Market Forces
College of Management Sciences

Volume 16, Issue 1, June 2021
https://doi.org/10.51153/mf.v16i1.446

Revisiting the Environmental Kuznets Curve Hypothesis in Pakistan

Muhammad Zaheer Khan[1]
Department of Economics, Balochistan University of Information Technology, Engineering and Management Science (BUITEMS), Quetta, Pakistan

Abstract

Several studies have already determined an inverted U-shaped Environment Kuznets Curve (EKC) in Pakistan. The existing literature has not considered structural breaks (SBs) in EKC-related studies in Pakistan. This study aims to understand whether SBs explain the EKC hypothesis in Pakistan from 1980-2016. The variables used include total energy consumption (TEC), real GDP per capita, foreign direct investment (FDI), and trade openness (TO). The current study has used conventional time series econometric methods to analyze the issue. A structural break (SB) can significantly impact the forecasting performance of a model. Therefore, we have used the Zivot-Andrews unit root test (ZAURT) with one structural break (SB) and the Gregory-Hansen cointegration test approach for empirical analysis. The Gregory-Hansen cointegration test also suggests that the long-run equilibrium relationship is affected by structural breaks (SBs). Historical data suggests that Pakistan has gone through some structural changes during the period 2000-2004, which includes implementing the structural adjustment program of IMF and liberalization of trade and investment policies to attract foreign investors. The 9/11 tragedy also played an important role as Pakistan remained on the front lines in the war against terrorism. Thus, the study concludes that structural breaks (SBs) have important implications for the EKC hypothesis in Pakistan.

Keywords: *Foreign direct investment, trade openness, environmental degradation, economic growth.*

Introduction

Foreign direct investment (FDI) is essential for capital inflows and economic development. FDI is equally important for both under-developed and developed countries (Solarin & Al-Mulali, 2018). Developing countries generally have a shortage of capital; therefore, their development process depends on capital inflows. On the

[1]Corresponding Author: Muhammad Zaheer Khan; Email: zaheer.onnet@gmail.com

other hand, developed countries expect a high return on their capital. FDI increases employment, productivity, exports, and technology transfer in a country (Zafar, Zaidi, Khan, Mirza, Hou & Kirmani, 2019; Buckley et al., 2018). The major advantages of FDI for the economy are that it increases domestic raw material use, brings the latest technology, and reduces the current account deficit (Paul & Feliciano-Cestero, 2021). FDI inflows also increase the quality and quantity of human capital (HC) by providing on-the-job training. Although FDI positively affects an economy's growth prospects (EGP), it also adversely affects a country's environmental quality (EQ) (Sapkota & Bastola, 2017; Alvarado, Iñiguez & Ponce, 2017), especially when a country lacks necessary regulations to protect the environment (Hundie & Daksa, 2019; Fan & Hao, 2020). Although many developing countries do not enforce environmental regulations as they are more interested in attracting FDI. Many researchers call it the "pollution haven hypothesis (PHH)." (Xing & Kolstad, 2002).

The existing literature suggests that developed countries have strict rules and regulations about environmental decay (ED) (Gerhardter, Prieler, Mayr, Landfahrer, Mühlböck, Tomazic & Hochenauer, 2018). Therefore, they move their industrial operations to "less developed countries (LDC) with less strict environmental regulations (ER)," leading to a phenomenon of industrial flight (Hundie & Daksa, 2019; Sjöman, Autiosalo, Juhanko, Kuosmanen & Steinert, 2018). Unlike the common belief that FDI also contributes to pollution, several researchers believe that foreign companies do not contribute towards environmental decay (ED). Developed countries (DC) use advanced technology and have better management, which causes foreign manufacturing companies to generate less pollution than local firms (Cetin, Ecevit & Yucel, 2018; Jeon, Ali & Lee, 2019). Past literature suggests that a firm's location is influenced by environmental considerations and project viability (Cheng, Hong & Yang, 2018). Likewise, there are inconsistent results related to the industrial flight hypothesis (IFH) (Blackman & Wu, 1998; Salehnia, Alavijeh & Salehnia, 2020).

Pakistan's economic reforms (ER) and trade liberalization policies (TLP) have contributed to increased FDI inflows, economic growth (EG), and environmental decay (ED) (Ahmad, Ahmed & Atiq, 2018). For instance, FDI in the period 1986-1990 was USD175m, which increased to USD440m in the period 2000 to 2005 (Malik & Malik, 2013). FDI reached its all-time high of USD1.3 billion in June 2008, which significantly decreased by June 2018. The average GDP growth per year also increased from 5.71% to 7.38% during 2000-2005 (Mehmood & Hassan, 2015). However, the GDP growth also declined to 5.8 % in the year 2018. Economic growth also contributed to environmental decay (Shahzad, Mithani, Al-Swidi & Fadzil, 2012). For example, average annual CO2 emissions in 1998 were 58097.11 kt, which increased to 136,635 kt by 2005. Despite the

decline in FDI and fluctuations in GDP growth, CO2 emissions reached approximately 166,300 kt by 2014-2015 (Sengupta & Puri, 2020). Many researchers think that an increase in economic development (ED) deteriorates the environmental condition (EC) of a country (Siping, et al., 2019; Aung, Saboori & Rasoulinezhad, 2017). Past studies also suggest that economic development (ED) initially promotes environment decay (ED). It reaches the highest possible level in the next few years, and subsequently, it declines as the economy develops further (Selden & Song, 1994; Grossman & Krueger, 1991; Rothman & de Bruyn, 1998).

