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Sectoral energy-environmental efficiency and its influencing factors in China: Based on S-U-SBM model and panel regression model

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Abstract: Energy use is often accompanied with air emissions including SO_x, NO_x, CO_2, etc. It is essential to consider both the energy and environmental performance of various sectors to ensure better policymaking. This study considered air pollutions by calculating energy-environmental efficiency (EEE) at the sectoral level. A few studies have previously applied the slack-based measure (SBM) model to multi-sector EEE assessments. Despite the advantages of SBM model, potential improvements have rarely been proposed. Therefore, a super-efficiency SBM model with undesirable outputs (S-U-SBM) was used to evaluate the EEE of 31 sectors in China. The policy implications of improving EEE, in microcosmic (potential improvement) and macroscopic (influencing factors) terms, were considered. The results indicated that for all sectors there was an overall trend of increasing EEE from 1995 to 2009, except for Rent and Other Business Activities, and Health and Social Work. The average annual potential for energy-saving and emission-reducing measures in all sectors was 1.396×10^{17}J and 7.0780×10^7 tons, respectively. Chemicals and Chemical Materials had the highest potential to save energy and reduce emissions. A panel regression indicated that the relationship between EEE and gross output was U-shaped for all industry, but had an inverted-U shape for heavy industry. Sectoral size, technology, and the proportion of energy demand satisfied by coal significantly influenced EEE.

Key Words: Energy-environmental efficiency; Undesirable outputs; Super-SBM Model; Panel regression

1. Introduction

Since the reform and opening-up was implemented, China has witnessed rapid growth of its economy, accompanied by a large increase in energy consumption, particularly since 2000. A range of sectors make important contributions to total energy use. According to the China Statistical Yearbook, China's total energy consumption was 4.26 billion tons of standard coal equivalent (tce) in 2014, of which sectoral production accounted for 88.91%. However, energy efficiency remains low compared with most developed countries (Li and Lin, 2016). The process of energy consumption often generates direct and indirect emissions, including fine particles, SO_x, NO_x, CO_2, etc., which raises concerns regarding both domestic environmental quality and global climate security. The Chinese government has committed to