The Environmental cost of Skiing in the Desert? Evidence from Cointegration with unknown Structural breaks in UAE

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Abstract: The present study explores the relationship between economic growth, electricity consumption, urbanization and environmental degradation in case of United Arab Emirates. The study covers the quarter frequency data over the period of 1975-2011. We have applied the ARDL bounds testing approach to examine the long run relationship between the variables in the presence of structural breaks. The VECM Granger causality is applied to investigate the direction of causal relationship between the variables.

Our empirical exercise reported the existence of cointegration among the series in case of United Arab Emirates. Further, we found an inverted U-shaped relationship between economic growth and CO_2 emissions i.e. economic growth raises energy emissions initially and declines it after a threshold point of income per capita (EKC exists). Electricity consumption declines CO_2 emissions. The relationship between urbanization and CO_2 emissions is positive. Exports seem to improve the environmental quality by lowering CO_2 emissions in case of UAE. The causality analysis validates the feedback effect between CO_2 emissions and electricity consumption. Economic growth and urbanization Granger cause CO_2 emissions.
Keywords: Electricity, Growth, CO_2 emissions

Introduction

The negotiations to extend the Kyoto Protocol which expired in 2012 and to prepare the ground for future global agreement to replace it are still blocked. This is due mainly to two issues. i) Developing countries are criticizing the non-commitment of industrialized countries to reduce their industrial emissions of carbon dioxide and other greenhouse gases. ii) Further, they are asking more financial aid from the rich nations to poorer countries to move forward for a cleaner energy source and to reduce greenhouse gases and thus fulfill their pledges under Kyoto Protocol. Yet, are oil-exporting countries concerned by the latest issue? Mining-resources rich countries enjoy sizeable revenues coming from oil and gas export. This is case of United Arab Emirates (UAE).The UAE is a federation of seven emirates namely: Abu Dhabi (the capital emirate), Ajman, Dubai, Fujairah, Ras-al-Khaimah, Sharjah and Umm al-Quwain. Since early 1960s, when oil was first extracted, the UAE moved from fishing and agricultural-based economy to an oil-based economy. The UAE is one of the biggest oil producers in the world.

The UAE has observed resilient economic growth in the last decades sustained by high oil prices. The country has taken advantage to improve its local infrastructure i.e. roads, ports, airports etc. Developed infrastructure had a direct impact on urbanization. World Urbanization Prospects (the 2011 Revision) reports that the UAE's urban population jumped from 54.4 % in 1950 to 84.4 % in 2010. The urbanization rate reached 2.9% over the period of 2005-2010, which is one of the highest rate in the world. The country's landscape has changed completely and the UAE has become one of the most attractive destinations of regional and global tourism. The UAE government's ambition went beyond the borders with unique projects including the world's tallest building, artificial island (The Palm and World map), and first shopping mall with indoor ski-resort (Dubai mall).

However, such development is costly to the environment, as well as to the public health. Construction industry pollutants are contributing heavily to the air deterioration and water quality. That is why environmental degradation–economic growth nexus has become one of the most attractive empirical topics in environmental economics. It has been producing a large amount literature since the beginning of the 1990s. The major concern of this literature is to investigate the relationship between income and environmental degradation is also known as Environmental Kuznets curve (EKC). The EKC hypothesis reveals that environmental deterioration increases when country witnesses economic growth, but starts to decrease when income reaches the so-called “turning point”. This hypothesis was first introduced and tested by Grossman and Krueger, (1991). However, the origins of the EKC are older. In fact, Simon Kuznets, in his presidential address entitled “Economic Growth and Income Inequality”, in 1955 suggested that as per capita income increases, income inequality increases initially and after a threshold level of income per capita, income inequality decreases (Kuznets, 1955). This implies that the relationship between income per capita and income inequality is an inverted U-shaped.

We have chosen to entitled our study “the environmental cost of skiing in the Desert” because Ski Dubai resort is source of skepticism about its impact on environmental degradation, as it is an indoor ski slope in the middle of a desert country, where temperature reaches 55° C in the summer time. Ski Dubai is an indoor ski resort with 22,500 m^2. It is within the Mall of the Emirates, which considered as one of the biggest shopping malls in the world. According to the

Ski Dubai resort website[1], the snow surface is maintained at -16° C and the air temperature is -1° to -2° during the day. Every night the old snow is moved to be used pre-cool incoming air for the Mall of the Emirates' air conditioning system. Exact estimations of energy use for Ski Dubai could not be found. It is strategic behavior to avoid any kind of criticism. However, some experts put approximate estimations based on available information and their knowledge[2]. The average temperature difference between the inside of the building and the outside is almost 32° C. It is easy to calculate it given the temperature maintained inside Ski Dubai and the average outdoor temperature (which can reach 50°). Ski Dubai uses between 525 and 915 Megawatt-hours (MWh) annually for maintaining its inside temperature, maybe more, depending on the exact insulation used. Add to this, the heat energy that needs to be removed from water to create snow, represents at least 700 kWh per day, or 255 MWh per year. Paster, (2010) suggests that Ski Dubai's electricity is generated primarily from natural gas, so its annual more than 1000 MWh of electricity use results in at least 500 tons of greenhouse gas emissions. He makes an interesting representation of the annual greenhouse gas emissions of Ski Dubai. He advances that they are equivalent to about 900 round-trip flights from Dubai to Munich (561 kg per person, per round trip). This make easy to target Ski Dubai as a model of waste and excess.

II. Literature Review

In pioneering effort, Grossman and Krueger, (1991) used the Kuznets curve as a tool to analyze the relationship between the environmental degradation and income per capita. It is important to mention that there is no convention on the best indicator to be used for environmental degradation. Some researchers use carbon dioxide emissions (Holtz-Eakinand and Selden, 1992;

[1] See www.theplaymania.com/skidubai

[2] See Pablo Paster, 2010 on www.treehugger.com/clean-technology/ask-pablo-indoor-skiing-really -that-bad.html.

Roberts and Grimes, 1997; Moomaw and Unruh, 1997 and among others) and other use sulfur dioxide emissions (Grossman and Krueger, 1991; Panayotou, 1997; Davidsdottir et al. 1998 and among others). A bulky amount of studies tested the economic growth and environmental pollution nexus. However, this literature could be divided to two distinguished components. The first component investigates the pollution–economic growth nexus for across-section and/or panel of countries. The second component investigates for individual countries. As it is impossible to review all studies due its large amount, we would review some of recent selected examples from both single studies and cross-sectional/panel data-based analysis of the EKC hypothesis.

In panel framework, Holtz-Eakin and Selden, (1995) estimated a quadratic polynomial model on the panel of 130 countries over the period of 1951-1986 and supported the EKC hypothesis. Similarly; Tucker, (1995) examined the EKC hypothesis using CO_2 emissions as an indicator of environmental degradation using cross-section data of 131 countries and results supported for EKC hypothesis. Cole et al. (1997) used wide range of indictors (Nitrogen dioxide, Sulphur dioxide, Suspended particulate matter, Carbon monoxide, Nitrogen dioxide from transport, Sulphur dioxide from transport, SPM from transport, Nitrate concentrations, Carbon dioxide, Total energy use, CFCs and halons, Methane, Municipal waste, Energy use from transport, Traffic volumes) to investigate the relationship between economic growth and environmental degradation. They employed a quadratic polynomial model using both linear and log-linear versions. Their empirical analysis advocated that the EKC hypothesis exists only for local air pollutants. Hill and Magnani, (2002) argued that the EKC for carbon emissions is found to be highly sensitive to the dataset used. They used data for 156 countries and examined the KEC hypothesis for 1970, 1980 and 1990. Their empirical exercised showed the EKC hypothesis for three cross-sections.

