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The nexus of renewable energy-agriculture-environment in BRICS

Xuyi Liu[a], Shun Zhang[a,b], Junghan Bae[a,*]

[a] School of International Economics and Business, Yeungnam University, Republic of Korea
[b] School of Business, Luoyang Normal University, Henan, PR China

HIGHLIGHTS

- The nexus of renewable energy-agriculture-emissions is examined in BRICS.
- Positive of agriculture and negative of renewable energy affect emissions.
- Renewable energy Granger causes emissions in short- and long-run.
- No causality is found between agriculture and renewable energy.
- Renewable energy use and agricultural management can halt the global warming.

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ABSTRACT

The present paper is the first attempt to investigate the nexus of per capita renewable energy, agriculture, and CO_2 emissions, together with output and non-renewable energy, in a 1992–2013 sample of BRICS countries. Panel unit root tests indicate that all the time series data are stationary in first difference, and panel co-integration tests prove the existence of co-integration relationship between the variables. The three panel long-run elasticities demonstrate that both per capita output and renewable energy play negative roles in emissions, while per capita nonrenewable energy and agriculture exert positive effects on emissions. Moreover, there is a feedback hypothetical relationship of CO_2 emissions and non-renewable energy, unidirectional relationships from renewable energy to both emissions and non-renewable energy, from agricultural value added to output, and from output to non-renewable energy in the short-run. In the long-run, causalities are found from other variables to emissions, and to non-renewable energy use. Therefore, BRICS countries' policymakers should encourage the consumption of renewable energy and strengthen the management of agriculture to halt global warming.

1. Introduction

Many climate changes and emissions milestones have been achieved in the past several decades. Fourteen years since 2000 have been the hottest years ever recorded. The average temperature growth globally was up to 1 °C in 2015 [1]. According to the International Panel on Climate Change,[1] the share of carbon dioxide (CO_2) emissions is about 76% of total global greenhouse gases (GHG). In the past half century, global CO_2 emissions have increased 2.59% per year, amounting to about 35.85 billion metric tons worldwide in 2013 [2]. In 2015, the Paris Climate Agreement made a plan to limit the global temperature increase to 2 °C [3]. To accomplish this goal, every participant made concrete post-2020 proposals [4].

According to the Food and Agriculture Organization of the United Nations,[2] GHG emissions from agricultural sectors accounted for 21% of the global total and were the second largest emitter. Agricultural GHG emissions are mainly produced from deforestation, livestock emissions, soil, and nutrient management, such as the use of fossil fuel-based fertilizers, agricultural machinery, and the burning of biomass. However, the report also stated that the agricultural sector can substantially contribute to reducing total emissions by 20–60% in 2030 and thus balance the global carbon cycle by reducing deforestation, rejuvenating forests, strengthening management of plant and livestock, and generating renewable energy.

With nearly half of the global population and economic development, the BRICS (Brazil, Russia, India, China, and South Africa) countries emitted more than 40% of global total CO_2 emissions in 2013. Their non-renewable energy consumption also accounts for more than

* Corresponding author.
E-mail addresses: liuxy1017@gmail.com (X. Liu), zhangshun0723@gmail.com (S. Zhang), jhbae@ynu.ac.kr (J. Bae).

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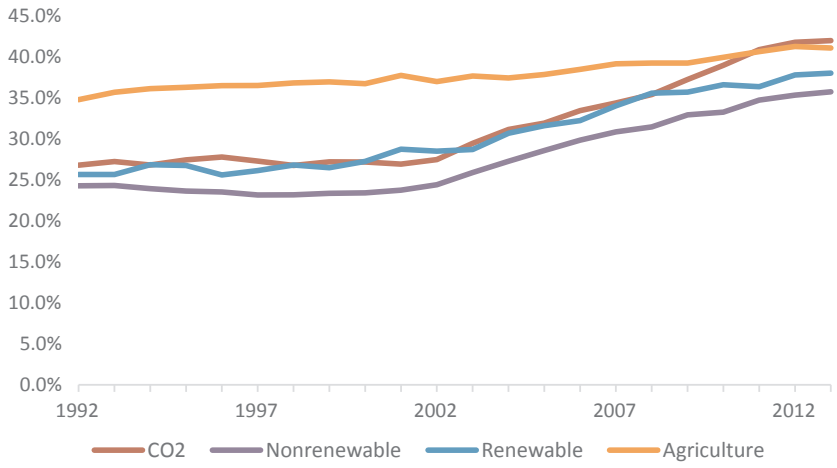

Fig. 1. The share of some selected variables in global total in BRICS.

