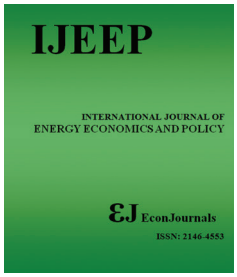


International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2017, 7(3), 287-293.

Multivariate Cointegration and Causality between Electricity Consumption, Economic Growth, Foreign Direct Investment and Exports: Recent Evidence from Vietnam

Tuyen Ngoc Nguyen[1]*, Winai Wongsurawat[2]

[1]Asian Institute of Technology, Thailand, [2]Mahidol University, Thailand. *Email: evn.tuyen@gmail.com

ABSTRACT

This paper investigates the relationship between electricity consumption (EC), economic growth, exports and foreign direct investment (FDI) in Vietnam using time series data from 1980 to 2013. Findings will benefit investors and policy makers who must make long term plans on energy investment and regulate electricity pricing. Our results indicate that real gross domestic product (GDP), EC, exports (EX) and FDI in Vietnam are cointegrated. There is unidirectional Granger causality running from real GDP to EC, EX and FDI, but not vice versa. The data also show that there is bidirectional Granger causality between EC and EX.

Keywords: Vietnam, Electricity Consumption, Economic Growth
JEL Classifications: C32, C52, Q43

1. INTRODUCTION

Energy security plays an important role in promoting and sustaining economic growth (EG), especially for industrializing, emerging economies. In particular, electricity must be reliable and supplied at a reasonable price for private use and industrial production.

Many countries plan to initiate energy conservation and energy efficiency programs. Investing in renewable energy and raising tariffs on electricity have been tabled for careful consideration. Some critical questions regarding the impact of such policies on the economy will undoubtedly require clarification. Specifically, when can we apply electricity conservation or renewable energy policies without causing negative effects on the EG? When will it be necessary to ramp up investment in the electric power system infrastructure to ensure the electricity for the stable EG?

Since the 1986 economic reforms toward a market economy ("Doi Moi"), Vietnam has experienced a high rate of growth. The country has become a leading exporter of agricultural products and an attractive destination for foreign investment in Southeast Asia. In 2010, according to the World Bank, Vietnam's gross domestic product (GDP) reached $103.57 billion, with a GDP per capita of $1,172.

To support the booming economy, electricity generation has also been increasing rapidly. Power production in 1985 was merely five billion kWh. By 2010, that number had soared to over 100 billion kWh. Nevertheless, seasonal blackouts remain common in Vietnam, particularly in the dry months because about a third of the country's capacity is hydroelectric.

The Vietnamese government is currently attempting to promote the country's energy security while maintaining EG momentum. Understanding the interaction between electricity consumption (EC) and growth will prove to be a key element in weighing the benefits and costs of various energy policies, including capacity expansion (domestic and FDI), energy conservation, and pricing.

The most sensitive issue between suppliers and consumers is electricity price. Electricity Vietnam or EVN, the country's largest producer, now reports that it costs more to add and deliver a kilowatt-hour of electricity than it is allowed to charge.

Although the government has agreed that electricity price should automatically adjust to changes in the price of oil and exchange rates, raising prices has proven to be very difficult in practice. In August 2011, for example, EVN's request to raise the price of electricity was rejected by the government due to concerns about the country's high rate of inflation.

Basic economics predicts that a higher price of electricity will induce households and manufacturers to economize on energy use. In the long-run, such adjustments can be efficiency enhancing. In the short-run, however, a higher price of electricity will hit the exporting sectors, which are often very energy intensive. As Vietnam's EG has become increasingly reliant on exports (EX), many are concerned a high price of electricity will be bad for the overall economy.

The impact of electricity price on FDI is another critical concern. FDI is an important source of funding, modern technology, and advanced management for Vietnam. More FDI may increase EC to meet the requirement of electricity-based production, especially for the steel and cement sectors. On the other hand, FDI may bring opportunities investment in more energy-efficient modes of production.

Given the urgent need for understanding the interplay between EC, EG and FDI, findings from this study should be of interest to both investors and Vietnamese policy makers.

2. LITERATURE REVIEW

2.1. The Relationship between EC and EG

Since Kraft and Kraft (1978) found a unidirectional causal relationship running from GDP to energy consumption in the US over the period 1947-1974, many studies have been undertaken for many countries with different approaches.

