findings of Saboori et al. (2012), Saboori and Sulaiman (2013), Lau et al. (2014) but Begum et al. (2015) who also reported the absence of EKC in case of Malaysia. Energy consumption is positively and significantly associated with CO_2 emissions. Keeping other things constant, a 1% increase in energy consumption increases CO_2 emissions by 0.35%. This empirical evidence is same as reported by Saboori et al. (2012), Saboori and Sulaiman (2013), Shahbaz et al. (2013), Lau et al. (2014), Begum et al. (2015) for Malaysian economy. The impact of composition effect on CO_2 emissions is negative and significant. The results show that 1% increase in composition effect (capital-labor ratio) leads to decrease CO_2 emissions by 0.57% keeping all else same. This finding is consistent with Tsurumi and Managi (2010), but contrasting to Cole (2006) who reported that composition effect is positively linked with energy intensity and leads CO_2 emissions. This notion further enumerates that change in the composition of production line (i.e. adoption of less capital intensive means of production) in presence of technique effect reduces emissions intensity. Trade openness has negative and significant effect on CO_2 emissions. It is noted that a 1% raise in trade openness declines CO_2 emissions by 0.69% by keeping other things constant. It reveals that the environmental friendliness of trade liberalization is long-run phenomenon in case of Malaysia. Trade openness sufficiently supports technological spill over, capital formation and institutional development in the country. The long-term national policies to increase trade volume enhance environmental quality in Malaysia. However, in comparison to past literature, our results contradict with Shahbaz et al. (2013, 2014a, b) who noted that trade openness increases CO_2 emissions for Malaysia, Bangladesh and Tunisia but consistent with Shahbaz et al. (2012) in case of Pakistan. The positive and statistically significant relationship found between comparative advantage effect and CO_2 emissions. These findings suggest that the reciprocal production using comparative advantage deteriorates environmental quality in Malaysia. It could be mainly because of loosing technical competitiveness in targeted industries due to outward shift of physical and human capital. It can also have positive effect on energy intensity and hence increases CO_2 emissions. Similarly, although partial impacts of trade openness and composite effect is negative, but it is dominated by comparative advantage effect which increases CO_2 emissions. The impact of dummy variable is positive and statistically significant at 1% level. This shows that the implementation of environmental auditing in 1989 is failed to control environment from degradation.

Table-4: Long Run Analysis

Dependent Variable = $\ln C_t$				
Variable	Coefficient	Std. Error	T-Statistic	Prob. value
Constant	2.7510	0.7460	3.6876	0.0003
$\ln Y_t$	2.2691	0.9032	2.5122	0.0130
$\ln Y_t^2$	-0.1686	0.0462	-3.6488	0.0004
$\ln E_t$	0.3532	0.0829	4.2595	0.0000
$\ln K_t$	-0.5742	0.2385	-2.4074	0.0172
$\ln O_t$	-0.6866	0.2153	-3.1887	0.0017
$\ln O_t.K_t$	0.2749	0.1005	2.7341	0.0070
D_{1989}	0.0415	0.0052	7.9520	0.0000
R^2	0.9891			
$Adj-R^2$	0.9805			
F-Statistic	23.9100*			
Note: * represents significance at 1% level.				

