REGRESSING NATURAL GAS, NUCLEAR ENERGY AND OIL CONSUMPTION ON REAL GDP: EVIDENCE FROM ASEAN COUNTRIES

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Abstract

Energy performances as the essence in the modern economy globally, where the natural gas, the nuclear energy and the oil apprehend the most if its area. These factors are the crucial element on the real GDP of the states. This study investigates the impact of degenerating the natural gas, oil consumption, and the nuclear energy as the depletion in the use of these factors will help the nation to achieve a better real GDP. For this purpose, we taken 10 ASEAN countries in the analysis that includes Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. The independent variables are nuclear energy, oil consumption, and natural gas and their effect is seen on the real GDP. The total electricity consumption is taken as a control variable. The data is collected over a period of 28 years as it is a time series analysis and for this, we have used panel Autoregressive distributed time lag (ARDL) model and Augmented Dickey Fuller (ADF) technique along with unit root tests and the co-integration tests among the variables. The results indicate that oil consumption, nuclear energy, significantly impact the fuel prices and the energy consumption in these countries. The research gives useful directions for the policy-makers and the government as how to cope up with the prices of these non-renewable resources.

Keywords: nuclear energy, oil consumption, natural gas, real GDP, ASEAN.

1. Introduction

In year 2018, the estimated GDP of states of ASEAN amounted to around 2.92 trillion U.S. dollars, a significant increment from past years (Alper & Oguz, 2016). Basically the GDP of different ASEAN countries has been skyrocketing for some of the years that show the thriving economy of the given region (Al-Mulali, Solarin, & Ozturk, 2016). In figure 1, the real GDP Growth rate of ASEAN countries have been provided. All of the figures have been provided in detail.

Natural gases act as a significant base of energy supply within ASEAN countries. In year 2016, natural gas accounted for around 24 percent of the energy mix of ASEAN countries (Utama, Ishihara, & Tezuka, 2012). It was attributable as energy's second largest soil. In addition to this, the suppression of coal is done by natural gas within ASEAN countries. Natural gas also plays an important role in power sector and other procedures of industry (BeNhet & Harun). Within industry, natural gas is not just used as a fuel to make electricity, but is also used as feedstock of various items like pharmaceutical items and fertilizers. Natural gas is mainly used for the production of methanol, which has different applications in industry (Boontome, Therdyothin, & Chontanawat, 2017). In the power sector of ASEAN countries, natural gas has the highest capacity with over one-third of the capacity coming through natural gas (Chinedu, Daniel, & Ezekwe, 2019). Therefore, there are more proofs of natural gas, playing an important in energy mix of ASEAN countries. The ASEAN center for Energy (ACE) published a research on Development of Nuclear Power Plant within ASEAN countries. ACE prepared the given report with governmental support under the program of Nuclear and Radiological Program Administrative Support (NPRAS). The research of

Dogan and Ozturk (2017) has identified some important developments. For example, 10 ASEAN countries like Philippines, Thailand, Vietnam, Malaysia and Indonesia have been considered as frontrunners to make programs of civilian nuclear power in the area (Dibenedetto, 2011). These five states are identified as frontrunners because of the regulatory and legal frameworks, infrastructures of nuclear energy, and developed human resources and organizations. In accordance with Ikegami and Wang (2016), ASEAN countries have small amount of oil and gas of world (around 2 percent of the total reserves of oil) (Tongsopit, Kittner, Chang, Aksornkij, & Wangjiraniran, 2016). However, it has played a significant role in the growth of industry. Oil developed through hand-dug wells within Sarawak was provided in the official documents of China (Mengistu, Simane, Eshete, & Workneh, 2015).

