CAUSALITY BETWEEN ENERGY CONSUMPTION, GROSS DOMESTIC PRODUCT, CARBON DIOXIDE EMISSIONS AND EMPLOYMENT IN INDONESIA, MALAYSIA AND THAILAND

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ABSTRACT

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By

Wong Siew Wei

This study examines the causality between energy consumption, gross domestic product, carbon dioxide emissions and employment in Indonesia, Malaysia and Thailand over the period 1980 to 2008. The Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Tests, Johansen and Juselius Cointegration Test, Normalized Equation, Error Correction Model and the Wald Test are conducted in this study. The result shows that there is a long run relationship among the variables. Besides, there is no causality relationship from gross domestic product to energy consumption in those three countries that have been studied. However, there is unidirectional causality from carbon dioxide emissions to energy consumption and no causality relationship between employment to energy consumption in Indonesia and Malaysia. Meanwhile, there is unidirectional causality from employment and carbon dioxide emissions to energy consumption in Thailand.

ABSTRAK

KAUSALITAS ANTARA PENGGUNAAN TENAGA, KELUARAN DALAM NEGARA KASAR, PENGELUARAN KARBON DIOKSIDA DAN GUNA TENAGA DI INDONESIA, MALAYSIA DAN THAILAND

Oleh

Wong Siew Wei

Kajian ini dijalankan untuk mengkaji kausalitas antara penggunaan tenaga, keluaran dalam negara kasar, pengeluaran karbon dioksida dan guna tenaga di Indonesia, Malaysia dan Thailand dalam tempoh 1980 hingga 2008. Ujian kepegunan *Augmented Dickey-Fuller* (ADF), *Phillips-Perron* (PP) dan *Kwiatkowski-Phillips-Schmidt-Shin* (KPSS), ujian Kopengamiran Pembolehubah *Johansen and Juselius*, *Normalized Equation*, *Error Correction Model* dan ujian *Wald* akan diaplikasikan dalam kajian ini. Hasil kajian ini, ujian kointegrasi telah menunjukkan bahawa penggunaan tenaga, keluaran dalam negara kasar, pengeluaran karbon dioksida dan guna tenaga mempunyai hubungan jangka panjang. Selain itu, tiada kausalitas dari keluaran dalam negara kasar ke penggunaan tenaga dalam ketiga-tiga buah negara tersebut. Walau bagaimanapun, terdapat hubungan sehala dari pengeluaran karbon dioksida ke penggunaan tenaga dan tiada hubungan kausalitas dari guna tenaga ke penggunaan tenaga di negara Indonesia dan Malaysia. Sementara itu, terdapat hubungan sehala dari pengeluaran karbon dioksida dan guna tenaga ke penggunaan tenaga di negara Thailand.

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CHAPTER ONE

INTRODUCTION

1.0 Overall introduction

Energy plays an important role in the economic development and it is also an important element factor both demand and supply of the economy. According to Chontanawat *et al.* (2006), energy on demand side is one of the products of a consumer who decides to buy in order to maximize their utility. As on the supply side, energy is a key of factor of production, economic growth, development other than capital, labor and materials.

Energy is also an important element in the socio-economic development which can help to improve the standard of living of the people through the increase in economic growth. There are four types of user which is transportation, industry, residential and commercial can identified it into sectors of the economy. According to U.S. Energy Information Administration, Annual Energy Review 2009, industrial sector has the highest share of energy consumed which is 30 percent follow by transportation, residential and commercial which is 29 percent, 22 percent and 19 percent.

Besides, energy has a significant relationship with macroeconomic indicators. The relationship between energy consumption, economic growth, carbon dioxide emissions and employment is the most widely investigated in the economy literature.

For example, Ozturk and Acaravci (2010) examined the long run and causal relationship between economic growth, carbon emissions, energy consumption and employment ratio in Turkey. However, there are many different results that had been done by researchers. Whether energy consumption aroused the economic activities, the economists and policy analysts have motivated curiosity and interest to investigate the direction of causality between energy consumption and economic variables (Chebbi, 2009a).

Before going further into this study, there is the need to understand the fundamental understanding about what is the background of energy in Indonesia, Malaysia and Thailand and also the trend for the macroeconomic indicators such as energy consumption, gross domestic product, carbon emissions and employment in the countries.