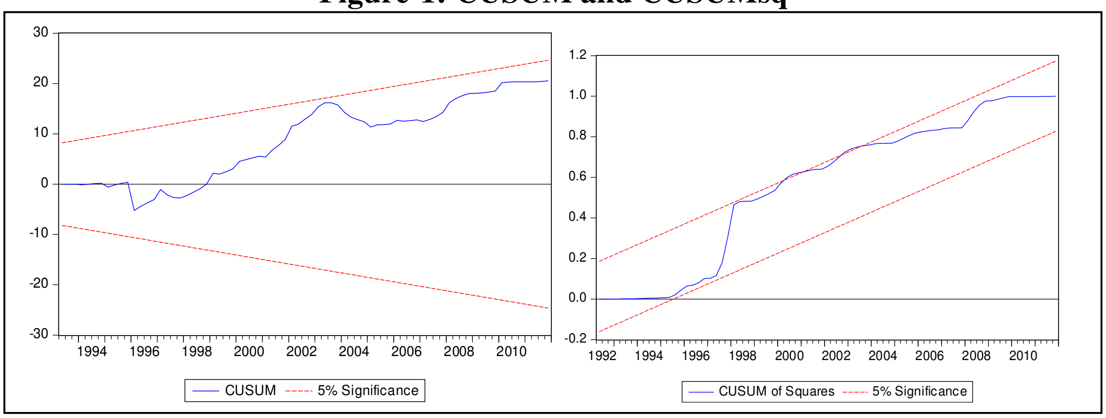
In short run, Table-5 reported that current CO_2 emissions are positively and significantly affected by CO_2 emissions in previous period. The effect of scale effect and technique effect is positive and negative at 1% level. Energy consumption affects CO_2 emissions positively at 1% level. The effect of composite effect and trade openness on CO_2 emissions is negative and positive but statistically insignificant. The relationship between comparative advantage effect and CO_2 emissions is positive but statistically insignificant. The impact of dummy variably i.e. implementation of environmental auditing in 1989 is positive and statistically significant. We find that the ECM_{t-1} (lagged error correction term) is with negative sign and statistically significant at 5% level. This reports the speed of adjustment from short run to equilibrium path in long run. The coefficient of ECM_{t-1} is -0.1005 indicates that short run deviation are corrected by 6.48% in every quarter. With this speed of adjustment, Malaysian economy takes almost 10 years to reach equilibrium path for CO_2 emissions function. Moreover, significance of ECM_{t-1} corroborates the established long run linkages between trade openness and CO_2 emissions[6].

[6] We have not reported of stability test just to conserve space but available upon request from authors. The long-run and short-run models do not face the problem of non-normality, serial correlation, white heteroskedisticity and functional form.

Table-5: Short Run Analysis

Dependent Variable = $\Delta \ln C_t$				
Variable	Coefficient	Std. Error	T-Statistic	Prob. value
Constant	-0.0032*	0.0010	-3.1586	0.0019
$\Delta \ln C_{t-1}$	0.3546*	0.0580	6.1073	0.0000
$\Delta \ln Y_t$	10.669*	2.9432	3.6249	0.0004
$\Delta \ln Y_t^2$	-0.5637*	0.1580	-3.5671	0.0005
$\Delta \ln E_t$	0.6862*	0.0747	9.1779	0.0000
$\Delta \ln K_t$	-0.0235	0.0447	-0.5272	0.5988
$\Delta \ln O_t$	0.0618	0.0744	0.8304	0.4076
$\Delta \ln O_t.K_t$	5.2332	4.2225	1.2393	0.2171
D_{1989}	0.0036*	0.0010	3.4080	0.0008
ECM_{t-1}	-0.1005*	0.0318	-3.1539	0.0019
R^2	0.5689			
$Adj-R^2$	0.5437			
F-Statistic	22.5856*			
D.W Test	1.5985			
Note: *, ** and*** represent significance at 1%, 5% and10% levels.				

Figure-1: CUSUM and CUSUMsq



The sensitivity analysis is also conducted to check the reliability and results are reported in Figure-1. Figure-1 shows the results of CUSUM and CUSUMsq tests. We find that graphs of CUSUM and CUSUMsq tests are between the critical bounds at 5% level of significance. This shows that long-and-short runs parameters ate stable and reliable (see more Pesaran et al. 2001).

The results of the VECM Granger causality reported in Table-6 indicate that in long run, economic growth Granger causes CO_2 emissions. The unidirectional causality running from economic growth to CO_2 emissions confirm the presence of environmental Kuznets curve (Narayan and Narayan, 2010). Composite effect uses causes CO_2 emissions in Granger sense.