Results from previous studies can be categorized into four groups. First, unidirectional causality running from EG to EC, which suggests electricity saving policies would have little to no adverse impact on economic development. Second, unidirectional causality running from EC to EG, a result that implies limiting EC could adversely affect EG. Third, a bi-directional relationship meaning both variables affect each other at the same time. Finally, if no causal relationship can be established, then neither saving nor expanding EC would have any effect on EG (Ozturk, 2010; Bouoiyour et al., 2014).

Ferguson et al. (2000) found a strong correlation between EC and EG in most of the 100 countries in his study. Correlation, however, says little about the existence or direction of a causal relationship.

Yoo (2005) studied the relationship between EC and EG for ASEAN countries in period 1971-2002. He found bi-directional causality for Singapore and Malaysia, but only a uni-directional causality from EG to EC in Thailand and Indonesia. Other ASEAN were not included in the study due to a lack of data.

Mehrara (2007) studied the causal relationship for 11 oil-exporters, namely Kuwait, Iran, UAE, Saudi Arabia, Oman, Bahrain, Nigeria, Algeria, Venezuela, Mexico and Ecuador. Using panel methods for unit root and cointegration, a uni-directional causal relationship running from GDP to energy consumption was established. These results suggest that energy conservation policies such as reforming energy prices would not adversely impact the economy.

Using standard techniques to investigate the relationship between growth and EC in ten countries (China, Hong Kong, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand), Chen et al. (2007), reported mixed and conflicting results. They hypothesized that these differences may be due to the sources of local energy supply, political structure, economic history or institutional arrangements.

Chontanawat et al. (2008) studied the causality in 30 OECD and 7 non - OECD countries by applying Grangers tests. They found that the causality from energy to GDP to be more common among the OECD countries.

Chiou-Wei et al. (2008) studied the relationship for the USA and Asian newly industrialized economies from 1954 to 2006. Applying Granger tests, they confirmed that there was no causality in Thailand, South Korea and the USA. They also confirmed the 'conservation hypothesis' in Singapore and the Philippines, whereas energy consumption might have negative effects on EG in Indonesia, Malaysia, Hong Kong and Taiwan.

2.2. Multivariate Studies

Other studies have investigated the causal relationship while including other explanatory variables such as electricity price, export volume, foreign direct investment (FDI), population, etc., Jamil and Ahmad (2010) added electricity price in their model for Pakistan, focusing on the period 1960-2008. Using the Johansen maximum likelihood approach, the authors found a unidirectional causality from real GDP to EC at the aggregate level. At the disaggregated level, there was a short-run bi-directional causality between output and electricity price in the manufacturing sector.

Tang (2008) studied the case of Malaysia during the years 1970-2005 using bounds-testing and autoregressive distributed lag (ARDL) model to study the short and long-run relationships. The Granger causality test was used in a multivariate model that included EC, FDI, income and population. The author found that EC, income, FDI and population were cointegrated, and the flow of FDI and population were significantly related to EC. Granger causality results showed that EC, FDI, income were of bi-directional casual relationships.

Study Japan from 1960 to 2007, Sami (2011) used bounds tests proposed by Pesaran et al. (2001) and found the cointegration between EC, EG and EX. In the long run, the results implied that there is causality from EX and real GDP per capita to EC.

Han et al. (2011) studied the impact of FDI on energy consumption intensity in China from 1997 to 2007. They applied the Granger causality test and measured the impact of FDI on energy consumption by combining the input-output method and the logarithmic mean devise index. The authors urged FDI-intensive

sectors such as steel and building materials to adopt energy conservation, and suggested the government support these initiatives by providing more intensive technical support.

Al-Mulali et al. (2015) investigated the influence of disaggregated renewable electricity production by source on CO_2 emission in 23 selected European countries for the period of 1990-2013. The Pedroni cointegration results indicated that CO_2 emission, GDP growth, urbanization, financial development, and renewable electricity production by source were cointegrated. Moreover, the fully modified ordinary least-square results revealed that GDP growth, urbanization, and financial development increase CO_2 emission in the long run, while trade openness reduces it. Furthermore, renewable electricity generated from combustible renewables and waste, hydroelectricity, and nuclear power have a negative long-run effect on CO_2 emission, while renewable electricity generated from solar power and wind power is insignificant.

2.3. The Case of Vietnam

Toan et al. (2010) studied energy supply and demand in Vietnam between 2000 and 2008, and produced projections up to the year 2030. They also analyze current energy policies, including energy conservation, renewable energy and establishing a competitive electricity market.