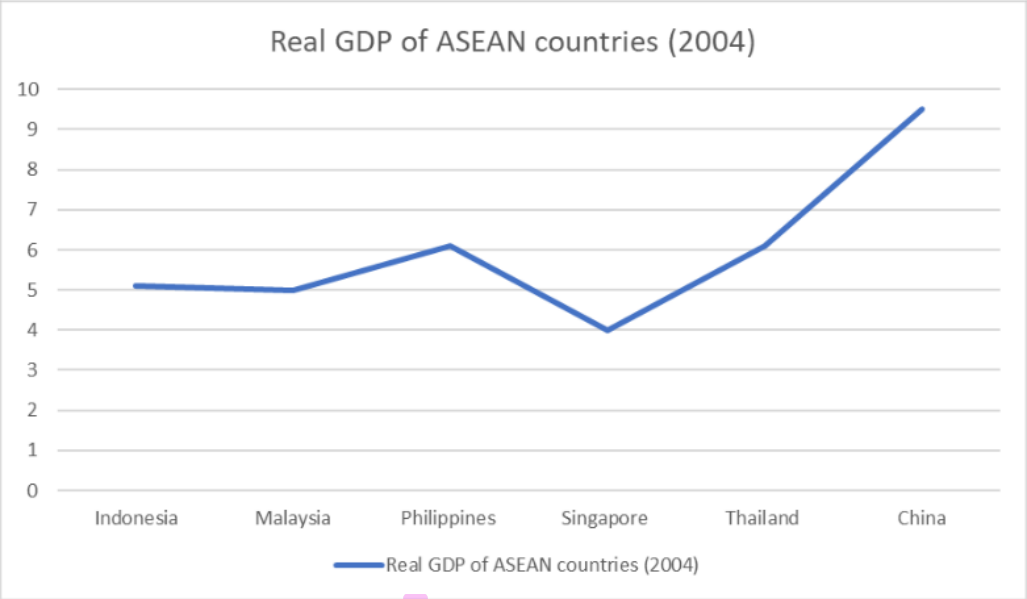

Figure 1: Real GDP of ASEAN Countries

More of the researches have been done on analysis of real GDP of ASEAN countries. The researchers have focused on analyzing the Real GDP and GDP. However, the factors that impact Real GDP of ASEAN countries have been explored in detail. With the aim to fill (Karyono, 2017) this gap in the literature, the researcher has targeted to analyze the regression of natural gas, oil consumption and nuclear energy on Real GDP (Mirzabaev et al., 2015). This research has been conducted in the context of ASEAN countries, because of the reason that ASEAN countries have not got studied in detail. This research will be beneficial in filling the literature gap. Given are the research objectives of this study.

1. To analyze the impact of natural gas on real GDP in ASEAN countries
2. To check the role of nuclear energy on Real GDP in ASEAN countries
3. To determine the impact of oil consumption on Real GDP in ASEAN countries

There are different benefits of the researches that have been done in past. The researches done on GDP are mainly helping the government of countries to analyze the factors affecting GDP. These researches are still providing limited benefits, as these researches do not encounter ASEAN countries. Moreover, the impact of natural gas, nuclear energy and oil consumption on Real GDP have not been analyzed in detail. This research will be helpful mainly for ASEAN countries (Shi, 2016). The government can take control on its real GDP through considering the given factors.

The division of this dissertation has been done into Introduction, Literature Review, Methodology, Discussion and Conclusion.

2. Literature Review

2.1. Natural Gas and Real GDP

Increasing the prices of natural gas are the major concern within macro-economy, because of the reason that there are different utility and industrial sectors that have intensive natural gas' users (Moriarty & Honnery, 2019). Most of the households within ASEAN countries are seen dependent over gas for heating homes in the months of winter. In 2005, the research of Mbarek, Nasreen, and Feki (2017) identified that higher cost of energy had increase the input prices and precipitated the surcharges of cost among some of the industries (Patel, Patel, & Upadhyay, 2016). Instances of this nature were cited in the research of (Naser, 2015). Petroleum items remain the major energy source for ASEAN countries. 40 percent of the energy consumption within ASEAN countries was derived through the petroleum items like consumption of gasoline, fuel and oil. Energy consumption acquired through natural gas was basically the second highest resource. A decrement is seen in the total amount of energy that is derived through the consumption of natural gas, getting decrementing since year 1971, which it went up to around 32.4 percent of total BTU (Naser, 2017). By year 1986, within ASEAN countries, the amount of total energy through natural gas got decremented to around 22 percent (Sovacool & Drupady, 2016). However, since then it got stabilized. There is lesser consumption of nuclear energy and hydroelectric power resources within ASEAN countries. The consumption of natural gas within ASEAN countries results into increasing the real GDP of countries. Traditionally, the industrial region is the major customer of natural gas. For example, in year 1950, it accounted for around 60 percent of total consumption of natural gas (Zhang, Qi, & Karplus, 2013). Since 1980s, an increment has been seen in the consumption of natural gases and it has acted as the major factor to make an increment in real GDP of ASEAN countries (Shadman, Sadeghipour, Moghavvemi, & Saidur, 2016). Therefore, from the given analysis, the given hypothesis has been developed.