The unidirectional causality exists running from trade openness to CO_2 emissions. These empirical results are same with Lau et al. (2014) for Malaysia but Arouri et al. (2014) and Tiwari et al. (2013) note the bidirectional causality between trade openness and CO_2 emissions for Thailand and India respectively. Comparative advantage Granger causes and energy consumption and CO_2 emissions. The feedback effect exists between energy consumption and CO_2 emissions. Trade openness composite effect and comparative advantage effect Granger cause energy consumption. Economic growth causes energy consumption in Granger sense.

In short run, the bidirectional causal relationship is found between economic growth and CO_2 emissions. Energy consumption Granger causes CO_2 emissions and in resulting, CO_2 emissions Granger cause energy consumption. The feedback effect exists between economic growth and energy consumption. Composite effect Granger causes energy consumption (economic growth) and in resulting, energy consumption (economic growth) Granger causes composite effect. The relationship between trade openness and economic growth is bidirectional. Energy consumption and economic growth Granger causes trade openness and same is not true from opposite side but trade openness Granger causes comparative advantage effect. The bidirectional causality is found between trade openness and composite effect.

Table-6: The VECM Granger Causality Analysis

Dependent Variable	Type of Causality						
	Short Run						Long Run
	$\sum \Delta \ln C_{t-1}$	$\sum \Delta \ln Y_{t-1}, \sum \Delta \ln Y_{t-1}^2$	$\sum \Delta \ln E_{t-1}$	$\sum \Delta \ln K_{t-1}$	$\sum \Delta \ln O_{t-1}$	$\sum \Delta \ln O_{t-1}.K_{t-1}$	ECT_{t-1}
$\Delta \ln C_t$	…	15.0539* [0.0000]	83.7104* [0.0000]	1.9964 [0.1395]	1.6335 [0.1988]	0.8361 [0.4354]	-0.0864* [-3.1921]
$\Delta \ln Y_t, \Delta \ln Y_t^2$	16.1756* [0.0000]	…	17.9372* [0.0000]	3.6889** [0.0371]	20.0545* [0.0000]	1.7712 [0.1736]	…
$\Delta \ln E_t$	9.2325* [0.0001]	14.9549* [0.0000]	…	4.2459** [0.0162]	1.4836 [0.2302]	1.0392 [0.3563]	-0.1071* [-4.4448]
$\Delta \ln K_t$	4.2896** [0.0155]	3.3777** [0.0150]	6.6437* [0.0017]	…	11.9028* [0.0000]	0.1668 [0.8465]	…
$\Delta \ln O_t$	1.5794 [0.2096]	24.2714* [0.0000]	2.2637*** [0.0759]	11.5008* [0.0000]	…	0.9829 [0.3767]	…
$\Delta \ln O_t.K_t$	0.9554 [0.3870]	1.0076 [0.4060]	0.6704 [0.5131]	0.5280 [0.5909]	3.9941** [0.0205]	…	…

Note: * and ** denote the significance at 1% and 5% levels respectively.

V. Conclusion and Policy Recommendation

We have investigated a question whether trade openness impedes environmental quality or does not in case of Malaysian economy over the period of 1970QI-2011QIV. We have used CO_2 emissions function by incorporating scale effect, technique effect, energy consumption effect, composition effect, trade effect and comparative advantage effect. In order to test the unit root properties, we have applied the ADF and PP unit root test. The bounds testing approach to cointegration is employed to test the presence of cointegration relation among CO_2 emissions, scale effect, technique effect, energy consumption effect, composition effect, trade effect and comparative advantage effect. The results indicated the confirmation of long run relationship amid the series. The scale effect increases CO_2 emissions but technique effect reduces CO_2 emissions. Energy consumption adds in CO_2 emissions. The composition effect lowers CO_2 emissions. Trade openness (trade effect) lowers CO_2 emissions but comparative advantage effect increases CO_2 emissions. The causality analysis reports the bidirectional between energy consumption and CO_2 emissions. The composition effect, trade effect and comparative advantage effect causes energy consumption and hence CO_2 emissions.