The study aims to revalidate the EKC hypothesis for Pakistan. The EKC suggests that economic growth (EG) and development initially contribute towards environmental decay (ED), but in the long run, it reduces environmental decay (ED) (Rothman & de Bruyn, 1998). Past literature suggests that energy consumption (EC) in a country and environment quality (EQ) are highly associated. Therefore, this study has taken "Co2 emission and energy consumption (EC) in the model" (Ali, Ashraf, Bashir & Cui, 2017). Many studies have examined EKC in Pakistan, but they have not investigated the significance of structural breaks (SBs) for Pakistan's environment-growth nexus (EGN) (Zhang, Wang & Wang, 2017; Gokmenoglu & Taspinar, 2018). The current research contributes to the existing literature on the EKC hypothesis as we have incorporated one endogenous structural break (SB) in the model for the period 1980-2016. We have also included "FDI and trade openness (TO)" in the model to determine their relevance with Pakistan's environmental degradation (ED).

Literature Review

Researchers argue that when a host country receives more investment, its environmental protection policies and implementation become strict (Perman & Stern, 2003). Many studies in developing countries have documented that sulfur emissions (SE) and economic growth (EG) are highly associated. (Kim & Baek, 2011; Abdo, Li, Zhang, Lu & Rasheed, 2020). Similarly, Liddle & Messinis (2018) also validated the same results. Stern (2004) found "empirical evidence in support of the EKC." Boyd & Smith (1992) also found an association between "environmental degradation (ED) and economic growth (EG)." Demena & Afesorgbor (2020) also found that environmental degradation (ED) declines "after a certain level of economic growth (EG)." A similar study using a data set of countries belonging to different income groups found a negative but insignificant growth-environment nexus in high-income countries (Porter & Van-der-Linde, 1995). Other studies also found support for the EKC in high-income countries (Ulucak & Bilgili, 2018). Dogan & Inglesi-Lotz (2020) found evidence of EKC in "middle and low-income countries." At the same time, Choi & Han (2018) also found that it promotes environmental degradation as the income level increases. Similarly, Chen, Fan & Guo

(2020) suggest that a country's economic prosperity promotes environmental decay and pollution. However, this relationship is not linear. It varies from developed countries (DC) to developing countries (Norbutas & Corten, 2018).

Boyd & Smith (1992) suggest that FDI is not effective in countries with liberalization and deregulation policies. The literature also suggests that growth and development in a country promote environmental degradation and adversely affect human well-being (Kim & Baek, 2011). Similary, Nováková, Šujanová & Nováková (2019) suggest that the "association between economic prosperity (EP) and environmental decay (ED) do not increase at the same rate." It depends on the GDP of a country. For example, countries whose GDP is low may adversely suffer due to economic growth. However, countries with a higher GDP contribute less to environmental degradation (Grossman & Kureger 1995; Ghebrihiwet & Motchenkova, 2017). At the same time, FDI helps in technology transfer to the host country, contributing to its overall growth (Romer, 1993). Alfaro, et. al., (2004) and Šušteršič & Kejžar (2020) found that FDI does not linearly affect all sectors of an economy. It significantly promotes the manufacturing sector and has an insignificant effect on the service sector (Herlitah, Fawaiq & Herlindah, 2020). Similarly, Herzer & Klasen (2008) based on the data set of twenty-eight developing countries, also found similar results. A few researchers investigating the growth-environment nexus found that a country at the initial rapid growth phase promotes environmental decay (Pandey, Dogan & Taskin, 2020). However, the environmental conditions improve after growth, and per capita income reached a certain level (Liddle & Messinis, 2018; Grimes & Kentor, 2003). Many researchers have also found that foreign investors prefer investing in economies with moderate environmental protection policies (Copeland & Taylor, 2005; Kurniawan, Sugiawan & Managi, 2021) or where the governments don't focus on environmental quality to attract foreign investment (Wei & Smarzynska, 1999).

Beak & Koo (2011) examined the EKC hypothesis in India and China. The study found that in India, FDI contribution towards energy emission is insignificant in the short run and significant in the long run. Comparatively, in China, "FDI has significantly increased energy consumption (EC), economic growth (EG), and CO2 emissions" (Salim, Yao, Chen & Zhang, 2017). Kim & Beak (2011), using an ARDL bounds approach, found that in advanced countries, economic growth (EG) increases energy emission (EE). Similarly, other studies also concluded that energy demand promotes energy emission while FDI insignificantly affects environmental decay (Khan, Hussain, Bano & Chenggang, 2020; Rafindadi, Muye & Kaita, 2018).

Liddle & Messinis (2018) argue that FDI contributes towards industries with extensive energy requirements resulting in increased CO2 emission levels. Ahmed & Long (2012)

also found that the association between FDI and CO2 "emission level depends on the countries' income levels." FDI contribution towards CO2 emission is high in middle-income countries and insignificant in high-income countries (Muhammad & Khan, 2019; Pazienza, 2019). Based on empirical evidence, Ugur & Gultekin (2018) concluded that FDI in a country promotes CO2-related pollution, although its intensity may be on the lower side.