Few studies have investigated the causal relationship between EG and EC in Vietnam. One exception is Binh (2011), who used threshold cointegration and causality analysis to explore the relationship over period 1976-2010. Various cointegration tests were implemented before the estimation of the vector error correction model (VECM). The results indicated a uni-directional causality running from GDP to energy consumption. EG had a significant impact on energy consumption after the point break in 1992. These results support the neoclassical hypothesis that energy consumption is not a constraint for EG. According to Tsani (2010), in neoclassical growth models, energy is simply an intermediate input for production. Bartleet and Gounder (2010), who favor this view, think that EG could remain in spite of limitations on energy sources. Therefore, increasing energy prices could be a good policy for the economy to promote substitution and technological innovation. Such views are not commonly accepted in Vietnam. EVN, the largest electricity company in Vietnam, has endured big financial losses because it has not been allowed to increase the price of electricity it generates.

This paper contributes to the scarce literature on this topic for Vietnam. In addition to updating the data to year 2013, we include additional important variables such as EX and FDI, which will hopefully contribute to a more comprehensive understanding of these important macroeconomic variables.

3. DATA ANALYSIS

3.1. Stationary and Cointegration Analysis

The study period covered the years 1980 to 2013. Vietnam was unified in 1975, thus earlier data were not available. GDP, FDI and export values have all been converted in to USD at year 2005 prices. All statistics were downloaded from the World Bank website.

Per capita GDP and EC are shown in Figure 1. Figures 2 and 3 report EX and FDI flows. Pronounced growth in EX and FDI can

Figure 1: EG and EC in period 1980-2013

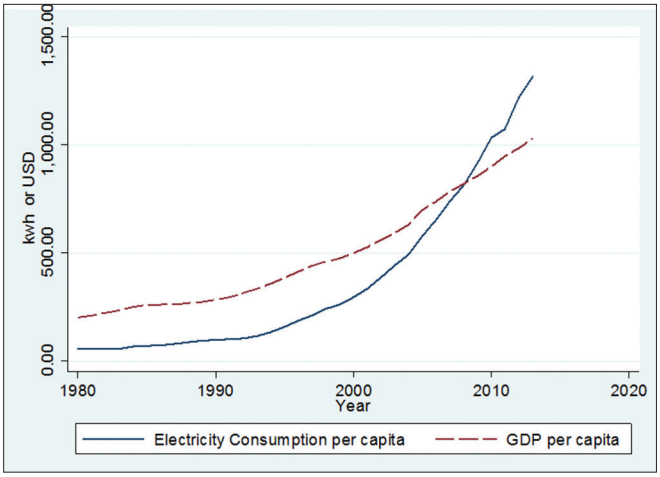


Figure 2: Exports in period 1980-2013

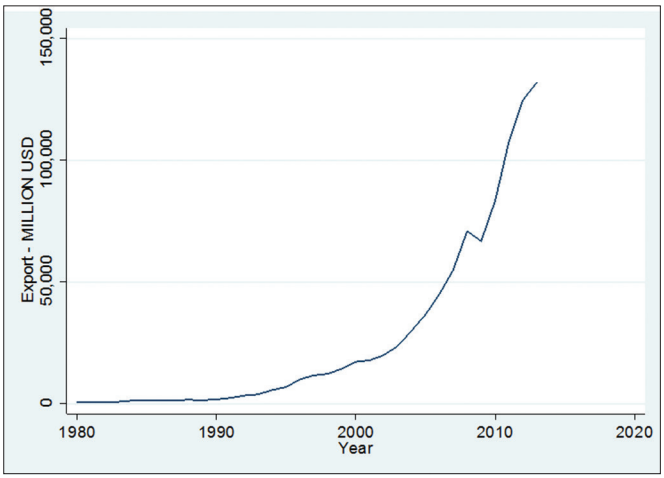
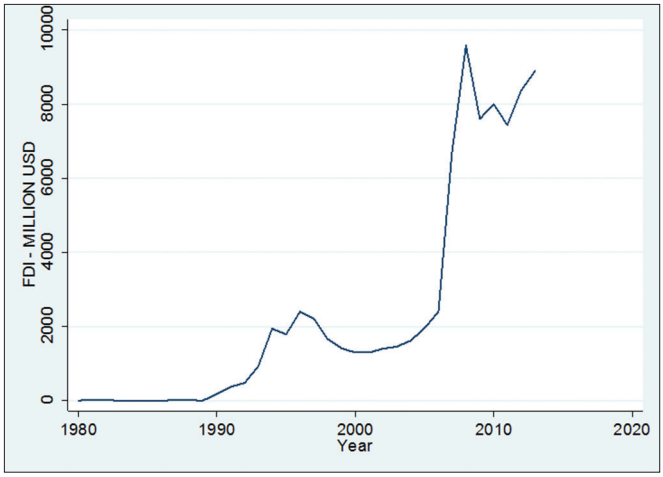


