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Financial Development, Economic Growth, and Energy Consumption Nexus: A Survey Literature

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ABSTRACT

This paper explores the several hypotheses supported by the causal relationship between economic growth, financial development, FDI, electricity consumption, and energy consumption along with a survey of the empirical studies. This survey centers on variables selected, econometric approaches, country coverage, various methodologies, and empirical results. The results are indeed mixed across the 103 studies in the two previous tables across more than 100 countries reported. The results of the specific studies surveyed show that 59% supported the unidirectional hypothesis; 34% the bidirectional hypothesis; and 7% the neutrality (non causality) hypothesis.

Keywords: Energy consumption, Economic growth, Granger-causality, Financial development, Electricity consumption.

H I G H L I G H T S

- The energy and electricity consumption; financial development; and economic growth nexus have been examined for various countries.
- Recently, the energy economics papers have focused on some new variables like trade openess, foregin direct investment, CO_2 emissions, and tourism.
- The results are indeed mixed across the 103 studies in the two previous tables across more than 100 countries reported.

1. Introduction

It is widely debated that energy consumption plays essential role in both the consumption and production of goods and services within an economy all over the world. So far, this relationship has been investigated in different perspectives with different variables. The first perspective of literature has discussed the interrelationship among economic growth includes financial development (FD), trade openness, foreign direct investment (FDI), and energy consumption (EC). For instance, (see, Kraft and Kraft, 1978; Yang, 2000; Yoo, 2005; Tang, 2008; Lee and Chang, 2008; Ozturk et al., 2010; Ciarreta and Zarraga, 2010; Shahbaz et al., 2011; Sami, 2011; Kouakou, 2011; Adom, 2011; Shahbaz et al., 2012; Shahbaz and Feridun, 2012; Haggar, 2012; Boutabba, 2014).

The second perspective has debated the interrelationship among electricity consumption (ELC), carbon dioxide emissions (CO_2), and economic growth (e.g., Fatai, et al., 2004; Morimoto and Hope, 2004; Jumbe , 2004; Narayan and Smyth, 2005; Squalli, 2007; Mozumder and Marathe, 2007; Ghosh, 2009; Thoma, 2004; Chen et al., 2007; Narayan and Prasad, 2008; Shahbaz et al., 2014; Hamdi et al., 2014). For many countries, the causal relationship may be one from energy consumption to economic growth, economic growth to energy consumption, in either directions, or the absence of causality entirely. On the other hand, causal relationship runs from electricity consumption to economic growth and from economic growth to electricity consumption. Actually, examining the causal relationship between energy, electricity consumption, CO_2 emissions, economic growth, FD, and FDI are very important in the strategy and performance of environmental and energy policies.

The causal relationship between economic growth and energy consumption has been synthesized into three testable hypothesizes within the literature: First, the growth hypothesis asserts unidirectional causality from energy and electricity consumption to economic growth. If such is the case, the reduction in energy consumption may have a prejudicial impact on economic growth. For example, Aqeel and Butt (2001); Altinay and Karagol (2005); Lee and Chang (2005); Narayan and Singh (2007); Odhiambo (2009) in Pakistan; Turkey; Taiwan; Fiji; and Tanzania, respectively; Narayan and Smyth, (2005); Squalli, (2007); Mozumder and Marathe, (2007); and Ghosh, (2009) in Australia; Sri Lanka; Malawi; Algeria; Bangladesh; India, respectively. Suites and Sari (2007) suggested a unidirectional causality relationship from electricity consumption to value added in Turkey. Zamani (2007) found a unidirectional causality running from GDP to EC in Iran during the 1976-2003 period. In Pakistan, Jamil and Ahmad (2010) found a unidirectional causality relationship run from economic growth to energy consumption, the same results have been found by Ciarreta and Zarraga (2010); Adom (2011); Shahbaz and Feridun (2012). On the other hand, several studies have indicated unidirectional; causality relationships run from energy consumption to economic growth (see, Yoo, 2005; Aktas and Yilmaz, 2008; Gupta and Chandra, 2009; Kouakou ,2011).

