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## Article

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# Determinants of Energy Consumption in Newly Industrialised Countries of Asia

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## ABSTRACT

This study focuses on identifying the factors that lead to energy consumption in select newly industrialized countries of Asia such as China, India, Indonesia, Malaysia, Philippines and Thailand. GDP, Exchange rate, industrialization, urbanization and trade openness are the select factors identified and such data is obtained for a period from 1980 to 2018. To check for stationarity, ADF unit root test and PP unit root test is employed where all variables are found to be stationary at first difference. OLS regression is applied to identify which factor has an impact on energy consumption. Besides, Johansen cointegration test to establish long run relationship and VECM is employed, where all variables were found to be integrated in the long run however VECM indicated that for China and Malaysia energy consumption is able to achieve equilibrium after a shock in the previous period. To determine causal links between variables, Toda Yamamoto Causality test is applied. Results indicate that industrialization, exchange rate, financial development and trade openness causes energy consumption in China. However, in India and Thailand only industrialization causes energy consumption. GDP causes energy consumption in Indonesia and trade openness causes energy consumption in Malaysia.

**Keywords:** Energy Consumption, OLS Regression, VECM, Toda Yamamoto Causality

**JEL Classifications:** O13, O20, Q43

## 1. INTRODUCTION

The consumption of energy is due to certain factors which directly or indirectly have an impact of energy consumption of a country. It is necessary to identify and study those factors that have an impact on energy use for a country so as to formulate appropriate energy policies and to control such factors accordingly.

The factors identified as those that affect energy consumption based on literature review are Economic growth (GDP), Industrialisation, Exchange rate, Financial development and Trade openness. Economic growth measured by gross domestic production (GDP) refers to the total output of an economy. An increase in GDP indicates that the economic growth of a country is robust. High economic growth implies more energy requirements to sustain economic activities. When a country is an emerging economy, it moves from dependence on agriculture

to the industry and services. The rapid spread of industries would lead to increase in demand for various forms of energy to support output. Exchange rate refers to the rate at which domestic currency can be exchanged for foreign currency. An increase in exchange rate would discourage import of energy thereby reducing energy consumption since emerging countries are not self-sufficient in energy resources. Financial development refers to the availability of finance especially with reference to the private sector. Increase in financial development will encourage energy demand as an economy will be able to incur energy cost. Trade openness is the ratio of trade to GDP of a country. Higher the trade openness of a country, higher energy consumption of a country.

Majority studies have focused on identify whether specific individual variables have an impact on energy consumption and which leads to the omission of important variables which may have a significant impact on energy consumption. This study makes a

multivariate attempt to identify which variables have a significant impact on energy consumption for China, India, Indonesia, Malaysia, Philippines and Thailand. This will assist individual countries to monitor identified variables in order to achieved desired policy outcomes with respect to energy consumption and related environmental issues.

Variables under study have been selected based on availability of data and literature review. Data is collected from the year 1980 to 2018 and therefore the period of the study is 38 years.

## 2. REVIEW OF LITERATURE

Researchers have identified and examined the various possible factors that lead to energy use in a context of time series and panel studies for countries. In case of ASEAN countries, (Shah et al., 2015) examined the linkages among energy consumption, foreign direct investment, financial development and trade using techniques such as ARDL testing approach and Granger causality test. Results indicated that there exists a long-run relationship among the variables and short-run unidirectional causality running from FDI inflows to energy consumption while (Hassan, 2018) advocated that economic growth, energy access and urbanization have significant effects on energy demand. According to (Çoban and Topcu, 2013) greater financial development leads to more energy consumption however (Obadi and Korček, 2015) employed logarithmic mean Divisia index decomposition technique and found that energy intensity effect was the major factor influencing energy consumption.

(Nasreen and Anwar, 2014) explored the causal relationship between economic growth, trade openness and energy consumption in Asian countries and identified economic growth and trade openness to have a positive impact on energy consumption while (Sadorsky, 2010) examined the impact of financial development on energy consumption for emerging economies and concluded that the relationship is positive and statistically significant. (Zeren and Koc, 2014) investigated the relationship between energy consumption and financial development for Newly Industrialised Countries and found bidirectional causality in only positive shocks for India and turkey while for Thailand, positive shocks of financial development are cause of Energy consumption. In South America, (Sadorsky, 2012) examined the relationship between Energy consumption, output and trade and concluded that there exists a short run bidirectional relationship between energy consumption and exports, output and exports/import and a long run causal relationship between trade and energy consumption. (Kahouli, 2017) examined the short and long run causality relationship among economic growth, energy consumption and financial development for South Mediterranean Countries and found short-run unidirectional causal relationships existing at least once for each country (except Egypt).

