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Energy Consumption, CO_2 and Economic Growth Nexus in Vietnam

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ABSTRACT

This study will demonstrate, through an econometric approach, the relationship among per capita GDP, CO_2 emissions, and energy use in Vietnam. Using annual data for years 1970-2014, stationarity, structural breaks, Toda-Yamamoto test, Johansen and Juselius approach, and Variance decomposition have been conducted. The causality results in our analysis highlight that the presence of unidirectional causality was running from economic growth to energy consumption. This result will be significant since it supports the conservation hypothesis for the economy of Vietnam. Finally, the results of the variance decompositions reject the hypothesis that energy is neutral for growth, but that there is a relationship link even if the effects last for a short time.

Keywords: Economic Growth, CO_2 Emissions, Energy Use, Vietnam, Time Series
JEL Classifications: B22, C32, N55, Q43

1. INTRODUCTION

This work aims to estimate the relationship between CO_2 emissions, economic growth, and energy use in Vietnam in the period from 1970 to 2014. Vietnam is one of the fastest growing emerging economies in Asia. However, the economic growth of this country has been accompanied by an increase in energy consumption with adverse effects on the environment. Vietnam's energy economy has changed rapidly in recent decades. It has undergone the same transformation as the economy: From an agricultural economy based on traditional fuels, it has passed to the use of biomass, and other forms of renewable energy. Internally, Vietnam is rich in energy resources such as crude oil, coal, natural gas, and hydroelectric power. They assisted Vietnam's economic growth as the country did not need to import these energy assets. However, in recent years, the increase in per capita income has increased energy demand and therefore also imports.

In general, Vietnam's energy sector is dominated by state-owned companies, which also set the price of energy sales for the domestic market. It is less than the cost of around 15%. The Vietnam National Oil and Gas Group (PetroVietnam) acts as a monopolist in the supply of oil and gas. The Vietnam National Coal-Mineral Industries Group (Vinacomin) manages and offers. Instead, 95% of the coal mined in the country. The Vietnam Electricity Power Group (EVN) controls the electricity market by supplying two-thirds of total electricity production. Therefore, state-owned enterprises dominate the entire energy market. In short, we can say that they have more than three-quarters of the electricity market and in particular, the Vietnam EVN alone controls 60% of the total (Table 1).

Regarding the total number of power plants in operation, they are 113. Those that produce hydroelectric power represent 37.6 percent, generating 15.8 GW; those that use coal, on the other hand, are 34.3 percent, producing 14.4 GW; 17.8% use gas causing 7.5 GW. The remaining energy capacity comes from renewable energy and oil, respectively, in percentage on the total, of 5.8% and 3.3% (Figure 1).

Over the years, regardless of the source, energy consumption has grown steadily. Concerning primary energy consumption in Vietnam from 2005 to 2017 we can see, in Figure 2, a more than

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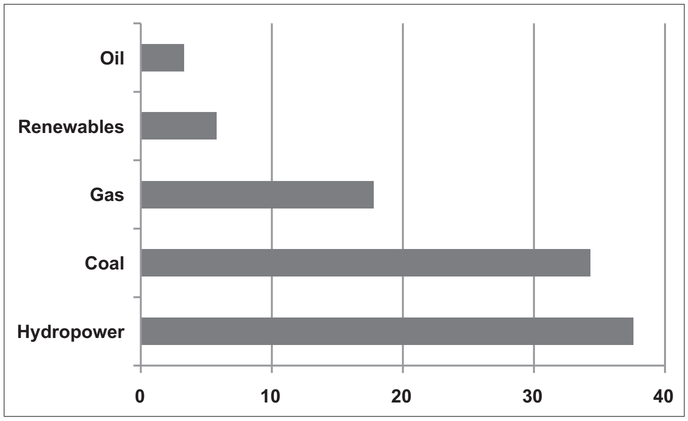
Table 1: Market share of Vietnam's power producers in 2014

Owner	Capacity (MW)	Rate (%)
Vietnam Electricity Power Group	20,539.7	60
Vietnam National Oil and Gas Group (PetroVietnam)	4,429.0	13
Vietnam National Coal-Mineral Industries Group (Vinacomin)	1,485.0	4
Local investors	4,765.6	14
Foreign investors	2,859.5	8

