The Financial Development-Environmental Degradation Nexus in the United Arab Emirates: The Importance of Growth, Globalization and Structural Breaks

Shahbaz, Muhammad and Haouas, Ilham and Sohag, Kazi and Ozturk, Ilhan

Beijing Institute of Technology, Beijing, China, Abu Dhabi University, Abu Dhabi, Universiti Teknologi MARA, Malaysia, Cag University, Turkey

1 January 2020

The Financial Development-Environmental Degradation Nexus in the United Arab Emirates: The Importance of Growth, Globalization and Structural Breaks

Muhammad Shahbaz
Center for Energy and Environmental Policy Research
Beijing Institute of Technology, Beijing, China.

COMSATS University Islamabad, Lahore Campus, Pakistan
E-mail: muhdshahbaz77@gmail.com

Ilham Haouas*
College of Business
Abu Dhabi University P.O. Box 59911, Abu Dhabi, UAE
Phone: +971-2-5015658, Fax: +971-2-5860184
E-mail: ilham.haouas@adu.ac.ae

Kazi Sohag
Accounting Research Institute
Universiti Teknologi MARA, Malaysia
&
School of Commerce
University of Southern Queensland, Australia
Email: sohagkaziewu@gmail.com

Ilhan Ozturk
Faculty of Economics and Administrative Sciences,
Cag University, 33800, Mersin, Turkey.
Email: ilhanozturk@cag.edu.tr

Abstract: This article revisits the nexus between financial development and environmental degradation by incorporating economic growth, electricity consumption and economic globalization in the CO_2 emissions function for the period $1975Q_I$-$2014Q_{IV}$ in the United Arab Emirates. We apply structural break and cointegration tests to examine unit root and cointegration between the variables. Further, the article also uses the Toda-Yamamoto causality test to investigate the causal relationship between the variables and tests the linkages of the robustness of causality by following the innovative accounting approach. Our empirical analysis shows cointegration between the series. Financial development increases CO_2 emissions. Economic growth is positively linked with environmental degradation. Electricity consumption improves environmental quality. Economic globalization affects CO_2 emissions negatively. The relationship between financial development and CO_2 emissions is U-shaped and inverted N-shaped. Further, financial development leads to environmental degradation and environmental degradation in turn leads to financial development in the Granger sense.

Keywords: Financial development, environment, growth, electricity, globalization

I. Introduction

One of the significant uses of investigating environmental degradation is for informing development policy in the United Arab Emirates (UAE). The UAE Green Agenda 2015-2030 calls for more environmentally responsible social development that can be spearheaded by financial institutions; prior research has ignored the use of financial development among other factors. Our research is motivated by competing views and ignored factors such as the evolution of economic globalization and how it relates to financial development and, more broadly, its environmental impact.

First, CO_2 emissions are a negative externality of human induced economic activities. Though existing literature explicitly focuses on the role of economic growth in explaining carbon emissions, little is known about the nexus between financial development and carbon emissions and the role that financial development plays in this. Primarily, financial development augments foreign direct investment (FDI) which enhances economic growth. Hence, financial development indirectly increases carbon emissions through higher energy use (Frankel and Romer, 1999; Javed and Sharif, 2016; Zhang, 2011). Further, existing literature argues that financial development increases access to consumer loans which enables consumers to purchase energy intensive devices like automobiles, air-conditioners and other electronic appliances (Sadorsky, 2010). Therefore, FDI augments carbon emissions through increasing household energy consumption. Then the development of stock markets reduces financing costs, increases the sources of finance and optimizes the asset/liability structure which eventually enables an economy to launch several projects which foster energy use and carbon emissions (Dasgupta et al., 2001).

However, a number of studies do not agree with these arguments. For example, Tamazian et al., (2009) document that financial development assists listed companies in enhancing technological innovations and adopting advanced technologies for promoting energy efficiency; eventually, carbon intensity diminishes. These contrasting stands in literature motivated us to re-examine the financial development-environmental degradation nexus in the UAE.

Second, the force of globalization significantly elevates international trade and foreign direct investments. Existing literature argues that the force of globalization correlates with international organizations like IMF, WTO and the World Bank with poverty, crises, environmental regulations and climate change policies in any country (Leitão, 2014). For a few decades now, literature has been discussing the linkage between economic development and globalization rigorously (Dreher, 2006; Gurgul and Lach, 2014). Therefore, we incorporate the role of globalization in our study.

Worldwide, energy is largely responsible for environmental degradation; it accounted for 83 per cent of the total emissions in 2011. The relationship between economic growth and environmental quality was analysed for the first time by Kuznets (1955), and since then, the academic community has shown a growing interest in this area. The Environmental Kuznets Curve (EKC) hypothesis posits that the relationship between economic development and environmental quality takes the form of an inverted U-shape. Specifically, economic growth leads to environmental degradation; this is followed by degradation reducing after a certain level of per capita income is reached. Here, the main questions that arise are: How can rich oil-exporting countries act to reduce carbon emissions? and How does financial development impact the environment? This is also case in the United Arab Emirates, where massive investments in infrastructure have influenced the urbanization process. According to the United Nations (2014) urbanization in the UAE increased from 85 per cent in 1990 to 91 per cent in 2014.

This study re-investigates the relationship between economic development and environmental degradation by adding globalization to the CO_2 emissions function in the case of the United Arab Emirates; this factor has been neglected in existing studies. The Gulf Cooperation Council (GCC) countries have experienced rapid growth mainly due to their oil and gas reserves. Therefore, the use of these resources manifests in high per capita carbon emissions. In addition, the construction industry's pollutants have led to the deterioration of air and water quality. CO_2 emissions in the UAE increased from 60.809 million tons in 1990 to 94.163 million tons in 2002; these reached 199.65 million tons of carbon dioxide emissions and other greenhouse gases in 2013.[1] In 2006, the government launched Masdar, a sustainability initiative designed to implement renewable and alternative energy programmes. It had an investment of US$15 billion for creating infrastructure for solar, wind and hydrogen power, reducing carbon emissions, sustainability research and development and education and manufacturing.[2] In addition, the government also established collaborations with private institutions to implement

[1]Todorova, V. (2015). 'UAE released 200m tonnes of greenhouse gases in 2013', The National, UAE. January: http://www.thenational.ae/uae/environment/uae-released-200m-tonnes-of-greenhouse-gases-in-2013.
[2]Embassy of the UAE in Washington (2015). *Energy in the UAE*: http://www.uae-embassy.org/uae/energy/energy-and-climate-change.

green projects, set high standards for the efficiency of product imports (for example, housing) and set standards for fuel, cars and the reduction of power consumption in its own buildings to improve environmental quality.

The globalization component will help inform UAE's competitiveness, both in economic terms and with regard to environmental sustainability. We use our financial development index to study the relationship between globalization and the role of investments in limiting environmental degradation which is a result of economic growth. This broader relationship has not been studied in previous research and will hence help in drafting new policy measures.

This paper contributes to existing literature on energy economics in five ways. (i) It re-examines the relationship between financial development and CO_2 emissions by adding economic globalization as a potential determinant of economic growth, energy consumption and pollutant emissions. (ii) It generates a financial development index comprising three bank-based and two stock market-based financial indicators by using the principal component analysis. (iii) It applies structural break unit root and cointegration approaches to examine the integrating properties of the variables and the cointegration between them. (iv) It applies the Toda-Yamamoto approach to determine the causal relationship. (v) It determines the robustness of causality between financial development and CO_2 emissions by using the innovative accounting approach (IAA). We find the presence of cointegration between financial development and CO_2 emissions. Financial development is positively linked with CO_2 emissions but electricity consumption declines with CO_2 emissions. Economic growth increases CO_2 emissions but economic globalization condenses emissions. A U-shaped and N-shaped relationship exists between financial development and CO_2 emissions. Moreover, we note the feedback effect between financial development and CO_2 emissions.

The rest of the paper is organized as follows. Section 2 discusses existing literature on the relationship between financial development and CO_2 emissions and other determinants. Section 3 details our methodological framework. The results and our interpretations are discussed in Section 4. Section 5 gives the conclusion and policy options.

II. Literature Review

Existing academic literature shows mixed results depending on the methodology and the sample size used when investigating the relationship between financial development and CO_2 emissions. On the one hand, evidence suggests that financial development and economic growth are positively linked to environmental degradation, while on the other hand, a number of empirical papers show a negative connection between these variables. These studies are based on different criteria in sample selection and the characteristics of various groups.

Many scholars (*inter alia,* Copeland and Taylor, 2004; Dasgupta et al., 2002; Dinda, 2004) give clear evidence of an inverted U-shape as follows: pollution increases and subsequently decreases as incomes reach higher levels. Concerns about environmentally sustainable economic development (Anderson, 1992; Grove, 1992; Meadows et al., 1992) have been addressed through different policies, which are designed to meet the needs of various countries (Antle and Heidebrink, 1995; Grossman and Krueger, 1995; Selden and Song, 1994; Shafik, 1994). In some cases, plans of targeting higher economic growth are threatened by the adoption of economic policies that negatively affect long-term environmental sustainability. It is difficult to achieve a balance between resource use, economic engagement and the quality of the environment. If energy resources and activities provide economic advantages in the short-run, their effects in the long-run will be negative (Kolstad and Krautkraemer,1993).