Recently; Apergis and Payne, (2009) examined the relationship between energy consumption, CO_2 emissions and economic growth for six Central American economies using the panel VECM. They reported that energy consumption raises CO_2 emissions and relationship between CO_2 emissions and economic growth in an inverted U-shaped i.e. KEC is confirmed. Narayan and Narayan, (2010) collected the data of 43 developing economies to examine whether EKC exist or not. Based on individual country analysis, they reported that in approximately 35 percent of the sample carbon dioxide emissions have fallen over the long run. Moreover, their results indicated that only for the Middle Eastern and South Asian panels, the income elasticity in the long run is smaller than the short run, implying that carbon dioxide emission has fallen with rise in income. For panel of BRIC countries; Pao and Tsai, (2010) investigated the dynamic causal relationships between pollutant emissions, energy consumption and economic growth. They found the long run relationship between the series. Energy consumption has positive impact on energy emissions and the EKC hypothesis also exists in BRIC region. The panel causality analysis revealed the feedback effect between energy consumption and CO_2 emissions and same is true for economic growth and energy consumption. They suggested that in order to reduce CO_2 emissions and not to adversely affect economic growth, increasing both energy supply investment and energy efficiency, and speeding up energy conservation policies to reduce wastage of energy can be initiated for energy-dependent BRIC countries.

Jaunky, (2011) attempted to test the environment Kuznets curve (EKC) hypothesis for 36 high-income countries following Narayan and Narayan, (2010). Based on single country analysis, results found inverted U-shaped relationship between economic growth and CO_2 emissions i.e. EKC only in Greece, Malta, Oman, Portugal and the United Kingdom. Piaggio and Padilla, (2012) explored the relationship between CO_2 emissions and economic growth for 31 countries (28 OECD, Brazil, China, and India). They confirmed the necessity relevance of considering the differences among countries in the relationship between air pollution and economic activity to avoid wrong estimations and conclusions. Arouri et al. (2012) investigated whether the relationship between economic growth and CO_2 emissions shows EKC phenomenon or not by applying bootstrap panel unit root tests and cointegration techniques. Their results showed that energy consumption is a major contributor to CO_2 emissions. However, the EKC hypothesis is confirmed in the long run in most sample countries, the turning points are very low in some cases and very high in other cases. This could reduce the evidence supporting of the EKC hypothesis. They suggested that future reductions in CO_2 emissions per capita might be achieved at the same time as GDP per capita in the MENA region continues to grow.

De Bruyn et al. (1998) argued that the estimation of the EKC from panel data cannot capture the dynamics of the relationship between income and emissions and policy implications from panel data analysis could not be helpful for single country. To overcome this issue, time series single country analysis must be conducted. Later on, Roca et al. (2001) used six indicators of environmental degradation in case of Spain to examine the existence of EKC hypothesis between emissions and economic growth. They only found inverted U-shaped relationship between SO_2 emissions and economic growth. However, Lindmark, (2002) reported that time-specific technological advancements may affect the relationship between economic growth and emissions in Swedish economy. In case of Austria, Friedl and Getzner, (2003) explored the relationship between economic growth and energy pollutants to test the either EKC hypothesis exists or not over the period of 1960-1999. They did not find inverted U-shaped or U-shaped but cubic i.e. N-shaped relationship between economic growth and CO_2 emissions.

Lantz and Feng, (2006) incorporated population and technology in emissions function to examine the relationship between economic growth and emissions over the period of 1970-2000 in case of Canada. They noted that did not find any evidence on relationship between economic growth and emissions but incorporation of population and technology supported for inverted U-shaped and U-shaped relationship between economic growth and emissions. He and Richard, (2010) also found the little evidence about the existence of KEC hypothesis between economic growth and CO_2 emissions. In case of French economy, Ang (2007) investigated the relationship between economic growth and CO_2 emissions by incorporating energy consumption in multivariate framework. He found long run relationship among the series but could not find evidence on EKC hypothesis and economic growth Granger causes energy consumption and CO_2 emissions in long run. In US economy, Soytas et al. (2007) examined the existence of inverted U-shaped relationship economic growth and CO_2 emissions by incorporating energy consumption, gross fixed capital formation and labor. They failed to find empirical evidence of EKC hypothesis but unidirectional causality is found running from economic growth to energy consumption.

Ang (2008) used same idea for Malaysian economy to examine whether KEC hypothesis does exit or not. He noted that the variables are cointegrated for long run relationships and energy consumption is Granger cause of economic growth. On contrary, Saboori et al. (2012) scrutinized the validation of EKC hypothesis by incorporating trade openness in CO_2 emissions function. They found long run relationship between the variables and existence of EKC in Malaysia. The VECM Granger causality analysis found that CO_2 emissions are Granger cause of economic growth in long run but in short run, feedback effect exists between economic growth and CO_2 emissions.

Chebbi, (2009) applied the Johansen cointegration for long run and the VECM Granger causality test for causal relationships. He found cointegration between the variables but failed to find EKC hypothesis. The VECM Granger causality analysis revealed that economic growth is Granger cause CO_2 emissions and economic growth Granger causes energy consumption. Halicioglu, (2009) examined the impact of determinants of CO_2 emissions in case of Turkey and reported long run relationship among economic growth, energy consumption, international trade and CO_2 emissions. He found positive impact of energy consumption and trade openness and inverted U-shaped i.e. EKC hypothesis between economic growth and CO_2 emissions. Later on, Ozturk, and Acaravci, (2010) applied trivariate model to investigate the relationship between energy consumption, economic growth and CO_2 emissions and found no evidence of environmental Kuznets curve in Turkey. They reported neutral effect among energy consumption, economic growth and CO_2 emissions. In case of Chinese economy; Jalil and Mahmud, (2009) investigated whether environmental Kuznets curve (EKC) relationship between CO_2 emissions and per capita real GDP holds in long-run or not in the presence of trade openness. The ARDL bounds testing approach is applied for long run. Their results showed a quadratic relationship between income and CO_2 emissions supporting EKC hypothesis. They further reported that economic growth Granger causes CO_2 emissions. But Kareem et al. (2012) examined the impact of energy consumption, economic growth, trade openness and capitalization on CO_2 emissions. They reported that the said variables contribute to CO_2 emissions but could not validate the findings of Jalil and Mahmud, (2009). Similarly, Shuang-Ying and Wen-Cong, (2011) applied bivariate model to examine relationship between economic growth and energy consumption but failed to find environmental Kuznets curve (EKC) empirically in Zhejiang province of China.

Iwata et al. (2010) investigated the existence of EKC hypothesis by incorporating nuclear energy consumption in CO_2 emissions function in case of France. They found long run relationship among economic growth, nuclear energy consumption and CO_2 emissions. Their empirical exercise validated that relationship between economic growth and CO_2 emissions is inverted U-shaped i.e. EKC effect exits and nuclear energy consumption lowers CO_2 emissions. Seetanah and Vinesh, (2010) used Mauritius data to investigate the nature of relationship between economic growth and CO_2 emissions by incorporating investment, trade openness, education and employment using multivariate framework. They reported that trade openness, economic growth and employment increase CO_2 emissions but education declines it. Their empirical exercise could provide support for the EKC hypothesis. Shanthini and Perera, (2011) investigated the cointegration between economic growth and CO_2 emissions in case of Australia. Their results indicated the long run relationship between the series but could evidence about the EKC hypothesis. They noted negative impact of economic growth on CO_2 emissions in short run as well as in long run.

Pao et al. (2011) applied the cointegration and causality approaches to examine the dynamic relationships between pollutant emissions and real output in case of Russia. Their results found inverse impact of real output on CO_2 emissions which does not present the support for EKC hypothesis. Their causality analysis revealed the feedback effect real output and CO_2 emissions. This suggests that to reduce emissions, the best environmental policy is to increase infrastructure investment to improve energy efficiency, and to step up energy conservation policies to reduce any unnecessary waste of energy. That is, energy conservation is expected to improve energy efficiency, thereby promoting economic growth. Saboori et al. (2011) investigated whether EKC exists or not in the presence of trade openness in Indonesia. Their findings found that relationship between economic growth and CO2 emissions are inverted-U shaped. But, Hwang and Yoo, (2012) failed to validate the findings reported by Saboori et al. (2011) and reported energy consumption and CO_2 emissions are Granger cause of economic growth. Hossain, (2012) incorporated urbanization and trade openness to investigate the relationship between economic growth and CO2 emissions in case of Japan. The empirical results found cointegration among the series and energy consumption, economic growth and urbanization are major contributors to CO_2 emissions while trade openness improves environmental quality by lowering CO_2 emissions. Hossain, (2012) could not provide empirical support for KEC effect for Japan. In case of Spain, Esteve and Tamarit (2012) empirically investigated the relationship between economic growth and CO_2 emissions by applying threshold cointegration over the period of 1857-2007. Their results confirmed the non-linear relationship between economic growth and CO_2 emissions supporting the EKC hypothesis.

