



ENERGY DEMAND AND ECONOMIC GROWTH: PANEL DATA EVIDENCE FROM DEVELOPING COUNTRIES (ASEAN 4)

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INTRODUCTION

Energy – important role in economic development in many countries; gained a crucial role in the world's political, economic developments and environmental challenges; generates sizeable revenues, creates jobs and business opportunities and often brings new roads and access to water and power to the isolated rural areas in which they are typically located and moreover have the potential to stimulate economic growth, reduce poverty and raise living standards.

INTRODUCTION

The importance of research on energy demand in developing economies:

1. Developing countries – important role in the world energy markets.

Consumption of energy increasing significantly over the past two decades.

EIA (2013) – developing countries will account for 65 % of the world's energy consumption by 2040.

This increase particularly pronounced among the developing countries of East and Southeast Asia – expected to continue into the next century.

INTRODUCTION

The importance of research on energy demand in developing economies:

2. Growing concern over the environmental problems – global warming, CO₂ emission

EIA (2013) – CO₂ emission from developing countries are projected to grow by 127% higher than in developed economies by 2040 and share of energy related CO₂ emission in developing countries will increase 46% over the same period.

This rising trend of CO₂ emission in developing countries will surpass the emission from the developed countries as a result of stronger economic growth rate and continues use of fossil fuels in relative to developed countries.

INTRODUCTION

The importance of research on energy demand in developing economies:

3. Price volatility in international energy markets.

In general, developing countries suffer more than the developed countries from energy price increases.

OECD (2011) – reported a sustained increase of \$10 in the crude oil price would reduce economic growth in the countries as a whole up to 0.5%.

This impact will be significantly higher in developing countries – energy-intensive manufacturing generally accounts for a larger share of their GDP and energy is used less efficiently.

INTRODUCTION

The importance of research on energy demand in developing economies:

4. Economic – Energy – Environment

The increasing importance of the share of developing economies in the global energy markets also means that economic growth and the energy and environmental policies taken in these economies will most likely have a significant impact on world prices of primary energies and the global environment.

Detailed understanding of the trends of energy demand in developing economies is clearly of crucial importance in obtaining more reliable forecasts of international energy prices and demands at the world level

INTRODUCTION

The strength of future energy demand – depend on factors such as – income levels, real energy price, urbanization, industrialization, motorization, use of electrical appliances by households and the use of renewable energy.

Therefore, accurately estimating and analyzing the determinants of energy demand can provide some information for governments as a basis of setting up appropriate policies related to environment such as pollution and energy taxes.

Objectives

1. To establish a model of energy demand in developing countries (ASEAN 4) by use of the panel data approach
2. To examine the impact of additional determinants of energy demand

Why the Association of Southeast Asian Nations (ASEAN)?

Southeast Asia is an extremely diverse set of countries with vast differences in the scale and patterns of energy use and energy resource endowments.