Various scholars (for example, Claessens and Feijen, 2007; Grossman and Krueger, 1995; Halicioglu, 2009; Tamazian et al. 2009) have highlighted the impact of financial development on environmental degradation explaining that new financial resources and practices could be connected to environmental projects that aim to lower costs and improve the overall quality of their surroundings. Moreover, funding opportunities can lead to collaborations between governments and other institutions with high potential for engagement in environmental protection projects (Tamazian and Rao, 2010). Sadorsky (2010) and Zhang (2011) conclude that financial development generates higher CO_2 emissions. For example, improvements in the stock market can help public companies reduce their financing costs, enlarge the financing channels, share operational risks and find a balance between assets and liabilities; they may acquire new installations and allocate resources for the implementation of new projects ultimately increasing both energy consumption and carbon emissions.

Foreign direct investment (FDI) generates economic growth along with new carbon emissions. In addition, financial intermediation allows the purchase of *dangerous* items (like cars, houses, air conditioners and washing machines) in terms of their higher carbon dioxide emissions (Zhang, 2011). Using a sample of 24 countries for the period 1993-2004, Tamazian and Rao (2010) show that economic development decreases environmental degradation. In addition, financial expansion positively impacted the environmental disclosure of the selected economies; specifically, an increase in FDI generated a lower level of CO_2 emissions. Jalil and Feridun (2011) explored the relationship between financial development and CO_2 emissions for the Chinese economy. Their findings support previous conclusions and note that financial development lowered environmental pollution. Investigating the sub-Saharan African countries, Al-Mulali and Sab (2012) demonstrated the significant role of energy consumption in economic growth and financial development. Their findings show a positive link between financial development and CO_2 emissions. The policies that need to be implemented consist of energy saving projects and new investments in the region for achieving higher energy efficiency.

A broader geographical coverage is important as Omri (2013) highlights the bidirectional causal linkage between energy consumption and economic growth in 14 MENA countries during 1990-2011. The MENA region is considered to be the second most polluted in the world with the highest level of CO_2 emissions. Omri used the Cobb-Douglas production function by rejecting the neo-classical assumption that economic growth is not impacted by energy. His results show that energy is a major driver of GDP growth and that greater economic expansion determines new energy demand and vice versa. However, new production levels lead to increased pollution. His findings also show bidirectional causality between CO_2 emissions and economic growth and the inter-relation between economic growth, trade openness and financial development.

Jammazi and Aloui (2015) examined the relationship between energy, growth and emissions in the GCC region. They found bidirectional causality between CO_2 emissions and economic growth/energy consumption in Saudi Arabia, Oman, Bahrain, the UAE and Qatar. Ozturk and Acaravci (2013) reported that financial development had an insignificant effect on CO_2 emissions but that the EKC hypothesis was valid over the period 1960-2007 in Turkey. Using a sample of 129 countries, Al-Mulali et al., (2015) emphasize the determining factors affecting pollution. They found that urbanization, economic growth and petroleum consumption had positive effects on CO_2 emissions in high-income countries in the long run. Their analysis indicated that financial development reduced environmental degradation.

In the case of the UAE, Charfeddine and Khediri (2015) examined the relationship between financial development and CO_2 emissions and found that financial development reduced CO_2 emissions and that the causality ran from financial development to CO_2 emissions. They also reported an inverted U-shaped linkage between financial development and CO_2 emissions.

Recently, Javed and Sharif (2016) investigated the validation of EKC by incorporating financial development in the emissions function. They found that EKC was valid but that financial development increased CO_2 emissions.

III. Model Construction and Data Collection

The relationship between financial development and CO_2 emissions gained popularity following Tamazian et al.'s (2009) study. They examined the determinants of CO_2 emissions in BRIC countries including USA and Japan. They used economic growth, industrial development, research and development expenditure, stock market development, foreign direct investments, ratio of deposit money bank assets to GDP, capital account openness, financial liberalization, financial openness and energy imports as determining factors of CO_2 emissions. Tamaziana and Rao (2010), Jalil and Feridun (2011), Omri et al., (2015), Al-Mulali et al. (2015) and Shahbaz et al., (2015c) included institutional quality, trade, capital, urbanization, coal consumption and industrial development as factors contributing to CO_2 emissions. We may note that existing studies have ignored the role of globalization while investigating the finance-emissions nexus. Globalization influences CO_2 emissions via three distinct effects -income, scale and composition effects. The growth of gross national product generated by high foreign trade and investments determines new levels of pollution, *ceteris paribus,* the relationship is valid both ways. The scale effect of globalization on the environment includes changes driven by structural transformations dictated by foreign trade and investments. In addition, the composition effect states that pollution-intensive production increases overall pollution, and the causality is valid both ways. The technique effect of globalization refers to a lower level of pollution (per unit of output) generated by new technology/production methods implemented through foreign trade or FDI when the scale and structure of the economic outcome do not change. According to a decomposition analysis, liberalization of foreign trade and investments provides both advantages and disadvantages. Therefore, there is a dynamic interaction between their determinants and only an empirical analysis can capture the net environmental effects of globalization.

Following existing literature on the finance-emissions nexus, we design the general form of the CO_2 emissions function as:

$$C_t = f(F_t, E_t, Y_t, G_t) \quad (1)$$

Here C_t , F_t, Y_t, and G_t indicate carbon emissions, financial development, energy use, GDP and globalization respectively.

We transformed the series into a natural log-form for reliability and consistency of empirical results. This led us to formulate the empirical form of the general CO_2 emissions function into a linear transformation:

$$\ln C_t = \beta_1 + \beta_2 \ln F_t + \beta_3 \ln E_t + \beta_4 \ln Y_t + \beta_5 \ln G_t + \mu_i \quad (2)$$

where $\ln$, C_t, E_t, Y_t and G_t are natural-log, CO_2 emissions per capita, the financial development index, energy consumption per capita, real income per capita measure of economic growth and the economic globalization index. μ is an error term with the assumption of normal distribution.

We included the squared (non-linear) term of financial development to examine whether the relationship between financial development and CO_2 emissions is inverted U-shaped or U-shaped (Equation 3). The relationship between financial development and CO_2 emissions is inverted U-shaped if the estimates of the linear and non-linear terms have positive and negative signs respectively. This entails the presence of the environmental Kuznets curve, which indicates that financial development is initially allied with CO_2 emissions and improves environmental quality once the financial sector achieves a certain maturity level (threshold level of financial development), otherwise the relationship between financial development and CO_2 emissions is U-shaped.

$$\ln C_t = \alpha_1 + \alpha_2 \ln F_t + \alpha_3 \ln F_t^2 + \alpha_4 \ln E_t + \alpha_5 \ln Y_t + \alpha_6 \ln G_t + \mu_i \quad (3)$$

We inserted a cubic term of financial development in Equation 3 to examine the polygonal relationship between financial development and CO_2 emissions following Sengupta (1996) and De Bruyn and Heintz (1999).[3] The reason is that financial development will be allied positively with CO_2 emissions if future economic growth is stimulated by financial development as an economic tool for achieving sustainable economic development. Further, the transformation of

[3]The authors reported a N-shaped relationship between economic growth and CO_2 emissions.

an economy from 'drive to maturity' to 'age of high mass consumption' is also linked to an increase in CO_2 emissions as people demand more financial services at lower costs to obtain their luxurious necessities that in return increase CO_2 emissions. This is termed as the polygonal (N-shaped) relationship between financial development and CO_2 emissions. Following the argument mentioned earlier, the empirical equation of the relationship between financial development and CO_2 emissions is modelled as:

$$\ln C_t = \delta_1 + \delta_2 \ln F_t + \delta_3 \ln F_t^2 + \delta_4 \ln F_t^3 + \delta_5 \ln E_t + \delta_6 \ln Y_t + \delta_7 \ln G_t + \mu_i \qquad (4)$$

Financial development is environment-friendly if $\beta_2 < 0$, otherwise financial development deteriorates environmental quality by increasing CO_2 emissions. Electricity consumption is positively linked to CO_2 emissions if $\beta_3 < 0$, otherwise it increases CO_2 emissions. If $\beta_4 > 0$ then economic growth is accompanied by CO_2 emissions, otherwise economic growth improves environmental quality by lowering CO_2 emissions. Economic globalization improves environmental quality if the technique effect dominates the income effect by keeping the composite effect constant, that is, $\beta_5 < 0$, otherwise economic globalization deteriorates the environment $\beta_5 > 0$. The EKC effect exists between financial development and CO_2 emissions if $\alpha_2 > 0, \alpha_3 < 0$. This relation is termed as inverted U-shaped. This relationship between financial development and CO_2 emissions turns out to be U-shaped if $\alpha_2 < 0, \alpha_3 > 0$, that is, an invalidation of the EKC effect. The polygonal relationship between financial development and CO_2 emissions is N-shaped if $\delta_2 > 0,\ \delta_3 < 0,\ \delta_4 > 0$. Otherwise the relationship between the variables is inverted N-shaped if $\delta_2 < 0,\ \delta_3 > 0,\ \delta_4 < 0$.