In case of India, Tiwari (2011) examined the relationship between total primary energy consumption, economic growth and CO_2 emissions. He found long run relationship among the series and economic growth Granger causes energy consumption but neutral effect exists between economic growth and CO_2 emissions while same is true for energy consumption and CO_2 emissions. Then, Tiwari et al. (2013) incorporated coal consumption in CO_2 emissions function to examine the EKC hypothesis in case of India. Their results confirmed the existence of long run relationship as well as the EKC hypothesis. The VECM causality analysis revealed the feedback hypothesis between economic growth and CO_2 emissions. The bidirectional causality was found between coal consumption and CO_2 emissions. Moreover, trade openness Granger causes economic growth, coal consumption and CO_2emissions. Later on, Kanjilal and Ghosh (2013) validated the findings of Tiwari et al. (2013) and reported the negative impact of trade openness on CO_2emissions. In case of Pakistan, Shahbaz et al. (2012) investigated the relationship between CO_2 emissions, energy consumption, economic growth and trade openness to examine whether the EKC exists or not. Their results supported the existence of the environmental Kuznets curve (EKC) hypothesis. The causality analysis revealed that CO_2 emissions are Granger cause of economic growth and energy consumption. Ahmed and Long, (2012) confirmed the findings reported by Shahbaz et al (2012) and found positive impact of energy consumption, exports and population growth on CO_2 emissions. In case of Romania, Shahbaz et al. (2013) probed the existence of EKC hypothesis over the period of 1980-2010. They applied the ARDL bounds testing for long run and reported that relationship between economic growth and CO_2 emissions is inverted U-shaped i.e. the EKC hypothesis is found. Furthermore, energy consumption contributes to CO_2 emissions significantly and democracy is negative linked with CO_2 emissions due to effective adoption of economic and financial policies.

Table-1: Summary of Single Country Time Series Studies on EKC Hypothesis

No	Authors	Country	Time period	Methodology	Variables	EKC Hypothesis	Causality
1.	Roca et al. (2001)	Spain	1980-1996	OLS	RGDPPC,CO_2,Nucl,Coal, SO_2, Trans, Therm, NO_x, CH_4, N_2O, NMVOC	EKC exist for SO_2 only	$SO_{2t} \rightarrow C_t$
2.	Lindmark, (2002)	Sweden	1870-1997	OLS, BBO-model, Kalman filter	CO_2, RGDP	EKC exists	$Y_t \rightarrow C_t$
3.	Friedl and Getzner, (2003)	Austria	1960-1999	OLS, Chow	CO_2, RGDP, IMP,V.AS	EKC exists	$Y_t \rightarrow C_t$
4.	Lantz, and Feng, (2006)	Canada	1970-2000	GLS	CO_2,, RGDPPC,POP,TECH	EKC does not exist	$POP_t \rightarrow C_t$ $TECH_t \rightarrow C_t$
5.	Ang (2007)	France	1960-2000	ARDL, VECM, GC	CO2, RGDP, E	EKC exists	$Y_t \rightarrow C_t$ $Y_t \rightarrow E_t$ $E_t \rightarrow Y_t$
6.	Soytasa et al. (2007)	USA	1960-2004	T-Y GC, VDC, IRF	CO2, RGDP, GRFC, LB, E	EKC does not exist	$Y_t \rightarrow E_t$ $E_t \rightarrow C_t$ $Y_t \rightarrow C_t$
7.	Ang (2008)	Malysia	1971-1999	VECM, GC	CO2, RGDP, E	EKC does not exist	$C_t \rightarrow Y_t$ $Y_t \leftrightarrow E_t$
8.	Chebbi, (2009)	Tunisia	1971-2004	VECM, IRF	CO2, RGDP, E	EKC does not exist	$C_t \rightarrow Y_t$ $Y_t \rightarrow E_t$
9.	Halicioglu, (2009)	Turkey	1960-2005	ARDL, GC	CO_2, E, RGDP, TR	EKC exists	$Y_t \leftrightarrow C_t$ $E_t \leftrightarrow C_t$ $Y_t^2 \leftrightarrow C_t$
10.	Jalil, and Mahmud (2009)	China	1975–2005	ARDL, PGC	CO_2, E, RGDP, TR	EKC exists	$Y_t \rightarrow C_t$
11.	Akbostanci et al. (2009)	Turkey	1968–2003	VAR, J-J	CO_2, RGDP	EKC does not exist	N. A
12.	He and Richard, (2010)	Canada	1948-2004	Semi parametric and nonlinear parametric	CO_2, RGDP, OILEXP, OILP, IMPOIL, EXPUS, IMPUS, IND	EKC does not exists	N. A
13.	Ozturk, and Acaravci, (2010)	Turkey	1968-2005	ARDL, GC	CO2, RGDP, E, EMP	EKC does not exists	$EMP_t \rightarrow Y_t$
14.	Iwata et al. (2010)	France	1960-2003	ARDL	CO2, RGDP, ENUC,TR, URB	EKC exists	$Y_t \rightarrow C_t$
15.	Seetanah and Vinesh, (2010)	Mauritius	1975-2009	VAR, OLS	CO2, RGDP, E ,EXP, INV, EMP,	EKC does not exists	N.A

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16.	Iwata et al. (2010)	France	1960-2003	ARDL, VECM, GC	CO_2, RGDP, EP, TR, E, URB	EKC exists	$Y_t \rightarrow C_t$ $E_t \rightarrow C_t$
17.	Fodha, and Zaghdoud,(2010)	Tunisia	1961–2004	VECM, GC	CO_2, SO_2, RGDP	EKC exists	$Y_t \rightarrow S_t$ $Y_t \rightarrow C_t$
18.	Pao, etal.(2011)	Russia	1990-2007	VECM, GC	CO_2, E, RGDP	EKC does not exist	$Y_t \rightarrow E_t$ $E_t \rightarrow C_t$ $Y_t \rightarrow C_t$
19.	Saboori et al. (2011)	Malaysia	1980-2009	ARDL,VECM, GC	CO_2, RGDP	EKC exists	$Y_t \rightarrow C_t$
20.	Shuang-Ying and Wen-Cong, (2011)	Zhejiang province	1990-2009	OLS	LOA, RGDP	EKC does not exist	N.A
21.	Shanthini and Perera, (2011)	Australia	1960-2009	ARDL	CO_2, RGDP,OILP	EKC exists	$Y_t \rightarrow C_t$
22.	Tiwari (2011)	India	1971-2007	VAR,GC,IRF	CO_2, E, RGDP, GFCF, POP	EKC does not exist	$E_t \rightarrow C_t$ $E_t \rightarrow Y_t$
23.	Fosten et al. (2012)	UK	1830-2003	NLC, ECM	CO_2, SO_2, RGDP, ENP	EKC exists	$Y_t \rightarrow S_t$ $Y_t \rightarrow C_t$
24.	Saboori et al. (2012)	Malaysia	1980-2009	ARDL, GC	CO_2, RGDP	EKC exists	$Y_t \rightarrow C_t$
25.	Shahbaz et al. (2012)	Pakistan	1971–2009	ARDL, PGC	CO_2, E, RGDP, TR	EKC exists	$Y_t \rightarrow C_t$ $E_t \rightarrow C_t$
26.	Kareem et al. (2012)	China	1971-2008	VECM, GC	CO_2, E, RGDP, GFCF, GEXP, IND	EKC does not exist	$C_t \rightarrow Y_t$ $Y_t \rightarrow E_t$ $IND_t \rightarrow C_t$
27.	Hwang and Yoo, (2012)	Indonesia	1965-2006	VECM, GC	CO2, RGDP, E,	EKC exists	$Y_t \rightarrow C_t$ $Y_t \rightarrow E_t$ $E_t \leftrightarrow C_t$
28.	Hossain, (2012)	Japan	1960-2009	ARDL,VECM, GC	CO2, RGDP, E, TR, URB	EKC does not exist	$E_t \rightarrow C_t$ $TR_t \rightarrow C_t$ $Y_t \rightarrow C_t$

