CO2 EMISSIONS - GDP NEXUS:
EVIDENCE FROM FIVE ASEAN COUNTRIES

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ABSTRAK

PENCEMARAN CO2 - GDP KAITAN: BUKTI DARI LIMA NEGARA ASEAN

Kajian ini bertujuan untuk mengkaji hubungan sebab akibat antara pelepasan karbon dioksida dan Keluaran Dalam Negeri Kasar per kapita (KDNK).Data Panel telah digunakan dari tempoh 1980 hingga 2010.Akibat antara pelepasan Karbon Dioksida per kilo tan (CO2) dan Keluaran Dalam Negeri Kasar per kapita (KDNK) telah diperiksa menggunakan silang set data panel negara pemerhatian setiap tahun meliputi 5 negara-negara ASEAN. Ujian ini dilakukan dengan menggunakan panel ujian unit root, panel ujian cointegrasi, panel vektor pembetulan ralat anggaran dan panel ujian Granger kesebaban untuk mengakses hubungan antara pembolehubah masing-masing. Semua pembolehubah yang didapati berkointegrasi menunjukkan kewujudan hubungan jangka panjang. Di samping itu, hubungan satu arah didapati daripada keluaran dalam negara kasar kepada pelepasan karbon dioksida. Keputusan kajian ini sangat berguna untuk pembuatan dasar dengan melaksanakan pendekatan tenaga mampan untuk mengawal pelepasan dan untuk mengurangkan kesan rumah hijau.

ABSTRACT

This research attempts to examine the causal relationship between carbon dioxide emission and Gross Domestics Product. Panel data were utilized from the period of 1980 to 2010.The nature of causality between Carbon Dioxide emission per kilo tan (CO_2) and Gross Domestic Product per capita (GDP) has been examined using a cross country panel data set of yearly observations covering 5 ASEAN countries. The test was carried out using panel unit root tests, panel cointegration test, panel vector error correction estimation and panel Granger causality tests to access the relationship between the respective variables. All the variables are found to be cointegrated thus indicating the existence of long-run relationship. In addition, unidirectional relationship was found from gross domestic product to carbon dioxide emission. This result would be useful for policy-making by implementing the sustainable energy approach to control the emission and to reduce a green-house effect.

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INTRODUCTION

1.0 Background of the Study

Over the past two decades, the world facing the issue of climate change and this becomes one of the major environmental challenges. Carbon dioxide emission is considered one of the principal causes of global warming and climatic instability. In order to investigate the climate change concern, this research examines the co-integration and causal relationship of the two variables of carbon dioxide emissions (CO2) and gross domestic product (GDP) in five selected Association of Southeast Asian Nations (ASEAN-5) namely Malaysia, Indonesia, Philippines, Singapore and Thailand. This research investigates the linkages of these variables by taking 20 years panel data from the year 1980 to 2010.

This research aims to discover the linkages of CO2 emissions and GDP as these variables are connected in contributing towards global warming and climate change. This issue has been discussed frequently and become a bigger concern globally. The research specifically focuses on ASEAN-5 countries only as these countries share similarity in the level of economic development since 1980 that coincided with significant increase in fossil fuel usage. According to Chandran & Tang (2013), ASEAN-5 has a healthy and progressed economic growth compared to the other five ASEAN member countries. One of the challenges for ASEAN-5 is to achieve an economic growth and manage CO2 emissions into the environment by utilising energy efficiency.

ASEAN originally consists of five original members which is known as ASEAN-5 and was first officially formed in the year 1967 in Bangkok, Thailand. Further on Vietnam, Myanmar, Laos, Brunei and Cambodia joined the ASEAN-5 members and making a group of 10. ASEAN in a short form stand for Association of Southeast Asian Nation and consist almost all of the Southeast Asian countries. One of the main objectives of the association are towards harmony and stability of the members countries and contributes a integration and collaboration in energy management, as taken from Balce, G.R.(2001).

ASEAN region lies within the waters of the Pacific Ocean, Indian Ocean, Andaman Sea and South China Sea. ASEAN borders from India and Bangladesh to the northwest, from China to the north and to the southeast of Papua New Guinea. ASEAN is surrounded majority by seas and gulfs as the Andaman Sea, South China Sea and the Gulf of Thailand. Geographically ASEAN land has a long coastline. ASEAN enjoys a humid and warm climate throughout the year according to Letchumanan (2008).