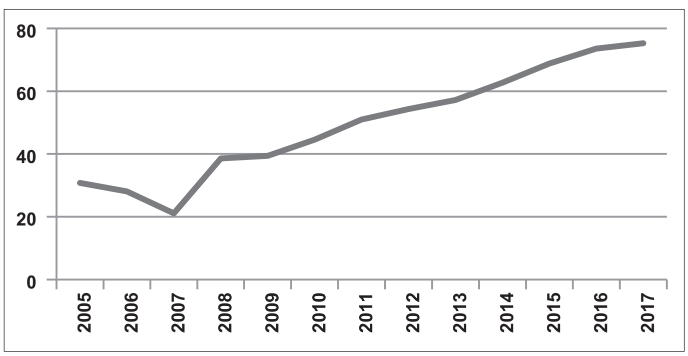
Source: BCTN, http://evn.vn, 2015

Figure 1: Installed capacity by fuel type in GW (2016)



Source: BCTN, http://evn.vn, 2017

Figure 2: Primary energy consumption in Vietnam from 2005 to 2017 (in million tons of oil equivalent)



Source: Statistics and Studies, Statistica, 2019

proportional growth. In 2017, in total around 75.3 million tons of oil equivalent of primary energy was consumed in Vietnam.

Despite the increase over the years of primary energy consumption, there has been a change in the type of final energy consumption. In terms of sectoral final energy consumption, from 2015 the industrial sector is the largest consumer with 43%, followed by the residential area with 29.6% and from the transport sector with 22.7%. The increase in energy consumption, in almost all its forms, has generated a rise in CO_2 emissions. In 2016, CO_2 emissions were 206,042.1 kt with a substantial growth between 1997 and 2016: Vietnam has recorded a value that has increased from 43,373.4 to 206,042.1 kt, an annual growth of over 18%. Only in the last quarter of 2016, the value fell by 0.09%. Concerning CO_2 emissions intensity in 2016 it was 0.37 kg per 1000 dollar GDP, with annual growth from 1997 to 2016 of 2.24%.

About the results up to this point in our introduction, understanding the time series behavior of Vietnam's aggregate income, carbon dioxide emissions and energy use are fundamental in assessing the sustainability of Vietnam's economic growth. In particular, below, we will try to verify whether the ECK theory in Vietnam is confirmed or not.

2. LITERATURE REVIEW

Numerous authors have addressed the literature on economic growth and energy consumption (Kraft and Kraft, 1978; Akarca and Long, 1980; Erol and Yu, 1987; Masih and Masih, 1996; Stern, 2000; Chontanawat et al., 2006; Rufael, 2006; Costantini and Martini, 2009; Ozturk, 2010; Bright and Machame, 2011; Mehdi and Maamar, 2012; Al-mulali et al., 2015; Tang et al., 2016; Nguyen and Wongsurawat, 2017; Phuong, 2018; Phong et al., 2018; Mele, 2019 etc…). In general, according to Squalli (2007) the causal relationship between energy consumption and economic growth involves the following directions: (a) "Neutrality hypothesis", when there isn't causality between energy consumption and GDP; (b) "Conservation hypothesis": When there is unidirectional causality running from GDP to Energy; (c) "Growth hypothesis": When there is unidirectional causality running from energy to economic growth; (d) "Feedback hypothesis": If there is, instead, bidirectional causality between energy consumption and economic growth.