29.	Ahmed and Long, (2012)	Pakistan	1971-2008	ARDL	CO2, RGDP, E, TR, POP	EKC exists	$Y_t \to C_t$ $TR_t \to C_t$ $POP_t \to C_t$
30.	Esteve and Tamarit, (2012a, b)	Spain	1857–2007	DOLS, threshold	CO_2, RGDP	EKC does not exist	$C_t \to Y_t$
31.	Shahbaz et al. (2013)	Romania	1980–2010	ARDL	CO_2, RGDP, E	EKC exists	$Y_t \to C_t$ $E_t \to C_t$
32.	Kanjilal and Ghosh (2013)	India	1971-2008	ARDL, GH,HJ	CO2, RGDP, E, TR	EKC exists	$Y_t \to C_t$ $E_t \to C_t$
33.	Tiwari et al. (2013)	India	1966-2011	ARDL, VECM, GC	CO_2, CO, RGDP, TR	EKC exists	$Y_t \to C_t$ $CO_t \to C_t$ $Y_t \to CO_t$
34.	Baek and Kim, (2013)	Korea	1971–2007, 1978–2007	ARDL, PGC	CO_2, RGDP, E, EP	EKC exists	$Y_t \to C_t$ $E_t \to C_t$

Note: $Y_t \to E_t$, $E_t \to C_t$, $Y_t \to C_t$, $Y_t \to S_t$, $CO_t \to C_t$ and $Y_t \to CO_t$ indicate unidirectional causality running from economic growth to energy consumption, energy consumption to CO_2 emissions, economic growth to CO_2 emissions, economic growth to SO_2 emissions, coal consumption to CO_2 emissions and economic growth to coal consumption. T-Y GC, VDC, IRF, ARDL, PGC, VECM GC, DOLS, NLC and ECM is for Toda-Yamatoo Granger causality, variance decomposition, impulse response function, autoregressive distributive lag modeling, pair-wise Granger causality, vector error correction method Granger causality, dynamic ordinary least squares, non-linear cointegration and error correction model. CO_2 (SO_2) emissions per capita, energy consumption per capita, electricity production, energy prices, real GDP per capita, trade openness, urbanization, gross fixed capital formation, labor force and coal consumption is indicated by CO_2 (SO_2), E, EP, ENP, RGDP, TR, URB, GRFC, LB and CO.

The Table-1 presents the summary of all time series studies of single countries. We found that there is no even single country study while investigating the relationship between economic growth and CO_2 emissions using the framework of environmental Kuznets curve in case of UAE. This is a humble effort to fill the gap in exiting literature in the case of United Arab Emirates. The present study opens up new insights for policy making authorities to design comprehensive economic, energy and environmental policy to sustain long run economic growth while improving environmental quality.

III.I The Data and Empirical Modelling

The data on CO_2 emissions (metric tons), real GDP, energy consumption (kt of oil equivalent) and urban population has collected from world development indicators (CD-ROM, 2012). We have combed international financial statistics to obtain data on exports and converted it into real terms by dividing exports series on GDP deflator. The population series is used to convert all series into per capita. The study covers time period of 1975-2011[3]. Following Soytas et al. (2007); Jalil and Mamud, (2009); Halicioglu, (2009); Iwata et al. (2010); Esteve and Tamarit, (2012a, b); Shahbaz et al. (2013), the general form of our empirical equation is modeled as following:

$$C_t = f(Y_t, Y_t^2, E_t, U_t, X_t) \quad (1)$$

We have converted all the series into logarithm to obtain reliable and efficient empirical evidence. Shahbaz et al. (2012) pointed out that log-linear specification reduces sharpness in the time series data and provides better results controllable variance as compared to simple specification. The log-linear specification of our empirical equation is modeled as following:

$$\ln C_t = \beta_1 + \beta_Y \ln Y_t + \beta_{Y^2} \ln Y_t^2 + \beta_E \ln E_t + \beta_U \ln U_t + \beta_X \ln X_t + \mu_i \quad (2)$$

where $\ln C_t$, $\ln Y_t$, $\ln Y_t^2$, $\ln E_t$, $\ln U_t$ and $\ln X_t$ is natural log of CO_2 emissions (metric tons) per capita, natural log of real income per capita, natural log of squared of real income per

[3]We have used Eviews software to convert annual frequency data into quarter frequency using quadratic-match-sum method.

capita, energy consumption (kt of oil equivalent) per capita, urbanization per capita and real exports per capita. μ_i is error term with constant variance and zero mean and having normal distribution. We expect inverted U-shaped i.e. EKC hypothesis between economic growth and CO2 emissions if $\beta_Y > 0$ and $\beta_{Y^2} < 0$ otherwise U-shaped relationship exist. The $\beta_E < 0$ implies that efficient use of energy lowers CO_2 emissions otherwise energy consumption degrades environmental quality if $\beta_E > 0$. We can expect positive or negative impact of urbanization on CO_2 emissions. If urbanization is planned and urban population has easy access to energy efficient technology such as consumer durables for consumers and advanced technology for producers then $\beta_U < 0$ otherwise $\beta_E > 0$. The impact of exports on CO_2 emissions depends upon the technology to be implemented in an economy if an economy uses energy efficient technology then $\beta_X < 0$ otherwise an increase in exports will raise CO_2 emissions i.e. $\beta_x > 0$.

III.II Zivot-Andrews Unit Root Test

The usual first step in empirical analysis is to test the stationarity properties of the variables. Traditional unit root tests are ADF by Dickey and Fuller (1979), P-P by Philips and Perron (1988), KPSS by Kwiatkowski et al. (1992), DF-GLS by Elliott et al. (1996) and Ng-Perron by Ng-Perron (2001). However, as pointed by Baum, (2004), empirical evidence on order of integration of the variable by ADF, P-P and DF-GLS unit root tests are not reliable in the presence of structural break in the series. In fact, unit root tests may be biased and inappropriate in absence of information about structural break occurred in series.

To overcome this problem, Zivot-Andrews (1992) suggested three models to test the stationarity properties of the variables in the presence of structural break point in the series. (i) First model permits a one-time change in variables at level form, (ii) second model allows a one-time change in the slope of the trend component i.e. function and (iii) last model has one-time change both in intercept and trend function of the variables to be used in the analysis. Zivot-Andrews, (1992) adopted three models to check the hypothesis of one-time structural break in the series as follows:

$$\Delta x_t = a + ax_{t-1} + bt + cDU_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \quad (3)$$

$$\Delta x_t = b + bx_{t-1} + ct + bDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \quad (4)$$

$$\Delta x_t = c + cx_{t-1} + ct + dDU_t + dDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad (5)$$

where DU_t represents the dummy variables displaying mean shift occurred at each point with time break while trend shift variables is presented by DT_t[4]. So,

$$DU_t = \begin{cases} 1 \ldots if \quad t > TB \\ 0 \ldots if \quad t < TB \end{cases} \text{ and } DU_t = \begin{cases} t - TB \ldots if \ t > TB \\ 0 \ldots if \ t < TB \end{cases}$$

The null hypothesis of unit root break date is $c = 0$ which indicates that series is not stationary with a drift not having information about structural break point while $c < 0$ hypothesis implies that the variable is found to be trend-stationary with one unknown time break. Zivot-Andrews unit root test fixes all points as potential for possible time break and does estimation through

[4]We used model-4 for empirical estimations following Sen, (2003)

regression for all possible break points successively. After that, this unit root test selects that time break which decreases one-sided t-statistic to test $\hat{c}(=c-1)=1$. Zivot-Andrews indicate that in the presence of end-points, asymptotic distribution of the statistics is diverged to infinity point. It is compulsory to choose a region where end-points of sample period are excluded. To do so, we followed Zivot-Andrews suggestions by choosing the trimming regions i.e. (0.15T, 0.85T).