In case of the Organisation of the Islamic Conference Countries, (Gamoori et al., 2017) investigated the relationship between foreign investment, financial development (FD) and foreign trade with energy consumption and identified foreign trade, investment and financial development to had a positive significant effect on energy consumption while in case of the OECD (Dedeoğlu and Kaya, 2013) found bidirectional causalities between exports,

imports and GDP on energy consumption. Granger causality from exports to energy consumption was found by a study conducted by (Sadorsky, 2011) on the Middle East.

Energy consumption is influenced by economic growth and financial development, both in the short and the long run, but population impacts energy consumption only in the long run according to a study conducted by (Islam et al., 2013) who explored the existence of a long run relation among energy use, aggregate production, financial development and population while (Shahbaz et al., 2015) advocated that Urbanization Affluence, Capital stock and Trade openness leads to increases in energy consumption. Recently (Ridzuan et al., 2020) analysed the macroeconomic indicators that influence Malaysia's electrical consumption and found that economic progression and urbanization that lead to increase in electrical consumption, whereas financial deepening and higher inflation leads to reduction. In case of India, (Mahalik and Mallick, 2014) using ARDL approach to cointegration concluded that EC is positively and significantly impacted by urban population however negatively and significantly impacted by financial development, economic growth and proportion of industrial output while (Shahbaz et al., 2016) identified Acceleration of globalization and financial development is negatively related to energy consumption however economic growth and urbanization lead to increased energy demand. (Bashir et al., 2019) investigated the causality between human capital, energy consumption, CO<sub>2</sub> emissions, and economic growth for Indonesia and found that in the short-run, there is causal evidence between CO<sub>2</sub> emission and energy consumption. In Vietnam (Morelli and Mele, 2020) used Toda-Yamamoto test and Johansen and Juselius approach to study the relationship among per capita GDP, CO<sub>2</sub> emissions, and energy use and concluded that economic growth leads to energy consumption. Similarly in Pakistan besides economic growth (Komal and Abbas, 2015) found a positive impact of urbanization and financial development on energy consumption and negative impact of energy prices on energy consumption. In Turkey, (Dumrul, 2019) using Johansen cointegration test FMOLS and DOLS test concluded that financial development and economic growth have a positive effect on energy consumption. (Shahbaz and Lean, 2012) assess the relationship among energy consumption, financial development, economic growth, industrialisation and urbanisation in Tunisia and found that long run bidirectional causalities between financial development and energy consumption, financial development and industrialisation, Industrialisation and energy consumption. (Rafindadi and Ozturk, 2017) investigated whether financial development, trade openness and economic growth add to the energy consumption and found that all three variables lead to energy consumption in South Africa. In Germany, (Rafindadi, 2014) predicted the effects of financial development and Trade openness on the German energy consumption using Bayer-Hank combined cointegration test, ARDL bounds test and VECM Granger causality test and concluded that financial development, capital use and trade openness decline energy demand.

## 3. DATA AND METHODOLOGY

Energy consumption (EC) is measures in million tonnes of oil equivalent and is sourced from BP statistical review. To identify which factors impact energy consumption, the select factors for

this study include economic growth which is measured by Real GDP per capita in constant 2010 USD sourced from World Bank indicators database.

Exchange rate data is sourced from the websites of UNCTADSTAT, OECD and World Bank. Financial development (FD) is measured in terms of domestic credit to private sector (% of GDP) and is sourced from World Bank indicators. Industry (including construction), value added (% of GDP) Trade openness is the ratio of trade to GDP of a country and is therefore measured by Trade (% of GDP) sourced from World Bank indicators.

Unit root tests are conducted to find out if a variable is time invariant i.e. whether the mean, variance and auto- covariance of the variable are the same in different lags. Augmented Dickey Fuller test and Philip Perron test (Phillips and Perron, 1988) is employed to check for stationarity of variables. From the Table 1, both tests indicate that variables are stationery at first difference.