Second, the bidirectional hypothesis asserts the interactional relationship between EC, electricity consumption, and economic growth in which causation known as bidirectional. Thus, under this hypothesis, an energy policy directed toward advancing in EC and electricity consumption efficiency may not negatively affect economic growth. In India suggested by Chen et al. (2007); in Hong Kong by Ho & Siu (2007); in China by Yuan et al. (2008). Nayaran & Smyth (2009) suggested a bidirectional causal relationship between per capita EPC and per capita real GDP in Saudi Arabia, Oman, Syria, Kuwait, Iran, and Israel. In the UK for example, Narayan and Prasad (2008) found that there is a strong bidirectional causality relationship between Electrical consumption and real GDP. Besides, the same result was suggested for the ASEAN 4 and Korea by Yoo (2006) and Yoo (2005) respectively. Zhixin and Xin (2011) suggested a long-run and bidirectional causality relationships between EC and the economic growth in China. Dagher and Yacoubian (2012) found a bidirectional causality relationship between EC and economic growth in Lebanon. The same results have been suggested by Ho and Siu (2008); Odhiambo (2010); Shahbaz et al. (2012); Shahbaz and Lean (2012); Nasreen and Anwar (2014).

Third, the neutrality hypothesis can be accepted in the case of the absence of any causal relationship between energy consumption, electricity consumption and economic growth. This result indicated by Akarca and Long (1980); Murray and Nan (1996) for Germany, Israel, Luxumoborg, Norway, UK, USA, and Zambia. In addition, the same result was indicated by Thoma (2004) in USA; Wolde-Rufael (2006) in Algeria; Chen et al. (2007) in China, Taiwan and Thailand. Narayan and Prasad (2008) found a neutral relationship between ELC and GDP in USA, Canada, Belgium, Denmark, Austria, France, Germany, Greece, Ierland, Japan, Luxembourg, New Zealand, Mexico, Poland, Norway, Turkey, Sweden, Switzerland, and Spain. Akpan and Akpan (2012) also found a neutral relationship between EC and economic growth in Nigeria. The main implication of the neutrality hypothesis is that energy conservation policies will have no effect on economic growth (Payne, 2010).

2. Economic growth and energy consumption

The relationship between energy consumption and economic growth has been discussed by tremendous studies. Some studies have chosen to explore single countries, while others have investigated many countries simultaneously in a panel data analysis framework. Some studies, like Fatai *et al*. (2004) compared the relationship between EC and GDP in New Zealand economy with Australia and different Asian economies. They suggested that energy conservation policies may not have significant impacts on GDP growth in New Zealand and Australia compared to some Asian economies. Lee and Chang (2005) found that the co-integration between EC and GDP in Taiwan is unstable, and some economic events may affect the stability between them. Hu and Lin (2008) confirmed a non-linear co-integration relationship between GDP and EC in Taiwan. Huang and Yang (2008) examined the relationship between GDP and EC for 82 countries by using panel data. They categorized the data into high income, upper middle income, lower middle income, and low income group. The results suggested that in the high income group countries the GDP leads EC negatively; while in the middle income group(upper and lower) the GDP leads EC positively; and there is no causal relationship between GDP and EC in the low income group. Sari and Soytas (2008) implied that employment and real output are long-run forcing variables for nearly all measures of disaggregating energy consumption in the United States. Wei *et al*. (2008) found a neutrality causal relationship between GDP and EC in the United States, South Korea, and Thailand. However, they detected a unidirectional causality running from GDP to EC in Philippines and Singapore. In addition, the EC may have affected GDP for, Malaysia, Hong Kong, Taiwan, and Indonesia. Yuan *et al*. (2008) suggested a short-run Granger causality runs from GDP to total energy consumption in China. In India Gosh, (2009) proposed the existence of a unidirectional long-run causality running from economic growth to crude oil import. Using a panel data for 51 countries, Ozturk *et al*. (2010) study revealed a bidirectional causality relationship between GDP and EC and a long-run causality relationship runs from GDP to EC for low income countries. Wolde-Rufael (2010) suggested a unidirectional causality relationship running from the nuclear EC to the GDP in India. Tsani