Figure 3: Foreign direct investment in period 1980-2013



be observed in the early 1990s and then again in the mid-2000s, indicating Vietnam's market reform ("Doi Moi") and its accession to the World Trade Organization respectively.

The empirical exercise will first establish the cointegration between stationary time series data using the bound test developed by Pesaran (1995, 1999; and 2001). This technique is especially efficient in studies that have small sample sizes. However, Pesaran et al. (2001) noted that the bound test is appropriate when independent variables are either I(0) or I(1) processes with no structural breaks.

A disadvantage of the Augmented Dickey and Fuller (ADF) unit root test is complications arising from structural breaks in the series. The test may fail to conclude the presence of stationary data if the series contains structural breaks. According to Perron (1989), a structural break leads to a bias that reduces the ability to reject a false unit root null hypothesis. To limit this problem, Perron has suggested allowing for known, exogenous structural breaks in the ADF tests. Based on this development, many authors, including Zivot and Andrews (1992) and Perron (1997), proposed determining the break points "endogenously" from the data.

The Clemente-Montanes-Reyes (1998) unit root test allows for two structural breaks in the series. It also does not require a priori knowledge of the structural break dates. Baum (2004) proposed that if the Clemente-Montanes-Reyes unit root test provides evidence of significant additive or innovation outliers in the time series, then there is evidence that the ADF test is misspecified due to structural breaks. Therefore, if the Clemente-Montaines-Reyes unit root test indicates that two structural breaks are not present in the series, a single structural break test should be considered next.

3.2. Empirical Results

To apply the Granger causality test, we first investigate whether the multiple non-stationary series are cointegrated, i.e., whether a linear combination of the series is stationary. The ADRL bound cointegration test developed by Pesaran et al. (2001) is also applied.

Table 1 presents the results of unit root test on FDI, the natural logarithms EC, EG, EX, and the first differences of the time series using the ADF test, which includes extra lagged terms of the dependent variables to eliminate autocorrelation. The lengths of the lags are determined by the Akaike Information Criterion. The null hypothesis of a unit root tested against the one-sided alternative is rejected if the ADF statistic is less than the critical value, implying the series is stationary. An intercept and a linear deterministic trend were included. The results show that LEX, FDI are I(1), while LEC and LEG are not I(1).

According to Binh (2011), EC and EG in Vietnam contain a structural break in the series, which may cause non-stationarity in a normal ADF test. The data hence is checked by the Clemente-Montaines-Reyes unit root test with two structural breaks. The test offers two models:

- An additive outliers (AO) model, which captures a sudden change in the series.
- An innovational outliers (IO) model, which allows for a gradual shift in the mean of the series.

The results are shown in Table 2 and Figure 4 for AO model. The EC and EG are both I(1) with two structural breaks in 1991 and 2003.

The last decade of the millennium brought many reforms and challenges for the Vietnamese economy. After the major market reforms ("Doi Moi") in 1986, privately owned enterprises were permitted in commodity production and later encouraged. The first half of the 1990s observed changes in the legal framework for the private sector. In 1990, the Law on Private Enterprises,

Table 1: Augmented dickey fuller unit root test

Variables	ADF
LEC	−2.268
LEG	−2.872
LEX	−2.789
FDI	−1.946
D.LEC	−2.449
D.LEG	−2.450
D.LEX	−5.279*
D.FDI	−4.677*

*Denotes the significance level at 1%. FDI: Foreign direct investment

Table 2: Clemente-Montaines-Reyes two-structural breaks unit root test

Variables	Additive outliers			
	t-statistic	TB1	TB2	Decision
LEC	−2.787	1995	2004	Non-stationary
LEG	−2.996	1994	2004	Non-stationary
D.LEC	−5.774*	1993	2008	I (1)
D.LEG	−13.876*	1991	2003	I (1)

