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Ecological Indicators

Growth and environmental quality in Singapore: Is there any trade-off?

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ABSTRACT

With a view to provide new evidence in favor of EKC hypothesis that claims a trade-off between growth and environmental quality at least in the short-run, we conduct a study for Singapore by analyzing the data on CO_2 emissions, energy consumption (measured by two proxies) and per capita GDP for 1975–2011 by means of cointegration and causality techniques. The results indicate a significant rise in CO_2 emissions as GDP rose over the years confirming a short-run trade-off between environment and growth. Further analysis on a possible turning point shows that continuous growth will be necessary for a long time before we experience any trickle-down effects on environmental pollution. The results of causality analysis indicate that CO_2 emissions indeed have caused decline in Singapore's growth. It is therefore argued that strict regulatory regimes on environmental protection in the city–state must remain in force.

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1. Introduction

Singapore is a success story and its rapid economic growth has been accompanied by structural transformation, full employment, high living standards, price stability, and good environmental quality. Though growth was the single-minded objective, the pragmatic role of the government led to the implementation of well-balanced economic and social policies and the key issues on top of policy-makers' minds were employment, shelter, national security, food security, industry development, public infrastructure, waste management, public healthcare, and many more. The government was always mindful of the fact that while pursuing high pace of economic growth and industrialization, there are obvious risks of negative externalities such as pollution. As pollution of the environment is a commonly-quoted example of a social cost that is seldom borne completely by the polluter in question, the government had to take strict regulatory measures to keep pollution under control and notable success has been achieved in that front. Today Singapore is an extremely livable country with reasonably clean environment and all pollution related indicators are within internationally accepted standards.

Pollution comes in various forms such as air quality degradation, noise pollution, water pollution, etc. In terms of air pollution, Choon (2010) collated four key indicators to describe the air pollution levels in Singapore (Table 1).

It is evident that sulphur dioxide emissions declined from an average of 20 $\mu g/m^3$ in the 1990s to 11 $\mu g/m^3$ in 2008. Also, emissions of nitrogen dioxide, carbon monoxide and ozone have been quite stable though data does not show any significant reduction of emissions at the national level. The author concludes that without any significant agricultural land or landfill sites, Singapore has no problems with methane gases, while CO_2 is the primary greenhouse gas emitted in the city state as it was produced by the use of fossil fuels in power generation. A breakdown of the main emitters of CO_2 shows the following sources of emission: industry (54%), transportation (19%), buildings (16%) and consumer households (9%). From the data that we have recently compiled, CO_2 emissions in Singapore rose from an average 11.1 tonnes per capita in the 1970s to 33.8 t per capita in the 2000s, and it seems to be stabilizing at an average of 41.9 t per capita in the three years from 2010 to 2012 (Fig. 1).

It is germane to mention at this point that economists, particularly those who subscribe to neoclassical welfare economics, have already established that the existence of externalities will result in outcomes that are not socially optimal. Those who suffer from external costs do so involuntarily, whereas those who enjoy external benefits do so at no cost.

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Table 1
Descriptive statistics.

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque–Bera
CO_2 emissions	3.1075	0.4544	−0.3142	1.6539	3.4945
Electricity production	8.5553	0.4947	−0.5443	2.0133	3.3279
Total energy consumption	1.9981	0.4658	−0.2944	1.6468	3.4482
Real GDP	10.2417	0.4993	−0.2361	1.8673	2.3845

When there are negative externalities, market failures happen because resources are inefficiently allocated. Private agents will engage too much in the polluting activity and government intervention is therefore required. As a country makes economic progress, its people and companies become richer, and the government becomes stronger. As a result, more and more efforts are likely to be made in correcting the problem by imposing a Pigouvian tax on polluting activities and incentivizing agents to behave in a more responsible manner that will contribute to environmental protection. It is therefore expected that although pollution goes hand-in-hand as a country's economy grows, after a certain point, pollution may actually slow down as the country concentrates on the quality of life of citizens rather than blind pursuit of economic growth.

1.1. The environment Kuznets curve (EKC)

A very well-known hypothesis called the environment Kuznets curve (EKC) has been highlighted in the literature and it describes a systematic pattern between economic growth and environmental quality. It followed the Kuznets curve proposed earlier by Kuznets (1955) who hypothesised that income inequality in a nation would first rise and then fall as economic development proceeds. By following similar logic, the EKC hypothesizes the existence of an inverted "U" shaped relationship between indicators of environmental degradation and economic growth. What this shows is that environmental degradation could not be avoided during the early stages of economic development because poorer countries do not have the resources, know-how and will to regulate polluters. Nevertheless, as the economy becomes richer, government will start to resolve the market failure in environment protection.