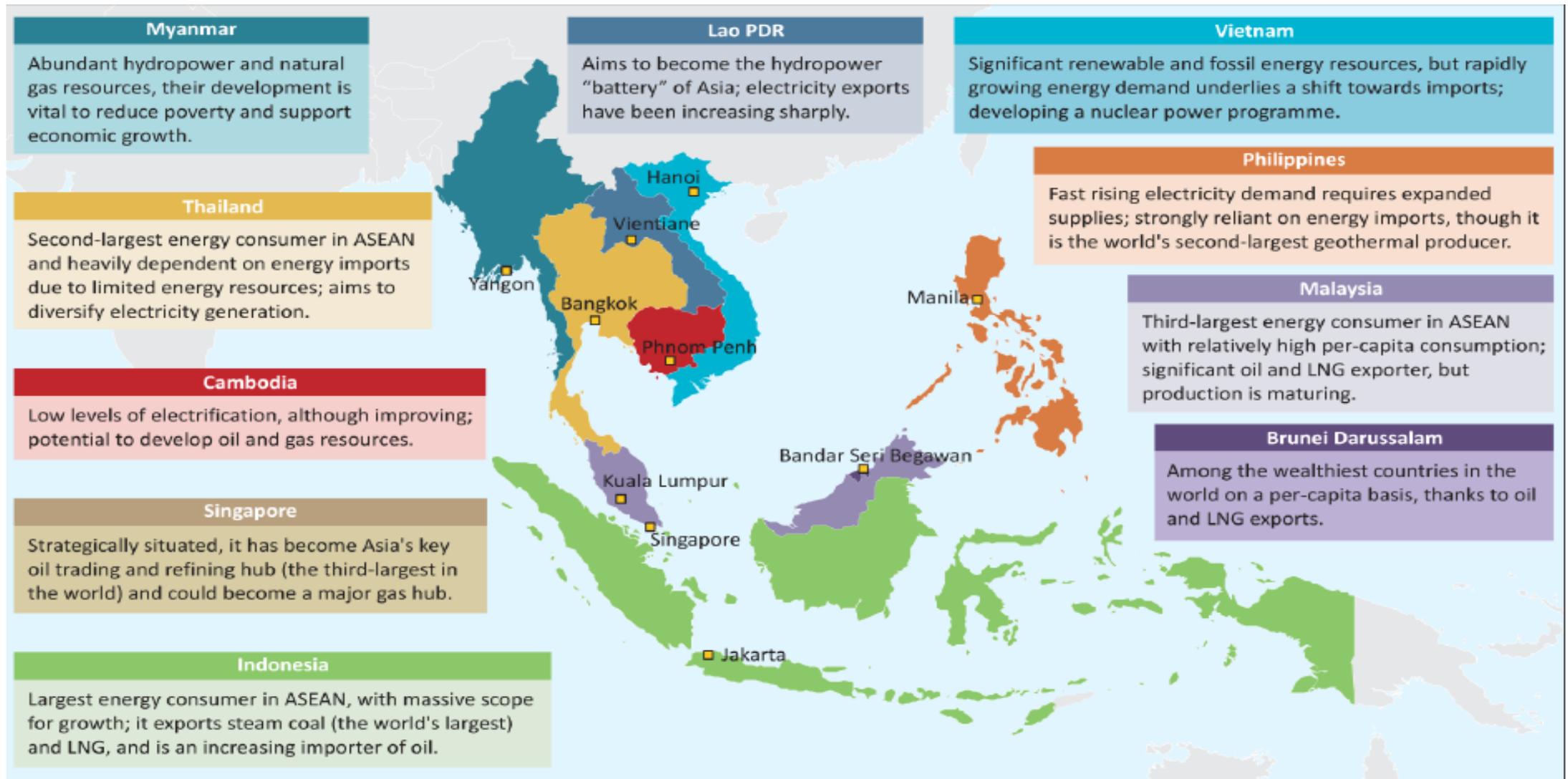
Strategically located in the coastal areas of the South China Sea - recognize as not only important as a major world trade route but also rich in resources and holds significantly strategic and political importance

EIA(2013) – estimates the South China Sea to contains approximately 11 billion barrels of oil and 190 trillion cubic feet of natural gas in proved and probable

Southeast Asia's energy demand increases by over 80% between today and 2035 (a rise equivalent to current demand in Japan).

Since Asian Financial Crisis 1997-1998, there is a sharp increase in energy consumption due to ongoing urbanization and industrialization

Energy in the ASEAN Region



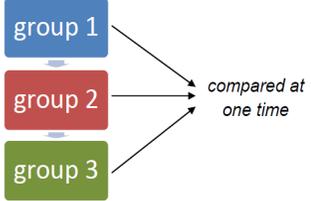
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Source: IEA (2013)

LITERATURE REVIEW

Cross-Sectional Research Study:

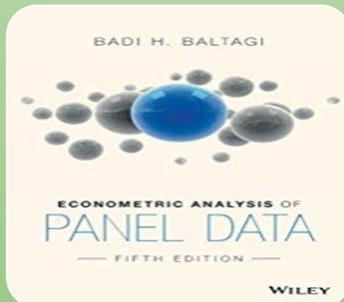
different groups



Kidane (1990), Petersen (2002), Estini (2015) and Jingchao and Kotini (2015)



Bentzen and Engsted (1992), Masih and Masih (1996), Adofo *et al.* (2013), Azlina *et al.* (2014), Adeyemi & Hunt (2014) and Tajudeen (2015)



Pesaran *et al.* (1998), Liu (2004), Atakhanora and Howie (2007) and Chaudry (2010)

Methodology

Empirical Model:

In practice, the demand for energy is basically a positive function of income or per capita income and a negative function of its own relative prices (Kouris, 1983, Bentzen and Engsted, 1993, and Galindo, 2005), which can be modelled as:

$$ENC_{it} = f(GDP_{it}, EPR_{it}) \quad (1)$$

The dependent variable ENC_{it} is per capita energy consumption by country i at time t ; GDP denotes the real per capita income and EPR represents the real price of energy.

