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Interaction Between Environmental Kuznet Curve and Urban Environment Transition Hypotheses in Malaysia

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ABSTRACT

The aim of this paper is to examine the interconnection bewteen the environmental Kuznet curve (EKC) and urban environment transition hypotheses in the Malaysian economy. Economic growth, CO_2 emissions, energy consumption, financial development (FD), urbanization variables for the 1971-2013 period, F-bound tests, and multivariate Granger causality methods are used. The long-run relationships among the above series of variables are examined. Also, the findings confirm the existence of an inveretd EKC hypothesis in the Malaysian economy. Furthermore, the study implies that long-run urban sprawl can create environmental and health burdens in Malaysia. Moreover, the causality analysis finds bidirectional causality between CO_2 emissions and energy consumption, between economic growth and urbanization, and from economic growth to FD. The overall results suggest that a rapid urbanization process can help to reduce the level of pollution and energy consumption by employing technical innovation and ecological modernization. In addition, the increased energy efficiency, implementation of energy savings projects, energy conservation, and energy infrastructure outsourcing reduce the level of pollution produced by urban areas. Also, alternative biofuels can reduce the emission intensity and fulfill future energy needs.

Keywords: CO_2 Emissions, Energy Consumption, Economic Growth, Urbanization Environment Transition, Environmental Kuznet Curve, Malaysia
JEL Classifications: Q2, Q4

1. INTRODUCTION

Over the past two decades, many researchers have analyzed the relationships between energy consumption and macroeconomics variables. Numerous studies have examined the causal relationship between energy consumption and independent variables such as economic growth, financial development (FD), employment, and population (Bekhet and Othman, 2014 and 2011; Al-Mulali and Oztruk, 2015, 2016; Saidi and Hammami, 2015; Omri et al., 2015; Tang and Tan, 2015; Mahalik et al., 2017; Yue et al., 2019). A rapid pace of development is accompanied by a continuous rise in CO_2 emissions. Recently, the International Energy Agency (IEA) indicated that global CO_2 emissions from the energy sector had dropped in 2014 for first time during the last 40 years. The IEA suggested that this reduction in emissions was not tied to any economic downturn. Global emissions stood at 32.3 billion tonnes in 2014, unchanged from the preceding year. The study also attributed this decline in emissions to changing patterns of energy consumption in China and Organization for Economic Cooperation and Development (OECD) countries. In China in 2014, the greater generation of electricity was from renewable sources, such as hydropower, solar, and wind and less burning of coal. Furthermore, in OECD economies, recent efforts to promote more sustainable growth, including greater energy efficiency and more renewable energy, are producing the desired effect of decoupling economic growth from greenhouse gas emissions (International Energy Agency, 2015a).

As a result of today's globalization process, around 55% of the world's population lives in urban areas, although substantial variability in the levels of urbanization exists across countries. With rapid economic growth comes challenges related to expansion in the urban population, which is known as modernization. Figure 1 shows that in 2007, for the first time in history, the global urban population exceeded the rural population, and since then the world's population has remained predominantly urban (UN, Department of Economic and Social Affairs, Population Division, 2018). Indeed, the world has gone through a process of rapid urbanization over the past six decades. In 1950, more than two-thirds (70%) of people worldwide lived in rural settlements and less than one-third (30%) lived in urban settlements. In 2014, 54% of the world's population lived in urban areas. The urban population is expected to continue to grow, so that by 2050, the world will be one-third rural (34%) and two-thirds urban (66%) (Shahbaz et al., 2016; He et al., 2016; Bekhet and Othman, 2017). Urbanization is integrally connected to the three pillars of sustainable development: economic development, social development, and environmental protection.

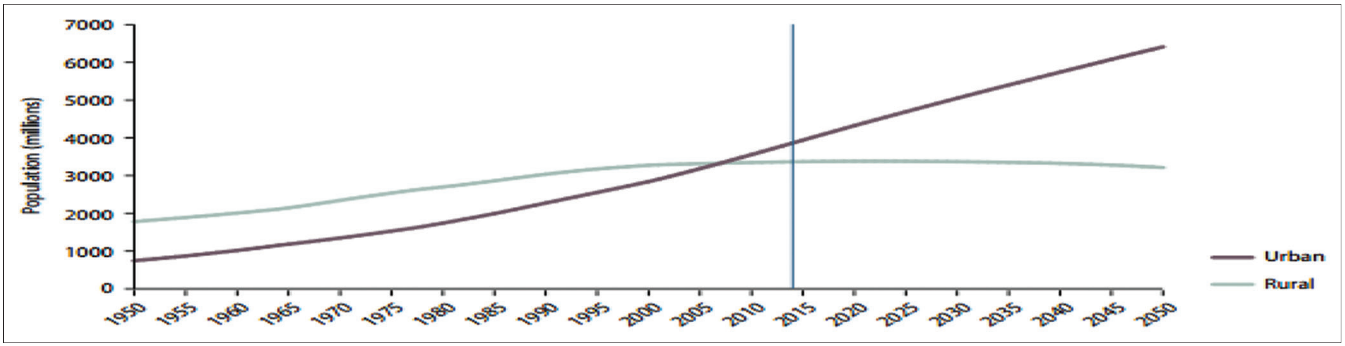
Urban development leads to increases in energy consumption and, consequently, to greater atmospheric pollution. Especially in developed regions, the process of economic development is accompanied by agricultural intensification, industrialization, and urbanization, with large-scale movement of the labor force from rural to urban settlements. Urban economic activities may influence environmental quality in as distinct a way as industrialization does. Due to urban sprawl, the world electricity demand is expected to increase by almost 80% from 2012 to 2040. The power sector represents more than half of the expected increase in global primary energy use, a rise comparable to current North American total energy demand (International Energy Agency, 2014).

In other words, the term urbanization does not fully reflect how many people settle in urban areas. The International Energy Agency (2014) also highlighted the high concentration of people, economic activities, and services in relatively small settlements. Urban economies of scale can promote better access to services, greater prosperity, and positive changes in lifestyle (Bekhet and Othman, 2017). However, it can also lead to increased slums and squatter settlements, social alienation, and environmental pollution. The positive and negative impact of urbanization is not distributed equally among the urban population; the rich and powerful draw more benefits from the positive effects and are better protected against adverse effects than the poor and marginalized. In the Association of Southeast Asian Nations (ASEAN) region, the countries are more ambitious in using economic integration as a tool for achieving broader regional prosperity and greater global competitiveness. However, many challenges remain despite the unique opportunities offered by three global megatrends: the ongoing expansion of cross-border trade, unprecedented urbanization, and the advent of multiple disruptive technologies (Woetzel et al., 2014). To support the urban planning, the Asian Development Bank is promoting city clusters by financing urban infrastructure to link cities and towns within a region to improve their economic development potential (Choe and Laquian, 2008).

In response to various economic and environmental challenges, the Malaysian economy has shifted its drivers of economic growth from energy-intensive industries toward services and higher value manufacturing, in addition to reforming fossil-fuel subsidies. Improvements in energy efficiency are also the result of implementation of dedicated measures that stem from Malaysia's commitment as a member of the Asia-Pacific Economic Cooperation countries to reduce its energy intensity. However, even with these ongoing efforts, challenges still lie ahead so careful future planning is needed to achieve sustainable growth. Figure 2 shows the upward trends of energy and CO_2 emissions in the Malaysian economy. In 2014, energy consumption and CO_2 emissions reached 145.31 billion ktoe and 0.4 billion kt, respectively. This means that a high gross domestic product (GDP) can be achieved through rapid development, but such development may threaten the environment due to the associated high CO_2 emissions. Fossil fuels in Malaysia's energy mix continue to be dominant, with the energy-related CO_2 emissions expected to double in the New Policies Scenario, increasing from 211 million tonnes (Mt) in 2013 to almost 430 Mt by 2040 (International Energy Agency, 2015b).

Urban growth is another driver of environmental challenges stemming from the rapid economic development in Malaysia. In the past few years, Malaysia has achieved an average of 4%-5% economic growth; in addition, rapid urbanization has put considerable pressure on energy demand. Figure 3 shows the percentage share (%) of the rural and urban population in Malaysia in 1960-2018. The figure shows a huge gap between the rural and urban population growth rate; in the beginning, the rural population was larger than the urban population, but after reaching equilibrium in 1991, the pace of urbanization outstripped rural population growth. This urban sprawl has introduced various health and environmental issues in Kuala Lumpur and Klang Valley, where the annual air pollution cost is around US $1.0-1.6 billion (Brandon, 1994; Marcotullio and Lee, 2003). Urban expansion also brings economic prosperity as it enables Malaysian citizens to pursue a higher quality of life. To enhance the quality of life, during the Tenth

Figure 1: Urban and rural population of the world, 1950-2050

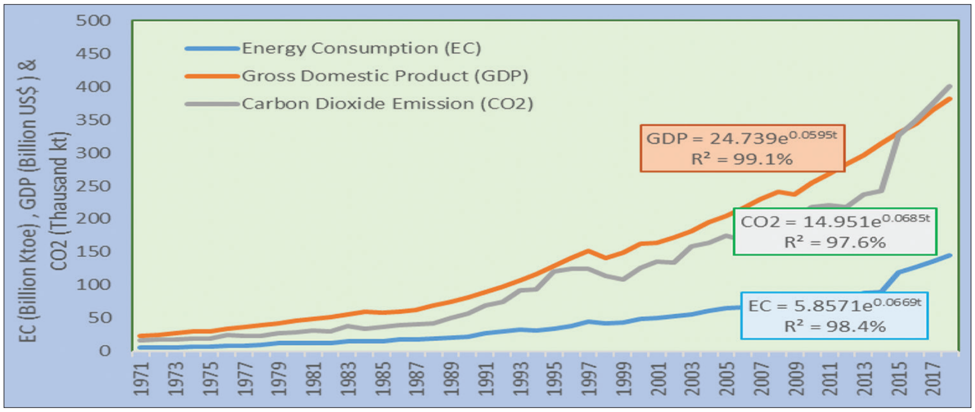


Source: United Nations, Department of Economic and Social Affairs, Population Division (2018). World urbanization prospects

Malaysia Plan, initiatives to enhance inclusivity included elevating the livelihood of the bottom 40% household income group (B40), building a progressive and more inclusive society, ensuring access to basic infrastructure and services, and promoting corridors as an engine of growth (Economic Planning Unit, 2010). Efforts were also undertaken to elevate the quality of life of rural households and enhance the economic participation of urban households through income-generating activities and micro-enterprise support programs.

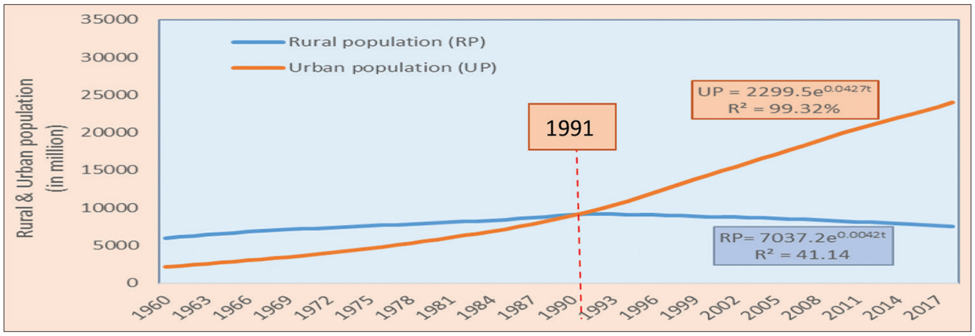
Financing activities have played a vital role in the new planning projects regarding renewable energy and sustainable economic growth. The overall total gross financing raised by the private sector through the banking system and the capital market amounted to RM281 billion in the second quarter of 2014 (Bank Negara Malaysia, 2015). The development of financial markets indicates that a country is strong in an economic sense. Financial deepening plays a significant role in transferring created funds to real sectors. In this case, the Malaysian financial system has exhibited continued improvement in the global and domestic financial markets. Overall, the financial intermediation has remained well supported by sound financial institutions, orderly financial market conditions, and sustained confidence in the financial system. In Figure 4, two important financial indicators, domestic credit to the private sector (DP) and domestic credit provided by financial sectors (DF), are shown as a percentage of GDP. During 1960-2018, DP and DF show an annual growth rate of 4.52% and 4.47%, respectively. A slump in the financial market

Figure 2: Trend of economic growth, energy and CO_2 emissions in Malaysia during(1970-2018)



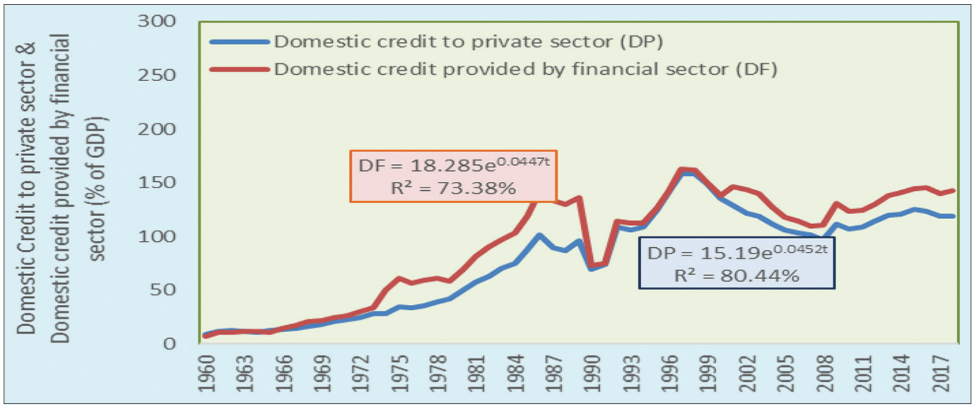
Source: World Bank Database (2019)

Figure 3: Urban sprawl in Malaysia during (1960-2018)



Source: World Bank Database (2019)

Figure 4: Finanacial Development in Malaysia during (1960-2018)



Source: World Bank Database (2019)

occurred during the Asian and global financial crises, but in 2011 the financial sector started to stabilize. Volatility in the domestic financial market also arose from uncertainties in the external environment.

