Effect of Light and Heavy Industries Energy consumption on economic in Thailand

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Abstract

Thailand's light and heavy industries energy consumption's effect on the economy is the most used indicator for studying the movement of Gross Domestic Products (GDP) and Foreign Direct Investment (FDI). This paper uses the time series data and Least Squares (LS) NLS and ARMA (Autoregressive moving average model) method to test the confidence of the data and all the results will be put into a summary. In this paper, we found relationships between energy consumption, GDP and FDI the empirical results fully support a positive relationship between them and it is found that if the economy has a lower growth rate but does not reduce the energy consumption (in quantitative terms), heavy industries energy consumption in Thailand has no trends or signal to reduce energy consumption but in the opposite direction it increases energy consumption every year.

Keywords:

Energy Consumption, GDP, FDI, Heavy industries, Light industries, Thailand

1. Introduction

Thailand located in Southeast Asia bordering Laos to the Northeast, Cambodia to the Southeast, Burma to the West and Northwest, and Malaysia to the South the population was about 69 million peoples in year 2011. It covers an area of 518,000 square kilometers, Bangkok is the capital city and center of political, commercial, industrial and cultural activities. Thailand has 4 regions: Central & East Coast, North, North East and South. It is universally acknowledged that foreign investment, for any country, is an important investment, especially for developing countries. Thailand is the second-largest economy in Southeast Asia, after Indonesia. Thailand jumping from a poor country started 1961 was known as The National Economic and Social Development Plan (1961-1966) or first the national plan of Thailand, in that year GDP was (37 Billion US$) and went up to (407 Billion US$) in 2016. However, Between June 1997 and January 1998 a financial crisis engulfed some of the fast-growing countries' economies of Asia, Thailand, Malaysia, Singapore, Indonesia, Hong Kong, and South Korea and sent their economies crashing like a shower of meteors. Starting with Thailand, and the subsequent crisis in year 2011 was the Thailand flood The World Bank has estimated 1,425 trillion baht (US$46.5 billion) in economic damages and losses due to flooding. These developing countries including Thailand have relatively low savings or investment in such industries. Foreign Direct Investment (FDI) is essential for development and to increase competitiveness, which directly affects the economic growth of the country. It has often been argued that FDI is one of the driving forces of economic growth in developing countries. Alfaro, L., et al.[1] FDI was a part of Thailand's recent rapid economic growth and net outflows in 2010. At its highest value over the past 32 years. The Foreign direct investment in year 1982 was 1.90 Billion US$, up to 15.93 Billion US$, in year 2013 over the past 34 years or the value higher than 840 percent.

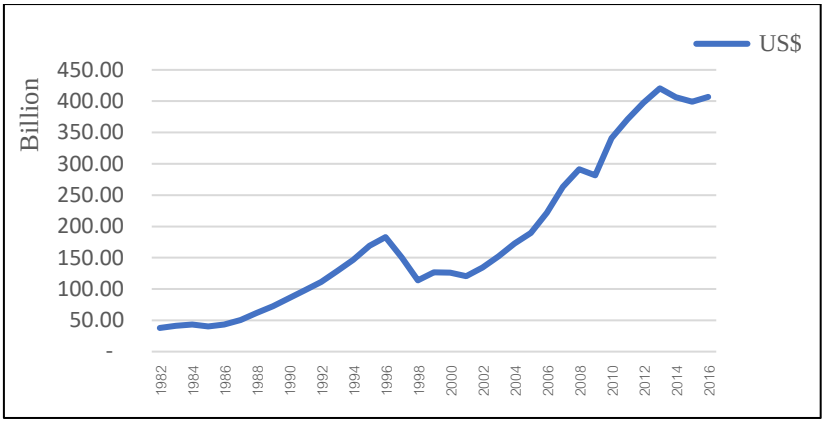

Fig. 1 Gross Domestic Products (GDP) 1982-2016.

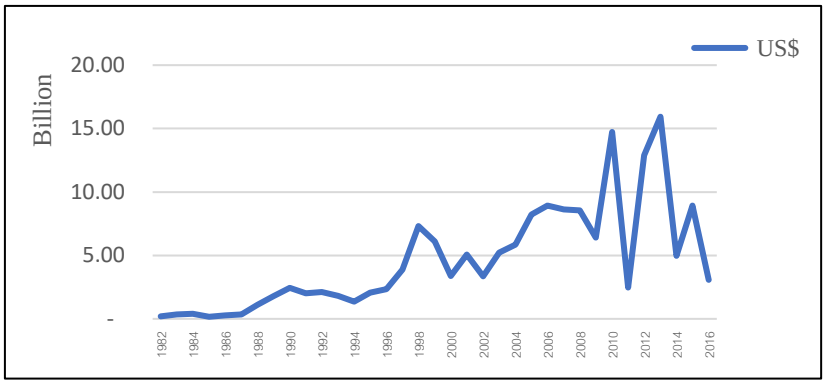

Fig. 2 Foreign direct investment (FDI) 1982-2016.

