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The Relationship between Foreign Direct Investment, Electricity Consumption and Economic Growth in Vietnam

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ABSTRACT

One of the prerequisites for the successful implementation of national industrialization and modernization is the synchronous development of fundamental industries. Electricity is a key industry that determines the success of other industries. The main purpose of this paper is to investigate the causal relationship between electricity consumption, foreign direct investment (FDI) and economic growth in Vietnam during the period 1990-2015, by using Toda-Yamamoto approach and autoregressive distributed lag approach. The empirical results show strong statistical evidence that electricity consumption and FDI have positive impacts on economic growth in Vietnam in both short term and long term.

Keywords: Foreign Direct Investment, Electricity Consumption, Economic Growth, Vietnam
JEL Classifications: F21, F43, Q43

1. INTRODUCTION

Rostow (1990) points out that a country usually goes through five stages of economic development: (1) Traditional society, (2) pre-conditions for take-off, (3) take-off, (4) drive to maturity and (5) age of mass consumption. The conditions for successful implementation of the pre-conditions take-off stage include: (i) Investment share in gross domestic product (GDP) increases from 5 to 10%; (ii) building leading sectors (fundamental industries such as electricity and energy, import-export markets and supporting industries); (iii) there must be a dynamic management mechanism that knows how to use technology and strengthens external economic relations. In terms of these three conditions, developing economies are subject to certain constraints including restrictions on fund sources and the availability of natural resources.

Electricity plays an important role in any country, because it affects both aggregate supply and aggregate demand. On the demand side, electricity is an essential product for consumers to maximize their utility, not to mention that it may show the civilization of a country/region compared to other countries/regions (Aytac and Guran, 2011). On the supply side, electricity is a key input of the production process; without electricity, the scale of production will be scattered, fragmented and the productivity will be low. According to the International Energy Agency, the world's primary energy demand will continue to increase (about 1.4% annually until 2035), which happens strongly in rapidly developing economies like China, Brazil and India.

Vietnam is a developing country, so we are also under great pressure due to an increase in the demand for electricity to serve people's consumption and the economy's expansion. After the 1986 economic reform, when Gross National Income (GNI) increased from $79.56 in 1986 to $1,961.75 in 2015,[1] the total electricity consumption of Vietnam increased rapidly from 3.3 billion kWh in 1980 to 140.72 billion kWh in 2015[2]. In 2014, the electricity consumption of the industrial sector was the largest; specifically, this sector accounted for 53.9%, the residential sector accounted for 35.6%, the service sector accounted for 4.8% and the rest was for other regions.

In terms of attracting foreign direct investment (FDI), Vietnam has made remarkable progress, from $180 million in 1990 to

1 Calculated at constant prices in 2010. Data from the United Nations Conference on Trade and Development (UNCTAD)
2 The International Energy Agency (IEA)

$11.8 billion in 2015. In general, FDI plays an important role in Vietnam's economy, significantly changes the structure of industries, the productivity and income of individuals. However, the development of foreign-invested enterprises also increases the pressure on Vietnam's electricity demand. Based on that reality, the authors examine the relationship between electricity consumption, FDI and economic growth to provide empirical evidence that helps the authorities make strategic planning and policy development, ensure energy security and economic development of the country.

The paper is divided into 5 sections. After the introduction, section 2 presents literature review related to the topic of the study. Section 3 introduces research models, data collection, processing and analysis. Research findings and policy implications are presented in section 4. The final section will be the conclusions and limitations of the study and some suggestions for further research.

2. LITERATURE REVIEW

2.1. The Relationship between FDI and Economic Growth

There are many theories explaining the origin of FDI. According to Williamson (1985) and Dunning and Lundan (2008), FDI enterprises (MNEs - Multinational Enterprises) only conduct FDI if satisfying three conditions: (1) Ownership advantages (O): The enterprise must possess some advantages over other enterprises such as size, technology, marketing network, access to low-interest capital or specific intangible assets of the enterprise; (2) Location-based advantages (L): Producing in a foreign country is less expensive than producing in the host country and then exporting those products. Location advantages can be obtained through natural resources, labor, trade barriers, investment incentive policies, and external influences that the firm may receive. (3) Internalisation advantages (I): The use of these advantages within the firm is more profitable than selling or renting them to other firms.

So far, theoretical and empirical evidence in many countries/regions has shown that FDI is considered as one of the pillars of economic growth. The role of FDI is evident as it contributes to economic growth through factors such as adding additional capital investment, promoting export, transferring technology, developing human resources and creating jobs etc. In addition, FDI also contributes positively to budget income and promotes deep integration into the world economy. The impact of FDI on economic growth is divided into three categories: Two-way impact (FDI ↔ GDP), one-way effect (FDI → GDP), no impact (FDI #→GDP). Impact is divided into two types: Positive (increase), negative (decrease).