The results of correlation in Table 2 indicates that GDP, Financial development and trade openness are highly positively correlated with energy consumption in case of China. The same is the case

for India in addition to exchange rate. In case of Indonesia GDP and exchange rate are highly positively correlated. The same is the case of Malaysia where financial development is also positively correlated. Correlation results for Philippines indicates a negative correlation for industrialization and energy consumption however GDP and financial development is positively correlated. Moreover the energy consumption of Thailand is positively correlated with all variables under study.

$$\begin{aligned} \text{CHINA\_EC\_LOG} = & 0.69752351574 * \text{CHINA\_} \\ & \text{GDP\_LOG} - 0.313664397653 * \text{CHINA\_INDUSTR} \\ & \text{IALISATION\_} - 0.223745440422 * \text{CHINA\_LOG\_} \\ & \text{EXCHANGE\_RATE} - 0.329203130314 * \text{CHINA\_LOG\_} \\ & \text{FD} + 0.229742822948 * \text{CHINA\_TRADE\_OPENESS\_} \\ & \text{LOG} + 0.330564482897 \end{aligned} \quad (1)$$

$$\begin{aligned} \text{INDIA\_EC\_LOG} = & 0.138310413329 * \text{INDIA\_} \\ & \text{EXCHANGE\_RATE\_LOG} + 0.45259347386 * \text{INDIA\_IN} \\ & \text{DUSTRIALISATION\_} - 0.0355207050584 * \text{IND} \\ & \text{IA\_LOG\_FD} + 0.737692257873 * \text{INDIA\_LOG\_} \\ & \text{GDP} - 0.0702699455952 * \text{INDIA\_TRADE\_OP\_} \\ & \text{LOG} - 1.77462719673 \end{aligned} \quad (2)$$

**Table 1: Results for unit root test**

Country	Variable	ADF unit	Root test	PP unit	Root test
		Test statistic level	Test statistic 1 <sup>st</sup> difference	Test statistic level	Test statistic 1 <sup>st</sup> difference
China	Energy consumption	(0.9710)	(2.816)**	0.0556	(3.024)*
	GDP	(2.872)	(4.180)**	(1.9517)	(3.4636)**
	Exchange rate	(1.7374)	(5.5256)**	(1.8097)	(5.5009)**
	Financial development	(2.6129)	(5.6639)**	(2.5974)	(5.8228)**
	Industrialization	(1.9126)	(4.0487)**	(1.8581)	(3.9791)**
	Trade openness	(1.4273)	(5.4014)**	(1.4490)	(5.3906)**
India	Energy consumption	(1.7546)	(6.4913)**	(2.0012)	(6.4909)**
	GDP	(0.6546)	(5.1698)**	(0.5184)	(15.6573)**
	Exchange rate	(1.0622)	(4.8409)**	(1.2199)	(4.8665)**
	Financial development	(4.5987)**	(2.4128)	(1.5489)	(5.4927)**
	Industrialisation	(2.3180)	(2.6003)*	(2.019)	(5.8330)**
	Trade openness	(1.3536)	(4.9075)**	(1.8429)	(4.9388)**
Philippines	Energy consumption	(1.5967)	(4.4506)**	(2.0274)	(4.4599)**
	GDP	(0.2246)	(8.6989)**	(0.8991)	(4.1915)**
	Exchange rate	(2.0790)	(4.5691)**	(2.0830)	(4.5772)**
	Financial development	(2.5844)	(3.9152)**	(1.9900)	(3.8850)**
	Industrialisation	(2.1501)	(6.9745)**	(2.0887)	(6.9645)**
	Trade openness	(0.9051)	(4.6678)**	(1.2376)	(4.7044)**
Malaysia	Energy consumption	0.8531	(3.4273)*	0.0967	(7.6755)**
	GDP	(1.8.73)	(5.0777)**	(2.0088)	(5.0777)**
	Exchange rate	(2.4899)	(4.7440)**	(1.9856)	(4.6548)**
	Financial development	(2.9353)	(5.5405)**	(2.9156)	(5.5312)**
	Industrialisation	(1.4361)	(6.5976)**	(1.4861)	(6.6300)**
	Trade openness	(0.1810)	(4.2758)**	(0.1811)	(4.1009)**
Indonesia	Energy consumption	(0.3268)	(5.1994)**	(0.2581)	(5.1344)**
	GDP	(2.2718)	(4.6402)**	(1.9531)	(4.6362)**
	Exchange rate	(1.8444)	(6.5069)**	(1.8059)	(6.5069)**
	Financial development	(2.4036)	(4.4939)**	(2.2735)	(4.4703)**
	Industrialisation	(1.1799)	(5.4061)**	(1.7634)	(5.3416)**
	Trade openness	(2.6748)	(8.3524)**	(2.6327)	(8.8411)**
Thailand	Energy consumption	(0.0368)	(4.4436)**	(0.4861)	(4.4095)**
	GDP	(1.9539)	(3.5696)**	(1.4622)	(3.5910)**
	Exchange rate	(1.3460)	(4.7029)**	(1.6063)	(4.6432)**
	Financial development	(2.3015)	(3.4219)*	(1.7774)	(3.4219)*
	Industrialisation	(1.3004)	(6.5642)**	(1.3104)	(6.5383)**
	Trade openness	(0.8383)	(5.0298)**	(1.0209)	(5.7275)**