Energy is a very important factor in the life of today's people and is important in driving the economy. International Energy Agency (IEA) estimates that between 2001 and 2030, the world needs to invest 16 billion US dollars in energy. 60% of the investment will be invested in electricity in terms of electricity generation, transmission lines and distribution lines. 32% of the increased energy demand comes from developing countries in Asia, particularly in China, India and Southeast Asia. (Ministry of Energy, 2015) The final value of energy consumption in Thailand is constantly increasing. In 2016, Thailand has a total energy consumption of 79,929 ktoe of total energy.

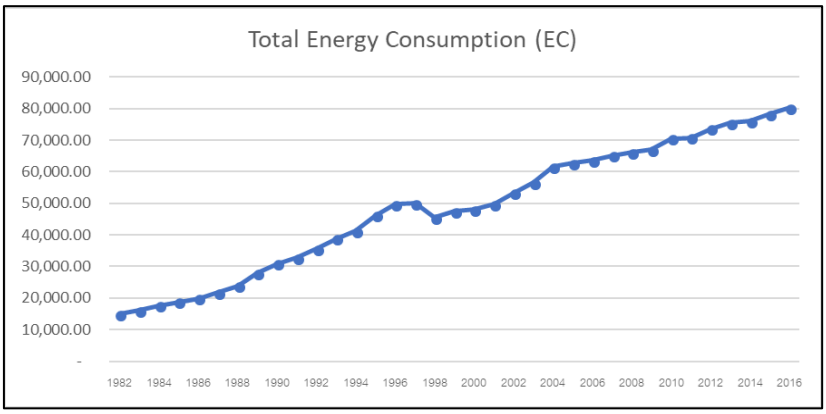

Fig. 3 Total energy consumption (EC) in Thailand from 1982 to 2016.

We had group of energy consumption in two group first is light industries and heavy industries, light is agriculture, residential and commercial, heavy industries is manufacturing, transportation and other.

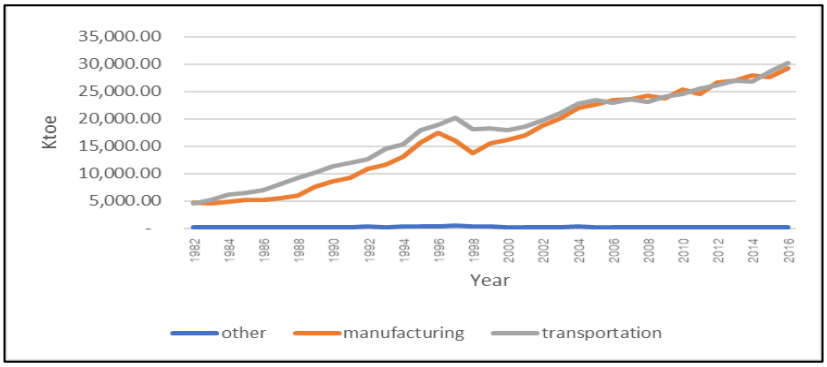

Fig. 4 Energy Consumption of Heavy industries.

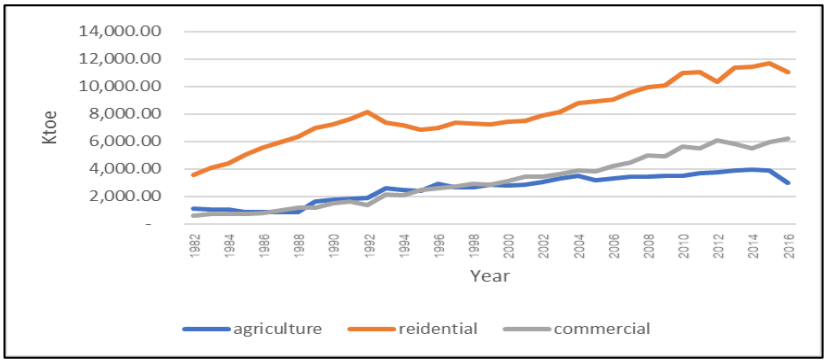

Fig. 5 Energy Consumption of Light industries.

However, the increasing demand for energy in Thailand has led to dependence on imported energy. Since Thailand can only produce some of its own energy and export some energy, it cannot compensate for the enormous amounts of energy imported. In addition, the global energy crisis, which is volatile in terms of prices, has forced many sectors to learn to adapt, including governments that have a policy to limit domestic energy consumption.