H1: There is a significant impact of natural gas on real GDP of ASEAN countries.

2.2. Nuclear Energy and Real GDP

On contrast to aggregating the consumption of energy, there are some of the researches that address the link in between consumption of nuclear energy and Real GDP. Some of the researches involve models of panel data, while others implement the analysis of time-series data. For example, Ozcan and Ari (2017) has identified the link in between nuclear energy consumption and Real GDP in different ASEAN countries. The outcomes have identified that nuclear energy does the stimulation of economic development within ASEAN countries (Ang & Goh, 2016). While doing the analysis of panel data, Pao, Chen, and Li (2015) did research on if consumption of nuclear energy encourages growth in real GDP. The outcomes have identified that consumption of nuclear energy results into an increment in real GDP. Nuclear consumption and real GDP had no such link in some of the ASEAN countries though. Through integrating the test of panel causality, which permits both heterogeneity and cross-sectional dependency, Qiao, Tong, Zhan, and Chen (2015) identified that there is an important link in between consumption of nuclear energy and real GDP in ASEAN countries. However, the results of have identified that there is no causal link in between real GDP and nuclear energy consumption in few ASEAN countries, that support the hypothesis of neutrality (Chang & Li, 2013). Targeting on some of the developing countries and developed countries for time period 1984 to time period 2007, Qiao et al. (2015) made use of model of panel error correction and their outcomes facilitate the causality to be unidirectional running towards real GDP in short run from consumption of nuclear energy in short race, while in long-race bidirectional causality is observed (Hong, 2013). Solarin, Al-Mulali, and Ozturk (2017) has identified that there is a bidirectional causality in between real GDP and consumption of nuclear energy in short-race. Unidirectional causality is seen running through the consumption of nuclear energy towards real GDP in long race. In another research, Valadkhani and Nguyen (2019) identified the long-run equilibrium and short-run dynamics for different developed ASEAN countries (Kanchana & Unesaki, 2014). The panel causality outcomes into finding evidence of unidirectional causality to run from the cost of oil and Real GDP to consumption of nuclear energy in long race. However, in short-run, there is no such causality in between the consumption of nuclear energy and real GDP. From this analysis, the given hypothesis can be generated.

H2: There is a significant impact of nuclear energy on real GDP of ASEAN countries.

2.3. Oil Consumption and Real GDP

While costs of oil have been stressed more as the major predictor of economic growth. In accordance with Al-Mulali, Solarin, Sheau-Ting, and Ozturk (2016), less research has been done on interpretation and quantification of the risk sources and return linked with oil costs. The models of derivatives of oil feature the costs of spot, exogenous procedures of demand and that is why silence on role of oil in macro-economy. The rapidly increasing literature on macro-finance has had success defining the conduct of asset costs and macroeconomic aggregates within economies

having complete markets of finance. However, there should be more literature for considering the costs and consumption of oil. In the research of Ozcan and Ari (2017), a model was built for considering oil costs and oil consumption. Moreover, the impact of consumption of oil has also been analyzed over real GDP of ASEAN countries. The model provided by Pao et al. (2015) matched the dynamics of macroeconomic aggregates with costs of oil and it yields more implications for pricing oil in future (Mishra & Smyth, 2014). The lower consumption of oil results into lower rate of Real GDP as provided in the research of Dogan and Ozturk (2017). Based on this, it can be stated that higher consumption of oil can result into higher rate of Real GDP. It can be stated that oil consumption and Real GDP are directly proportional to each other. In accordance with the research of Ozcan and Ari (2017), the prices of oil can be linked to the consumption of oil and thereby the increment or decrement in real GDP. Higher prices of oil cause an externality which decreases the productivity growth. When the supply of oil gets constrained and is unable to make response to the alterations in cost of oil, then oil cost exhibit lesser shocks and reversions, then the costs of oil become persistent (Nian & Chou, 2014). These shocks that are highly persistent tend to affect the wealth, and also the utility of agent. The oil price act like a function of aggregate output and aggregated consumption of oil. When oil gets entrance into the consumption baskets of household, the cost of oil act as the function of levels of consumption of products and oil. The decrement in price of oil increases its consumption. The increment in its consumption then outcomes into an increment in real GDP. From the given analysis, the following hypothesis has been generated.

H3: There is a significant impact of oil consumption on real GDP of ASEAN countries.