Bende-Nabende and Ferd (1998) use a simultaneous equation to analyze the effect of FDI and government policy on economic growth in Taiwan. The authors determine that FDI has the potential to boost economic growth and policy has the potential to promote growth, particularly in terms of infrastructure development and liberalization. The study by Shaari et al. (2012) uses the vector autoregression (VAR) model to examine the effect of FDI on annual GDP in Malaysia for the period 1972-2010. The results show that an increase in FDI has a positive impact on economic growth in Malaysia. Specifically, a 1% increase in FDI leads to a 49.1% increase in Malaysia's GDP. The authors also find that GDP has a causal relationship with FDI and vice versa.

Tang et al. (2016) analyse the relationship between energy consumption and economic growth in Vietnam using the neoclassical Solow growth framework for the 1971–2011 period. The results confirm the existence of cointegration among the variables. In particular, energy consumption, FDI and capital stock were found positively influence economic growth in Vietnam. The Granger causality test revealed unidirectional causality running from energy consumption to economic growth. Al-Mulali et al. (2015) examined the existence of the environmental Kuznets curve (EKC) hypothesis in Vietnam during the period 1981–2011. The results revealed that the pollution haven hypothesis does exist in Vietnam because capital increases pollution. In addition, imports also increase pollution which indicates that most of Vietnam's imported products are energy intensive and highly polluted. However, exports have no effect on pollution which indicates that the level of exports is not significant enough to affect pollution. Moreover, fossil fuel energy consumption increases pollution while renewable energy consumption has no significant effect in reducing pollution.

Ahmed et al. (2017) attempt to shed some light on the energy consumption and associated emissions linking recent trade integration for eight economies in the ASEAN region: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam. Considering the heterogeneity across the panel of countries, a long-run relationship is established between output, energy, trade, and emissions over a period of three decades. The overall findings indicate that the environmental consequences of economic growth are alarming for most of the countries in the panel, and non-renewable energy consumption is the key contributing factor towards environmental deterioration in the ASEAN region. Of the eight, it is further established that five economies from the region (Cambodia, Indonesia, Malaysia, Thailand and Vietnam) predominantly engage in emission-intensive trade and an increase in future energy demand and environmental degradation is projected for these countries. Yildirim et al. (2014) reexamine the relationship between energy consumption per capita and real GDP per capita for Indonesia, Malaysia, the Philippines, Singapore and Thailand using both panel data causality which is taking into account cross-sectional dependence and heterogeneity among the countries and time series causality tests for the period 1971–2009. The findings indicate that taking into account cross-sectional dependence has a substantial effect on the achieved results. The conservation hypothesis is supported for Indonesia, Malaysia and the Philippines. Although a bidirectional relation is found in the case of Thailand, since there is no positive effect of energy consumption on GDP, the conservation hypothesis is supported. In the pattern of Singapore, the neutrality hypothesis is supported.

In Vietnam, Nguyen (2003) shows that FDI stimulates economic growth at the national level and suggests that in order to attract FDI into Vietnam, it is necessary to expand the market and find new partners. Nguyen (2004) concludes that FDI has a positive

impact on local economic growth through the formation and accumulation of capital assets and the interaction between FDI and human resources. Nguyen et al. (2006) using time series data from 1988 to 2003 show the impact of FDI on economic growth through investment channels. The conclusion of the study is that FDI complements domestic investment, which helps to expand production, reduce government deficits, contribute to export earnings, and create jobs. At the same time, the domestic private sector plays an important role in promoting spillover effects of FDI. This suggests that policies for promoting the development of the private sector should be strengthened to increase the spillover effects of FDI. Bang (2008) using the OLS, GLS, and causality test for the 1990-2002 data set concludes that FDI positively influences economic growth through labor productivity.

Le Viet (2009) studies the relationship between FDI and economic growth in Vietnam, shows the positive contribution of FDI inflows to Vietnam's economic growth from 1988 to 2002, which is estimated at about 7% of the total capital contributing to growth (i.e., 37%) during this period. The regression results show that FDI is positively correlated with domestic investment and economic growth as well as FDI creates significant short-term and long-term positive effects on economic growth in Vietnam. Nguyen and Wongsurawat (2017) examined the relationship between electricity consumption (EC), economic growth, exports and FDI in Vietnam using time series data from 1980 to 2013. The results indicate that real 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.

However, Ericsson and Irandoust (2001) fail to determine any causal relationship between FDI and growth for Denmark and Finland when examining the causal relationship between FDI and output for four OECD countries including Denmark, Finland, Norway and Sweden. Haddad and Harrison (1993) also find no significant impact of FDI on domestic economic growth when conducting spillover effects of FDI to domestic companies in Morocco. Similarly, Karikari (1992) examines the causal relationship between FDI and economic growth in Ghana during the period 1961-1988, the author indicates that FDI does not affect economic growth in country. Recently, Temiz and Gökmen (2014) investigate the relationship between FDI inflows and economic growth in Turkey. By applying quarterly time series from quarter 1 1992 to quarter 3 2007 and OLS regression, the authors conclude that there is no meaningful relationship between FDI and economic growth in Turkey in the short and long terms. Karimi et al. (2009) studying the relationship between FDI and economic growth in Malaysia also show that FDI has no significant impact on growth.

