



Impact of fossil fuels energy consumption, energy policies, and urban sprawl on carbon emissions in East Asia and the Pacific: A panel investigation



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ABSTRACT

This paper employs the Environmental Kuznets Curve (EKC) hypothesis in studying the impact of energy consumption, economic growth, and urbanization on carbon emissions in developing economies. Data from twelve developing East Asian and Pacific countries for the period 1990 to 2014 has been used for analysis. The empirical results, estimated through application of the System Generalized Method of Moment (GMM), show that energy consumption, economic growth, and urbanization all significantly increase carbon emissions, thereby adding to serious environmental challenges in the region. Moreover, public policies designed to shift economies from non-renewable to renewable energy resources have been taken into account, and their impact was found to have been insignificant in the sampled countries. However, the results depict an inverted U-shaped relationship between per capita economic growth and carbon emissions, confirming the existence of an EKC in the region. The empirical findings suggest that energy conservation and policies fostering use of renewables helped to improve economic growth, control carbon emissions, and support the rising energy demand resulting from increased urban sprawl. In order to improve the influence of public policies in controlling carbon emissions, our analysis finds a need for stronger initiative to be taken in regional dialogues and policy frameworks, and for greater collaboration among diverse stakeholders often characterized by differing values, interests, and objectives.

1. Introduction

The promotion of industrialization in developing economies, to improve the production of goods and satisfy the demands of growing populations, is seen as inevitable to such nations' economic progression. Corresponding advances in technology have resulted in massive production increases but have also created new challenges in the form of rising demand for energy, increased pressure on natural resources, and issues of solid waste management and carbon emissions. For example, the waste generated per day in the East Asia and Pacific regions was in 2013 estimated at around 760,000 tons per day, and this is expected to intensify to as much as 18 million tons per day by the year 2025 [9,36,67].

Over the past few decades, the social benefits accrued from the exploitation of biotic systems have been sharply declining. Thus the need has arisen to tackle resource depletion in a serious way; if humans continue to consume natural resources at the current rate, the planet will no longer be able to meet the growing demand [29–31,47,72]. Meanwhile, economic growth is seen as essential to promoting development and to coping with issues such as poverty, unemployment, low per capita income, and health concerns. As a result, developing countries are consuming resources voraciously, in pursuit of

industrialization and growth but overlooking negative externalities generated by consumption. In order to speed economic growth, developing countries are meanwhile dependent on consumption of non-renewable fossil fuels (which, apart from exerting pressure on limited resources, produces enormous volumes of noxious gases such as carbon dioxide, nitrous oxide, and methane). Alarming, the East Asian and Pacific region as a whole has lost 70 to 90% of its original wildlife habitat – particularly in Indonesia, Cambodia, Vietnam, and Thailand. In just a few decades, due to infrastructural and agricultural development, land degradation, deforestation, shrimp farming, and other practices, these habitat losses plus rising carbon dioxide levels in the atmosphere have brought the region to a crisis point [65].

Carbon dioxide is considered the global pollutant chiefly responsible for global warming and climate change [41,4,15,16,22,23]. In global terms, 75% of total greenhouse gases consist of carbon dioxide, and these gases do not dissipate or vanish, but merely move from one zone to another, remaining within the biosphere for thousands of years. Higher absorption of carbon dioxide in sea water converts into carbonic acid, which increases the acidity of oceans and damages coral reefs and other marine life [20]. Beyond being the main source of carbon dioxide in the air, the use of fossil fuels also creates acute health problems. According to the World [64]; greenhouse gas emissions from

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Table 1
Averages of Key Indicators in East Asia and Pacific (1990–2014).
Source: Based on World Bank Data (1990–2015)

Countries	CO ₂ Emissions (Kilotons)	Environment Rating (Rating points)	Energy Use (Kg of oil)	Fossil Fuels Use (% of total)	GDP Per Capita (in US\$)	Urbanization (in millions)
Cambodia	2558.72	1.25	220.77	17.88	529.72	9.31
China	4751043.01	1.06	1124.43	75.69	2793.61	17.09
Indonesia	296428.41	0.21	673.41	57.24	2560.52	10.21
Korea Rep.	40396.94	1.24	850.57	82.51	586.92	12.02
Lao PDR	900.24	1.57	301.03	80.87	839.64	9.32
Malaysia	135414.81	0.78	2018.96	85.92	7553.05	17.73
Mongolia	11973.88	1.31	1177.93	87.74	2166.44	35.21
Myanmar	8603.91	0.28	253.31	22.02	569.43	10.27
Philippines	63986.19	0.96	427.97	50.67	1825.93	14.39
Thailand	190579.81	1.02	1212.08	71.71	4101.53	12.19
Timor-Leste	103.09	0.84	9.18	78.92	498.34	8.57
Vietnam	71203.83	1.51	407.13	46.16	964.17	10.22