2. Literature review

Farhani and Rejeb [2] Study energy consumption (EC), economic growth (GDP) and CO_2 emissions for 15 MENA countries covering the annual period 1973-2008. Found 15 MENA countries and during the period starting from 1973 to 2008 panel long- run equilibrium relationship between energy consumption, real income (GDP), and the CO^2 emissions, meaning that these three variables move together in the long run. The study of Akkemik and Goksal [3] and Apergis and Payne [4] used econometric Modern is Dynamic Panel Data model and Pedroni Panel Cointegration Test by such tools can test a long-term relationship between the use of renewable energy and energy from fossil fuels to growth economies. However, in a study of Apergis and Payne [4] that demonstrates the necessity of the field variables such as the amount of labor or capital accumulation and population being taken into account in the estimating equation as well. Empirical evidence on the link between FDI and economic growth is also inconclusive.

These authors, Bosworth and Collins [5] Blomstrom et al.,[6] Borensztein et al. [7] and Balasubramanyam et al.[8] provide evidence on the positive effects of FDI on economic growth. Growth enhancing effect of FDI is not, however, automatic, but depends on various country specific

factors. Also, UNCTAD, 2005 indicate that the stronger the positive effect of FDI is, the higher the level of development of a host country. Higher level of development allows countries to reap the benefits of productivity fostered by foreign investment. For similar reasons, have found that significant relations between FDI flows and economic growth depend on the level of human capital. Host countries with better endowment of human capital are believed to benefit more from FDI induced technology transfer as spillover-effects than others with less human capital.

Trade and energy consumption in the Middle East Sadorsky, P., [9] more over 30 years, emerging and developing economies have experienced rapid increases in trade, income, and energy consumption. How is Export – Import affected by to energy consumption? This paper found a relationship between imports and energy consumption. Long run elasticities estimated from FMOLS show that a 1 % increase in per capita exports increases per capita energy consumption by 0.11% while a 1 % increase in per capita imports increases per capita energy consumption by 0.04%. This means that changes in imports affect energy consumption and changes in energy consumption affect imports. FDI inflows and economic growth in case of China. FDI inflow is one of the driving forces of economic growth in developing countries. Mah, J.S., [10] when Special Economic Zones (SEZs) were established in the coastal areas, China attracted huge amounts of FDI inflows, the current study tests whether or not an increase in FDI caused an increase in economic growth of China with a co-integration test procedure allowing for different orders of integration and the Granger causality test using stationary data.

This study examines the causality between FDI inflows and economic growth for the case of China using a small sample co-integration test. The empirical results show that since economic reform FDI inflows have not caused economic growth, but the latter has caused the former.

For China, the analysis of the FDI Effect on Energy Consumption Intensity in Jiangsu Province Ting, Y.U.E., L.R. Yin, and Z.Y. Ying, [11].

With analyzing the FDI effect on energy consumption intensity in Jiangsu Province, China, the researchers conclude that FDI promotes energy consumption intensity reduction in Jiangsu Province. Theoretically analyzing, the expansion of the FDI scale may promote economic growth, increase production efficiency and boost per capita income in importing country's or places. In the meantime, growth of living standards requires higher life quality and stricter environment management, which adds the demand and provision of energy-saving technology. On the other hand, FDI can affect the industry structure of the importing place or country by spillover effect, structural effects of factor inputs and competitive effect. FDI in Jiangsu concentrated on industry, especially in manufacturing. The imbalance of FDI distribution in every industry had a negative effect on industry structure. To sum up, the negative effects that come with Jiangsu energy consumption intensity reduction were stronger than the positive ones.

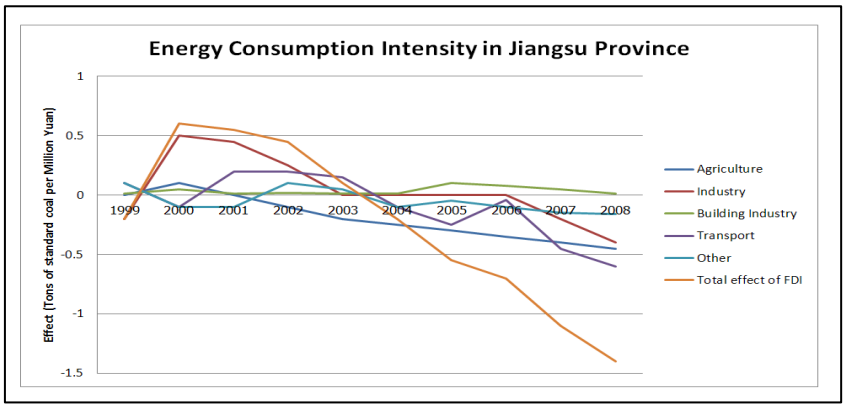

Fig. 6 Energy Consumption Intensity in Jiangsu Province [10].