1.1 Background of Energy in Indonesia, Malaysia and Thailand

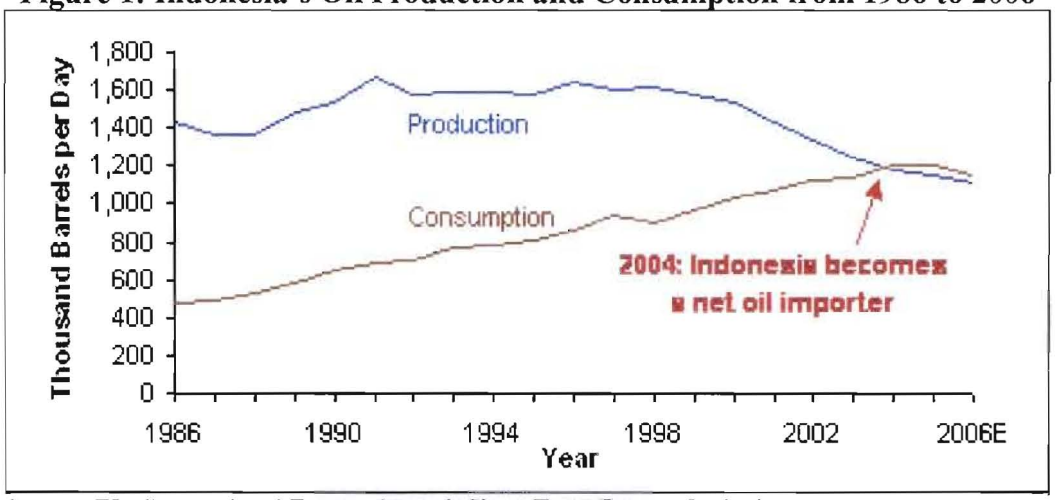
1.1.1 Indonesia

Indonesia is the only Southeast Asian member joined the Organization of the Petroleum Exporting Countries (OPEC) in 1962 and became a net oil importer in 2004 (EIA, 2007). According to International Financial Statistics (IFS), Indonesia's Gross Domestic Product (GDP) increased from RM3, 949, 320 in 2007 to RM4, 954, 030 in 2008. Employment in Indonesia also increased 2.625 percent to 102.6 thousands in 2008. According to Statistical Review of World Energy June 2010,

primary energy consumption increase from 119.4 million tons oil equivalent in 2007 to 124.7 million tons oil equivalent in 2008. The carbon dioxide (CO_2) emissions also show it is increasing from 363.8 million tons carbon dioxide in 2007 to 379.9 million tons carbon dioxide in 2008. From the statistic above, we can say that those variables are related to each others. For example, primary energy consumption increase will lead to the increase of CO_2 emissions, primary energy consumption increase will lead to the increase of employment and other connections as well.

1.1.1.1 Oil

Figure 1: Indonesia's Oil Production and Consumption from 1986 to 2006

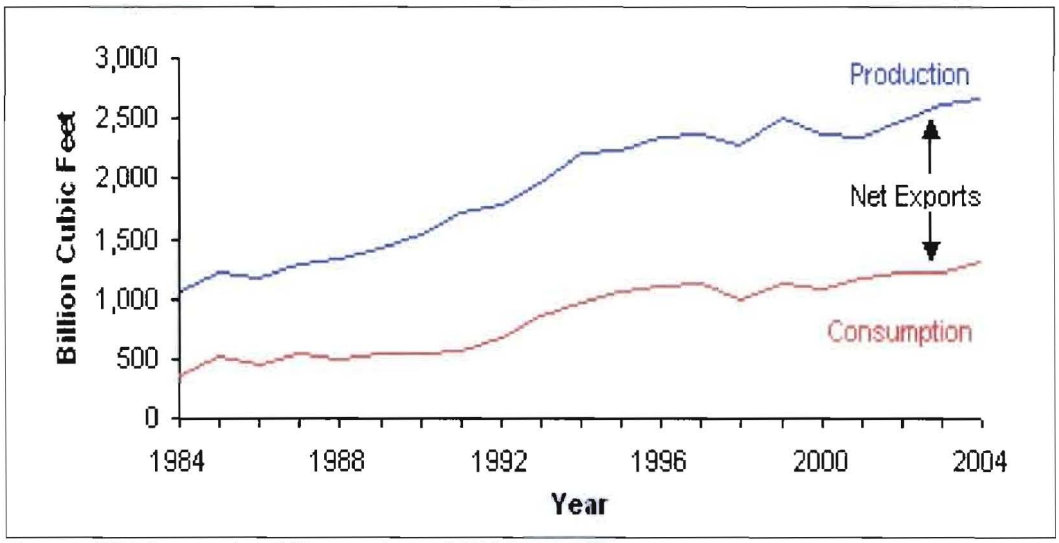


Source: EIA International Energy Annual, Short-Term Energy Outlook.

Figure 1 shows Indonesia's oil production and consumption from 1986 to 2006. Oil production for Indonesia during 2001 to 2006 is decreasing from 1, 389 barrels per day (bbl/d) to 1, 017 bbl/d whereas oil consumption for Indonesia increased from 1, 162 bbl/d in 2001 to 1, 252 bbl/d in 2006. Both oil production and consumption meet at year 2004 where Indonesia became a net oil importer (EIA, 2007).

