A State-specific Analysis of Environmental Kuznets Curve for the United States

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Background

- **Motivation**
  - Although there is robust literature on Environmental Kuznets Curve (EKC) that examines the relationship between CO_2 emissions, per capital income, and energy consumption at the country level, but few authors have considered the relationship on a state perspective in US.
  - Inclusive results regarding the existence of EKC on the entire U.S. cannot be extrapolated as evidence of similar results for all states (Aldy, 2005; Roach, 2013)
  - Some states in US pursued more constrained policy to reduce CO_2 emissions through direct approach and indirect approach. How these policies such as the 2006 Regional Greenhouse Gas Initiative (RGGI) influence the CO_2 emissions?

- **Research Focus**
  - Use a longer and complete data at U.S. state level to account for the time-series properties of emissions
  - Investigate the long run relationships between CO_2 emissions, energy consumption, and economic development for each state
  - Examine the short run relationship between the variables by focusing on how the past year CO_2 emissions, energy consumption, and economic development influence current year

Data

- We use the annual time series data of carbon dioxide emissions, GDP, and energy consumption, for the total 50 states and the District of Columbia in US from 1960 to 2011

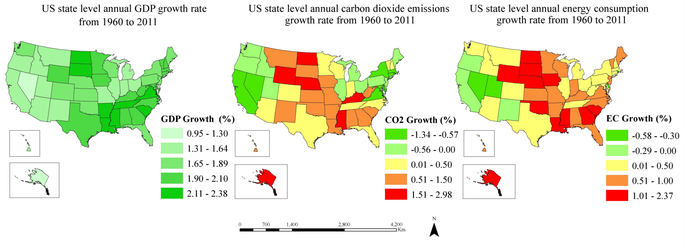

Fig.1. US state level annual GDP, CO_2 emissions, and energy consumption growth rate from 1960 to 2011

Methods

- Our empirical approach consists of two steps

1. Test the cointegration by Engle and Granger Two Step Method and estimate the long run relationship

$$In(CO2_{i,t}) = \alpha_0 + \alpha_1 LnY_{i,t} + \alpha_2 (LnY_{i,t})^2 + \alpha_3 (LnY_{i,t})^3 + \alpha_4 E_{i,t} + \varepsilon_{i,t}$$

2. Apply Vector Error Correction Model (VECM) to test the short run relationship

$$\Delta In(CO2_t) = c + \sum \alpha_i \Delta LnY_{t-i} + \sum \beta_j \Delta (LnY_{t-j})^2 + \sum \gamma_k \Delta (LnY_{t-k})^3 + \sum \mu_l \Delta LnE_{t-l} + \sum \theta_m \Delta LnCO2_{t-m} + \eta ECT_{t-1} + \varepsilon_t$$

Results I

- The unit root tests are applied to support that all the variables in each state are integrated of order 1.
- Based on the results found by the Engle and Granger (1987) two step methods, we observed that each state showing different long run relationships. In addition, there were mainly 5 different relationships among CO_2 emission, GDP growth, and energy consumption.
  - 8 states show no cointegration relationship among the variables, 6 states show a decreasing path, while 6 states corresponding to increasing patterns. 13 states show an inverted U shape, and the remaining 18 states lead to N shape.
- Table 1 Representative states long run relationship (select 3 states from the defined category state classification)