Industrial relocation and energy consumption: Evidence from China Zhao, X. and H. Yin,[12] and others, China's industrial relocation in the early 1990s has resulted in significant energy saving. In addition to macro-policy changes, the researchers present two other factors that may be responsible for the observed positive relationship: substitution of energy with capital and labor, and energy efficiency gap between different areas, following policy suggestions: First, strengthening the evaluation of environmental benefits/costs and reducing the market failure pointed out that the ignorance of externalities is the greatest market failure ever known. Second, paying more attention to the coordinated development between economy, environment, and society rather than emphasizing only the GDP growth. Investment push and high growth rate are the most important characteristics of China's economic development. If the economic development mode is not changed, no matter where industries move to, the energy saving and CO_2 emission reduction that may be achieved through industrial relocation would be very limited. Only when China's government pays more attention to the importance of coordinated development between economy, environment, and society, can the environmental externalities in the process of industrial relocation be reduced. In the twelfth five-year plan. Amnart Yasothorn, Pard Teekasap and Sombat Teekasap[13] studied the system dynamics model with reducing electricity consumption according to government policy in Thailand can effect economic growth for the years 1999-2012. The results show that the economic growth was reduced in case of reserve or keep all saving from the reduction of electricity consumption caused more economic growth reduction (case 1) and expense the saving from the reduction of electricity consumption after subtraction with the net saving (case 2). In the case 1 impact more than the case 2.

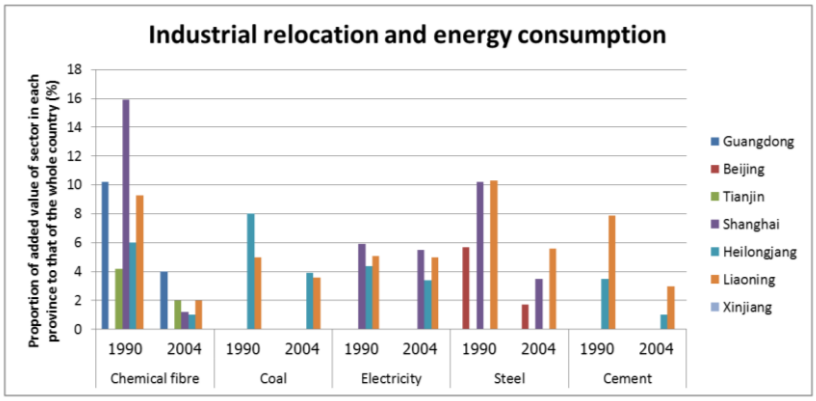

Fig. 7 Industrial relocation and energy consumption [12].

Economic Reforms, FDI, and Economic Growth in India Chakraborty, C. and P. Nunnenkamp[14] against this backdrop, this paper addresses two major issues: first, researchers discuss in Section 2 whether India's reforms in 1991, apart from giving rise to FDI, have also induced changes in the structure and type of FDI which may be relevant for its growth impact. Second, researchers evaluate in Section 3 whether the growth impact of FDI differs between the primary, secondary, and tertiary sectors. Researchers find that the growth impact of FDI differs significantly across sectors. Most notably, there is at best weak evidence for a causal link between FDI and output growth in the services sector, which attracted the bulk of additional FDI in recent years. By contrast, manufacturing output appears to have been promoted not only by FDI in this sector but also by FDI in the services sector through spillovers across sectors. Energy consumption and economic growth in Asian economies. Wang, Y., et al.[15] This paper makes its mark in the extant literature by empirically examining long-run co-movement and the causal relationship between energy consumption and real GDP. The empirical results fully support a positive long-run co-integrated relationship between real GDP and energy consumption when the heterogeneous country effect is taken into account. It was found that although economic growth and

energy consumption lack short-run causality, there is long-run unidirectional causality running from energy consumption to economic growth. Based on the short-run and long-run dynamics of energy consumption and GDP, as concerns the energy-income relationship in these Asian economies, we refute the neutrality hypothesis that has previously been advanced. Energy consumption is found to Granger cause GDP in the long-run, but not vice versa. There is no short-run or long-run causal relationship running from GDP to EC. In other words, high EC tends to come with high GDP, but not the reverse. Thus, given the explicit unidirectional causality, the implication is that energy conservation plans may be implemented but with some effect on income in Asian economies. Unquestionably, this reflects the fact that energy serves as an engine of economic growth and that changes in energy consumption usually affect economic activity. Furthermore, we break our panel down to investigate the group effects between two organizations, APEC and ASEAN. There is a strong indication of long-run causality from EC to GDP but fully through the ECT in the long-term in both the APEC and ASEAN groups, but there is no causality from GDP to EC in either the short-run or long-run.