1.1.1.2 Natural Gas

Figure 2: Indonesia's Natural Gas Production and Consumption from 1984 to 2004

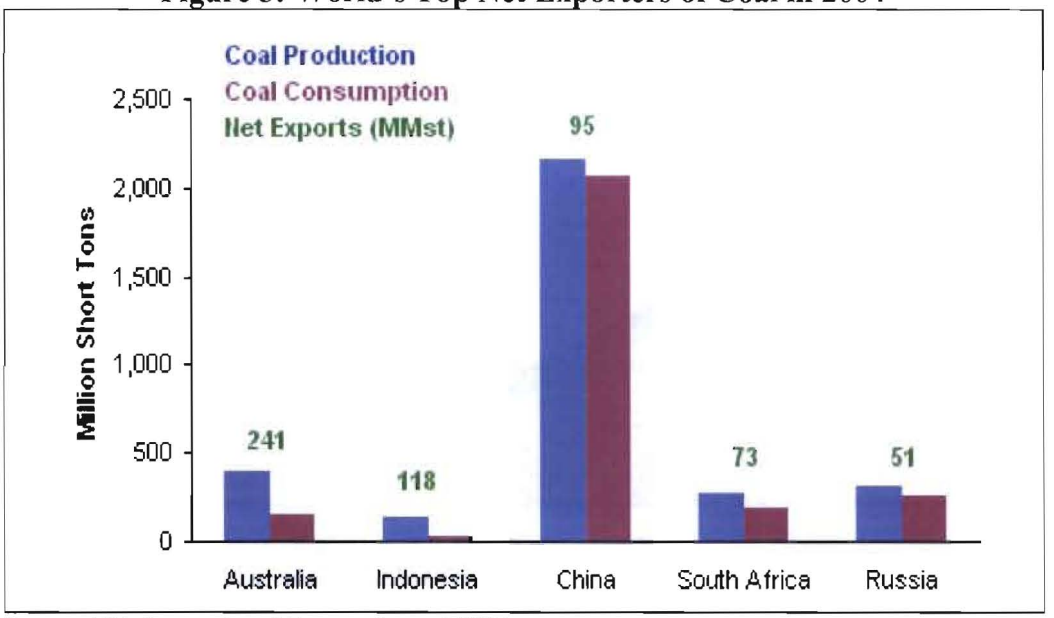


Source: EIA International Energy Annual 2004.

Figure 2 shows Indonesia's natural gas production and consumption from 1984 to 2004. Indonesia is a leading liquefied natural gas (LNG) exporter and was the world's largest exporter of LNG. In 2004, Indonesia produced 2.6 trillion cubic feet (Tcf) of natural gas while consuming 1.3 Tcf. Indonesia also had exported about 1.2 Tcf of LNG to Japan, South Korea, and Taiwan in 2004. About 68 percent of Indonesia's LNG exports to Japan, 19 percent to South Korea and the remainder are to Taiwan (EIA, 2007).

1.1.1.3 Coal

Figure 3: World's Top Net Exporters of Coal in 2004

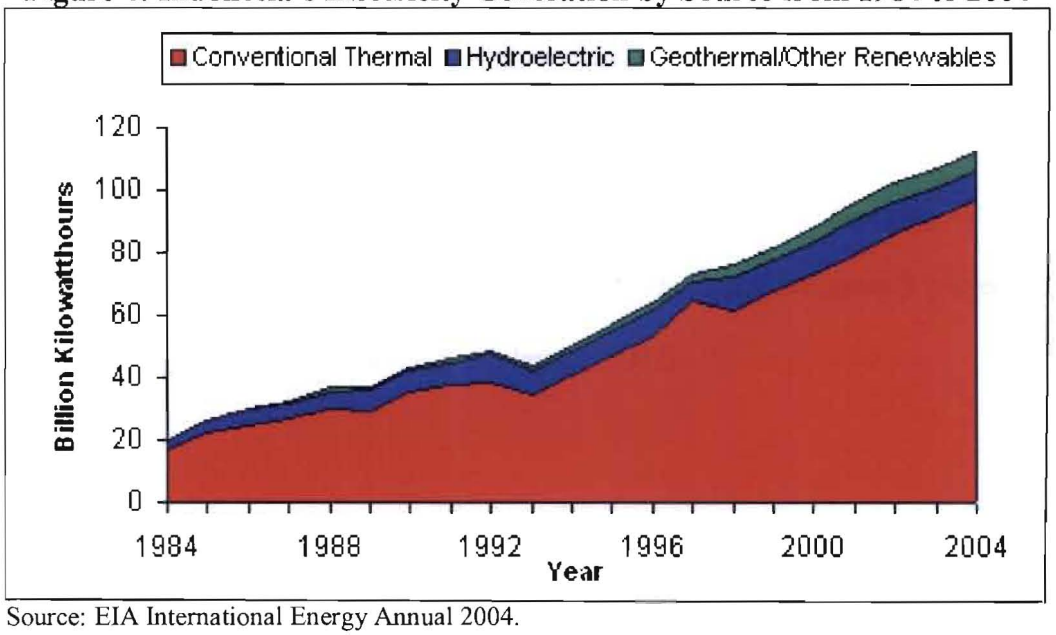


Source: EIA International Energy Annual 2004.