In ASEAN, from the period of 1980 to 1999, its economy grew by nearly 5 percent a year and energy consumption by 7.5 percent. The economy is expected to continue to grow at this rate over the period from 2000 to 2020, and it is estimated that annual energy supply must increase by 4.2 percent a year to sustain this growth, Balce, G.R.(2001). As energy consumption is needed to maintain the growth, CO2 emissions are expected to grow over the years to be in line with the aspiration in achieving an economic growth.

As stipulated by Karki, Mann, & Salehfar (2005), the economy in ASEAN is linked with its diverse energy resources, high-level urbanization and rapid industrialization. ASEAN's growing economy in the last two decades has increased the concern of sustainable development in the face of deteriorating energy security,

environmental pollution and economic hardship in energy investments. ASEAN-5, namely Malaysia, Indonesia, Singapore, Philippines and Thailand have progressed economically well compared to other members of ASEAN. Among the ASEAN countries (excluding Brunei), in terms of per capita income in 2008, Singapore (USD 39,991) ranked the highest followed by Malaysia (USD 8032), Thailand (USD 4103), Indonesia (USD 2245) and the Philippines (USD 1840). The average GDP growth of ASEAN-5, between 2004 and 2009, was 5.9% with Singapore and Indonesia recording over 5% growth rates. The rapid growth of the ASEAN-5, specifically for Singapore and Malaysia compared to the rest, poses an interesting question among policymakers. The level of economic growth is expected to grow further and in line with that, CO2 emissions are expected to increase due to extensive energy use. It is essential to heavily investigate the relationship between CO2 and GDP in ASEAN in order to make preventive actions before it is too late; avoiding the dilemma like what is happening in China.

Furthermore, according to ACE (2002), ASEAN makes up one of the largest regional markets in the world; contributing a combined gross domestic product (GDP) of US$578 billion in 2000. The region hosts approximately US$53 billion in direct US investments, and it is the third largest overseas market for US exports with two-way ASEAN–US trade totalling up to US$120 billion in 2001. The rapid economic growth for ASEAN can be seen as in 2011, ASEAN GDP per capita per US dollar was US$3,601 billion, which is equivalent to 67% of China and 7% of United State GDP. The data was taken from ASEAN economic chart book, 2012.

1.1 History of C02 Emissions in ASEAN

ASEAN consists of ten countries and each country has a unique level of energy demand, energy resource endowments and levels of access to modern energy services. Over the past four decades the demand for energy in the region has continuously increased. The demand drive comes together with economic growth, urbanisation and industrialization. The massive development of economic growth has contributed to

global warming. Taken from WRI (2011), 60% of CO2 emissions in ASEAN come from fossil-fuel combustion.

According to Sandu, Sharma, & Vaiyavuth (2009), the historical development in CO2 emissions for ASEAN countries over the period of 1971 to 2009, have shown that: (1) population growth and increased levels of affluence are the largest contributors to emissions growth in most countries; (2) fossil fuels have increasingly become the major fuel source in the region despite recent global environmental pressures – reversing this trend will be a challenging task; (3) production structures for most countries have become increasingly concentrated towards energy-intensive industrial sector; (4) the region has achieved energy efficiency gains at both end-use and conversion levels – in fact, this is the only factor that has led to reduced emissions; and (5) the effect of changes in carbon intensity of primary energy was only negligible and no meaningful trend can be observed. As fossil fuel is one of the major CO2 contributors in the air, it is relevant to reinvestigate whether the CO2 emissions have a causality effect to GDP and how these two variables react with each other. This research will answer the relationship interplay between CO2 emissions and GDP.

A large growth in energy consumption in the region which is equivalent to 0.9 tonnes of oil is very worrying. However, this range it is still considerably lower if we compare to the developed world average. At the moment, although the population growth in ASEAN is increasing the demand for more energy, it is not considered a major problem because 30% of the population in the region still do not have access to electricity IEA (2009). However, with continuous increase in the population of up to 30% by the year 2050 UN (2011) and coupled with ever increasing urbanisation and industrialisation, the energy demand is expected to increase substantially unless there are fundamental changes in the patterns of economic production and fuel-mix. The implication from this makes greenhouse-gas emissions became higher and continue to grow significantly in the years to come. For example, according to IEA (2009), the region's share of global emissions could reach 5% in 2030.

An important detail to be considered before starting the study on the relationship of CO2 and GDP is that the relationship and effects varies from one country to another depending on the level of social, economic as well as political developments. As such, in this research, ASEAN-5 pooled together the countries sharing similarities in terms of economic growth as well as social and political development. This section will discuss further the history of CO2 emissions through the perspective of ASEAN-5. This current research focuses only on CO2 emission because this emission is the most frequently listed in the Intergovernmental Panel on Climate Change (revised in 1996) and has the most effect to climate changes according to world-nuclear (2014). Latest updates revealed that 72% of the total emitted greenhouse gases are carbon dioxide (CO2), 18% Methane and 9% Nitrous oxide (NOx). CO2 is inevitably created by burning fuels e.g. oil, natural gas, diesel, organic-diesel, petrol, organic-petrol, ethanol. The emissions of CO2 have gradually increased within the last 50 years and are still increasing by almost 3% each year.

