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The effect of urbanization on road energy consumption and CO_2 emissions in emerging megacity of Jakarta, Indonesia

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Abstract

Few studies have been made to explore quantitatively and systematically the impact of urbanization on transport energy use for cities in emerging countries. This paper tries to examine the relationship between urbanization and transport sector energy use in megacity Jakarta. Data from Jakarta Statistical Bureau for the megacity Jakarta and the period 2001-2014 are used and analyzed. Applying both the carbon-emissions-coefficient and the transport-energy-consumption method, we predicted the carbon emissions based on energy consumption, explored the characteristics of energy consumption and carbon emissions in different urbanization stages. Our results show the existence of co-integration and validated that urbanization is a major contributor in transport energy consumption. Income raises vehicle ownership and travel demand. The causality analysis finds that urbanization Granger causes transport energy consumption.

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Keywords: Urbanization; Transport Energy Use; CO_2 emissions; VECM; Granger Causality

1. Introduction

Urbanization in developing countries is known to be one of the most significant demographic changes in this century. This is due to the national economic restructuring and reshaping the lives of billions people. An analysis of the world urbanization trends released by the United Nations, in 2008, for the first time in history, 50% of population

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lived in urban areas and this number will increase to 60% by 2025 (UNDESA, 2008, 2012). The entire urban areas built in the developing countries will triple from 200,000 km^2 to 600,000 km^2 (between 2000 and 2030) (Angel, Sheppard, & Civco, 2005). In 2025, 60% of Indonesia's population will live in urban area (i.e., more than 160 million people). Jakarta population alone will rise about 30% to nearly 13 million people in 2030 (MGI, 2012). Although Jakarta metropolitan area and other urban areas in Java will continue to host the largest urbanizations, medium cities across the country will also grow at a steady pace (OECD, 2014; UNDESA, 2012).

Urbanization has enabled economic growth and innovation across the world. Urbanization contributes to three-quarters of global economic output and is often seen as an important aspect in the assessment of nations' development level (L. Li et al., 2010; MGI, 2011). However, urbanization has also contributed to the socio-economic and environmental challenges including climate change, pollution, congestion, and rapid growth of slums (Al-mulali, Binti Che Sab, & Fereidouni, 2012; Suzuki, Dastur, Moffatt, Yabuki, & Maruyama, 2010). More than half of the world's population now live in urban areas and are blamed for producing as much as 80% of greenhouse gas emissions (GHG) (Feng, Chen, & Zhang, 2013; IEA, 2012; UNDESA, 2008). Whilst urbanization leads to economic growth and living standard improvement, it also increases energy consumption and causes environment pollution (Al-mulali et al., 2012).

Urbanization is defined as a process of regrouping large permanent residents in moderately small areas and as a result forming crowded metropolises (Shahbaz, Loganathan, Sbia, & Afza, 2015). Further, urbanization is immigration from the agricultural area of non-agricultural area. The relationship between urbanization and energy use has been highly studied within energy economics field primarily by multinational empirical research. Results are, however, inconsistent. On the one hand, studies undertaken by H. Li, Mu, Zhang, & Li (2011), O'Neill, Ren, Jiang, & Dalton (2012), and Parshall et al. (2010) nominated urbanization as one of the most important factors affecting energy consumption in China, India, and the United States. These results were supported by studies undertaken in relation to developing countries by Jones (1991) and Parikh & Shukla (1995) and Poumanyvong & Kaneko (2010); in Japan by Sharif Hossain (2011) ; in Tunisia by (Shahbaz et al., 2015); in Canada by Lantz & Feng (2006); in regional China by Zhang & Lin (2012) and in ASEAN countries by Y. Wang, Chen, & Kubota (2015). On the other hand, Larivière & Lafrance (1999) and Ewing (2010) found a negative relationship between urbanization and energy consumption. Similarly, Liddle (2004) argues that urbanization in developed countries is associated with less transport energy use. In line with this argument, Liddle & Lung (2010) report that urban households in the US drive less than their rural counterparts. IEA (2008) also reports that each urban dweller consumes 11% less transport energy than the average US resident. Donglan, Dequn, & Peng (2010) found that residential CO_2 emissions decline in response to energy intensity and increases in response to income effects, in both urban and rural China. In addition, while Cole & Neumayer (2004), and (Liddle & Lung, 2010) found a positive relationship between urbanization and CO_2 emissions, Fan, Liu, Wu, & Wei (2006) located a negative relationship between the two variables in developing countries. Similarly, whilst Martinez-Zarzoso & Maruotti (2011) demonstrated an inverted U-shaped relationship between urbanization and CO_2 emissions, Zhu, You, & Zeng (2012) found little evidence to support that relation. Moreover, the impact of urbanization on urban transportation energy consumption is rarely discussed (Poumanyvong, Kaneko, & Dhakal, 2012; Ren, Wang, Wang, & Liu, 2014; Yuan, Ren, & Chen, 2015). Our article contributes to this debate by examining road energy consumption in a case study of megacity Jakarta.

Whilst previous studies focused largely on regional or national level of analysis our research aimed to estimate the elastic coefficients in the provincial "urban" level. On a regional level analysis, for instance, Liang & Yuchen (2012) conducted panel estimation for urbanization, energy consumption and CO_2 emissions using the IPAT model. Similarly, Feng et al. (2013) focused on a regional comparative analysis of CO_2 emissions using IPAT model. H. Li, Mu, Zhang, & Li (2011) analyzed the regional differences on impact factors of China's energy-related CO_2 emissions using STIRPAT model. Drawing on these previous studies, firstly we calculated the CO_2 emissions in Jakarta province over the period of 2001 to 2014. This is followed by an investigation of the relationship between urbanization, energy consumption, and CO_2 emissions using unit root tests, co-integration test, and Granger causality test. The research results indicate that understanding the relationship between these factors is key to guide the coordination and sustainable development of urbanization, energy consumption, and CO_2 emissions.

The rest of the paper is organized as follows. Section 2 covers general situation of case study area, estimation methods of CO_2 emissions and data issues. Section 3 reports and discusses the empirical results, and conclusions and policy implications are provided in Section 4.