State	Constant	GDP	GDP^2	GDP^3	Energy Consumption
		Downward Linear Relationship			
Hawaii	-7.74***	-0.06***			1.00***
	(0.20)	(0.02)			(0.02)
Massachusetts	-8.47***	-0.32***			1.30***
	(0.65)	(0.01)			(0.06)
New York	-7.62***	-0.49***			1.38***
	(0.84)	(0.02)			(0.07)
		Upward Linear Relationship			
Indiana	-5.10***	0.15***			0.60***
	(0.67)	(0.03)			(0.08)
Nebraska	-7.14***	0.37***			0.55***
	(0.31)	(0.04)			(0.06)
Oklahoma	-10.25***	0.34***			0.86***
	(0.58)	(0.04)			(0.08)
		Inverted U Shape Relationship			
Delaware	-216.46***	40.74***	-1.99***		0.94***
	(34.26)	(6.75)	(0.33)		(0.16)
Georgia	-51.40***	8.18**	-0.41**		1.18***
	(16.05)	(3.46)	(0.17)		(0.19)
Texas	-49.03***	8.51***	-0.41***		0.72***
	(12.24)	(2.59)	(0.13)		(0.09)
		N shape Relationship			
Florida	-807.79***	237.09***	-23.57***	0.78***	1.56***
	(184.73)	(54.43)	(5.34)	(0.17)	(0.09)
Illinois	-2911.38***	852.50***	-83.46***	2.72***	1.27***
	(394.39)	(114.23)	(11.02)	(0.35)	(0.06)
Ohio	-1307.39***	380.71***	-37.17***	1.21***	1.01***
	(404.25)	(118.83)	(11.63)	(0.38)	(0.07)

- Figure 2 The goodness of fit based on the long run estimation for the representative states

Results II

- The results of VECM granger causality test

1. Most states CO_2 emissions reacts significantly to lagged own CO_2 emission adjustment such as Indiana, Kansas, Alabama and so on.
2. Few states CO_2 emissions show significantly lagged to the annual GDP growth and energy consumption
3. The signs and magnitude of short-run reactions (e.g., CO_2 emissions to GDP and energy consumption) vary by states, which again indicate heterogeneity at the state level

Conclusions

- Considering that U.S. states have different technique, structural, and economic patterns, and each of them tries to effectively implement saving CO_2 emissions energy policies according to its own characteristics, we assume that the EKC shapes could be different for each state. With the use of used the Engle and Granger Two Step Method, we successfully defined 5 category relationship among CO_2 emissions, GDP growth, and energy consumption.

- For the states showed negative relationship between CO_2 emissions and economic growth, we concluded the mainly reasons :
  - ✓ Restrictions on CO2 emissions level through regulation and Act
  - ✓ Mature, complete, and efficient transportation and electricity use
  - ✓ Decreased dependence on heavy industry

  So, stated showed an upward trend CO_2 emissions with economic growth could learn lessons from states with negative relationship between CO_2 emissions and economic growth.

- Stated with N shaped curve indicated that the CO_2 emissions would continue to increase as these states pursue economic growth polices. Then it is important for these states to continue pursuing the goal of stabilizing and reducing of CO_2 emissions with the implementation of strong and effective laws.

- Based on the long run estimation results, we found that energy consumption is another main source of CO_2 emissions. Thus, policies such as decreasing energy intensity, increasing energy efficiency in renewable energy use, increasing the utilization of cleaner energy sources may help to mitigate the carbon emissions.

- The finding of existence of both inverted U shape and N shape EKC is important because it poses the concerning question of whether pollution actually begins to decline when an economic threshold is reached or whether the decrease is only in local pollutant and pollution is simply exported to poorer developing countries.

- Observe spatial pattern for the relationship between CO2 emissions and economic activity, indicate economic activity between states may have impact on own and neighboring CO2 emissions. Further research can investigate how the spatial dependence among the states influence policies across states such as RGGI.

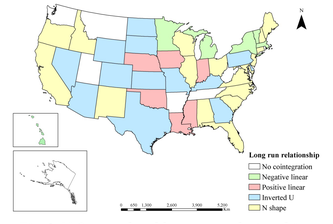

Fig.6. U.S. state level long run relationship five category state classification

References

Aldy, J.E. "An Environmental Kuznets Curve Analysis of U.S. State-Level Carbon Dioxide Emissions." *Journal of Environment and Development* 14 (2005):48-72.

Roach, T. "A dynamic state-level analysis of carbon dioxide emissions in the United States." *Energy Policy* 59 (2013):931-7.

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