Figure above shows the world's top net exporter of coal in 2004. In 2004, Indonesia produced 142 million short tons (MMst) of coal, up about 68 percent since 2000. Coal consumption has remained relatively flat in Indonesia, with 2004 consumption at 24 MMst. According to EIA statistics, Indonesia was the second largest net exporter of coal in the world in 2004, with 118 MMst of apparent net exports (EIA, 2007).

1.1.1.4 Electricity

Figure 4: Indonesia's Electricity Generation by Source from 1984 to 2004



Source: EIA International Energy Annual 2004.

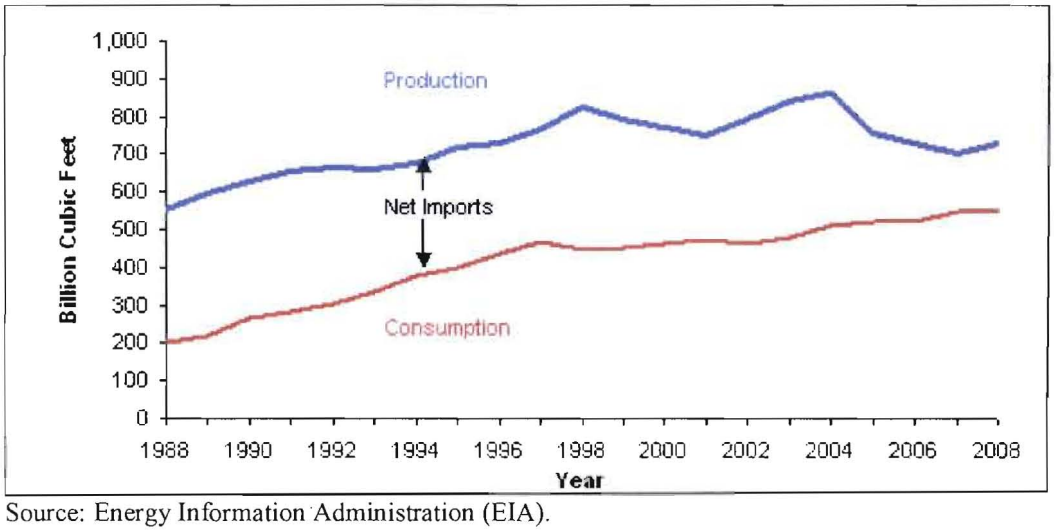
Figure 4 shows Indonesia's electricity generation by source from 1984 to 2004. In 2004, Indonesia had 25 gigawatts (GW) of installed electricity generating capacity. During 2004, Indonesia generated 112.6 billion kilowatthours (Bkwh) of electricity, where 86 percent came from conventional thermal sources which include oil, natural gas, and coal, 8 percent from hydroelectric sources, and 5 percent from geothermal and other renewable sources. In 2004, Indonesia consumed 104.7 Bkwh of electric power, showing it is a net electricity exports (EIA, 2007).

1.1.2 Malaysia

Malaysia is a significant net exporter of oil and the second largest exporter of LNG in the world. Malaysia's western coast runs alongside the Strait of Malacca, an important route for seaborne energy trade that links the Indian and Pacific Oceans (EIA, 2009). GDP growth in 2007 is projected at 6 percent and the Malaysian economy is expected to expand faster in 2008 with the real GDP growth projected at between 6 and 6.5 percent (The Edge Malaysia, 2007).

1.1.2.1 Oil

Figure 5: Malaysia's Oil Production and Consumption from 1988 to 2008



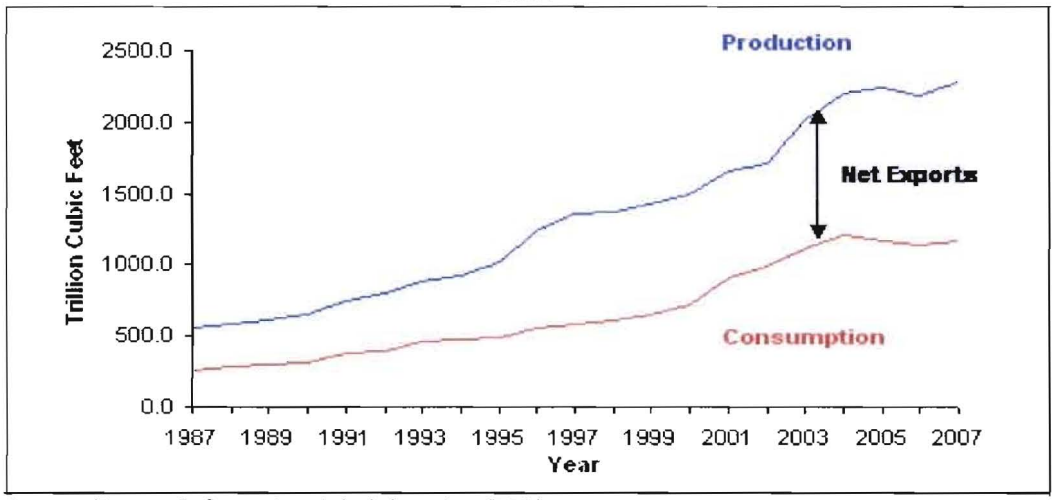
Source: Energy Information Administration (EIA).