(2010) found the existence of a unidirectional causality relationship running from the total EC to the real economic growth in Greece. Eggoh *et al*. (2011) proposed a long-run equilibrium relationship between real GDP, EC, labor, capital, and prices for 21 African countries. In Canada, Haggar (2012) proposed a unidirectional causality relationship running from economic growth to the EC in the short-run and a unidirectional causality running from the EC to the economic growth and greenhouse gas emissions in the long-run. Pirlogea and Cicea (2012) suggested that EC affects the GDP in the short-run for Romania. Besides, they found a unidirectional causality between EC with GDP and natural gas in Spanish. Jr and Zoumara (2012) indicated a bidirectional causality relationship between energy consumption and economic growth in Liberia. Sebri and Abid (2012) proposed that both aggregated and disaggregated EC and trade openness Granger causes agricultural value added in Tunisia. Yildirim et al. (2012) found only one unidirectional causal relationship running from biomass-waste-derived energy consumption to real GDP in USA. Dergiades et al. (2013) indicated a unidirectional causal relationship running from total useful energy to economic growth in Greece. Islam et al. (2013) suggested that the EC is influenced by economic growth and financial development in Malaysia in short and long-run, but for the population-energy relationship holds only in the long-run. Shahbaz et al., (2013) investigated the relationship between CO2, financial development, energy consumption, and economic growth in Malaysia to answer the question does financial development decreases the CO_2?. They found a long-term relationship among the selected variables. Besides, their granger causality test indicated a bidirectional relationship between energy consumption and CO_2. Sbia et al., (2014) examined the relationship between economic growth and energy consumption, FDI, trade openness, and carbon dioxide emissions (CO_2) in UAE. Both of the ARDL and VECM approaches have been tested to analyse the co-integration and causality relationship among the variables. The results suggested a co-integration relationship among the variables with a positive impact on energy consumption. By using ARDL and Granger causality tests, Lau et al. (2014) investigated the relationship between FDI, CO_2, trade openness, and economic growth in Malaysia. The study confirmed the interrelationship between economic growth and the selected variables. Khan et al. (2014) found that FDI plays a vital role in increasing energy demand in both of high income, middle income OECD countries. On another study for Khan et al. (2014), they analyzed the causality relationship between economic growth, FDI, financial development (FD), and energy consumption. They found three unidirectional causality relationships run from GDP, FDI, and FD to energy consumption. Nasreen and Anwar (2014) examined the relationship between energy consumption, trade openness, and energy consumption of 15 Asian countries. Their panel Granger causality test suggested bidirectional relationships between energy consumption and economic growth, and between energy consumption with trade openness. Omri and Kahouli (2013) explored the interrelationship between economic growth, FDI, and energy consumption of 65 countries. They found bidirectional causality relationships among the selected three variables for the high-income countries. Besides, they suggested unidirectional causality relationships among the variables for the high and middle-income countries.

In MENA countries, Tang and Abosedra (2014) concluded that energy consumption, tourism, and political instability lead the economic growth. In India, Boutabba (2014) found causality and long-run relationships between energy consumption, FD, and trade openness. In OECD countries, Saboori et al., (2014) examined the causality relationship between CO_2, energy consumption, and economic growth. The result suggested a bidirectional relationship between CO_2 and economic growth.

The summary of studies on energy consumption and economic growth is given in Table 1.

Author	Country	Variables	Methodology	Causality results			
				EC→Y	Y→EC	EC↔Y	EC≠ Y
Khan et al. (2014)	South Asia	FDI, FD, EC, Y	ECM-Granger causality		√		
Sbia et al., (2014)	UAE	Trade openness, FDI, CO_2, EC, Y	ARDL		√		
Yang and Zhao (2014)	India	EC, CO_2, Y	Granger causality	√			
Yildrim et al. (2014)	11 countries	EC, Y	Bootstrapped autoregressive metric causality	√			
Saboori et al.(2014)	OECD	EC, CO_2, Y	VAR-Granger causality	√	√		
Nasreen and Anwar (2014)	Asian countries	Trade openness, EC, Y	VECM-Granger causality			√	
Boutabba (2014)	India	Trade openness, FD, EC, CO_2, Y	ARDL- VECM Granger causality		√		
Tang and Abosedra, (2014).	MENA	EC, Tourism, Y	GMM estimator	√			
Farhani et al., (2014)	MENA	Trade openness, CO_2, Y	Panel data analysis	√		√	
Shahbaz et al. (2014)	91 countries	Trade openness, EC, Y	Panel data analysis				
Shahbaz et al. (2013)	Malaysia	FDI, EC, Y	VECM-Granger causality			√	
Omri, (2013)	MENA	EC, CO_2, Y	Simultaneous equations models		√		
Omri and Kahouli (2013)	65 countries	FDI, EC, Y	Granger causality	√		√	
Al-mulalli and Tang (2013)	GCC	EC, Y	Panel data analysis		√		
Alkhathlan and Javid (2013)	Saudi Arabia	EC, CO_2, Y	ARDL	√			
Islam et al., (2013)	Malaysia	EC, Y, FD, population	VECM and Granger-Causality	√			
Haggar (2012)	Canada	EC, Y	Panel co-integration		√		
Yildirim et al. (2012)	USA	EC, Y	VAR-Granger causality	√			
Shahbaz and Feridun (2012)	Pakistan	EC,Y	ARDL		√		
Shahbaz et al. (2012)	Romania	EC, CO_2, Y	ARDL		√		
Dagher and Yacoubian, (2012)	Lebanon	EC, Y	ECM and Granger-Causality			√	
Akpan and Akpan (2012)	Nigeria	EC, CO_2, Y	ARDL- VECM Granger causality				√
Apergis and Payne (2012)	80 countries	EC, Y	Panel Analysis			√	
Magnani and Vaona (2011)	Italy	EC, Y	Granger causality	√			
Mengaki (2011)	27 European countries	EC, Y	Random effect model				√
Tiwari (2011a)	16 European countries	EC, CO_2, Y	VAR- Panel analysis			√	
Tiwari (2011b)	India	EC, CO2, Y	VAR			√	
Bobinaite et al. (2011)	Lithuania	EC, Y	J-J	√			
Acaravici and Ozturk (2010)	Europe	EC, Y	ARDL	√	√		√
Ozturk et al. (2010)	51 countries	EC, Y	Panel data analysis			√	
Odhiambo, (2010)	Sub-Saharan African countries	EC, Y, consumer price index	ARDL and Granger-Causality	√			
Wolde-Rufael, (2010)	India	Nuclear EC, Y, real gross fixed capital formation, labor force	ARDL and Granger-Causality	√			
Tsani, (2010)	Greece	EC, Y	Granger- Causality and	√			