*Indicate significant level at 5% of significant

Table 3: ARDL bounds test for cointegration

Significant level	Lower I (0)	Upper I (1)
Number of adjusted critical values bound (F-test)		
1 percent	4.29	5.61
5 percent	3.69	4.89
10 percent	3.23	4.35
Conclusion: Cointegrated		
Calculated F-statistics 42.271**		
F (LEC|LEG, LEX, FDI)		

**Indicate significant level at 1% of significant, ARDL: Autoregressive distributed lag, FDI: Foreign direct investment

Table 4: Long-run relationship

Dependent variable is LEC			
Variable	Coefficient	t-statistic	Significance
Constant	−5.4677	−6.59	0.000
LEG	1.7113	6.36	0.000
LEX	−0.0162	−0.74	0.474
FDI	$1.05e^{-11}$	2.46	0.030
R^2=0.9720			
Adjusted R^2=0.9323			
F-statistic=24.51			
Prob (F-statistic)=0.0000			

FDI: Foreign direct investment

which provided a legal basis to private firms was enacted, while the Companies Law acknowledged joint-stock companies and private limited liability company. The constitution of 1992 officially recognized the role of the private sector. Soon after, the economy was hit by the 1997 Asian Financial Crisis. By the dawn of the new millennium, however, recovery was fully underway.

Lag lengths of variables need to be determined for ARDL bound tests. The optimum lag order of all the series are chosen by the Akaike Information Criteria. Table 3 shows that F-statistics are all >1% upper critical values for I(1). This implies that FDI, EX and EGs are moving together with EC in the long run, although deviations may occur in the short run. The diagnostic test results confirm the validity of the estimation. The long-run impacts of EC and its determinants are reported in Table 4. The results reveal that a rise in real GDP and FDI will boost EC. The adjusted $R^2 = 0.93$ supports the validity of the model in the long-run.

Tables 5 and 6 report the results of the Granger causality test by applying VECM and vector autoregression (VAR) model for