Malaysia's oil reserves are the third highest in the Asia-Pacific region (EIA, 2009). Figure above shows Malaysia's oil production and consumption from 1988 to 2008. Malaysia's oil production trend is up and down not consistently. The oil consumption is increasing from 1988 to 1997 (209.7 bbl/d to 430.7 bbl/d) and decrease to 403.5 bbl/d in 1998 due to the Asian financial crisis. It continues to

increase again from 1999 to 2004 (434.8 bbl/d to 485.1 bbl/d). Compare to 2004, the oil consumption is decreasing in 2008 to 468.1 bbl/d. The oil production in 2008 was 768, 000 bbl/d. During 2008, Malaysia consumed at 475, 600 bbl/d, and the net exports are 292, 400 bbl/d.

1.1.2.2 Natural Gas

Figure 6: Malaysian Natural Gas Production and Consumption from 1987 to 2007



Source: Energy Information Administration (EIA).

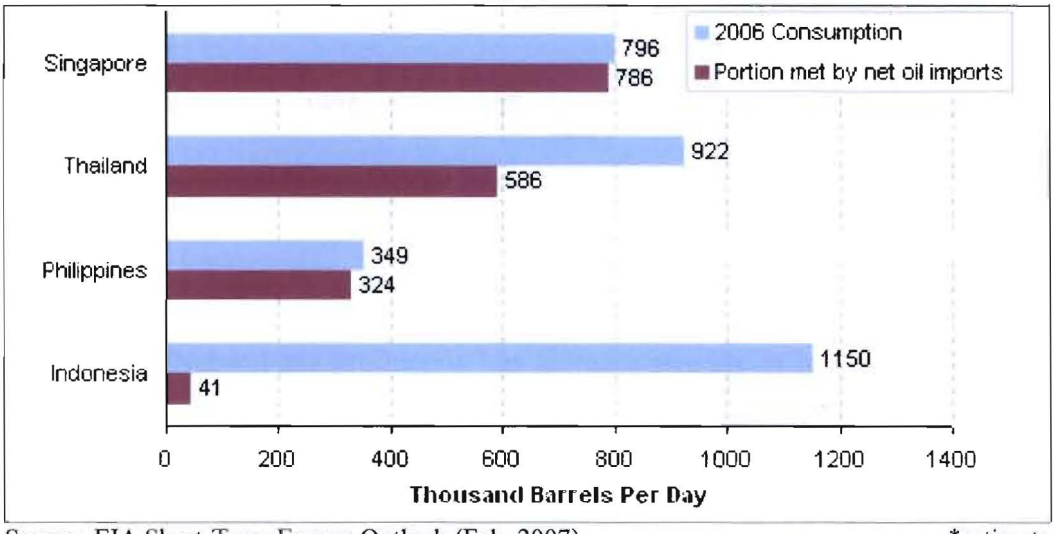
Figure 6 shows Malaysian natural gas production and consumption from 1987 to 2007. Malaysia is the world's eighth largest holder of natural gas reserves and was the second largest exporter of LNG in 2007 exporting over 1 Tcf of LNG, which accounted for 13 percent of total world LNG exports. It exports mostly to Japan, South Korea, and Taiwan. Natural gas production has been rising steadily, reaching 2.3 Tcf in 2007, while domestic natural gas consumption has also increased steadily, reaching 1.2 Tcf in 2007 (EIA, 2009).

1.1.3 Thailand

Thailand is a net importer of oil and natural gas although the country is a growing producer of natural gas. During 2006, Thailand's real gross domestic product (RGDP) grew by an estimated 5.0 percent, exactly on trend with average 5 years growth levels which is the ninth national development and social development plan (2001 to 2006) (EIA, 2007).