The main motivation behind the idea that growth is rather necessary to maintain or improve the environmental quality came from an argument that was brought about by the World Commission on Environment and Development (1987) in *Our Common Future*. In the early 1990s, Grossman and Krueger (1991) took the hypothesis further and studied the potential impacts of NAFTA.

However, the main pillar the EKC was based upon and popularized was the background study conducted by Shafik and Bandyopadhyay (1992) for the 1992 issue of the *World Development Report*. The authors claimed that the view that greater economic activity hurts the environment is based on static assumptions about technology, tastes and environmental investments and argued that "As incomes rise, the demand for improvements in environmental quality will increase, as will the resources available for investment" (p 39). Others have taken this position further and Beckerman (1992, p 482) in his study claims that "there is clear evidence that, although economic growth usually leads to environmental degradation in the early stages of the process, in the end the best – and probably the only – way to attain a decent environment in most countries is to become rich."

1.2. A brief review of literature

A quick literature review showed several empirical studies that supported the hypothesis (Cole, 2003; Frankel and Rose, 2005; Grossman and Krueger, 1995; Lean and Smyth, 2010; Selden and Song, 1994; Shafik and Bandyopadhyay, 1992; Stern et al., 1996; World Bank, 1992).

In an influential study, Kraft and Kraft (1978) found a unidirectional causality running from output to energy consumption for the United States during the period 1947–1974. Following
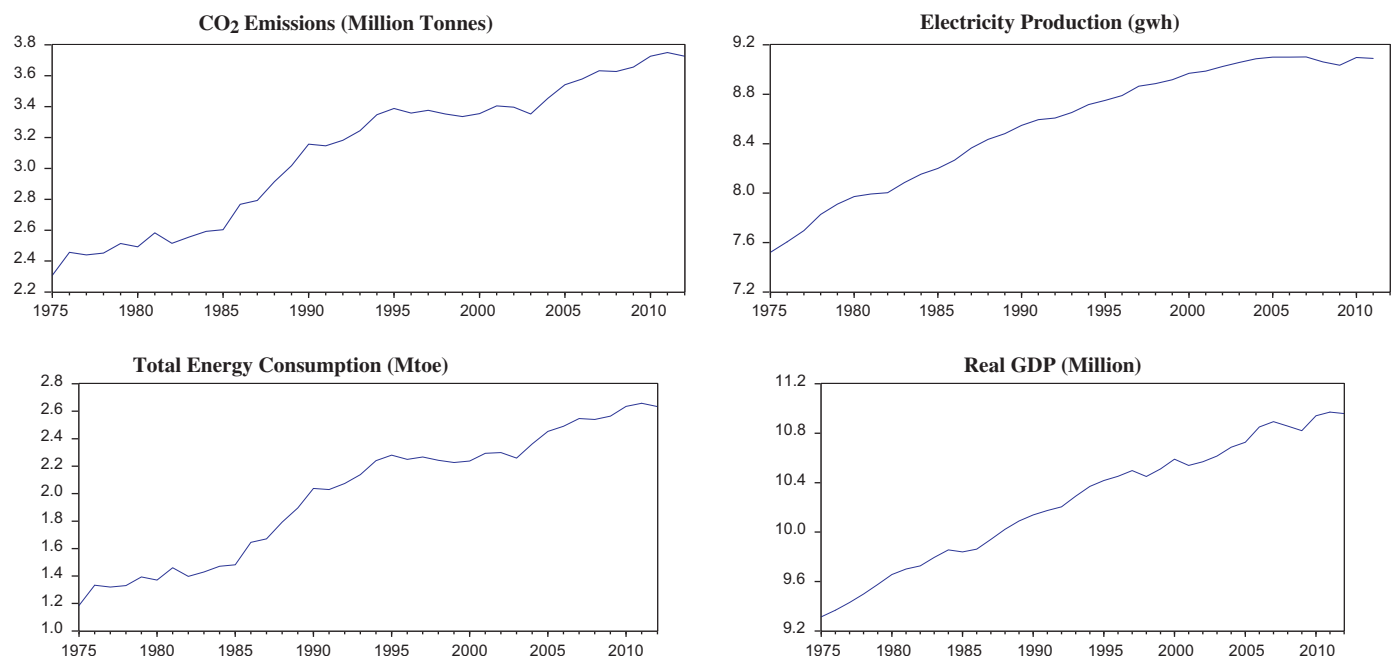

Fig. 1. Visual representation of independent and dependent variables.