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The impact of sources of energy production on globalization: Evidence from panel data analysis

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ABSTRACT

Greenhouse gas (GHG) emission is one of the major reasons for global warming and climate change. Among various sources responsible for GHG emission, energy generation is found to be the leading one. Increased economic activities facilitated by the ever-expanding level of globalization lead to substantial accumulation of GHG in the atmosphere. Hence, the relationship between economic growth and environmental degradation remains a primary concern to policymakers as well as concerned stakeholders. This study aims at investigating the relationship between the sources of energy production – fossil sources and renewables, and the level of globalization. A panel data consisting of 26 countries from the list of Annex I Parties to the United Nations Framework Convention on Climate Change (UNFCCC) for 21 years has been analyzed. The study finds that an increase in the electricity production from fossil based sources, i.e. oil and coal, reduces the level of globalization. It also supports the argument that coal is more detrimental to the environment. Moreover, this study finds a significant negative influence of the use of renewables for energy production on the level of globalization. This finding supports the premise that renewable energy is used domestically and works as import substitute for energy demand leading to a negative effect on globalization. Further study in developing countries with larger sample may help compare and contrast the effect of sources of energy on globalization.

1. Introduction

The year 2016 experienced the highest annual global average land and ocean surface temperature since 1880 with an anomaly of 0.94 °C above the 20th century average [23]. Annual record of average temperature has been broken in three years since 2014 in a row by the largest margin ever. The year 2008 was the coldest year of the 21st century, and the period 2001–2010 was 0.217 °C warmer than that of the preceding decade [18,22]. More specifically, "each of the last three decades has been successively warmer at the earth's surface than any preceding decades since 1985" [15]. The Fourth Assessment Report (AR4), prepared by the Intergovernmental Panel on Climate Change (IPCC), affirms that the global sea level has risen on an average at the rate of 1.8 mm per year over the period of 1961–2003 and at the rate of 3.1 mm per year over the period of 1993–2003 [14]. Recently published, the Fifth Assessment Report (AR5) indicates that over the period of 1901–2010, global mean sea level has risen by 0.19 mm per year ranging from 0.17 to 0.21 mm [15]. However, these changes are nothing new because the humanity has experienced several extensively long-term climatic changes in the past; for instance, the most recent ice age lasted up until 10,000 years ago. AR5 also informs that greenhouse gas (GHG) emissions – the major reason for anthropogenic climate change – between 2000 and 2010 increased by 10 Giga ton Carbon di Oxide (CO_2) equivalent (CO_{2e}) [16]. While important for sustenance in the earth, CO_2 is affecting global warming and climate change.

Future GHG emissions are the product of very complex dynamic systems, determined by driving forces such as demographic development, socio-economic development, and technological change [13]. These driving forces are greatly the results of production and consumption attitude of individuals and nations whilst affect the volume of emissions. Production and consumption are also the indicators of national income and growth. The Environmental Kuznets Curve explains the environmental degradation and income, where it underpins that at the initial stage of growth pollution increases and after a certain level the trend reverses. Boutabba [4] also argues that financial development causes environmental pollution. Hence, decoupling growth and environmental pressure has been a priority to the global leaders; for instance, the Organization for Economic Cooperation and Development (OECD) adopted this principle as the main objective of the OECD Environmental Strategy [24]. Research has found that

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growth of an economy is promoted by globalization [7]. In contrast, some researchers have argued that globalization is threatening and irresistible with the potential to eliminate local differences [26]. Whatever the controversy in defining and analyzing globalization, people from different wings of the society including academia and practitioners acknowledge that the world is more globalized and the behavior of the different sectors of the society displays accordingly [21].

The competitive advantage that an economy can achieve from being global is much pronounced among other reasons boosting globalization. Natural environment is affected by any dimension of globalization irrespective of its focus to the economic integration, political interaction, flow of information and cultural assimilation [27]. In academia and research, globalization has received considerable attention in the recent years. Globalization has been tested as dependent and also as independent variable with relation to a wide range of topics. Studies have concentrated on the association of globalization with, for instance, energy demand [29], environment [27], emission [12,17], growth and economic development [10,2,6], tourism [8], infant mortality [31] as well as obesity [9]. Panyotou [27] discussed globalization with trade-related environmental effect, relation of environment to capital flow and foreign investment as well as technology. Shahbaz et al., [28] found that economic growth in the long run is inversely related to CO_2 emissions as well as energy consumption; and financial development is positively related to CO_2 emission [20] and thus contribute to environmental degradation. Study also found a positive relationship between per capita real income growth rate and carbon emissions; however, Shahbaz et al., [28] found neutral relationship between globalization and CO_2 emissions. Lee and Min [19] also showed how carbon emission is affected by globalization. Chen and Hsu [5] showed that oil price volatility reduces trade significantly for net oil-importing countries while for net oil exporters the impacts are not statistically significant. The volume of trade ultimately affects globalization. Al-mulali [1] investigated the relationship among emissions, trade and energy consumption. Al-mulali and Binti Che Sab (2012) examined the relationship between emissions and development. It is evident that emissions already attracted substantial number of researchers globally with specific focus on different regions. However, Overland [25] argued that although globalization covers many sub-topics, energy is a missing link. Overland [25] also showed that energy has not been taken into consideration in the six major composite indices of globalization including the *Konjunkturforschungsstelle* (KOF) Index which has been used in this research.