Figure 4: Two-structural break unit root test for first different of LEC and LEG

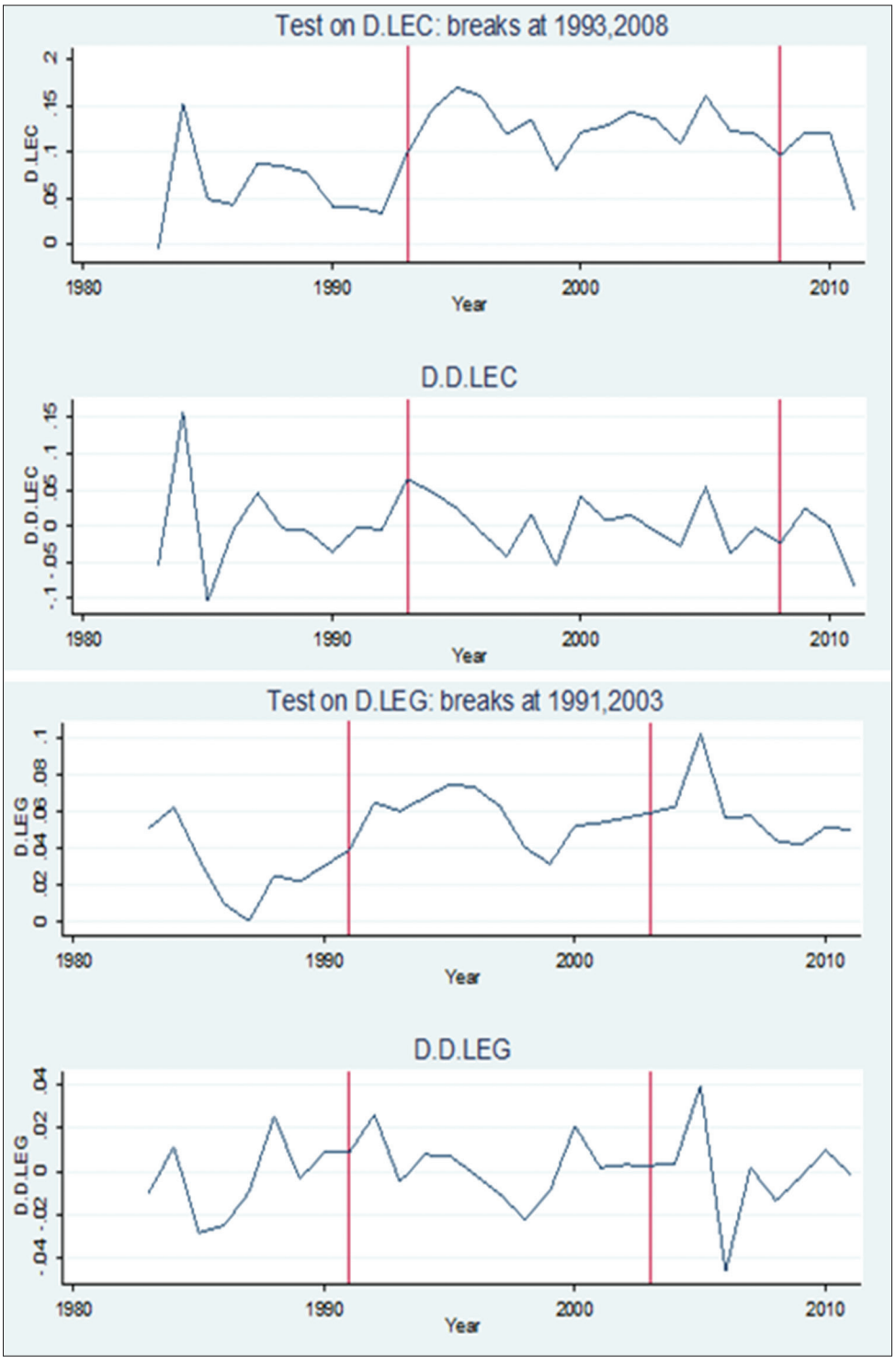


Table 5: Granger causality test

Dependent variables	F-statistic			
	LEC	LEG	LEX	FDI
Long-run relationship				
LEC		−1.99*	2.26*	1.54
LEG	0.01		1.09	0.33
LEX	−2.01*	2.34*		−0.47
FDI	1.14	−2.89*	0.58	
Short-run relationship				
LEC		−0.67	2.13*	−1.34
LEG	−0.63		2.90*	−1.91
LEX	−1.60	2.27*		−0.36
FDI	0.06	−0.68	−1.16	

*Denotes the probability smaller than 5%. FDI: Foreign direct investment

Table 6: Granger causality relationship

Causal relationship		
LEC	←	LEG
LEC	↔	LEX
LEG	→	LEX
LEG	→	FDI

FDI: Foreign direct investment

long-run and short-run relationships. LEG is found to Granger cause all other variables. This confirms the importance of economic development and its broad impact on Vietnamese society. The empirical results also show a bi-directional causation between EC and EX. In other words, in order to produce these exported products, large amounts of electricity is required. Policies to boost EX must also take into consideration the long-run need for greater electricity generation. FDI exhibits a causal impact neither in the short nor long run on any other variable.

4. CONCLUSION

This paper investigated on the causal relationship between per capita electricity (EC), gross domestic product (GDP), FDI and EX in Vietnam from 1980 to 2013. In doing so, many cointegration testing approaches were conducted and the VECM and VAR model were estimated. The empirical findings suggest that in the long run, the unidirectional causality runs from GDP to other variables such as EC, EX and FDI. Conversely, there is no Granger causality from FDI to any other factors. Finally, EC and EX Granger cause each other.

Though in many Asian countries, electricity conservation policies may leave several negative effects on EG due to unidirectional causality from EC to GDP, this is not the case in Vietnam. According to our results, the causation runs from GDP to EC in the long run. Therefore, electricity is not a limiting factor for Vietnam's EG.

Raising electricity prices can be a good opportunity for the Vietnamese economy to promote substitution and technological innovation. Since high levels of EG has contributed to expanding electricity demand, the government can promote environmental-friendly energy conservation by allowing prices to respond to market forces. A competitive energy market would represent a step toward allocating the country's valuable resources efficiently.

Vietnam initiated its electricity market in 2005 and achieved the first phase of production-side market in 2014. The competitive wholesale market represents the second phase, and is scheduled for completion in 2022. The final stage involving the retail market will then commence.

According to Doing Business 2017, a Project of the World Bank, electricity access index of Vietnam has experienced continuous improvement. This index is based on procedures, time and cost for new electricity connections. Vietnam has jumped 5 positions from 101st to 96th last year. This index is one of vital factors making Vietnam more attractive for FDI. Foreign investment in electricity generation will be critical to raise the installed capacity from 40,000 MW in 2016 to 60,000 MW in 2020 as stipulated in the revised master plan VII issued by the Government of Vietnam in March 2016.