\*Indicates significance at 10% significance level. \*\*Indicates significance at 5% significance level.  $H_0$ : Variable is not stationery (Has a unit root).  $H_1$ : Variable is stationery (Does not have a unit root)

**Table 2: Results for correlation**

	EC China	EC India	EC Indonesia	EC Malaysia	EC Philippines	EC Thailand
GDP	0.987065	0.991081	0.957242	0.980850	0.773138	0.994677
Industrialization	-0.085809	0.533567	0.495878	0.267888	-0.700328	0.771328
Exchange rate	0.615978	0.933498	0.960813	0.836903	0.695094	0.731504
Financial development	0.909008	0.905934	0.393648	0.711091	0.820790	0.877992
Trade openness	0.800247	0.932795	-0.007690	0.586957	0.587869	0.966438

Source: Researchers compilation

**Table 3: Results of OLS regression**

Dependent variable: Energy consumption				
	Coefficient	SE	t-Statistic	Prob.
<b>CHINA</b>				
GDP	0.697524	0.039543	17.63940	0.0000**
Industrialisation	-0.313664	0.250092	-1.254196	0.2186
Exchange rate	-0.223745	0.044105	-5.073069	0.0000**
Financial development	-0.329203	0.145613	-2.260810	0.0305**
Trade openness	0.229743	0.056921	4.036205	0.0003**
Constant	0.330564	0.521134	0.634318	0.5302
R-squared	0.993299			
<b>INDIA</b>				
GDP	0.737692	0.079907	9.231929	0.0000**
Industrialisation	0.452593	0.205526	2.202124	0.0348**
Exchange rate	0.138310	0.030645	4.513341	0.0001**
Financial development	-0.035521	0.083067	-0.427617	0.6717
Trade openness	-0.070270	0.047646	-1.474831	0.1497
Constant	-1.774627	0.345719	-5.133154	0.0000
R-squared	0.993964			
<b>INDONESIA</b>				
GDP	0.559986	0.131830	4.247785	0.0002**
Industrialisation	0.597530	0.236679	2.524645	0.0166**
Exchange rate	0.213003	0.037711	5.648312	0.0000**
Financial development	0.069118	0.037324	1.851853	0.0730
Trade openness	-0.051914	0.138570	-0.374645	0.7103
Constant	-2.401055	0.367800	-6.528153	0.0000
R-squared	0.979848			
<b>MALAYSIA</b>				
GDP	1.061029	0.059576	17.80963	0.0000**
Industrialisation	0.102322	0.339966	0.300977	0.7653
Exchange rate	0.091623	0.109669	0.835448	0.4095
Financial development	-0.043932	0.068679	-0.639674	0.5268
Trade openness	0.274255	0.116960	2.344865	0.0252**
Constant	-2.869976	0.495932	-5.787036	0.0000
R-squared	0.981068			
<b>PHILIPPINES</b>				
GDP	0.433738	0.072213	6.006376	0.0000**
Industrialisation	-0.696052	0.170250	-4.088417	0.0003**
Exchange rate	-0.040097	0.038908	-1.030563	0.3102
Financial development	0.161312	0.043238	3.730760	0.0007**
Trade openness	0.285208	0.074572	3.824593	0.0006**
Constant	0.036113	0.351600	0.102710	0.9188
R-squared	0.959037			
<b>THAILAND</b>				
GDP	1.059659	0.054081	19.59384	0.0000**
Industrialisation	-0.188792	0.110925	-1.701974	0.0982
Exchange rate	0.243879	0.043983	5.544859	0.0000**
Financial development	0.128935	0.031483	4.095362	0.0003**
Trade openness	0.291784	0.067551	4.319494	0.0001**
Constant	-3.071457	0.167377	-18.35053	0.0000
R-squared	0.997942			

