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THE IMPACT OF ELECTRIC POWER CONSUMPTION ON GREEN ECONOMY DEVELOPMENT IN MALAYSIA

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Abstract

The Malaysian government has identified that low carbon economy is vital for economic growth. There is a need for further securitisation of the adoption of government initiatives and its environmental impacts. This paper analyses low-carbon economy in Malaysia amidst the transformation of the economy. This study applies the model of STIRPAT from 1970 to 2013. Results from cointegration indicate a co-movement between variables. At 10% significant level, there exists a unidirectional causality of electric power consumption to carbon emission. Therefore, the Malaysian economy has to transform so that the faster the economic growth rate and the faster its climb up the value chain to green technology industrial development, the less the carbon emission. Furthermore, Malaysia has been promoting the carbon emission reduction policy more intensively only after the COP 15. Therefore, future research with a more recent and longer period, as well as research that can gauge the influence of external factors to Malaysia.

Keywords: Carbon Emission, Energy consumption, Green Economy, Industrialisation, Urbanisation.

Introduction

The United Nations World Commission on Environment and Development 1987 issued a call for the creation of a new charter that would set forth fundamental principles for sustainable development.

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After consultation for over a ten-year period, The Earth Charter, a declaration of fundamental ethical principles for building a just, sustainable and peaceful global society in the 21st century, was launched in 2000. Lee (2011) suggests that The Earth Dialogues were used more pertinently to disseminate and attain the endorsement from the stakeholders (grassroots, NGOs and heads of states) to stimulate their actions to achieve sustainable development. According to the UK House of Commons (2010), the development of low carbon technologies will have the potential to make a very significant contribution to economic growth and job creation. In other words, investment in low carbon technologies is also a means of encouraging sustainable economic growth.

Green Growth and Policies

The Malaysian government has identified that low carbon economy is vital for economic growth. Specifically, the initiatives of the Ministry of Energy, Green Technology and Water, towards achieving low carbon growth give priorities to the four areas, i.e. energy, water and waste Management, building and transportation. Ho (2008) points out that the low carbon society can be achieved through cost effective ways of reducing greenhouse gases emissions, protection of the carbon sinks, motivation of desired behavioural changes of 3R (reuse, reduce and recycle), building energy efficient cities, R & D in green technology, and research collaboration between ASEAN and developed nations on the climate change. Energy has been recognised by Economic Transformation Programme (ETP) as one of the main National Key Economic Areas (PEMANDU, 2009).

Carbon Emissions Reduction and Policies

According to Ninth Malaysia Plan (9MP), by 2010, the country mainly generates power from fossil fuels i.e. 56% LNG and 36% coal (EPU, 2006). Particularly, the results from Mustapa and Bekhet (2015) demonstrated that fuel consumption (FE), fuel price (FP) and distance travel (DT) were the main factors influencing CO_2 emissions growth. According to the United Nations data, Malaysia generated 7.2 tons per capita or 187 million tons of carbon emission in 2006. Due to increasing carbon emission that brings climate change, countries have to adopt sustainable electricity generation.

Greening Industrialisation and Policies

Green technology shall be a driver to speed up the economy and promote green growth. The four pillars of the Policy on Green Technology are energy, environment, economy and social. The government has strengthen the Fifth-Fuel Policy in the 11th Malaysia Plan to encourage industries to adopt green technology. Chua and Oh (2011) suggest that pursuing green technology not only promotes renewable energy, safeguard and minimise environmental deplationbut also develops a vibrate green economy. Specifically, Sims, Rogner and Gregory (2003) suggest alternatives to generate electricity and reduce greenhouse gas emissions, including using plant designs with more efficient power generation, greater use of renewable energy or nuclear power, and capturing CO_2. Consequently, the green economy is a vehicle for economic and sustainable development in Malaysia.

Efficient Energy Consumption and Policies

The government promotes green procurement and environment-friendly labelling. The Government has introduced legal requirements related to energy efficiency, i.e. National Energy Efficiency Action Plan 2016-2025, Efficient Management of Electrical Energy Regulations 2008 and Minimum Energy Performance Standards for energy rating labels. The Government has introduced the certification programme for energy managers. In addition, among the strategies to achieve low carbon economy include the recognition of green technology via standard rating and labelling programmes. In addition, the SIRIM Eco-Labelling Scheme is recognized as the National Eco-labelling Programme of Malaysia, and the mark competitively positions environmentally-friendly products over other similar products in a consumer market. SIRIM QAS International (2016) is a member of the Global Eco-labelling Network. The drivers to green purchasing are influenced by regulations, customer pressures, expected business benefits and firm ownership (ElTayeb, Zailani and Krishnaswamy, 2010). Results from Rashid (2009) show that the consumers react positively to the eco-label after they are exposed to environment-related experiences.

