Does Renewable Energy Consumption Improve Air Quality? Evidence from a Panel Approach

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Introduction

• Increasing economic activities have been accompanied with excessive energy consumption, which had a negative impact on environment. Particularly, air pollution has been a global issue, which was related not just to human health but also to global warming. According to the World Health Organization (2018), about 92% of people do not breathe clean air and air pollution cost amounts to about $5 trillion every year.

• Renewable energy has been considered an alternative energy source to replace fossil fuels and improve environmental quality. Due to the contribution of renewable energy use to energy security and environment, the consumption of renewable energy increased dramatically from about 2,871 TWh in 2000 to about 5,299 TWh in 2014 in the world (Ritchie and Roser, 2017). Many researchers have confirmed that increasing renewable energy intensity is beneficial for environment, particularly a decline in CO_2 emissions (Dong et al., 2016).

• Air quality varies with economic growth and energy use, but the literature has little paid attention to the relationships among air quality, economic growth and renewable energy use. Thus, this paper 1) examines how economic growth is associated with air quality and 2) determines whether the use of renewable energy can contribute to a reduction in air pollution.

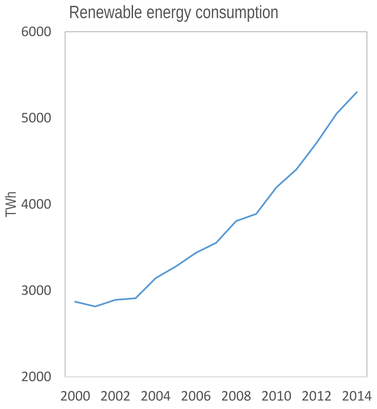
Data

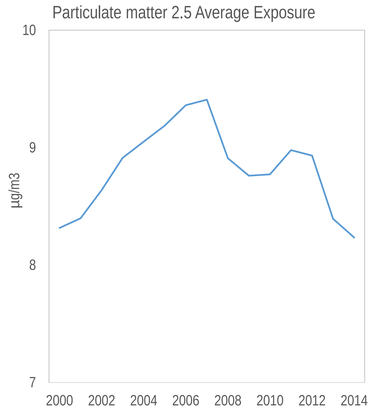
• A panel dataset comprising 156 countries from 2000 to 2014 was used for empirical analysis. Air quality is represented by particulate matter 2.5 average exposure (PMA), sulfur dioxide (SO2) emissions, and nitrogen oxide (NOX) emissions. To test our hypotheses, we also collected the data such as renewable energy consumption (REC), gross domestic product (GDP), urbanization (URB), and trade openness (TRA).

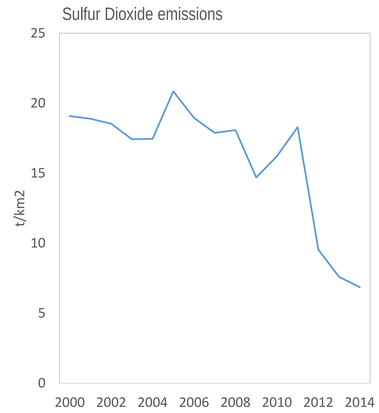
• PMA is obtained from the Environmental Performance Index (EPI) constructed by Yale University (2016), and SO2 and NOX are collected from CEDS dataset. Yearly data for renewable energy consumption rate (the ratio to total final energy consumption), GDP per capita (constant 2010 US$), urbanization rate, trade openness (the ratio of total trade to GDP) are collected mainly from the World Development Indicator of the World Bank.

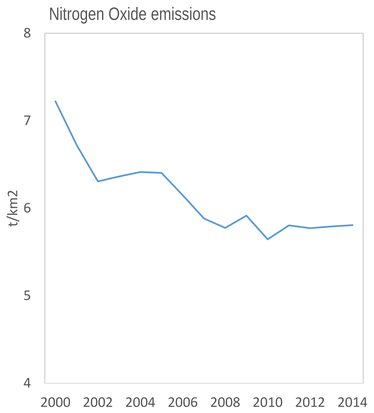
	Unit	Mean	Std. dev.	Min.	Max.
PMA	µg/m3	8.82	6.24	0.00	50.30
SO2	t/km2	16.02	2993.89	0.17	39187.98
NOX	t/km2	6.13	2612.68	0.22	33879.65
GDP	constant 2010 US$	13290.12	18231.33	221.10	111968.30
REC	% of total final energy consumption	32.04	0.30	0.00	97.29
URB	% of total population	57.63	0.23	8.25	100.00
TRA	% of GDP	87.94	0.54	0.00	442.62

Renewable Energy Consumption and Air Quality









Panel Model

• The panel model is specified as follows (Shaw et al. 2010, Salim et al., 2017);

$$\ln AP_{it} = \alpha_1 \ln GDP_{it} + \alpha_2 (\ln GDP_{it})^2 + \alpha_3 REC_{it} + \alpha_4 URB_{it} + \alpha_5 TRA_{it} + \gamma_i + \varepsilon_{it}$$

where subscript *i* denotes country and *t* denotes year. The dependent variable (AP) includes PMA, SO2, and NOX emissions.

• According to the results of Hausman test, we use the fixed-effect panel model. With the quadratic specification, if the coefficients of the linear term and its squared term are positive and negative, respectively, then the EKC hypothesis will hold.

Results

Variables	PMA	SO2	NOX
Constant	-1.895***	-10.763***	-7.053***
	(0.613)	(1.041)	(0.598)
GDP	1.002***	3.005***	1.411***
	(0.148)	(0.251)	(0.144)
GDP2	-0.058***	-0.193***	-0.078***
	(0.009)	(0.015)	(0.009)
REC	-0.417***	-3.103***	-1.547***
	(0.100)	(0.171)	(0.098)
URB	-0.424**	0.157	2.071***
	(0.191)	(0.324)	(0.186)
TRA	-0.013	-0.128***	-0.072***
	(0.021)	(0.035)	(0.020)

Notes: *** , ** and * denote the level of significance at 1%, 5% and 10% respectively; Numbers in parentheses are standard errors.

Conclusions

• There exists an inverted U-shape curve between air pollution and GDP per capita. Implying that air pollution tends to getting worse until the GDP per capita reaches a certain level, and then air pollution decreases as income grows.

• Renewable energy consumption is negatively associated with air pollution factors, showing that the use of renewable energy can improve air quality.

• Urbanization decreases PM 2.5 emissions but increases NOX emissions. The results attributable to the burning of fossil fuels (coal, gasoline, diesel), the burning of biomass (straw, wood), and garbage incineration. Urbanization has transformed the rural energy structure dominated by solid fuels to the urban energy structure dominated by clean fuels, thereby reducing PM 2.5 emissions.

• Trade openness reduces SO2 and NOX emissions, which is attributed to the opening up of trade strengthens technological exchanges between countries, making energy use more efficient and reducing air pollution.

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