The main objective of this paper is to examine the interconnection between environmental Kuznet curve (EKC) and urban environmental transition (UET) theories in Malaysia. This paper makes several contributions: Examining the energy and emission nexus by adding the urbanization perspective can shed light on problems in Malaysian cities caused by high concentrations of industry. Moreover, air, water, noise, and solid waste pollution problems have increased rapidly and can have dramatic impacts on the life and health of city inhabitants. This single-country study uses both a static and a dynamic framework to model the impact of urbanization on CO_2 emissions to compare whether Malaysia is improving through new energy policies with increasing economic growth or whether urban sprawl has impeded sustainable development. However, the understandable determination of the Malaysian government to deliver modern development to its citizens means that urban places will become critical for innovation and development in the low-carbon transition. Importantly, the results of this study can drive policy responses at the national level to this global dilemma. The current study adds a powerful policy thrust that emphasizes the role of technological innovation, such as improved financial policies in raising funds for greening cities, development of compact cities, reduction of auto-dependent systems, and green building (Brown and McGranahan, 2016). Last, the current study results can enhance ongoing efforts with respect to alternative sources of energy, and the development of modernism means that Malaysia must prioritize these policies for adaption in urban places so that the majority of people will be able to live a sustainable life style that can withstand the upcoming challenges.

The remainder of the paper is structured as follows: Section 2 describes both the theoretical and empirical literature. Section 3 explains the data and model construction used in the analysis. Section 4 analyzes the empirical findings and offers relevant discussion. Finally, the concluding remarks and policy implications of the findings are outlined in Section 5.

2. THEORETICAL BACKGROUND AND PREVIOUS STUDIES

A large body of research can be found on the relationships among GDP, CO_2 emissions, FD, urbanization, and energy use covering a range of countries and using different methodologies. This section classifies this research into two sub-sections: EKC and UET theories and previous findings.

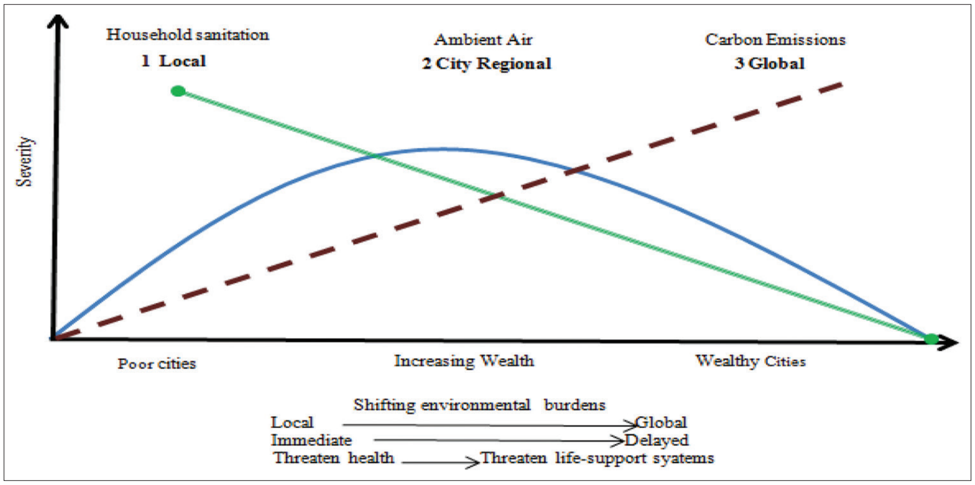
2.1. EKC and UET Theories

The environmental implications of economic growth and the planning implications for reducing environmental burdens are under hot debate. The main challenge in this context is how various changes affect the energy and environment perspective. The EKC hypothesizes that income inequality first rises and then falls as economic development proceeds (Kuznets, 1955). This term was coined in the 1980s in response to the finding that environmental problems display a similar pattern, initially increasing with economic growth and then declining. In the early stages of economic growth, degradation and pollution increase, but beyond some threshold of income per capita, which will vary for different indicators, the trend reverses, so that at high income levels economic growth leads to environmental improvement. This implies that the environmental impact indicator is an inverted U-shaped function of income per capita. In other words, this application leads to modernization and the affluence concept, where as societies continue to evolve to higher stages of development, environmental damage becomes more important and societies seek more environmentally sustainable practices (Dietz and Rosa, 1997; Shahbaz et al., 2015). Second, based on UET theory, urban growth is also usually blamed for environmmental problems. Basically, there is a relationship between rapid sprawl of the urban population and environmental degradation. As cities continue to become wealthier, industrial pollution problems may be lessened via environmental regulations, technological innovation, or changes in the energy mix and production methods. Last, the urbanization concept includes compact city theory, mostly focused on the benefits of increased urbanization leading to changes in demographics (Zhou et al., 2015). Higher urban density facilitates economies of scale for public infrastructure but at the same time lead to lower environmental damage.

From the first time when EKC was popularized in the World Development Report of 1992 (World Bank, 1992), it has been evident that not all the environmental burdens exhibit the same type of relationship with per capita income, either cross nationally or over time. A great deal of variation in environmental burdens is not related casually or statistically to economic status. Thus, in this context, more specifically as the basis for claiming that economic growth is inherently good for the environment or that economic growth affects the environment generally, the EKC has various implications (Ekins, 1997 and 2000; Stern, 2004). Based on such issues, McGranahan and Singsore (1994) and McGranahan et al. (2001) proposed contrasting curves for sanitation, urban air pollution, and carbon emissions. The existing literature points to three theories (ecological modernization, UET, and compact city theories) that are useful for explaining how urbanization can affect the natural environment (Poumanyvong and Kaneko, 2010). The current study employs UET theory, highlighting the interaction with EKC and covering the three perspectives involving demographic, economic, and technological factors.

Figure 5 identifies layers of changes in the relationships among affluence, technical innovation, and urban environmental burdens.The three curves indicate that the severity of different environmental burdens changes with affluence. The first curve shows a decline in local burdens and a move toward global burdens, the second shows the rise and fall of the city-regional burden known as EKC, and the third shows the rise of global burdens in the form of CO_2 emissions. The third curve reflects the tendency for urban environmental burdens to be more dispersed and delayed in higher income cities than in lower income cities. In summary, this suggests that in poor cities, environmental challenges are localized, immediate, and health threatening. In middle-income, rapidly developing cities, environmental burdens are citywide or regional, somewhat more delayed in their impacts, and a threat to both health and ecological sustainability. In affluent or high-income cities, environmental burdens are

Figure 5: Environemntal risk and urban transitions



Source: McGranahan et al. (2001)

global, intergenerational, and primarily a threat to sustainability (McGranahan et al., 2001; Zi et al., 2016).

The EKC and UET theories can applied for different contexts, including economies in rapidly developing Asia (Bai and Imura, 2000; Marcotullio, 2003). These applications either simply describe differences between cities of different income levels or include changes in the speed of transitions. Moreover, some researchers have analyzed the energy consumption and production technology pattern changes under rapid urbanization (Elias and Victor, 2005). However, Figure 5 helps to explain why ecologists are associated with the claim that environmental burdens increase with affluence and economists are associated with EKC. The theories of ecological modernization and UET recognize that urbanization can have both positive and negative impacts on the natural environment, with the net effect being hard to determine a priori (Sadorsky, 2014a and 2014b).

2.2. Existing Literature

A close relationship exists between energy cosumption and economic development. With rapid development, the demand for energy also rises. Begum et al. (2015) highlighted this relationship in Malaysia. They demonstrated that both per capita energy consumption and per capita GDP have long-term positive impacts on per capita carbon emissions in Malaysia. Furthermore, Sebri and Ben-Salha (2014) confirmed long-run equilibrium relationships among economic growth, energy consumption, and CO_2 emissions in Brazil, Russia, India, and China (the BRIC countries). In contrast, Kivyiro and Arminen (2014) identified causal links among CO_2 emissions, energy consumption, economic development, and foreign direct investment (FDI) in six sub-Saharan African countries. They found varied results in these countries. Omri and Kahouli (2014) elaborated the FDI and economic growth in 65 countries. They found a positive impact on energy consumption with FDI flows.

The research also expands on the environment and energy in a causality relation. Bastola and Sapkota (2015) elaborated that the existing energy crisis, alleviating poverty, and mitigating the potential impacts of climate change have captured significant attention among policy makers in Nepal. Granger causality tests suggested the presence of long-run bidirectional causality running from energy consumption to CO_2 emissions and vice versa and a unidirectional causality running from economic growth to both CO_2 emissions and energy consumption. These findings implied that policies that boost energy consumption may not spur economic growth but rather are more likely to have adverse effects on the environment. Salahuddin and Gow (2014) suggested that energy consumption and CO_2 emissions Granger cause each other while a unidirectional causal link running from economic growth to energy consumption is also found. Both absolute and relative decoupling occurred in all the Gulf Cooperation Council countries except Saudi Arabia during the study period. Lin and Moubarak's (2014) results showed bi-directional long-term causality between renewable energy consumption and economic growth in China. Caraiani et al. (2015) investigated the causality relationship between energy consumption and GDP in the context of emerging European countries covering 1980-2013. They found that in some specific cases the results implied that energy consumption and economic growth are jointly determined via bi-direction causality (Kalimeris et al., 2014; Farhani et al., 2014; Heidari et al., 2015).

Today, researchers are also considering the FD element in the energy and economic growth relationship. In this context, Komal and Abbas (2015) explored the finance–growth–energy nexus for Pakistan. Their study identified significant implications while considering the impact of FD on energy consumption through the economic growth channel. The result suggested that FD positively and significantly affects energy consumption through the economic growth channel. Furthermore, Omri et al. (2015) highlighted the relationship among FD, CO_2 emissions, and economic growth in Middle East and North Africa (MENA) countries. They found unidirectional causality running from FD to economic growth and from trade openness to CO_2 emissions. Alam et al. (2015) examined the relationship among energy consumption, economic growth, relative prices of energy, FDI, and different FD indicators in the South Asian Association for Regional Cooperation member countries, Bangladesh, India, Nepal, Pakistan, and Sri Lanka, in 1975-2011.The results showed a significant relationship among energy consumption, economic growth, FDI, and FD proxies;

however, FD indicators had the larger impact on increasing energy demand, followed by GDP per capita and FDI.

Economic growth has posed another key question in economic development related to urbanization, which creates increasing pressure on the energy supply and the natural environment (Wang et al., 2016). Many researchers have discussed this issue to bring a better understanding of the relationship among urbanization, energy consumption, and CO_2 emissions (e.g., Poumanyvong and Kaneko, 2010; Al-Mulali et al., 2012; Liu and Xie, 2013; Shahbaz et al., 2014; Wang, 2014; Ren et al., 2015; Shahbaz et al., 2015; Wang et al., 2015; Rafiq et al., 2016; Shen and Lin, 2016; Lang et al., 2016; Yang et al., 2016; Bekhet and Othman, 2017; Shahbaz et al., 2016; He et al., 2016). They highlighted the related research regarding energy consumption patterns and the urbanization process in various studies. Moreover, some of these studies argued that the impact of urbanization on energy consumption is greater than the impact of CO_2 emissions in each region.