Our study covers the period 1975-2014. We used data on CO_2 emissions (metric tons) as our dependent variable. Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid and gas fuels and gas flaring. We also take GDP's constant prices in the local currency and electricity consumption (kWh) from the World Bank's World Development Indicators. The economic globalization index was obtained from http://globalization.kof.ethz.ch/. The data on real domestic credit to the private sector, liquid liabilities, domestic credit provided by the financial sector, stock market capitalization of listed companies and total value of stocks traded is also collected from the World Development Indicators (CDD-ROM, 2015). The data was transformed into per unit values using total population, except for the economic globalization index.[4] Finally, we converted annual data into quarter frequency following Sbia et al., (2014) using the quadratic match-sum method.

III.I The Financial Development Index

To capture the complete picture of the financial sector's development, we followed Shahbaz et al., (2015) and generated an index of financial development for UAE. We used five indicators (three bank-based and two stock-market based) to generate a financial development index using PCA. The bank-based indicators are real domestic credit to the private sector, liquid liabilities and domestic credit provided by the financial sector; stock market capitalization of listed companies and total value of stocks traded are the stock market-based indicators. Charfeddine and Khediri (2015) used domestic credit to the private sector as a measure of financial development. This indicator of financial development captures the actual level of savings disbursed to the private sector, but is totally silent about the size of the financial sector and the stock market as well as about efficiency (Shahbaz et al., 2015). This weakens the reliability of Charfeddine and Khediri's (2015) empirical findings. To overcome this issue, we generated an index of financial development. The results are given in Table 1 (lower part). We find that the correlation between domestic credit provided by the financial sector and liquid liabilities (M_2) is positive and high. Please check. Stock market capitalization of listed companies and the total value of stocks traded are positively correlated with domestic credit to the private sector. A positive correlation exists between stock market capitalization of listed companies and the total value of stocks traded; between domestic credit provided by the financial sector and stock market capitalization of listed companies; and between domestic credit provided by the financial sector and total value of the stocks traded. The high correlation between the financial indicators led us to generate a financial development index using the Principal Component Analysis (PCA) to avoid the possibility of multi-collinearity. The empirical evidence is reported in Table 1 (middle section). The first principal component explains 50.08 per cent of the standard deviation, while

[4]We converted real domestic credit to the private sector, liquid liabilities, domestic credit provided by the financial sector, stock market capitalization of listed companies and the total value of stocks traded into per capita units before processing for generating the financial development index.

46.57 per cent of the standard deviation is explained by the second principal component. The standard deviation of each variable shown by the principal component is minimal compared to the first PCA. This suggests that we should use the first principal component analysis as the weight for generating the financial development index. The financial development index has fluctuations for the period of 1975-2005.

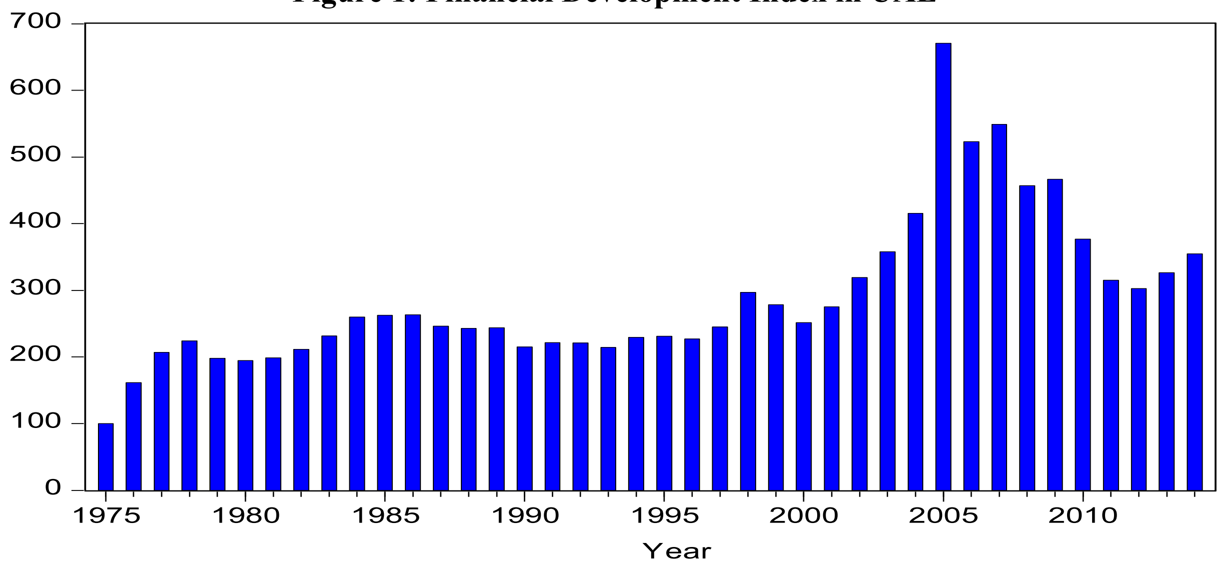
Table 1: Principal Component Analysis

Number	Value	Difference	Proportion	Cumu.Value	Cumu. Proportion
1	3.1046	1.9381	0.6209	3.1046	0.6209
2	1.1664	0.6455	0.2333	4.2710	0.8542
3	0.5209	0.3794	0.1042	4.7919	0.9584
4	0.1414	0.0748	0.0283	4.9333	0.9867
5	0.0666	---	0.0133	5.0000	1.0000
Eigenvectors or Factor Loadings					
Variable	PC 1	PC 2	PC 3	PC 4	PC 5
DC_t	0.5008	0.3636	-0.1284	-0.4973	-0.5942
M_t	0.4657	-0.1567	-0.7379	-0.0075	0.4624
DCB_t	0.3205	0.7287	0.1909	0.5228	0.2373
SM_t	0.4530	-0.5034	0.1130	0.5810	-0.4369
SP_t	0.4735	-0.2421	0.6242	-0.3764	0.4309
Pair-wise Ordinary Correlation					
Variables	DC_t	M_t	DCB_t	SM_t	SP_t
DC_t	1.0000				
M_2	0.6892	1.0000			
DCB_t	0.7486	0.2636	1.0000		
SM_t	0.4597	0.6895	0.0702	1.0000	
SP_t	0.6012	0.5027	0.3065	0.8015	1.0000

Note: DC_t, M_t, DCB_t, SM_t and SP_t refer to real domestic credit to the private sector, liquid liabilities (M_2), domestic credit provided by the financial sector, stock market capitalization of listed companies and the total value of stocks traded. All data is in per capita units.

The evolution of the financial development index in the UAE gives evidence that a resource-backed economy associated with a solid regulatory environment generated improvements in financial conditions and created valuable opportunities for development (World Economic Forum, 2012). UAE's financial expansion has been positively impacted by foreign direct investment inflows, especially in the Dubai region. In 2012, the volume of FDI rose by 26.5 per cent, reaching US$8 billion. In addition, the Government of Dubai implemented policies to encourage free trade through the division of 10 major free zones which currently host 19,000 firms. The major advantages include tax-free conditions, full foreign ownership and repatriation of capital and profits, easy entry in terms of administrative procedures and duty-free status. The government also supported the creation of start-ups and SMEs and the inflow of foreign skilled human capital by funding schemes that provide incentives for implementing innovative technologies with benefits in terms of competitiveness and new investments (Deloitte and DEC, 2014). Overall, the UAE government has allocated massive resources to the financial sector which are aimed at enhancing sustained economic growth. According to data released in November 2015, the federal government engaged in commercial loan guarantee schemes for projects financed by the Ministry of Finance with a strategic partnership with the UAE banking sector.[5]

Figure 1: Financial Development Index in UAE



III. Methodological Strategy

III.I. Zivot-Andrews Unit Root Test

A number of unit root tests are available in applied economics to test the stationarity properties of the variables: 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).