\*\*5% level of significance



$$\begin{aligned} \text{INDONESIA\_EC\_LOG} = & 0.559986187182 * \text{INDONESIA\_GDP\_LOG} \\ & + 0.213003141631 * \text{INDONESIA\_EXCHANGE\_RATE} \\ & + 0.597529946157 * \text{INDONESIA\_INDUSTRIALISAT} \\ & + 0.0691177829398 * \text{INDONESIA\_LOG\_FD} \\ & - 0.0519144752016 * \text{INDONESIA\_TRADE\_OP\_LOG} - 2.40105492863 \end{aligned} \quad (3)$$

$$\begin{aligned} \text{MALAYSIA\_EC\_LOG} = & 0.102321970337 * \text{MALAYSIA\_INDUSTRIALISAT} \\ & + 0.0916229067461 * \text{MALAYSIA\_IA\_EXCHANGE\_RATE\_L} \\ & + 1.0610289205 * \text{MALAYSIA\_GDP\_LOG} \\ & - 0.0439322878018 * \text{MALAYSIA\_LOG\_FD} \\ & + 0.27425514624 * \text{MALAYSIA\_TRADE\_OP\_LOG} - 2.86997569294 \end{aligned} \quad (4)$$

$$\begin{aligned} \text{PHILIPPINES\_EC\_LOG} = & -0.0400968777434 * \text{PHILIPPINES\_EXCHANGE\_RATE} \\ & + 0.433738314966 * \text{PHILIPPINES\_GDP\_LOG} \\ & - 0.696052281808 * \text{PHILIPPINES\_INDUSTRIALISAT} \\ & + 0.161311823803 * \text{PHILIPPINES\_LOG\_FD} \\ & + 0.285208415197 * \text{PHILIPPINES\_TRADE\_OP\_OPENES} \\ & + 0.0361129753543 \end{aligned} \quad (5)$$

$$\begin{aligned} \text{THAILAND\_EC\_LOG} = & 0.243878920341 * \text{THAILAND\_EXCHANGE\_RATE\_L} \\ & + 1.05965892383 * \text{THAILAND\_GDP\_LOG} \\ & - 0.188791518478 * \text{THAILAND\_INDUSTRIALISAT} \\ & + 0.128934537752 * \text{THAILAND\_LOG\_FD} \\ & + 0.291784230579 * \text{THAILAND\_TRADE\_OP\_LOG} - 3.07145728454 \end{aligned} \quad (6)$$

Table 3 indicates OLS regression where in case of China, economic growth, exchange rate, financial development and trade openness have a significant impact on energy consumption. A 1% increase in GDP and trade openness leads to 0.69% and 0.23% resp. increase in energy consumption. A 1% increase in exchange rate and financial development will each cause a decrease in energy consumption by 0.22% and 0.33% resp.

In case of India, GDP, Industrialization and exchange rate have a significant impact on energy consumption. A 1% increase in economic growth, industrialization and exchange rate will each lead to an increase in energy consumption by 0.73%, 0.45% and 0.14% resp. The same is in the case of Indonesia

where a 1% increase in GDP, industrialization and exchange rate will each increase energy consumption by 0.55%, 0.59% and 0.21% resp.

GDP and trade openness have a significant impact on energy consumption of Malaysia where a 1% increase in the variables will cause energy consumption to increase by 1.06% and 0.27% resp. GDP, Industrialization, financial development and trade openness have a significant impact on the energy consumption of Philippines. A 1% increase in GDP financial development and trade openness will each cause energy consumption to increase by 0.43%, 0.16% and 0.28% resp. while industrialization will decrease energy consumption by 0.69%.

GDP, exchange rate, financial development and trade openness has a significant impact on energy consumption of Thailand. A 1% increase in these variables will lead to an increase in energy consumption by 1.05%, 0.24%, 0.12% and 0.29% resp.

Table 4 indicating Johansen's Cointegration test reveals that the variables under study are integrated in the long run towards equilibrium which is supported by trace statistic and max Eigen value.

VECM indicates the speed at which energy consumption returns to equilibrium after a change in the independent variables viz. GDP, industrialization, exchange rate, financial development and trade openness. VECM results in Table 5 indicate that incase of China and Malaysia there exists a long run relationship among the variables. For China, energy consumption is corrected towards long run equilibrium by 85% each year while for Malaysia energy consumption is corrected towards long run equilibrium by 11% each year.