REFERENCES

Al-Mulali, U., Ozturk, I., Lean, H.H. (2015), The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. Natural Hazards, 79(1), 621-644.

Bartleet, M., Gounder, R. (2010), Energy consumption and economic growth in New Zealand: Results of trivariate and multivariate models. Energy Policy, 38, 3508-3517.

Baum, C. (2004), Clemao IO: Stata Module to Perform Unit Root Tests with One or Two Structural Breaks. St. Louis: Statistical Software Components from Boston College Department of Economics.

Binh, P.T. (2011), Energy consumption and economic growth in Vietnam: Threshold cointegration and causality analysis. International Journal of Energy Economics and Policy, 1(1), 1-17.

Bouoiyour, J., Selmi, R., *Ozturk, I.* (2014), The nexus between electricity consumption and economic growth: New insights from meta-analysis. *International* Journal of Energy Economics and Policy, 4(4), 621-635.

Clemente, J.L., Montanes, A., Reyes, M. (1998), Testing for a unit root in variables with a double change in the mean. Economics Letters, 59(2), 175-182.

Chen, S.T., Kuo, H.I., Chen, C.C. (2007), The relationship between GDP and electricity consumption in 10 Asian countries. Energy Policy, 35, 2611-2621.

Chiou-Wei, S.Z., Chen, C.F., Zhu, Z. (2008), Economic growth and energy consumption revisited: Evidence from linear and nonlinear granger causality. Energy Economics, 30, 3063-3076.

Chontanawat, J., Hunt, L.C., Pierse, R. (2008), Does energy consumption cause economic growth? Evidence from a systematic study of over 100 countries. Journal of Policy Modeling, 30, 209-220.

Ferguson, R., Wilkinson, W., Hill, R. (2000), Electricity use and economic development. Energy Policy, 28, 923-934.

Han, Y., Liu, L., Kong, J., Tang, L., Kan, S. (2011), Analysis about Impact on FDI to Energy Consumption Intensity in China. IEEE. DOI: 978-1-61284-109-0/11.

Jamil, F., Ahmad, E. (2010), The relationship between electricity consumption, electricity prices and GDP in Pakistan. Energy Policy, 38, 6016-6025.

Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. Journal of Energy Development, 3, 401-403.

Mehrara, M. (2007), Energy consumption and economic growth: The case of oil exporting countries. Energy Policy, 35, 2939-2945.

Ozturk, I. (2010), A literature survey on energy-growth nexus. Energy Policy, 38(1), 340-349.

Perron, P. (1989), The great crash, the oil price shock and the unit root hypothesis. Econometrica, 57, 1361-1401.

Perron, P. (1990), Testing for a unit root in a time series with a changing mean. Journal of Business and Economic Statistics, 8, 153-162.

Pesaran, M.H., Smith, R.J. (1995), Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics, 68(1), 79-113

Pesaran, M.H., Shin, Y., Smith, R.J. (1999), Bounds Testing Approaches to the Analysis of Long Run Relationships. Edinburgh School of Economics, Discussion Paper Series Number 46.

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

Toan, P.K., Bao, N.M., Dieu, N.H. (2010), Energy supply, demand, and policy in Vietnam, with future projections. Energy Policy, 13, 1627-1632.

Tang, C.F. (2008), A re-examination of the relationship between electricity consumption and economic growth in Malaysia. Energy Policy, 36, 3077-3085.

Tang, C.F. (2008), Electricity consumption, income, foreign direct investment, and population in Malaysia: New evidence from multivariate framework analysis. Journal of Economic Studies, 36(4), 371-382.

Tsani, S.Z. (2010), Energy consumption and economic growth: A causality analysis for Greece. Energy Policy, 32, 582-590.

Sami, J. (2011), Multivariate cointegration and causal relationship between exports, electricity consumption and real income per capita: Recent evidence from Japan. International Journal of Energy Economics and Policy, 1(3), 59-68.

Yoo, S.H. (2005), Electricity consumption and economic growth: Evidence from Korea. Energy Policy, 33, 1627-1632.

Zivot, E., Donald, W.K.A. (1992), Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. Journal of Business and Economic Statistics, 10(3), 251-270.