Methodology

In the literature, the function is specified in linear double-log form so that the elasticities are given by the slope coefficients:

$$\ln ENC_{it} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln EPR_{it} + \varepsilon_{it} \quad (2)$$

where ε is an error term and is assumed to be identically and independently distributed with zero mean and constant variance.

Incorporating other explanatory variables that potentially will have an important impact on energy demand, the above equation is extended as follows:

$$\ln ENC_{it} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln EPR_{it} + \ln Z_{it} + \varepsilon_{it} \quad (3)$$

Where Z represents other explanatory variables (e.g., Structural change and renewable energy consumption).

Methodology

Econometric Methodology:

This study uses panel data techniques to estimate variants of equation (3), thereby exploiting the cross-section (N) and time-series (T) dimensions of the data.

Equation (3) can be examined empirically using the panel data techniques:

Pooled ordinary least square (OLS) – estimates a common constant for all countries – there are no differences between the estimated cross-section – useful under the hypothesis that the data set is a priori homogenous (e.g. we have a sample of only developing countries, or only ASEAN countries, etc).

Fixed effects (FE) – allows for heterogeneity or individuality among ASEAN 4 countries by allowing to have its own intercept value.

Random effects (RE) – ASEAN 4 countries have a common mean value for the intercept.

Table 1: Description, Units and Sources of the Data

Variable	Data Description	Unit of measurement (Sources)
ENC	Energy use per capita	Kg of oil equivalent (kgoe) per capita
GDP	GDP per capita	Constant 2005 US dollars
EPR	Energy price	Proxied by Consumer price index (2010 = 100)
IND	Industry, value added	Constant 2005 US\$
REC	Renewable energy consumption	% of total energy

Source: World Bank, World Development Indicators, 2015

Table 1: Panel Data Analysis on Energy Demand of ASEAN Developing Countries

Independent Variable	Pooled	Random Effects	Fixed Effects
LGDP	0.8483*** (9.7355)	0.8484*** (9.74)	-0.5194 (-1.61)
LEPR	-0.0862*** (-3.0817)	-0.0862*** (-3.08)	-0.1986*** (-5.48)
LIND	0.1223*** (4.4196)	0.1244*** (4.42)	0.9316 (4.03)
LREC	0.0281 (0.3592)	0.0281 (0.36)	-0.1349 (-1.34)
constant	-2.3699 (-2.3684)	-2.3699 (-2.37)	-6.355 (-4.477)
Breusch-Pagan test		0.0000 (1.000)	
Hausman test			6.49 (0.165)
R-squared	0.81	0.93	0.41

Notes: The figures in parentheses are t-statistics. ***, ** and * indicate significance at 1%, 5% and 10%, respectively. The Breusch-Pagan and Hausman tests are χ^2 tests for the appropriateness of random effects (versus no effects and fixed effects, respectively).

Conclusion

This study examines the determinants of energy consumption using the panel data framework for ASEAN 4 developing nations.

The results of this study indicate that not only income and price are important determinant for energy demand, but the degree of industrialization is also statistically significant to determine energy demand in ASEAN 4 countries.

Nevertheless, the economic growth indicator demonstrates more powerful impact on energy consumption compared to other explanatory variables.

High-income elasticities for ASEAN 4 countries reflect the response of energy demand is large - high income elasticity indicate higher GDP will have a major impact on energy demand

Conclusion

If this continues to be the scenario – future energy demands are likely to have a major impact for the environment and energy supply policy within developing countries.

Price elasticity of energy consumption in developing countries is quite low – indicate that higher prices will have only a minor effect in energy consumption. This result suggest that energy conservation measures based on the price mechanism are less effective – policy makers could not rely on the price of energy as a policy instrument – another policy initiative is needed.

The statistically significant level of industrialization for developing countries seems to suggest the importance of industrial sector in energy consumption

Therefore, the policy makers should take it into account for policy formulation.



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