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Trade and Environment Nexus in Saudi Arabia: An Environmental Kuznets Curve Hypothesis

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ABSTRACT

This research explores the impacts of trade and income level on the carbon dioxide emissions (CDE) in Saudi Arabia by using a period 1970-2016. Unit root and cointegration tests have been utilized for data analysis. Unit root test confirms the level of integration as one and cointegration has been found in our estimated model through bound testing procedure. In the long run, income is found responsible for increasing CDE but its square term is showing a negative impact on CDE. Therefore, this study has inveterate the environmental Kuznets curve hypothesis. Further, trade has negative impact on CDE. Therefore, trade has been remained helpful in reducing pollution levels in Saudi Arabia. The income, its square and trade have same directions of relationships in short run as in long run. Based on findings, this study recommends the Saudi government to liberalize trade policy to protect environment.

Keywords: Carbon Dioxide Emissions, Trade, Environmental Kuznets Curve
JEL Classifications: Q53, O49, Q56

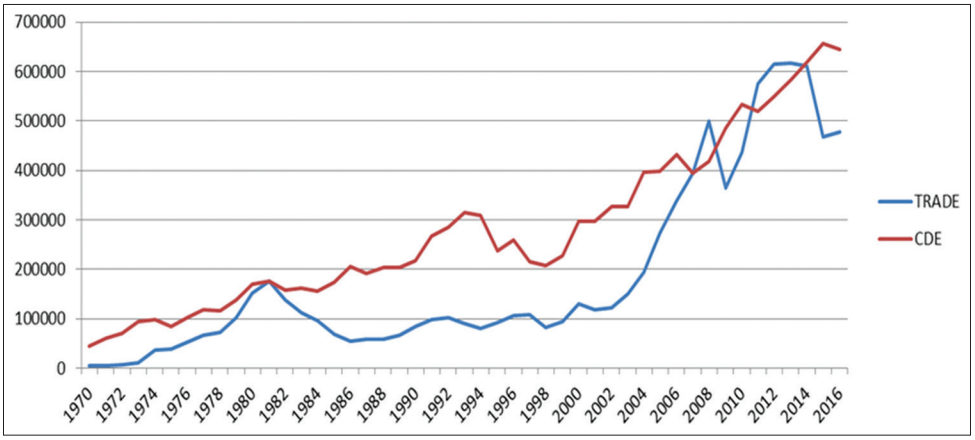
1. INTRODUCTION

Trade is a very important component of growth and supporting the balance of payment as well if trade balance is found favorable. A rising trade may give the economic prosperity but it is very important to test the impact of trade on the sustainable development. For example, it may increase the pollution level or may help in the reducing pollution by adopting the environmental friendly technology in production of exports. Saudi Arabia has a greatest contribution of oil in her total exports which may contribute to higher pollution level if clean technology could not be used. Further, motor vehicles are her highest imports which may contribute the pollution emissions if imported technology is pollution oriented. However, net impact of trade on pollution is an empirical question in any country. Therefore, it is very important to check this in Saudi Arabia with present state of imports and exports in her trade. Because, a rising trade is definitely very important for the prosperity of current generation but the care of next generation is also very important to take care of pollution emissions.

Figure 1 is showing the trends of CDE and trade. From year 1970 to 1981, both series are showing rising trends hence a positive relationship can be claimed. But from 1982 to 1994, CDE has a positive trend and trade has mostly negative trend hence showing a negative relationship. From 1995 to 2006, both series are showing again a positive relationship but afterwards these are showing negative relationships mostly. Considering a negative relationship initially from CDE and trade trends in most of years, this present study has an intention to explore EKC hypothesis with trade variable in analysis to verify the exact relationship between trade and CDE and CDE and income levels.

The modern literature has a lot of concern about environment with rising development in the world. Environment literature has a great interest in EKC because pollution may increase at the first stage of development and it may reduce as well afterwards with adopting environmental friendly technology with a further level of development. This shape of relationship, inverted-U shape, at first has been proposed by Kuznets (1955). Afterwards, this shape of relationship has been intensively utilized in relationship

Figure 1: Trends of trade and CSE



of income and environment and is called as EKC hypothesis. Most of developed economies have achieved an inverted-U hypothesis in their economies. This implies that pollution is increasing with economic growth but it starts decreasing with a further level of income growth in developed countries. Saudi Arabia presently stands in a list of high income countries and therefore, it is very pertinent to verify either EKC is existed in this country or not.