Other studies find a negative relationship between FDI and economic growth. Karikari (1992), when examining the causal relationship between FDI and economic growth in Ghana from 1961 to 1988, conclude that FDI does not affect economic growth; conversely, economic growth may reduce FDI inflows. According to the author, FDI promotes free trade rather than boosts economic growth. Ang (2009) uses the error correction model to assess the effect of FDI on Thailand's economy during the period 1970-2004. Consequently, FDI has a negative impact on Thailand's economy. Differences in the results of the above studies on the relationship between FDI and economic growth demonstrate that it is necessary to collect more empirical evidence on this relationship.

2.2. The Relationship between Electricity Consumption and Economic Growth

So far we have not recorded any economic theory directly addressing the impact of electricity consumption on economic growth, but many researchers, through empirical results, suggest that this may be a positive relationship. In Arrow's endogenous growth theory (1962), technology is considered as a direct contributor to economic growth. The technology mentioned here is plant, machinery or generally, the process of converting inputs into outputs. If there is not enough power supply (in this case electricity or gasoline), these technologies are actually useless. The thermodynamic law helps to explain this by saying that *"no production process can be controlled without converting energy."* Therefore, although energy in general, and electricity in particular, are not the only determinants of technology, they are important factors to ensure that technology can be used effectively and become an essential input for economic growth. Additionally, the conversion of raw energy to useful energy illustrates a high level technology.

The study of Kraft and Kraft (1978) is considered as a fundamental research on the relationship between economic growth and energy consumption. Specifically, the study finds a one-way causal relationship from economic growth to electricity consumption in the US economy in the period 1947-1974. Studies in other countries/regions also aim at testing and confirming this relationship under specific conditions. If EC and GDP have a two-way causal relationship (EC↔GDP), there may exist an additional relationship. In other words, an increase in electricity consumption may have a positive impact on economic growth and vice versa.

If there is only a one-way effect causal relationship from GDP to EC (GDP → EC), it reflects that a country/region is less dependent on electricity, while if there is only a one-way effect causal relationship from EC to GDP (EC → GDP), the use of electricity must be considered in the national energy policy, because the initial investment cost for power plants is very expensive. There are a number of studies that find no relationship between these two variables. An explanation for findings on such relationship must be put in the context of specific research because electricity consumption is highly dependent on factors such as scientific and technical level, people's living standards, the geographical location, the weather as well as people's consumption habits, the enterprise and the national electricity policy. A summary of studies on the relationship between EC and GDP is shown in Table 1.

Results in Table 1 show that the relationship between EC and GDP is not uniform across countries/regions. This demonstrates that it is necessary to test such causal relationship in Vietnam.

3. RESEARCH METHODOLOGY

3.1. Research Models

Vietnam has just implemented economic reforms since 1986 and FDI only flows into Vietnam after 1990, so the length of the data sample is relatively short. From this point of view, in order to increase the relevance of the experimental results, the authors choose the autoregressive distributed lag (ARDL) method and the Toda-Yamamoto causality test to investigate the relationship between FDI, electricity consumption and economic growth in Vietnam. Based on studies by Tang (2009), Abdullah (2013), Anis et al. (2014) and Ibrahiem (2015), we propose a research model derived from the Cobb- Douglas as follows:

$$Y = e^{\varepsilon} A K^{a} L^{\beta} E^{\lambda} \quad (1)$$

Where: Y is the real output (GDP), A is the total factor productivity, K is the capital input of the economy (domestic capital and FDI), L is the labor input. E is the total electricity consumption. α, β, λ are the output elasticities of labor, capital and electricity, respectively. Because domestic capital is not considered in this study, we propose that K is expressed as K = c.FDI. Then equation 1 is rewritten as:

$$Y = c^{\alpha} e^{\varepsilon} A(FDI)^{\alpha} L^{\beta} E^{\lambda} \quad (2)$$

Assume that output Y is constant returns to scale, (i.e., α+β+λ=1), then divide both sides of equation 2 by L to find the per capita income, equation 2 is written as:

$$\frac{Y}{L} = c^{\alpha} e^{\varepsilon} A(\frac{FDI}{L})^{\alpha} (\frac{E}{L})^{\lambda} \quad (3)$$

Take the logarithm of both sides of equation 3 to obtain:

$$\log(\frac{Y}{L}) = \log(c^{\alpha} A) + \alpha \log(\frac{FDI}{L}) + \lambda \log(\frac{E}{L}) + \varepsilon \quad (4)$$

Since $\log(c^{\alpha} A)$ is constant, we can represent equation 4 as a model for time series data as follows:

$$log(\frac{Y}{L})_t = \beta_0 + \beta_1 log(\frac{FDI}{L})_t + \beta_2 \log(\frac{E}{L})_t + \varepsilon_t \quad (5)$$