III.II The ARDL Bounds Testing

We employ the autoregressive distributed lag (ARDL) bounds testing approach to cointegration developed by Pesaran et al. (2001) to explore the existence of long run relationship between economic growth, electricity consumption, urbanization, exports and CO_2 emissions in the presence of structural break. This approach has multiple econometric advantages. The bounds testing approach is applicable irrespective of whether variables are I(0) or I(1). Moreover, a dynamic unrestricted error correction model (UECM) can be derived from the ARDL bounds testing through a simple linear transformation. The UECM integrates the short run dynamics with the long run equilibrium without losing any long run information. The UECM is expressed as follows:

$$\begin{aligned}\Delta \ln C_t &= \alpha_1 + \alpha_T T + \alpha_C \ln C_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_E \ln E_{t-1} + \alpha_X \ln X_{t-1} + \alpha_U \ln U_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta \ln C_{t-i} \\ &+ \sum_{j=0}^{q} \alpha_j \Delta \ln Y_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \alpha_l \Delta \ln X_{t-l} + \sum_{m=0}^{t} \alpha_m \Delta \ln U_{t-m} + \alpha_D D_1 + \mu_t \end{aligned} \quad (6)$$

$$\Delta \ln Y_t = \alpha_1 + \alpha_T T + \alpha_C \ln C_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_E \ln E_{t-1} + \alpha_X \ln X_{t-1} + \alpha_U \ln U_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \ln Y_{t-i} + \sum_{j=0}^{q} \beta_j \Delta \ln C_{t-j} + \sum_{k=0}^{r} \beta_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \beta_l \Delta \ln X_{t-l} + \sum_{m=0}^{t} \beta_m \Delta \ln U_{t-m} + \beta_D D_2 \mu_t \quad (7)$$

$$\Delta \ln E_t = \alpha_1 + \alpha_T T + \alpha_C \ln C_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_E \ln E_{t-1} + \alpha_X \ln X_{t-1} + \alpha_U \ln U_{t-1} + \sum_{i=1}^{p} \vartheta_i \Delta \ln E_{t-i} + \sum_{j=0}^{q} \vartheta_j \Delta \ln Y_{t-j} + \sum_{k=0}^{r} \vartheta_k \Delta \ln C_{t-k} + \sum_{l=0}^{s} \vartheta_l \Delta \ln X_{t-l} + \sum_{m=0}^{t} \vartheta_m \Delta \ln U_{t-m} + \vartheta_D D_3 + \mu_t \quad (8)$$

$$\Delta \ln X_t = \alpha_1 + \alpha_T T + \alpha_C \ln C_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_E \ln E_{t-1} + \alpha_X \ln X_{t-1} + \alpha_U \ln U_{t-1} + \sum_{i=1}^{p} \rho_i \Delta \ln X_{t-i} + \sum_{j=0}^{q} \rho_j \Delta \ln C_{t-j} + \sum_{k=0}^{r} \rho_k \Delta \ln Y_{t-k} + \sum_{l=0}^{s} \rho_l \Delta \ln E_{t-l} + \sum_{m=0}^{t} \rho_m \Delta \ln U_{t-m} + \vartheta_D D_4 + \mu_t \quad (9)$$

$$\Delta \ln U_t = \alpha_1 + \alpha_T T + \alpha_C \ln C_{t-1} + \alpha_Y \ln Y_{t-1} + \alpha_E \ln E_{t-1} + \alpha_X \ln X_{t-1} + \alpha_U \ln U_{t-1} + \sum_{i=1}^{p} \rho_i \Delta \ln U_{t-i} + \sum_{j=0}^{q} \rho_j \Delta \ln C_{t-j} + \sum_{k=0}^{r} \rho_k \Delta \ln Y_{t-k} + \sum_{l=0}^{s} \rho_l \Delta \ln E_{t-l} + \sum_{m=0}^{t} \rho_m \Delta \ln X_{t-m} + \vartheta_D D_5 + \mu_t \quad (10)$$

where Δ is the first difference operator, D is dummy for structural break point based on Z-A test and μ_t is error term assumed to be independently and identically distributed. The optimal lag structure of the first differenced regression is selected by the Akaike information criteria (AIC). Pesaran et al. (2001) suggest F-test for joint significance of the coefficients of the lagged level of variables. For example, the null hypothesis of no long run relationship between the variables is $H_0 : \alpha_C = \alpha_Y = \alpha_E = \alpha_X = \alpha_U = 0$ against the alternative hypothesis of cointegration $H_a : \alpha_C \neq \alpha_Y \neq \alpha_E \neq \alpha_X \neq \alpha_U \neq 0$. Pesaran et al. (2001) computed two set of critical value (lower and upper critical bounds) for a given significance level. Lower critical bound is applied if the regressors are I(0) and the upper critical bound is used for I(1). If the F-statistic exceeds the upper critical value, we conclude in favor of a long run relationship. If the F-statistic falls below the lower critical bound, we cannot reject the null hypothesis of no cointegration. However, if the F-statistic lies between the lower and upper critical bounds, inference would be inconclusive. When the order of integration of all the series is known to be I(1) then decision is made based on the upper critical bound. Similarly, if all the series are I(0), then the decision is made based on the lower critical bound. To check the robustness of the ARDL model, we apply diagnostic tests. The diagnostics tests are checking for normality of error term, serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity and the functional form of empirical model.

III.III The VECM Granger Causality

After examining the long run relationship between the variables, we use the Granger causality test to determine the causality between the variables. If there is cointegration between the series then the vector error correction method (VECM) can be developed as follows:

$$\begin{bmatrix}\Delta\ln C_t\\ \Delta\ln Y_t\\ \Delta\ln E_t\\ \Delta\ln X_t\\ \Delta\ln U_t\end{bmatrix}=\begin{bmatrix}b_1\\ b_2\\ b_3\\ b_4\end{bmatrix}+\begin{bmatrix}B_{11,1}\ B_{12,1}\ B_{13,1}\ B_{14,1}\ B_{15,1}\\ B_{21,1}\ B_{22,1}\ B_{23,1}\ B_{24,1}\ B_{25,1}\\ B_{31,1}\ B_{32,1}\ B_{33,1}\ B_{34,1}\ B_{35,1}\\ B_{41,1}\ B_{42,1}\ B_{43,1}\ B_{44,1}\ B_{45,1}\\ B_{41,1}\ B_{42,1}\ B_{43,1}\ B_{44,1}\ B_{45,1}\end{bmatrix}\times\begin{bmatrix}\Delta\ln C_{t-1}\\ \Delta\ln Y_{t-1}\\ \Delta\ln E_{t-1}\\ \Delta\ln X_{t-1}\\ \Delta\ln U_{t-1}\end{bmatrix}+\ldots+\begin{bmatrix}B_{11,m}\ B_{12,m}\ B_{13,m}\ B_{14,m}\ B_{15,m}\\ B_{21,m}\ B_{22,m}\ B_{23,m}\ B_{24,m}\ B_{25,m}\\ B_{31,m}\ B_{32,m}\ B_{33,m}\ B_{34,m}\ B_{35,m}\\ B_{41,m}\ B_{42,m}\ B_{43,m}\ B_{44,m}\ B_{45,m}\\ B_{51,m}\ B_{52,m}\ B_{53,m}\ B_{54,m}\ B_{55,m}\end{bmatrix} \quad (11)$$

$$\times\begin{bmatrix}\Delta\ln C_{t-1}\\ \Delta\ln Y_{t-1}\\ \Delta\ln E_{t-1}\\ \Delta\ln X_{t-1}\\ \Delta\ln U_{t-1}\end{bmatrix}+\begin{bmatrix}\zeta_1\\ \zeta_3\\ \zeta_3\\ \zeta_4\\ \zeta_5\end{bmatrix}\times(ECM_{t-1})+\begin{bmatrix}\mu_{1t}\\ \mu_{2t}\\ \mu_{3t}\\ \mu_{4t}\\ \mu_{5t}\end{bmatrix}$$

where difference operator is Δ and ECM_{t-1} is the lagged error correction term, generated from the long run association. The long run causality is found by significance of coefficient of lagged error correction term using t-test statistic. The existence of a significant relationship in first differences of the variables provides evidence on the direction of short run causality. The joint χ^2 statistic for the first differenced lagged independent variables is used to test the direction of short-run causality between the variables. For example, $B_{12,i} \neq 0 \forall_i$ shows that economic growth Granger causes CO_2 emissions and economic growth is Granger of cause of CO_2 emissions if $B_{11,i} \neq 0 \forall_i$.