			Toda and Yamamoto				
Gosh, (2009)	India	EC, Y, employment	ARDL		√		
Ziramba (2009)	South Africa	EC, Y	ARDL			√	
Sadorsky (2009)	18 countries	EC, CO2, Y	Panel analysis		√		
Payne (2009)	USA	EC, Y	Toda-Yamamoto causality				√
Hu and Lin (2008)	Taiwan	EC, Y	VECM		√		
Sari et al., (2008)	USA	EC, Y, employment	ARDL	√			
Huang et al. (2008)	82 countries	EC, Y	VAR			√	
Ewing et al., (2007)	USA	EC, Y	VAR	√			
Narayan and Smyth (2005)	Australia	EC, Y	ARDL		√		
Wolde-Rufael (2004)	China	EC, Y	Toda-yamamoto causality			√	
Ghali and El-Sakka (2004)	Canada	EC, Y	ECM			√	
Yang (2000)	Taiwan	EC, Y	Granger causality			√	
Akarca and Long (1980)	USA		Granger causality				√
Kraft and Kraft (1978)	USA	EC, Y	VAR- Granger causality		√		

Notes: 1. Abbreviations defined as follows: EC = energy consumption;Y = real or nominal GDP or GNP; IP
2. J-J = Johansen-Juselius; ARDL = Autoregressive distributed lags; VAR = Vector autoregressive; VECM = Vector autoregressive model.

3. Economic growth and electricity consumption

The relationship between ELC and economic growth has been intensively dedicated by numerous studies. Oztruk (2010) provided a survey of the literature to show the relationship between energy consumption and economic growth; electricity consumption and economic growth causality nexus. There are some other researchers who have highlighted this relation (see Wang et al., 2011; Iwata et al., 2010). Shahbaz et al., (2014) examined the interrelationship among FD, electricity consumption, and CO_2 in Bangladesh. Hamdi et al., (2014) used the ARDL and VECM models to investigate the relationship between economic grwoth, FDI, and electricity consumption in Bahrain. Their result suggested unidirectional causal relationships run from FDI and electricity consumption to economic growth. They found that FD and trade openness have a positive impact on energy pollutants. However, different researches have utilized time series models and Granger causality analysis to test the relationship between ELC and economic growth in different countries. Some studies have been based on the VAR model (e.g., Yang, 2000; Aqeel and Butt 2001; Ghosh, 2002; Thoma, 2004; Yoo, 2006; Huang et al., 2008; Lai et al., 2011). In addition, several studies have been used the VEC model (see, Jumbe, 2004; Shiu and Luan, 2004; Yoo, 2005; Lee and Chang, 2005; Ho and Siu, 2007; Muzamdir and Marathe, 2007; Soytas and Sari, 2007; Chen et al., 2007; Zamani, 2007; Yuan et al., 2008; Odhiambo, 2011; Narayan and Smyth, 2009; Yoo and Kwak, 2010; Bekhet and Othman, 2011; Islam et al., 2013). The following group of studies has employed the ARDL model, for instance, Fatai, et al.(2004); Narayan and Smyth (2005); Wolde-Rufael (2006); Squalli (2007); Narayan and Singh (2007); Tang (2008); Tang (2009); Ouédraogo (2010); Adom (2011); Shahbaz et al. (2011); Sami (2011); Shahbaz and Lean (2012); Hamdi et al. (2014). Cowan et al., (2014) investigated the causal relationship between CO_2, electricity consumption, and economic growth in BRICS countries of Brazil, Russia, India, China, and South Africa. Their results indicated that there a unidirectional relationship run from GDP to CO_2 in Russia and South Africa. In contrast, there is no any existence of this relationship found in China and India. In China, Wang et al., (2013) examined the relationship between CO_2 and economic growth. Their results suggested evidence that economic growth is a critical factor in the