1.1.3.1 Oil

Figure 7: Selected Southeast Asia Oil Consumption and Net Oil Imports in 2006*



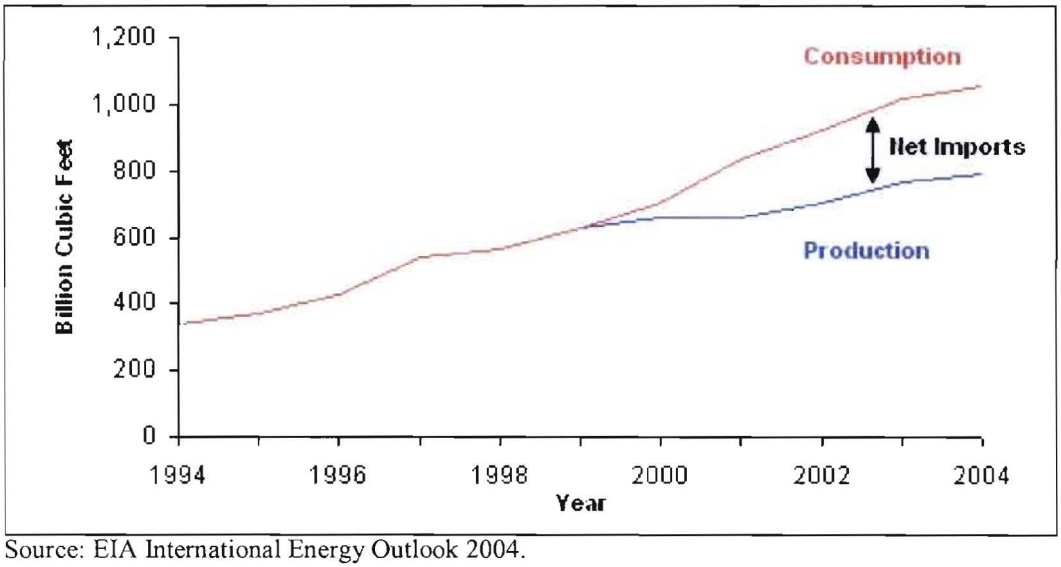
Source: EIA Short-Term Energy Outlook (Feb. 2007). *estimate

Thailand is the second largest net oil importer in Southeast Asia behind Singapore. In 2006, Thailand produced an estimated 336, 000 bbl/d of total oil liquids, of which 130, 000 bbl/d was crude oil, 76, 000 bbl/d was lease condensate, and 111, 000 bbl/d was natural gas liquids, and the remainder was refinery gain. Thailand consumed an estimated 922, 000 bbl/d of oil in 2006, leaving net imports

of 586, 000 bbl/d and an estimated of 586, 000 bbl/d for an oil production (EIA, 2007).

1.1.3.2 Natural Gas

Figure 8: Thailand's Natural Gas Production and Consumption from 1994 to 2004

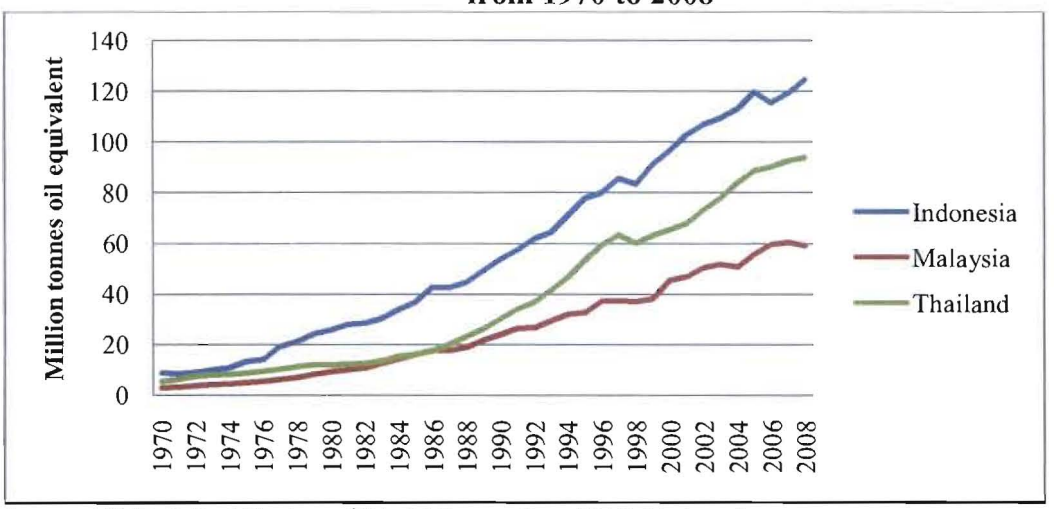


Source: EIA International Energy Outlook 2004.

Figure 8 shows Thailand's natural gas production and consumption from 1994 to 2004. Natural gas production has increase steadily in recent years although not enough to keep up with the growth in domestic consumption. Thailand produced 790 billion cubic feet (Bcf) of natural gas in 2004, while consuming 1, 055 Bcf. The country showed net natural gas imports of 265 Bcf in 2004, which consisted mostly of piped imports from Burma (EIA, 2007).