IV. Results Interpretations

We find descriptive statistics and pair-wise correlations between the variables (see Table-2). The results reveal that CO_2 emissions, economic growth, electricity consumption, urbanization and exports are found to be normally distributed. The statistics by Jarque-Bera indicate that all the series are having zero mean and finite covariance. The findings of pair-wise correlation show that economic growth and urbanization are positively correlated with CO_2 emissions while negative correlation is found from electricity consumption and exports to CO_2 emissions. The positive correlation exists from electricity consumption and exports to economic growth. Urbanization is inversely correlated with economic growth. Exports and urbanization are positively linked with electricity consumption and same inference is drawn between urbanization and exports.

Table-2: Descriptive Statistics and Correlation Matrix

Variable	$\ln C_t$	$\ln Y_t$	$\ln E_t$	$\ln U_t$	$\ln X_t$
Mean	3.4406	12.3273	9.0609	4.3876	8.3744
Median	3.4293	12.2620	9.1399	4.3826	8.3115
Maximum	4.1511	12.8449	9.5342	4.4355	9.2260
Minimum	2.7692	11.5962	7.7773	4.3607	7.7646
Std. Dev.	0.2863	0.2919	0.4321	0.0201	0.3835
Skewness	0.3600	-0.0706	-1.3198	0.9095	0.5170
Kurtosis	4.1451	2.9880	4.3433	2.8811	2.4247
Jarque-Bera	2.8212	0.0309	3.5247	5.1229	2.1590
Probability	0.2439	0.9846	0.1100	0.0771	0.3397
$\ln C_t$	1.0000				
$\ln Y_t$	0.6726	1.0000			
$\ln E_t$	-0.7574	0.7267	1.0000		
$\ln U_t$	0.2205	-0.4709	0.3299	1.0000	
$\ln X_t$	-0.3975	0.4582	0.4584	0.0812	1.0000

The assumption of the ARDL bounds testing is that the series should be integrated at I(0) or I(1) or I(0) / I(1). This implies that the none of variables is integrated at I(2). To resolve this issue, we have applied traditional unit root tests such as ADF, PP and DF-GLS[5]. Our empirical exercise finds that CO_2 emissions ($\ln C_t$), electricity consumption ($\ln E_t$), economic growth ($\ln Y_t$),

[5]Results are available upon request from authors

exports ($\ln X_t$) and urbanization ($\ln U_t$) are not found to be stationary at level with constant and trend. This shows that the variables are integrated at I(1). The main issue with these unit tests is that these tests do not seem to consider information about unknown structural beaks in the series. This implies that traditional unit root tests provide ambiguous results regarding integrating properties of the variables. The appropriate information about structural break would help policy makers in designing inclusive energy, economic, urban and trade policy to sustain environmental quality in long run. We have applied Zivot-Andrews unit root test which accommodates single unknown structural break in the variables.

Table-3: Zivot-Andrews Structural Break Unit Root Test

Variable	**At Level**		**At 1st Difference**	
	T-statistic	Time Break	T-statistic	Time Break
$\ln C_t$	-3.285 (2)	1999Q2	-9.170 (4)*	1997Q3
$\ln Y_t$	-2.551 (5)	2000Q2	-7.632 (2)*	1988Q2
$\ln E_t$	-4.503 (3)	1997Q4	-8.277 (0)*	1992Q2
$\ln U_t$	-4.962 (5)	1995Q3	-7.943 (0)*	1995Q2
$\ln X_t$	-4.384 (4)	1982Q1	-8.359 (0)*	1980Q3

Note: * represent significant at 1% level of significance. The critical value at1% is -5.57 and at 5% is -5.08. Lag order is shown in parenthesis.

The results are detailed in Table-3. We find, while applying Zivot-Andrews, (1992) test with single unknown break, that economic growth, electricity consumption, exports, urbanization and CO_2 emissions have unit root at level with intercept and trend. The structural breaks are found in economic growth, electricity consumption, exports, urbanization and CO_2 emissions in 2000Q2, 1997Q4, 1982Q1, 1995Q3 and 1999Q2 respectively. The variables are found to be stationary at 1^{st} difference. This implies that series have same level of integration. The robustness of results is validated by applying Zivot-Andrews, (1992) with single unknown structural break. Our findings indicate that variables are integrated at I(1). The unique integrating order of the variables lends a support to test the existence of cointegration between the variables. In doing so, we apply the ARDL bounds testing approach in the presence of structural break to examine cointegration between the variables. The results are reported in Table-4. The lag order of the variable is chosen following Akaike information criterion (AIC) due to its superiority over Schwartz Bayesian criterion (SBC). AIC performs relatively well in small samples but is inconsistent and does not improve performance in large samples whilst SBC in contrast appears to perform relatively poorly in small samples but is consistent and improves in performance with sample size (Acquah, 2010).

The appropriate lag section is required because F-statistic variables with lag order of the variables. The lag order of the variables is given in second column of Table-4. The results reported in Table-4 reveal that our computed F-statistics are greater than upper critical bounds generated by Pesaran et al. (2001) which are suitable for small data set. We find three cointegrating vectors once CO_2 emissions, electricity consumption and exports are used as dependent actors. This validates that there is long run relationship between economic growth, electricity consumption, exports, urbanization and CO_2 emissions in case of UAE. The diagnostic tests such as autoregressive conditional heteroskedasticity (ARCH), white heteroskedasticity and functional form of the model are also applied. The results of diagnostic tests are reported in Table-4. We find that there is no evidence of autoregressive conditional heteroskedasticity. The results indicate that white heteroskedasticity does not exist. The functional form of long run model is well designed confirmed by Ramsey RESET test.

Table-4: The Results of ARDL Cointegration Test

	Bounds Testing to Cointegration			Diagnostic tests		
Estimated Models	Optimal lag length	Break Year	F-statistics	χ^2_{ARCH}	χ^2_{HETERO}	χ^2_{RESET}
$F_c(C_t / Y_t, E_t, U_t, X_t)$	6, 6, 6, 6, 6	1999Q2	6.157*	0.6412	1.8418	0.1901
$F_Y(Y_t / C_t, E_t, U_t, X_t)$	6, 6, 6, 5, 6	2000Q2	1.187	1.6731	1.3768	1.6938
$F_E(E_t / C_t, Y_t, U_t, X_t)$	6, 6, 6, 6, 6	1997Q4	5.954*	0.1034	[1.8625	0.9696
$F_U(U_t / C_t, Y_t, E_t, X_t)$	6, 5, 6, 4, 6	1995Q3	1.717	1.1042	0.6823	1.3154
$F_X(X_t / C_t, Y_t, E_t, U_t)$	6, 4, 5, 5, 4	1982Q1	3.929***	1.5974	0.7724	2.1754
Significant level	Critical values (T= 148)#					
	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 and 10 per cent levels, respectively. The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. # Critical values are collected from Pesaran et al. (2001).