The issue of the relationship among GDP, energy and CO_2 emissions has been addressed in the empirical literature with an approach known as the Environmental Curve theory (1955). It considers the existence of a relationship between environmental quality indices and per capita income and this relationship can be represented graphically with a bell shape: In the initial phase of development, with increasing wealth, we can witness a deterioration of environmental quality, since a higher income corresponds to a higher level of polluting emissions. Instead, we can observe, instead, an inversion of trend and, for further increases of income, we obtain lower emission levels; this thanks to the structural changes that accompany the different stages of development as well as a more felt environmental sensitivity on the part of the citizens. The higher demand for environmental quality encourages the production of cleaner goods. One of the first studies on the EKC literature was the World Development Report (1992). This analysis showed that some indicators of environmental degradation (for example carbon dioxide emissions and urban solid waste) increase with income, others decrease as income increases (such as water pollution) and finally, some (sulfur dioxide and nitrous oxide) showed the classic inverted U shape. In fact, the relationship between income and environmental impact can also have different trends. In detail, we can distinguish two types of relationships: Monotone and non-monotone. According to the first, the pollution appears to be a growing function, for example occurs for solid urban waste, or a decreasing income, such as access to water supply services. Instead, among the non-monotonous forms, those of the inverted U type seem to prevail in which, as previously stated, environmental damage initially increases with income, and therefore it begins to decrease when per capita income reaches a level of de-linking (improvement of environmental quality with increasing income). Another typology is represented by the so-called N relationship, in which the phenomenon of de-linking is only temporary. However, sometimes even more complex types of relationships can appear, even if the empirical evidence shows a greater tendency towards EKC, although it is sensitive both to the type of environmental phenomenon and to the data used for the estimation.

Studies on the relationship between economic growth, energy consumption, and CO_2 are very recent, and some of them deal with the problem more generally. In general, these studies focus their discussion and verification of the inverted U-shaped testing its validity. Holtz-Eakin and Selden (1995) analyze the link between per capita GDP and CO_2 per capita in a panel of 130 countries, from 1951 to 1986. They highlight the presence of an inverted U shape. De Bruyn et al. (1998) study the environmental Kuznets curve (EKC) building a dynamic model that considers three variables: Energy intensity, structural intensity, and technological change and the level of GDP. They analyzed West Germany, the United States, the Netherlands, and Great Britain, in a time series ranging from 1960 to 1993. Their results confirm a direct relationship between economic growth and emissions. Taskin and Zaim (2000) through a cross-section analysis analyze the environmental efficiency index about per capita GDP, from 1975 to 1990. They consider 52 countries and the U-curve was verified for those countries that have a per capita GDP above $5,000.

Azomahou et al. (2006) through an analysis in time series, from 1960 to 1996, they examined the relationship between CO_2 and GDP. They used a dataset of 100 countries and verified a correlation between CO_2 and economic development. Lantz and Feng (2006) examined the EKC theory and the relationship between CO_2 and GDP in Canada with a time series from 1970 to 2000. Their results do not confirm the economic theory. Soytas et al. (2007), analyzed the relationship between CO_2, energy and economic growth in the USA for a period ranging from 1960 to 2004. Their results show a direct correlation between the variables. Lee et al. (2008) examined a historical period between 1960 and 2001 through a panel of 22 OECD countries. Their study verifies the relationship between three variables: Energy consumption, economic growth, and social capital. The result is that all the variables were connected. Apergis and Payne (2010) carried out a critical examination. They studied the relationship between economic growth and the consumption of coal for 25 OECD countries and a period from 1980 to 2005. Their work, one of the most cited among the publications, confirmed the presence of a two-way causal relationship between all the indicators. Menyah and Wolde-Rufael (2010), on the other hand, conducted a study on South Africa with time series 1965-2006. Through a model of cointegration, they have verified a unidirectional causal link between CO_2 towards economic growth, energy consumption towards CO_2 emissions and energy consumption towards economic growth. He and Richard (2010), examined CO_2 emissions in Canada concerning the EKC theory. They used a time series from 1948 to 2004 and verified that there is no evidence for a theoretical and empirical confirmation. Wang et al. (2011) examined the case of China. In particular, they studied the causality between CO_2 emissions, energy consumption and economic growth for a period from 1995 to 2007. They found a high bidirectional causality between CO_2, energy consumption and economic growth.