According to Luukkanen & Kaivo-oja (2002), the general observation on the basis of decomposition analyses have provided that the development of energy sectors in ASEAN countries is, to an increasing extent, based on fossil energy use. Decomposition analyses quantify the contribution of each group of energy use to the aggregate index. This type of development is mainly due to the fact that the ASEAN countries are industrializing economies, and follows the Western pattern of development. This summarizes each country's responsibilities and that participation of the developing countries in emission reduction is central; nonetheless, the ASEAN countries economic constraints can deplete the environmental concerns.

Increasing energy demand in ASEAN is mainly driven by a rapid level of urbanization and industrialization. ASEAN region has one of the fastest urbanization trends in the world. It is predicted that, by the year 2025, more than 50 percent of the ASEAN population will reside in urban areas, as compared with 39 percent in 2000. Moreover, rapid economic growth with export oriented industrialization has caused

increasing environmental degradation and excessive depletion of natural resources by Elliot (2000).

1.1.1 History of CO2 in Malaysia

Malaysia experienced rapid economic growth within the past five decades. From the year 1961 to 1997 (before the financial crisis), Malaysia's economic growth increased by an annual average growth rate of 7.26% and from the year 1999 to 2008 (before the Asian financial crisis), Malaysia experienced 5.55% increase in its annual average growth rate. Malaysia is categorized as a high-income developing country in Southeast Asia. From statistics, the energy consumption in Malaysia increased by an average annual growth rate of 6.76% in 2010 to settle at 72,646 kilo tonne of oil equivalent (ktoe) from 6,093 ktoe in 1971 (World Bank, World Development Indicator).

Chik, Rahim, & Studies (2012) concluded that of the CO2 emissions intensity in the energy sector, electricity has contributed the highest CO2 emission; while in the non-energy sector, transportation has contributed the highest CO2 emission in 2005. Malaysia's initiative to combat the environmental issue based on energy use is by limiting and minimizing new energy intensive sectors but will promote energy efficient and high production industries.

According to Tang (2008), Malaysia's electricity consumption is the second highest among the five ASEAN founding nation's economies. The electricity consumption per capita has been growing continuously since 1971 and this may be one of the important factors that led to Malaysia's economic growth. The high electricity consumption is as expected due to the rapid development of information and communication technologies (ICTs) and other infrastructures that consume high power electricity in Malaysia. Electricity is a vital input of power for the economic growth and development of Malaysia parallel with the country's vision to become a developed

country by the year 2020.

Saboori, Sulaiman, & Mohd (2012) said that Malaysia has experienced rapid transformation from an agriculture based economy to industrialization, with a significant rise in pollutant emissions, specifically CO2 emissions. In 2007, CO2 emissions in Malaysia were at 7.32 metric tons per capita, while the world average was only 4.63 metric tons. Thus, it is proven that real GDP per capita and per capita CO2 emissions move closely together over time, implying a co-integrating relationship between them. Econometric testing has been applied in my research to evidence the existence of the relationship. Therefore, investigating the co-integration and causality issues between these two variables is justifiable.

1.1.2 History of CO2 emissions in Philippines

Philippines is an archipelago located in Southeast Asia and as a country that is full of islands and a sensitive eco-system, Philippines is not excluded from the effects of global warming. Even slight changes in the environment can cause big environmental harm in Philippines. In 1994, 10,603 kilotons of CO2 were released from the industry sector. A major fraction (86%) of the industrial CO2 emissions comes from cement and metal industries. The emissions come directly from industrial processes. The greenhouse gas emissions in the energy sector consist largely of CO2, which comes mostly from fuel combustion as stipulated by Bureau & Resources (2004).

Fabian (2009) reported that the impacts of climate change and local air pollution problems will continue to plague the Philippines. The problem can be slowly eliminated if a new program for land-use and transportation planning is implemented. Transportation sector plays a main role in Philippines economic development. Philippines and its cities are often cited as the "engines" of growth of the country. In 2008 CO2 emission and particulate matter (PM) emissions in the Philippines have

shown totalled of 30 million tons, whereas 56 thousand tons for particulate matter. In 2000 CO2 emissions from the transport sector contributed for 38 per cent of the total fuel combustion. If the economic scenario prevails, the numbers of motorized vehicles are expected to be doubled before the year 2020.