In context of policy implications, the empirical findings of this study suggest that income works under self-correcting mechanism; where, environmental quality lost due to scale effect is improved later due to technique effect. This notion suggests that the existing environmental policies sufficiently reduce environmental consequence of economic development in Malaysia. However, the positive causality running from trade openness, composition effect and comparative advantage to energy consumption alerts towards structural policy gaps in case of Malaysia. The composition effect in energy sector could possibly be the key underlying factor as per our best of knowledge. The replacement of conventional energy sources with renewable/alternate energy may not necessarily reduce CO_2 emission unless technique effect adequately supports the composition effect. It means the adoption of updated technology is equally important while shifting from conventional to renewable energy sources in order to maintain efficiency level.

Moreover, our study offers two key innovative points in the existing literature on EKC hypothesis, first - it conclude the existence of EKC hypothesis in Malaysia, and secondly - it declares sign of causality among the variables. We further disintegrate the EKC and empirically investigate the environmental repercussion of scale- technique- and composition effect. The model is robust and findings possess deep policy implications for Malaysia and helps policy makers in diverse ways.

References

1. Agus, F., Gunarso, P., Sahardjo, B. H., Harris, N., van Noordwijk, M. and Killeen, T. J. (2013). Historical CO2 emissions from land use and land use change from the oil palm industry in Indonesia, Malaysia and Papua New Guinea. *Roundtable on Sustainable Palm Oil, Kuala Lumpur*.
2. Ahmed, K. and Long, W. (2013). An empirical analysis of CO2 emission in Pakistan using EKC hypothesis. *Journal of International Trade Law and Policy*, *12*(2), 188-200.

3. Ahmed, K., Shahbaz, M., Qasim, A. and Long, W. (2015). The linkages between deforestation, energy and growth for environmental degradation in Pakistan. *Ecological Indicators*, *49*, 95-103.
4. Ang, J. B. (2008). A survey of recent developments in the literature of finance and growth. *Journal of Economic Surveys*, 22 (3), 536-576.
5. Antweiler, W., Copeland, B. R. and Taylor, M. S. (2001). Is free trade good for the environment? *American Economic Review*, 91, 877-908.
6. Arouri, M., Shahbaz, M., Onchang, R., Islam, F. and Teulon, F. (2014). Environmental Kuznets curve in Thailand: Cointegration and causality analysis. *The Journal of Energy and Development*, 39, 149-170.
7. Baek, J., Cho, Y. and Koo, W. W. (2009). The environmental consequences of globalization: A country-specific time-series analysis. *Ecological Economics*, 68, 2255-2264.
8. Baylis, J. and Smith, S. (2005). The globalization of world politics. Oxford University Press, 2005.
9. Begum, R. A., Sohag, K., Abdullah, S. M. S. and Jaafar, M. (2015). CO2 emissions, energy consumption, economic and population growth in Malaysia. *Renewable and Sustainable Energy Reviews*, 41, 594-601.
10. Bekhet, H. A. and Yasmin, T. (2013). Disclosing the relationship among CO2 emissions, energy consumption, economic growth and bilateral trade between Singapore and Malaysia: An econometric analysis. *International Journal of Social, Human Science and Engineering*, *7*(9), 50-55.
11. Bhattacharyya, R. and Ghoshal, T. (2010). Economic growth and CO2 emissions. *Environment, Development and Sustainability*, 12 (2), 159-177.
12. Busse, M. (2004). Transnational corporations and repression of political rights and civil liberties: An empirical analysis. *Kyklos*, 57 (1), 45-66.
13. Chang, C. (2010). A multivariate causality test of carbon dioxide emissions, energy consumption and economic growth in China. *Applied Energy*, 87, 3533-3537.
14. Chebbi, H. E., Olarreaga, M. and Zitouna, H. (2010). Trade openness and CO2 emissions in Tunisia. Working Paper 518, Economic Research Forum.
15. Cole, G. (2004). Personnel and human resource management. *Personnel Review*, 33 (3), 373-374.
16. Cole, M. A. (2006). Does trade liberalization increase national energy use? *Economics Letters*, 92, 108-112.
17. Cole, M. A. and Elliott, R. J. (2003). Determining the trade–environment composition effect: the role of capital, labor and environmental regulations. *Journal of Environmental Economics and Management*, 46 (3), 363-383.
18. Copeland, B. R. (2005). Policy endogeneity and the effects of trade on the environment. *Agricultural and Resource Economics Review*, 34 (1), 1-15.
19. Copeland, B. R. and Taylor, M. S. (1994). North-South trade and the environment. *The Quarterly Journal of Economics*, 755-787.
20. Copeland, B. R. and Taylor, M. S. (1994). North-South trade and the environment. *The Quarterly Journal of Economics*, 755-787.
21. Copeland, B. R. and Taylor, M. S. (2004). Trade, growth and the environment (No. 9823). National Bureau of Economic Research.
22. Dean, J. M. (2002). Does trade liberalization harm the environment? A new test. *Canadian Journal of Economics*, 35 (4), 819-842.

