



Coal consumption, urbanization, and trade openness linkage in Indonesia

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ABSTRACT

This paper explores the effects of economic growth, urbanization, industry, and trade openness on coal consumption in Indonesia over the period 1970–2015. To closely adhere to the Environmental Kuznets curve narratives, we consider coal consumption which has been scarcely explored in the EKC debate, as a proxy of environmental pressure. We estimate the autoregressive distributed lag (ARDL) method and confirm that the variables are cointegrated for long run linkage with the presence of structural breaks. The empirical evidence showed that economic growth, urbanization and trade openness increase coal consumption while decreasing share of secondary industry reduce it. We also verify the existence of environmental Kuznets curve. Having a vital role in the energy mix, Indonesia needs to restrain excessive coal consumption to enhance environmental quality. Our results also imply urbanization and trade openness are crucial factors on coal consumption. Consequently, it should be taken into consideration in energy policy-making process, such as energy conservation policies in the residential sector and prioritize foreign investment which brings cutting-edge coal technologies.

1. Introduction

The relationship between energy consumption, climate change, economic development, and demographic change has been the subject of intense study in the last decades. In the Asian region, climate change is becoming big environmental issues. Negative economic impact of climate change accompanied by rapid natural capital depletion remain significant burdens for many nations' performance, particularly for extreme vulnerability to climatic change and resource-driven economies (Kurniawan and Managi, 2017). Economic impacts of climate change on the secondary and tertiary level of economic activities are wide and complex and eventually may be larger, including on human health, productivity, and agricultural production (Kumar and Yalew, 2012). In several countries such as China and India which characterized by substantial differences across their industrial structure and their level of urbanization, both are expected to further deteriorate the linkage between their economic development and the pollutant emissions (Jiang, 2008).

Concerning for sustainable development issue, especially in countries with high growth rates, the study related to the Environmental

Kuznets Curve (EKC) is gaining interest in the relevant literature. It posits the link between economic growth and environmental indicator follows an inverted U-shaped curve. EKC hypothesizes prompt that after achieving a certain level of gross domestic product (GDP) per capita, the increasing pattern of environmental indicator reverses so that rising GDP per capita induces environmental recovery.

Over the last decades, Indonesia, a member of the G20 and addition the largest economy in Southeast Asia has enjoyed high rates of economic growth. According to World-Bank (2017), Indonesia's GDP per capita has steadily soared from US\$ 665 in the year 1965 to \$ 3974 in 2016. With more than 4% urbanization growth Indonesia has been becoming urbanized, currently, more than one half of the Indonesian population lives in urban areas (UNDP, 2017). Following the growth, energy consumption has been increased, the residential sector is one of the largest consumers of energy in Indonesia.

Facing huge demand, coal is expected to be the fuel of choice for Indonesia in the future, because of its reserves, price, and ease of use. Concerning coal consumption and CO₂ emissions, the previous study (Bloch et al., 2012; Govindaraju and Tang, 2013) have confirmed the strong causality in both short-run and long-run among it. Having lower

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thermal efficiency, we need more coal to get the same amount of heat, even compare to another fossil fuels such as oil and gas. It leads to higher emissions of carbon dioxide (CO₂), the primary Green House Gas (GHG). Even though emitting much CO₂ during its combustion, coal consumption has been continuously growing. Facing this issue, coal consumption can be considered as a proxy for Indonesia's environmental performance.

Scholars have been studied the existence of the EKC hypothesis with respect to energy, both for developed and developing countries. Therefore, the empirical evidence remains controversial and is not conclusive to present policy recommendations that can be applied to a specific country (Ozturk and Acaravci, 2010). While a substantial amount of this work relies on cross-country panel data analysis, portraying only general inferences of the EKC hypothesis far less is known about the distinctive complexity of economic environments and the historical experience of individual countries (Ang, 2008; Lindmark, 2002; Stern et al., 1996).

On the other hand, several studies investigated the linkage between energy consumption, economic growth, trade openness and urbanization. Incorporating panel data of newly industrialized countries, Hossain (2011) found cointegration among the variables. Focusing on Malaysia, Shahbaz et al. (2015) found the effect of urbanization and trade openness toward increasing energy consumption in the country. As suggested by Shahbaz et al. (2013b), trade openness is considered not only related to China's economic growth but also strongly related to its energy consumption. Ma and Du (2012) found urbanization has a positive linkage toward energy consumption in China case. Ekpo et al. (2011) found the dynamic relationship between energy demand and per capita income growth, industrialization and urbanization for Nigeria case. Specifically to coal, previous studies suggested the relevance of per capita economic growth toward coal consumption (Bloch et al., 2012). From the demand point of view, urban population tend to consume more electricity and industrial good (Azam et al., 2015), while secondary industries considered as the primary consumers of coal (Hao et al., 2015). The strong relationship between coal consumption, economic development, and the socioeconomics provide the empirical evidence of the EKC hypothesis. However, considered as the fourth most populous country and major coal exporter, to the best of our knowledge, there have been no comprehensive studies on the impacts of the variable to the coal consumption in Indonesia.