3.2. Methods of Data Analysis and Processing

The study uses the ARDL model introduced by Pesaran et al. (2001) due to the following advantages: (i) The variables in the model just need to ensure that they are stationary at a maximum of level 1, it is possible to be stationary at same level (the root level I(0) or level 1 I(1)), (ii) avoid endogenous problems and be more reliable for small observations since lagged dependent variables are added as independent variables in the model, (iii) the short term and long term coefficients can be estimated at the same time, the error correction model can estimate both short-term adjustments and long-term equilibrium without omitting information in the long term, (iv) the model itself selects the optimal lag length, allows differences in the optimal lag length of variables, thus significantly improving the fit of the model (Davoud et al., 2013 and Nkoro and Uko, 2016). In order to increase the accuracy of the study, we use GNI per capita instead GDP per capita as the dependent variable. In terms of independent variable, to examine total impact in short-term and long-term, we use FDI inflow and electricity consumption, instead of FDI per capita and electricity consumption per capita. Data is collected from 1990 to 2015, sources and detailed illustrations of variables are shown in Table 2.

Then, equation 5 can be represented as an ARDL model as follows:

$$\Delta LnGNI_t = \beta_0 + \delta_1 LnGNI_{t-1} + \delta_2 LnFDI_{t-1} + \delta_3 LnEC_{t-1} + \sum_{i=1}^{p_1} \theta_i \Delta LnGNI_{t-1} + \sum_{i=1}^{p_2} \vartheta_i \Delta LnFDI_{t-1} + \sum_{i=1}^{p_3} \omega_i \Delta LnEC_{t-1} + \mu_t \quad \text{(Model 1)}$$

Table 1: The relationship between EC and GDP

Author	Country	Methods	Relationship
Tang (2009)	Malaysia	ARDL, Granger	EC↔GDP
Esso (2010)	7 countries	Threshold cointegration	EC↔GDP
Aslan et al. (2014)	America	ARDL, Granger	EC↔GDP
Kyophilavong et al. (2015)	Thailand	VECM, Granger	EC↔GDP
Ciarreta and Zarraga (2007)	Spain	Granger	GDP→EC
Canh (2011)	Vietnam	Threshold cointegration	GDP→EC
Hwang and Yoo (2014)	Indonesia	ECM-Granger	GDP→EC
Abdullah (2013)	India	VECM-Granger	EC→GDP
Mai (2015)	Asean6	Panel-VECM	EC→GDP
Wolde-Rufael (2006)	17 countries	ARDL	No relationship
Acaravci and Ozturk (2012)	Turkey	ARDL	No relationship

Source: The authors' summary. GDP: Gross domestic product, ARDL: Autoregressive distributed lag, VECM: Vector error correction model

Table 2: Source and measurement method of variables in the model

Variable symbol	Description	Unit	Expected impact	Source
GNI	The gross national income per capita (calculated at comparative prices in 2010)	USD/person	Dependent variable	World Bank
FDI	Total FDI flows into Vietnam	Million dollars	+	UNCTAD
EC	Total electricity consumption	Billion kWh	+	IEA

FDI: Foreign direct investment, IEA: International Energy Agency

Where Δ: The deviation of variables

- $\delta_1, \delta_2, \delta_3$ are regression coefficients that express long-term effects
- μ_t is the white noise error term.

The regression testing process includes the following steps: (1) Verifying the stationarity of variables in the model, (2) estimating model 1 by least squares method (OLS), (3) calculating F-statistic to determine whether there exists a long-term relationship between the variables. If there is a cointegration relationship in the long term, the error correction model (ECM) is estimated based on the following equation:

$$\Delta LnGNI_t = \beta_0 + \alpha.ECM_{t-1} + \sum_{i=1}^{p_1} \theta_i \Delta LnGNI_{t-1} + \sum_{i=1}^{p_2} \vartheta_i \Delta LnFDI_{t-1} + \sum_{i=1}^{p_3} \omega_i \Delta LnEC_{t-1} + \mu_t$$

(Model 2)

And if there exists α in which α is different from zero and statistically significant, the alpha coefficient shows the speed of adjustment of GNI per capita towards equilibrium after a short-term shock. (4) Moreover, in order to make the results of the study reliable, the authors will conduct additional diagnostic tests including: Testing for heteroscedasticity, testing for autocorrelation, testing for functional form, testing for residual normality, testing the stability of the model through the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ).

To determine the causal relationship between variables, instead of traditional Granger causality test, the authors use the modified Wald (MWALD) proposed by Toda and Yamamoto (1995). The Toda-Yamamoto method is based on the VAR model that contains the root level variable (instead of the first degree variable in the Granger causality test). This approach minimizes the risk of incorrectly identifying the degree of association of variables in the sample and is able to conduct notwithstanding that variables are stationary at level 0 or level 1 and there exists cointegration or no cointegration (Mavrotas and Kelly, 2001).