23. Dietzenbacher, E. and Mukhopadhyay, K. (2007). An empirical examination of the pollution haven hypothesis for India: towards a green Leontief paradox? *Environmental and Resource Economics*, 36 (4), 427-449.
24. Dinda, S. and Coondoo, D. (2006). Income and emission: a panel data-based cointegration analysis. *Ecological Economics*, 57 (2), 167-181.
25. Farhani, S. and Ozturk, I. (2015). Causal relationship between CO2 emissions, real GDP, energy consumption, financial development, trade openness, and urbanization in Tunisia. *Environmental Science and Pollution Research*, 1-14.
26. Forslid, R., Okubo, T. and Ultveit-Moe, K. H. (2011). *Does international trade contribute to global CO2 emissions?* Third Conference of GIST, International Trade, Firm Location and Services.
27. Frankel, J. A. and Rose, A. K. (2005). Is trade good or bad for the environment? Sorting out the causality. *Review of Economics and Statistics*, *87*(1), 85-91.
28. Gale, L. R. and Mendez, J. A. (1998).The empirical relationship between trade, growth and the environment. *International Review of Economics & Finance*, 7 (1), 53-61.
29. Ghosh, C. (2003). Healthy People 2010 and Asian Americans/Pacific Islanders: defining a baseline of information. *American Journal of Public Health*, 93 (12), 2093-2098.
30. Grossman, G. M. and Krueger, A. B. (1991). Environmental impacts of a North American free trade agreement (No. w3914). National Bureau of Economic Research.
31. Grossman, G. M. and Krueger, A. B. (1994). Economic growth and the environment (No. 4634). National Bureau of Economic Research.
32. Gu, Z., Gao, Y. and Li, C. (2013). An empirical research on trade liberalization and CO2 emissions in China. International Conference on Education Technology and Information System (ICETIS 2013), 243-246.
33. Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy*, 37 (3), 1156-1164.
34. Harris, R. and Sollis, R. (2003). Applied Time Series Modeling and Forecasting. John Wileyand Sons Inc., West Sussex, England.
35. Hoa, T. V. (2012). *Trade, growth and CO2 emissions in China: Evidence from an economic integration model*. Victoria Institute of Strategic Economic Studies, Victoria University, Australia.
36. Ibrahim, M. H. and Law, S. H. (2015). Institutional Quality and CO_2 Emission–Trade Relations: Evidence from Sub-Saharan Africa. South African Journal of Economics, DOI: 10.1111/saje.12095.
37. Iwata, H., Okada, K. and Samreth, S. (2012). Empirical study on the determinants of CO2 emissions: evidence from OECD countries. *Applied Economics*, 44 (27), 3513-3519.
38. Jalil, A. and Mahmud, S. F. (2009). Environment Kuznets curve for CO2 emissions: A cointegration analysis for China. *Energy Policy*, 37 (12), 5167-5172.
39. Kearsley, A. and Riddel, M. (2010). A further inquiry into the Pollution Haven Hypothesis and the Environmental Kuznets Curve. *Ecological Economics*, 69 (4), 905-919.
40. Khalid, A., Shahbaz, M. and Long, A. Q. (2014). The linkages between deforestation, energy and growth for environmental degradation in Pakistan. *Ecological Indicators*, 49, 95-103.
41. Khalil, S. and Inam, Z. (2006). Is trade good for environment? A unit root cointegration analysis. *The Pakistan Development Review*, 1187-1196.
42. Kohler, M. (2013). CO_2 emissions, energy consumption, income and foreign trade: A South African perspective. *Energy Policy*, 63, 1042-1050.