Sharma (2011) studied the determinants of CO_2 emissions for 69 countries between 1985 and 2005. He analyzed the relationship with GDP, energy use and international trade, concluding that economic growth and international trade causes an increase in CO_2. Jayanthakumaran et al. (2012) through an ARDL model studied the existing relationship between CO_2 emissions, energy consumption, trade and income growth in China and India between 1971 and 2007. The results show a direct relationship between the variables under study. Akpan and Akpan (2012) studied the case of Nigeria with a time series 1970-2008. In particular, they analyzed the situation of long-term relationships between electricity consumption, CO_2 and economic growth. The result of their long-term study was a positive relationship between CO_2 emissions and economic growth. Zhang and Wang (2013), studied the relationship between, energy consumption, CO_2 emissions and economic growth in China between 1995 and 2009. The results of this study found that CO_2 emissions increased with China's rapid economic growth. Shahbaz and Hooi (2014) examined the existing relationship, in industrialized countries, between CO_2 emissions, electricity consumption and economic development. They used a period between 1975 and 2010 and concluded that the increase in electricity consumption generates an increase in CO_2. Zhang and Da (2015), through a fascinating study, have decomposed carbon emissions in China with the intensity of carbon emissions, compared to economic growth. They analyzed a period from 1996 to 2006 and concluded that the cause of CO_2 emissions in China was economic growth. Ma et al. (2016), examined the relationship between CO_2 emissions and economic growth in China between 1994 and 2012 through the use of a decoupling index. The results show how CO_2 emissions are correlated with economic growth, especially of families. Chen et al. (2016), carried out a regional study on China. In particular, they verified the interregional differences in CO_2 emissions, concluding that government growth choices, activated in each region, caused different levels of CO_2.

Concerning Vietnam, few studies have examined the relationship links that are the subject of this study. Linh and Lin (2014) studied the relationship between CO_2, energy consumption, FDI and economic growth in Vietnam for some time from 1980 to 2010. Their result is that the theory of EKC is not supported in Vietnam. Nevertheless, the cointegration analysis highlighted a direct relationship between the variables under study. Nguyen-Trinh and Ha-Duong (2015; 2016) addressing the problem of the relationship between CO_2, energy and economic growth under another point of view. They studied how urbanization affects energy and on the intensity of CO_2 emissions in Vietnam, through a historical panel series from 2010 to 2013. They showed how urbanization, in low-income provinces, thanks to economic growth increases the use of energy and therefore also of CO_2 emissions. Ho (2018) studies carbon dioxide (CO_2) emissions, renewable energy consumption and economic growth in Vietnam in the period from 2010 to 2019. She carries out a forecasting study stating that

Table 2: Summary of some literature on energy use-emissions-GDP nexus

Author(s)	Countries	Time period	Results
Holtz-Eakin and Selden (1995)	130 countries	1951-1986	They highlight the presence of an inverted U shape
De Bruyn et al. (1998)	4 countries	1960-1993	Their results confirm a direct relationship between economic growth and emissions
Taskin and Zaim (2000)	52 countries	1975-1990	U-curve was verified for those countries that have a per capita GDP above \$5,000
Lantz and Feng (2006)	Canada	1970-2000	Their results do not confirm the economic theory.
Azomahou et al. (2006)	100 countries	1960-1996	There is a correlation between CO_2 and economic development
Soytas et al. (2007)	USA	1960-2004	Their results show a direct correlation between the variables
Lee et al. (2008)	22 OECD countries	1960-2001	All the variables were connected
Apergis and Payne (2010)	25 OECD countries	1980-2005	There is the presence of a two-way causal relationship between all the indicators
Menyah and Wolde-Rufael (2010)	South Africa	1965-2006	They have verified a unidirectional causal link between CO_2 towards economic growth, energy consumption towards CO_2 emissions and energy consumption towards economic growth
He and Richard (2010)	Canada	1948-2004	There is no evidence for a theoretical and empirical confirmation about EKC theory
Wang et al. (2011)	China	1995-2007	They found a high bidirectional causality between CO_2, energy consumption and economic growth
Sharma (2011)	69 countries	1985-2005	Economic growth and international trade causes an increase in CO_2
Akpan and Akpan (2012)	Nigeria	1970-2008	There is a positive relationship between CO_2 emissions and economic growth
Zhang and Wang (2013)	China	1995-2009	The results of this study found that CO_2 emissions increased with China's rapid economic growth
Shahbaz and Hooi (2014)	United Arab Emirates	1975-2010	The increase in electricity consumption generates an increase in CO_2
Linh and Lin (2014)	Vietnam	1980-2010	Their result is that the EKC' theory is not supported in Vietnam
Tang and Tan (2015)	Vietnam	1976-2009	There is a bidirectional relationship between CO_2 and economic growth
Kasman and Duman (2015)	EU	1990-2010	There is a bidirectional relationship between CO_2 and economic growth
Zhang and Da (2015)	China	1996-2006	The cause of CO_2 emissions in China was economic growth
Chen et al. (2016)	China	Cross-section	This article demonstrated that, due to government policy the interregional economic and emissions are different
Ma et al. (2016)	China	1994-2012	The results show how CO_2 emissions are correlated with economic growth, especially of families
Nguyen and Ha-Duong (2015; 2016)	Vietnam	2010-2013	They showed how urbanization, in low-income provinces, thanks to economic growth increases the use of energy and therefore also of CO_2 emissions
Ho (2018)	Vietnam	2010-2019	She carries out a forecasting study stating that with 5% GDP growth, emissions of CO_2 of Vietnam will grow by 3%