According to Bhattacharya (2000), one of the sources of indoor air pollution in ASEAN comes from improper burning of biomass and coal. For example in Philippines household sector contributes 90% of biomass combustion which came from improper and inefficient cook stoves. In 1995, CO2 was emitted from fossil fuel and biomass combustion for 50.2Mt and 29.1Mt. Low efficiency and high emission from the cook stoves generates high CO2 emissions. Besides the heat from the burning wasted, the emissions are also contributed from improper designed chimneys that lead to more serious indoor air pollution.

1.1.3 History of CO2 emissions in Singapore

Referring to Kluver and Weber (2003), Singapore is an island and was separated from the newly formed Republic of Malaysia since 1965.The separation is the strategy in order to keep communism at arm's length. From the past decade of the twentieth century, Singapore has done very well and rise from port centre to a global city and becoming a developed nation country.Top three energy consumptions for Singapore are electricity generation, industry and road transport. However, it is difficult for electricity generation and industries to reduce significantly without affecting the economy. The number of passenger car population reached 392,961 in 2000 and has increased to 617,570 in 2012, which contributed a 57% growth within a 12-year span Land Transport Authority (2013). Passenger car population forms 64% of the total vehicle population, with an average annual mileage of 19,000 km in 2011 taken from Land Transport Authority (2012).

Tan, F., Lean, H.H, & Khan, H. (2014) indicated a significant rise in CO2 emissions as GDP rose. Another study on a possible turning point showed that continuous growth will be necessary for a long time before we experience any trickle-down effects on environmental pollution. The results of causality analysis concluded that CO2 emissions indeed have caused a decline in Singapore's growth. It is therefore argued that strict regulatory regimes on environmental protection in the city–state must remain enforced. Tan et al. (2014) also indicated a significant rise in CO2 emissions as GDP rose over the years, thus confirming a short-run trade-off between environment and growth.

Furthermore, according to Tan et al. (2014), with the absence of any significant agricultural land or landfill sites, Singapore has no problems with methane gases. CO2 is the primary greenhouse gas emitted in the city-state and produced by the use of fossil fuels for power generation. Singapore's CO2 is produced by industry (54%), transportation (19%), buildings (16%) and consumer households (9%). CO2 emissions in Singapore rose from an average 5.26 million tonnes per capita between 1970s and 1980s, to 10.29 million tonnes per capita in the mid-1990s; stabilizing at an average 10.19 million tonnes per capita for the period of 1995 to 2008.

Compared with total global emissions, CO2 emissions in Singapore have accounted for less than 0.2% although Singapore's contribution has increased from an average of 0.07% between 1970s and 1980s to 0.17% in 1991 to 2008. For instance, Singapore has been considered a high emitter of greenhouse gases. The Energy Information Administration (EIA), which provides energy statistics to the United States government, indicated in its 2006 data that Singapore emitted 141 million tonnes of CO2. The EIA ranked Singapore as the 33rd highest emitter of greenhouse gases among 215 countries.

In another study, Bradshaw, Giam (2010) indicated that among 179 countries in terms of proportional environmental impact Singapore was ranked the worst environmental offender. Singapore's poor ranking is attributed to its massive economic development and urbanization that has led to high proportional natural forest loss and greater release of CO2.

1.1.4 History of CO2 emissions in Thailand

Thailand consists of approximately 65 million people in population and the world's largest exporter of rice and often called "the rice bowl of Asia". The majority of the people in Thailand live in rural or agriculture areas whereby agriculture employs 49% of the population and contributes 10% towards GDP. Tourism and fisheries play important roles in the economy, providing 6% of GDP and a livelihood to 10% of the population. Capital city of Thailand is Bangkok, giving it the status of global city where the home to 15% of the country's population and serves as the economic, political and social centre. Climate changes affect three important sectors of Thailand's economy inclusive of agriculture, tourism and trade.

According to Phdungsilp & Wuttipornpun (2013), Thailand is heavily dependent on imported fossil fuels and the utilization of energy resources is the main source of CO2 emissions. It is essential for Thailand to restructure its current energy system for the realization of low-carbon futures. An efficient and rational implementation of low emission reduction policies and strategies require the application of energy system models that have the ability to estimate the baseline energy demand and CO2 emissions, and to explore technical and economic effects of different strategies over time.

The three-wheeled passenger vehicles called TUTU and two-stroke motorcycles are mainly responsible for excessive air pollution in the city areas. Total suspended