The causal relationship between pollution, energy consumption and output in Southeast Asia Countries

Jaruwan Chontanawat

King Mongkut's University of Technology Thonburi, Thailand

E-mail Address: j.chontanawat@gmail.com
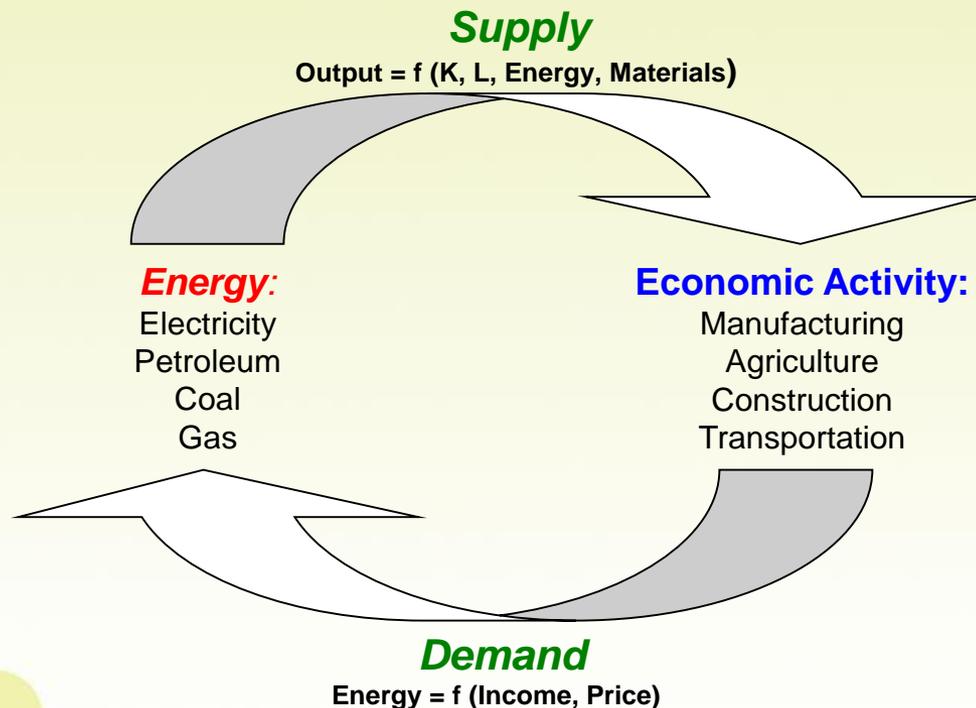
Outline

- Introduction
  - Why is the issue important?
  - Research questions
  - Objectives
- Models /data
- Results
- Conclusion

Why is this issue important ?

- SEA is the one of the most dynamic and diverse regions in the world.

- Rapid population and economic growth, high energy consumption and emissions.

- Difference in scale and patterns of energy use and energy source within the countries.

- It is interesting to understand how these variables evolved and link to each others.

Causal link between Energy and Economic activity

'Role of Energy on Demand side and Supply side'

Supply

Output = f (K, L, Energy, Materials)

Energy:
Electricity
Petroleum
Coal
Gas

Economic Activity:
Manufacturing
Agriculture
Construction
Transportation

Demand

Energy = f (Income, Price)

Research questions

- "What are the relationships between energy consumption, CO_2 emission and economic growth in the SEA countries?"

- "How have these variables linked to each others?

Research objectives

- To investigate the relationships, we use *cointegration/causality model*.

Data & Sources

- Main variables :
  - Population,
  - GDP,
  - Energy
  - CO_2 emission.

- Data : (IEA, WDI)
  - Time series 1971-2013

- Countries : Indonesia, Malaysia, Philippines, Thailand.