Different initiatives and approaches have been undertaken and implemented in both developed and developing countries to reduce carbon emission. For developing countries, Nationally Appropriate Mitigation Actions (NAMA) refers to the actions under the supervision of the national government that reduce GHG emission. On the other hand, developed countries have agreed on nationally appropriate mitigation commitments or actions on quantified economy-wide emission targets for 2020. Apart from NAMA, clean development mechanism, Reducing Emissions from Deforestation and Forest Degradation (REDD) and REDD+, emissions from international aviation and maritime transport are other initiatives for reducing emissions.

Although both emission and globalization separately appealed the researchers globally with a varied set of investigations, study focusing the impact of emission on globalization is hardly found. The level of emissions varies extensively with the sources of energy production. CO_2 emission from the use of fossil fuel constitutes 57% of the total global GHG; and energy supply, while emitting more than one fourth of the total, is the highest contributor to the accumulation of GHG [14]. Considering these substantial impacts of fossil fuel and energy generation on emissions, this study aims at finding the relation, if there is any, between the sources of energy production, i.e. fossil sources and renewables, and the level of globalization. This study investigates how the varied emissions from fossil-based energy generation and also from renewable sources affect the level of globalization of countries. Since the volume of oil export and import for energy generation fluctuates significantly among nations, it is likely that diverse sources of energy differently affect trade and consumption and thus globalization. Hence, the research focuses on how the level of globalization is affected by the use of fossil and renewable sources a country consumes for energy production.

This study contributes to the existing literature in two important ways. First, the research relates two seemingly unrelated issues – globalization and the sources of energy. Although globalization has many contributions to other variables and vice versa, link of globalization to fossil and renewable energy sources is likely to add a new dimension. Second, the quantitative approach for linking globalization to energy sources is likely to assist policymaker's emphasis on energy sources as an additional dimension towards trade policy.

The next section discusses the data and methods followed by findings and discussions in Section 3. Section 4 concludes the paper.

2. Data and methodology

2.1. Data description

This research considers Annex I countries to the United Nations Framework Convention on Climate Change (UNFCCC). The rationale behind, these countries are excessively involved with production and usage of renewable energy; hold superior position in the ranking of globalization compared to the developing part of the world (i.e. all of the sample countries are among the top 50 globalized nations in the world); and maintain a standard and accessible database, which is essential for the intended research. Moreover, the selected countries represent the OECD group to a larger extent (only three of the 26 selected countries are non-OECD countries) and share almost 59% of the world's gross domestic product (GDP) (in 2016 price). This implies that the sample countries can render a general conclusion about the topic of interest of this research. However, data for all Annex I countries are not available especially at the threshold periods. As such, some countries for which data for a substantial period is missing (or because of the presence of extreme values that are considered outliers) have been excluded from the study. Finally, 21-year data ranging from 1990 to 2010 have been gathered for 26 countries out of 43 Annex I Parties (Table 1).

To test the causal relationship between variables, this study considers the overall level of countries' globalization as dependent variable. Of course, globalization can be driven by various factors. However, the theme of the current research is to check the impact of sources of energy on globalization. As such, this research selects few independent variables, which are assumed to represent different sources of energy. Sources of energy are primarily bifurcated as renewable and non-renewable. Non-renewable sources of energy are the fossil fuels comprised of coal, petroleum and natural gas. Electricity produced from coal and electricity produced from oil are treated separately as proxies for fossil-based sources of energy. An alternative to fossil-based fuel is renewable sources of energy. Renewable energy is generally defined as energy that is collected from resources, which are

Table 1
List of countries included.

Australia	France	Latvia	Russian Federation
Austria	Germany	Netherlands	Spain
Belgium	Greece	Norway	Sweden
Bulgaria	Hungary	Poland	Turkey
Canada	Ireland	Portugal	UK
Denmark	Italy	Romania	USA
Finland	Japan		