Poumanyvong et al. (2012) investigated empirically the effects of urbanization on transport energy use and CO_2 emissions with consideration of the different development stages. They suggested that the impact of urbanization on energy use and CO_2 emissions varies across the stages of development. Surprisingly, urbanization decreases energy use in the low-income group, while it increases energy use in the middle-and high-income groups. The impact of urbanization on CO_2 emissions is positive for all the income groups, but it is more pronounced in the middle-income group than in the other groups. Sharma (2011) found that urbanization has a negative impact on CO_2 emissions in high-income countries.

China's economic development and urbanization created increased pressure on the energy supply and the natural environment. Tan et al. (2016) detailed the literature regarding the urbanization process. They found that an energy transition from high-pollution coal to clean electricity is also present in China, although the fundamental transition to renewable energy is still in its infancy. From a regional perspective, urbanization has asymmetric impacts on provincial energy use so that energy policies associated with urbanization should be province-specific. Xu and Lin (2015) confirmed an inverted U-shaped nonlinear relationship between industrialization and CO_2 emissions in the three regions in China. Urbanization follows an inverted U-shaped pattern with CO_2 emissions in the eastern region and a positive U-shaped pattern in the central region. However, the nonlinear impact of urbanization on CO_2 emissions is insignificant in the western region. Chen et al. (2016) also highlighted the National New Urbanization Plan (2014-2020) unveiled by the Chinese central government, which revealed a new path for urbanization that accommodated unique Chinese characteristics. The most notable aspect was the transfer from land-centered urbanization to people-oriented urbanization.

As an emerging economy, the Malaysian economy is going through a transformation process which has brought various energy and environmental challenges. In this context, Rafiq et al. (2016) analyzed the impact of urbanization and trade openness on emissions and energy intensity in 22 increasingly urbanized emerging economies. They employed three second-generation heterogeneous linear panel models as well as recently developed nonlinear panel estimation techniques allowing for cross-sectional dependence. They found that population density and affluence increase emissions and energy intensity while renewable energy seems to be dormant in these emerging economies, but non-renewable energy increases both CO_2 emissions and energy intensity. Wang et al. (2016) further suggested that ASEAN countries need rational planning of urban development and energy-efficiency improvement strategies. For Malaysia cases, Shahbaz et al. (2015) investigated the impact of urbanization on energy consumption by applying the stochastic impacts by regression on population, affluence, and technology (STIRPAT) method. The F-bound test approach was applied to examine integrating properties and long-run relationships in the presence of structural breaks. The results validated the existence of cointegration and exposed urbanization as a major contributor to energy consumption. Also, affluence raises energy demand. The causality analysis found that urbanization Granger causes energy consumption. This was justified by Shahbaz et al. (2016), who confirmed that the relationship between urbanization and CO_2 emissions is U-shaped in Malaysia (i.e., urbanization initially reduces CO_2 emissions, but after a threshold level, it increases CO_2 emissions). The causality analysis also suggested that the urbanization Granger causes CO_2 emissions. Utilizing a different framework, Bekhet and Othman (2017) combined the augmented Cobb–Douglas production and ecological modernization theories in a single framework investigate the link between urbanization growth and CO_2 emissions. They revealed the inverted U-shaped relationship between CO_2 emissions and urbanization in the long run and it was reported similar to Shahbaz et al. (2016). Instead of that, various studies on urban planning in Malaysia have also been conducted (Hossain, 2011; Azam et al., 2015; Morris et al., 2016; Shuid, 2016).

The relationship among economic growth, energy, and the CO_2 emissions nexus has been studied extensively regarding EKC. Appendix 1 summarizes various studies in the context of the EKC hypothesis. The existing literature provides panel as well as single-country case studies. These studies provide effective energy policies and emission-reduction strategies. However, most existing studies have focused on the effects of urbanization regarding CO_2 emissions and energy consumption and have not fully considered other important factors such as demographic, growth, and technical advancements in Malaysia. This paper fills the gap in the existing literature by applying the EKC and UET theoretical perspectives in Malaysia for in-depth analysis. Thus, based on the above literature review and to achieve the objective of the current paper, we have formulated the following hypotheses:

H_1: Significant EKC influence exists in Malaysia.
H_2: Significant UET influence exists in Malaysia.
H_3: Significant long- and short-run relationships exist between CO_2 and its determinants in Malaysia.
H_4: Significant long- and short-run causalities exist between CO_2 and its determinants in Malaysia.

3. MODEL FRAMEWORK AND DATA SOURCES

In the literature, much attention has been paid to Ehrlich and Holdren's (1971) IPAT model, which suggests that the environmental impact (I) is the product of three factors, population (P), affluence (A), and technology (T), in the analysis of the effect of economic activity on energy consumption and the environment. This can be written as in equation (1).

$$I = P \times A \times T \tag{1}$$

Where I denotes the impact, P represents demographic, A is the economic, and T is the technological factors. The pivotal limitation of IPAT is that it does not permit hypothesis testing because the known values of some terms determine the value of the missing term (York et al., 2003). To overcome the limitations of the IPAT model, Dietz and Rosa (1997) proposed the STIRPAT model as in equation (2).

$$I_{it} = aP_{it}^{b}A_{it}^{c}T_{it}^{d}\varepsilon_{it} \tag{2}$$

Non-linear equation (2) can be transformed to become linearized by taking logarithms (L), as shown in equation (3).

$$L(I_{it}) = a + bL(P_{it}) + cL(A_{it}) + dL(T_{it}) + \varepsilon_{i} \tag{3}$$

where a, b, c, and d represent the coefficients term, ε denotes the error term, and the subscripts i and t display as the country, province, and sectors and time, respectively. The IPAT model allows for assessing factors' impact on the environment (CO_2). In the current paper, this model is extended by incorporating various variables, as shown in Figure 6.

To examine the impact of interaction among the EKC and UET hypotheses, energy consumption (EC), economic growth (GDP), FD, and urbanization (UR) in relation to environmental pollution (CO_2) are used. Then, Equation (3) is extended as in equation (4).

$$\begin{aligned} LCO_{2t} &= \beta + \alpha_1 LEC_t + \alpha_2 LGDP_t + \alpha_3 LGDP_t^2 \\ &+\alpha_4 LFD_t + \alpha_5 LUR_t + \alpha_6 LUR_t^2 + \psi_t \end{aligned} \tag{4}$$

where β is the intercept and t is the time period, while ψ stands for a residual or error term with constant variance and zero mean that is assumed to be normally distributed and α_is (i= 1,…., 6) are the coefficients of the variables. The EKC hypothesis between the economic growth level and CO_2 emissions (inverted U-shape) and the theory of UET recognize that urbanization can have positive and negative impacts on the natural environment. If urbanization has a statistically insignificant impact on CO_2 emissions, then urbanization will have no meaningful impact on CO_2 emissions. This is consistent with the positive and negative effects of urbanization on CO_2 emissions canceling each other, so the hypotheses regarding urbanization and CO_2 emissions are accepted in Malaysia if $\alpha_2>0$, $\alpha_3<0$ and $\alpha_5>0$, and $\alpha_6<0$, respectively. Annual data from the World Bank Development databases (2019) were used for all reserach variables by employing E-views and Microfit packages. This will involve more regression analysis and the sample size consists of only 42 observations, so the critical values are not available to compare the cointegrtaion result in a Pesaran table. However, this can be done by using the Microfit package.

To determine the level of stationarity [*I(0), I(1),* and *I(d)]*, augmented Dickey and Fuller [ADF] (1979,1981), Phillip and Perron [P-P] (1988), and Kwiatkowski, Phillips, Schmidt, and Shin [KPSS] (1999) statistical tests are used. To examine the equilibrium relationship among the variables above, the ARDL bounds testing model (Pesaran and Pesaran, 1997; Pesaran and Shin, 1999; Pesaran et al., 2001) is employed. This is because it can be used with a small sample size, it estimates long-run and short-run relationships simultaneously, and it allows for testing the existence of relationships among variables for stationary data at various level, *I(0)* and *I(1),* or both (Bekhet and Othman, 2018; Bekhet & Abdul, 2018; Bekhet & Harun, 2017; Hamdi et al., 2014; Pesaran and Shin, 1999; Pesaran and Pesaran, 1997). Equation (5) is constructed to examine the long-run and short-run relationships among the variables.

$$\begin{bmatrix} \Delta LCO_2 \\ \Delta LEC \\ \Delta LGDP \\ \Delta LGDP^2 \\ \Delta LFD \\ \Delta LUR \\ \Delta LUR^2 \end{bmatrix}_t = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \beta_5 \\ \beta_6 \\ \beta_7 \end{bmatrix} + \begin{bmatrix} \varphi_{11} & \varphi_{12} & \varphi_{13} & \varphi_{14} & \varphi_{15} & \varphi_{16} & \varphi_{17} \\ \varphi_{21} & \varphi_{22} & \varphi_{23} & \varphi_{24} & \varphi_{25} & \varphi_{26} & \varphi_{27} \\ \varphi_{31} & \varphi_{32} & \varphi_{33} & \varphi_{34} & \varphi_{35} & \varphi_{36} & \varphi_{37} \\ \varphi_{41} & \varphi_{42} & \varphi_{43} & \varphi_{44} & \varphi_{45} & \varphi_{56} & \varphi_{47} \\ \varphi_{51} & \varphi_{52} & \varphi_{53} & \varphi_{54} & \varphi_{55} & \varphi_{56} & \varphi_{57} \\ \varphi_{61} & \varphi_{62} & \varphi_{63} & \varphi_{64} & \varphi_{65} & \varphi_{66} & \varphi_{67} \\ \varphi_{71} & \varphi_{72} & \varphi_{73} & \varphi_{74} & \varphi_{75} & \varphi_{76} & \varphi_{77} \end{bmatrix}$$

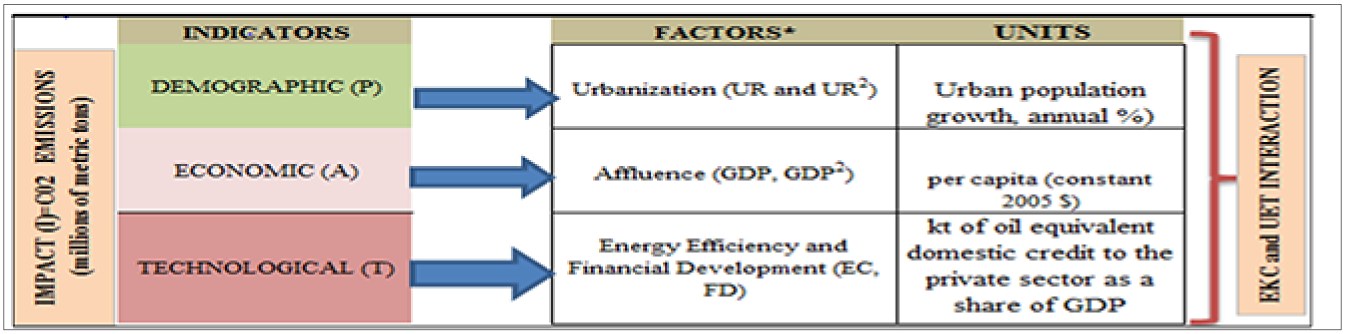
$$\begin{bmatrix} LCO_2 \\ LEC \\ LGDP \\ LGDP^2 \\ LFD \\ LUR \\ LUR^2 \end{bmatrix}_{t-1} + \sum_{s=1}^{k} \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{15} & \alpha_{16} & \alpha_{17} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} & \alpha_{25} & \alpha_{26} & \alpha_{27} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} & \alpha_{35} & \alpha_{36} & \alpha_{37} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} & \alpha_{45} & \alpha_{56} & \alpha_{47} \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & \alpha_{55} & \alpha_{56} & \alpha_{57} \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} & \alpha_{66} & \alpha_{67} \\ \alpha_{71} & \alpha_{72} & \alpha_{73} & \alpha_{74} & \alpha_{75} & \alpha_{76} & \alpha_{77} \end{bmatrix}_s$$

$$\begin{bmatrix} \Delta LCO_2 \\ \Delta LEC \\ \Delta LGDP \\ \Delta LGDP^2 \\ \Delta LFD \\ \Delta LUR \\ \Delta LUR^2 \end{bmatrix}_{t-s} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \\ \varepsilon_7 \end{bmatrix}_t \tag{5}$$

Where Δ is the first difference operator, β_is represent the intercepts, ϕ_{ij}s denote the long-run coefficients of the variables, α_{ij}s denote the short-run coefficients, ε_{it}s denote the error terms which are normally distributed, k represents the optimal lag length, s is the lag order, and i,j=1,…, 7. The optimal lag structure of the first differenced regression is selected by the Akaike information criteria.