3. Research methodology

This research is primarily objective studying the relationship between the dependent variable of the study is Energy Consumption (EC) and the independent variables are Foreign Direct Investment (FDI), Gross Domestic Product (GDP), Heavy Energy Consumption (H_EC) and Light Energy Consumption (L_EC). This paper used data from Office of the National Economic and Social Development Board, The World Bank, Department of Alternative Energy Development and Efficiency and Ministry of Energy. The energy consumption from heavy and light energy consumption was analyzed to see the energy consumption in Thailand's past is how it is now. And what is the future trend? For future predictions Method of Estimating Equation model. The information on energy consumption and economic of the country.

As well as other important economic variables which are stored in the form of annual time series. A major step for the analysis consists of the following steps. Use data from year 1982-2016 it's time series data type most of the data is non-stationary data, test homoskedasticity by Breusch-Pagan-Godfrey (BPG) (see Breusch-Pagan, 1979, and Godfrey, 1978) this analysis most use in time serial data Zheng, Y., J. Qi, and X. Chen[16] researchers had hypothesize that research is based on theories "Analysis by Least Squares(LS), Nonlinear Least Square (NLS) and ARMA (Autoregressive moving average)" because NLS and ARMA's can be used in nonlinear estimation by breaking the formula into four equations

Equation:1 Analyze or verify data EC, FDI and GDP directly without improving the data to know after analyzing that we can use the data or will reject it.

Equation:2 Analyze data LOG(EC), LOG(FDI) and LOG(GDP) to know that after analysis we can use the data or will reject it.

Equation:3 Analyze data LOG(EC), LOG(FDI) and LOG(GDP) together to know that after analysis we can use the data or will reject it.

Equation:4 Analyze data LOG(EC), LOG(FDI), LOG(GDP) , LOG(H_EC) and LOG(L_EC) all together to know that after analysis we can use the data or will reject it.

Step of analysis

1) Prepare data in time serial
2) Test heteroskedasticity by Breusch Pagan Godfrey test
3) Adjust data by LS LOG
4) Test correlation by the Durbin-Watson (DW)
5) Analysis by Least Squares(LS), Nonlinear Least Square (NLS) and Autoregressive moving average (ARMA)

$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$ (1)
$LnY = \alpha + \beta_1 \ln x_1 + \beta_2 \ln x_2$ (2)
$LnY = \alpha + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3$ (3)
$LnY = \alpha + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + \beta_5 \ln x_5$ (4)

Estimation Equation:
EC = C(1) + C(2)*FDI + C(3)*GDP (1)
LOG(EC) = C(1) + C(2)*LOG(GDP) (2)
LOG(EC) = C(1) + C(2)*LOG(FDI) (2)
LOG(EC) = C(1) + C(2)*LOG(FDI) + C(3)*LOG(GDP) (3)
LOG(EC) = C(1) + C(2)*LOG(FDI) + C(3)*LOG(GDP) + C(4)*LOG(H_EC) + C(5)*LOG(L_EC) (4)

Variable (Y) = Energy Consumption (EC) "Independent Variable"
Variable (x2) = Foreign Direct Investment (FDI1) "Dependent Variable"
Variable (x3) = Gross Domestic Products (GDP) "Dependent Variable"
Variable (x4) = Heavy Energy Consumption (H_EC) "Dependent Variable"
Variable (x5) = Light Energy Consumption (L_EC) "Dependent Variable"

The databases were collected from the databank of the World Bank, Department of Alternative Energy Development and Efficiency and Ministry of Energy Thailand because the data sources are the most reliable and are used by almost every researcher. We employed the data set of Energy Consumption EC (ktoe) the dependent variable Gross Domestic Product GDP (billion US$) is the independent variable, Foreign Direct Investment FDI (billion US$) time of 1982-2016.

4. Research findings

4.1 Heteroskedasticity

Start to test data EC, FDI and GDP by heteroskedasticity by the Breusch Pagan Godfrey test to know "P value" is less than (typically 0.05), will reject the null hypothesis. So, we have a p-value of 0.0365, which is less than our selected alpha value of 0.05. Therefore, we reject the null hypothesizer.

Table 1.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	3.734314	Prob. F(2,32)	0.0349
Obs*R-squared	6.623032	Prob. Chi-Square(2)	0.0365
Scaled explained SS	3.349474	Prob. Chi-Square(2)	0.1874

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/10/18 Time: 14:25
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	47091097	15384386	3.060967	0.0044
FDI	0.008149	0.002982	2.732399	0.0102
GDP	-0.000197	9.93E-05	-1.982712	0.0560

R-squared	0.189229	Mean dependent var	48973144
Adjusted R-squared	0.138556	S.D. dependent var	54656961
S.E. of regression	50729307	Akaike info criterion	38.40372
Sum squared resid	8.24E+16	Schwarz criterion	38.53704
Log likelihood	-669.0651	Hannan-Quinn criter.	38.44974
F-statistic	3.734314	Durbin-Watson stat	0.723018
Prob(F-statistic)	0.034863		

After analyzed table 1 we had improved the data in LS LOG are LOG(FDI) and LOG(GDP) and then we did test heteroskedasticity by the Breusch Pagan Godfrey we found the result p-value = 0.5563 is more than (typically 0.05), will can't reject the null hypothesis.