The adoption of green technology will reduce energy consumption. Mahlia et al. (2005) discuss the energy label for electric fans based on Malaysian Standards. For instance, Saidur et al. (2009) report on the significant amount of energy that can be saved using Variable Speed drives (VSDs) and capacitor banks in industrial motors to improve the power factor, thus cutting energy costs, and Saidur and Mahlia (2010) introduce high-efficiency motors potential for energy savings in Malaysia. Furthermore, Malaysia has the potential to be one of the major contributors to renewable energy in palm oil biomass and become a role model (Ong, Mahlia and Masjuki, 2011).

According to the Sustainable Energy Development Authority (SEDA), Malaysia's installed PV capacity currently stands at 296.5 MW, with 34.5 MW of new solar added in 2016. Malaysia has implemented two new policies in 2016 to boost the solar energy capacity in the country, net energy metering, and large scale solar mechanisms that account for about 1.5 GW of the total (Hamdan, 2017).Solar power generation possesses advantages for generation of power in the future (Hosseini and Wahid, 2014).

On the supply side, 48 solar projects with more than 26,700 job opportunities created as of 2015. (Hamdan, 2017). This is in line with the Malaysia's year 2020 target to become the largest producer after China in solar PV manufacturing. Reported by BERNAMA (Edra to build RM400 milion solar plant in Kedah, 22 May 2016), Edra Power will build a RM400 milion solar plant in Kuala Ketil, the first 50MWAC solar panel farm in Kedah and the largest in Malaysia.

The International Organisation for Standardisation (ISO) introduced ISO 50001 Energy Management System: 2011, a system of certification based on excellence in energy management. The energy management practices seek to achieve energy efficiency and carbon emission reduction. ISO 50001 certified manufacturing and services companies in Malaysia include Camfil Farr, CSC Steel, Guinness Anchor, Petronas, WIKA Malaysia, FREENET, Hitachi Sunway Data Centre, also Sime Darby Property. On the other hand, in addressing the energy challenges in Malaysia, Oh, Pang and Chua

(2010) suggest that the overall approach. Husin et al. (2017) suggest five energy efficiency criteria.

Low Carbon Cities Framework (LCCF) launched in 2011 is one of the national initiatives in greening the building sector. The four elements of the low carbon cities framework are urban environment, building, urban infrastructure and urban transportation. Another national initiative introduced in greening the building sector is the Green Building Index (GBI) launched in 2009. The building sector life-cycle could be divided into Development period, Operating period, and Decommission period (Sood, Chua & Leong, 2011). Malaysian Carbon Reduction and Sustainability Tool (MyCREST) is also a national initiative which takes into account a more holistic lifestyle view of the built environment from design to constructions and then operation and maintenance. Nevertheless, without the building energy efficiency legislation, the building sector increases its ‘carbon lock-in’ risk and further contributes to the growing GHG emissions (Zaid, et al., 2014). According to Fujita, Matsumoto and Ho (2009), the main sources of emission of CO_2 construction phase’s building components.

Samari, et al. (2013) elaborate the main obstacles of developing green buildings. Kamar and Hamid (2012) suggest that the adoption of green building can be accelerated by green public procurement, Research and Development (R&D), education to change public mindset, life cycle costing and Industrialised Building System (IBS), and legislative and financial frameworks. Specifically, Shaikh et al. (2014) recommend that the integration of renewable micro-grid resources and utility grid supply in buildings needs more research effort. Particularly, the key success factors to increase the implementation of the green building amongst the architects are green building technology, and clients’ awareness and government’s initiatives on the green building construction (Lop, Ahmad & Zulkipli, 2016).