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Cointegration /Causality Model

- Relationship between economic growth, energy consumption and carbon emissions can be illustrated as follows:

$$C_t = f(E_t, Y_t)$$

C= CO2 emission
E = Energy Consumption
Y = GDP

- Testing procedure : 3 steps
  1. Unit root test
  2. Cointegration test
  3. Causality test

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Procedure

1. Unit Root test: augmented Dickey-Fuller(ADF) (1979)

- *The objective is to test for the stationarity of the time series variables in the model.*

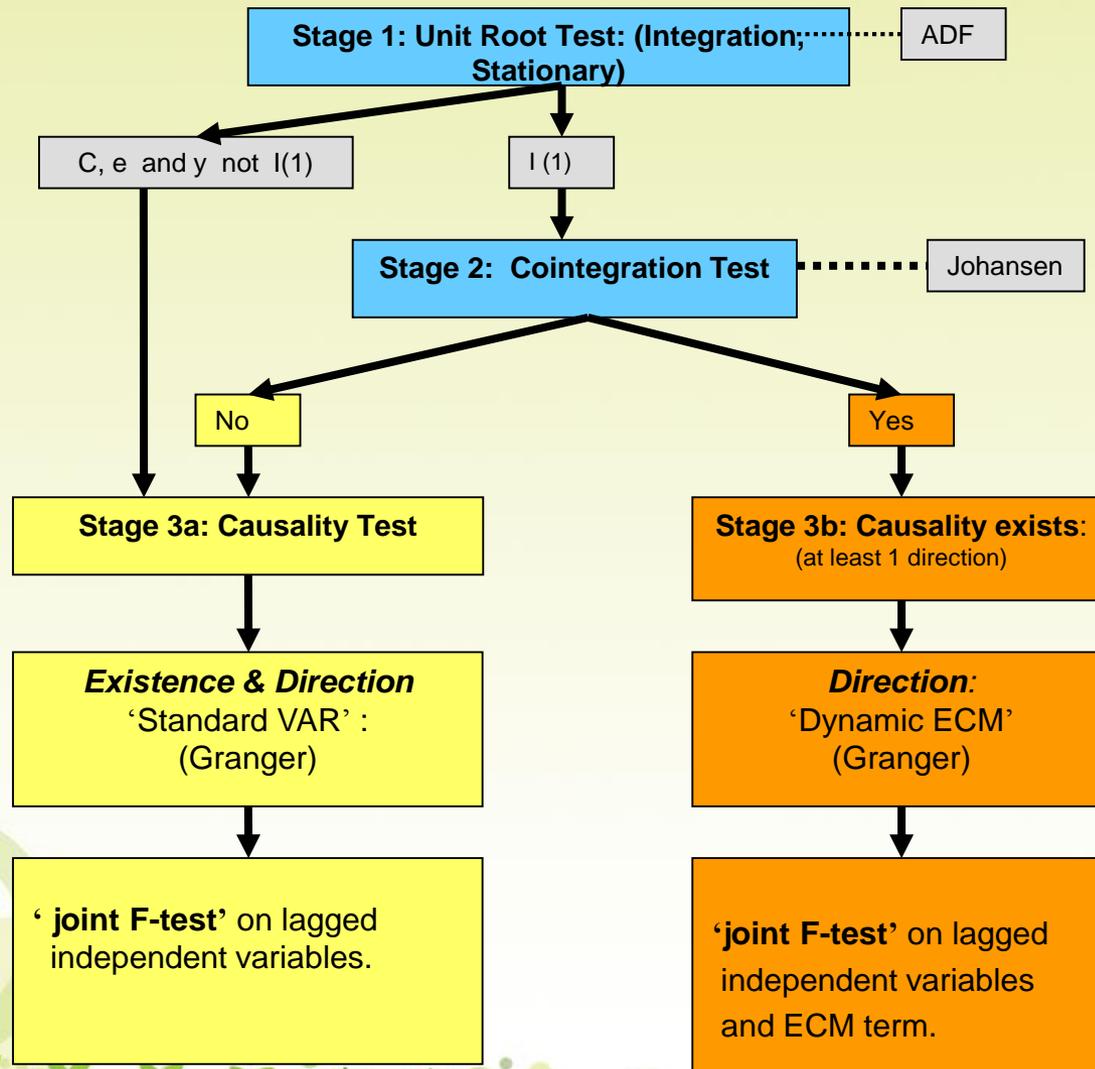## 2. Cointegration test : Johansen and Juselius (1990)