The next step is to examine long run marginal impact of economic growth, electricity consumption, exports and urbanization on CO_2 emissions after fining long run relationship between them. The results detailed in Table-5 reveal that impact of linear and non-linear terms of real GDP capita on CO_2 emissions is positive and negative at 1 percent level of significance. This validates the existence of environmental Kuznets curve (EKC) in case of UAE. We find that a 19.81% increase in CO_2 emissions is due to 1% increase in real GDP and negative sign of squared term seems to corroborate the delinking of CO_2 emissions and real GDP at the higher level of income per capita. This reveals that CO_2 emissions increase at the initial stage of economic growth and decline once economy achieves mature level of per capita income. Nowadays, the success of a nation takes into account its contribution to the protection of the environment and natural resources and its efficiency for designing and implementing policies to improve the living standards of communities without environment degradation. In 2012, UAE government announced the launch of a long-term national initiative to build green economy in the UAE entitled “A green economy for sustainable development”. This initiative has three goals: (i) to make the UAE one of the global pioneers in green economy; (ii) a hub for exporting and re-exporting green products and technologies, and (iii) a country preserving a sustainable environment that supports long-term economic growth.

The impact of electricity consumption is negative on CO_2 emissions and statistically significant at 1% level of significant. We find that a 1% increase in electricity consumption declines CO_2 emissions by 0.5054%, keeping other things constant. This shows that UAE is using environmental friendly source of energy (electricity). The UAE has tried to decrease its dependency on natural gas and oil for producing electricity. As an alternative, it has encouraged sustainable development approach, which promotes the use of renewable resources that can produce pure “clean energy” that can satisfy electricity, cooling and heating demand. The UAE launched a strategic vision that fosters an investment-friendly ecosystem and innovative planning in the green economy, implementing a number of programs, projects and initiatives. One of the most ambitious projects is the creation of a multi-million-dollars solar-energy park managed by the Dubai Water and Electricity Authority (Dewa). Another example was the establishment of Masdar city in 2006. The City is accommodated for 40,000 residents, supplied with a fully integrated eco-friendly energy including solar panels and wind tower. The positive and statistically significant impact of urbanization on CO_2 emissions is found. The rising trend in urbanization has pressure for housing, public as well as individual transpiration, industrialization, health facilities raises demand for energy which in resulting; raises CO_2 emissions. All else is same, 0.7401% increase in CO_2 emissions is linked with 1% increase in urbanization. As explained above, massive construction projects to build up approximately from the scratch a well-developed infrastructure to become a global tourism destination have drastically increased the air pollution.

Table-5: Long Run Analysis

Dependent Variable = $\ln C_t$			
Variables	Coefficient	T-Statistic	Prob. Values
Constant	-36.6285*	-4.1980	0.0000
$\ln Y_t$	19.8155*	3.8213	0.0002

$\ln Y_t^2$	-0.7941*	-3.7557	0.0003
$\ln E_t$	-0.5054*	-7.1546	0.0000
$\ln U_t$	0.7401*	5.1537	0.0000
$\ln X_t$	-0.1739**	-2.5629	0.0114
R^2	0.6629		
$Ajd-R^2$	0.6510		
F-statistic	55.8497*		
Diagnostic Test			
Test	F-statistic	Probability	
$\chi^2 NORMAL$	0.8567	0.1833	
$\chi^2 ARCH$	0.9854	0.3102	
$\chi^2 WHITE$	2.5629	0.1661	
$\chi^2 REMSAY$	0.1801	0.6672	
Note: * and ** represent significance at 1% and 5% levels respectively. $\chi^2 NORMAL$ is for normality test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity, $\chi^2 WHITE$ for white heteroskedasticity and $\chi^2 REMSAY$ for Remsay Reset test.			

Our findings indicate that the relationship between exports and CO_2 emissions is negative and it is statistically significant at 5% level. A 1% increases in exports is linked with 0.1739% decline inCO_2 emissions. With the economic prosperity that UAE has witnessed, its demand for higher environmental quality has increased. Moreover, to become globally competitive, UAE started to invest massively in the most efficient technologies. Hence, the technique effect has a clear positive effect on environment quality in case of UAE. Further, Free (industrial) zones in UAE served by their own ports have reduced considerably the pollutant emissions caused by transport. We find that there is no evidence of non-normality of error term and same inference is drawn for autoregressive conditional heteroskedasticity. The results indicate that homoskedasticity exits and functional form of long run model is well designed confirmed by Ramsey RESET test. This shows that long run model has passed the assumption of classical linear regression model (CLRM).

The short run results are reported in Table-6. The results reveal that inverted U-shaped relationship is found between income per capita and CO_2 emissions. We find that linear and non-linear terms of real GDP per capita are positively and negatively linked with CO_2 emissions and it is statistically significant at 10 percent level. The impact of electricity consumption on CO_2 emissions is negative but statistically insignificant. The relationship between urbanization and electricity demand is also inverted U-shaped. Urbanization and exports have positive and negative impact on CO_2 emissions but it is statistically insignificant. The significant and negative coefficient of lagged ECM_{t-1} (-0.3814) confirms the established long run relationship between the variables. The term is significant at the 1% level, which suggests that short run deviations in electricity consumption are corrected by 38.14% every quarter towards the long run equilibrium and may take 10 years and 7 months to reach stable long run equilibrium path.

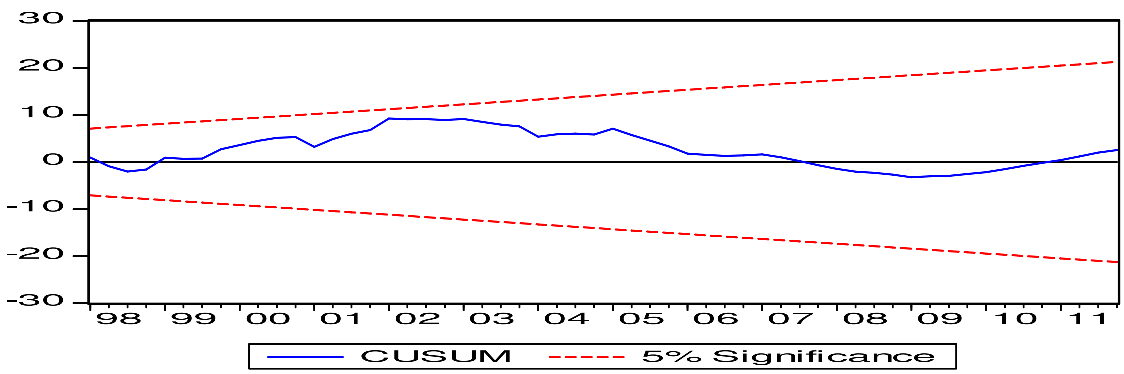
Table-6: Short Run Analysis

Dependent Variable = $\Delta \ln C_t$			
Variables	Coefficient	T-Statistic	Prob. Values
Constant	-0.0002	-0.1661	0.8683
$\Delta \ln C_{t-1}$	0.5802*	4.5020	0.0000
$\Delta \ln Y_t$	14.4969***	1.8796	0.0624
$\Delta \ln Y_t^2$	-0.5820***	-1.8968	0.0600
$\Delta \ln C_t$	-0.2012	-0.6196	0.5366
$\Delta \ln U_t$	4.8598	0.8093	0.4198
$\Delta \ln X_t$	-0.0102	-0.1075	0.9145
ECM_{t-1}	-0.1152*	-2.8729	0.0047
R^2	0.3814		
$Ajd - R^2$	0.3486		
F-statistic	11.6268*		
D.W Test	2.2163		
Diagnostic Test			
Test	F-statistic	Probability	
$\chi^2 NORMAL$	0.6098	0.6102	
$\chi^2 ARCH$	0.6545	0.4196	
$\chi^2 WHITE$	0.8083	0.6583	
$\chi^2 REMSAY$	0.1684	0.6821	

Note: * and*** represent significance at 1% and 10% levels. $\chi^2 NORMAL$ is for normality test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity, $\chi^2 WHITE$ for white heteroskedasticity and $\chi^2 REMSAY$ for Remsay Reset test.