The H_0: ϕ_{ij}s=0 and the alternative H_1: ϕ_{ij}s ≠ 0 are used to determine the non-existence of long-run relationships among the selected variables. The decision rule is based on comparing the calculated F-statistics value with the critical values tabulated in statistical tables (Pesaran et al., 2001):

Figure 6: IPAT extended model



- If the calculated F-statistics value is >the upper bounds value *I(1)*, the H_0 is rejected, which means that the variables included in the model share long-run relationships.
- If the calculated F-statistics value is <the lower bounds value, *I(0)*, the H_0 is accepted, which means that the variables included in the model do not share long-run relationships.
- If the calculated F-statistics value falls in the range *I(0)* ≤F-statistics value ≤*I(1)*, the decision is inconclusive with regard to accepting or rejecting the long-run relationship. In this case, Boutabba (2014) and Banerjee et al. (1998) argued that an efficient way to establish co-integration among the variables is to test the error correction term (ecM_{t-1}) and confirm it with past studies.

Furthermore, Johansen and Juselius (1990) argued that the maximum likelihood method is more appropriate in a multivariate system to identify the number of cointegrated vectors in the model. However, the cointegration test, Johansen and Juselius (1990), is utilized to determine whether the variables in the vector are cointegrated in one or more long-run relationships using trace and maximum eigenvalue tests. The decision rule is to reject the H_0 of no co-integration when the estimated likelihood test statistic (trace and maximum eigenvalue tests) exceeds its critical value (Brooks, 2008; Johansen and Juselius, 1990, Juselius, 1991). In other words, the trace test aims to provide a single co-integration vector among the variables to test the H_0 of no co-integration (H_0: r = 0) and the alternative hypothesis (H_1: r=1). This test can be written as in equation (6).

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{k} Ln(1-\lambda_i) \qquad (6)$$

However, the maximum eigenvalue test aims to determine the minimum co-integration (Brooks, 2008). Equation (7) shows that the H_0 of no co-integration is accepted if (H_0: r = 0) and the alternative hypothesis is (H_1: r≥2).

$$\lambda_{max}(r, r+1) = -T\,Ln(1-\lambda_{r+1}) \qquad (7)$$

Where r is the number of co-integrating vectors and T is the number of observations.

Since co-integration between the series exists, the long-run and short-run causality directions among the variables can be determined (Bekhet and Al-Smadi, 2014; Engle and Granger, 1987). Thus, the vector error correction model is applied as in equation (8).

$$\begin{bmatrix}\Delta LCO_2\\ \Delta LEC\\ \Delta LGDP\\ \Delta LGDP^2\\ \Delta LFD\\ \Delta LUR\\ \Delta LUR^2\end{bmatrix}_t = \begin{bmatrix}\delta_1\\ \delta_2\\ \delta_3\\ \delta_4\\ \delta_5\\ \delta_6\\ \delta_7\end{bmatrix} + \sum_{s=1}^{k}(\Delta) \begin{bmatrix}\beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} & \beta_{16} & \beta_{17}\\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} & \beta_{26} & \beta_{27}\\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} & \beta_{36} & \beta_{37}\\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} & \beta_{56} & \beta_{47}\\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & \beta_{55} & \beta_{56} & \beta_{57}\\ \beta_{61} & \beta_{62} & \beta_{63} & \beta_{64} & \beta_{65} & \beta_{66} & \beta_{67}\\ \beta_{71} & \beta_{72} & \beta_{73} & \beta_{74} & \beta_{75} & \beta_{76} & \beta_{78}\end{bmatrix}_s \begin{bmatrix}LCO_2\\ LEC\\ LGDP\\ LGDP^2\\ LFD\\ LUR\\ LUR^2\end{bmatrix}_{t-s} + \begin{bmatrix}\gamma_1\\ \gamma_2\\ \gamma_3\\ \gamma_4\\ \gamma_5\\ \gamma_6\\ \gamma_7\end{bmatrix}\begin{bmatrix}ecM_1\\ ecM_2\\ ecM_3\\ ecM_4\\ ecM_5\\ ecM_6\\ ecM_7\end{bmatrix}_{t-1} + \begin{bmatrix}\varepsilon_1\\ \varepsilon_2\\ \varepsilon_3\\ \varepsilon_4\\ \varepsilon_5\\ \varepsilon_6\\ \varepsilon_7\end{bmatrix}_t \qquad (8)$$

where δ_is denote the intercepts, β_{ij}s present the short-run coefficients, and γ_is represent the coefficients of ecM_{t-1} and i, j=1,…, 7. In addition, ecM_{t-1} is the lagged value of the residuals derived from the F-bounds test among the variables. This is used to detect the long-run causality among the variables, while 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 (Bekhet and Harun, 2017; Bekhet and Al-Smadi, 2015; Hamdi et al., 2014; Boutabba, 2014). For exampel, ΔLEC_t does not Granger cause ΔLCO_{2t}, if $\beta_{12} = \ldots = \beta_{21,i}=0$.

In the final step, the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals is used to check the stability of the long-run parameters' movements for the ΔLCO_{2t} model. In addition, the impulse response functions test is used to trace the effect of a 1-time shock to one of current and future values of the endogenous variables. This provides the time path of the impact of a shock on the future values of all the variables in the multivariate dynamic system, and the IFR should provide better insights into short-term and long-term linkages among the variables employed in each of the models (Hamdi et al., 2014; Pesaran and Shin, 1999; Pesaran and Pesaran, 1997).

4. EMPIRICAL RESULTS

4.1. Data Quality, Stationarity and Co-integration Results

The first aim of any statistical procedure is to provide a succinct description of the data being analyzed. Also, in the time series data, the descriptive statistical tests, normality, and interrelationship matrix are very important to determine whether the data collected are adequate and sufficient for time series analysis (Bekhet and Al-Smadi, 2015). Table 1 shows that (LCO_{2t}, LEC_t, $LGDP_t$, LFD_t, LUR_t) variables are positively and significantly interrelated with each other within the acceptance range of correlation coefficients. Furthermore, it reveals that these variables have no possibility of the negative effects of multicollinearity and that all variables are normally distributed, as confirmed by skewness and Jarque–Bera normality tests (Brooks, 2008).

Table 2 shows the ADF, P-P, and KPSS unit root test results, which indicate that the above variables are stationary at *I(1)* with intercept and trend at different significance levels (1%, 5%, and 10%, respectively).

Table 3 shows that the F-statistic values for the LCO_{2t}, LEC_t, $LGDP_t$, and LFD_t models are co-integrated. This means that long-run relationships exist among the variables in these models. In addition, the F-statistic values for the LUR_t model show that the

Table 1: Descriptive statistics and correlation matrix results

Variables	Mean	Median	Maximum	Minimum	SD	LCO_{2t}	LEC_t	$LGDP_t$	LFD_t	LUR_t
LCO_{2t}	1.29	1.36	2.23	0.39	0.59	1.00				
LEC_t	7.20	7.32	7.89	6.26	0.53	0.90	1.00			
$LGDP_t$	8.14	8.17	8.85	7.26	0.46	0.91	0.92	1.00		
LFD_t	4.36	4.60	5.06	3.05	0.57	0.84	0.87	0.86	1.00	
LUR_t	3.95	3.94	4.29	3.53	0.23	0.89	0.88	0.90	0.86	1.00
Skewness						−0.06	−1.28	−0.19	−0.29	−0.13
Kurtosis						1.50	1.77	1.78	1.87	1.75
Jarque-Bera						4.01	3.27	2.92	4.12	2.90
Probability						0.13	0.19	0.23	0.18	0.23

Source: Output of the E-views 7.2 econometric software. SD: Standard deviation

Table 2: Unit root test results

Variables	ADF		P.P		KPSS		Decision
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	
	Intercept and trend						
LCO_{2t}	−2.60	−7.75***	−2.62	−7.75***	0.20***	0.06	I (1)
LEC_t	−1.57	−6.91***	−1.59	−9.32***	0.17**	0.14**	I (1)
$LGDP_t$	−2.19	−5.65***	−2.29	−5.65***	0.12*	0.04	I (1)
LFD_t	−1.37	−5.45***	−1.67	−5.37***	0.21***	0.09	I (1)
LUR_t	−1.14	−4.36***	−1.27	−4.79***	0.19**	0.11*	I (1)

(1) H_0 for KPSS test is rejected if the variables stationary, (2) ***, **, * Indicate significance at the 1%, 5% and 10% level respectively. Source: Output of the E-views 7.2 econometric software. ADF: Augmented Dickey-Fuller, PP: Phillips-Perron, KPSS: Kwiatkowski, Phillips, Schmidt, and Shin

Table 3: Result of co-integration tests

Models		Bound critical values			
a. F-bound testing approach	***F*-statistic**	**1%**	**5%**	**10%**	**Decisions**
		I (0), I (1)	**I (0), I (1)**	**I (0), I (1)**	
$LCO_{2t}=f(LEC_t, LGDP_t, LFD_t, LUR_t)$	4.04**	4.38, 5.61	3.21, 4.37	2.71, 3.80	Co-integration
$LEC_t=f(LCO_{2t}, LGDP_t, LFD_t, LUR_t)$	3.89**	4.38, 5.61	3.21, 4.37	2.71, 3.80	Co-integration
$LGDP_t=f(LEC_t, LCO_{2t}, LFD_t, LUR_t)$	3.71**	4.38, 5.61	3.21, 4.37	2.71, 3.80	Co-integration
$LFD_t=f(LEC_t, LCO_{2t}, LGDP_t, LUR_t)$	10.6***	4.38, 5.61	3.21, 4.37	2.71, 3.80	Co-integration
$LUR_t=f(LEC_t, LCO_{2t}, LGDP_t, LFD_t)$	2.94*	4.38, 5.61	3.21, 4.37	2.71, 3.80	Inconclusive
b. Johansene-Juselius test	**λ_{trace} statistic**	**Critical value**	**λ_{max} statistic**	**Critical value**	**Decisions**
r=0	183.92***	125.61	46.95**	46.23	Co-integration
r≤1	136.97***	95.753	43.92**	40.07	Co-integration
r≤2	93.046**	69.818	40.87**	33.87	Co-integration
r≤3	52.171*	47.856	27.66*	27.58	Co-integration
r≤4	24.701	29.797	15.63	21.13	No Co-integration

(1) F-statistics critical values retrieved from Pesaran AND Pesaran (2009), (2) ***, **, *as defined in Table 2. Sources**:** (a) The Output of the Micro-fit 4.1 econometric software packages. (b) The output of the E-views 7.2 econometric software

calculated F-statistic value falls in the range *I(0)* ≤ F-statistics value ≤ *I(1),* indicating that it is inconclusive with respect to accepting or rejecting the H_0. Thus, the results of this model compared with those of past studies confirm the long-run relationship among the variables. Also, the researchers followed Boutabba (2014) to verify the co-integration among the variables by applying the stationarity test for the ecM_{t-1}. Furthermore, the results of the multivariate Johansene-Juselius test also confirmed that long-run relationships among the variables exist in all models except the LUR_t model. In summary, the four models depict co-integration but we have focused on the first model (CO_2 model) due to the relevant objective of the study.

In summary, Table 3 shows that the variables in the CO_2 emissions, energy consumption, economic growth, and FD models have an equilibrium relationship. The table also shows that with the pace of development in Malaysia these variables move together. Also, it highlights that despite the rapid economic development challenges remain regarding how to manage energy consumption and control CO_2 emissions. Ozbugday and Erbas (2015) argued that the scale of economic activity measured by real income and industrialization has a significant positive effect on CO_2 emissions.

FD promotes investment, which raises energy demand due to economic growth. This means that it may influence energy consumption through the economic growth channel in Malaysia. A well-established financial system boosts the effectiveness and efficiency of financial institutions through enhanced innovation in financial services delivery, reduction of information cost, efficient management of complex and risky transactions, and enhancement of transparency between borrowers and lenders, thereby guaranteeing the profitability of investment (Islam et al., 2013; Shahbaz, 2013). All these factors improve business investment and economic activities, thereby boosting domestic production and economic growth, while the urbanization variable predicts the need for careful planning regarding rapid urban sprawl in Malaysia.

4.2. Short and Long Run Results

The results of the co-integration relationship among the variables as in the first model (Table 3) are used to estimate the coefficients of the long- and short-run relationship between the above variables. Table 4 shows that energy consumption is positively associated with CO_2 emissions. This means that a 1% rise in energy consumption increases CO_2 emissions by 1.33%. This highlights the need for technical innovation and renewable energy production methods.