4. RESEARCH RESULTS AND DISCUSSION

4.1. Descriptive Statistics

With the opening of the economy in 1986, the promulgation of the Law on FDI in 1987 and being an official membership of the World Trade Organization in 2008, Vietnam's economy has undergone many positive changes. FDI inflows continuously increase and provide significant support to the industrialization and modernization of the country. In addition, Vietnam has a geographic location with many rivers and large water flows. This is a necessary condition for the development of the electricity industry. Descriptive statistics of variables are presented in Table 3.

4.2. Research Results

4.2.1. Test for stationarity

First, a test for stationarity is used to ensure that no variable is stationary at the second difference (a condition for using the ARDL model). An augmented Dickey-Fuller test is a popular method for studying time series data. However since the number of observations in the study is limited, we use the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) and Zivot-Andrews test to ensure the accuracy of the results obtained. The results of these tests shown in Table 4 suggest that with ADF and KPSS tests, variables are stationary at level 1. The Zivot-Andrews test rejects the hypothesis that variables are stationary at a level greater than level 2. Therefore, the application of the ARDL into the model is reasonable.

4.2.2. Bound test

The ARDL model itself calculates the optimal lag length. Based on AIC standard, regarding the data of the observation, the optimal model is ARDL (2,0,0) with the initial maximum lag length for the auxiliary variables is 4. The result of F-statistic test is 7.859 which is greater than the critical value of the upper bound (upper bound = 5) at the significance level of 1%, thus rejecting the null hypothesis. In other words, variables in the model have cointegration relationship in the long run. The results of bound test are shown in Table 5.

4.2.3. Error correction model

Because there exists cointegration between variables in the long run, the authors continue to use the error correction model (Model 2) to determine the error term coefficient. As a result, the estimated result of model 2 shows that the coefficient of $\alpha = -0.493$ is statistically significant at 1%. This implies that GNI per capita will automatically adjust to equilibrium level after a short-term shock due to the effects of FDI and EC. The coefficients of FDI and EC variables are positive, statistically significant at the 1% level, which indicates that in the short run both FDI and electricity

Table 3: Descriptive statistics of variables

Variable	Medium	Median	Max	Min	Error
LnGNI	6.24	6.09	7.58	4.48	0.91
LnFDI	7.78	7.57	9.37	5.19	1.10
LnEC	3.45	3.50	4.94	1.87	1.01

Source: Authors' calculations

Table 4: Results of the stationary test

Variable	ADF test	KPSS test	Zivot-Andrews test
LnGNI	−2.386	0.752***	−5.561**
ΔLnGNI	−3,846**	0.235	
LnFDI	−2.433	0.672**	−7.543***
ΔLnFDI	−3.546*	0.154	
LnEC	−0.974	0.752**	−2.606**
ΔlnEC	−2.962*	0.196	

***, **and *denote the significance level of 1%; 5% and 10%. Source: The authors' calculations

Table 5: Results of bound test

Bound test		Critical values for bound test		
Statistical value	Value	Significance level (%)	I (0) Bound	I (1) Bound
F-statistics	7.859838	10	2.63	3.35
k	2	5	3.1	3.87
		2.5	3.55	4.38
		1	4.13	5

consumption positively influence average income. The regression coefficient of EC variable is greater than that of FDI variable, implying that electricity consumption is more likely to improve the short-term average income. The results of the error correction model are shown in Table 6.

4.2.4. Long-term estimation results

Next, we estimate the long-term impact to investigate the effect of FDI and power consumption on Vietnam's per capita income over the period 1990-2015. The results in Table 7 show that both LnFDI and LnEC variables are positively correlated with per capita income and statistically significant at 1% level. Accordingly, ceteris paribus, a 1% increase in FDI inflows leads to a 0.21125% increase in per capita income. Similarly, a 1% increase in electricity consumption leads to 0.6463% increase in per capita income.

Table 6: Results of the error correction model

Variable	β	Standard error	t-statistic	P
Intercept	1.196052	0.242998	4.922073	0.0001
ECM(-1)	−0.493059	0.104721	−4.708290	0.0002
LnFDI	0.104159	0.035098	2.967678	0.0079
LnEC	0.318671	0.073399	4.341622	0.0004
ΔLnGNI(-1)	0.319704	0.162385	1.968800	0.0637

Source: The authors' calculations

Table 7: Estimated results of long term impact coefficient

Variable	β	Standard error	t-statistic	P
LnFDI	0.211251	0.049888	4.234508	0.0004
LnEC	0.646315	0.051693	12.50307	0.0000
Intercept	2.425779	0.245548	9.879025	0.0000
ECM=LnGNI - (0.2113*LnFDI+0.6463*LnEC+2.4258)				

Source: The authors' calculations

Table 8: Results of additional tests

Types of test	Statistical value	P
Heteroscedasticity test (White test)	1.77461	0.1949
Serial correlation LM test (Breusch-Godfrey test)	0.10182	0.9037
Normality test of residuals (normality test)	0.44101	0.8021

Source: The authors' calculations

4.2.5. Additional tests

Afterwards, we test the stability of the model by checking the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ). Figure 1 shows that both CUSUM and CUSUMSQ lines (the solid line) stay within the critical bounds at the 5% level (the dashed line), so we conclude that estimated coefficients in the model are stable in the long run.