with 5% GDP growth, emissions of CO_2 of Vietnam will grow by 3%. A summary of some literature on energy use-emissions-GDP nexus is presented in Table 2.

3. EMPIRICAL ANALYSIS

The empirical analysis aims to analyze the presence of a causal relationship between CO_2 emissions, energy consumption and per capita GDP. In our study, we use 1970-2014 annual data where Table 3 shows the sources of variables used in our empirical analyses: CO_2 is CO_2 emissions (metric tons per capita); PCGDP is GDP per capita in 2000 US\$, and PCEU is per capita energy use (kg of oil equivalent). The STATA and Gretl software we use for data processing.

For this work, to avoid distortions in the analysis, the variables used were calculated in the logarithmic terms. In Table 4, an exploratory data analysis is given.

As we can see in Table 4 mean present a positive value for all variables; 10-Trim values are near the mean; the inter-quartile range shows the absence of outliers.

Table 3: List of the variables

Variable	Explanation	Source
PCGDP	GDP per capita in 2000 US\$ (converted at Geary Khamis PPPs)	FRED Data
CO_2	CO_2 emissions (metric tons per capita)	World Bank Data
PCEU	Per capita energy use, kg of oil equivalent	World Bank Data

The correlation analysis shows that, in our dataset, the variables are strongly correlated: Corr. (CO_2, PCGDP) = 0.9829; corr. (CO_2, PCEU) = 0.9934; corr. (PCGDP, PCEU) = 0.9686 with all significant variables (0.000).

The visual analysis confirms the presence of a high correlation between the variables of our study in Figure 3 where we use the Hodrick-Prescott filter.

As we can see from the Figure 3, applying a filter for historical data capable of outlining the cycles, both energy use, and CO_2 emissions follow the recessive and expansive phases of the Vietnamese

Table 4: Exploratory data analysis

Variable	Mean	SD	Minimum	Maximum	Ex. Kurtosis	10 Trim	IQR
PCGDP	3.8502	1.5134	2.4051	8.0429	0.85540	3.90	1.7321
CO_2	0.63834	0.42636	0.26229	1.7014	0.13833	0.66	0.54688
PCEU	5.8273	0.32347	5.5239	6.5011	−0.46814	5.91	0.47191

Table 5: Results for unit roots and stationary tests

Variable	ADF	ERS	PP	KPSS
Level				
PCGDP	−2.050 (−3.140)	−1.167 (−3.020)	−2.030 (−3.140)	0.450*** (0.146)
CO_2	−2.060 (−3.125)	−1.105 (−3.150)	−2.150 (−3.125)	0.375*** (0.146)
PCEU	−1.045 (−3.075)	−1.827 (−3.054)	−3.046 (−3.615)	0.150*** (0.146)
First differences				
PCGDP	−6.288*** (−2.098)	−5.822*** (−2.543)	−6.288*** (−2.098)	0.354* (0.463)
CO_2	−3.034*** (−2.241)	−1.505 (−2.152)	−8.050*** (−2.544)	0.250 (0.463)
PCEU	−3.384** (−1.985)	−2.315*** (−2.015)	−8.114***(−2.946)	0.150 (0.463)

