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The dynamic links between CO_2 emissions, economic growth and coal consumption in China and India

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HIGHLIGHTS

- ▶ CO_2 emissions, economic growth and coal consumption relationship in China and India is examined.
- ▶ The results indicated the presence of cointegration in China, but not in India.
- ▶ In China, uni-directional causality runs from economic growth to CO_2 emissions.
- ▶ In the case of India, only a short-run causality is detected.

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ABSTRACT

In this study, we employ recent and robust estimation techniques of cointegration to provide more conclusive evidence on the nexus of CO_2 emissions, economic growth and coal consumption in China and India. Furthermore, the causal relationships among the variables are further examined using the Granger causality test. Our empirical results suggest that the variables are cointegrated in the case of China but not India. In other words, there is a long-run relationship between CO_2 emissions, economic growth and coal consumption in China. Granger causality test for China reveal a strong evidence of uni-directional causality running from economic growth to CO_2 emissions. Moreover, there is a bi-directional causality between economic growth and coal consumption as well as CO_2 emissions and coal consumption in the short and long run. In the case of India, only a short-run causality is detected. Causality between economic growth and CO_2 emissions as well as CO_2 emissions and coal consumption are bi-directional. Nonetheless, there is only a uni-directional Granger causality running from economic growth to coal consumption in India. The implications of the results are further discussed.

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1. Introduction

In achieving rapid developmental goals, countries at large face conflicting policy choices from rapid economic growth, significant consumption of resources and environmental deterioration [1,2]. It is more so in emerging economies such as China and India where both the countries have recorded higher economic growths and significant increases in the consumption of coal [1,3,4]. China and India, together, showed significant increases in their percentage of energy use of total world energy consumption, from 10% in 1990 to 21% in 2008 and are expected to increase their energy use to 31% in 2035 [5]. Robust growth in these two countries, even during recession, is expected to increase the coal consumption and consequently influence the CO_2 emissions. If these countries decide to pursue sustainable developmental goals, it might require a reduction in energy consumption, specifically coal, and an increase in the proportion of renewable energy in primary energy supply. In other words, fear of climatic change may limit the use of coal in the future [6]. Indeed, coal consumption contributes more carbon per tonne of oil equivalent than other resources like natural gas and oil. Nevertheless, currently, coal still plays an important role in economic growth and is the second largest source of world CO_2 emissions [3,7]. Although reduction in energy consumption seems to be a viable option in reducing CO_2 emissions, its impact on economic development can be negative. For instance, China's coal consumption in terms of percentage of total energy consumption is nearly 69% and any attempt to reduce it may have potential reciprocal influence on economic growth. Therefore, there is an urgent need to understand the dynamic links between coal consumption, CO_2 emissions and economic development in these countries. This study is timely given the fact that both countries have recorded high economic development and the consumption of coal is becoming an essential energy mix. On the contrary, pressure to

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reduce the CO_2 is mounting, forcing policymakers to find alternatives to reduce per capita CO_2 emissions. In addition, as part of the Kyoto Protocol, participating countries are required to reduce CO_2 emissions collectively, about 5% on average over 2008–2012 [3]. Nevertheless, in reality, CO_2 emissions between 1992 and 2007 have increased by 38% [2].

The real GDP, coal consumption and CO_2 emissions of China and India over the periods of 1965–2009 showed an increasing trend (see Fig. 1). China and India recorded a remarkable growth and in the period of 2001–2009, these economies have been growing at an average rate of 10.5% and 7.4% per annum respectively (see Table 1). China and India being the most populous developing countries have significant influences on global coal consumption and emissions and are expected to have an increasing influence in the future [2,4,6,8,9]. China's and India's per annum average growth for the same periods for coal consumption are 10% and 6.4% respectively and CO_2 emissions are 8.5% and 5.7% respectively. In both countries, with large domestic coal reserves, the coal use for electricity power and industrial processes has increased. Moreover, with increasing coal-fired generation capacity in China and India, coal consumption is expected to increase. Industrial coal consumption from 2008 to 2035 is expected to grow by 67% in China and 94% in India [10]. Between 2003 and 2008, China's coal consumption increased by 71% [10].