Finally, to confirm the relationship between variables, we conduct the Granger causality test based on the Toda-Yamamoto method with the null hypothesis of no Granger causality. The results are shown in (Tables 8 and 9, Figure 2).

4.2.6. Robustness analysis

Because the length of the data series is limited, in order to avoid biased results in the long term, we perform robustness analysis using FMOLS (Fully Modified OLS) and DOLS (Dynamic OLS) methods. Although Kao and Chiang (2000) note that DOLS is more effective than FMOLS, we still use both methods to confirm the effect of long-term estimates. The results obtained in Tables 7 and 10 show that beta coefficients of LnFDI and LnEC variables are relatively similar. This confirms that the estimated effects of FDI and electricity consumption on Vietnam's economic growth in the long run is consistent and unbiased.

4.3. Discussion and Policy Implications

The experimental results of the study are consistent with the pre-conditions for take-off stage proposed by Rostow. These results are also consistent with the conclusions of other studies for countries/regions which have similar starting points and

Table 9: Granger causality test based on the Toda-Yamamoto method

Null hypothesis	Number of observations	F-statistic	P
LnFDI does not have a causal effect on LnGNI	24	4.99569	0.0181
LnGNI does not have a causal effect on LnFDI		4.99481	0.0181
LnEC does not have a causal effect on LnGNI	24	4.59245	0.0236
LnGNI does not have a causal effect on LnEC		0.53783	0.5926
LnEC does not have a causal effect on LnFDI	24	1.66254	0.2161
LnFDI does not have a causal effect on LnEC		0.06944	0.9332

Figure 1: (a and b) Results of the stability test of the model

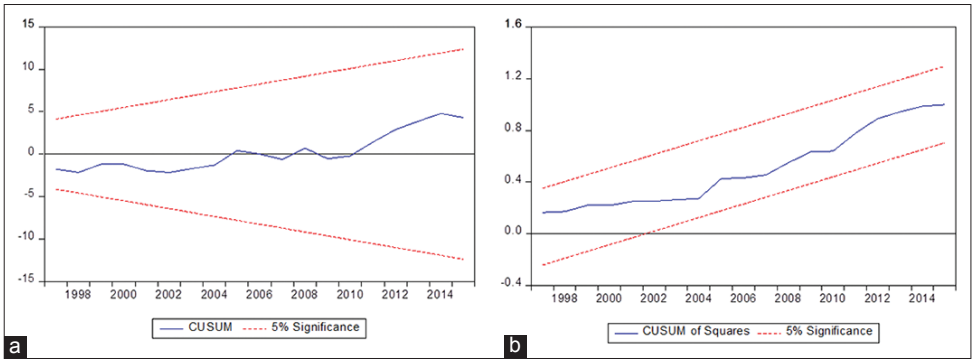
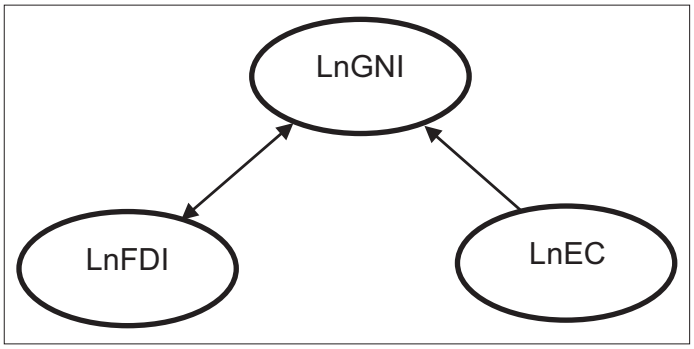


Table 10: Results of robustness analysis using FMOLS and DOLS methods

Variable	FMOLS	DOLS
LnFDI	0.28235***	0.270062***
LnEC	0.60708***	0.614113***
Intercept	1.94719***	2.039115***
Adjusted R^2	0.991	0.993

***, **and *denote the significance level of 1%; 5% and 10%. Source: The authors' calculations

Figure 2: Granger causality between variables based on Toda-Yamamoto approach



similar conditions like Vietnam. Such studies are Tang (2009) for the Malaysian economy in the period 1970-2005, Abdullah (2013) for the Indian economy 1975-2008, Odhiambo (2009) for the Tanzania economy 1971-2006, Kasperowicz (2014) for the Polish economy or Ibrahiem (2015) for the Egyptian economy etc. This is reasonable, because according to Alam (2006) energy is an indispensable resource/input for all economic activities. Energy efficiency not only helps to save production costs but also enhances profitability through improved labor productivity. Oviemuno (2006) states that *"Even though it cannot conclude that energy is finite, more efficient use of existing energy also increases the wealth of a nation."*

Based on the results of the study, the authors suggest some considerations when applying these results in practice as follows:

First, Vietnam should strive to attract FDI as well as develop the electricity industry. The beta coefficient of LnEC variable is 0.646 while the beta coefficient of LnFDI variable is 0.211. This implies that increased investment in the electricity sector will have a greater impact on economic growth than increased investment in FDI. Therefore, policies which aim at attracting FDI and evaluating FDI projects need to prioritize projects that have low electricity consumption, advanced technology and are environmentally friendly.