These findings are in line with Heidari et al. (2015). Moreover, the impact of income is positive on CO_2 emissions. Both linear and non-linear terms of GDP confirm the EKC hypotheses that the inverted-U relationship between economic growth and CO_2 emissions in Malaysia exists (Bekhet and Yasmin, 2013a and 2013b; Begum et al., 2015). The results indicate that a 1% rise in GDP will increase CO_2 emissions by 0.006% while the negative sign of the squared term seems to corroborate the delinking of CO_2 emissions and GDP at higher levels of income in the Malaysian economy. This shows the relevance of Vision 2020 in that the Malaysian economy is growing fast and people's cosumption patterns are changing. This evidence confirms that in Malaysia CO_2 emissions increase in the initial stage of economic growth and decline after a threshold is reached.

Table 4: Long, short runand ecM_{t-1} Co-efficients results for LCO_{2t} model

Variables	Coefficient	SE	T-ratio	Significant level (%)
a: Long-run results				
LEC_t	1.335**	0.693	1.92	5
$LGDP_t$	0.006***	0.001	3.84	10
$LGDP^2_t$	−0.510**	0.145	−3.49	5
LFD_t	0.014*	0.007	1.81	5
LUR_t	−0.581**	0.188	−3.08	5
LUR^2_t	0.007***	0.001	4.02	1
C	−5.64*	4.929	−1.14	10
b: Short-Run and ecM_{t-1} Results				
LEC_t	0.001**	0.699	2.38	5
LEC_{t-1}	−0.003**	0.954	−3.43	5
LEC_{t-2}	−0.002**	0.882	−2.52	5
$LGDP_t$	0.003**	0.001	2.17	5
$LGDP_{t-1}$	−0.005***	0.001	−3.58	1
$LGDP_{t-2}$	−0.003*	0.001	−2.85	10
$LGDP^2_t$	−0.282**	0.144	−1.95	5
$LGDP^2_{t-1}$	0.567***	0.137	4.12	1
$LGDP^2_{t-2}$	0.452***	0.154	2.93	1
LFD_t	−0.005	0.005	−1.06	----
LFD_{t-1}	−0.014*	0.008	−1.73	10
LFD_{t-2}	−0.013*	0.007	−1.77	10
LUR_t	18.32***	6.262	2.92	1
LUR_{t-1}	14.91*	6.390	2.33	10
LUR_{t-2}	7.231	5.176	1.39	----
LUR^2_t	−0.172**	0.062	−2.78	5
LUR^2_{t-1}	−0.136**	0.0592	−2.30	5
LUR^2_{t-2}	−0.075	0.048	−1.55	----
C	−7.433***	5.629	−1.32	1
ecM_{t-1}	−1.31***	0.290	−4.52	1

1***, **, * as defined in Table 2, respectively; (2) multiplier test of residual serial correlation=0.794; (3) autoregressive conditional heteroscedasticity test=0.187; (4) Normality test=2.57; (5) RESET test using the square of the fitted values=1.112; (6) *F*-statistics=11.70; (7) R^2=84%; (8) Durbin Watson=2.09; (9) t, t-1 and t-2 are the one, two and three lagged period respectively; (10) ---- is Insignificant results. Source: The output of the Micro-fit 4.1 econometric software. SE: Standard error

In addition, the results reveal that an increase in FD leads to an increase in the effect of CO_2 emissions in the Malaysian economy in the long run. The coefficient of LFD_t suggests that a 1% contribution of FD leads to 0.014% increase in CO_2 emissions during the estimation period. These findings are similar to earlier results from Ziaei (2015), Omri et al. (2015), and Boutabba (2014). From the urban sprawl perspective, the coefficient of LUR_t shows an inverse impact on CO_2 emissions in Malaysia. However, according to UET theory, the coefficient of LUR_t^2 is positive, which means that in the long run Malaysia will still face pollution challenges due to the urbanization process. This suggests upcoming urban sprawl with various implications for the Malaysian economy. Azam et al. (2015) suggested that the population growth rate has a positive and statistically significant relationship with energy consumption only in the case of Malaysia among the ASEAN countries. Shahbaz et al. (2015) also argued that from the Malaysian perspective, due to the rapid urbanization process with a huge number of industrial areas, "over-urbanization" exists.

The short-run dynamics results showed empirical evidence that energy consumption leads to an increase in CO_2 emissions in Malaysia at one lagged period. Note that a 1% rise in energy consumption increases CO_2 emissions by 0.001% while negatively affecting it at two and three lagged periods. The sign of coefficients of GDP and GDP^2 confirmed the existence of the inverted-U Kuznet curve also in the short run in Malaysia. In addition, the results showed that the short-run elasticities for CO_2 emissions are less than the long-run elasticities. In the long run, the result shows that urbanization lowers CO_2 emissions by 0.58%. However, in the short run, emissions will increase due to Malaysia's urbanization process. The study shows that land use development and urban density are the real sprawling problems. Landownership structures and the inability or unwillingness of government to intervene in these structures are perhaps the main factors contributing to 'illegal' settlements and chaotic urban sprawl. This result is consistent with Hossain (2011), who studied the urbanization process in newly industralized countries. In contrast, for the long run, the signs of UR and UR^2 highlight the UET application that cities becoming wealthier by increasing their manufacturing base leads to industrial polltion problems that affect the land, water, and air (Ma et al., 2015; Ren et al., 2015; Wang et al., 2015, 2016; He et al., 2016). Conversely, with modernization and more wealth, the environmental problems can be lessened through technical innovation, strict regulations, and changes in the composition of economic sectors (McGranahan et al., 2001).

In addition, the coefficient of ecM_{t-1} is also negative and statistically significant at the 1% confidence level. This indicates that the ΔLCO_{2t} model is corrected from the short-run equilibrium toward the long-run equilibrium at high speed by 131%. This shows that the long-run equilibrium between CO_2 emissions and other variables would correct back within 7 months (1 divided by the estimated coefficient of ecM_{t-1}). This is also consistent with the Malaysian policy target to cut CO_2 emissions by 40%. Furthermore, the results of diagnostic tools suggest no possibility for the non-normal distribution of error terms, serial correlation, functional form, and heteroscedasticity phenomena (Table 5).

4.3. Causality Results

The multivariate Granger causality test results are reported in Table 5, which shows evidence of the long-run bidirectional Granger causality running between the variables in the models at the 1% and 5% significance levels. Engle and Granger (1987) argued that if a co-integration relationship exists among the variables, then causal directions between these variables must exist.

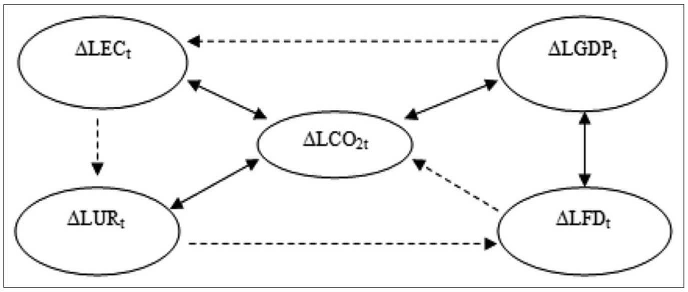
Based on above discussion, Figure 7 summarizes that short-run Granger causality directions among the study variables exist. Bidirectional causality running from CO_2 emissions to energy consumption, economic growth, and urbanization and from economic growth to FD is confirmed. Unidirectional causality running from energy consumption to urbanization, from economic growth to energy consumption, from FD to CO_2 emissions, and from urbanization to FD is also confirmed. These findings are consistent with the empirical evidence of Omri et al. (2015) for MENA countries, Ziaei (2015) for 13 European and 12 East Asia countries, Boutabba (2014) for India, Shahbaz et al. (2013) for Turkey, Saboori and Sulaiman (2013) for ASEAN countries, and Chang (2015) for 53 countries.

In addition, Figure 8 presents the results for stability of the long-run relationship for the CO_2 emissions model. It indicates that the CO_2 emissions model is stable in the long-run parameters because the above test results lie within critical bounds at the 5% significance level. This implies that the estimated parameters are valid for the 1971-2013 period. In other words, the ecM_{t-1} value is relatively stable.

5. CONCLUSION AND POLICY IMPLICATIONS

This paper examined the interaction between EKC and UET theories by incorporating economic growth, energy consumption, FD, urbanization, and CO_2 emissions in Malaysia. We applied the F-bounds testing approach of cointegration and error-correction-based Granger causality models for 1970-2013. Our results revealed that co-integration exists between the study variables. From a theoretical application perspective and cosidering the hypotheses testing, the EKC hypothesis applies but the UET hypothesis is not validated for Malaysia. The empirical results suggested evidence of long-run relationships among the

Figure 7: The Short-run direction of causality. (1) denote the unidirectional results. (2) denote the bidirectional results



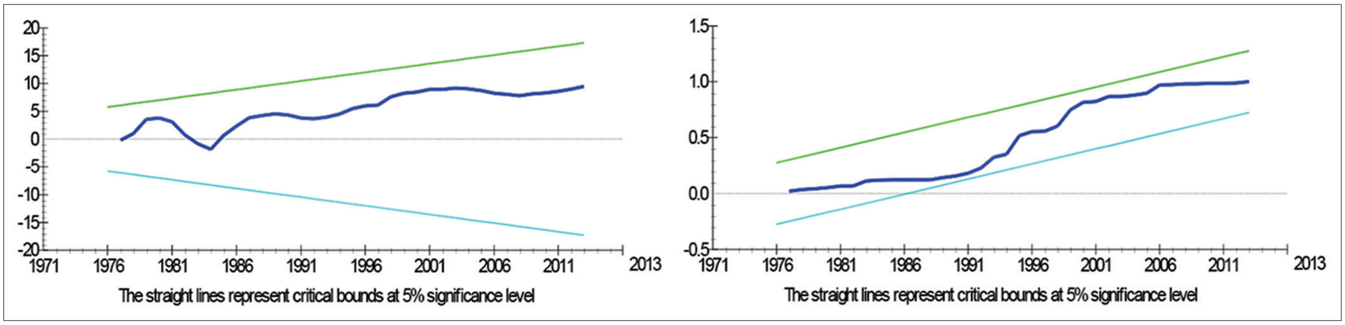
Source: The results of Table 5

Table 5: The multivariate granger causality results

Models	Short-run causality					Long-run causality
	ΔLCO_{2t-1}	ΔLEC_{t-1}	$\Delta LGDP_{t-1}$	ΔLFD_{t-1}	ΔLUR_{t-1}	ecM_{t-1}
ΔLCO_{2t}	------	5.87**	4.21**	1.02	5.39**	-1.31***
ΔLEC_t	6.61**	------	2.00	1.79	5.45**	-0.50**
$\Delta LGDP_t$	3.31*	3.08*	------	3.19*	0.65	-0.61**
ΔLFD_t	3.11*	0.61	3.58*	-------	0.66	-0.22**
ΔLUR_t	3.34*	0.40	0.68	4.68*	-----	-0.14**

(1) ***, ** and * as defined in Table 2. (2) The short-run causality obtained from Wald Test. (3) The long-run causality obtained from ecM_{t-1}. (4) The optimal lag order is determined by AIC. **Source**: Output of E-views 7.2 econometric software. AIC: Akaike information criteria

Figure 8: Cumulative sum of recursive residuals and cumulative sum of squares of recursive residuals tests for the (1971-2013) period



Source: The Output of the Micro-fit 4.1 econometric software

variables for the LCO_2, LEC, LGDP, and LFD models at the 5% significance level. The findings unveiled that energy consumption, economic growth, and FD have a positive effect on CO_2 emissions whereas urbanization has a negative effect. In the short run, the variables display different levels of significance. However, energy consumption, GDP, and urbanization have a positive relationship with emissions; only the finnacial component shows a negative relation. The causality analysis exposed the bidirectional causality from CO_2 emissions to energy consumption, GDP, and urbanization. This means that two-way relationships exist among these variables and any change in one affects the others. There is unidirectional causality running from energy consumption to urbanization, GDP to energy consumption, FD to CO_2 emissions, and urbanization to FD.

Based on the overall results of the current study in Malaysia, challenges have increased due to rapid economic growth resulting in high urbanization, energy consumption, and CO_2 emissions. In this context, it is important for Malaysia to promote the ‘government take the lead’ measure to drive energy efficiency. The government should also engage in continuous cooperation with non-governmental bodies to promote energy efficiency and energy conservation measures in the residential sector. The increased energy demand in the country is expected to lead to both energy efficieny and new energy sources (Omri and Nguyen, 2015). Rafindadi and Ozturk (2015) highlighted that natural gas consumption and the economic growth nexus will enable the speedy actualization of the Kyoto target of reducing CO_2 emissions and ensure environmentally friendly working conditions. Various energy agencies, such as KeTHA, the Sustainable Energy Development Authority (SEDA), and the Suruhanjaya Tenaga (ST) Energy Commission, have undertaken joint efforts to establish a comprehensive national energy database to support the dissemination and distribution of energy statistics in Malaysia to local and international stakeholders and the public. This can help to enhance research work which will support effective long-term energy and environmental policy decisions.