The desire of higher economic growth and higher trade may lead towards their environmental effects. The pleasant environment cannot be ignored to win the sustainable development for the future generations. Therefore, it is very important to test the environmental impacts of rising trade and income levels. Environment-trade nexus in testing the EKC hypothesis may help the policy makers to make a balance between trade growth, economic growth and environmental protection. A surplus of foreign trade has a definite contribution in the economic growth as it is a component of it. But, its environmental impact is also very important for any society to achieve sustainable development. There has not been a single study which investigates EKC hypothesis along with trade in analysis for Saudi Arabia. Therefore, we are trying to capture the environmental influence of trade in EKC model of Saudi Arabia by utilizing maximum frequency of available data from 1970 to 2016.

2. LITERATURE REVIEW

There is mass of literature on EKC hypothesis but our study is just focusing on the latest literature. For example, Al-Mulali et al. (2015a) investigate EKC hypothesis in Vietnam by using data of a period 1981-2011. They approve EKC by finding the positive association between pollution and income and negative between squared income and pollution. Further, they find positive impact of imports and capital on pollution as well. Effect of export remains insignificant in their estimations and labor has been negatively impacting the pollution. It is due a reason that most of Vietnam's labor is involved in agriculture sector. Keho (2017) used quantile regression to test EKC hypothesis in the 5 panels from 59 selected countries. EKC hypothesis has been validated in the all quantiles' results of all panels expect the panels of Asia and MENA economics where EKC is proved at low level of pollution. This means that income growth has been proved healthy for the environment in most of cases. Rabbi et al. (2015) explore the EKC for Bangladesh using a period of 1972-2012. They reported that income has negatively affected the CDE and its square has positively affected the CDE. Therefore, they conclude that income growth has very adverse effects on the environment. Ahmad et al. (2013) inspect the population, CO_2 emissions and industrial growth relationships in Pakistan and find a positive contribution of population and industrial growth in CDE. Salahuddin et al. (2015) examine the income and pollution nexus for gulf cooperation council countries in panel settings by applying FMOLS and DOLS on a period 1980-2012. They claim that electricity consumption (EC) and income have positive effects on pollution while financial development has negative influence on the pollution. Further, they find a feedback effect in pollution and GDP and uni-directional causality from EC to GDP. Balibey (2015) utilizes a period of 1974-2011 to verify the EKC hypothesis for Turkey by using an additional variable of Foreign Direct Investment (FDI) in analysis. He finds the causality from income growth and FDI to CDE. Further, he tests the EKC hypothesis through regression analysis by assuming different functional forms of regression and validates EKC hypothesis in Turkey.

In the presence of trade in EKC hypothesis analysis, Charfeddine and Khediri (2016) investigate EKC hypothesis for Qatar using a period 1975-2011. They find that EC and trade openness are positively influencing the pollution. They also care the structural breaks in the analysis considering maximum two breaks and confirm the EKC hypothesis in quadratic relationship of income and pollution. Farhani et al. (2014) explore EKC hypothesis in case of Tunisia for a period 1971-2008. An evidence for the presence of EKC is found in their analysis. Further, they find negative contribution of EC on pollution and a positive influence of trade on pollution has been found. They also find one-way causality from GDP and EC to the pollution. Moghadam and Lotfalipour (2014) consider a triangular relationship among pollution, financial development and trade in Iran for a period 1970-2011. They find a positive effect of financial market on pollution and find a negative influence of trade on pollution. Therefore, they conclude a pleasant contribution of trade on environment. Lau et al. (2014) scrutinize EKC hypothesis in Malaysia, one of the faster growing economy, for a period 1970-2008. They confirm the EKC by finding a quadratic

relationship between GDP and pollution. Further, they find that FDI and trade have positively influenced the pollution. They find the feedback effects between GDP and pollution and GDP and FDI. They also conclude one-way relation from trade and FDI to pollution and FDI to trade. Al-mulali et al. (2015b) explore EKC hypothesis for a panel of Latin America and Caribbean countries. by using a period 1980–2010. They find a cointegration in their hypothesized model. Further, they validate the existence of EKC hypothesis through regression analysis. Shahbaz et al. (2015) apply the Auto-Regressive Distributive Lag (ARDL) on a period of 1971-2008 to investigate the EKC hypothesis in Portugal. They find that income and its square are causing to CDE. Further, they also validate the EKC hypothesis through long and short run ARDL results. Furthermore, they also reported a positive contribution of urbanization and energy consumption in CDE.

From literature review, we can observe the importance of EKC hypothesis testing. Further, trade is also a point of discussion in recent empirical literature to verify its impact on pollution emissions. Although, Alkhateeb et al. (2017) investigate effect of oil price on employment level and found a positive contribution of oil price on employment levels. But, the testing EKC hypothesis with trade in time series analysis is absent in the Saudi literature at best of our knowledge. Therefore, testing of EKC in the presence of trade by this study can be claimed for a contribution in Saudi environment literature.