Pao & Tsai (2011) also found support for the EKC hypothesis in BRIC countries. The study also found that FDI inflow causes environmental degradation (ED). On the contrary, many researchers believe that the conventional econometric methods lack the power to validate the EKC hypothesis (Pata, 2019; Stern, 2004; Herzer & Klasen, 2008; Xing & Kolstad, 2002). Given this constraint, researchers have focused "on structural breaks (SBs) while validating the EKC hypothesis." Tiwari (2012) examined the association between GDP, energy consumption (EC), and pollution in India. The study used the static and dynamic frameworks and found the "structural breaks (SBs) in the model."

At the same time, Jaunky (2011) did not find support for the "EKC hypothesis in the presence of structural breaks (SBs). The results were based on the panel data of 36 countries. Mahmood & Chaudhary (2012) based on the Zivot-Andrews test (Zivot & Andrews, (2002) found "structural breaks (SBs)" in the model. The study also found that "FDI, CO2, and population density (PD) are associated in the long-term only. In the short term, these variables have no association. Yousaf et al. (2016), in a study of Pakistan over the period 1972-2013, found that foreign loans and aid promote CO2 emissions. Ahmed & Long (2010) examined the validity of the EKC hypothesis in Pakistan over 1971-2008 by using the ARDL approach. The study found "evidence of both long run and short run EKC in Pakistan."

Ur-Rehman et al. (2019) used the nonlinear ARDL method to confirm the population haven hypothesis in Pakistan. The study also found evidence for the EKC hypothesis with the nonlinear specification in Pakistan. Cetin et al. (2018), based on data from 1960-2014, found the "presence of EKC with one structural break (SB)." Pata (2019) adopted the "bootstrapped autoregressive distributed lag (ARDL) model to validate the EKC hypothesis and the presence of structural breaks (SBs)" in Turkey from 1969-2017. The results suggest a long-term association between "trade openness (TO), per capita income, per capita real income, and CO2 emissions, and the presence of one structural break." Salahuddin et al. (2019), in a study in South Africa, used the Zivot-Andrews unit root test and found a strong association between "CO2 emissions, globalization, and urbanization."

Ugur & Gultekin (2018) reinvestigated the association between "environmental degradation (ED) and economic growth (EG) in Turkey for the period 1960-2011. The study used the Zivot-Andrews unit root test (ZAURT) and Gregory-Hansen cointegration (GHC) method. The study also found evidence of the EKC hypothesis in Turkey with one structural break in 1992. Alvarado & Toledo (2017), based on empirical evidence, concluded that it is possible to reduce environmental degradation, which is also a sign of developed economies. Hundie & Daksa (2019) found that there exists an "inverted U-Shaped Curve for Environment-growth nexus." Felix-Fofana (2018) suggests that the industrialization and environment quality relationship is nonlinear. At the initial stage of industrialization, a country's environmental quality is adversely affected. But at the later stage of industrialization, environmental decay decreases. Thus, countries need to align development, growth, and energy consumption (Ozcan, Tzeremes & Tzeremes, 2020).

Perman & Stern (2003) analyzed the EKC hypothesis for 23 OECD countries using carbon emission data and GDP per capita. The study used a model that incorporated multiple endogenous structural breaks (SBs). The study found support for the EKC hypothesis in only 4 out of 23 countries. For another 15 countries, the authors found insignificant effects of income on CO2 emissions due to positive but declining energy emission elasticity. The study concluded that the presence of the EKC hypothesis is country-specific and time-varying.

Methodology

This paper aims to analyze the EKC hypothesis in Pakistan. The data for the period 1980 to 2016 was obtained from secondary sources. The variables used in the model are inclusive of "FDI, real-GDP per capita, CO2 emission and trade openness (TO)." The validity of EKC hypothesis with structural breaks (SBs) was tested by extending the work of Mahmood & Chaudhary (2012) and Jalil & Feridun (2010). The model is as follows:

$$ENV = F(GDP, FDI, GDP^2, TOP, ECM) \ldots\ldots (1)$$

While the empirical equation takes the following form:

$$lnCO2 = \alpha + \beta_1 lnGDP + \beta_2 lnFDI + \beta_3 lnGDP^2 + \beta_4 lnTOP + \beta_5 lnECM + \mu_i \ldots\ldots (2)$$

Where,
CO2 = Carbon Emissions
FDI = Foreign Direct Investment
TOP = Trade Openness
ECM = Primary Energy Consumption

GDP = Real GDP Per Capita
μ_i = Error Term

The EKC hypothesis suggests that economic growth (EG) increases energy consumption (EC) proportionally in the short run (SR). However, in the "long run (LR), economic growth (EG) increases energy consumption (EC) at a slower rate." Thus, we expect β_1 to have a positive sign. β_3, in the long run, may have a negative sign showing a declining trend of energy consumption (EC). Per capita, energy consumption (EC) may contribute towards pollution. Thus, the expected sign of β_5 will also be positive. We have also added two other important variables in the model, i.e., trade openness (TOP) and FDI. We expect that trade openness will negatively affect energy emission, and FDI will increase environmental degradation. FDI influences the production capacity, and higher production "increases energy consumption (EC) and carbon emissions." Before performing time series analysis (TSA), we checked the order of integration of the variables. Subsequently, we examined their long-term relationship.