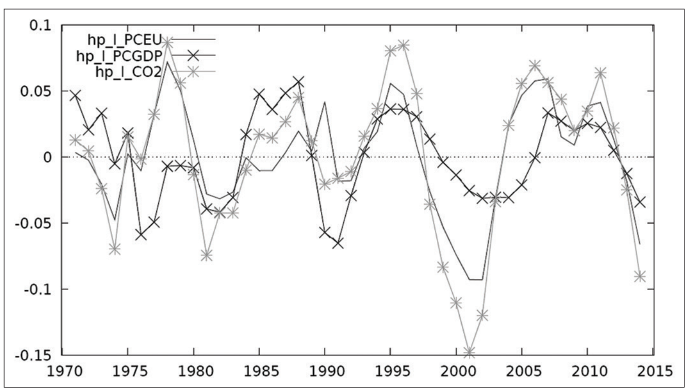
*P<0.1; **P<0.05; ***P<0.01. In our analysis 5% critical values are given in parentheses

Table 6: Results for unit root with structural breaks tests

Variable	ZA[a]	ZA[b]	CMR[a]	CMR[b]
Level				
PCGDP	−2.700 (1975)	−2.565 (1997)	−2.157 (1973)	−2.064 (1985)
CO_2	−6.450*** (1976)	−6.045*** (1996)	−9.050*** (1977)	−2.510 (1984)
PCEU	−6.125*** (1984)	−5.145*** (1997)	−6.250*** (1980)	−3.010 (1987)
First differences				
PCGDP	−7.050*** (1975)	−6.785 (1984)	−8.025*** (1985)	−6.130*** (1997)
CO_2	−4.195 (1975)	−3.150 (1979)	−9.249*** (1975)	−5.785*** (1985)
PCEU	−6.150*** (2006)	−6.232*** (2007)	−2.450 (1975)	−1.150 (1971)

*P<0.1; **P<0.05; ***P<0.01. ZA[a] with break in intercept; ZA[b] with break in trend; CMR[a] innovative outlier; CMR[b] additive outlier

Figure 3: Hodrick-Prescott Filter-lamda=100. Cyclical component



Source: Our elaboration in Gretl on ln_variables

economy. Subsequently, stationary tests (ADF, ERS, PP, and KPSS) were performed for each time series of each variable, first on levels and then on the first differences (Table 5).

As proved by the test table, they failed to reject the null hypothesis for all the variables relative to the 5% significance levels except for the KPSS test. However, this last test, using a different approach, reject the I (0) value at the 95% confidence level, indirectly confirming the previous tests. Therefore, we can affirm that the tests used on the unit roots confirm the notion that all the variables are not stationary at the level, but they are stationary in the first difference, I (1). However, these results could be economically distortive. These values in first differences and levels may have been affected by shocks arising from changes in economic policies, as currency crises or exogenous recessive cycles worldwide character. Therefore, in order to mitigate

Table 7: Toda-Yamamoto causality results

Dependent variable	PCGDP	CO_2	PCEU
PCGDP	-	2,064 (0.305)	2,205 (0.310)
CO_2	1,325 (0.480)	-	0,457 (0.450)
PCEU	12,253*** (0.000)	2,202 (0.315)	-

*P<0.10; **P<0.05; ***P<0.01

the misleading results, we performed the ZA and CMR tests, in order to verify the presence of structural breaks (Table 6).

The test results confirm the economic theory: Where there are structural breaks, shocks have occurred. In the levels, they are present especially for energy use and CO_2 emissions. The structural breaks present over the years 1975-1980 coincide with the government's second five-year plan (1976-1981) which is a change in the country's economic policies. This policy generated high levels of annual growth, especially in the industrial sectors. This phenomenon fueled the use of producing fuels that explained both the increase in energy use and CO_2. Values relative to historical periods 1984-1985 represent the Third five-year plan result (1981-1985) where necessary changes have been made to decentralize planning and improve the managerial skills of government officials. Finally, the years 1996-2006 and 2007 (in first differences) are the results of exogenous shocks were coming from the currency and financial markets: First the currency crisis of the Thai, then the financial crisis of the subprime ones.