The Toda Yamamoto causality test is considered to be an advanced causality test as pretests for unit root and cointegration is not a prerequisite. This test follows the method of adding extra lags intentionally in the estimation. The usual strategy that one tests some economic hypothesis conditioned on the estimation of a unit root, a cointegrating rank, and a cointegrating vector(s) may suffer from severe pretest biases (Toda and Yamamoto, 1995). Table 6 indicates which variable causes

**Table 4: Johansen's cointegration test**

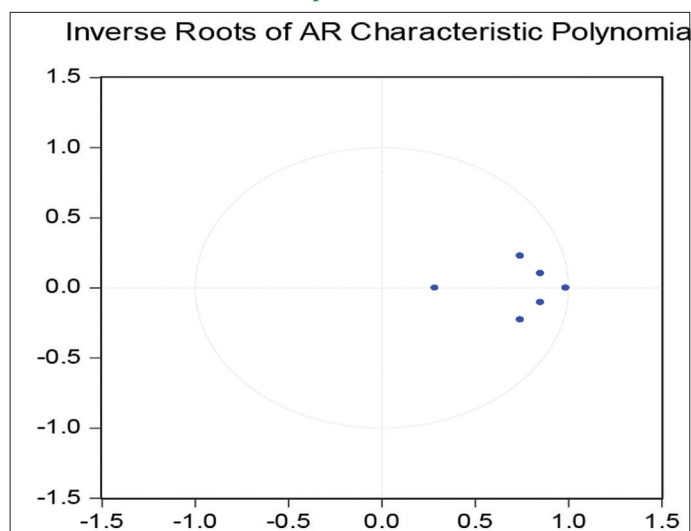
Country	Hypothesised number of cointegrating equations	Eigen value	Trace statistic	Critical value at 5% (P value)	Max eigen statistic	Critical value at 5% (P value)
China	None	0.913320	235.9224	95.75366 (0.0000)	85.59369	40.07757 (0.0000)
	At most 1	0.830164	150.3287	69.81889 (0.0000)	62.05225	33.87687 (0.0000)
India	None	0.780068	148.8716	95.75366 (0.0000)	56.03415	40.07757 (0.0004)
	At most 1	0.658735	92.83742	69.81889 (0.0003)	39.77850	33.87687 (0.0088)
Indonesia	None	0.746577	135.7644	95.75366 (0.0000)	50.78977	40.07757 (0.0022)
	At most 1	0.615253	84.97460	69.81889 (0.0019)	35.34123	33.87687 (0.0332)
Malaysia	None	0.662928	116.7574	95.75366 (0.0009)	40.23602	40.07757 (0.0480)
	At most 1	0.594869	76.52141	69.81889 (0.0132)	33.43115	33.87687 (0.0564)
Philippines	None	0.718112	136.0521	95.75366 (0.0000)	46.85115	40.07757 (0.0075)
	At most 1	0.617659	89.20094	69.81889 (0.0007)	46.85115	33.87687 (0.0311)
Thailand	None	0.982123	273.9532	95.75366 (0.0000)	140.8488	40.07757 (0.0001)
	At most 1	0.839631	133.1044	69.81889 (0.0000)	64.05970	33.87687 (0.0000)

Source: Authors compilation

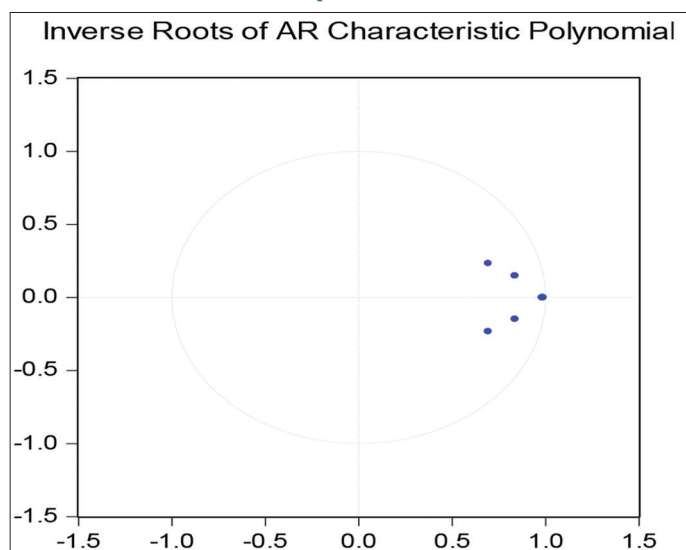
energy consumption with respect to each country under study. Industrialization, Exchange rate, financial development and trade openness causes energy consumption in China. However, in India and Thailand only industrialization causes energy consumption. In Indonesia, GDP causes energy consumption and trade openness causes energy consumption in Malaysia. The energy consumption of the Philippines is not caused by any of the select factors.

The inverse roots of AR characteristic polynomial i.e. the reciprocal of the roots indicates stability. If all inverse roots lie within the unit circle, the process is stationary. The inverse roots of Graph 1 which indicates stability for China, Graph 2 for India, Graph 3 for Indonesia, Graph 4 for Malaysia, Graph 5 for Philippines and Graph 6 for Thailand are situated within the circle which indicates stability.