CO_2 growth process, and energy intensity plays substantial role in reducing CO_2. In Malaysia, Bekhet and Othman (2011) analyzed the co-integration and causality relationships among ELC, Y, FDI, and consumer expenditure. They found a unidirectional causality relationship runs from EC to Y. In the case of 18 Latin American countries, Almulali et al. (2014) investigated the direction of the causality relationship between ELC and Y and found the feedback effect between both the variables with unidirectional runs from electricity consumption to economic growth. The same result has been found by different studies, for example, Sebri and Abid (2012); Pirlogea and Cicea (2012); Lai et al., (2011); Kouakou (2011); Yoo and Kwak (2010); Abosedra et al. (2009); Odhiambo, (2009); Tang, (2008); Narayan and Prasad (2008); Soytas and Sari (2007); Ho and Sui (2006); Lee and Chang (2005); Fatai, et al. (2004); Ghosh (2002); Aqeel Butt (2001). Narayan and Prasad (2008) indicated that a bootstrapped model may fail to capture causality between the electricity consumption and economic growth in Canada, USA, Belgium, Denmark, Austria, France, Germany, Greece, Ierland, Japan, Luxembourg, New Zealand, Mexico, Poland, Norway, Turkey, Sweden, Switzerland, and Spain. In contrast, their results suggested bidirectional causality in the UK, Iceland, and Korea, unidirectional causality runs from ELC to Y in Australia, Slovak Republic, Portugal, Italy, and the Czech Republic, and the other one runs from Y to ELC in Hungary and Finland. Following the above studies, some studies have incorporated real gross fixed capital formation Apergis and Payne (2011); labor force, Lorde et al., (2010); Narayan and Singh (2007); FDI, Hamdi et al., (2014); Tang (2009); export, Sami (2011) ; population, Tang (2009); employment, Yuan et al. (2008); Soytas and Sari (2007); and trade openness Sebri and Abid, (2012); in production function as important determinants of economic growth and electricity consumption. There are other studies in this aspect are as: Tang, (2008) discussed about Malaysia; Pirlogea and Cicea (2012) and Mengaki (2011) have discussed this relationship for European Union, Belaid and Abdulrahman (2013) for Algeria; Aktas and Yilmaz (2008) for Turkey. Apergis & Payne, (2011) investigated the relationship in high, upper middle, and lower middle income countries. Narayan and Smyth, (2009) investigated the nexus between ELC and Y in Oman, Kuwait, Saudi Arabia, Syria, Iran, and Israel; Shahbaz and Lean (2012) for Pakistan; Abosedra et al. (2009) in Lebanon; Sebri and Abid, (2012) for Tunisia; Narayan and Singh (2007) for Fiji; Ohler and Fetters (2014) for 20 OECD countries; Apergis and Payne (2011) for 88 countries.

The summary of studies on electricity consumption and economic growth is given in Table 2.

Author	**Country**	**Variables**	**Methodology**	**Causality results**			
				ELC→Y	**Y→ELC**	**ELC↔Y**	**ELC≠ Y**
Al-mulali et al. (2014)	18 Latin America n	ELC, Y	VECM-Granger causality	√			
Hamdi et al., (2014).	Bahrain	ELC, Y, FDI, capital	ARDL and VECM-Granger causality			√	
Cowan et al. (2014)	BRICS countries	ELC, CO_2, Y	Granger causality				√
Lin and Ouyang (2014)	China	ELC, Y	J-J		√		
Ohler and Fetters (2014)	20 OECD countries	ELC, Y	Panel analysis			√	