[5]UAE Interact (2015). 'Environment Minister Releases first Reports on State of Green Investment for Banks and Financial Institutions in UAE', November: http://www.uaeinteract.com/docs/Environment_Minister_releases_first_report_on_state_of_green_investment_for_bank_and_financial_institutions_in_UAE/72411.htm

These tests provide biased and spurious results as they lack information about structural break points occurring in the series. To address this, Zivot-Andrews (1992) developed three models to test the stationarity properties of the variables in the presence of a structural break point in the series: (i) this model allows a one-time change in the variables at level form, (ii) this model permits a one-time change in the slope of the trend component, that is, function, and (iii) this model has a one-time change in both the intercept and trend functions of the variables to be used for empirical purposes. Zivot-Andrews (1992) followed these three models to check the hypothesis of a one-time structural break in the series as:

$$\Delta x_t = a + a x_{t-1} + bt + cDU_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \tag{5}$$

$$\Delta x_t = b + b x_{t-1} + ct + bDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \tag{6}$$

$$\Delta x_t = c + c x_{t-1} + ct + dDU_t + dDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \tag{7}$$

where the dummy variable is indicated by DU_t showing that a mean shift occurred at each point with a time break, while the trend in shift variables is shown by DT_t. So:

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

The null hypothesis of the unit roots break date is $c = 0$, which indicates that the series is not stationary with a drift as it lacks information about the structural break point, while the $c < 0$ hypothesis implies that the variable is trend-stationary with one unknown time break. The Zivot-Andrews unit root test fixes all points as potential points for possible time breaks and does the estimation through a regression of all the possible break points successively. Then, this unit root test selects that time break which decreases the one-sided t-statistic to test $\hat{c}(=c-1)=1$. Zivot-Andrews intimate that in the presence of end points, asymptotic distribution of the statistics is diverged to infinity. It is necessary to choose a region where the end points of the sample period are excluded. Further, Zivot-Andrews suggest that the trimming regions, that is, (0.15T, 0.85T) be followed.

III.II The Gregory and Hansen Cointegration Test

We used the Gregory-Hansen (1996) cointegration test which accommodates structural breaks while investigating the cointegration relationship between the variables. This test is an augmentation of the univariate approach and is considered a multivariate extension. The null hypothesis of the G-H test is H_0: no cointegration accounting for a structural break. The G-H test is a two-step procedure. In the first step, we determine whether cointegration is subject to a structural break or not. This is accomplished by applying the instability (linearity) test developed by Hansen (1992). We used *Lc* tests to establish cointegration between financial development and CO_2 emissions. In the second step, we determine a structural break in the long-run equation endogenously and cointegration simultaneously. The modified versions of the ADF test by Engle-Granger (1987) and Z_t and Z_α by Phillips and Ouliaris (1990) are modelled as:

$$ADF^* = \inf_{T_b} ADF(T_b) \tag{8}$$

$$Z_t^* = \inf_{T_b} Z_t(T_b) \tag{9}$$

$$Z_\alpha^* = \inf_{T_b} Z_\alpha(T_b) \tag{10}$$

III.III. The Toda-Yamamato Non-Causality Test

Existing literature on applied economics uses the Granger (1969) causality test to check whether causality between variables is unidirectional, bidirectional or neutral. Gujrati (1995) notes that the Granger causality test provides spurious and ambiguous results due to a specification problem. This issue was solved by Toda-Yamamato (1995) who introduced a new causality approach. Their test provides reliable and efficient empirical results in the absence of cointegration in the VAR system. This approach does not require information about the variables' integrating properties. We used the Wald test to test the significance of VAR(p) parameters where p is the optimal lag length used by the system. If the statistics provided by the Wald test are statistically significant then we may reject the null hypothesis, that is, no causality, which confirms the presence of causality that is either unidirectional or bidirectional. Following

Toda-Yamamato (1995), we examined the causality relationship among the variables by applying VAR(p+d_{max}), where the maximum order of integration is denoted by d_{max}, and p is the optimal lag length. Further, Rambaldi and Doran (1996) suggest that the VAR process developed by Toda-Yamamato (1995) can be designed following the seemingly unrelated regression (SUR) system. In doing so and using five variables the VAR system can be built following the SUR form:

$$\begin{bmatrix} \ln C_t \\ \ln F_t \\ \ln E_t \\ \ln Y_t \\ \ln G_t \end{bmatrix} = \forall_0 + \forall_1 \begin{bmatrix} \ln C_{t-1} \\ \ln F_{t-1} \\ \ln E_{t-1} \\ \ln Y_{t-1} \\ \ln G_{t-1} \end{bmatrix} + \ldots + \forall_k \begin{bmatrix} \ln C_{t-k} \\ \ln F_{t-k} \\ \ln E_{t-k} \\ \ln Y_{t-k} \\ \ln G_{t-k} \end{bmatrix} + \forall_{k+1} \begin{bmatrix} \ln C_{t-k-1} \\ \ln F_{t-k-1} \\ \ln E_{t-k-1} \\ \ln Y_{t-k-1} \\ \ln G_{t-k-1} \end{bmatrix} + \ldots + \forall_{k+d} \begin{bmatrix} \ln C_{t-k-d} \\ \ln F_{t-k-d} \\ \ln E_{t-k-d} \\ \ln Y_{t-k-d} \\ \ln G_{t-k-d} \end{bmatrix} \quad (11)$$

Following Equation 11, we build the null hypothesis, for example, to examine the relationship between financial development and CO_2 emissions. If we want to test whether financial development causes CO_2 emissions then we follow the null hypothesis with chi-square statistics, that is, $H_0 : \ln F^{\forall_1} = \ln F^{\forall K} = \ln F^{\forall K+1} = \ln F^{\forall_{k+d}} = 0$. If the Wald test provides statistical significance, then we reject the null hypothesis and conclude that financial development leads to CO_2 emissions. The alternate hypothesis test provides an inverse causality direction: $H_0 : \ln C^{\forall_1} = \ln C^{\forall K} = \ln C^{\forall K+1} = \ln C^{\forall_{k+d}} = 0$, where $\forall_s$ are estimates of $\ln F$ and $\ln C$.

V. Empirical Results

Table 2 presents the descriptive statistics and correlation analysis. The results show that the standard deviation of financial development is higher than the standard deviation of economic growth and CO_2 emissions. The variation in globalization is lower than the variations in electricity consumption. The Jarque-Bera test statistics show that CO_2 emissions, financial development, electricity consumption, economic growth and economic globalization have normal distribution allied with constant variance. The correlation analysis shows a positive correlation between financial development and CO_2 emissions, but electricity consumption is inversely correlated with CO_2 emissions. A positive correlation exists between economic growth and CO_2 emissions. Economic globalization is negatively associated with CO_2 emissions. The correlation of electricity consumption, economic growth and economic globalization with financial development is positive. Economic growth (economic globalization) is positively (negatively) correlated with electricity consumption. The correlation between economic globalization and economic growth is negative.

Table 2: Descriptive Statistics and Correlations

Variables	$\ln C_t$	$\ln F_t$	$\ln E_t$	$\ln Y_t$	$\ln G_t$
Mean	3.3812	5.6045	9.1115	12.2659	4.3432
Median	3.4039	5.5173	9.2425	12.2548	4.3206
Maximum	4.1526	6.5085	9.4460	12.8457	4.4837
Minimum	2.7702	4.6051	8.1988	11.6138	4.2614
Std. Dev.	0.3326	0.3563	0.3119	0.3480	0.0743
Skewness	0.1497	0.2790	-1.1634	-0.2648	0.8345
Kurtosis	3.1119	3.9779	3.8831	2.5346	2.1807
Jarque-Bera	0.1704	2.1131	0.3242	0.8286	2.7621
Probability	0.9183	0.3476	0.8557	0.6607	0.2560
$\ln C_t$	1.0000				
$\ln F_t$	0.1634	1.0000			
$\ln E_t$	-0.0640	0.2143	1.0000		
$\ln Y_t$	0.0148	0.0129	0.2790	1.0000	
$\ln G_t$	-0.0090	0.0931	-0.2051	-0.0048	1.0000

Table 3 gives the results of the unit tests ADF and PP. The results show that CO_2 emissions, financial development, electricity consumption, economic growth and economic globalization are non-stationary at the levels confirmed by the ADF and PP tests. By considering the constant and trend all the variables are stationary at first difference. This posits that CO_2 emissions, financial development, electricity consumption, economic growth and economic globalization are integrated at I(1). ADF and PP unit root tests ignore the role of structural breaks in the series, which may be the reason for non-stationarity. This leads the ADF and PP tests to show misleading unit root empirical results.

The structural breaks are outcomes of economic policies implemented by the government to improve the performance of macroeconomic variables. We applied the ZA unit root test, which contains information about a single unknown structural break in the series. The results are reported in the lower part of Table 3. The ZA test finds that the variables contain unit root problems in the presence of structural breaks. These breaks are 1999Q1, 2004Q2, 1996Q2, 1998Q2 and 1988Q2 in the series on CO_2 emissions, financial development, electricity consumption, economic growth and economic globalization respectively. The ZA test results at first difference confirm the stationarity of the variables. This shows that the variables have a unique order of integration, I(1).