3. Research Methodology

The panel ARDL approach, also known as pooled mean group (PMG) is used in the current study to fulfill the aim of the study. The main concept is taken from the work of "Osabohien et al. (2017), Ahmed and Hasan (2016)". The study has focused on Real GDP (RGDP), natural gas (NG), nuclear energy (NE), oil consumption (OC) and TEC. All of these variables will be tested for their impacts on each other. The impacts that all of these variables cast on each other is focused in this study. The panel ARDL and co-integration approach shows that there exists a long-term relationship between all of these variables and all of the variables are seen to be impacting each other in a significant way. The data is acquired from 8 ASEAN countries which include Brunei, Laos, Myanmar (Burma), Cambodia, Vietnam, Indonesia, Malaysia and Singapore, data was collected from the World Bank website extending from 1995 to 2019 which was enough for the implementation of panel ARDL.

3.1. Model specification and method of estimation

The panel ARDL and the co-integration approach is applied on this study in order to achieve the aims set by this study as this approach has its own advantages over the other approaches used for co-integration. Panel ARDL approach has its advantages because it is applicable irrelevant of the stationarity present in the variables. The different natures of stationarity involve the level of [I (0)], level of [I (1)] and level of [I (2)]. The error correction mechanism takes in the different aspects of the long and the short-term equilibrium. The problems arising from the non-stationary data of time series can be nullified using the panel ARDL approach, both of the forms of the model are given below:

$$RGDP = f(NG, NE, OC, TEC) \quad (1)$$

$$RGDP = \beta_0 + \beta_1 NG_t + \beta_2 NE_t + \beta_3 OC_t + \beta_4 TEC_t + e_t \quad (2)$$

In the equation above, RGDP refers to the real GDP, in here, NG stands for natural gas, NE here stands for nuclear energy, OC is showing oil consumption and TEC. β_0 is a constant term whereas, β_1, β_2, β_3 and β_3 are showing the explanatory variables and e is showing to be the error term.

$$\Delta RGDP_t = \beta_0 + \sum_{t=1}^{n} \beta 1 \Delta NG_{t-1} + \sum_{t=0}^{n} \beta 2 \Delta NE_{t-1} + \sum_{t=0}^{n} \beta 3 \Delta OC_{t-1} + \sum_{t=0}^{n} \beta 4 \Delta TEC_{t-1} + \gamma ECM_{t-1} + e_{t-1} \quad (3)$$

Where Δ is showing the operator changes and ECM_{t-1} is showing the error correction term. γ is the sign to denote the distance from short to long run. The model is given below:

$$\Delta RGDP_t = \beta_0 + \sum_{t=1}^{n} \beta 1 \Delta NG_{t-1} + \sum_{t=0}^{n} \beta 2 \Delta NE_{t-1} + \sum_{t=0}^{n} \beta 3 \Delta OC_{t-1} + \sum_{t=0}^{n} \beta 4 \Delta TEC_{t-1} + e_{t-1} \quad (4)$$

Thus, it can be said that there is an expectation that, β_1, β_2 and $\beta_4 < 0$; $\beta_3 > 0$. It is expected that the variables will be significantly impacting each other.

H_0: $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4$ (There is no long-term relationship)

H_1: $\beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4$ (There is long-term relationship)

In panel ARDL approach there are three steps involved, first is devising and testing hypothesis and the null hypothesis is stated as well. ECM is supposed to be equal to 0, panel ARDL co-integration involves advantages, it has all of the variables that are stationary at their nature, the variables need to be of the order 1[I(0)], 0[I(0)] because it will be the only way that panel ARDL will be applicable. It can also be seen that panel ARDL gives a closer and clearer view of the long-term model. The first assumption taken into account is that, the variables will be at a stationary condition at the first phase that is [I(1)], the second assumption that is made is that the variables will become stationary at [I(1)] at level 2. The data was acquired from 8 ASEAN countries which include Brunei, Laos, Myanmar (Burma), Cambodia, Vietnam, Indonesia, Malaysia and Singapore, data was collected from the World Bank website extending from 1995 to 2019 which was enough for the implementation of panel ARDL.

3.2. Presentation and Discussion of the Results

The second section of this study will be providing the summary of the results and analytics, results will be stated regarding the impacts of RGDP, NE, NG, OC and TEC. The section will provide, mean, standard deviation, minimum and maximum points for all of the variables. The test of stationarity will be provided. Moreover, the results and details of ADF, augmented dickey fuller unit root test will be provided in this section of the study.