Results and Discussion

The study aims to identify if structural breaks (SBs) significantly affect "FDI, CO2 emissions and Pakistan's economy (PE)" for the period 1980-2016. The study has ascertained the "order of integration based on unit-roots." We have used "both the conventional unit root tests, i.e., Augmented Dickey-Fuller and the Phillips-Perron unit root test." Table 1 "suggests that all the variables are non-stationary at level," suggesting that a unit root is present among all data series. However, all the 'variables become stationary when tested at the first difference." The results confirm that all individual data series were of order I(1). The Zivot-Andrews unit root test with one structural break also confirms the results of conventional unit root tests in Table 2.

Table 1: Conventional Unit Root Tests

	ADF				PP			
	Level		First Difference		Level		First Difference	
	τ_μ	τ_τ	τ_μ	τ_τ	$Z(t_{b1}^*)$	$Z(t_b)$	$Z(t_{b1}^*)$	$Z(t_b)$
GDP	0.82	-3.17*	-1.21	-5.59*	-1.75	-5.40	-1.28	-5.66*
TOP	-1.76	-4.89*	-1.812	-4.90*	-2.03	-4.89*	-2.03	-4.90*
GDP2	-1.2	-3.58*	0.83	4.32*	0.82	-3.58*	-1.2	-5.37*
FDI	2.3	-5.67*	0.78	5.32*	-1.24	4.56*	1.23	3.76*
CO2	1.51	-7.95*	-1.78	6.88*	0.98	2.12	5.67*	-5.56*
ECM	0.89	3.56*	0.24	3.21*	-2.32	5.67*	-1.34	4.76*

Table 2: Zivot-Andrews Unit Root Test

H_0: The Series has a Unit Root With Structural Break						
H_1: The Series is Stationery With Structural Break						
Variable	**Break-in intercept**	**Breakpoint**	**Break-in trend**	**Breakpoint**	**Break-in both**	**Breakpoint**
CO2	-0.98	2004	-5.19	2003	-4.58	2002
FDI	-4.98	2006	-6.37	2005	-6.65	2004
GDPGR	-5.41	2001	-4.31	1996	-5.80	2002
GDPGR2	-4.76	2002	-3.94	2005	-6.60	2003
TOP	-4.28	1998	-3.01	1991	-4.19	1998
EC	-2.85	1990	-2.72	1992	-2.34	2003
	Critical values		**Critical values**		**Critical values**	
	1	-5.34	1%	-4.80	1%	-5.57
	5%	-4.93	5%	-4.42	5%	-5.08
	10	-4.58	10	-4.11	10	-4.82

After determining the "non-stationary variables and the order of integration, we determined the long-run equilibrium relationship in the model using the Johansen cointegration test."The optimal lag length was determined using the Akaike Information Criteria (AIC). The Johansen cointegration test results in Table 3 "confirms the presence of a long-run association between the variables in the model" as the trace statistics show that 4 co-integrating equations and Eigenvalue statistics indicate 3 co-integrating equations, thus confirms the presence of cointegration in the model. Table 4 showed a "positive relationship between FDI and GDP with CO2 emission." GDP^2 was found to have a negative sign as expected. Interestingly TOP "also seems to have a positive relationship with CO2 emissions," which indicates that trade openness also hampers the environmental condition in Pakistan.

To confirm the conventional cointegration test results and "determine the possible significance of structural breaks (SBs) in the model, we used the Gregory-Hansen cointegration test. In the model, we also incorporated one endogenous structural break (SB). The Gregory-Hansen cointegration test in Table 5 further confirms the co-integrating relationship "in the model in the presence of one structural break" at the 1% level of significance. The coefficient of GDP^2 reported in Table 4 shows an expected negative sign thus, "confirming the presence of EKC in Pakistan." The study found support for the long-term relationship in the model both with and without a structural break. Subsequently, the study determined the error-correction terms in the model. The error correction model results in Table 6 show the error correction term for energy consumption (EC), CO2 emission, and GDP^2. However, our results suggest that FDI, GDP,

and TOP have no short-run impact on the model. The study "also found a positive sign for GDP and a negative sign" for GDP^2 in the error correction model.

Table 3: Johansen Cointegration Test Results

No. of CE(s)	Trace Stat	No. of CE(s)	Max-Eigen Stat	
None *	232.35 (107.34)	None *	81.67	(43.41)
At most 1 *	150.67 (79.34)	At most 1 *	64.61	(37.16)
At most 2 *	86.06 (55.24)	At most 2 *	37.39	(30.81)
At most 3 *	48.67 (35.01)	At most 3	34.67	(48.25)
At most 4	14.03 (18.39)	At most 4	13.95	(17.14)
At most 5	0.04 (3.84)	At most 5	0.04	(3.84)

Table 4: Normalized Cointegrating Coefficients

LNCO2	LNGDP	LNFDI	LNECM	LNGDP2	LNTOP
1.000000	-11.24	-7.26	-34.29	31.01	23.81
	(12.16)	(0.498)	(76.67)	(62.69)	(10.62)

Table 5: Gregory-Hansen Cointegration Test Results (with One Structural Break)

Tests	Level Shift with Constant	Level Shift with Trend	Regime Shift
ADF	-6.41 (2002)	-5.99(2002)	-7.23(2002)
Zivot-Andrews	-1.12 (2002)	-34.28 (2002)	-34.29 (2002)
Zivot-Andrews	-1.03(2002)	-4.66(2002)	-4.99 (2002)

We used the Wald test of causality within the error correction framework to conclude the "direction of the causal relationship between the variables." The results of Granger causality in Table 7 indicate that unidirectional causality exists "between FDI and CO2 emissions, and the direction of causality runs from FDI to CO2 emissions." A "bidirectional causal relationship exists between GDP growth and CO2 emissions." The results also "show a bidirectional causal relationship between energy consumption (EC) and CO2 emission." The results suggest that as the "foreign direct investment inflow increases in

the economy, environmental degradation also increases."