In order to verify the causal relationship between energy use, CO_2 and per capita economic growth will use the Toda-Yamamoto test.

Table 8: Johansen's cointegration tests

Null	Alternative	λmax Statistic	Trace Statistic	IC SBIC	HQIC	AIC
r=0	r=1	23.0648	32.6471	−5.4454	−5.8521	−5.9951
r≤1	r=2	7.9438*	7.9284*	−7.0256*	−7.4150	−7.6455
r≤2	r=3	0.0215	0.0215	−6.8853	−7.2140*	−7.4240*

Table 9: Variance decomposition

Percentage of variations	Time	Innovation		
ΔPCGDP		ΔPCGDP	ΔCO_2	ΔPCEU
	1	1.0000*	0.0000	0.0000
	3	0.9295*	0.0250	0.0280
	6	0.9119*	0.0325	0.0425
	10	0.9085*	0.0350	0.0438
ΔCO_2				
	1	0.0058	0.9920*	0.0000
	3	0.0067	0.9185*	0.0765
	6	0.0986	0.7795*	0.1098
	10	0.1005	0.7789*	0.1098
ΔPCEU				
	1	0.0351	0.0353	0.9158*
	3	0.1198	0.0751	0.7745*
	6	0.1765	0.1340	0.6540*
	10	0.1950	0.1374	0.6249*

*Represent their own shocks

It is necessary in order to test the non-Granger causality allowing, however, the causal inferential analysis on a VAR which contains or does not present cointegration processes. So, in Table 7 we can observe the result of the test carried out on our historical data series.

As we can see from the results obtained, we can reject the null hypothesis of non-Granger causality per capita GDP and energy use concerning a 5% significance level. The peculiarity of our result is that Vietnam registers an opposite direction of causality, affirming the existence of the conservation hypothesis. In particular, the conservation hypothesis is present when there is a unidirectional causality that goes from economic growth to energy consumption, as in our case. This situation shows that economic growth causes energy consumption in Vietnam because the economy is overgrowing. Therefore, the demand for energy in the various economic sectors affected by economic growth also increases. This result can be interpreted differently: An emerging country, like Vietnam, needs enormous amounts of different forms of energy in order to achieve faster economic growth which will always explain higher energy consumption.

Subsequently, in order to determine the number of cointegrating vectors, we applied the Johansen and Juselius procedure (1990) in Table 8. In this model, the lag-order derives from pre-established criteria attributable to the forecasting error as well as to the Akaike' information criteria (AIC), Schwarz (SBIC) and Hannan and Quinn (HQIC).

As we can see from the results of cointegration, the tests fail to reject the null hypothesis of non-cointegration. Faced with these results and given that the Johansen procedure is sensitive to long-term structural interruptions (Table 5), in order to overcome these limits we have analyzed historical data through the decomposition of the generalized variance (GVDC) in Table 9.

The variance decomposition in the Table 9 was able to separate the variations of an endogenous variable in the shock of the VAR components, in order to detect useful information about the effect of a random innovation. Real GDP has a high impact on the use of energy over time, but a shock on per capita GDP influences CO_2 and PCEU for a few periods. In fact, towards the end of the years taken into consideration, this situation ceases to exist very quickly.

4. CONCLUSION

This study, using many time series econometric techniques, analyzed the relationship between per capit GDP, CO_2 emissions and energy consumption in Vietnam, for the years 1970-2014. The tests carried out concerning stationarity have failed to reject the hypothesis of a unit root for all the variables at a 5% significance level. It was, therefore, necessary to carry out the structural break tests which showed in the economic plans of the 80s and 90s and the financial and currency crises of the significant interruptions. In the Toda-Yamomoto test, a significant result emerged which highlighted an opposite direction of causality due to the "conservation hypothesis." This result also confirmed in the variance decomposition, suggests essential policy implications. The results showed that the country needs enormous amounts of different forms of energy consumption in order to achieve faster economic growth.

The study, therefore, recommended to Vietnam's policymakers to focus on economic policies based on investments to find new sources of alternative energy in the face of rapid growth in aggregate demand. This situation also coincides with the assumption of energy efficiency and self-sufficiency in energy production that, in a later study model, could show how energy can lead to economic growth.

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