Table 3: Unit Root Analysis

Variable	ADF Unit Root Test		PP Unit Root Test	
	Level	1st Difference	Level	1st Difference
$\ln C_t$	-2.4679(2)	-5.1497(3)*	-2.8123(3)	-7.1838(3)*
$\ln F_t$	-2.1911(3)	-4.3575(4)*	-2.4757(3)	-6.4640(3)*
$\ln E_t$	-2.8558(2)	-6.2229(3)*	-2.0106(3)	-7.2324(3)*
$\ln Y_t$	-1.7889 (1)	-3.8258(2)**	-1.5141(3)	-5.5519(3)*
$\ln G_t$	-1.3393(4)	-3.8426 (3)**	-1.2477(3)	-6.1463(3)*
Variable	ZA Test at Level		ZA Test at 1st Difference	
	T-statistic	Break Year	T-statistic	Break Year
$\ln C_t$	-4.610 (2)	1999Q1	-9.497 (3)*	1997Q3
$\ln F_t$	-4.560 (1)	2004Q2	-8.573 (2)*	1980Q3
$\ln E_t$	-3.665 (3)	1996Q2	-9.555 (1)*	19983Q3
$\ln Y_t$	-3.427 (3)	1998Q2	-7.105 (1)*	2006Q2
$\ln G_t$	-3.357 (2)	1988Q2	-8.504 (2)	2002Q2

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

We investigated the long-run stability of the parameters by applying the Hansen (1992) instability test. The results are given in Table 4. We chose the lag length by applying the unrestricted VAR approach, following AIC due to its superior properties.[6] We note that at lags 0 and 1, the null hypothesis of parameter stability is accepted. After lags 1 to 6, probability values are significant, which leads us to reject the null hypothesis. This posits that long-run parameters are unstable. The next step is examining cointegration among CO_2 emissions, financial development, electricity consumption, economic growth and economic globalization by applying the Gregory-Hansen, (1996) cointegration test accommodating a structural regime shift. The G-H cointegration is an augmented version of the Engle-Granger (1987) and Phillips-Ouliaris (1990)

[6] AIC suggests that a maximum of lag 6 is suitable. The results are available on request from the authors.

tests. The empirical results reported in Table 5 show that the null hypothesis may be rejected at the 1 per cent level, as confirmed by the ADF (Engle-Granger, 1987) test statistics following a shift with constant, shift with trend and a regime shift. A similar outcome is reported by Z_a^* and Z_t^* (Phillips-Ouliaris, 1990) statistics. This leads us to conclude that CO_2 emissions, financial development, electricity consumption, economic growth and economic globalization are cointegrated for the long-run in the presence of structural breaks over the sampled period in the United Arab Emirates.

Table 4: The Hansen Instability Test

Optimal lags	$L_C - Statistic$	Prob.value
0	0.4948	0.2
1	0.6645	0.1681
2	1.0993**	0.0261
3	2.0218*	0.0100
4	4.9027*	0.0100
5	8.6061*	0.0100
6	10.4963*	0.0100

Note: * and ** shows significance at the 1% and 5% levels, that is, rejection of the hypothesis of stability of parameters. Constant and trend are used as deterministic regressors.

Table 5: The Gregory-Hansen Cointegration Test

Tests	Level Shift with Constant	Level Shift with Trend	Regime Shift
ADF	-5.587 [1999Q1]*	-5.991 [1999Q1]*	-7.233 [1999Q1]*
Z_a^*	-34.495 [1999Q1]*	-34.284 [1999Q1]*	-34.290 [1999Q1]*
Z_t^*	-4.469 [1999Q1]*	-4.661 [1999Q1]*	-4.993 [1999Q1]*

Note: * shows significance at the 1% level, that is, rejection of the hypothesis of stability of parameters. Constant and trend are used as deterministic regressors.

The long-run and short-run impacts of financial development, economic growth, electricity consumption and economic globalization follow next. Table 6 shows that in the long-run, financial development is positively but significantly (at the 1 per cent level) linked with CO_2 emissions, that is, financial development deteriorates environmental quality by increasing CO_2 emissions. Keeping other factors constant, a 1 per cent increase in financial development leads to an increase in CO_2 emissions by 0.4005 per cent. This empirical finding is similar to that of Zhang (2011) for China, Boutabba (2014) for India, Shahbaz et al., (2014a) for Bangladesh, Omri et al., (2015) for the MENA region, Al-Mulali et al., (2015) for European countries and Ali et al., (2015) for Pakistan; but it is contrary to Tamazian et al., (2009) for the BRIC countries, Tamazian and Rao (2010) for transitional economies, Jalil and Feridun (2011) for the Chinese economy, Shahbaz et al., (2013a,b) for South Africa and Indonesia and Salahuddin et al., (2015) for the GCC countries, who reported that financial development lowered CO_2 emissions via liberalizing policies to improve environmental quality. The association between economic growth and CO_2 emissions is positive and significant at the 1 per cent level. We note that a 0.31-0.34 per cent increase in CO_2 emissions is linked to a 1 per cent increase in economic growth if all else remains the same. This empirical finding is consistent with Shahbaz et al., (2014b) for the United Arab Emirates and Salahuddin et al., (2015) for the GCC countries. Electricity consumption affects CO_2 emissions negatively but significantly at the 1 per cent level. Keeping other factors constant, a 1 per cent increase in electricity consumption lowers CO_2 emissions by 0.91-0.95 per cent. These results are consistent with Shahbaz et al., (2014b) for the United Arab Emirates and Salahuddin et al., (2015) for the GCC countries. The relationship between economic globalization and CO_2 emissions is negative and significant at the 1 per cent level. This shows that economic globalization improves environmental quality via lowering CO_2 emissions. A 1 per cent increase in economic globalization is associated with a decline in CO_2 emissions of 0.54-0.56 per cent when other factors are constant. Shahbaz et al., (2015b) too reported that globalization lowered CO_2 emissions, as the technique effect dominated the scale effect by keeping the composite effect constant.

The impact of linear and non-linear (squared) terms of financial development on CO_2 emissions is negative and positive, and significant at the 1 per cent level. We note that a 1 per cent increase in financial development lowers CO_2 emissions by 0.42 per cent, while the positive sign of the non-linear term corroborates the delinking of CO_2 emissions and financial development at higher levels of credit disbursement. This confirms the presence of a U-shaped association between financial development and CO_2 emissions. This finding contradicts Charfeddine and Khediri's (2015) findings who noted that the relationship between financial development and CO_2 emissions was an inverted U-shaped, that is, financial development was accompanied by CO_2 emissions initially, which declined after a threshold level of financial development was reached. These results are consistent with Shahbaz et al., (2015a), who reported that financial development is accompanied by lower CO_2 emissions initially but that the financial sector increases CO_2 emissions at higher levels of financial development for the Portuguese economy.

Table 6: Long-run and Short-run Analysis

Dependent Variable = $\ln C_t$						
Long-run Results						
Variables	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	7.2725*	8.3870	7.8475*	7.787362	17.5369*	3.5617
$\ln F_t$	0.4005*	5.2686	-0.4207*	-5.5694	-21.5627**	-2.0446
$\ln F_t^2$	....	....	0.2872*	10.1172	15.8474**	2.0456
$\ln F_t^3$	....	....	....	....	-3.7767**	-2.0096
$\ln Y_t$	0.3257*	4.9441	0.3108*	4.6285	0.3401*	4.9965
$\ln E_t$	-0.9383*	-10.6688	-0.9137*	-10.0873	-0.9501*	-10.3832
$\ln G_t$	-0.5413*	-9.6602	-0.5417*	-9.6685	-0.5622*	-9.9671
D_{1999}	0.0702*	5.8568	0.0688*	5.7180	0.0614*	4.9254
R^2	0.7928		0.7944		0.7998	
$Ajd-R^2$	0.7860		0.7864		0.7905	
F-statistic	117.8605*		98.5835*		86.7552*	
Short-run Results						
Constant	-0.0016	-1.0210	-0.0017	-1.0477	-0.0020	-1.2357
$\Delta \ln F_t$	0.2772**	2.8760	-0.2659	0.5208	-0.4001	-0.7567
$\Delta \ln F_t^2$			0.2755	0.1074	1.6556	0.6004
$\Delta \ln F_t^3$					-8.1653	-1.3421
$\Delta \ln Y_t$	0.0553**	2.2640	0.0531**	2.2526	0.0602**	2.2871
$\Delta \ln E_t$	-0.2109**	-2.2372	-0.1885**	-2.1938	-0.2143**	-2.2392
$\Delta \ln G_t$	1.0931	0.9303	1.0769	.8882	0.4783	0.3710
D_{1999}	-0.0021	-0.8043	-0.0020	-0.7667	-0.0015	-0.5832
ECM_{t-1}	-0.1209*	-3.8578	-0.1222*	-3.8697	-0.1141*	-3.5594
R^2	0.1306		0.1320		0.1423	
$Ajd-R^2$	0.0963		0.0917		0.0965	
F-statistic	3.8079*		3.2811*		3.1113*	
Diagnostic Tests						
Test	F-statistic	Probability				
$\chi^2 SERIAL$	2.9500	0.2371	2.6790	0.2012	2.9781	0.2012
$\chi^2 ARCH$	2.3361	0.1323	2.0091	0.1123	2.0001	0.1210
$\chi^2 REMSAY$	1.3463	0.2427	1.4057	0.2246	1.3033	0.2467

Note: * and ** represent significance at the 1% and 5% levels respectively. $\chi^2 SERIAL$ is the LM serial correlation test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity and $\chi^2 REMSAY$ for the Remsay Reset test.