Belaid and Abdulrahman (2013)	Algeria	ELC, Y	VECM-Granger causality				√	
Shahbaz and Lean (2012)	Pakistan	ELC, Y	ARDL- VECM Granger causality			√		
Sebri and Abid, (2012)	Tunisia	ELC, Y, trade openness, and agricultural value added per capita.	Granger- Causality	√				
Pirlogea and Cicea (2012)	European Union	ELC, Y	Granger- Causality	√				
Bekhet and Othman (2011)	Malaysia	ELC, Y, FDI, and consumer expenditure	VECM	√				
Lai et al., (2011)	China	ELC, Y	VEC and Granger-Causality	√				
Sami (2011)	Japan	Export, ELC, Y	ARDL- VECM Granger causality		√			
Apergis and Payne (2011)	88 countries	ELC, Y, real gross fixed capital formation, and labor force	VAR Panel and Granger-Causality	√		√		
Shahbaz et al. (2011)	Portugal	ELC, Y	ARDL- VECM Granger causality		√			
Adom (2011)	Ghana	ELC, Y	ARDL	√				
Mengaki (2011)	27 European countries	ELC, Y	Random effect model		√			
Kouakou (2011)	Ivory coast	ELC, Y	VECM-Granger causality	√		√		
Ouédraogo (2010)	Burkina Faso	ELC, Y	ARDL			√		
Ciarreta and Zarraga (2010a)	Spain	ELC, Y	VAR-Granger causality		√			
Ciarreta and Zarraga (2010b)	12 European countries	ELC, Y	VECM-GMM			√		
Yoo and Kwak (2010)	7 South American countries	ELC, Y	ECM and Granger-Causality	√		√		
Jamil and Ahmad (2010)	Pakistan	ELC, Y	VECM-Granger causality		√			
Lorde et al., (2010)	Barbados	ELC,Y, capital stock, labor force, and technology	J-J and Granger-Causality			√		
Narayan and Smyth (2009)	MENA countries	ELC, Y, export	VECM and Granger Causality			√		
Abosedra et al. (2009)	Lebanon	ELC, Y	Granger causality	√				
Odhiambo, (2009)	Tanzania	ELC, Y	VAR and Granger-Causality	√				
Gupta and Chandra (2009)	India	ELC,Y	Granger causality	√				
Tang (2009)	Malaysia	ELC, Y, FDI, population	ARDL			√		
Aktas and Yilmaz (2008)	Turkey	ELC, Y	J-J-Granger causality			√		
Hu and Lin (2008)	Taiwan	ELC, Y	VECM		√			
Tang, (2008)	Malaysia	ELC per capita and real GNP per capita	ARDL	√				
Yuan et al. (2008)	China	ELC, Y, employment, capital	VECM and J-J			√		
Narayan and Prasad (2008)	30 OECD	ELC, Y	Granger-Causality	√	√	√		√

	countries						
Zachariadis and Pashourtidou (2007)	Cyprus	ELC, Y	VECM-Granger causality			√	
Yuan et al. (2007)	China	ELC, Y	Co-integration test	√			
Chen et al., (2007)	10 ASEAN countries	ELC, Y	VECM and J-J	√	√	√	√
Narayan and Singh (2007)	Fiji	ELC, Y, labor force	ARDL	√			
Zamani (2007)	Iran	Industrial and agricultural electricity consumption; industrial and agricultural valued added	VECM and Engle–Granger		√		
Ho Siu (2007)	Hong Kong	ELC, Y	VECM and J-J			√	
Squalli, (2007)	Algeria	ELC, Y	ARDL		√		
Soytas and Sari (2007)	Turkey	Value added manufacturing, industry ELC, manufacturing real fixed investment, manufacturing employment.	VECM and J-J	√			
Yuan et al. (2007)	China	ELC, Y	VECM and J-J	√			
Yoo and Kim (2006)	Indonesia	ELC, Y	Granger causality		√		
Ho and Sui (2006)	Hong Kong	ELC, Y	VECM	√			
Yoo (2006)	ASEAN 4	ELC per capita and real GDP per capita	VAR and Engle–Granger		√	√	
Wolde-Rufael (2006)	17 African countries	ELC, Y	ARDL and Granger Causality		√		
Narayan and Smyth (2005)	Australia	ELC, Y, Manufacturing employment index	ARDL		√		
Lee and Chang (2005)	Taiwan	ELC, Y	VECM and J-J	√			
Yoo (2005)	Korea	ELC, Y	VECM and J-J			√	
Altinay Karagol (2005)	Turkey	ELC, Y	Dolado–Lutkepohl causality	√			
Jumbe (2004)	Malawi	ELC, Y	ECM			√	
Morimoto Hope (2004)	Sri Lanka	ELC, Y	VAR and Engle–Granger	√			
Fatai, et al. (2004)	Australia	ELC, real GDP, and Consumer prices	ARDL, Granger-causality, and J-J		√		
Thoma, (2004)	USA	ELC, Y	Granger causality		√		
Shiu Lam (2004)	China	ELC, Y	VECM and Engle–Granger	√			
Ghosh (2002)	India	ELC, Y	Granger causality		√		
Aqeel Butt (2001)	Pakistan	ELC, Y	VAR and Engle–Granger	√			