Table 6: Error Correction Model

Error Correction:	D(LNCO2)	D(LNGDP)	D(LNECM)	D(LNFDI)	D(LNGDP2)	D(LNTOP)
CointEq1	-0.04	0.03	- 0.07	0.05	-0.01	0.06
	(0.08)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
	[-1.44825]	[1.76227]	[- 3.13150]	[5.29072]	[-3.99336]	[1.97109]
D(LNCO2(-1)	0.19	-0.00	0.00	-0.09	-0.00	-0.00
	(0.26)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)
	[0.72239]	[-0.07717]	[1.22256]	[-3.32814]	[-4.01348]	[-1.01530]
D(LNGDP(-1)	700.24	2.30	-0.14	-1403.91	0.37	-3.64
	(2316.25)	(1.51)	(0.04)	(249.34)	(0.40)	(1.64)
	[0.30232]	[1.52117]	[-3.40227]	[-5.63044]	[0.91849]	[-2.21841]
D(LNECM(-1)	12129.23	-9.51	0.36	3311.47	2.09	2.83
	(18170.53)	(11.88)	(0.32)	(1956.05)	(3.16)	(12.87)
	[0.66752]	[-0.80033]	[1.10598]	[1.69294]	[0.66036]	[0.21995]
D(LNFDI(-1)	-1.45	-0.00	0.00	1.33	0.00	0.00
	(2.10)	(0.00)	(0.00)	(0.23)	(0.00)	(0.00)
	[-0.69146]	[-1.16849]	[1.14313]	[5.89390]	[4.70477]	[1.31415]
D(LNGDP2(-1)	215.97	-0.16	-0.00	3.33	-0.01	-0.22
	(167.22)	(0.11)	(0.00)	(18.00)	(0.03)	(0.12)
	[1.29151]	[-1.47937]	[-0.67401]	[0.18479]	[-0.41875]	[-1.82193]
D(LNTOP(-1)	700.57	-0.10	-0.01	1.87	-0.14	-0.42
	(375.47)	(0.25)	(0.01)	(40.42)	(0.07)	(0.27)
	[1.86584]	[-0.39434]	[-0.95565]	[0.04627]	[-2.09157]	[-1.58067]
C	3753.71	0.99	0.01	61.93	0.21	0.19
	(1548.57)	(1.01)	(0.03)	(166.70)	(0.27)	(1.10)
	[2.42398]	[0.98128]	[0.34303]	[0.37148]	[0.77771]	[0.17003]

The results also indicate bidirectional causality between TOP and CO2 emissions, suggesting an increase in trade volume due to trade openness would increase air pollution. The increased production will also affect the environment. FDI and GDP also have a bidirectional causal relationship. The results also indicate bidirectional causality between TOP and FDI, suggesting trade liberalization and FDI are interrelated and

essential for each other.

Table 7: Causality Test Results Based On Error Correction Model

Dependent	**Independent**					
	LNCO2	**LNFDI**	**LNECM**	**LNGDP**	**LNTOP**	**LNGDP²**
LNCO2	--	2.57*	1.96*	3.10*	2.86*	1.66*
LNFDI	0.45*	--	0.34	2.15*	1.02*	0.45
LNECM	3.24*	2.63*	--	0.27	2.27*	0.23
LNGDP	1.13*	1.57*	0.66	--	0.33	2.35*
LNTOP	5.32*	2.86*	3.21*	4.34*	--	0.98
LNGDP2	4.45*	3.00	2.56*	0.00	4.67*	--

Conclusion

The study determines the presence of the EKC hypothesis in Pakistan for the period 1980-2016. The study documents some important findings. The results support the EKC hypothesis in Pakistan. The coefficients of trade openness and FDI also have important policy implications as it is evident that FDI and trade openness positively affect CO2 emissions in Pakistan. Many researchers believe that Pakistan has not properly implemented environment protection policies in manufacturing sectors such as textile and chemicals. The Gregory-Hansen cointegration test also suggests that the long-run equilibrium relationship is affected by structural breaks (SBs). Historical data suggests that Pakistan has gone through some structural changes during the period 2000-2004, which includes implementing the structural adjustment program of IMF and liberalization of trade and investment policies to attract foreign investors. The 9/11 tragedy also played an important role as Pakistan remained on the front lines in the war against terrorism. Thus, the study concludes that structural breaks (SBs) have important implications for the EKC hypothesis in Pakistan.