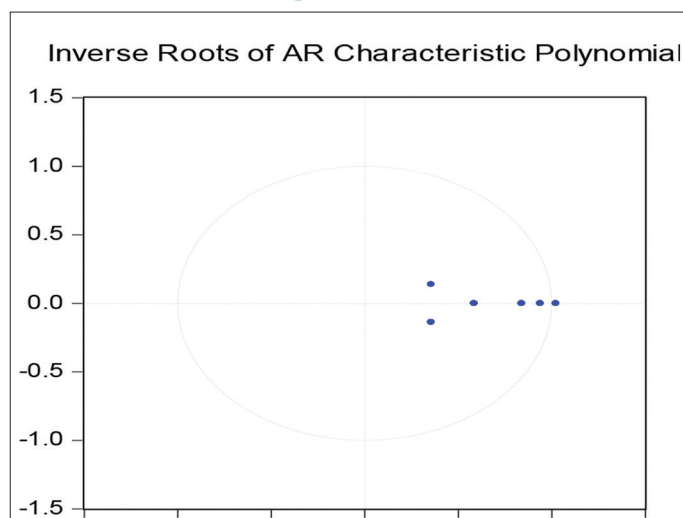
Graph 1: China



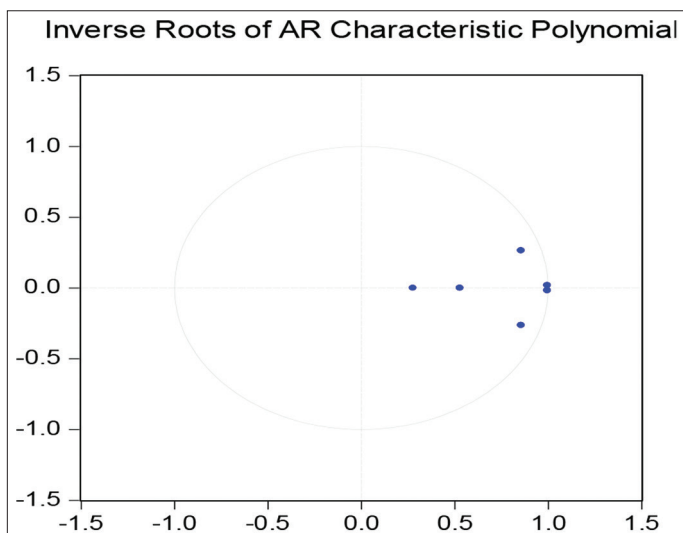
Graph 2: India



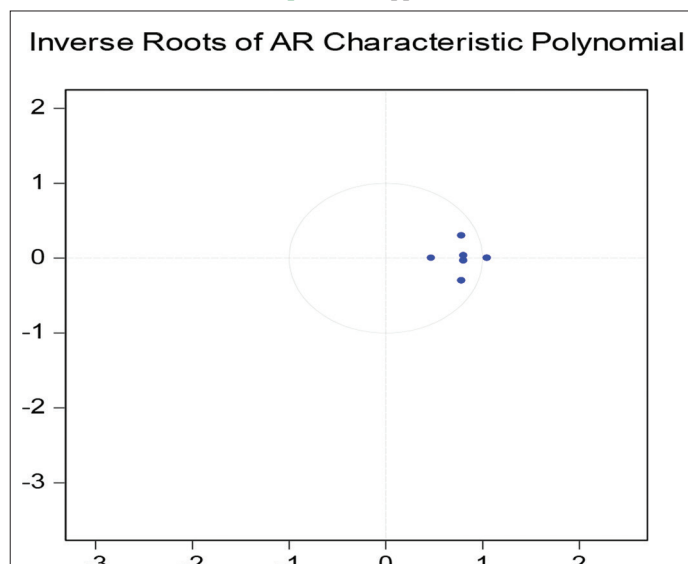
Graph 3: Indonesia



Graph 4: Malaysia



Graph 5: Philippines



## 4. CONCLUSION

Economic growth (GDP), exchange rate, financial development and trade openness has a significant impact on energy consumption for China. Since the 13<sup>th</sup> Five Year Plan which ends in the year 2020 focuses on expanding exports, increasing outbound and inbound investment as well as strengthening the domestic currency and the GDP of the country, energy will have increased. A positive sign is that the 14<sup>th</sup> Five Year Plan had stressed upon the need to cap carbon emissions and reducing coal consumption (non-renewable energy consumption) in addition to expanding non-fossil fuel (hydro power and nuclear energy) energy generation by 20% of energy mix. (chinadialogue.net). Long run relationship among the variables also exists where energy consumption of china is able to correct itself towards long run equilibrium by 85% after a shock in the previous period. According to Toda Yamamoto Causality test, industrialization, exchange rate, financial development and trade openness causes energy consumption in China. In India and Indonesia, results suggest that GDP, Industrialization and