In this context, the Eleventh Malaysian Plan (2015-2020) emphasizes energy security and economic efficiency as well as environmental and social considerations. The policy focuses on specifically four areas: green growth, sustainable methods of production to cut emissions, protection of natural resources, and strong responses to climate change challenges. The plan has further accelerated the urban and rural transformation process with a healthy environment. This means that the concept of cities as islands of privilege and opportunity is supported by indicators on health, education, and income, which generally reflect better outcomes in urban areas than rural areas. However, with increased globalization, the urban transition has widened the gaps between social groups and is making inequality more visible. Large cities generate creativity and solidarity, but also make conflicts more acute. Moreover, the eradication of poverty is also vital because measurement of poverty in both rural and urban areas is generally based on income, which does not necessarily provide an accurate picture of the scale and multidimensional nature of poverty. One view is that urban poverty is a transient phenomenon of rural-to-urban migration and will disappear as cities develop, thus absorbing the poor into the mainstream of urban society. This view is reflected in Malaysian national poverty reduction strategies, which tend to be rural-focused, with the result that interventions have had limited effect in reducing relative poverty, exclusion, and inequality in cities (Economic Planning Unit, 2015).

Furthermore, from the environmental perspective on FD, the findings show a strong co-integration. This justifies that any planned financial system must encourage economic growth through effective investment policies. Also, a developed financial sector promotes economic growth through investment channels. It also plays a vital role in cutting CO_2 emissions by applying eco-friendly techniques during production processes. Frankel and Romer (1999) argued that FD attracts FDI from the developed world to emerging economies. Moreover, the financial sector motivates local firms to adopt environmentally friendly techniques for production processes. This implies that a sound financial sector can improve environmental quality through the new-technology-using effect but this effect is nullified during periods of financial instability. Regarding the financial element in an economy, Shahbaz (2013) argued that to avoid financial instability and its impact on environmental degradation, financial sector reforms should be implemented step by step with great care.

In Malaysia, the financial sector promotes many investment schemes in green technology. In 2010, Green Technology Malaysia (2016) established the Green Technology Financing Scheme (GTFS) to accelerate expansion of the green technology industry in the country by providing easier access to financing from financial institutions. RM3.5 billion in loans was allocated for use through 2015. The Scheme, which targets both producers and users of green technology, offers a rebate of 2% per annum on the interest rate or profit rate charged by the financial institutions and a government guarantee of 60% on the financed amount. Moreover, Bank Negara Malaysia has worked closely with the Ministry of Finance and the Ministry of Energy, Green Technology, and Water to establish the GTFS. Efforts are also underway to strengthen the capacity of financial institutions to provide advisory support to businesses. To achieve comprehensive financial allocation of green technology funds, the various phases consist of research and development, manufacturing processes, and end-use technology.

Last, from the urbanization perspective, our analysis elaborated that with urban expansion there is an element of modernazation in Malayisa, but in the long run this needs careful planning. UNHABITAT (2016a and 2016b) highlighted the national urbanization policy which aimed to ensure that urban centers play an optimal role as engines of the nation's economic growth by providing a high quality of life through a systematic and planned urbanization process. Overall, city growth provides opportunities for modernization and cultural enrichment and accelerates social change. Rapidly growing cities, especially larger ones, include various generations of migrants, each with a diversity of social and cultural backgrounds. A diverse global network of vibrant cities needs continual adjustment and adaptation to the mix of traditional values and contemporary perspectives of communities and governments. The creation of cities with a vision which supports harmonious communities and living conditions through sustainable urban development is beneficial. Both urbanization and globalization have brought drastic changes to the image of major cities, as justified in UET theory, which suggests that urbanization policy should consider land use which reduces emissions and will lead to achieving future green technology targets in Malaysia. This can result in sustainable green energy growth. Various environmental challenges still exist in Malaysia that are related to urban sprawl; these can be handled by effective policy initiatives. The World Bank (2015) highlighted that Malaysia needs to establish lead transport agencies at the metropolitan level to spearhead integrated approaches to the planning and delivery of both public and private urban transport, identify and implement sustainable financing mechanisms, and align public transport with incentives to discourage the use of private transport in congested areas, such as London, Singapore, and other major world cities have done successfully. This includes projects such as mass rapid transit construction and establishment of the Land Public Transport Commission (SPAD), which has developed into a capable, multi-disciplinary planning and regulatory agency. Institutional challenges remain, but further policy steps can ensure that urban transport planning is integrated across modes and administrative boundaries at the metropolitan level.

In Malaysia, most urban centres are still weak at portraying a distinct identity and exceptional character. The influx of external influence has created more cities with a global character, such as Kuala Lumpur, Georgetown, and Johor Bahru. With the rapid pace of urbanization expected by 2020, urban governance will face various complex challenges ahead. These challenges require that the respective parties be more focused in undertaking each and every responsibility in urban development. However, the involvement of multiple agencies and departments in urban management has made it difficult to coordinate many actions and in turn compromises the effectiveness of those actions. To strengthen Malaysia's role in the new urban agenda, the best opportunity is to collaborate with United Nations – Habitat. To this end, Malaysia will host the World Urban Forum (WUF9) in 2018. The government of Malaysia hopes that by hosting WUF9, a major and concrete legacy will be created for sustainable urban communities (UNHABITAT, 2016b).

The present study opens up new dimensions for future research; for example, the model used for this paper can be improved by including other variables (e.g., governance, institutional quality, political scenarios, credit management) to examine their impact on CO_2 emissions. This idea can be enhanced to investigate the effect of the US financial crisis on environmental degradation in developed and developing economies (Bekhet and Yasmin, 2014). The availability of data on domestic credit to the private sector at the provincial level will make it possible to conduct a study to examine the effect of financial instability on the environment at the provincial level. This might provide new ways for policy makers to develop sound financial markets to contribute to saving the environment.

REFERENCES

Alam, A., Malik, I.A., Abdullah, A.B., Hassan, A., Faridullah, Awan, U., Ali, G., Zaman, K., Naseem, I. (2015), Does financial development contribute to SAARC′S energy demand? From energy crisis to energy reforms. Renewable and Sustainable Energy Reviews, 41, 818-829.

Al-Mulali, U., Ozturk, I. (2015), The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North African) region. Energy, 84, 382-389.

Al-Mulali, U., Ozturk, I. (2016), The investigation of environmental Kuznets Curve hypothesis in the advanced economies: The role of energy prices. Renewable and Sustainable Energy Reviews, 54, 1622-1631.

Al-Mulali, U., Sab, C.N.B., Fereidoun, H.G. (2012), Exploring the bi-directional long run relationship between urbanization, energy consumption, and carbon dioxide emission. Energy, 46, 156-167.

Al-Mulalia, U., Ozturk, I., Solarin, S.A. (2016), Investigating the environmental Kuznets Curve hypothesis in seven regions: The role of renewable energy. Ecological Indicators, 67, 267-282.

Apergis, N. (2016), Environmental Kuznets Curves: New evidence on both panel and country-level CO_2 emissions. Energy Economics, 54, 263-271.

Azam, M., Khan, A.Q., Zaman, K., Ahmad, M. (2015), Factors determining energy consumption: Evidence from Indonesia, Malaysia and Thailand. Renewable and Sustainable Energy Reviews, 42, 1123-1131.

Azlina, A.A., Law, S.H., Mustapha, N.H.N. (2014), Dynamic linkages among transport energy consumption, income and CO_2 emission in Malaysia. Energy Policy, 73, 598-606.

Bai, X., Imura, H. (2000), A comparative study of urban environment in East Asia: Stage model of urban environmental evolution. International Review for Environmental Strategies, 1, 135-158.

Banerjee, A., Dolado, J.J., Mestre, R. (1998), Error-correction mechanism tests for co-integration in a single-equation framework. Journal of Time Series Analysis, 19, 267-283.

Bank Negara Malaysia, N.M. (2015), Economic and Financial Developments in Malaysia in the Second Quarter of 2015. Available from: http://www.bnm.gov.my/files/publication. [Last accessed on 2016 Jan 10].

Bastola, U., Sapkota, P. (2015), Relationships among energy consumption, pollution emission, and economic growth in Nepal. Energy, 80, 254-262.

Begum, R.A., Sohag, K., Abdullah, S.M.S., Jaafar, M. (2015), CO_2 emissions, energy consumption, economic and population growth in Malaysia. Renewable and Sustainable Energy Reviews, 41, 594-601.

Bekhet, H.A. Abdul, L.N.W. (2018), The impact of technological innovation and governance institution quality on Malaysia's sustainable growth: Evidence from a dynamic relationship. Technology in Society, 54, 27-40.

Bekhet, H.A., Al-Smadi, R. W. (2014), Determining the causality relationships among FDI determinants: Evidence from Jordan. International Journal of Sustainable Economy, 6, 261-274.

Bekhet, H.A., Al-Smadi, R.W. (2015), Determinants of Jordanian foreign direct investment inflows: Bounds testing approach. Economic Modelling, 46, 27-35.

Bekhet, H.A., Harun, N.H. (2017), Elasticity and causality among electricity generation from renewable energy and its determinants in Malaysia. International Journal of Energy Economics and Policy, 7(2), 202-216.

Bekhet, H.A., Othman, N.S. (2011), Causality analysis among electricity consumption, consumer expenditure, gross domestic product (GDP) and foreign direct investment (FDI): Case study of Malaysia. Journal of Economics and International Finance, 3(4), 228-235.

Bekhet, H.A., Othman, N.S. (2014), Long-run elasticities of electricity consumption, FDI, export and GDP in Malaysia. International Journal of Economics and Finance, 6(8), 78-90.

Bekhet, H.A., Othman, N.S. (2017), Impact of urbanization growth on Malaysia CO_2 emissions: Evidence from the dynamic relationship. Journal of Cleaner Production, 154, 374-388.

Bekhet, H.A., Othman, N.S. (2018), The role of renewable energy to validate dynamic interaction between CO_2 emissions and GDP toward sustainable development in Malaysia. Energy Economics, 72(C), 47-61.

Bekhet, H.A., Yasmin, T. (2013a), Exploring EKC, trends of growth patterns and air pollutants concentration level in Malaysia: A nemerow index approach. IOP conference Series: Earth and Environmental Science, 16, 012015.

Bekhet, H.A., Yasmin, T. (2013b), Disclosing the relationship among CO_2 emissions, energy consumption, economic growth and bilateral trade between Singapore and Malaysia: An Econometric Analysis. International Journal of Social, Human Science and Engineering, 7, 50-55.

Bekhet, H.A., Yasmin, T. (2014), Assessment the global financial crisis effects on energy consumption and economic growth in Malaysia: An input-output analysis. International Economics, 140, 49-70.

Bilgili, F., Koçak, E., Bulut, U. (2016), The dynamic impact of renewable energy consumption on CO_2 emissions: A revisited environmental Kuznets Curve approach. Renewable and Sustainable Energy Reviews, 54, 838-845.

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

Brandon, C. (1994), Reversing pollution trends in Asia. Finance and Development, 31, 21-23.

Brooks, C. (2008), RATS Handbook to Accompany Introductory Econometrics for Finance. Cambridge: Cambridge University Press.

Brown, D., McGranahan, G. (2016), The urban informal economy, local inclusion and achieving a global green transformation. Habitat International, 53, 97-105.

Caraiani, C., Lungu, C.I., Dascălu, C. (2015), Energy consumption and GDP causality: A three-step analysis for emerging European countries. Renewable and Sustainable Energy Reviews, 44, 198-210.

Chang, S. (2015), Effects of financial developments and income on energy consumption. International Review of Economics and Finance, 35, 28-44.

Chen, M., Liu, W., Lu, D. (2016), Challenges and the way forward in China's new-type urbanization. Land Use Policy, 55, 334-339.

Choe, K., Laquian, A.A. (2008), City Cluster Development (CCD): Towards an Urban-led Development Strategy for Asia. Manila: Asian Development Bank.

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

Dickey, D.A., Fuller, W.A. (1981), The likelihood ratio statistics for autoregressive time series with a unit root. Econometrica: Journal of the Econometric Society, 49, 1057-1072.

Dietz, T., Rosa, E.A. (1997), Effects of population and affluence on CO_2 emissions. Proceedings of the National Academy of Sciences, 94, 175-179.

Economic Planning Unit. (2010), Tenth Malaysian Plan (2011-2015). Available from: http://www.onlineapps.epu.gov.my/rmke10/rmke10_english.html. [Last accessed on 2016 Jan 10].

Economic Planning Unit. (2015), Eleventh Malaysian Plan (2015-2020). Available from: http://www.rmk11.epu.gov.my/book/eng/Elevent-Malaysia-Plan/RMKe-11%20Book.pdf. [Last accessed on 2016 Jan 10].