3.3. Unit Root Test for Stationarity

It has been witnessed that the variables in the time series study will be having unit root, and unit root is only present when the variables are not stationary and the unit root can be witnessed and seen after the stationarity test performance. The ground rule set for the being stationary is that the absolute critical value of the ADF should be greater than the critical value of the variables so that they can be called as stationary. To check on the integrating order of the involved variables, the unit root test for the stationarity was conducted. This step is important because it validates that all of the variables at least are differenced. So, the importance of carrying out unit root test is that it will make clear that none of the variable is integrated of order 2. Then the panel ADRL is presented both for long and short term, it can be clearly seen that whether long run relation exists or not.

4. Empirical discussion

4.1. Unit root test results

When a time series analysis is utilized in any investigation, it turns out to be significant for the predictor to check whether the variables persist to be stationary over the time period chosen or not. And this test states the analysis of integration of the time series used for this research. The Augmented Dickey Fuller (ADF) tests explains the stationary levels of the variables over the years that how much have they changed or have remained stationary throughout the analysis. The results include both the analysis at level and at the first differences.

Table 1: ADF and LLC unit root

Constructs	ADF Test		LLC Test	
	Level	1st diff.	Level	1st diff.
NG	1.985*	6.294**	-0.409*	-5.396***
NE	3.758	4.376**	-2.578	-7.356***
OC	0.598	8.499**	-0.898	-3.996***
TEC	2.649*	7.388**	-3.398*	-9.593***
RGDP	5.483*	10.398***	-5.287*	-13.498***

Here with the ADF results at level, natural gas, total electricity consumption and the real GDP have been significant, hence rejecting the null hypothesis of non-stationarity. So, we conclude that natural gas, real GDP, and total electricity consumption have been stationary here. However, oil consumption, nuclear energy has been insignificant

in the level intercept of ADF, thus, it can be determined that these have been non-stationary at the level intercept. Yet, all the constructs have been practical to be substantial at the 1st difference in the ADF test and revealed significance at 5% level, in that way rejecting the null hypothesis of non-stationarity.

Similarly, the LLC unit test is taken both at level and first differences. At level, natural gas, real GDP, and total electricity consumption have been significant hence rejecting the null hypothesis of non-stationarity. So, we conclude that natural gas, real GDP, and total electricity consumption have been stationary here. However, oil consumption, nuclear energy has been insignificant in the level intercept of the LLC unit root test, thus, it can be determined that these have been non-stationary at the level intercept and have a unit root at the level. Hitherto, all the constructs have been practical to be substantial at the 1st difference in the LLC unit root test and exposed significance at 10% level, thereby rejecting the null hypothesis of non-stationarity.

4.2. Co-integration Test Results

The variables should have a stronger relation in the optimum time lag length used for this study. If the variables have no integration with each other, there cannot be the positive dependence of the variables on each other. For this test, we look at the F-statistic value which should lie above the lower bound critical value and the upper bound critical value thereby we can reject the null hypothesis of no co-integration among the variables. The results are shown as follows:

Table 2: Co-integration Test

O.P.L. length (A.I.C)	(2,0,0,0,0,0)		
F-Stat. (Bound Test)	27.954***		
V.C	1%	5%	10%
L.B.C.V.	2.76	2.05	1.78
U.B.C.V.	5.82	4.27	3.95

The F-statistic value is 27.954 which is significant ta 10% level and designates that it lies above the lower and upper bound critical values of the test, henceforth we reject the null hypothesis and state that there is co-integration amongst the variables. That total electricity consumption, real GDP, natural gas, oil consumption, and nuclear energy have a stronger co-integration among each other.

4.3. Panel ARDL Estimation Results

The panel ARDL technique is used to test the effect in short run and long run of the variables on the real GDP of these countries. The results as shown below state that nuclear energy, oil consumption, natural gas have been significantly impacting the real GDP in the long run and short run. The results are shown in the table below:

Table 3: Panel ARDL Estimation Results

Run Long Results	***B***	***t-value***	***Summary & Diagnostic Test***	
RGDP	2.395***	-	**R^2**	0.689
RGDP (-1)	0.794**	-	**Adj. R^2**	0.662
RGDP (-2)	1.402***	-	**D.W.**	2.04
NG	0.310	4.532***	***X^2SC***	1.867 (0.465)
NE	0.229	3.395**	***X^2W***	3.976 (0.496)
OC	0.274	2.247***	***X^2AR***	1.086 (0.369)
TEC	0.136	4.246**		