Urban Transportation and Policies

On the other hand, the transportation sector accounts for a substantial amount of air pollution and contributes significantly to greenhouse gas emissions (Al-Mofleh, Taib & Salah, 2010). Ong, Mahlia and Masjuki (2012) suggest balancing the energy demand, reducing emission in the transportation sector and improving its sustainability. The transportation sector causes to 21% of carbon emission; of the carbon emission from the transportation industry, 85% came from vehicles, 13% from the aviation sector and 1.4% from the marine transport (Tho, 2017). According to Fong et al. (2008), it is important to carry out measures in various energy-consuming sectors and it requires a holistic analysis and a clear understanding of the nature of the highest energy consuming and $C0^2$ emission sector. Shahid, Minhans and ChePuan (2014) added that even though GHG emission from the transportation sector of Malaysia has been decelerating, the current measures may not be enough to reduce GHG emission, and therefore more prudent strategies for the climate-friendly development of transportation are required to achieve sustainability goals. The Government has introduced the Malaysia Biofuels Industry Act 2007 and National Automotive Policy 2014 on top of national initiatives in greening the transport sector that include electric mobility and energy efficient vehicles. In short, Hezri and Hasan (2006) suggest that should environment and sustainability be accepted, Malaysia is capable of implementing sustainable development.

Literature Review

Dietz and Rosa (1997) presented a reformulation into a stochastic equation that employed the STIRPAT model (STochastic Impacts by Regression on Population, Affluence, and Technology). In relation, there are various studies conducted that focus on advanced and developing countries. The causality results of France support that economic growth exerts a causal influence on energy use and pollution in the long run (Ang, 2007). In other words, energy is important for the development of economy that conservation of energy may affect economic development in developing countries

(Lee, 2005). According to Hossain (2011), higher consumption of energy in the newly industrialized countries gives rise to more emission of carbon. Findings also support the link between electricity consumption and economic growth in Algeria (Belaid & Abderrahmani, 2013). There is also a disparity within regions in a country. According to Li, et al. (2010), the income elasticity of energy consumption in eastern China isover two times that of western China. Evidence from Zhang and Cheng (2009) shows that the government can pursue energy conservation and reduction in carbon emissions in the long run without impeding the economic growth. Findings from Chindo et al. (2015) found that carbon emissions had a significant positive impact on the gross domestic product in Nigeria. In terms of the impact of trade on pollution, for instance, Frankel and Rose (2005) found that trade reduces measures of air pollution.

Jalal and Bodger (2009) discuss the impacts of National Energy Policy, National Depletion Policy and Four Fuel Diversification. Shafie, et al. (2011) examined renewable energy and environmental issues associated with energy policies. With the challenge of global climate change, Chong, et al. (2015) recommend that Malaysia must pay more attention to renewable energy, green technology and energy conservation. Cautiously, Basri, Ramli and Aliyu (2015) assert that environmental ramifications should be part of the diversification and expansion plan of the national grid. Huang, Hwangc and Yang (2008) reported that countries of the middle income groups including Malaysia experienced economic growth that led to energy consumption positively. According to a study of Sadorsky (2013) on a panel of 76 developing countries, a 1% increase in income reduces energy intensity by −0.45% to −0.35% in the long-run. Findings from a study of Lau, Chye and Choong (2011) on 17 Asian countries indicate that energy is a force for development of economy in the short-run, but the energy usage is basically due to economic growth in the long-run. The results from Lean and Smyth (2009) point to the unidirectional Granger causality running from emission to electricity consumption in the short-run. On the other hand, Wahid, Aziz and Mustapha (2013) reported that the causality result shows unidirectional causality from emission of CO_2 to power usage then to development of economy in Malaysia.

On the other hand, literature such as Lean and Smyth (2010) and Azam, et al. (2015) reported a unidirectional Granger causality running from development of economy to electricity generation. The results from Azlina and Mustapha (2012) suggest that measures on energy consumption can be implemented without affecting economic growth, but it is difficult to decrease pollutant emissions without cutting energy consumption and economic growth. Using data from 1971 to 2012, Mugableh (2013) reports that energy consumption is positively associated with CO_2 emission in the long-run and short-run. The results from Bekhet and Yusop (2009) reveal that there are long-run and short run relationships between the oil price, employment, development of economy and consumption of energy.

Furthermore, the results from Saboori, Sulaiman and Mohd (2012) support the EKC hypothesis and demonstrate the unidirectional causality from GDP to emission of CO_2 in the long-run. The causality test shows the unidirectional relationship between economic growth and CO_2, emissions Granger-cause income, consumption of energy and use of renewable energy, income Granger-causes consumption of energy and use of renewable energy, and both structural change and use of renewable energy Granger-cause energy consumption in road transportation (Azlina, Law & Mustapha, 2014). In contrast, energy consumption fuels growth in the short run among the energy exporter developing countries (Mahadevan & Asafu-Adjaye, 2007).