References

Abdo, A. B., Li, B., Zhang, X., Lu, J., & Rasheed, A. (2020). Influence of FDI on environmental pollution in selected Arab countries: a spatial econometric analysis perspective. *Environmental Science and Pollution Research*, *27*, 28222-28246.

Ahmad, M. H., Ahmed, Q. M., & Atiq, Z. (2018). The impact of quality of institutions on sect oral FDI: evidence from Pakistan. *Foreign Trade Review*, *53*(3), 174-188.

Ahmed, K., & Long, W. (2012). Environmental Kuznets curve and Pakistan: an empirical analysis. *Procedia Economics and Finance*, *1*, 4-13.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2004). FDI and economic growth: the role of local financial markets. *Journal of International Economics*, *64*(1), 89-112.

Ali, G., Ashraf, A., Bashir, M. K., & Cui, S. (2017). Exploring environmental Kuznets curve (EKC) in relation to green revolution: a case study of Pakistan. *Environmental Science and Policy*, *77*, 166-171.

Alvarado, R., Iñiguez, M., & Ponce, P. (2017). Foreign direct investment and economic growth in Latin America. *Economic Analysis and Policy*, *56*, 176-187.

Alvarado, R., & Toledo, E. (2017). Environmental degradation and economic growth: evidence for a developing country. *Environment, Development, and Sustainability*, *19*(4), 1205-1218.

Aung, T. S., Saboori, B., & Rasoulinezhad, E. (2017). Economic growth and environmental pollution in Myanmar: an analysis of environmental Kuznets curve. *Environmental Science and Pollution Research*, *24*(25), 20487-20490.

Baek, J., & Koo, W. W. (2009). A dynamic approach to the FDI-environment nexus: the case of China and India. *East Asian Economic Review*, *13*(2), 87-106.

Blackman, A., & Wu, X. (1999). Foreign direct investment in China's power sector: trends, benefits and barriers. *Energy Policy*, *27*(12), 695-711.

Boyd, J. H., & Smith, B. D. (1992). Intermediation and the equilibrium allocation of investment capital: Implications for economic development. *Journal of Monetary Economics*, *30*(3), 409-432.

Buckley, P. J., Clegg, L. J., Voss, H., Cross, A. R., Liu, X., & Zheng, P. (2018). A retrospective and agenda for future research on Chinese outward foreign direct investment. *Journal of International Business Studies*, *49*(1), 4-23.

Cetin, M., Ecevit, E., & Yucel, A. G. (2018). Structural breaks, urbanization and CO 2 emissions: evidence from Turkey. *Journal of Applied Economics Business Review*, *8*(2), 122-139.

Chen, L., Fan, Y., & Guo, W. (2020). Relationship of economic development, family income and health status in China: The moderating role of environmental pollution perception. *Journal of Health Psychology*, *25*(13-14), 2499-2510.

Cheng, T. M., Hong, C. Y., & Yang, B. C. (2018). Examining the moderating effects of service climate on psychological capital, work engagement, and service behavior among flight attendants. *Journal of Air Transport Management*, *67*, 94-102.

Choi, J. Y., & Han, D. B. (2018). The links between environmental innovation and environmental performance: Evidence for high-and middle-income countries. *Sustainability*, *10*(7), 1-14.

Copeland, B. R., & Taylor, M. S. (2005). *Trade and the Environment: Theory and Evidence*. New Jersey: Princeton University Press.

Demena, B. A., & Afesorgbor, S. K. (2020). The effect of FDI on environmental emissions: Evidence from a meta-analysis. *Energy Policy*, *138*, 1-15.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica, 49*(4) 1057-1072.

Dogan, E., & Inglesi-Lotz, R. (2020). The impact of economic structure to the environmental Kuznets curve (EKC) hypothesis: evidence from European countries. *Environmental Science and Pollution Research*, *27*(11), 12717-12724.

Fan, W., & Hao, Y. (2020). An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China. *Renewable Energy*, *146*, 598-609.

Felix-Fofana, N. Z. (2018). The environment and growth nexus: an empirical examination of the environmental Kuznets curve hypothesis in Cote D'Ivoire. *International Journal of Development Research*, *8*(09), 22846-22854.

Gerhardter, H., Prieler, R., Mayr, B., Landfahrer, M., Mühlböck, M., Tomazic, P., & Hochenauer, C. (2018). Assessment of a novel numerical model for combustion and in-flight heating of particles in an industrial furnace. *Journal of the Energy Institute*, *91*(6), 817-827.

Ghebrihiwet, N., & Motchenkova, E. (2017). Relationship between FDI, foreign ownership restrictions, and technology transfer in the resources sector: A derivation approach. *Resources Policy*, *52*, 320-326.

Gokmenoglu, K. K., & Taspinar, N. (2018). Testing the agriculture-induced EKC hypothesis: the case of Pakistan. *Environmental Science and Pollution Research*, *25*(23), 22829-22841.

Gregory, A. W., & Hansen, B. E. (1996). Residual-based tests for cointegration in models with regime shifts. *Journal of Econometrics*, *70*(1), 99-126.

Grimes, P., & Kentor, J. (2003). Exporting the greenhouse: Foreign capital penetration and CO? Emissions 1980 1996. *Journal of World-Systems Research*, *9*(2), 261-275.

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. *The Quarterly Journal of Economics*, *110*(2), 353-377.