The short-run results in Table 6 show that financial development tends to increase CO_2 emissions significantly at the 5 per cent level. Economic growth is positively but significantly associated with environmental degradation. Electricity consumption improves environmental quality by curbing CO_2 emissions at the 5 per cent level of significance. Economic globalization increases CO_2 emissions insignificantly. The dummy variable has a negative but insignificant impact on CO_2 emissions. The impact of the linear and squared terms of financial development is U-shaped but insignificant. Similarly, the non-linear relationship between financial development and CO_2 emissions is an inverted N-shaped, that is, financial development is accompanied by a decline in CO_2 emissions, it then increases emissions and then lowers them again at a higher level of financial development, but this relationship is statistically insignificant. This implies that the initial development of a financial market reduces carbon emissions but further financial development fosters carbon emissions up to certain point which decrease again with the further development of the financial market. The coefficient of the lagged error correction (ECM_{t-1}) is -0.1209 (-0.1222, -0.1141), significant at the 5 per cent level. The statistically significant estimate of ECM_{t-1} shows the optimal speed of adjustment towards a long-run equilibrium path. Overall, the short-run is statistically significant at the 1 per cent level. The short-run model has no issues with serial correlation and autoregressive conditional heteroskedasticity. There is no specification problem in the short-run model.

We investigated the causal relationship between financial development and CO_2 emissions – including other determinants of CO_2 emissions – by employing the Toda-Yamamato non-causality test. The results presented in Table 7 show that financial development led to CO_2 emissions and CO2 emissions in turn led to cause financial development, that is, a feedback effect. This finding contradicts Charfeddine and Khediri's (2015) findings who documented that CO_2 emissions were both the cause and effect of financial development. Unidirectional causality exists, running from electricity consumption to CO_2 emissions. Charfeddine and Khediri (2015) reported a feedback effect between electricity consumption and CO_2 emissions. Financial development and electricity consumption are interdependent, that is, financial development leads to electricity consumption and electricity consumption leads to financial development. This confirms the existence of feedback between financial development and electricity consumption. Contrarily, Charfeddine and Khediri (2015) documented the unidirectional causal relationship running from financial development to electricity consumption. We found a bidirectional causal association between globalization and CO_2 emissions and draw a similar inference between globalization and electricity consumption. The feedback effect exists between economic growth and electricity consumption, revealing that electricity consumption leads economic growth and economic growth leads electricity consumption. This finding is not consistent with Charfeddine and Khediri (2015) who support the growth hypothesis, that is, economic growth leads to electricity consumption, but the same is not true from the opposite side.

Table 7: The Toda-Yamamato Non-Causality Analysis

Variable	$\ln C_t$	$\ln F_t$	$\ln E_t$	$\ln Y_t$	$\ln G_t$
$\ln C_t$	….	4.3858* [0.0005]	2.3302* [0.0369]	2.7265** [0.0256]	1.8759*** [0.0910]
$\ln F_t$	3.8803* [0.0051]	….	8.2737* [0.0000]	3.2763* [0.0033]	19.3355* [0.0000]
$\ln E_t$	1.4312 [0.1997]	2.8727* [0.0085]	….	4.3551* [0.0003]	2.9460* [0.0072]
$\ln Y_t$	1.3976 [0.2123]	7.5720* [0.0000]	4.9946* [0.0001]	….	5.2120* [0.0000]
$\ln G_t$	4.0105* [0.0006]	5.4661* [0.0000]	1.7696 [0.1002]	4.3484* [0.0003]	….

Table 8 gives the empirical results of the variance decomposition approach. We find that almost 50 per cent of the CO_2 emissions are attributed to innovative shocks. Innovative shocks in financial development explain 15 per cent of the CO_2 emissions. The contributions of economic growth and electricity consumption are minimal. Economic globalization contributes 26 per cent to CO_2 emissions; while innovative shocks in CO_2 emissions and economic growth contribute 14 per cent and 47 per cent to financial development respectively. Electricity consumption's contribution to financial development is almost 1 per cent while 27 per cent of the financial development comes from innovative shocks. CO_2 emissions and electricity consumption contribute 8 per cent and 1 per cent respectively to economic growth. The contributions of financial development and globalization to economic growth are significant at 30 per cent and 43 per cent respectively. When an innovative shock occurs in CO_2 emissions, financial development explains electricity consumption by 12 per cent while economic growth's contribution to electricity consumption is negligible. Innovative shocks stemming from economic globalization contribute significantly to economic growth (63 per cent). Financial development too makes a significant contribution to economic globalization while CO_2 emissions contribute 13 per cent to globalization. Economic growth and electricity consumption's role in globalization is minimal. Innovative shocks contribute a significant portion (67 per cent) to globalization.

On the basis of these empirical results, we conclude that financial development leads to CO_2 emissions, but the same is not true from the opposite side. Unidirectional causality runs from economic globalization to electricity consumption and CO_2 emissions. Economic growth is the reason for financial development and economic globalization. Financial development leads to economic globalization and economic globalization leads to financial development. We found a neutral effect between electricity consumption and CO_2 emissions; between economic growth and electricity consumption; between electricity consumption and financial development; and between financial development and economic growth. Therefore, controlling for more environmentally responsible economic growth in the short-run will help policymakers balance the negative impact of carbon emissions on the environment, especially over the long-run (see Table 8). Further, we also conclude that the use of financial investments can help in the development of more economical electricity consumption which leads economic growth to begin with.

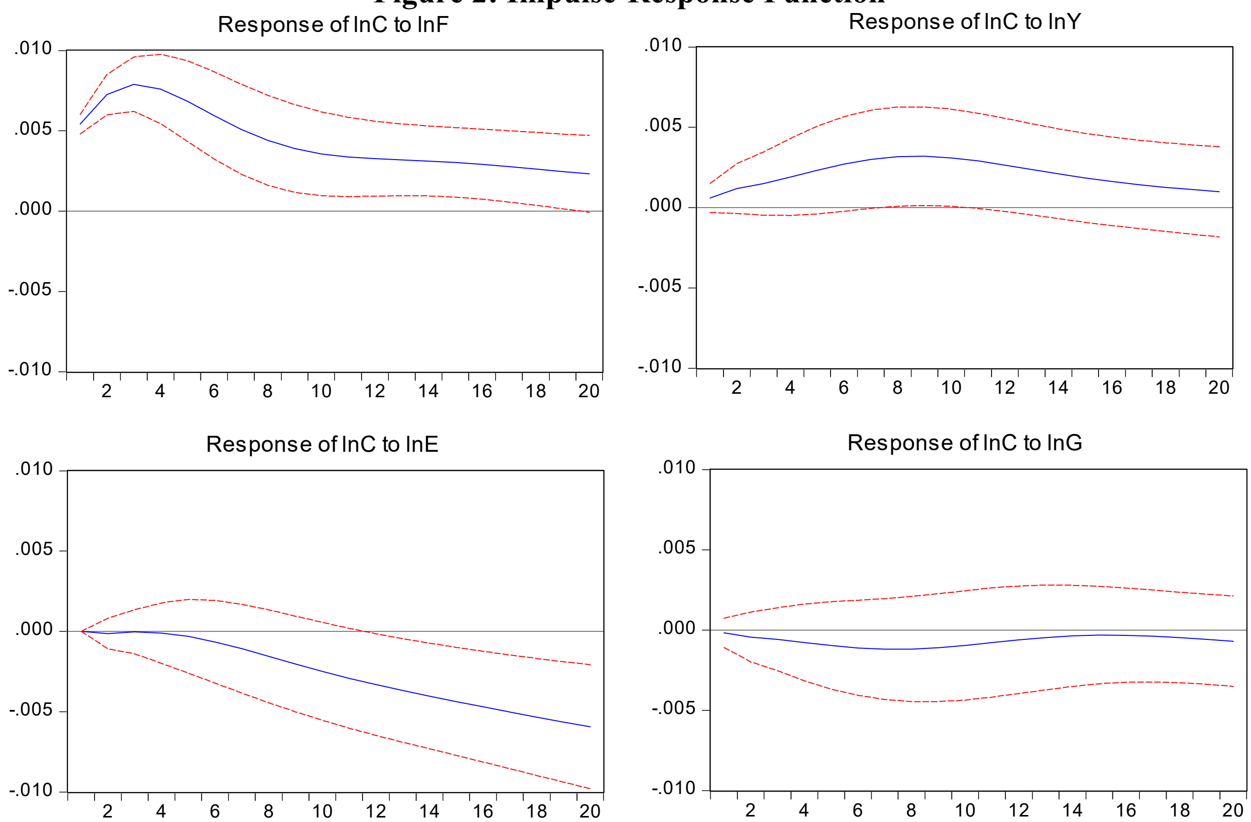
Table 8: The Variance Decomposition Analysis