C	4.876	5.395**		
Short Run Results	***B***	***t-value***	***Summary & Diagnostic Test***	
NG	0.274	3.053***	$\mathbf{R^2}$	0.564
NE	0.103	3.299**	**Adj. $\mathbf{R^2}$**	0.553
OC	0.168	2.573***	X^2SC	1.395 (0.533)
TEC	0.038	0.377	X^2W	3.743 (0.754)
-	-	-	X^2AR	2.764 (0.205)

The results of the long run analysis state that nuclear energy, oil consumption, natural gas, and total electricity consumption have all significantly impacted the real GDP of the countries. Natural gas has the highest impact on the real GDP as an increase in natural gas accounts for 45% increase in real GDP. Nuclear energy also impacts about 33% increase in the real GDP of the states. Total electricity consumption effects an increase of 42 % on the real GDP and similarly, oil consumption causes an effect of 22% on the real GDP. The value for adjusted R^2 here is 66% which means that all these variables have a combined effect of 66% on the real GDP. In the short run results, natural gas, oil consumption, and nuclear energy have been significantly affecting the real GDP with an effect of 30%, 32% and 25 % increase. However, total electricity consumption has not been significant in the short run to cause an effect on the real GDP of the nations over the years. The value for adjusted R^2 here is 66% which means that all these variables have a combined effect of 56% on the real GDP.

5. Discussion and conclusion

5.1. Discussion

This is obvious that natural resources have significant importance in any country's economy (Yang, Wang, Wang, & Yeh, 2018). The primary objective of the given study is to analyze the impact of nuclear energy, oil consumption as well as natural gas on real GDP growth of ASEAN countries. The table and findings illustrate the consumption of natural gas impact the real GDP growth in ASEAN countries significantly. The results show that there is a significant relationship between real GDP growth and natural gas regression. The more people consume natural gas, the more it affects the GDP growth and overall economy (Fadiran, Adebusuyi, & Fadiran, 2019). Moreover, the ADF and unit root test illustrates that nuclear energy has also a significant impact on the real GDP growth of the ASEAN countries. A study also indicates that the consumption of natural gas and nuclear energy positively affect the economy of the country because of Consumption of nuclear energy and conventional hydroelectric power sources are significantly smaller, both less than 10 percent of the total (Ben-Salha, Hkiri, & Aloui, 2018). Moreover, according to results and findings, the consumption of oil has a significant impact on energy consumption as well. The higher is the natural resources consumption, the higher will be the GDP growth in that country and vice versa (Balsalobre-Lorente, Shahbaz, Roubaud, & Farhani, 2018). Thus, the panel ARDL estimation results table indicates that all hypotheses accepted and there is a significant relationship between energy consumption and real GDP. In the following study, the total energy consumption is a control variable. The results show that in the short run, the total energy consumption has an insignificant impact.

5.2. Conclusion

The purpose of the following study is to illustrate the role of regression natural gas, oil consumption and nuclear energy on real GDP growth of the ASEAN countries. The various statistical tests have been applied to get reliable results and outcomes. Moreover, the panel ARDL estimation results technique is being used to analyze hypotheses acceptance and rejection. The panel ARDL estimation result table shows that nuclear energy, oil consumption, and regression natural gas has a significant impact on real GDP growth of the ASEAN countries. All hypotheses accepted in the long run. Similarly, the total energy consumption as a control variable has an insignificant impact in the short run and significant impact in the long run.

5.3. Implications

The results and discussions indicate that the consumption of natural resources such as natural gas, crude oil, nuclear energy, and oil consumption has a significant impact on real GDP growth in ASEAN countries. The results and

discussion significantly prove that the consumption of natural resources or their prices affects an economy. Oil price increases are generally thought to increase inflation and reduce economic growth. In terms of inflation, oil prices directly affect the prices of goods made with petroleum products. Increases in oil prices can depress the supply of other goods because they increase the costs of producing them. Thus, in ASEAN countries context, the growth in natural resources and its consumption affect the real GDP growth.

5.4. Limitations/Recommendations

The overall study focuses on the consumption of natural resources and gas on gross domestic growth of the ASEAN countries which is consider as one of the primary limitations. There are various other aspects that may highlight or may consider while conducting research. For instance, the study may focus on natural resources prices and their impact on real GDP growth. This is an interesting aspect that may come to highlight. It is recommended that future studies should focus on this aspect to get reliable results.

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