coal alone are causing about 50,000 premature deaths and 0.4 million new cases of bronchitis every year. In the past few decades, due to these environmental changes, noxious hazes are also on the rise in the region, causing serious safety and health concerns – particularly in Indonesia, Thailand, Malaysia, Brunei, and Singapore. These rapidly increasing hazes are perilous for local inhabitants, adding further economic costs to the list of negative consequences. Consequently, populations from developing East Asian and Pacific nations have grown more sensitive to environmental damages and are demanding well-defined policies to preserve the natural environment. Considering the consequences of this burning issue, the developing countries of East Asia and the Pacific are now addressing various environmental concerns as cross-border issues. In the context of such efforts, there is a dire need at the regional level to observe the Environmental Kuznets Curve (EKC) test results and to inspect the impact of non-renewable energy consumption, energy management policies, and urban sprawl on carbon emissions – which the present study undertakes to do.

A sizeable literature has already determined the impact of economic growth and fossil fuels consumption on carbon emissions, including: [1,3,6,18,23,31,43,46,59,60,67,38,13,34]. Additionally, individual studies have focused on different pollutants [26,27] used sulphur dioxide emissions [54]; examined sulphur dioxide and nitrogen oxide [31,60,6] all examined CO₂ emissions to determine the impact of economic development on environmental degradation. Moreover, many studies have employed a Granger causality test and reported unidirectional as well as bidirectional causalities between economic growth and carbon dioxide emissions for various regions [40,14,41,49,25,50,51,55,4]. Empirical findings are inconsistent due to variations in time-span, indicators examined, regions or countries selected, and models followed; thus the empirical evidence is still seen as inadequate for recommending effective policy to improve energy efficiency and environmental quality, particularly in the East Asian and Pacific economies.

The present study is an attempt to draw together analyses of the impacts of fossil fuels consumption, per capita growth, and energy management policies on carbon emissions in these developing countries. In addition, we consider the rising pace of industrialization and rural-to-urban migration, which exert increasing strains on natural resources via increased consumption of energy, foods, and other goods, and which are equally imperative in determining the impact of growing urbanization on carbon emissions in these developing countries. Furthermore, very few studies have so far addressed energy management, energy consumption, and carbon emission issues in terms of East Asia and the Pacific; the present study hopes to fill that gap in the literature by using the most recent panel data for the period 1990 to 2014.

Generally speaking, variables of energy consumption, growth, and urbanization are seen to ‘cause’ one another, but simultaneity becomes an unavoidable problem in the case of bidirectional causality, and an

estimation model may lead to biased results. Moreover, carbon emissions are a product of energy consumption as well as other factors, known and unknown; the omission of any important indicator in model construction may lead to mis-specification bias. Quantification of the impact of energy consumption, energy policies, urban sprawl, and economic growth on carbon emissions is tricky and demands effective control over simultaneity and mis-specification bias in the model. Thus, a methodology based on a two-step System Generalized Method of Moment (GMM) has been adopted to tackle problems of simultaneity, measurement error, and omitted variable bias, in order to report the most concentrated results and to suggest effective and efficient policy frameworks for controlling carbon emissions. Our empirical findings confirm an inverted U-shape relationship between per capita real GDP and per capita carbon emissions in the East Asia and Pacific region. The results further depict an insignificant influence of environmental management policies toward achieving sustainable development and toward controlling carbon emissions in East Asia and the Pacific, and elsewhere.

The following section explains our data and methodology. Section 3 estimates results, section 4 interprets those results, and section 5 presents the conclusions.

2. Data and methodology

Energy is essential for economic progress as well as for the attainment of sustainable development. However, it is prerequisite of sustainable development to foster economic growth without harming the environment. Commonly, developing countries are facing multi-fold challenges to improve economic growth. Owing to antiquated technologies, developing economies are bound to make excessive use of fossil fuels in order to meet the growing demand for energy and to produce more goods. Such economies are therefore experiencing stagnant economic growth while contributing ever more towards the generation of toxic gases, excessively consuming fossil fuels and adding to environmental decline in the form of air and land degradation. As a general summary of statistics concerning the economies in East Asia and the Pacific, the average values of carbon emissions, fossil fuels consumption, economic growth, and urbanization are reported in Table 1.

In addition, the East Asian and Pacific regions are highly vulnerable to climate change owing to their geography, climate, socioeconomic conditions, and demographic factors, as well as to the great sensitivity of their natural assets (such as forests and biodiversity) to climate change. Rising emissions of carbon dioxide are endangering species, increasing air pollution, causing damage to coral reefs, and increasing deforestation and water insecurity. Our summary of key environmental, economic, and demographic factors in Table 1 allows assessment of the heterogeneity of the countries included in the panel.

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