From the backdrops, there are specific endowments of this study that incorporate current empirical research on the energy-related literature. First, we intend to discover the linkage between coal consumption, economic growth, urbanization, industrial, and trade openness in Indonesia case over the 1970–2015 period. Second, we propose coal consumption which has been scarcely explored in the EKC debate, as a proxy for environmental pressure for the environmental Kuznets curve hypothesis in Indonesia's context. Third, by focusing on Indonesia, this study intends to conduct a novel study to the main coal exporting country alongside fulfilling fast-growing domestic demand as a fourth most populous nation. Fourth, we account for the presence of two unknown structural breaks in the estimation process by employing the Narayan and Popp (2010). This is particularly important in the case of Indonesia where coal consumption increased at the beginning of 1980 and the Asian financial crisis hit the country in 1997 with the potential of creating breaks in the series. Then, we employ the ARDL bounds testing approach to examine the cointegration existence among the variables in the presence of structural breaks.

This paper is organized as follows. Section 2 provides Indonesia's pattern of energy consumption especially coal. Section 3 describes the literature related to the coal consumption and EKC hypothesis. Section 4 outlines the research methodology and data. The results are presented in Section 5. Conclusions and policy implications are presented in Section 6.

2. Background: Indonesia's energy profile

Indonesia is considered as a major fossil fuel producer and exporter. The country is one of the world's largest producers and exporters of coal, especially thermal coal. In term global coal reserves, Indonesia currently ranks 9th, approximately 2.2% of total proven global coal reserves according to BP Statistical Review of World Energy. In addition, this country is the seventh-largest liquefied natural gas (LNG) exporter. Coal as part of natural capital is considered as one of the important productive based that contribute to wellbeing (Kurniawan and Managi, 2018c). As oil production declined and demand rose, Indonesia has shifted from an oil exporter to a net oil importer in 2004.

The energy sector in Indonesia faces several deviances. With the political change following the Asian Financial Crisis in the late 1990s, the government began to decentralize by transferring authority for some resources, such as coal, to the provincial and local governments. This brought confusion to the resources management followed by massive exploitation, along with the limited capacity of the local governments to enforce the regulation and the low competence of the investors (Gandataruna and Haymon, 2011). Gunningham (2013) point out an energy trilemma as a central challenge for energy governance in Indonesia, competing for demands of energy security, climate change mitigation and energy poverty. Too many licenses were granted to unqualified businesses as a quick way to raise revenues. It also contributed to the development of illegal mining, as control by the central government diminished.

In the energy sector, despite its huge renewable-energy potential, the share of fossil fuels is currently approximately 96% of the total primary energy consumption (NEC, 2014). Indonesia's energy consumption still depends on fossil fuel such as oil, coal and natural gas as sources of primary energy (Hasan et al., 2012). The extraction and utilization of coal have also potentially damaged Indonesia ecological systems at the same time. The country is considered experiencing a wide range of environmental problems including threats of climate change. The economic loss as undesirable output attributed to climate change in Indonesia is estimated to reach 2.5–7.0% of GDP by 2100, according to World Bank. The health problem caused by air pollution can cost more than \$400 million per year (Leitmann et al., 2009).

Considering the reserves, price, and ease of use, coal plays important role in Indonesia's energy sector. After oil, coal was the main contributor to Indonesia's energy mix, followed by gas. Coal has managed to gradually reduce the share of oil in the Indonesia energy mix, which has grown at a slower average rate of 1.9% per year in the past decade. A high dependency on fossil fuels, especially coal, also found in the electricity sector, in 2014, 52.8% of the electricity was generated from coal. To increase the electrification rate to 100% by 2020 and to ensure the security of the energy supply, Indonesia has launched the Electricity Fast Track program to boost the electricity generation capacity. The first phase of the program relies completely on the coal-fired power plant. Furthermore, several big Indonesian coal mining companies have expanded into integrated energy companies that consume their own coal for producing electricity.

From a policy perspective, the coal role affects energy in Indonesia is captured from the National Energy Plan, which is regulated in Government Regulation 79/2014. This policy sets out the plan toward energy mix composition by 2025 ambition to transform the energy mix by 2025 as follows: 30% coal, 25% natural gas, 23% renewable resources, and 22% oil. Translating to absolute figure, using the scenario, coal contribution is more than triple compared to the current figure. Furthermore, this policy sets out on re-establishing Indonesia's energy independence to the domestic market. As for an implication, coal export is to be declined and prioritize domestic consumption. Following the policy direction, Indonesia launch General Plan of Electricity, a derivative of the policy on the electricity sector. According to the document, in order to serve the base load and to fulfil 100% of electrification rate by 2020, the country will continue to develop coal-fired power

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