1.2 Trends of Primary Energy Consumption in Indonesia, Malaysia and Thailand

Figure 9: Primary Energy Consumption in Indonesia, Malaysia and Thailand from 1970 to 2008



Source: BP Statistical Review of World Energy June 2010, Various Issues.

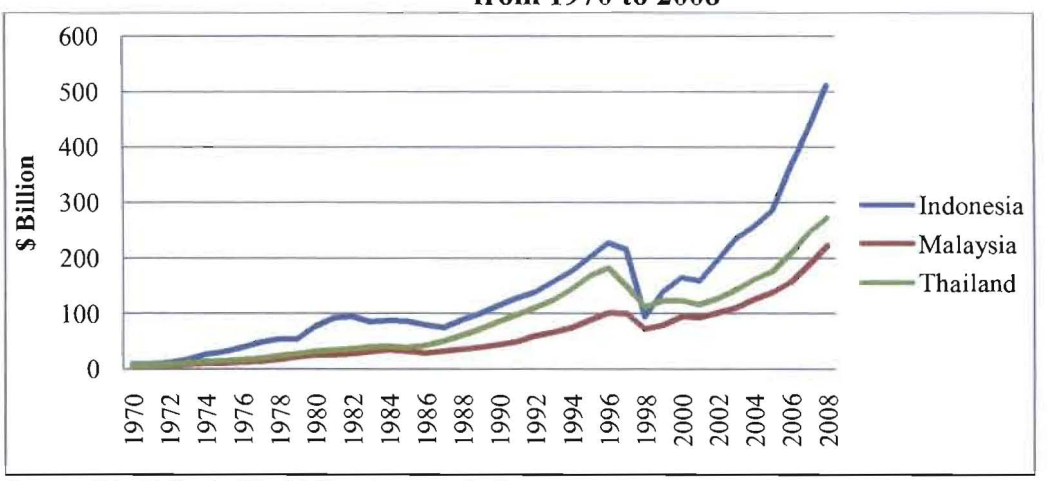
Figure above shows primary energy consumption in Indonesia, Malaysia and Thailand from 1970 to 2008. Overall, the primary energy consumption in Indonesia, Malaysia and Thailand is increasing rapidly from 8.9 million tons oil equivalent in 1970 to 85.6 million tons oil equivalent in 1997. There is a decreasing in 1998 due to the Asian financial crisis happen in that time. After the crisis the energy consumption continue to increase.

The global financial crisis occurs in the middle of 2007 and into 2008 do not affect much to Indonesia and Thailand. This can be seen in the figure above that the primary energy consumption is still increase in 2009. From the Statistical Review of World Energy 2010, it has increase 2.8 percent to 128.2 million tons oil equivalent in 2009 for Indonesia and increase 0.1 percent to 95.1 million tons oil equivalent in

2009 for Thailand. However, for Malaysia, there is decrease from 59 million tons oil equivalent in 2008 or 5.6 percent to 55.7 million tons oil equivalent in 2009.

1.3 Trends of Gross Domestic Product in Indonesia, Malaysia and Thailand

Figure 10: Gross Domestic Product in Indonesia, Malaysia and Thailand from 1970 to 2008



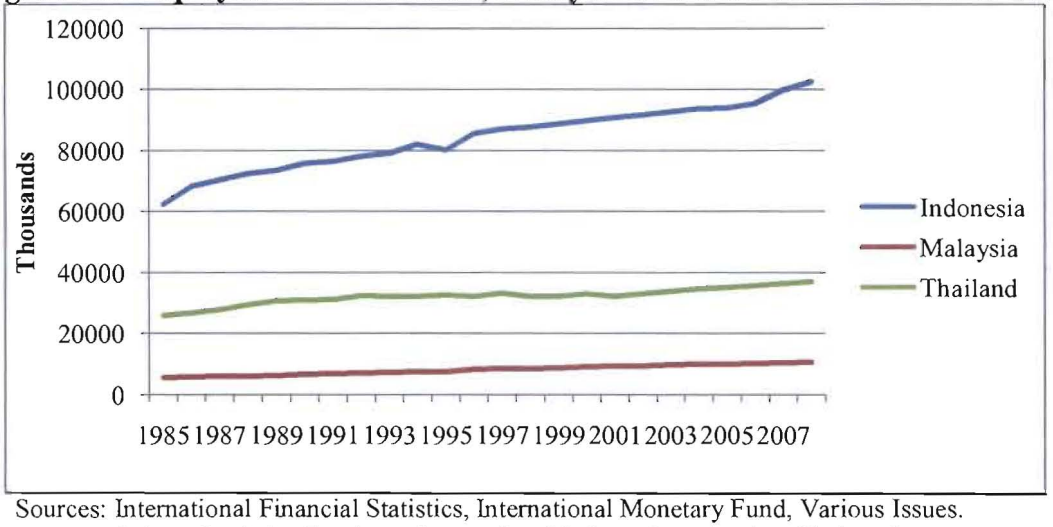
Source: World Bank, World Development Indicators.