- *to test whether the long-run relationship between the variables in the model exist or not.*

3. Causality test : Engle and Granger (1987)

- *to find the causal relationship between the variables. (directions)*

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Model

Causality

- ## Error Correction Model (ECM):

$$\Delta C_t = a_1 + \sum_{i=1}^{j} a_{1i}\Delta C_{t-i} + \sum_{i=1}^{j} b_{1i}\Delta E_{t-i} + \sum_{i=1}^{j} c_{1i}\Delta Y_{t-i} + \Phi_1 ECM_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta E_t = a_2 + \sum_{i=1}^{j} a_{2i}\Delta Y_{t-i} + \sum_{i=1}^{j} b_{2i}\Delta E_{t-i} + \sum_{i=1}^{j} c_{2i}\Delta C_{t-i} + \Phi_2 ECM_{t-1} + \varepsilon_{2t} \quad (2)$$

$$\Delta Y_t = a_3 + \sum_{i=1}^{j} a_{3i}\Delta Y_{t-i} + \sum_{i=1}^{j} b_{3i}\Delta E_{t-i} + \sum_{i=1}^{j} c_{3i}\Delta C_{t-i} + \Phi_3 ECM_{t-1} + \varepsilon_{3t} \quad (3)$$

where   C=CO_2 Emission per capita, E=energy consumption per capita, Y=real GDP per capita,
ECM = error correction term . All are in natural log terms.

- **Direction :**

    C ← Y   if $c_{1i} \neq 0$ (SR), $\phi_1 \neq 0$ (LR), $c_{1i} \neq \phi_1 \neq 0$ (strong) :   eq.(1)

    C ← E   if $b_{1i} \neq 0$ (SR), $\phi_1 \neq 0$ (LR), $b_{1i} \neq \phi_1 \neq 0$ (strong) :   eq.(1)

    E ← Y   if $a_{2i} \neq 0$ (SR), $\phi_2 \neq 0$ (LR), $a_{2i} \neq \phi_2 \neq 0$ (strong) :   eq.(2)

    E ← C   if $c_{2i} \neq 0$ (SR), $\phi_2 \neq 0$ (LR), $c_{2i} \neq \phi_2 \neq 0$ (strong) :   eq.(2)

    Y ← E   if $b_{3i} \neq 0$ (SR), $\phi_3 \neq 0$ (LR), $b_{3i} \neq \phi_3 \neq 0$ (strong) :   eq.(3)

    Y ← C   if $c_{3i} \neq 0$ (SR), $\phi_3 \neq 0$ (LR), $c_{3i} \neq \phi_3 \neq 0$ (strong) :   eq.(3)

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Result

	Stage1: Integration	Stage2: Cointegration	Stage3: Causality					
			1	**2**	**3**	**4**	**5**	**6**
			$C \leftarrow E$	$C \leftarrow Y$	$E \leftarrow C$	$E \leftarrow Y$	$Y \leftarrow E$	$Y \leftarrow C$
Indonesia	√	√	√	√	√	√	×	×
Malaysia	√	√	√	√	×	×	×	×
Philippines	√	√	×	×	√	√	√	√
Thailand	√	√	√	√	×	×	×	×

C= CO_2 emission
E = Energy Consumption
Y = GDP

- Unit root : All variables are I(1)

- Cointegration : Long-run relationship among variables

- The causality : slightly vary across countries.

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Conclusion & Policy implication

- The empirical results suggest that in all countries there is a long-run relationship between the variables, indicating that energy consumption and output are related to CO_2 emissions.

- The causality results to some extent show evidence of the relationships between these variables. The results imply that policies relating to a reduction of energy consumption, or an improvement in energy efficiency, or the investigation of new energy sources, should be taken into consideration as they could reduce the level of CO_2 emissions without affecting the Nation's economic growth.

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Thank you

J.chontanawat@gmail.com