Notes: 1. Abbreviations defined as follows: ELC = electricity consumption; Y = real or nominal GDP or GNP; IP.
2. J-J = Johansen-Juselius; ARDL = Autoregressive distributed lags; VAR = Vector autoregressive; VECM = Vector autoregressive model.

Meta Methodology

Various studies were using Engle and Granger (1987) and Johansen-Juselius (1991) models to test the co-integration between economic growth and energy counsumption (see Tables 1 and 2). These techniques require that all variables (regressors) in the system must be stationary and with equal order of integration. One of the most important approaches to analyze stationary time series data is VAR model, thus to analyze the short-term relationship between stock price and macroeconomics variables. The development of VAR model is based on multivariate time series analysis, for example, a methodology of VAR model which considers several endogenous variables together (Sims, 1980). The standard form of VAR for this study can be specified as in equations 1.

$$\Delta LEC_t = \chi_0 + \sum_{i=1}^{k} \alpha_1 \Delta LEC_{t-1} + \sum_{i=1}^{k} \alpha_2 \Delta LY_{t-1} + \sum_{i=1}^{k} \alpha_3 \Delta LFD_{t-1} + \sum_{i=1}^{k} \alpha_4 \Delta LCO2_{t-1} + \varepsilon_t$$

(1)

Where Δ is the first difference operator; χ_0 is the intercepts; α_1,…., α_4: are the short-term coefficients of the (EC, Y, FD, CO2) variables; *k* is the lag ; and ε_t is white noise error term. The Johansen's VECM, is one of the most suitable model which has become a standard technique for examining co-integration among financial variables. The co-integration has the ability to explore dynamic co-movements among variables examined. When two variables are co-integrated there is a long-term or equilibrium relationship between them. There may be disequilibrium in the short run and the error term can therefore be treated as equilibrium error, this error term can be used to tie the short-term behaviour of a variable to its long-term value.

$$\Delta LEC_t = \Pi_0 + \sum_{i=1}^{k} \alpha_1 \Delta LEC_{t-i} + \sum_{i=0}^{k} \alpha_2 \Delta LY_{t-i} + \sum_{i=0}^{k} \alpha_3 \Delta LFD_{t-i} + \sum_{i=0}^{k} \alpha_4 \Delta LCO2_{t-i} - \delta_1 ECT_{t-1} + \varepsilon_{t1}$$

(2)

Where Π_0: is the intercepts; α_1,…., α_4 are the short-term coefficients for the variables. ECT_{t-1} is the error correction term, δ_1 is the long-term coefficients. Pesaran et al. (2001) has developed a model to introduce a surrogate co-integration technique known as ARDL bound testing approach. ARDL approach has many advantages over the previous co-integration techniques. First, it has more proper considerations than the J-J & Engle-Granger techniques for testing the co-integration among variables in small sample size (Ghatak and Siddiki, 2001). Comparatively, the Johansen co-integration techniques need large data sample for validity. Second, no need to examine the non-stationary property and order of integration, this means that we can apply ARDL whether underlying regressors are purely I(0) or purely I(1), while other co-integration techniques require all the regressors to be integrated of the same order (Pesaran et al., 2001). Third, the ARDL application allows the variables may have different optimal lags, while it is impossible with conventional co-integration procedures (Ozturk and Acaravci, 2011). Finally, the ARDL model has become increasingly popular in recent years (Jayaraman and Choong, 2009).