Ehrlich, P.R., Holdren, J.P. (1971), Impact of population growth. Science, 171, 1212-1217.

Ekins, P. (1997), The Kuznets Curve for the environment and economic growth: Examining the evidence. Environment and Planning A, 29, 805-830.

Ekins, P. (2000), Economic Growth and Environmental Sustainability: The Prospects for Green Growth. New York, USA: Routledge.

Elias, R., Victor, D. (2005), Energy Transitions in Developing Countries: A Review of Concepts and Literature: Publication Number WP-40, Program on Energy and Sustainable Development. USA: Stanford University.

Engle, R.E., Granger, C.W.J. (1987), Co-integration and error correction: Representation, estimation and testing. Econometrica, 55, 251-276.

Esteve, V., Tamarit, C. (2012), Threshold cointegration and nonlinear adjustment between CO_2 and income: The environmental Kuznets Curve in Spain, 1857-2007. Energy Economics, 34, 2148-2156.

Farhani, S., Chaibi, A., Rault, C. (2014), CO_2 emissions, output, energy consumption, and trade in Tunisia. Economic Modelling, 38, 426-434.

Frankel, J., Romer, D. (1999), Does trade cause growth? American Economic Review, 89, 379-399.

Green Technology Malaysia. (2016), Green Technology Financing Scheme (GTFS). Available from: https://www.gtfs.my/news/green-technology-financing-scheme-gtfs. [Last accessed on 2016 May 20].

Halicioglu, F. (2009), An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37, 1156-1164.

Hamdi, H., Sbia, R., Shahbaz, M. (2014), The nexus between electricity consumption and economic growth in Bahrain. Economic Modelling, 38, 227-237.

Hamit-Haggar, M. (2012), Greenhouse gas emissions, energy consumption and economic growth: A panel cointegration analysis from Canadian industrial sector perspective. Energy Economics, 34, 358-364.

He, C., Chen, T., Mao, X., Zhou, Y. (2016), Economic transition, urbanization and population redistribution in China. Habitat International, 51, 39-47.

He, Z., Xu, S., Shen, W., Long, R., Chen, H. (2016), Impact of urbanization on energy related CO_2 emission at different development levels: Regional difference in China based on panel estimation. Journal of Cleaner Production, 140, 1719-1730.

Heidari, H., Katircioglu, S.T., Saeidpour, L. (2015), Economic growth, CO_2 emissions, and energy consumption in the five ASEAN countries. Electrical Power and Energy Systems, 64, 785-791.

Hossain, M.S. (2011), Panel estimation for CO_2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries. Energy Policy, 39, 6991-6999.

International Energy Agency. (2014), World Energy Outlook 2014 Factsheet Power and renewable. Available from: https://www.iea.org/media/news/2014/. [Last accessed on 2015 Dec 10].

International Energy Agency. (2015a), Global Energy-related Emissions of Carbon Dioxide Stalled in 2014. Available from: http://www.iea.org/newsroom. [Last accessed on 2015 Dec 10].

International Energy Agency. (2015b), Southeast Asia Energy Outlook 2015. Available from: https://www.iea./weo2015_southeastasia.pdf. [last accessed on 2016 Jun 19].

Islam, F., Shahbaz, M., Ahmed, A.U., Alam, M.M. (2013), Financial development and energy consumption nexus in Malaysia: A multivariate time series analysis. Economic Modelling, 30, 435-441.

Iwata, H., Okada, K., Samreth, S. (2010), Empirical study on the environmental Kuznets Curve for CO_2 in France: The role of nuclear energy. Energy Policy, 38, 4057-4063.

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

Johansen, S. (1991), Estimation and hypothesis testing of co-integration vectors in gaussian vector autoregressive models. Econometrica: Journal of the Econometric Society, 59, 1551-1580.

Johansen, S., Juselius, K. (1990), Maximum likelihood estimation and inference on co-integration with applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52, 169-210.

Kalimeris, P., Richardson, C., Bithas, K. (2014), A meta-analysis investigation of the direction of the energy-GDP causal relationship: Implications for the growth-degrowth dialogue. Journal of Cleaner Production, 67, 1-13.

Khan, S.A.R., Zaman, K., Zhang, Y. (2016), The relationship between energy-resource depletion, climate change, health resources and the environmental Kuznets Curve: Evidence from the panel of selected developed countries. Renewable and Sustainable Energy Reviews, 62, 468-477.

Kivyiro, P., Arminen, H. (2014), Carbon dioxide emissions, energy consumption, economic growth, and foreign direct investment: Causality analysis for Sub-Saharan Africa. Energy, 74, 595-606.

Komal, R., Abbas, F. (2015), Linking financial development, economic growth and energy consumption in Pakistan. Renewable and Sustainable Energy Reviews, 44, 211-220.

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

Lang, W., Chen, T., Li, X. (2016), A new style of urbanization in China: Transformation of urban rural communities. Habitat International, 55, 1-9.

Lau, L., Choong, C., Eng, Y. (2014), Investigation of the environmental Kuznets Curve for carbon emissions in Malaysia: Do foreign direct investment and trade matter? Energy Policy, 68, 490-497.

Lin, B., Moubarak, M. (2014), Renewable energy consumption economic growth nexus for China. Renewable and Sustainable Energy Reviews, 40, 111-117.

Liu, Y., Xie, Y. (2013), Asymmetric adjustment of the dynamic relationship between energy intensity and urbanization in China. Energy Economics, 36, 43-54.

Ma, B. (2015), Does urbanization affect energy intensities across provinces in China? Long-run elasticities estimation using dynamic panels with heterogeneous slopes. Energy Economics, 49, 390-401.

Mahalik, M.K., Babu, M.S., Loganathan, N., Shahbaz, M. (2017), Does financial development intensify energy consumption in Saudi Arabia? Renewable and Sustainable Energy Reviews, 75, 1022-1034.

Marcotullio, P.J. (2003), Globalization, urban form and environmental conditions in Asia Pacific cities. Urban Studies, 40, 219-247.

Marcotullio, P.J., Lee, Y.S.F. (2003), Urban environment transitions and urban transportation systems: A comparison of North American and Asian experiences. International Development Planning Review, 25, 325-354.

McGranahan, G., Songsor, J. (1994), Wealth, health and the urban household: Weighing environmental burden in Jakarta, Accra, Sao Paulo. Environment, 36, 40-45.

McGranahan, G., Songsor, J., Surjadi, C., Kjellen, M., Jacobi, P. (2001), The Citizens at Risk: From Urban Sanitation to Sustainable Cities (Earths Can Risk in Society). London: Routledge.

Morris, K.I., Chan, A., Salleh, S.A., Ooi, M.C.G., Oozeer, M.Y., Abakr, Y.A. (2016), Numerical study on the Urbanisation of Putrajaya and its interaction with the local climate, over a decade. Urban Climate, 16, 1-24.

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

Omri, A., Kahouli, B. (2014), Causal relationships between energy consumption, foreign direct investment and economic growth: Fresh evidence from dynamic simultaneous-equations models. Energy Policy, 67, 913-922.

Omri, A., Nguyen, D.K. (2015), On the determinants of renewable energy consumption: International evidence. Energy, 72, 554-560.

Ozbugday, F.C., Erbas, B.C. (2015), How effective are energy efficiency and renewable energy in curbing CO_2 emissions in the long run? A heterogeneous panel data analysis. Energy, 82, 734-745.

Ozturk, I., Acaravci, A. (2010), CO_2 emissions, energy consumption and economic growth in turkey. Renewable and Sustainable Energy Reviews, 14, 3220-3225.

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.

Ozturk, I., Al-Mulali, U. (2015), Investigating the validity of the environmental Kuznets Curve hypothesis in Cambodia. Ecological Indicators, 57, 324-330.

Pao, H.T., Yu, H.C., Yang, Y.H. (2011), Modeling the CO_2 emissions, energy use, and economic growth in Russia. Energy, 36, 5094-5100.

Pesaran, M., Pesaran, B. (1997), Micro-fit 4.0, Interactive Econometric Analysis. New York, USA: Oxford University Press.

Pesaran, M.H., Shin, Y. (1999), An autoregressive distributed lag modeling approach to co-integration analysis. In: Strom, S., editor. Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium. Ch. 11. Cambridge, UK: Cambridge University Press.

Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16, 289-326.

Phillip, P.C.B., Perron, P., (1988), Testing for a unit root in time series. Biometrika, 75(2), 335-346.

Poumanyvong, P., Kaneko, S. (2010), Does urbanization lead to less energy use and lower CO_2 emissions? A cross-country analysis. Ecological Economics, 70, 434-444.

Poumanyvong, P., Kaneko, S., Dhakal, S. (2012), Impact of urbanisation on national transport and road energy use: Evidence from low, middle and high income countries. Energy Policy, 46, 208-277.

Rafindadi, A.A., Ozturk, I. (2015), Natural gas consumption and economic growth nexus: Is the 10th Malaysian plan attainable within the limits of its resource? Renewable and Sustainable Energy Reviews, 49, 1221-1232.

Rafiq, S., Salim, R., Nielsen, I. (2016), Urbanization, openness, emissions, and energy intensity: A study of increasingly urbanized emerging economies. Energy Economics, 56, 20-28.

Ren, L., Wang, W., Wang, J., Liu, R., (2015), Analysis of energy consumption and carbon emission during the urbanization of Shandong Province, China. Journal of Cleaner Production, 103, 534-541.

Saboori, B., Sulaiman, J. (2013), Environmental degradation, economic growth and energy consumption: Evidence of the environmental Kuznets Curve in Malaysia. Energy Policy, 60, 892-905.

Saboori, B., Sulaiman, J., Mohd, S. (2012), Economic growth and CO_2 emissions in Malaysia: A cointegration analysis of the Environmental Kuznets Curve. Energy Policy, 51, 184-191.

Sadorsky, P. (2014a), The effect of urbanization on CO_2 emissions in emerging economies. Energy Economics, 41, 147-153.

Sadorsky, P. (2014b), The effect of urbanization and industrialization on energy use in emerging economies: Implications for sustainable development. American Journal of Economics and Sociology, 73, 392-409.

Saidi, K., Hammami, S. (2015), The impact of energy consumption and CO_2 emissions on economic growth: Fresh evidence from dynamic simultaneous-equations models. Sustainable Cities and Society, 14, 178-186.

Salahuddin, M., Gow, J. (2014), Economic growth, energy consumption and CO_2 emissions in Gulf Cooperation Council countries. Energy, 37, 44-58.

Sebri, M., Ben-Salha, O. (2014), On the causal dynamics between economic growth, renewable energy consumption, CO_2 emissions and trade openness: Fresh evidence from BRICS countries. Renewable and Sustainable Energy Reviews, 39, 14-23.

Shahbaz, M. (2013), Does financial instability increase environmental degradation? Fresh evidence from Pakistan. Economic Modelling, 33, 537-544.

Shahbaz, M., Khraief, N., Jemaa, M.M.B. (2015), On the causal nexus of road transport CO_2 emissions and macroeconomic variables in Tunisia: Evidence from combined co-integration tests. Renewable and Sustainable Energy Reviews, 51, 89-100.

Shahbaz, M., Khraief, N., Uddin, G.S., Ozturk, I. (2014), Environmental Kuznets Curve in an open economy: A bounds testing and causality analysis for Tunisia. Renewable and Sustainable Energy Reviews, 34, 325-336.

Shahbaz, M., Lean, H.H., Shabbir, M.S. (2012), Environmental Kuznets Curve hypothesis in Pakistan: Cointegration and Granger causality. Renewable and Sustainable Energy Reviews, 16, 2947-2953.

Shahbaz, M., Loganathan, N., Muzaffar, A.T., Ahmed, K., Jabran, M.A. (2016), How urbanization affects CO_2 emissions in Malaysia? The application of STIRPAT model. Renewable and Sustainable Energy Reviews, 57, 83-93.

Shahbaz, M., Loganathan, N., Sbia, R., Afza, T. (2015), The effect of urbanization, affluence and trade openness on energy consumption: A time series analysis in Malaysia. Renewable and Sustainable Energy Reviews, 47, 683-693.

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

Shahbaz, M., Solarin, S.A., Ozturk, I. (2016), Environmental Kuznets Curve hypothesis and the role of globalization in selected African countries. Ecological Indicator, 67, 623-636.

Sharma, S.S. (2011), Determinants of carbon dioxide emissions: Empirical evidence from 69 countries. Applied Energy, 88, 376-382.

Shen, J., Lin, L. (2016), State-sponsored and spontaneous urbanization in Fujian province of China, 1982-2010. Cities, 60, 420-427.