3. MODEL, DATA AND ECONOMETRIC STRATEGY

We employ the yearly series of GDP and total trade (exports + imports) in million US dollars and CDE in kt of Saudi Arabia for a period 1970-2016. All series are collected from world development indicators. In testing EKC hypothesis, our model is as follows:

$$CDE_t = f(Y_t, Y_t^2, TRADE_t) \quad (1)$$

CDE_t is CDE, Y_t is for GDP and its square (Y_t^2) is to test the inverted-U hypothesis/EKC hypothesis. $TRADE_t$ is showing total trade. Rising income (GDP) of any country is symbol of rising economic activities which requires the energy consumption to fuel the industrial production, commerce and consumption. Therefore, it is expected to contribute higher pollution emissions as well. Further, square of GDP is taken in equation 1 to verify the non-linear relationship between income and pollution emissions. Firstly, an insignificant coefficient of Y_t^2 may suggest a linear relationship between income and pollution emissions. Secondly, a positive coefficient of Y_t^2 may show an exploding behavior of income on the pollution emissions which means that pollution is rising with even higher rate with further economic growth. Lastly, a negative coefficient of Y_t^2 is a proof for existence of EKC hypothesis which means that pollution is falling with further economic growth. According to EKC, we are hypothesizing a negative coefficient of Y_t^2. In the relationship of trade and pollution emissions, trade may increase the pollution emissions because of increase in consumption, production and commercial activities due to trade. This positive relationship has also been corroborated by the empirical findings of Farhani et al. (2014), Charfeddine and Khediri (2016) and Lau et al. (2014). Oppositely, trade can also help in reducing the pollution emissions. For example in the production of exports, the exporter countries may produce the products with a tag of green technology to increase the goodwill and demand for their environmental friendly products. Further, imports of a country can also be better environmental friendly products than that of domestic products of a country. Therefore, a positive relationship of trade and pollution emissions may also be expected and it is corroborated by an empirical finding of Moghadam and Lotfalipour (2014).

In testing the equation (1), at first we are investigating the unit root in our model. We are using augmented Dickey Fuller (ADF) test for this purpose. This test is developed by Dickey and Fuller (1981) and test equation is as follows:

$$\Delta X_t = \nu_0 + \nu_1 X_{t-1} + \sum_{i=0}^{k} \nu_{2i} \Delta X_{t-i} + \xi_{it} \quad (2)$$

X_t may assume all variables of equation (1) for unit root problem one by one. A negative coefficient, v_i, can be claimed for stationarity of any series $\sum_{i=0}^{k} \nu_{2i} \Delta X_{t-i}$ and is incorporated to remove endogeneity in the equation (2). In next step, we can test the cointegration through ARDL model recommended by Pesaran et al. (2001) which is as follows:

$$\begin{aligned} \Delta CDE_t = {} & o_0 + o_1 CDE_{t-1} + o_2 Y_{t-1} + o_3 Y_{t-1}^2 + o_4 TRADE_{t-1} \\ & + \sum_{j=1}^{p} \phi_{1j} \Delta CDE_{t-j} + \sum_{j=0}^{q} \phi_{2j} \Delta Y_{t-j} \\ & + \sum_{j=0}^{q} \phi_{3j} \Delta Y_{t-i}^2 + \sum_{j=0}^{q} \phi_{4j} \Delta TRADE_{t-j} + \psi_{it} \end{aligned} \quad (3)$$

Above equation can be tested by bound test to determine a cointegration on a null hypothesis of $o_1=o_2=o_3=o_4=0$. Then, long run parameters can be estimated by normalizing procedure recommended by Pesaran et al. (2001). Afterwards, we can estimate the short run effect through following equation:

$$\begin{aligned} \Delta CDE_t = {} & \sum_{j=1}^{p} \lambda_{1j} \Delta CDE_{t-j} + \sum_{j=0}^{q} \lambda_{2j} \Delta Y_{t-j} \\ & + \sum_{j=0}^{q} \lambda_{3j} \Delta Y_{t-j}^2 + \sum_{j=0}^{q} \lambda_{4j} \Delta TRADE_{t-j} \\ & + \tau ECT_{t-1} + \omega_{it} \end{aligned} \quad (4)$$

The estimated equation (4) can be used to verify a short run relationship in the model through negative coefficient τ and the short run effects may also be captured through parameters of difference variables.

4. DATA ANALYSES AND DISCUSSIONS

Table 1 shows the ADF test results and all variable are showing non-stationary behavior in their level. But after first differencing, all variable are stationary and we can go forward for cointegration.