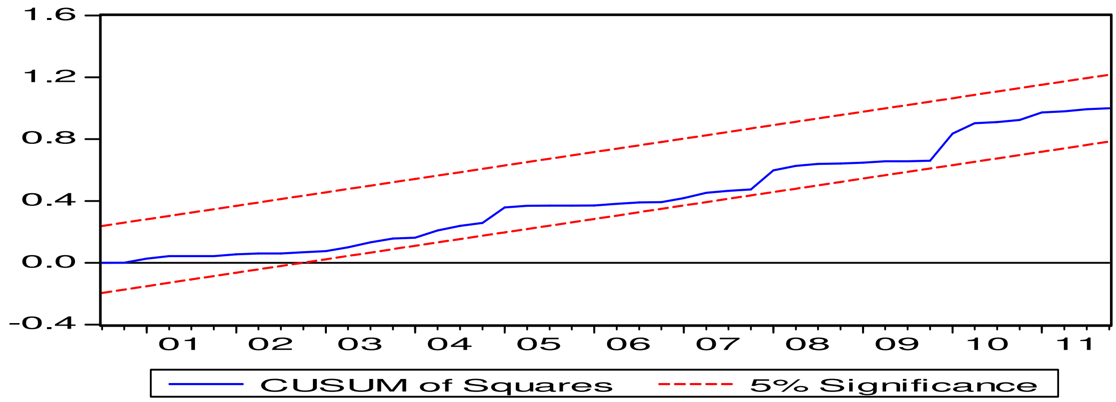
The lower segment of Table-6 deals with diagnostic tests. The results indicate that error term has normal distribution. There is no evidence of autoregressive conditional heteroskedasticity and same inference is drawn for white heteroskedasticity. The functional form of short run model is well constructed confirmed by Ramsey Reset test statistic. The results of stability tests such as CUSUM and CUSUMsq are shown in Figure 1 and 2. The results of CUSUM and CUSUMsq tests indicate the stability of the ARDL parameters because both diagrams are within critical bounds at 5 percent level of significance.

Figure-1: Plot of cumulative sum of recursive



Note: The straight lines represent critical bounds at 5% significance level.

Figure-2: Plot of cumulative sum of squares of recursive residuals



Note: The straight lines represent critical bounds at 5% significance level.

The VECM Granger Causality Analysis

If cointegration is confirmed, there must be uni-or bidirectional causality between/ among the series. We examine this relation within the VECM framework. Such knowledge is helpful in crafting appropriate growth, energy and environmental policies for sustainable economic growth in case of UAE. Table-7 reports results on the direction of long and short run causality. In long run, we find the bidirectional causality between electricity consumption and CO_2 emissions. This is why the UAE government initiated many projects to produce a clean energy and reduce CO_2 emissions coming from electricity generation from pollutants process. The causality between exports and electricity consumption supports the existence of feedback effect. This implies that exports and electricity consumption and exports are complementary. This implies that exports raise electricity demand and in resulting supply of electricity enhance more domestic production and hence exports. It suggests in launching of energy exploration policies for sustainable energy in long run to enhance economic exports and hence economic growth. Exports and CO_2 emissions are Granger cause of each other. Economic growth Granger causes CO_2 emissions validating the existence of the EKC hypothesis. This suggests that UAE is growing at the cost of environment that's why reduction in CO_2 emissions means reduction in economic growth. The UAE government should adopt energy efficient technology while enhancing domestic production to sustain long run economic growth and environmental quality. Economic growth Granger causes electricity consumption and exports. Further, CO_2 emissions are Granger cause of urbanization.

Table-7: The VECM Granger Causality Analysis

Dependent Variable	Direction of Causality										
	Short Run					Long Run	Joint Long-and-Short Run Causality				
	$\Delta \ln C_{t-1}$	$\Delta \ln E_{t-1}$	$\Delta \ln Y_{t-1}$	$\Delta \ln U_{t-1}$	$\Delta \ln X_{t-1}$	ECT_{t-1}	$\Delta \ln C_{t-1}, ECT_{t-1}$	$\Delta \ln E_{t-1}, ECT_{t-1}$	$\Delta \ln Y_{t-1}, ECT_{t-1}$	$\Delta \ln U_{t-1}, ECT_{t-1}$	$\Delta \ln X_{t-1}, ECT_{t-1}$
$\Delta \ln C_t$	....	0.3191* [0.7273]	0.2145 [0.9921]	1.1109 [0.3325]	0.0349 [0.9657]	-0.1059* [-2.9286]	....	4.5449* [0.0052]	2.8697** [0.0168]	4.0899* [0.0082]	3.1548** [0.0271]
$\Delta \ln E_t$	0.5648 [0.5698]	....	4.5431* [0.0018]	0.1443 [0.8657]	1.6724 [0.1918]	-0.0117** [-2.1691]	2.8929** [0.0341]	....	3.9664* [0.0022]	2.7872*** [0.0688]	2.3324*** [0.0772]
$\Delta \ln Y_t$	0.1094 [0.8964]	5.7674* [0.0040]	....	0.2945 [0.7455]	4.1407* [0.0013]	....	....	....	....	....	....
$\Delta \ln U_t$	4.2663** [0.0160]	0.7427 [0.4778]	1.0985 [0.3601]	....	1.7496 [0.1773]	....	....	....	....	....	....
$\Delta \ln X_t$	0.0308 [0.9696]	0.6875 [0.5044]	2.3412*** [0.0765]	2.8764** [0.0552]	....	-0.0456* [-2.8771]	2.8089** [0.0421]	3.3625** [0.0208]	2.2121*** [0.0941]	3.7888** [0.0120]	....

Note: *, ** and *** show significance at 1%, 5% and 10% levels respectively.

In short run, we find unidirectional Granger causality running from electricity consumption to CO_2 emissions. The feedback effect is found between electricity consumption and economic growth. Exports and economic growth are Granger cause of each other. Urbanization Granger causes exports and CO_2 emissions Granger causes urbanization.

V. Conclusion and Future Research

This study investigates either environmental Kuznets curve (EKC) in case of United Arab Emirates over the period of 1975Q1-2011Q4. We have applied augmented version of CO_2 emissions function by incorporating urbanization and exports. The structural break unit root test (ZA) is applied to test the integrating properties of the variables. The ARDL bounds testing is used to examine long run relationship between the variables in the presence of structural breaks stemming in the series. The causal relationship between is investigated by applying the VECM Granger causality.

Our empirical evidence presents the support for long run relationship among the variables. We find that environmental Kuznets curve exists in case of UAE. Electricity consumption declines CO_2 emissions. Urbanization increases CO_2 emissions. Exports improve environmental quality by declining CO_2 emissions. The causality results reveal the bidirectional causality between electricity consumption and CO_2 emissions. The feedback effect is found between electricity consumption and exports and same is true for exports and CO_2 emissions. Economic growth Granger causes CO_2 emissions and CO_2 emissions is Granger cause of urbanization.

Electricity consumption has negative impact on CO_2 emissions. This suggests in adopting the more energy efficient technology which not only produces more clean energy but also lower CO_2 emissions. In this case, adoption of energy conservation policy can be used as tool to improve the environmental quality to enhance living standards. The feedback effect between economic growth and CO_2 emissions also indicates that UAE is growing at the cost of environment i.e. rise in economic growth impedes environmental quality. The adoption of more energy efficient can solve this issue. Urbanization increases CO_2 emissions (Urbanization Granger causes CO_2 emissions). This implies that urbanization should be planned otherwise urbanization impedes environmental. For this purpose, threshold level of urbanization must be known from where CO_2 emissions start to decline i.e. delinking point between urbanization and CO_2 emissions. In future, a study can be conducted to examine the impact of urbanization on CO_2 emissions in case of United Arab Emirates following Poumanyvong and Kaneko, (2010) because UAE has 84.398% urban population as share of total population. We can apply unit root test with single and two unknown structural breaks stemming in the series developed by Narayan and Popp, (2010) and newly development cointegration approach by Bayer and Hanck, (2012).

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