Variance Decomposition of $\ln C_t$					
Period	$\ln C_t$	$\ln F_t$	$\ln Y_t$	$\ln E_t$	$\ln G_t$
1	100.0000	0.0000	0.0000	0.0000	0.0000
5	78.8491	5.2213	4.2037	8.9236	2.8022
10	64.9481	10.9305	4.4688	7.4033	12.2491
15	54.2857	13.4591	3.7175	5.9239	22.6135
16	52.9873	13.9136	3.6233	5.7322	23.7433
17	51.9088	14.3429	3.5432	5.5715	24.6334
18	51.0193	14.7411	3.4755	5.4385	25.3254
19	50.2911	15.1046	3.4188	5.3299	25.8554
20	49.6997	15.4319	3.3716	5.2426	26.2539
Variance Decomposition of $\ln F_t$					
Period	$\ln C_t$	$\ln F_t$	$\ln Y_t$	$\ln E_t$	$\ln G_t$
1	8.9538	91.0461	0.0000	0.0000	0.0000

5	8.9124	31.0640	10.5607	0.4913	48.9714
10	14.0873	27.0966	10.0216	0.5565	48.2377
15	14.0253	27.9717	9.8308	0.7550	47.4170
16	14.0023	27.9442	9.8193	0.8024	47.4315
17	13.9836	27.8863	9.8064	0.8448	47.4786
18	13.9692	27.8086	9.7909	0.8814	47.5497
19	13.9591	27.7194	9.7722	0.9122	47.6369
20	13.9531	27.6258	9.7505	0.9373	47.7331
Variance Decomposition of $\ln Y_t$					
Period	$\ln C_t$	$\ln F_t$	$\ln Y_t$	$\ln E_t$	$\ln G_t$
1	0.0017	19.0198	80.9784	0.0000	0.0000
5	1.5482	39.0169	51.9310	4.3410	3.1627
10	3.7727	32.1522	28.3212	2.5712	33.1824
15	7.2053	29.6367	19.0700	1.7380	42.3498
16	7.5482	29.6812	18.2161	1.6573	42.8970
17	7.8202	29.7828	17.5397	1.5937	43.2634
18	8.0353	29.9198	17.0038	1.5449	43.4961
19	8.2041	30.0774	16.5803	1.5085	43.6295
20	8.3351	30.2449	16.2470	1.4827	43.6901
Variance Decomposition of $\ln E_t$					
Period	$\ln C_t$	$\ln F_t$	$\ln Y_t$	$\ln E_t$	$\ln G_t$
1	0.8040	8.9284	1.9459	88.3214	0.0000
5	1.3005	4.7545	5.0425	54.9138	33.9885
10	8.5095	3.8337	4.0487	20.3848	63.2231
15	11.5375	8.2760	3.2697	12.4705	64.4461
16	11.8099	9.0876	3.1641	11.7161	64.2221
17	12.0264	9.8373	3.0726	11.1059	63.9575
18	12.1986	10.5240	2.9936	10.6122	63.6714
19	12.3351	11.1482	2.9254	10.2134	63.3777
20	12.4423	11.7115	2.8667	9.8928	63.0864
Variance Decomposition of $\ln G_t$					
Period	$\ln C_t$	$\ln F_t$	$\ln Y_t$	$\ln E_t$	$\ln G_t$
1	0.0922	1.9023	0.4343	0.0705	97.5005
5	7.5398	5.1309	1.3901	2.0406	83.8984
10	11.4051	11.8632	1.4107	1.5731	73.7476
15	12.5378	15.7337	1.3492	1.1761	69.2029
16	12.6458	16.3062	1.3317	1.1314	68.5846
17	12.7284	16.8209	1.3145	1.0968	68.0392
18	12.7902	17.2798	1.2982	1.0712	67.5603
19	12.8350	17.6852	1.2832	1.0537	67.1426
20	12.8662	18.0394	1.2699	1.0433	66.7809

The empirical evidence of the impulse-response function given in Figure 2 shows that CO_2 emissions respond positively to forecast errors that occur in financial development. Economic growth also positively contributes to CO_2 emissions. This shows that financial development and economic growth increase CO_2 emissions. These results are consistent with the long-and short-run results. The response of CO_2 emissions is negative as forecast errors stem negatively from electricity consumption and CO_2 emissions due to forecast errors stemming from economic globalization. This shows that electricity consumption and economic globalization improve environmental quality by lowering CO_2 emissions. These findings are also consistent with long- and short-run empirical analyses, which confirm the robustness of the empirical results.

Figure 2: Impulse-Response Function



V. Conclusion and Policy Implications

This paper did an empirical investigation of the financial development-CO_2 emissions nexus for the United Arab Emirates for the period $1975Q_I$-$2014Q_{IV}$. For empirical purposes, we applied structural break unit root and cointegration tests to examine stationarity and cointegration between the variables. We also used the Toda-Yamamato causality test to investigate the causal relationship between the variables and tested the robustness of causality linkages by applying the innovative accounting approach. Our research recommends the following policy steps that can inform the UAE Green Agenda towards 2030:

(1) Attracting investments for pollution and control mechanisms; (2) strengthening institutional control mechanisms in the short-run with investments in research that will increase energy efficiency as the economy grows via urbanization; (3) creating incentives for industries to adopt environmentally friendly technologies; and (4) encouraging trade openness as globalization will invite innovative ideas and technologies for environmentally sustainable development.

Our results show the presence of cointegration between financial development and CO_2 emissions and other determinants of CO_2 emissions. Additionally, economic growth increases CO_2 emissions and worsens environmental quality. Financial development is positively related to CO_2 emissions. Electricity consumption improves the environment by reducing CO_2 emissions. Globalization reduces CO_2 emissions and improves environmental quality. The causality results show a feedback effect between financial development and CO_2 emissions. A bidirectional causal relationship is noted between electricity consumption and economic growth; between electricity consumption and CO_2 emissions; and between economic growth and CO_2 emissions.

This suggests that the UAE should attract investments for pollution control mechanisms to limit the negative effects of CO_2 emissions. Financial development should continue, with a special focus on projects that include incentives for the amelioration of environmental degradation. In November 2015, the Emirates Green Development (EGD) Council organized a meeting to discuss the objectives of the EGD Strategy, which aims to support the creation of a low-carbon green economy and to prepare for an initial international meeting. The efforts of both the government and the private sector towards the adoption of policies and green investments can continue the development of the national economy and also improve its international competitiveness (UAE Interact, 2015)

Strengthening institutional infrastructure in the short-run will lead to positive outcomes in the long-run. Investments in research and development play a major role in promoting a healthier environment and a superior quality of life. In addition, new energy conservation policies will generate lower CO_2 emissions and the implementation of alternative sources of energy will help control pollution. The feedback effect between economic growth and environmental degradation shows that UAE has experienced high environmental costs. Increased energy efficiency may be the solution to this problem.

It is very important to set priorities in terms of both cost and investment efficiency and to create incentives for industries to adopt environment-friendly technologies. The government, banks and other institutions should engage in projects or activities that recognize the importance of environmental issues and embrace a code of good practices in this area. In UAE, the development of the bond and securities market could provide multiple opportunities for the implementation of clean energy-related technologies.

Trade openness and globalization should be encouraged in the light of new knowledge transfers. Green urbanization is a concept that can have a major effect on the reduction of carbon emissions, while clean intelligent transport systems and water-related technologies can ensure environmentally sustainable development.

Our findings imply that financial market development can play a positive role in designing environmental policy. If done right with a greater focus on the environmentally positive factors identified in this paper, an FD embodied government policy can reduce carbon intensity in the UAE.

References

Ali, S., Waqas, H. and Ahmad, N. (2015). Analyzing the dynamics of energy consumption, liberalization, financial development, poverty and carbon emissions in Pakistan. Journal of Applied Environment and Biological Sciences, 5, 66-183.

Al-Mulali, U., Ozturk, I. and Lean, H. H. (2015). The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. Natural Hazards, 79, 621-644.

Al-Mulali, U., Sab, C.N.B.C. (2012). The impact of energy consumption and CO2 emission on the economic growth and financial development in the Sub Saharan African countries. Energy, 39, 180–186.

Al-Mulali, U., Tang, C. F. and Ozturk, I. (2015). Does financial development reduce environmental degradation? Evidence from a panel study of 129 countries, 22, 14891-14900.

Anderson, D. (1992). Economic growth and the environment. World Bank Policy Research Working Paper, 979. The World Bank, Washington, DC.

Antle, J.M., Heidebrink, G. (1995). Environment and development: theory and international evidence. Economic Development and Cultural Changes, 43 (3), 603–625.

Barbier, E.B. (1997). Introduction to the environmental Kuznets curve special issue, environment and development. Economic growth and the environment: whose growth? Whose environment? World Development, 20 (4), 481–496.

Boutabba, M. A. (2014). The impact of financial development, income, energy and trade on carbon emissions: Evidence from the Indian economy. Economic Modeling, 40, 33–41.

Charfeddine, L., Khediri, K. B. (2015). Financial development and environmental quality in UAE: Cointegration with structural breaks. Renewable and Sustainable Energy Reviews, 55, 1322-1335.