Table 2 shows the estimates of CDE Model. F-value generated from bound test approves the presence of cointegration in our model. Further, F-values of diagnostic tests are reasonability low and their p-values are higher than 0.1. Therefore, we can claim that our model has no econometric problem to interpret results. In the long run results, GDP (Y_t) is positively affecting to CDE. It means that rising income is increasing demand for energy and in turn it is increasing the pollution emissions. Its coefficient reflects that one million increased in GDP is responsible for 2.9641 kt increased in CDE. But, square term of GDP (Y_t^2) is negatively affecting the CDE. It means that income is reducing the CDE after a point of economic/GDP growth. A very low coefficient of Y_t^2 is due to the big values while squaring the GDP. A positive coefficient of Y_t and negative coefficient of Y_t^2 are validating the EKC in our analysis and our finding are in line of most of literature on EKC which confirms EKC hypothesis. In the relationship of trade and CDE, trade has a negative effect on the CDE. It is proving an evidence that Saudi Arabian most of trade is environmentally friendly. This result is inline of the findings of Moghadam and Lotfalipour (2014) as well. Further, one million increased in trade is helping in reducing the 1.776 kt of CDE.

In the short run estimates, parameter of ECT_{t-1} is negative and significant. This proofs the existence of short run relationship in our model. Further, magnitude of coefficient (−0.3043) is showing 30.43% adjustment from short fluctuation of model towards the long run equilibrium in a year. Further, GDP (Y_t) and square of GDP (Y_t^2) again have positive and negative effects on CDE respectively in the short run results which is in line of long run findings. Though, magnitudes of these effects are lesser than that of long run but EKC hypothesis is again approved in the short run estimation as well. Trade is again negatively impacting the CDE like in long run and the magnitude of this effect is lower than that of long run.

Table 1: ADF Test

Variable	Intercept	Intercept and trend
CDE_t	1.1681 (0)	−0.7986 (0)
Y_t	0.4968 (0)	−1.0446 (0)
$TRADE_t$	−0.4007 (0)	−1.4995 (0)
ΔCDE_t	−6.4629*** (0)	−6.7672*** (0)
ΔY_t	−4.7476*** (0)	−4.7436*** (0)
$\Delta TRADE_t$	−4.8733*** (0)	−4.7551*** (0)

***Stationarity at 1% level of significance

5. CONCLUSION

International trade is very important for any country to economically perform well but side-effects of trade cannot be ignored. This study has investigated the trade and CDE nexus in the EKC model of Saudi Arabia. ADF unit root and ARDL cointegration tests are utilized for data analysis of sample period 1970-2016. ADF test shows the level of integration as one. After that, GDP, square of GDP and trade have been regressed on the CDE after confirming the cointegration in the model. GDP has positive influence on CDE. Therefore, increasing income and economic activities are responsible for higher CDE. But, square of GDP shows a negative impact on CDE. Therefore, we can claim that after a point of economic growth, income level is showing a negative impact on pollution level which is also a confirmation of EKC hypothesis.

The impact of trade has been found negative on CDE. Therefore, we can claim that trade is helping in reducing the CDE in Saudi Arabia instead of increasing. Same directions of relationships between CDE and GDP, square of GDP and trade have been found in the short run analysis of our model but with lesser magnitudes than that of long run. EKC is also proved in the short run estimations as well. Based on results, our study recommends the government of Saudi Arabia to liberalize the trade as it is supporting the clean environment.

Table 2: Carbon dioxide emissions model

Variable	Parameters	SE	t-statistic	P-value
Long run results				
Y_t	2.9641	0.5920	5.0068	0.0000
Y_{t2}	$-9.1254E^{-6}$	$3.3453E^{-6}$	−2.7278	0.0094
$TRADE_t$	−1.7760	0.5772	−3.0769	0.0038
Intercept	42465.76	32147.16	1.3210	0.1940
Short run results				
ΔY_t	0.9020	0.3143	2.8703	0.0065
ΔY_{t2}	$-2.7698E^{-7}$	$1.3415\ E^{-7}$	−2.0646	0.0455
$\Delta TRADE_t$	−0.5405	0.2239	−2.4134	0.0205
ECT_{t-1}	−0.3043	0.1108	−2.7461	0.0090
Diagnostics				
Bound test	Estimated F-value=14.1390			
	Critical F-values			
	At 10% (2.72-3.77)			
	At 5% (3.23-4.35)			
	At 1% (4.29-5.61)			
Heteroscedasticity	F-value=1.9295		P-value=0.1243	
Serial correlation	F-value=1.1812		P-value=0.3179	
Normality	F-value=1.3045		P-value=0.5208	
Functional form	F-value=0.2988		P-value=0.5878	

SE: Stardard error

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