Table 2.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.554827	Prob. F(2,32)	0.5796
Obs*R-squared	1.173008	Prob. Chi-Square(2)	0.5563
Scaled explained SS	0.578405	Prob. Chi-Square(2)	0.7489

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/10/18 Time: 14:46
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.056701	0.074710	0.758951	0.4534
LOG(FDI)	0.002939	0.002795	1.051433	0.3009
LOG(GDP)	-0.004318	0.004646	-0.929526	0.3596

R-squared	0.033515	Mean dependent var	0.009617
Adjusted R-squared	-0.026891	S.D. dependent var	0.010598
S.E. of regression	0.010739	Akaike info criterion	-6.147994
Sum squared resid	0.003691	Schwarz criterion	-6.014679
Log likelihood	110.5899	Hannan-Quinn criter.	-6.101974
F-statistic	0.554827	Durbin-Watson stat	1.132405
Prob(F-statistic)	0.579596		

Analyzed data LOG(FDI), LOG(GDP), LOG(H_EC) and LOG(L_EC) by heteroskedasticity by the Breusch Pagan Godfrey test p-value we found p-value = 0.3314 is more than (typically 0.05), will can't reject the null hypothesis.

Table 3.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.133528	Prob. F(4,30)	0.3596
Obs*R-squared	4.595280	Prob. Chi-Square(4)	0.3314
Scaled explained SS	3.328244	Prob. Chi-Square(4)	0.5045

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/10/18 Time: 18:52
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.20E-05	4.76E-05	0.672481	0.5064
LOG(FDI)	-2.79E-06	1.56E-06	-1.786256	0.0842
LOG(GDP)	-1.32E-06	4.59E-06	-0.287368	0.7758
LOG(H_EC)	5.00E-06	7.44E-06	0.671023	0.5073
LOG(L_EC)	1.48E-06	1.28E-05	0.115658	0.9087

R-squared	0.131294	Mean dependent var	3.11E-06
Adjusted R-squared	0.015466	S.D. dependent var	4.44E-06
S.E. of regression	4.40E-06	Akaike info criterion	-21.69772
Sum squared resid	5.81E-10	Schwarz criterion	-21.47552
Log likelihood	384.7101	Hannan-Quinn criter.	-21.62102
F-statistic	1.133528	Durbin-Watson stat	1.732928
Prob(F-statistic)	0.359554		

4.2 Correlation

After testing p-value, we did test the correlation between all data to know all relations by the Durbin-Watson (DW) test, we found EC and FDI correlation = 0.7537 had relation in midden to high and we found between EC and GDP correlation = 0.9275 had relation in high, if we will forcast we will cut GDP out of forcating.

Table 4 Correlation.

	EC	**FDI**	**GDP**
EC	1.000000	0.753790	0.927569
FDI	0.753790	1.000000	0.712477
GDP	0.927569	0.712477	1.000000

4.3 Least Square (LS) NLS and Autoregressive moving average (ARMA)

Analyzed EC, FDI and GDP by Least Squares(LS), Nonlinear Least Square(NLS) and Autoregressive moving average (ARMA) we found all independents have Statistical significance flowing this 0.0000, 0.0397 and 0.0000 confidence level 95% (Prob.< 0.05), R-squared value = 0.877919 but in a table 1 we had testing heteroskedasticity by the Breusch Pagan Godfrey we found a p-value of 0.0365, which is less than our selected alpha value of 0.05. Therefore, we reject the null hypothesizer. We can't use this data for test and forecasting.

Table 5.

Dependent Variable: EC
Method: Least Squares
Date: 06/10/18 Time: 14:23
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20337.21	2219.521	9.162883	0.0000
FDI	9.22E-07	4.30E-07	2.143895	0.0397
GDP	1.29E-07	1.43E-08	9.010239	0.0000

R-squared	0.877919	Mean dependent var	48225.11
Adjusted R-squared	0.870289	S.D. dependent var	20321.24
S.E. of regression	7318.769	Akaike info criterion	20.71609
Sum squared resid	1.71E+09	Schwarz criterion	20.84940
Log likelihood	-359.5315	Hannan-Quinn criter.	20.76211
F-statistic	115.0609	Durbin-Watson stat	0.374109
Prob(F-statistic)	0.000000		