Claessens, S., Feijen, E. (2007). Financial sector development and the millennium development goals, World Bank Working Paper No. 89. The World Bank.

Copeland, B., Taylor, M.S. (2004). Trade, growth and the environment. Journal of Economic Literature, 42 (1), 7–71.

Dasgupta, S., Laplante, B., Mamingi, N., (2001). Pollution and capital markets in developing countries. Journal of Environmental Economics and Management 42 (3), 310–335.

Dasgupta, S., Laplante, B., Wang, H. and Wheeler, D. (2002). Confronting the Environmental Kuznets Curve. The Journal of Economic Perspective, 16 (1), 147–168.

De Bruyn, S. M., Heintz, R. J. (1999). The environmental Kuznets curve hypothesis. Handbook of Environmental and resource economics. Cheltenham, UK, Edward Elgar, 656-677.

Deloitte and Dubai Economic Council (2014). Financial sector development for promoting investment and sustainable growth in Dubai. Report, March. http://www2.deloitte.com/content/dam/Deloitte/xe/Documents/finance/me_DEC_%20Report_23122014.pdf

Dickey, D., Fuller, W.A. (1979). Distribution of the estimates for autoregressive time series with unit root. Journal of the American Statistical Association, 74, 427-431.

Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. Ecological Economics, 49 (4), 431–455.

Dreher, A. (2006). Does globalization affect growth? Evidence from a new index of globalization. *Applied economics*, *38*(10), 1091-1110.

Elliot, G., Rothenberg, T.J. and Stock, J. H., (1996). Efficient tests for an autoregressive unit root. Econometrica, 64, 813-836.

Embassy of the UAE in Washington (2015). Energy in the UAE. http://www.uae-embassy.org/uae/energy/energy-and-climate-change.

Engle, R. F., Granger, C. W. J. (1987). Cointegration and error correction: representation, estimation and testing. Econometrica, 55, 251-276.

Frankel, Jeffrey A., and David H. Romer. "Does trade cause growth?." *American economic review* 89, no. 3 (1999): 379-399.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 37, 424-438.

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

Grossman, G., Krueger, A. (1995). Economic environment and the economic growth, Quarterly Journal of Economics 110, 353–377.

Grove, R.H. (1992). Origins of western environmentalism. Scientific American 267 (1), 42–47.

Gujrati, D. N. (1995). *Basic econometrics*. 3rd edition, McGraw-Hill Inc.

Gurgul, H., & Lach, Ł. (2014). Globalization and economic growth: Evidence from two decades of transition in CEE. *Economic Modelling*, *36*, 99-107.

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey, Energy Policy, 37 (3), 1156–1164.

Hansen, B. E. (1992). Tests for parameter instability in regression with I(1) process. Journal of Business and Economic Statistics, 10, 321-335.

Jalil, A., Feridun, M. (2011). The impact of growth, energy and financial development on the environment in China: A cointegration analysis. Energy Economics, 33, 284–291.

Jammazi, R., Aloui, C. (2015). On the interplay between energy consumption, economic growth and CO2 emission nexus in the GCC countries: A comparative analysis through wavelet approaches. Renewable and Sustainable Economy Reviews, 51, 1737-1751.

Javid, M, Sharif, F. (2016). Environmental Kuznets curve and financial development in Pakistan. Renewable and Sustainable Energy Reviews, 54, 406-414.

Javid, M., Sharif, F. (2016). Environmental Kuznets curve and financial development in Pakistan. Renewable and Sustainable Energy Reviews, 54, 406-414.

Kolstad, C. D., Krautkraemer, J. A. (1993). Natural resource use and the environment. In: Kneese, A.V., Sweeney, J.L. (Eds.), Handbook of Natural Resources and Energy Economics, vol. III. Elsevier Science Publishers, pp. 1219–1265.

Kuznets, S. (1955). Economic growth and income inequality. American Economic Review, 45, 1-28

Kwiatkowski D., Phillips P., Schmidt P. and Shin, Y. (1992). Testing the null hypothesis of stationary against the alternative of a unit root: how sure are we that economic time series have a unit root? Journal of Econometrics, 54, 159-178.

Leitão, N. C. (2014). Economic growth, carbon dioxide emissions, renewable energy and globalization. International Journal of Energy Economics and Policy, 4(3), 391-399.

Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W. (1992). The Limits to Growth. Universe Books, New York.

Ng, S., Perron, P. (2001). Lag length selection and the construction of unit root test with good size and power. Econometrica, 69, 1519-1554.

Omri, A. (2013). CO2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. Energy Economics, 40, 657–664.

Omri, A., Daly, S., Rault, C. and Chaibi, A. (2015). Financial development, environmental quality, trade and economic growth: What causes what in MENA countries. Energy Economics, 48, 242–252.

Ozturk, I., Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. Energy Economics, 36, 262-267.

Phillips, P. C. B. and Ouliaris, S. (1990). Asymptotic properties of residual based tests of cointegration. Econometrica, 58, 165-193.

Phillips, P.C.B., Perron, P. (1988). Testing for a unit root in time series regression. Biometrika, 75, 335-346.

Rambaldi, A. N., Doran, H. E. (1996). Testing for Granger non-causality in cointegrated systems made easy, *Working Papers in Econometrics and Applied Statistics*, Department of Econometrics, The University of New England, No.88, 22 pages.

Sadorsky, P. (2010). The impact of financial development on energy consumption in emerging economies, Energy Policy, 38, 2528-2535.

Salahuddin, M., Gow, J. and Ozturk, I. (2015). Is the long-run relationship between economic growth, electricity consumption, carbon dioxide emissions and financial development in Gulf Cooperation Council Countries robust? Renewable and Sustainable Energy Reviews, 51, 317-326.

Sbia, R., Shahbaz, M., Hamdi, H. and Ozturk, I. (2014). Economic growth, electricity consumption, urbanization and environmental degradation relationship in United Arab Emirates. Ecological Indicators 45, 622-631.

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

Sengupta, R. (1996). Economic development and CO_2 emission: Economy-Environment relationship and policy approach for the choice of emissions standard. Boston: Institute for Economic Development, Boston University.

Shafik, N.T. (1994). Economic development and environmental quality: an econometric analysis. Oxford Economic Papers 46, 757-773.

Shahbaz, M., Farhani, S. and Ozturk, I. (2015c). Do coal consumption and industrial development increase environmental degradation in China and India? Environ Science and Pollution Research 22, 3895-3907.

Shahbaz, M., Hye, M. Q. A., Tiwari, A. K. and Leitão, N.C. (2013b). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. Renewable and Sustainable Energy Reviews, 25, 109–121.

Shahbaz, M., Jam, F. A., Bibi, S. and Loganathan, N. (2015b). Multivariate granger causality between CO2 emissions, energy intensity and economic growth in Portugal: evidence from cointegration and causality analysis, Technological and Economic Development of Economy, DOI: 10.3846/20294913.2014.989932.

Shahbaz, M., Mallick, H., Mahalik, M. K. and Loganathan, M. N. (2015a). Does globalization impede environmental quality in India? Ecological Indicators 52, 379-393.

Shahbaz, M., Tiwari, A. K. and Nasir, M. (2013a). The effects of financial development, economic growth, coal consumption and trade openness on CO2 emissions in South Africa. Energy Policy 61, 1452-1459.

Shahbaz, M., Uddin, G. S., Rehman, I. and Imran, K. (2014). Industrialization, electricity consumption and CO2 emissions in Bangladesh. Renewable and Sustainable Energy Reviews, 31, 575–586.

Tamazian, A., Rao, B. B. (2010). Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. Energy Economics, 32, 137–145.

Tamazian, A., Chousa, J. P. and Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. Energy Policy, 37, 246–253.

The World Bank (2000). Is globalization causing a “race to the bottom” in environmental standard? PREM economic policy group and development Economics Group.

Toda, H. Y., Yamamatoo, T. (1995). Statistical inference in vector autoregression with possibly integrated process. Journal of Econometrics, 66, 225-250.

Todorova, V. (2015). UAE released 200m tonnes of greenhouse gases in 2013. The National, UAE. January: http://www.thenational.ae/uae/environment/uae-released-200m-tonnes-of-greenhouse-gases-in-2013.

UAE Interact (2015). Environment Minister Releases first Reports on State of Green Investment for Bank and Financial Institution in UAE. November: http://www.uaeinteract.com/docs/Environment_Minister_releases_first_report_on_state_of_green_investment_for_bank_and_financial_institutions_in_UAE/72411.htm.

United Nations (2014). World Urbanization Prospects.http://esa.un.org/unpd/wup/highlights/wup2014-highlights.pdf

World Economic Forum (2012). The Financial Development Report 2012. http://www3.weforum.org/docs/WEF_FinancialDevelopmentReport_2012.pdf

Zhang, Y.J. (2011). The impact of financial development on carbon emissions: An empirical analysis in China. Energy Policy, 39, 2197–2203.

Zivot, E., Andrews, D. (1992). Further evidence of great crash, the oil price shock and unit root hypothesis. Journal of Business and Economic Statistics, 10, 251-270.