35% of worldwide total (Fig. 1). In order to coordinate the tasks of global emission reduction to combat global warming, BRICS countries have enacted different emissions plans. Under the business as usual levels, Brazil and South Africa have pledged to reduce emissions by 36–39% and 34% by 2020. In relation to the emissions intensity of GDP, China and India have announced 40–45% and 20–25% reduction by 2020, compared with the level of 2005. Russia has committed to a reduction of 10–25% compared with the 1990s.[3] In 2014, China's agricultural output was valued at about 656.9 billion US$ (constant 2010 US$), which is double India's, the second ranked. Brazil created about 100.9 billion US$. BRICS countries in total contribute more than 40% of global agricultural value added.

According to the Goa Declaration at Eighth BRICS Summit, the five countries released a joint declaration that emphasized the importance of cooperation in agriculture. Moreover, the summit agreed on the first set of loans by the New Development Bank (NDB) to mainly support the renewable energy projects in these countries. As the main generators of renewable energy, BRICS countries generate more than 35% of total renewable energy in the world, with national contributions decreasing in the following order: Brazil (74%), China (23%), Russia (16%), India (15%), and South Africa (6%).[4] Fig. 1 presents the share of selected variables in global total in BRICS.

As an association of five major emerging national economies, few studies deal with the relationship between CO_2 emissions, renewable energy, and agriculture in BRICS countries. For this purpose, the present paper is to explore the nexus of per capita renewable energy consumption, agricultural value added, and CO_2 emissions, together with output and non-renewable energy consumption in a panel of BRICS countries from 1992 to 2013. The paper makes the following new contributions beyond the present literature: First, this is the first paper to examine the linkage of renewable energy, agriculture, and emissions, which can fill the research gap of literature on the relationship among selected variables in BRICS countries. Second, two panel co-integration test are used to explore whether or not co-integration exists between the variables. Third, this paper uses panel long-run estimates to analyze the impact of output, nonrenewable and renewable energy, and agriculture on emissions. Finally, we use the panel vector error correction model (VECM) to confirm directional causalities among selected variables.

The rest of the paper is structured as follows. Section 2 reviews the literature. Section 3 outlines the model, methodology, and data. Section 4 presents the results and discussion. Finally, Section 5 provides the conclusions and implications.

2. Literature review

In recent decades, many econometrical studies have examined the relationships among the carbon dioxide emissions and other variables, such as economic growth, energy (nonrenewable and renewable energy) consumption, capital, labor force, trade openness, foreign direct investment, and urbanization [5–12]. Some variables have been found to play positive and some negative roles in emissions. The inconsistent results mainly depend on the usage of different data sets, countries' characteristics, time periods, and methodologies [13–15]. By using VECM and Lagrange Multiplier (LM) tests, Ang [16] explores the long-run linkages of economic growth, CO_2 emissions, and energy usage in Malaysia from 1971 to 1999. The LM test indicates that in the long-run both emissions and energy use play positive roles in economic growth. According to VECM results, both unidirectional short- and long-run were found from economic growth to energy use. Employing the Toda-Yamamoto (TY) approach [17], Soytas and Sari [18] combined the emissions-related determinants such as economic growth, energy use, capital, and labor to examine the Granger causalities in Turkey from 1960 to 2000. The empirical result shows that emissions Granger cause energy use only. An emission reduction policy can be implemented because of lack of long-run causal linkage in GDP and emissions. Jaunky [19] uses two-step difference generalized methods of moments (GMM) [20] and dynamic ordinary least squares (DOLS) [21] to investigate the linkage of CO_2 emissions and real incomes with a sample of 36 high-income countries from 1980 to 2005. The finding shows that short- and long-run unidirectional causal linkage exists from real income to emissions. Moreover, the DOLS estimates indicate that a 1% increase of per capita income leads to 0.68% short-run and 0.22% long-run increases of emissions.

Applying the methodologies of augmented mean group (AMG) [22] estimator and GMM Granger causality, Shafiei and Salim [23] explore the impacts of population, income, renewable and nonrenewable energy, industrialization, and urbanization on CO_2 emissions from 1980 to 2011 in the 29 Organization for Economic Cooperation and Development (OECD) countries. The findings indicate that non-renewable energy has a positive impact on emissions, but renewable energy negative. Moreover, the higher the urbanization, the lower the environmental degradation. Some implications have been given such as urban planning and the development of clean energy use. Tang and Tan [24] examine the linkage of per capita carbon dioxide emissions, energy consumption, foreign direct investment (FDI) and real GDP in the case of Vietnam from 1976 to 2009. Using the methodologies of multivariate Johansen co-integration [25] and VECM Granger causality, the empirical long-run estimates indicate that per capita energy consumption and real GDP play positive roles in CO_2 emissions. Moreover, in the short- and long-run, energy Granger causes emissions. Only short-run

[3] Goa Declaration at Eighth BRICS Summit, 2016. http://www.mea.gov.in/bilateral-documents.htm?dtl/27491/Goa+Declaration+at+8th+BRICS+Summit.

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