Figure 10 shows the gross domestic product (GDP) in Indonesia, Malaysia and Thailand from 1970 to 2008. From the figure above we can see that there is decreasing trend in 1998 due to the economic recession attack which is Asian financial crisis which bring the high pressure to unemployment rate and low level of production in developing countries includes Malaysia, Indonesia and Thailand (Masih and Masih, 1996). In Indonesia, the GDP has decreased from $216 billion in 1997 to $95.4 billion in 1998. The GDP in Malaysia has decreased 27.8 percent or $100 billion in 1997 to $72.2 billion in 1998 and for Thailand, the GDP has decreased 25.8 percent to $112 billion in 1998 if compare to previous year. The decrease in GDP may cause the energy consumption to decline which shown in Figure 9.

After the crisis, the GDP increased steadily which brings the rapid performance and sustainable economic growth. High economic growth tends to lead to the high energy consumption and vice versa (Masih and Masih, 1996). From the figure above, we can see that those three countries GDP is increasing from 1999 to 2008. In Indonesia, the GDP increase continuously from $140 billion to $511 billion. The GDP in Malaysia and Thailand also increase continuously from $79.1 billion to $222 billion and $123 billion to $272 billion.

1.4 Trends of Employment in Indonesia, Malaysia and Thailand

Figure 11: Employment in Indonesia, Malaysia and Thailand from 1985 to 2008



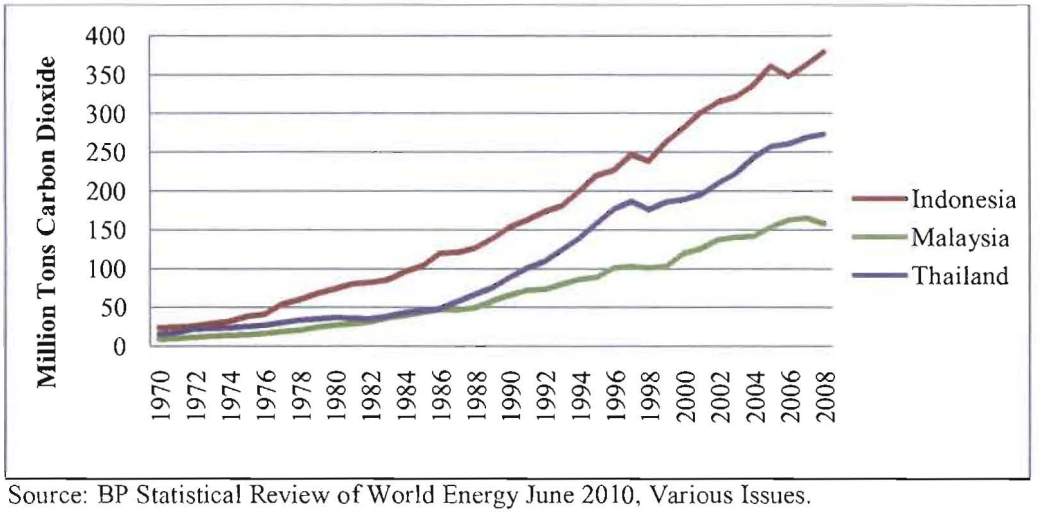
Sources: International Financial Statistics, International Monetary Fund, Various Issues.
Labour Statistics Database, International Labour Organization, Various Issues.

Figure above shows the employment in Indonesia, Malaysia and Thailand from 1985 to 2008. From the figure above, we can see that the employment trends in those three country overall shows increasing. The employment trend for Indonesia is the highest compare to other two countries. The employment trend for Malaysia and Thailand is increasing from 1985 to 2008 but in a slow movement compare to

Indonesia. From the figure above, there is a slightly decrease in Indonesia from 82.04 thousands in 1994 to 80.11 thousands in 1995. From Figure 9, 10 and 11, we can see that employment is a very important factor. It is an important factor to the economic growth and energy consumption. We can see that the employment growth help the economic to growth better every year and also the growth of the energy consumption.

1.5 Trends of Carbon Dioxide Emissions in Indonesia, Malaysia and Thailand

Figure 12: Carbon Dioxide Emissions in Indonesia, Malaysia and Thailand from 1970 to 2008



Source: BP Statistical Review of World Energy June 2010, Various Issues.

Figure 12 shows the carbon dioxide (CO_2) emissions in Indonesia, Malaysia and Thailand from 1970 to 2008 is at an increase trend. Indonesia has the highest CO_2 emissions compare to Malaysia and Thailand. According to Arga (2007), Indonesia is the world's top three greenhouse gas emitters after United States and China because of deforestation, peatland degradation and forest fires problems mostly for agriculture usage. This can be proved by Economy Watch (2008) which