Herlitah, H., Fawaiq, M., & Herlindah, H. (2020). Revisiting the Nexus of FDI and Employment in International Trade: Evidence from the Emerging Construction Service Sector. *Iranian Economic Review*, *24*(3), 675-705.

Herzer, D., & Klasen, S. (2008). In search of FDI-led growth in developing countries: The way forward. *Economic Modelling*, *25*(5), 793-810.

Hundie, S. K., & Daksa, M. D. (2019). Does energy-environmental Kuznets curve hold for Ethiopia? The relationship between energy intensity and economic growth. *Journal of Economic Structures*, *8*(1), 21-32.

Jalil, A., & Feridun, M. (2010). Explaining exchange rate movements: an application of the market microstructure approach on the Pakistani foreign exchange market. *The Journal of Developing Areas, 44*(1)255-265.

Jaunky, V. C. (2011). The CO2 emissions-income nexus: evidence from rich countries. *Energy Policy*, *39*(3), 1228-1240.

Jeon, H. M., Ali, F., & Lee, S. W. (2019). Determinants of consumers' intentions to use smartphones apps for flight ticket bookings. *The Service Industries Journal*, *39*(5-6), 385-402.

Johansen, S. (1992). Testing weak exogeneity and the order of cointegration in UK money demand data. *Journal of Policy Modeling*, *14*(3), 313-334.

Khan, A., Hussain, J., Bano, S., & Chenggang, Y. (2020). The repercussions of foreign direct investment, renewable energy and health expenditure on environmental decay? An econometric analysis of B&RI countries. *Journal of Environmental Planning and Management*, *63*(11), 1965-1986.

Kim, H. S., & Baek, J. (2011). The environmental consequences of economic growth revisited. *Economics Bulletin*, *31*(2), 1198-1211.

Kurniawan, R., Sugiawan, Y., & Managi, S. (2021). Economic growth–environment nexus: An analysis based on natural capital component of inclusive wealth. *Ecological Indicators*, *120*, 1-10.

Liddle, B., & Messinis, G. (2018). Revisiting carbon Kuznets curves with endogenous breaks modeling: evidence of decoupling and saturation (but few inverted-Us) for individual OECD countries. *Empirical Economics*, *54*(2), 783-798.

Liu, Q., Wang, S., Zhang, W., Zhan, D., & Li, J. (2018). Does foreign direct investment affect environmental pollution in China's cities? A spatial econometric perspective. *Science of the Total Environment*, *613*, 521-529.

Mahmood, H., & Chaudhary, A. R. (2012). FDI, population density and carbon dioxide emissions: A case study of Pakistan. *Iranica Journal of Energy & Environment*, *3*(4), 354-360.

Malik, S., & Malik, Q. A. (2013). Empirical analysis of macroeconomic indicators as determinants of foreign direct investment in Pakistan. *IOSR Journal of Business and Management*, *7*(2), 77-82.

Mehmood, K. A., & Hassan, S. (2015). A study on mapping out an alliance between economic growth and foreign direct investment in Pakistan. *Asian Social Science*, *11*(15), 113-123.

Muhammad, B., & Khan, S. (2019). Effect of bilateral FDI, energy consumption, CO2 emission, and capital on economic growth of Asia countries. *Energy Reports*, *5*, 1305-1315.

Norbutas, L., & Corten, R. (2018). Network structure and economic prosperity in municipalities: A large-scale test of social capital theory using social media data. *Social Networks*, *52*, 120-134.

Nováková, R., Šujanová, J., & Nováková, N. (2019). Improving Quality Management-the Way Toward Economic Prosperity and Quality of Life. *Production Engineering Archives*, *24*.10-13.

Ozcan, B., Tzeremes, P. G., & Tzeremes, N. G. (2020). Energy consumption, economic growth and environmental degradation in OECD countries. *Economic Modelling*, *84*, 203-213.

Pandey, S., Dogan, E., & Taskin, D. (2020). Production-based and consumption-based approaches for the energy-growth-environment nexus: evidence from Asian countries. *Sustainable Production and Consumption*, *23*, 274-281.

Pao, H. T., & Tsai, C. M. (2011). Multivariate Granger causality between CO2 emissions, energy consumption, FDI (foreign direct investment) and GDP (gross domestic product): evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries. *Energy*, *36*(1), 685-693.

Pata, U. K. (2019). Environmental Kuznets Curve and Trade Openness in Turkey: Bootstrap ARDL Approach with a Structural Break. *Environmental Science and Pollution Research*, *26(*20), 20264-20276.

Paul, J., & Feliciano-Cestero, M. M. (2021). Five decades of research on foreign direct investment by MNEs: An overview and research agenda. *Journal of Business Research*, *124*, 800-812.

Pazienza, P. (2019). The impact of FDI in the OECD manufacturing sector on CO2 emission: Evidence and policy issues. *Environmental Impact Assessment Review*, *77*, 60-68.

Perman, R., & Stern, D. I. (2003). Evidence from panel unit root and cointegration tests that the environmental Kuznets curve does not exist. *Australian Journal of Agricultural and Resource Economics*, *47*(3), 325-347.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, *9*(4), 97-118.

Rafindadi, A. A., Muye, I. M., & Kaita, R. A. (2018). The effects of FDI and energy consumption on environmental pollution in predominantly resource-based economies of the GCC. *Sustainable Energy Technologies and Assessments*, *25*, 126-137.