$$\Delta LEC_t = \Omega_{01} + \sum_{i=1}^{n1} \alpha_{11} \Delta LEC_{t-i} + \sum_{i=0}^{n2} \alpha_{12} \Delta LY_{t-i} + \sum_{i=0}^{n3} \alpha_{13} \Delta LFD_{t-i} + \sum_{i=0}^{n4} \alpha_{14} \Delta LCO2_{t-i} + \phi_{11} LEC_{t-1} + \phi_{12} LY_{t-1} + \phi_{13} LFD_{t-1} + \phi_{14} LCO2_{t-1} + \varepsilon_{t1} \quad (3)$$

$$\Delta LY_t = \Omega_{02} + \sum_{i=1}^{n1} \alpha_{21} \Delta LY_{t-i} + \sum_{i=0}^{n2} \alpha_{22} \Delta LEC_{t-i} + \sum_{i=0}^{n3} \alpha_{23} \Delta LFD_{t-i} + \sum_{i=0}^{n4} \alpha_{24} \Delta LCO2_{t-i} + \phi_{21} LY_{t-1} + \phi_{22} LEC_{t-1} + \phi_{23} LFD_{t-1} + \phi_{24} LCO2_{t-1} + \varepsilon_{t2} \quad (4)$$

$$\Delta LFD_t = \Omega_{03} + \sum_{i=1}^{n1} \alpha_{31} \Delta LFD_{t-i} + \sum_{i=0}^{n2} \alpha_{32} \Delta LEC_{t-i} + \sum_{i=0}^{n3} \alpha_{33} \Delta LY_{t-i} + \sum_{i=0}^{n4} \alpha_{34} \Delta LCO2_{t-i} + \phi_{31} LFD_{t-1} + \phi_{32} LEC_{t-1} + \phi_{33} LY_{t-1} + \phi_{34} LCO2_{t-1} + \varepsilon_{t3} \quad (5)$$

$$\Delta LCO2_t = \Omega_{04} + \sum_{i=1}^{n1} \alpha_{41} \Delta LCO2_{t-i} + \sum_{i=0}^{n2} \alpha_{42} \Delta LEC_{t-i} + \sum_{i=0}^{n3} \alpha_{43} \Delta LY_{t-i} + \sum_{i=0}^{n4} \alpha_{44} \Delta LFD_{t-i} + \phi_{41} LCO2_{t-1} + \phi_{42} LEC_{t-1} + \phi_{43} LY_{t-1} + \phi_{44} LFD_{t-1} + \varepsilon_{t4} \quad (6)$$

Where $\Omega_{01},\ldots, \Omega_{04}$: are the intercepts; $\alpha_{11},\ldots, \alpha_{44}$ are the short-term coefficients for the variables; $\phi_{11},\ldots, \phi_{44}$: are the long-term coefficients; $n_1,\ldots,n_4$: are the lag length; and $\varepsilon_{t1,\ldots,} \varepsilon_{t4}$ is white noise error term.

4. Concluding Remarks

This study is very important for different parties such as for policy makers, researchers to fill the gap in existing energy literature and to keep updating the regarding literature. With respect to the conclusions pertaining to three causality hypotheses, the results are indeed mixed across the 103 studies in the two previous tables across more than 100 countries reported. The results of the specific studies surveyed show that 59% supported the unidirectional hypothesis; 34% the bidirectional hypothesis; and 7% the neutrality (no causal) hypothesis. This survey provides researchers various studies on the causal relationship between economic growth and energy consumption across different regions and countries. These studies included many variables in term of economic growth represented by GDP, FD, FDI, trade openness, export, and other different variables (see the Tables 1 and 2). On the other hand, these studies dealt with electricity consumption and CO_2 with respect to the energy consumption variables. Analyzing the causality relationship between economic growth and energy consumption provides different parties with debates on the convenient design and application of environmental and energy policies. Related to the interrelationship between economic growth and energy consumption, it is not striking that the empirical results have resulted in different outcomes in terms of the three hypotheses (unidirectional, bidirectional, and neutrally causality relationship). The deviation in these empirical results could be attributed to the region (country), time period of each study, variable selection, and time series and models specification. Nevertheless, this paper added to the canon of knowledge in various ways by combining the recent energy economic studies with the existing literature and compares their various results and gives some suggestions and recommendation for further studies. We recommend examining additional factors that might change the output of the relationship between the economic growth and energy consumption, for instance, pollution, financial indices, export, nuclear energy, solar system, and unemployment rates. Besides, addressed some ignored countries to the panel of investigation, such as Commonwealth states, Moocow, Jordan, Singapore. Eventually, that the future studies should take attention to examine the structural breaks that may happen during the

study period and impacting the results of studies, for example, financial crises, wars, terrorist attacks, and revolutions (see, Bekhet and Matar, 2013a, Bekhet and Matar, 2013b).

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