exchange rate have a significant impact on energy consumption. In addition energy consumption is caused due to industrialization and GDP for India and Indonesia resp. according to Toda Yamamoto causality test. The Government of India has stressed upon encouraging domestic production and consumption through 'Make in India' initiatives and encouraging exports which leads to industrialization. GDP and trade openness have a significant impact on energy consumption of Malaysia and there exists a long run relationship between the variables according to VECM which is in line with (Islam et al., 2013; Shahbaz et al., 2015). Moreover Toda Yamamoto causality test suggests that trade openness causes energy consumption. The 11<sup>th</sup> Five Year Plan (2016-2020) has focused on increasing exports to improve the country's trade balance. Besides, the government has aimed to promote productivity and investment to increase sustainable economic growth in other words green growth. In case of the Philippines, GDP, Industrialization, financial development and trade openness have a significant impact on the energy consumption. By 2022, the development plan of the Philippines focuses on alleviating the country to upper middle income by lowering poverty and unemployment rates in rural areas through inclusive growth (manila2018.dof.gov.ph).

Graph 6: Thailand

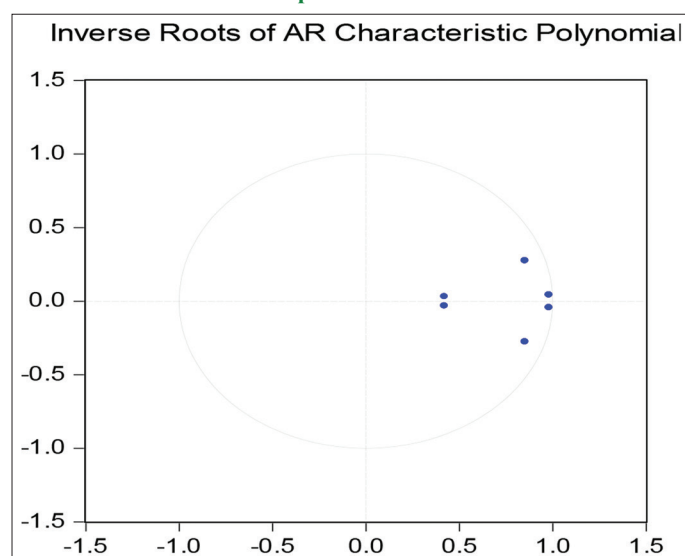


Table 5: Vector error correction model

	ECT coefficient	SE	t-Statistic	Prob.
China	-0.853437	0.276379	-3.087925	0.0075**
India	0.181179	0.090903	1.993095	0.0557
Indonesia	-0.067305	0.155462	-0.432936	0.6712
Malaysia	-0.107820	0.049879	-2.161634	0.0390**
Philippines	-0.040591	0.168186	-0.241348	0.8110
Thailand	-0.017373	0.017753	-0.978585	0.3359

\*\*5% level of significance

Table 6: Toda Yamamoto causality test

Country	Industrialisation causes EC	GDP causes EC	Exchange rate causes EC	Financial development causes EC	Trade openness causes EC
China	0.0009**	0.0751	0.0000**	0.0024**	0.0096**
India	0.0144**	0.7024	0.5918	0.1187	0.7076
Indonesia	0.4850	0.0469**	0.6960	0.2536	0.0613
Malaysia	0.4264	0.1015	0.9957	0.1679	0.0418**
Philippines	0.4719	0.5742	0.4814	0.8553	0.4471
Thailand	0.0290**	0.4108	0.5983	0.9993	0.8259

\*\*5% level of significance

GDP, exchange rate, financial development and trade openness has a significant impact on energy consumption of Thailand. However, Toda Yamamoto causality test indicates that industrialization causes energy consumption of Thailand. The 12<sup>th</sup> National Economic and Social Development Plan focuses on promoting its industrial sector through advanced science, technology and innovation thereby generating economic value added (EVA) as well as enhancing the potential of existing production and service base by strengthening connectivity in the manufacturing sector. Besides, the development plan aims to expand Thai outward investment and making the financial sector more efficient and competitive.

Therefore it is evident that the energy consumption needs of all countries under study will increase in the future as analysis indicate that the various select factors have a significant impact on energy consumption. Therefore there is a need to invest in discovering renewable sources of energy to sustain economic development.

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