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EXAMINING THE ENERGY REBOUND EFFECT IN SOUTH AFRICA WITHIN A BRICS COUNTRIES CONTEXT

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Overview

Given its contribution to the warming of the earth atmosphere, the carbon dioxide (CO_2) matter captivates the attention of the world. The CO_2 emitted throughout human activities has been characterized as the most compelling contributor to greenhouse gas (GHG) emissions. From a supply point of view, substitution of traditionally "dirty" fossil fuels for energy generation with renewable cleaner ones is considered the way forward to eliminate the negative consequences of CO_2 emissions. Their main aim for a demand point of view is the reduction of the energy requirements of the countries and at the same time, make sure they consume energy less intensively (energy efficiency improvements).

In the past two decades, South Africa has taken significant steps towards the reductions of CO_2 emissions. In 2002 South Africa signed the Kyoto Protocol which is a legally binding agreement to lower emissions of GHG. South Africa adhered to the United Nations Framework Conventions on Climate Change (UNFCCC) with the aim to reduce GHG emissions by 34% by 2020. In 2005, the first National Energy Efficiency Strategy of South Africa was released demonstrating the political will to improve energy efficiency in the country by suggesting and promoting certain technologies, programmes and policies. South Africa established a carbon capture and storage (CCS) Centre in 2009. The aim was to construct a CCS plant by 2020 for coal and liquid fuels, capturing 40 million tons per year. The South African energy development institute (SANEDI) was put in place in 2008 to uplift the climate mitigation options, energy efficiency and renewable energy and to facilitate the implementation of drafted climate policies. So if all these are in place why do CO_2 emissions keep rising? And of course not only in South Africa but in most emerging economies such as the BRICS.

In the literature, the rebound effect is the reason why energy saving and energy efficiency policies do not have necessarily and always the expected impact on the reduction of CO_2 emissions. A new energy-saving technology (which can be a programme, a tax or an actual tangible technology) aims at lowering the energy bill of the consumers and hence, eventually, a reduction in emissions. However, such a "lowering of the bill" may be perceived as a reduction of the real price of energy services and hence, a tendency of the consumers to eventually increase their demand for energy which partially offsets the energy-saving potential of the initial technology. Also, by this reduction in energy prices, the real incomes of consumers increase, and the consumers spend the increases in consuming other goods and services, offsetting here once more the emission reduction prospects of the initial technology. In the literature, technologies that were evaluated for their rebound effects were the carbon tax and technologies that directly increase the energy efficiency of consumers.

The main purpose of this study is to test the hypothesis of the rebound effect for the South African case in the years between 1990 to 2014 by firstly, decomposing the driving forces of the changes in CO_2 emissions of the country and secondly, comparing with the behaviors of other emerging economies such as BRICS.

Methods

Decomposition techniques have been used extensively in the energy literature to decouple the effects of various factors on the evolution of emissions (for example some recent studies include Ang and Choi, 1997; Bhattacharyya et al. 2010; Hammond and Norman, 2011; Kumbaroglu, 2011; Sheinbaum et al., 2011; Wang et al, 2011; Zhao et al, 2010b; Cansino et al., 2015; Shao et al. 2016; Sumabat et al., 2016; Xu et al., 2016). The paper of Shao et al. (2016) for example employed the specific LMDI model to disaggregate China's emissions into factors such production of the economy and the intensity of energy use. They extended their model by including also investment behaviors. Among their results, they showed that the impact of energy intensity towards cutting emissions was less than expected due to the rebound effect.

This study adopts the theoretical foundations from the initial Kaya identity: I=PAT, impact=population x affluence x technology). The assumption in that identity is that the drivers of the emissions do not interact with each other; but their relative contributions both in sign and magnitude can be detected and compared over time. In the LMDI method used here, changes in CO_2 emissions are decomposed into five factors: the carbon intensity of energy use (CIt), energy intensity of real GDP (EIt), contribution of the economy to the rest of the world (OutputShare), GDP per capita (OutputCap) and population. The decomposition identity looks as follows:

$$C02_i = \sum \frac{C0_{2,i}}{Energy\ consumption_i} \frac{Energy\ Consumption_i}{GDP_i} \frac{Output_i}{Output} \frac{Output}{population} population$$

Hence, changes in emissions are equal to the sum in changes of each of all the drivers. The logarithmic scheme (weight) used here is adopted from Zhao, Ma and Hong (2010) where w_{it}= ln (CO_{2it}/CO_{2i0})=(CO_{2it}-$C0_{2i0}$)/ln(CO_{2it}/CO_{2i0}).The energy and emissions data are retrieved from the BP Statistical Review 2016 dataset while the economic and population data from the World Development Indicators of the World Bank for the BRICS countries (Brazil, Russia, India, China, South Africa) for the period 1990 to 2014. To answer the main research question of the study, the empirical results presentation will be primarily focused on the second driver as discussed above: the energy intensity effect. I will examine the specific case of South Africa (within the context of BRICS) and see if the findings indicate a significant rebound effect for the full sample or whether it appeared only for some of the years and whether South Africa's behavior has any differences to the rest of the BRICS.

Results

The overall results of the decomposition exercise for the BRICS countries for the whole studies period suggest that the changes in CO_2 intensity and Energy intensity had a negative impact to the changes in CO_2 emissions: in other words, as the energy intensity (energy consumption per unit of economic output) decreased for all the countries (possible technological developments), the emissions kept rising. The factors that intensified the increasing trend are primarily the socioeconomic drivers considered in the model (output share to the rest of the world, output per capita and population). These preliminary results provide an indication that the BRICS experienced a rebound effect for this period. Dividing the sample period in three (1990-2000; 2000-2008; and 2008-2014), it is observed the energy intensity was a negative contributor to CO_2 emissions only for the last period, after the financial crisis of 2008-09. That is exactly the period where the effect of the output share to the world, although always positive, grew in magnitude substantially.

The BRICS countries presented quite a variety in their results for the period. The energy intensity effect was a positive contributor to CO_2 emissions ("pushed" the emissions higher) for Brazil and Russia, while for India and China an indication of the rebound effect was observed (negative contributors: lower intensity lead to higher emissions). For South Africa, the energy intensity effect was negative for the overall period (with fluctuations when examined on a year-on-year basis). The results for the rest of the driving forces vary as well (to be discussed in detail in the final paper and presentation).

Conclusions

Energy efficiency improvements have the potential to reduce the effective prices of energy and hence, reduce the initial targeted energy savings and conservation. Understanding, thus, the existence and magnitude of the rebound effect in a country, stemming from efforts to improve the country's energy intensity, will assist in choosing the most appropriate design and timing of an energy conservation policy or energy reducing technology promotion and implementation. In this paper, I adopt a macroeconomic point of view in the studying of the phenomenon for the South African case. To do so, I use an LMDI decomposition model to disaggregate the energy intensity effect and other factors affecting the evolution of CO_2 emissions in the BRICS countries. The results show an indication of the rebound effect taking place in the country. Establishing the size of this direct effect will assist the policy makers of the country with their expectations of the expected outcomes from environmental and energy policies and implementation of technologies with regards to emission reduction. Future research will include an econometric analysis taking into account microeconomic principles and household characteristics of the rebound effect and the relationship between energy efficiency and CO2 emissions.

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