Shuid, S. (2016), The housing provision system in Malaysia. Habitat International, 54, 210-223.

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

Tan, Y., Xu, H., Zhang, X. (2016), Sustainable urbanization in China: A comprehensive literature review. Cities, 55, 82-93.

Tang, C.F., Tan, B.W. (2015), The impact of energy consumption, income and foreign direct investment on carbon dioxide emissions in Vietnam. Energy, 79, 447-454.

UN, Department of Economic and Social Affairs, Population Division. (2018), World Urbanization Prospects: The 2018 Revision, Methodology. Working Paper No. ESA/P/WP.252. New York: United Nations.

UNHABITAT. (2016a), National Urban Policy: A Guiding Framework. Available form: http://www.unhabitat.org/books/national-urban-policy-a-guiding-framework. [Last accessed on 2016 Jun 10].

UNHABITAT. (2016b), Kuala Lumpur to host World Urban Forum in 2018. Available from: http://www.unhabitat.org/kuala-lumpur-to-host-world-urban-forum-in-2018. [Last accessed on 2016 Jun 10].

Wang, Q. (2014), Effects of urbanization on energy consumption in China. Energy Policy, 65, 332-339.

Wang, Q., Wu, S., Zeng, Y., Wu, B. (2016), Exploring the relationship between urbanization, energy consumption, and CO_2 emissions in different provinces of China. Renewable and Sustainable Energy Reviews, 54, 1563-1579.

Wang, S., Fang, C., Guan, X., Pang, B., Ma, H. (2015), Urbanisation, energy consumption, and carbon dioxide emissions in China: A panel data analysis of China's provinces. Applied Energy, 136, 738-749.

Wang, Y., Chen, L., Kubota, J. (2016), The relationship between urbanization, energy use and carbon emissions: Evidence from a panel of Association of Southeast Asian Nations (ASEAN) countries. Journal of Cleaner Production, 112, 1368-1374.

Woetzel, J., Tonby, O., Thompson, F., Burtt, P., Lee, G. (2014), Southeast Asia at the crossroads: Three paths to prosperity. New York: The McKinsey Global Institute. p1-180.

World Bank. (1992), World Development Report 1992: Development and the Environment. Available from: https://www.openknowledge.worldbank.org/handle/10986/5975. [Last accessed on 2016 Apr 15].

World Bank. (2015), Integrated, Local-level Planning can Reduce High Costs of Congestion and Boost Growth in Malaysia. Available from: http://www.worldbank.org/en/news/press-release. [Last accessed on 2015 Jun 16].

World Bank. (2019), World Development Indicators Database. Available from: http://www.data.worldbank.org/country/malaysia. [Last accessed on 2019 Feb 20].

Xu, B., Lin, B. (2015), How industrialization and urbanization process impacts on CO_2 emissions in China: Evidence from nonparametric additive regression models. Energy Economics, 48, 188-202.

Yang, J., Zhang, W., Zhang, Z. (2016), Impacts of urbanization on renewable energy consumption in China. Journal of Cleaner Production, 114, 443-451.

York, R., Rosa, E.A., Dietz, T. (2003), STIRPAT, IPAT and IMPACT: Analytic tools for unpacking the driving forces of environmental impacts. Ecological Economics, 46, 351-365.

Yue, S., Lu, R., Shen, Y., Chen, H. (2019), How does financial development affect energy consumption? Evidence from 21 transitional countries. Energy Policy, 130, 253-262.

Zhou, Y., Liu, Y., Wu, W., Li, Y. (2015), Effects of rural-urban development transformation on energy consumption and CO_2 emissions: A regional analysis in China. Renewable and Sustainable Energy Reviews, 52, 863-875.

Zi, C., Jie, W., Hong-Bo, C. (2016), CO_2 emissions and urbanization correlation in China based on threshold analysis. Ecological Indicators, 61, 193-201.

Ziaei, S.M. (2015), Effects of financial development indicators on energy consumption and CO_2 emission of European, East Asian and Oceania countries. Renewable and Sustainable Energy Reviews, 42, 752-759.

APPENDIX

Appendix 1: EKC application studies

Authors	Period	Country	Methodology	EKC	Variables Used	Causality
			A.Single Country			
Saboori and Sulaiman (2013)	1980–2009	Malaysia	ARDL bound testing approach, VECM granger causality	Not exist	CO_2, Energy consumption (EC), GDP and GDP^2	$GDP \leftrightarrow CO_2$ $GDP \leftrightarrow EC$
Saboori et al. (2012)	1980–2009	Malaysia	ARDL bound testing approach, VECM granger causality	Exist	CO_2 emission, Energy consumption, GDP and GDP^2	GDP---CO_2 (short run) $GDP \rightarrow CO_2$ (long run)
Lau et al. (2014)	1970–2008	Malaysia	ARDL bound testing approach, VECM granger causality	Exist	CO_2, GDP, GDP^2, Foreign direct investment and Trade	$GDP \leftrightarrow CO_2$, $FDI \rightarrow GDP$ $FDI \rightarrow CO_2$, $TRADE \rightarrow CO_2$
Azlina et al. (2014)	1975-2011	Malaysia	Johansen–Juselius co-integration tests, VECM granger causality	Not exist	CO_2, GDP, GDP^2, road sector energy consumption per capita (RES), IVA is a structural change in the economy, and CRE is renewable energy use.	$GDP \rightarrow CO_2$ $GDP \rightarrow RES$ $RES \rightarrow IVA$
Shahbaz et al. (2014)	1971–2010	Tunisia	ARDL bound testing approach, VECM granger causality, innovative accounting approach (IAA)	Exist	CO_2 emission, GDP, GDP^2, energy consumption and Trade	$CO_2 \leftrightarrow TRADE$
Esteve and Tamarit (2012)	1857–2007	Spain	Threshold cointegration, VECM granger causality	Exist	CO_2 emission, GDP and GDP^2	$GDP \leftrightarrow CO_2$
Tiwari et al. (2011)	1966–2011	India	ARDL bound testing approach, VECM granger causality	Exist	CO_2 emission, GDP, GDP^2, coal consumption, trade openness	$GDP \leftrightarrow CO_2$ Coal consumption$\leftrightarrow CO_2$ Trade openness$\leftrightarrow CO_2$
Shahbaz et al. (2012)	1971–2009	Pakistan	ARDL bound testing approach, VECM granger causality	Exist	CO_2 emission, GDP, GDP^2, energy consumption, trade openness	$GDP \rightarrow CO_2$
Iwata et al. (2010)	1960–2003	France	ARDL bound testing approach, VECM granger causality	Exist	CO_2 emission, GDP, GDP^2, energy consumption, Electricity produced from the nuclear source, trade openness, urbanization	$GDP \rightarrow CO_2$ Electricity produced from the nuclear source$\rightarrow CO_2$
Halicioglu (2009)	1960–2005	Turkey	ARDL bounds testing approach, VECM Granger causality.	Exist	CO_2 emission, GDP, GDP^2 , energy consumption and trade openness	$CO_2 \leftrightarrow EC$
Ozturk and Acaravci 2010)	1968–2005	Turkey	ARDL bounds testing approach, VECM Granger causality	Not Exist	CO_2 emission, GDP, GDP^2 , energy consumption and employment	CO_2---EC
Ozturk and Acaravci (2013)	1960–2007	Turkey	ARDL bounds testing approach, VECM Granger causality	Exist	CO_2 emission, GDP, GDP^2 , energy consumption, Financial development (FD) and trade	$GDP \rightarrow CO_2$ $EC \rightarrow CO_2$, $FD \rightarrow CO_2$
Ozturk and Al-Mulali (2015)	1996-2012	Cambodia	Generalized Method of Moments	Exist	CO_2 emission, GDP, GDP^2 , energy consumption, trade openness and urbanization	--------

(Contd...)

Appendix 1: (Continued)

Authors	Period	Country	Methodology	EKC	Variables Used	Causality
A.Single Country						
Shahbaz et al. (2013)	1970–2010	Romania	ARDL bound testing approach, VECM granger causality	Exist	CO_2 emission, GDP, GDP^2 , energy intensity, Financial development (FD)	Energy intensity↔CO_2
Pao et al. (2011)	1990–2007	Russia	Johansen co-integration, OLS model, and VECM Granger causality.	Not Exist	CO_2 emission, GDP, GDP^2 , energy consumption	CO_2↔EC
Hamit-Haggar (2012)	1990–2007	Canada	Pedroni co-integration test, fully modified OLS (FMOLS), VECM Granger causality.	Exist	CO_2 emission, GDP, GDP^2 , energy consumption	EC→CO_2 GDP→CO_2
Tang and Tan (2015)	1976-2009	Vietnam	Multivariate Johansen co-integration test,	Exist	CO_2 emission, GDP, GDP^2, EC, FDI	GDP↔CO_2, FDI↔CO_2
Javid and Sharif (2016)	1972–2013	Pakistan	ARDL bound testing approach, VECM granger causality	Exist	CO_2 emission, energy consumption, GDP, GDP^2 , trade openness, financial development (FD)	CO_2↔EC, FD→EC
B. Pana Data						
Al-Mulali et al. (2016)	1980–2010	107 Countries[1]	Panel Data Analysis, Pedroni co-integration, fully modified OLS, and VECM Granger causality.	Exist: inEast Asia and the Pacific, Western Europe, East Europe and Central Asia, The Americas		Western Europe, East Asia and the Pacific, Middle East and North Africa CO_2↔EC, CO_2↔GDP URB↔ CO_2, GDP→FD
				Not Exist: Middle East and North Africa and Sub Saharan Africa	CO_2 emission, energy consumption, GDP, GDP^2 , urbanization (UR), trade openness, financial development (FD)	South Asia CO_2↔FD, URB↔ GDP CO_2↔EC Americas GDP→CO_2, TR→CO_2 GDP→URB, GDP→FD Sub Saharan Africa CO_2↔EC, CO_2↔GDP GDP →TR, GDP→URB GDP →FD
Al-Mulaliand Ozturk (2016)	1990–2012	Advanced economies[2]	Panel Data Analysis, Pedroni co-integration, fully modified OLS, and VECM Granger causality.	Exist in 27 advanced economies	CO_2 emission, electricity consumption, GDP, GDP^2 , urbanization, trade (TR), energy prices (EP)	CO_2↔EC, CO_2↔GDP TR→CO_2, URB→ CO_2 EP→ CO_2
Shahbaz et al. (2016)	1971–2012	African countries[3]	Panel Co-integration, Bayer and Hanck co-integration	Exist in Africa, Algeria, Cameroon, Congo Republic, Morocco, Tunisia and Zambia	GDP, GDP^2, energy intensity (EI), globalization (G)	No causality application

(Contd...)

Appendix 1: (Continued)

Authors	Period	Country	Methodology	EKC	Variables Used	Causality
			B. Pana Data			
Apergis (2016)	1960–2013	15 Countries[4]	Panel Data Analysis, Common Correlated Effects (CCE), the Fully Modified, OLS (FMOLS) and the quantile estimation procedures	Exist in Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK, US, Belgium, Canada, Denmark, Finland	CO_2 emission, GDP, GDP^2, CPI, Population	No causality application
Bilgili et al. (2016)	1977–2010	17 OECD countries[5]	Panel Data Analysis, Common Correlated Effects (CCE), the Fully Modified, OLS (FMOLS) and the quantile estimation procedures	Exist in Denmark, France, Greece, Netherlands and Sweden	CO_2 emission, GDP, GDP^2, Renewable Energy (RE)	No causality application
Khan et al. (2016)	2000-2013	Developed countries[6]	Panel Generalized Method of Moments (GMM)	Exist in countries	CO_2 emission, GDP, GDP^2, fossil fuel energy Consumption (F), energy use	No causality application

→ represents unidirectional causality; ↔ displays bi directional causality and --- shows no causality.

[1] East Asia and the Pacific, Western Europe, East Europe and Central Asia, The Americas, Middle East and North Africa, South Asia, Sub Saharan Africa

[2] Austria, Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, Latvia, Netherlands, New Zeal- and, Norway, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, United Kingdom, and the United States of America.

[3] Africa, Algeria, Angola, Cameroon, Congo Republic, Ghana, Kenya, Libya, Morocco, Nigeria, South Africa, Sudan, Tanzania, Togo, Tunisia, Zambia and Zimbabwe.

[4] Austria, Belgium, Canada, Denmark, Finland, France, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, UK, US

[5] Australia, [4]Austria, Belgium, Canada, Denmark, Finland, France, Greece, Italy, Luxemburg, Netherlands, New Zealand, Norway, Portugal, Sweden, Turkey, USA.

[6] Austria, Czech Republic, Estonia, Germany, Ireland, Lithuania, Poland, Slovenia, and Slovak Republic.