Second, the consumption of electricity contributes to enhance economic growth in Vietnam, this does not mean that Vietnam has to build a lot of power plants. Electricity efficiency, saving electricity, switching off unnecessary equipment, reducing losses in the power transmission etc. are also methods for Vietnam to increase the electricity output.

Third, with favorable geographic position, Vietnam has great potential to develop alternative energy sources such as solar, wind, biofuels and geothermal power etc. These are more environmentally friendly types of energy. Exploiting and using these energy sources are extremely important in terms of socio-economic and energy security and sustainable development.

5. CONCLUSION

In the process of development, the demand for capital to invest in infrastructure, social security, education, health care, defense, etc. is always great. With the data from 1990 to 2015, by using the ARDL and the Granger causality test proposed by Toda-Yamamoto, we conclude that electricity consumption and FDI have positive impacts on economic growth in Vietnam. We also find a two-way Granger causal relationship between FDI and GNI per capita (FDI↔GNI), a one-way Granger causal relationship from power consumption to GNI per capita (GN → GNI).

Although the number of observations and test results are satisfactory, it should be noted that the data of the study may be not long enough. In addition, the study does not analyze in detail the impact of electricity consumption by the industrial sector and population to economic growth. This can be the direction for further research.

REFERENCES

Abdullah, A. (2013), Electricity power consumption, foreign direct investment and economic growth. World Journal of Science, Technology and Sustainable Development, 10(1), 55-65.

Acaravci, A., Ozturk, I. (2012), Electricity consumption and economic growth nexus: A multivariate analysis for Turkey. The Amfiteatru Economic Journal, 14(31), 246-257.

Ahmed, K., Bhattacharya, M., Shaikh, Z., Ramzan, M., Ozturk, I. (2017), Emission intensive growth and trade in the era of the Association of Southeast Asian Nations (ASEAN) integration: An empirical investigation from ASEAN-8. Journal of Cleaner Production, 154, 530-540.

Alam, M.S. (2006), Economic Growth with Energy. MRPA Working Paper. Available from https://www.mpra.ub.uni-muenchen.de/1260. [Last retrieved on 2006 Nov 20].

Al-Mulali, U., Saboori, B., Ozturk, I. (2015), Investigating the environmental Kuznets curve hypothesis in Vietnam. Energy Policy, 76, 123-131.

Ang, J. (2009), Foreign direct investment and its impact on the Thai economy: The role of financial development. Journal of Economics and Finance, 33(3), 316-323.

Anh, N.T.T., Hong, V.X.N., Thang, T.T., Hai, N.M. (2006), Tác động của Đầu tư trực tiếp nước ngoài tới tăng trưởng kinh tế ở Việt Nam. Science and Technics Publishing House.

Anis, O., Nguyen, D.K., Rault, C. (2014), Causal interactions between CO_2 emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models. Economic Modelling, 42, 382-389.

Arrow, K. (1962), The Economic implication of learning-by-doing. Review of Economic Studies, 29(1), 155-173.

Aslan, A., Apergis, N., Yildirim, S. (2014), Causality between energy consumption and GDP in the US: Evidence from wavelet analysis. Frontier in Energy, 8(1), 1-8.

Aytac, D., Guran, M.C. (2011), The relationship between electricity consumption, electricity price and economic growth in Turkey: 1984-2007. Argumenta Oeconomica, 2(27), 101-123.