Furthermore, the results of Begum et al. (2015) demonstrate that both energy consumption and economic growth has a long term positive impact on emission of carbon in Malaysia. Energy use adjusted for the changing fuel Granger cause changes in GDP (Stern, 1993).

Similarly, the result from Razali et al. (2015) shows that long run relationships do exist between consumption of energy consumption and development of economy in Malaysia.

Nevertheless, the findings of Loganathan and Subramaniam (2010) reveal that there are some bidirectional effects between consumption of energy and economic growth in Malaysia. Tang and Tan (2013) found that both in the short and in the long run consumption of electricity and development of economic Granger-cause each other. In addition, using data from 1985 to 2012 the results from Ali, Abdullah and Azam (2016) indicate that a short-run bidirectional causality is running between consumption of energy and development of economic. Chen, Kuo and Chen (2007) suggest that electricity conservation policies and managing demand side could be initiated without an adverse effect on the economic growth for countries involved in the study.

Lately, researchers started to scrutinise the impacts of the urban population to carbon emission. There are similar findings from Islam and Shahbaz and Alam (2013) that the population-energy relation holds in the long run only. According to Bekhet & Othman (2017), the unidirectional causality from urbanization to emission of CO_2 in the short run is significant, and the bidirectional causality between emission of CO_2 and urbanization is significant in the long run. They also found significance in the bidirectional causality among energy consumption, domestic investment, GDP, emission of CO_2, and unidirectional causality from financial development to emission of CO_2 According to Chik, et al. (2013), urban households contribute more emission of CO_2 relatively; thus, there should be measures to reduce the emission intensity caused by household demands.

Methodology

In this study, the STIRPAT model was analysed empirically. The emission of carbon is the dependent variable. Urban population, electric power consumption and the level of technology are explanatory variables. The study uses EViews 9 for analysis of the World Bank data for years 1971 to 2013.

The Model

The model used in this study, STIRPAT, was formerly known as IPAT environmental stress equation, namely I = PAT, where I is the environmental pressure, P is the population, A is the degree of affluence, and T is the technology.

$$I = PxAxT \qquad (1)$$

I: environmental impact

STIRPAT is expressed as a random form of the IPAT equation, which represents regression analysis of the influence of environmental pressure randomly by the driving forces of population, affluence and technology.

$$I = a\ P^{b}\ A^{c}\ T^{d}\ e \qquad (2)$$

The logarithm of both sides of the equation is taken for the corresponding logarithmic equation. The environmental stress equation is where C is the carbon emission, U is the urban population, GDP is the gross domestic product, I is industrialisation, and EC is electric power consumption.

$$\ln C = a + b\ln U + c\ln GDP + d\ln I + e\ln EC + f \qquad (3)$$

Where:

lnC denotes the natural logarithm of carbon emission (kilotons of carbon emission)

lnU denotes the natural logarithm of urban population (% of total)

lnGDPPC denotes the natural logarithm of gross domestic product per capita, GDPPC (current US$)

lnI denotes the natural logarithm of industrialisation (Industry, value added (% of GDP))

lnEC denotes the natural logarithm of Electric power consumption (kWh per capita)

Indicators and Data Sources

The industrial value added (I) can be seen as the technology variable; I = industrial GDP of Malaysia / GDP of Malaysia. Electric power consumption (EC) can be seen as energy consumption capita; EC = electric power consumption of Malaysia / total population in Malaysia.

Analyses to be conducted are Augmented Dickey Fuller (ADF) test, Johansen test, Granger test and regression.

Results and Discussions

The raw data was first transformed to the logarithmic format. Carbon emission variable is Urban Population UP variable LNUP, Gross Domestic Product per capital GDPPC variable, LNGDPPC, and Industry Value Added variable, LNI and electric power consumption variable are all logarithmi

Results

Table 1

Root (Stationary) Test Results

Variables	ADF at Level	ADF at 1st Difference	ADF 2nd Difference
LNC	-0.749 (0.823)	-7.708 (0.000) ***	-7.911 (0.000) ***
LNUP	-1.419 (0.564)	-0.955 (0.760)	-5.614 (0.000) ***
LNGDPPC	-2.089 (0.250)	-5.087 (0.001) ***	-8.289 (0.000) ***
LNI	-3.000 (0.043) **	-6.129 (0.000) ***	-7.279 (0.000) ***
LNEC	-1.653 (0.445)	-2.769 (0.074) *	-9.054 (0.000) ***

Note: Values in brackets are probability values (p-values).