Analyzed LOG(GDP) by heteroskedasticity by the Breusch Pagan Godfrey we found p-value = 0.6411 is more than (typically 0.05), will can't reject the null hypothesis and then we take this data analyzed Least Squares(LS), Nonlinear Least Square(NLS) and Autoregressive moving average (ARMA)

Table 6.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.206180	Prob. F(1,33)	0.6528
Obs*R-squared	0.217318	Prob. Chi-Square(1)	0.6411
Scaled explained SS	0.118872	Prob. Chi-Square(1)	0.7303

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/12/18 Time: 07:00
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.066467	0.109900	0.604796	0.5495
LOG(GDP)	-0.001943	0.004278	-0.454071	0.6528

R-squared	0.006209	Mean dependent var	0.016586
Adjusted R-squared	-0.023906	S.D. dependent var	0.018668
S.E. of regression	0.018890	Akaike info criterion	-5.044973
Sum squared resid	0.011775	Schwarz criterion	-4.956096
Log likelihood	90.28703	Hannan-Quinn criter.	-5.014293
F-statistic	0.206180	Durbin-Watson stat	0.324915
Prob(F-statistic)	0.652750		

From table 6 we analyzed LOG(GDP) by Least Squares(LS), Nonlinear Least Square(NLS) and Autoregressive moving average (ARMA) and found LOG(GDP) have Statistical significance flowing this 0.0000 and 0.0000 confidence level 95% (Prob.< 0.05) and R-squared = 0.934347 show the level of confidence is higher than data not improve by LS LOG

Table 7.

Dependent Variable: LOG(EC)
Method: Least Squares
Date: 06/12/18 Time: 06:56
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.042071	0.771653	-7.830032	0.0000
LOG(GDP)	0.650949	0.030037	21.67123	0.0000

R-squared	0.934347	Mean dependent var	10.67355
Adjusted R-squared	0.932357	S.D. dependent var	0.509959
S.E. of regression	0.132631	Akaike info criterion	-1.147046
Sum squared resid	0.580503	Schwarz criterion	-1.058169
Log likelihood	22.07331	Hannan-Quinn criter.	-1.116366
F-statistic	469.6420	Durbin-Watson stat	0.150051
Prob(F-statistic)	0.000000		

Analyzed LOG(FDI) by heteroskedasticity by the Breusch Pagan Godfrey we found p-value = 0.7518 is more than (typically 0.05), will can't reject the null hypothesis and then we take this data analyzed Least Squares(LS), Nonlinear Least Square(NLS) and Autoregressive moving average (ARMA)

Table 8.

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.094608	Prob. F(1,33)	0.7603
Obs*R-squared	0.100055	Prob. Chi-Square(1)	0.7518
Scaled explained SS	0.117165	Prob. Chi-Square(1)	0.7321

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/12/18 Time: 07:28
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.108783	0.213607	0.509267	0.6140
LOG(FDI)	-0.003021	0.009822	-0.307584	0.7603

R-squared	0.002859	Mean dependent var	0.043188
Adjusted R-squared	-0.027358	S.D. dependent var	0.071123
S.E. of regression	0.072089	Akaike info criterion	-2.366387
Sum squared resid	0.171495	Schwarz criterion	-2.277510
Log likelihood	43.41177	Hannan-Quinn criter.	-2.335707
F-statistic	0.094608	Durbin-Watson stat	1.580610
Prob(F-statistic)	0.760332		

From table 8 we analyzed LOG(GDP) by Least Squares(LS), Nonlinear Least Square(NLS) and Autoregressive moving average (ARMA) we found LOG(GDP) have Statistical significance flowing this 0.0002 and 0.0000 confidence level 95% (Prob.< 0.05) and R-squared = 0.829045 show the level of confidence is higher than data not improve by LS LOG

Table 9.

Dependent Variable: LOG(EC)
Method: Least Squares
Date: 06/12/18 Time: 07:25
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.664091	0.634170	4.200907	0.0002
LOG(FDI)	0.368902	0.029161	12.65042	0.0000

R-squared	0.829045	Mean dependent var	10.67355
Adjusted R-squared	0.823864	S.D. dependent var	0.509959
S.E. of regression	0.214022	Akaike info criterion	-0.190030
Sum squared resid	1.511580	Schwarz criterion	-0.101153
Log likelihood	5.325518	Hannan-Quinn criter.	-0.159349
F-statistic	160.0331	Durbin-Watson stat	1.267047
Prob(F-statistic)	0.000000		

Analyzed LOG(EC), LOG(FDI) and LOG(GDP) by Least Squares(LS), Nonlinear Least Square(NLS) and Autoregressive moving average (ARMA) we found LOG(GDP) has Statistical significance flowing this 0.0000, 0.0000 and 0.0000 confidence level 95% (Prob.< 0.05) and R-squared = 0.961934 show the level of confidence is higher than data is not improve by LS LOG and included data was improved by LS LOG too.