43. Kukla-Gryz, A. (2009). Economic growth, international trade and air pollution: A decomposition analysis. *Ecological Economics*, 68 (5), 1329-1339.
44. Lau, L-S., Chee-Keong, C. and Eng, Y-E. (2014). Investigation of the environmental Kuznets curve for carbon emissions in Malaysia: Do foreign direct investment and trade matter? *Energy Policy*, 68, 490-497.
45. Lee, C., Chiu, Y. and Sun, C. (2009). Does one size fit all? A re-examination of the environmental Kuznets curve using the dynamic panel data approach. *Review of Agricultural Economics*, 31, 751-778.
46. Levinson, A. and Taylor, M. S. (2001). Trade and the Environment: Unmasking the Pollution haven effect. Unpublished manuscript, US National Science Foundation.
47. Levinson, A. and Taylor, M. S. (2008). Unmasking the pollution haven effect. *International Economic Review*, 49 (1), 223-254.
48. Liddle, H. A. (2002). Advances in family-based therapy for adolescent substance abuse. In LS Harris (red.). Problems of drug dependence 2001: proceedings of the 63rd annual scientific meeting: the College on Problems of Drug Dependence (pp. 113-115).
49. Low, P. and Yeats, A. (1992). Do dirty industries migrate? World Bank Discussion Papers, 1992.
50. Lucas, R. E., Wheeler, D. and Hettige, H. (1992). Economic Development, Environmental Regulation, and the International Migration of Toxic Industrial Pollution, 1960-88 (Vol. 1062). World Bank Publications.
51. Managi, S. (2004). Trade liberalization and the environment: carbon dioxide for 1960-1999. *Economics Bulletin*, *17*(1), 1-5.
52. Managi, S., Hibiki, A. and Tsurumi, T. (2009). Does trade openness improve environmental quality? *Journal of Environmental Economics and Management*, 58 (3), 346-363.
53. Mani, M. and Wheeler, D. (1998). In search of pollution havens? Dirty industry in the world economy, 1960 to 1995. *The Journal of Environment & Development*, 7 (3), 215-247.
54. McArthur, J. W. and Sachs, J. D. (2001). Institutions and geography: comment on Acemoglu, Johnson and Robinson (2000) (No. w8114). National bureau of economic research.
55. Menyah, K. and Wolde-Rufael, Y. (2010). Energy consumption, pollutant emissions and economic growth in South Africa. *Energy Economics*, 32 (6), 1374-1382.
56. Naranpanawa, A. (2010). Does trade openness promote carbon emissions? Empirical evidence from Sri Lanka. *The Empirical Economics Letters*, 10 (10), 973-986.
57. Narayan, P. K. and Narayan, S. (2010). Carbon dioxide emissions and economic growth: Panel data evidence from developing countries. *Energy Policy*, 38, 661-666.
58. Nasir, M. and Rehman, F-U. (2011). Environmental Kuznets curve for carbon emissions in Pakistan: an empirical investigation. *Energy Policy*, 39, 1857-64.
59. Ozturk, I. (2010). A literature survey on energy-growth nexus. *Energy Policy*, 38, 340-349.
60. Porter, M. E. and Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *The Journal of Economic Perspectives*, 97-118.
61. Saboori, B. and Sulaiman, J. (2013). Environmental degradation, economic growth and energy consumption: Evidence of the environmental Kuznets curve in Malaysia. *Energy Policy*, 60, 892-905.
62. Saboori, B., Sulaiman, J. and Mohd, S. (2012). Economic growth and CO2 emissions in Malaysia: A cointegration analysis of the environmental Kuznets curve. *Energy Policy*, 51, 184–191.