In 2008, China was the top total CO_2 emitter in the world surpassing the United States while India ranked at third place. China's per capita CO_2 emissions increased by two and a half times, while India's per capita CO_2 emissions increased two times [5]. Future forecast shows that annual CO_2 emissions will increase 2.5 times from 2005 to 2030 reaching 3084 million tons (Mt) of CO_2 in 2030, recording an annual growth of 3.7% in India [4]. In 1996 China accounted for 13.8% of CO_2 world emissions and the share had increased to 21% in 2007 [9]. The biggest challenge for leaders in China and India is on how to maintain economic growth, while keeping CO_2 emissions as well as coal consumption at an acceptable level so that it will not harm economic growth especially if

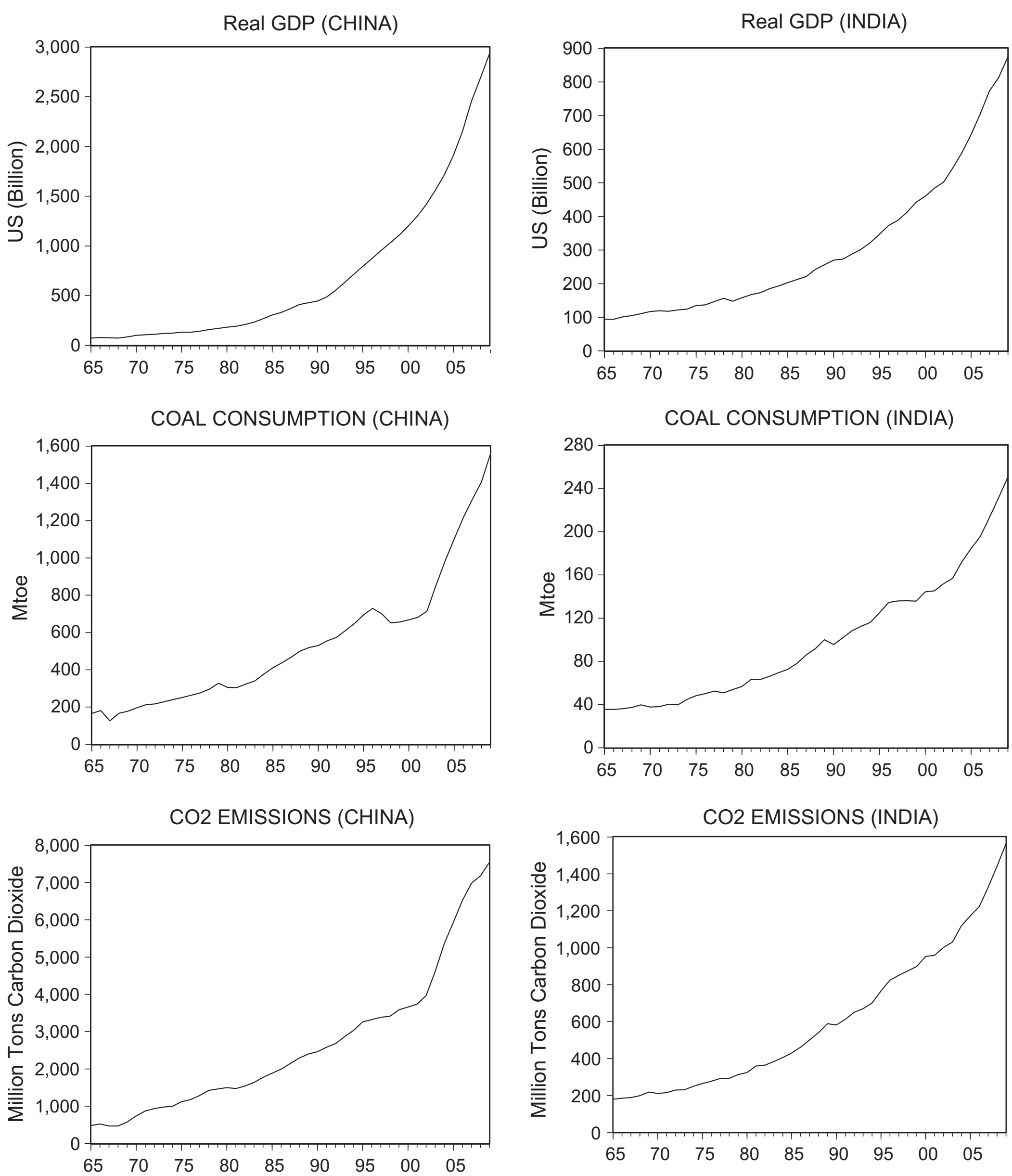

Fig. 1. The plots of real GDP, coal consumption, CO_2 emissions, China and India, 1965–2009.

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