Table 10.

Dependent Variable: LOG(EC)
Method: Least Squares
Date: 06/10/18 Time: 14:36
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.158483	0.713460	-5.828614	0.0000
LOG(FDI)	0.128538	0.026692	4.815657	0.0000
LOG(GDP)	0.468917	0.044366	10.56937	0.0000

R-squared	0.961934	Mean dependent var	10.67355
Adjusted R-squared	0.959555	S.D. dependent var	0.509959
S.E. of regression	0.102558	Akaike info criterion	-1.634959
Sum squared resid	0.336581	Schwarz criterion	-1.501644
Log likelihood	31.61179	Hannan-Quinn criter.	-1.588939
F-statistic	404.3196	Durbin-Watson stat	0.807794
Prob(F-statistic)	0.000000		

Analyzed LOG(EC), LOG(FDI), LOG(GDP), LOG(H_EC) and LOG(L_EC) by Least Squares(LS) NLS and ARMA we found LOG(GDP) has Statistical significance flowing this 0.0000, 0.1993, 0.4977, 0.0000 and 0.0000 confidence level 95% (Prob.< 0.05) except LOG(FDI) = 0.1993 and LOG(GDP) = 0.4997 in case will use this analyzed for forecasting will pull out LOG(FDI) and LOG(GDP) for forecasting R-squared = 0.999988 show the level of confidence is highest.

Table 11.

Dependent Variable: LOG(EC)
Method: Least Squares
Date: 06/10/18 Time: 18:50
Sample: 1982 2016
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.653000	0.020633	31.64780	0.0000
LOG(FDI)	-0.000888	0.000676	-1.312536	0.1993
LOG(GDP)	0.001365	0.001989	0.686505	0.4977
LOG(H_EC)	0.701377	0.003224	217.5584	0.0000
LOG(L_EC)	0.292745	0.005546	52.78864	0.0000

R-squared	0.999988	Mean dependent var	10.67355
Adjusted R-squared	0.999986	S.D. dependent var	0.509959
S.E. of regression	0.001906	Akaike info criterion	-9.556120
Sum squared resid	0.000109	Schwarz criterion	-9.333927
Log likelihood	172.2321	Hannan-Quinn criter.	-9.479419
F-statistic	608506.8	Durbin-Watson stat	1.123851
Prob(F-statistic)	0.000000		

5. Conclusions

Thailand has emerged to global economy since 1961, the same time as the first national economic and social development plan was launched, which the country's GDP was at 3.036 billion US dollars. Thailand's economy has been growth well. The GDP reached 407.026 billion US dollars in 2016, although the country confronted two major crises. The first crisis was "Tom Yum Kung Crisis" when the GDP dropped 32 billion US dollars and 36 billion US dollars in 1997 and1998 compared to 1996. This resulted in the decrease of energy consumption in the heavy industry sector (0.23 % in 1997 and 12.36 % in 1998) which was the first decline since Thailand adopted the national economic and social development plan. The second crisis that made a huge impact on the country was the devastating flood

in 2011. It dwindled the country's GDP by 13% compared to 2010. Most importantly, it resulted in a sharp decline of FDI by 83.23% compared with the previous year. The consequence of these two crises escalated the lack of confidence of foreign investors in the country's administration at that time. Even though, the energy consumption rose but merely by 0.43 percent which was the lowest growth rate in Thailand since 1961.

The results of the research showed that energy consumption in terms of "ktoe" has never been reduced since 1961 which are 70.16% and 29.84% (average of 35 years) belongs to heavy industry and light industry, respectively. Based on Equation 2, the economic growth in term of GDP and FDI are in line with energy consumption where the confidence value "R-square" equals 0.9343(with a confidence probability of more than 95%). The heteroskedasticity has been tested by the Breusch Pagan Godfrey obtained the correlation of P > 5% (can't reject) meanwhile the correlation test by the Durbin-Watson (DW) found correlation values equals to 0.9275. In comparison with the growth of FDI, the results tested by Breusch Pagan Godfrey and the correlation test by DW are 0.8290 and 0.7537, respectively. Furthermore, according to Equation 4 it was found that the overall energy consumption (EC) has mutual relationship with GDP, FDI, Light EC and Heavy EC with "R-square" equals 0.9343(with a confidence probabilistic more than 95%) and the correlation of P > 5% in heteroskedasticity test.

In summary, the energy consumption has been stimulated by the heavy industry sector over the past 30 years which is unlikely to be declined. This is an intention of every government to transform both light- and heavy- industries in Thailand toward the "Industry 4.0 policy".

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