63. Saboori, B., Sulaiman, J. and Mohd, S. (2012). Economic growth and CO2 emissions in Malaysia: a cointegration analysis of the environmental Kuznets curve. *Energy Policy*, *51*, 184-191.
64. Sbia, R., Shahbaz, M. and Hamdi, H. (2014). A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. *Economic Modelling*, *36*, 191-197.
65. Shahbaz, M., Khan, S. and Tahir, M. I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: fresh evidence from multivariate framework analysis. *Energy Economics*, *40*, 8-21.
66. Shahbaz, M., Khraief, N., Uddin, G. S. and Ozturk, I. (2014b). Environmental Kuznets curve in an open economy: A bounds testing and causality analysis for Tunisia. *Renewable and Sustainable Energy Reviews*, 34, 325-336.
67. Shahbaz, M., Lean, H. H., and Shabbier, M. M. (2012). Environmental Kuznets Curve hypothesis in Pakistan: Cointegration and Granger causality. *Renewable and Sustainable Energy Reviews*, 16, 2947-2953.
68. Shahbaz, M., Mallick, H., Mahalik, M. K. and Loganathan, N. (2015a). Does globalization impede environmental quality in India? Ecological Indicators, 52, 379–393.
69. Shahbaz, M., Sbia, R., Hamdi, H. and Ozturk, I. (2014c). Economic growth, electricity consumption, urbanization and environmental degradation relationship in United Arab Emirates. *Ecological Indicators*, 45, 622-631.
70. Shahbaz, M., Solarin, S. A., Mahmood, H. and Arouri, M. (2013). Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis. *Economic Modelling*, 35, 145-152.
71. Shahbaz, M., Solarin, S. A., Sbia, R. and Bibi, S. (2015b). Does energy intensity contribute to CO2 emissions? A trivariate analysis in selected African countries. Ecological indicators, 50, 215-224.
72. Shahbaz, M., Tiwari, A. K. and Nasir, M. (2013). The effects of financial development, economic growth, coal consumption and trade openness on CO_2 emissions in South Africa. *Energy Policy*, *61*, 1452-1459.
73. Shahbaz, M., Uddin, G. S., Rehman, I. and Imran. K. (2014a). Industrialization, electricity consumption and CO2 emissions in Bangladesh. *Renewable and Sustainable Energy Reviews*, 31, 575-586.
74. Shahbaz, M., Zeshan, M. and Afza, T. (2012). Is energy consumption effective to spur economic growth in Pakistan? New evidence from bounds test to level relationships and Granger causality tests. *Economic Modelling*, *29*(6), 2310-2319.
75. Solarin, S. A. (2014). Tourist arrivals and macroeconomic determinants of CO2 emissions in Malaysia. *Anatolia*, *25*(2), 228-241.
76. Suri, V. and Chapman, D. (1998). Economic growth, trade and energy: implications for the environmental Kuznets curve. Ecological Economics, 25(2), 195-208.
77. Takeda, F. and Matsuura, K. (2006). Trade and the environment in East Asia: Examining the linkages with Japan and the USA. *The Journal of the Korean Economy*, 7 (1), 33-56.
78. Temurshoev, U. (2006). Pollution haven hypothesis or factor endowment hypothesis: theory and empirical examination for the US and China. CERGE-EI.
79. Tiwari, A. K., Shahbaz, M. and Hye, Q. M. A. (2013). The environmental Kuznets curve and the role of coal consumption in India: Cointegration and causality analysis in an open economy. *Renewable and Sustainable Energy Reviews*, 18, 519-527.

80. Tsurumi, T. and Managi, S. (2010). Decomposition of the environmental Kuznets curve: scale, technique, and composition effects. *Environmental Economics and Policy Studies*, *11*(1-4), 19-36.
81. Van Beers, C. and Van Den Bergh, J. C. (1997). An empirical multi-country analysis of the impact of environmental regulations on foreign trade flows. *Kyklos*, 50 (1), 29-46.
82. Zivot, E. and Andrews, D. (1992). Further evidence of great crash, the oil price shock and unit root hypothesis. Journal of Business and Economic Statistics, 10, 251–270.