Romer, P. (1993). Idea gaps and object gaps in economic development. *Journal of Monetary Economics*, *32*(3), 543-573.

Rothman, D. S., & de Bruyn, S. M. (1998). Probing into the environmental Kuznets curve hypothesis. *Ecological Economics*, *25*, 143-145.

Salahuddin, M., Gow, J., Ali, M. I., Hossain, M. R., Al-Azami, K. S., Akbar, D., & Gedikli, A. (2019). Urbanization-globalization-CO2 emissions nexus revisited: empirical evidence from South Africa. *Heliyon*, *5*(6), 1-9.

Salehnia, N., Alavijeh, N. K., & Salehnia, N. (2020). Testing Porter and pollution haven hypothesis via economic variables and CO 2 emissions: a cross-country review with panel quantile regression method. *Environmental Science and Pollution Research*, *27*(25), 31527-31542.

Salim, R., Yao, Y., Chen, G., & Zhang, L. (2017). Can foreign direct investment harness energy consumption in China? A time series investigation. *Energy Economics*, *66*, 43-53.

Sapkota, P., & Bastola, U. (2017). Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America. *Energy Economics*, *64*, 206-212.

Shahzad, A., Mithani, D. A., Al-Swidi, A. K., & Fadzil, F. H. (2012). Political stability and the foreign direct investment inflows in Pakistan. *British Journal of Arts and Social Sciences*, *9*(2), 199-213.

Siping, J., Wendai, L., Liu, M., Xiangjun, Y., Hongjuan, Y., Yongming, C., ... & Ahmad, B. (2019). Decoupling environmental pressures from economic growth based on emissions monetization: case in Yunnan, China. *Journal of Cleaner Production*, *208*, 1563-1576.

Sjöman, H., Autiosalo, J., Juhanko, J., Kuosmanen, P., & Steinert, M. (2018). Using Low-Cost Sensors to Develop a High Precision Lifting Controller Device for an Overhead Crane—Insights and Hypotheses from Prototyping a Heavy Industrial Internet Project. *Sensors*, *18*(10), 3328.

Selden, T. M., & Song, D. (1994). Environmental quality and development: is there a Kuznets curve for air pollution emissions?. *Journal of Environmental Economics and Management*, *27*(2), 147-162.

Sengupta, P., & Puri, R. (2020). Exploration of relationship between FDI and GDP: A comparison between India and its neighbouring countries. *Global Business Review*, *21*(2), 473-489.

Shahbaz, M., Mutascu, M., & Azim, P. (2013). Environmental Kuznets curve in Romania and the role of energy consumption. *Renewable and Sustainable Energy Reviews,* 18, 165-173.

Solarin, S. A., & Al-Mulali, U. (2018). Influence of foreign direct investment on indicators of environmental degradation. *Environmental Science and Pollution Research*, *25*(25), 24845-24859.

Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. *World Development*, *32*(8), 1419-1439.

Šušteršič, T. G., & Kejžar, K. Z. (2020). The role of skilled migrant workers in FDI-related technology transfer. *Review of World Economics*, *156*(1), 103-132.

Tiwari, A. K. (2012). On the Dynamics of Energy Consumption, CO_2 Emissions and Economic Growth: Evidence from India. *Indian Economic Review*, 47*(1),* 57-87.

Ugur, A., & Gultekin, E. (2018). Approaching the Environmental Kuznets Curve: Empirical Evidence from Turkey. *Journal of Economic Cooperation & Development*, *39*(4), 1-18.

Ulucak, R., & Bilgili, F. (2018). A reinvestigation of EKC model by ecological footprint measurement for high, middle and low income countries. *Journal of Cleaner Production*, *188*, 144-157.

Ur Rahman, Z., Chongbo, W., & Ahmad, M. (2019). An (a) symmetric analysis of the pollution haven hypothesis in the context of Pakistan: a non-linear approach. *Carbon Management*, *10*(3), 227-239.

Wei, S. J., & Smarzynska, B. (1999). Pollution Havens and foreign direct investment: dirty secret or popular myth? Policy Research Working Papers. *The World Bank*. {Available}, https://www.nber.org/system/files/working_papers/w8465/w8465.pdf

Xing, Y., & Kolstad, C. D. (2002). Do lax environmental regulations attract foreign investment?. *Environmental and Resource Economics*, *21*(1), 1-22.

Yousaf, A., Khan, H., Erum, N., & Rasul, S. (2016). An analysis of foreign aid and environmental degradation in Pakistan using the ARDL bounds testing technique (1972-2013). *Environmental Economics*, *7*(1), 16-23.

Zafar, M. W., Zaidi, S. A. H., Khan, N. R., Mirza, F. M., Hou, F., & Kirmani, S. A. A. (2019). The impact of natural resources, human capital, and foreign direct investment on the ecological footprint: the case of the United States. *Resources Policy*, *63*, 1-10.

Zivot, E., & Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business & Economic Statistics*, *20*(1), 25-44.

Zhang, B., Wang, B., & Wang, Z. (2017). Role of renewable energy and non-renewable energy consumption on EKC: Evidence from Pakistan. *Journal of Cleaner Production*, *156*, 855-864.