*** 1% level of significance.
** 5% level of significance.
* 10% level of significance.

Refer Table 1. The result indicates that each of the variables, LNC, LNUP, LNGDPPC, LNI and LNEC, has no unit root and is stationary at the 1% level of significance at the 2nd Difference. Next, refer to Table 2 for the outcomes of the Johansen cointegration analysis.

Table 2

Test Results of Cointegration

H_o No. of CS(s)	Trace Statistics	5% Critical Value
None	71.666	69.819
A most 1	47.015	47.856

Refer to Table 3. The findings for unidirectional causality from carbon emission to electric power consumption and from electric power consumption to gross domestic products are similar to Wahid, Aziz and Mustapha (2013), while the findings for unidirectional causality from carbon emission and electric power consumption to gross domestic products are similar to Ang (2008). The finding of unidirectional causality run from urban population to emission of carbon is similar to York, Rosa and Dietz (2003).

Table 3

Test Results of Granger Causality

	Source of Causation (F-statistics)				
Dependent Variables	LNC	LNUP	LNGDPPC	LNI	LNEC
LNC	-	2.315 (0.113)	0.488 (0.618)	0.361 (0.700)	2.665 (0.083)
LNUP	5.177 (0.011)	-	0.060 (0.942)	0.326 (0.724)	1.155 (0.327)
LNGDPPC	2.716 (0.080)	3.983 (0.027)	-	2.916 (0.067)	3.500 (0.041)
LNI	0.138 (0.872)	1.795 (0.181)	0.011 (0.895)	-	0.149 (0.862)
LNEC	6.736 (0.003)	4.410 (0.019)	1.147 (0.329)	0.188 (0.829)	-

Notes: Values in brackets are probability values (p-values).

Results of the regression analysis are obtained as follows:

$$\ln C = 3.277 + 0.625 \ln Up - 0.020 \ln GDPP - 0.338 \ln I + 0.940 \ln EC \quad (3)$$

$$(1.802) \quad (0.848) \quad (0.075) \quad (0.232) \quad (0.236)^{***}$$

$R^2=0.987$ Adj $R^2=0.986$ $F=747.274^{***}$

*** 1% level of significance.

Variable lnEC is significant, and electric power consumption results in carbon emission, which is similar to the findings of Mugableh (2013).

Discussion

Besides, electric power consumption and urban population also give a positive, though insignificant, effect on carbon emission. On the other hand, gross domestic products and industrialisation have a negative, though insignificant, effect on carbon emission. The increase of electric power consumption adds pressure to the environment.

Conclusions

Negative signs for variables gross domestic products and industrialisation may indicate that the faster the economic growth rate and the faster it climbs up the value chain to high-technology industrial development, the less carbon emission will be. The regression result indicates prediction of the emission of carbon using the rate of electric power consumption.

Recommendations

Transformation in Malaysia to a sustainable low carbon economy requires the efforts of the government, business and individual residents jointly. As electrical power consumption is a significant contributor to carbon emission, the Government of Malaysia should accelerate the adoption of renewable energy. Compared with ASEAN4 neighbouring countries, Malaysia’s target of 17% RE in 2030 is less than half of the 35% target of the Philippines in the same year. Similarly, Malaysia's target of 11% RE in 2020 is less than the 19% target of Indonesia in 2019 and even less than the 25% target of Thailand in 2021. Although Malaysia has enforced Efficient Management of Electrical Energy Regulations 2008, the Government should intensify efforts to encourage green technology innovation and improve energy efficiency. Businesses and individual residents should also consider the acquisition of properties accredited with Green Building Index (GBI), which was designed specifically for the tropical climate (hot and humid) and Malaysia's current social, infrastructure and economic developments. There should be a public transportation policy in urban centres to improve environmental quality.

Limitation

Nevertheless, there is a limitation to this study. The results should be taken with a data restriction. Future studies will study a longer period, involving other variables such as trade openness. Previously, 34 per cent of the public transport modal share was recorded in 1985. Since then, one of the government's industrial policies was to develop a national automotive industry that indirectly encouraged the ownership of private vehicles. It is anticipated that the implementation of National Automotive Policy (NAP) 2014 which embraces energy efficient vehicle (EEV) and National Land Public Transport Master Plan helps to make public transportation "cool" again with the target of 40 per cent modal share. On the other hand, stronger government's encouragement in terms of legislation is required besides the industry initiatives such as green building indexed. However, the fundamental aim is that environmental awareness of the public still can be enhanced for wider acceptance of the green economy development initiatives.

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