Bang, V.T. (2008), Foreign direct investment and endogenous growth in Vietnam. Applied Economics, 40, 1165-1173.
Bende-Nabende, A., Ferd, J.L. (1998), FDI, policy adjustments and endogenous growth multiplier effects form a small dynamic model for Taiwan, 1959-1995. World Development, 26, 115-130.
Canh, L.Q. (2011), Electricity consumption and economic growth in Vietnam: A cointegration and causality analysis. Journal of Economics and Development, 13(3), 24-36.
Ciarreta, A., Zarraga, A. (2007), Electricity consumption and economic growth: Evidence from Spain. Biltoki 2007.01, Universidad del Pais Vasco. p1-20.
Davoud, M., Behrouz, S.A., Farshid, P., Somayeh, J. (2013), Oil products consumption, electricity consumption-economic growth nexus in the economy of Iran: A bounds test co-integration approach. International Journal of Academic Research in Business and Social Sciences, 3(1), 353-367.
Dunning, J., Lundan, S. (2008), Institutions and the OLI paradigm of the multinational enterprise. Asia Pacific Journal of Management, 25(4), 573-593.
Ericsson, J., Irandoust, M. (2001), On the causality between foreign direct investment and output: A comparative study. The International Trade Journal, 15, 122-132.
Esso, L.J. (2010), Threshold cointegration and causality relationship between energy use and growth in seven African countries. Energy Economics, 32(6), 1383-1391.
Haddad, M., Harrison, A. (1993), Are there positive spillovers from direct foreign investment? Evidence from panel data for Morocco. Journal of Development Economics, 42, 51-74.
Hwang, J.H., Yoo, S.H. (2014), Energy consumption, CO_2 emissions, and economic growth: Evidence from Indonesia. Quality and Quantity, 48(1), 63-73.
Ibrahiem, D.M. (2015), Renewable electricity consumption, foreign direct investment and economic growth in Egypt: An ARDL approach. Procedia Economics and Finance, 30, 313-323.
Kao, C., Chiang, M.H. (2000), On the estimation and inference of a cointegrated regression in panel data. Center for Policy Research, 2000, 145.
Karikari, J.A. (1992), Causality between direct foreign investment and economic output in Ghana. Journal of Economic Development, 17(1), 7-17.
Karimi, M.S., Yusop, Z. (2009), FDI and Economic Growth in Malaysia. MPRA Paper, 14999(03).
Kasperowicz, R. (2014), Electricity consumption and economic growth: Evidence from Poland. Journal of International Studies, 7(1), 46-57.
Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. Journal of Energy and Development, 3(2), 401-403.
Kyophilavong, P., Shahbaz, M., Anwar, S., Masood, S. (2015), The energy-growth nexus in Thailand: Does trade openness boost up energy consumption? Renewable and Sustainable Energy Reviews, 46, 265-274.
Le Viet, A. (2009), FDI-Growth Nexus in Vietnam. Nagoya University.
Mai. T.T. (2015), Mối quan hệ nhân quả giữa sản lượng điện tiêu thụ và tăng trưởng kinh tế ở các nước Asean. Master's Thesis in Economics. Ho Chi Minh City: University of Economics.
Mavrotas, G., Kelly, G. (2001), Old wine in new bottles: Testing causality between savings and growth. Manchester School, 69(1), 97-105.
Nguyen, M. (2003), FDI và tăng trưởng kinh tế Việt Nam. Vietnam Investment Review, 24-12-2003.
Nguyen, T., Wongsurawat, W. (2017), Multivariate cointegration and causality between electricity consumption, economic growth, foreign direct investment and exports: Recent evidence from Vietnam. International Journal of Energy Economics and Policy, 7(3), 287-293.
Nguyen, T.P.H. (2004), Foreign Direct Investment and its Contributions to Economic Growth and Poverty Reduction in Vietnam (1986-2001). Peter Lang, Frankfurt am Main, Germany.
Nguyen, TTA., Vu, XNH., Tran, TT., Nguyen, MH. (2006), Tác động của Đầu tư trực tiếp nước ngoài tới tăng trưởng kinh tế ở Việt Nam_. _NXB Khoa học và Kỹ thuật.
Nkoro, E., Uko, A.K. (2016), Autoregressive distributed lag (ARDL) cointegration technique: Application and Interpretation. Journal of Statistical and Econometric Methods, 5(4), 63-91.
Odhiambo, N.M. (2009), Energy consumption and economic growth nexus in Tanzania: An ARDL bounds testing approach. Energy Policy, 37(2), 617-622.
Oviemuno, A.O. (2006), Impact of Energy on the Manufacturing Sector of Nigeria. Available from: www.searchwarp.com. [Last retrieved on 2007 Nov 01].
Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326.
Rostow, W.W. (1990), The Stages of Economic Growth: A Non-Communist Manifesto. 3rd ed. Cambridge: Cambridge University Press.
Shaari, M.S.B., Hong, T.H., Shukeri, S.N. (2012), Foreign direct investment and economic growth: Evidence from Malaysia. International Business Research, 5(10), 100-106.
Tang, C.F. (2009), Electricity consumption, income, foreign direct investment, and population in Malaysia: New evidence from multivariate framework analysis. Journal of Economic Studies, 36(4), 371-382.
Tang, C.F., Tan, B.W., Ozturk, I. (2016), Energy consumption and economic growth in Vietnam. Renewable and Sustainable Energy Reviews, 54, 1506-1514.
Temiz, D., Gökmen, A. (2014), FDI inflow as an international business operation by MNCs and economic growth: An empirical study on Turkey. International Business Review, 23(1), 145-154.
Toda, H.Y., Yamamoto, T. (1995), Statistical inference in vector autoregressive with possibly integrated processes. Journal of Econometrics, 66(1), 225-250.
Williamson, O. (1985), The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting. New York: Free Press.
Wolde-Rufael, Y. (2006), Electricity consumption and economic growth: A time series experience for 17 African countries. Energy Policy, 34(10), 1106-1114.
Yildirim, E., Aslan, A., Ozturk, I. (2014), Energy consumption and GDP in ASEAN countries: Bootstrap-corrected panel and time series causality tests. The Singapore Economic Review, 59(2), 1450010.