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Economic growth, CO_2 emissions, and fossil fuels consumption in Iran

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ABSTRACT

Environmental issues have attracted renewed interest and more attention during recent years due to climatic problems associated with the increased levels of pollution and the deterioration of the environmental quality as a result of increased human activity. This paper investigates the causal relationships between economic growth, carbon emission, and fossil fuels consumption, using the relatively new time series technique known as the Toda-Yamamoto method for Iran during the period 1967–2007. Total fossil fuels, petroleum products, and natural gas consumption are used as three proxies for energy consumption. Empirical results suggest a unidirectional Granger causality running from GDP and two proxies of energy consumption (petroleum products and natural gas consumption) to carbon emissions, and no Granger causality running from total fossil fuels consumption to carbon emissions in the long run. The results also show that carbon emissions, petroleum products, and total fossil fuels consumption do not lead to economic growth, though gas consumption does.

1. Introduction

During the last decade, an unprecedented state of global warming has been witnessed. Many scientists have argued that increasing levels of carbon dioxide (CO_2) emissions as a greenhouse gas, significantly contribute to the warming of global temperatures and climactic instability (IPCC [1]). Climatic problems associated with the increased accumulation of pollution affecting the world economy have been assessed intensively by researchers since 1990. The combustion of fossil fuels is the largest contributor to CO_2 emissions. During the period 1967–2007, the final fossil fuel consumption increased by about 617%, and CO_2 emissions sharply increased by about 610% in Iran.

The main reason for studying CO_2 emissions is that they play a focal role in the current debate on environment protection and sustainable development. A recent study (Bacon and Bhattacharya [2]) found that CO_2 accounts for as much as 58.8% of total greenhouse gas emissions. Since some of the growth in CO_2 emissions is attributed to economic growth, the authors conclude that reduction in CO_2 at the cost of economic growth, especially in developing countries, may not necessarily be a desirable outcome. Another reason is that CO_2 emissions are directly related to the energy consumption, which is an essential factor in the world economy, both for production and consumption. Therefore, the relationship between CO_2 emissions and economic growth has important implications for an appropriate joint economical and environmental policy.

It is presumed that income causes environmental changes and not vice versa. But it is being asserted that the nature and direction of causality may vary from one country to the other. As far as the cause–effect relationship between emission and income is concerned, there are two alternative relations. The first one regards income as the cause and may be interpreted as the *engel cure* for emission (which is regarded as a *bad* item from the point of view of *consumer preferences*). The second relationship regards emission as the *cause* and income as the *effect* variable. This may be considered as a production relation, so that emission is an *essential* input for income generation (Coondoo and Dina [3]).

Economic development is closely related to energy consumption, since more the energy consumption, higher is the economic development. However, it is also likely that expansion of economic development could result in more efficient use of energy, and thus a reduction in energy consumption. Therefore, energy consumption and economic development may be jointly determined, and the direction of causality cannot be determined *a priori*. It can be observed that energy consumption has a direct impact on the level of environmental pollution, and there is a strong correlation between fossil energy use, CO_2 emissions, and economic activities.

The above discussion highlights the importance of the link between CO_2 emissions with economic growth and fossil fuels

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consumption. Hence, to avoid problems of misspecification, these relationships are tested under the same framework (Ang, [4,5]).

Whether energy consumption and carbon emissions stimulate, retard, or are neutral to economic activities, has motivated interest among economists and policy analysts to investigate the direction of causality among these variables. The empirical outcomes of the subsequent studies on this subject, which differ in terms of the time period, various characteristics of the considered economy, econometric techniques, and the proxy variables used in the estimation, have reported mixed results and are not conclusive to present policy recommendation that can be applied across countries. Depending upon the direction of causality, the policy implications can be considered from the point of view of energy conservation, emission reduction, and economic performance.

This study investigates the existence of causality among economic growth, fossil fuels consumption, and carbon emissions in Iran using the Toda and Yamamoto [6] approach. Three proxies of energy namely, total fossil fuels, petroleum products, and gas consumption are considered in separate models. A country-specific case study can capture and account for the complexity of the economic environment and history of an individual country. The choice of Iran as the country chosen for this study is also motivated by the fact that Iran has experienced a significant rise in fossil fuels consumption and carbon emissions in the recent decade, and no known study has been conducted to examine the relationship among output, energy consumption, and pollutant emissions in Iran. According to the human development report [7], Iran was ranked as the 13th energy-related CO_2 emitter in the world.

The paper is organized as follows. In Section 2, we present a review of the literature. Section 3 presents data description and the used econometrics procedure. The estimation results are covered in Section 4. Section 5 represents conclusions.

2. Review literature

Three research strands in the literature on economic growth, energy consumption, and environmental pollutants can be considered. The first strand mainly concentrates on the environmental pollutants and output nexus. They specially examine the environmental Kuznets curve (EKC), which is an inverted-U shaped curve and implies that, starting from low levels of income per capita, environmental degradation increases, but after a certain level of income (turning point), it diminishes. Ever since the original empirical study by Grossman and Krueger [8], an increasing body of literature has tested the nexus between economic growth and environmental pollution. Some studies have found evidence supporting the existence of an EKC for CO_2. Examples include Shafik and Bandyopadhyay [9], Seldon and Song [10], Holtz-Eakin and Selden [11], de Bruyn and Opschoor [12], Panayotou [13], Unruh and Moomaw [14], Galeotti and Lanza [15], Agras and Chapman [16], Friedl and Getzner [17], Dinda and Coondoo [18], Coondoo and Dinda [19], and Managi and Jena [20].

In contrast, other studies have found direct evidence that supports a strictly monotonic relationship between GDP/capita and CO_2. Examples include Shafik [21], Cole et al. [22], de Bruyn et al. [23], Roca et al. [24], and Coondoo and Dinda [19]. The EKC model is criticized for its lack of feedback from environmental pollutants to economic output (Arrow et al. [25], Hung and Shaw [26]). Samples of studies incorporating trade as a variable in testing the EKC hypothesis include Grossman and Krueger [8], Suri and Chapman [27], and Nohman and Antrobus [28]. Stern [29] and Dinda [30] provide extensive review surveys of these studies.

The second strand of the research is related to energy consumption and economic growth. This nexus suggests that economic growth and energy consumption may be jointly determined and the direction of causality may not be determined *a priori*. Starting with the study of Kraft and Kraft [31], an increasing number of studies have assessed the empirical evidence employing Granger causality and cointegration model, which present inconclusive evidence. Examples of this line of research include Masih and Masih [32], Cheng and Lai [33], Glasure and Lee [34], Asafu-Adjaye [35], Stern [36], Soytas and Sari [37], Paul and Bhattacharya [38], Wolde-Rufael [39], Mehrara [40], and Narayan and Smyth [41] that mainly focus on the cointegrating relationship between income and energy consumption. Additionally, some researches include Seifritz and Hodgkin [42], Yoo and Kim [43], and Lee and Chang [44] have considered the possibility of nonlinear effect of energy consumption on economic growth.

Finally, a combined approach of these two streams has emerged in the recent literature, which enables the researchers to prove the validity of the both nexuses in the same framework. This approach facilitates the examination of the dynamic relationship among economic growth, energy consumption, and environmental pollutants altogether.

The causality results of Ang [4] support the argument that economic growth exerts a causal influence on energy use and pollution growth in the long run. The results also point to a strand of unidirectional causality running from growth of energy use to output growth in the short run. Ang [5] found that output growth Granger causes energy consumption in Malaysia. Also, weak unidirectional causality was found between CO_2 emissions and income in the long run. Soytas et al. [45] found no Granger causality between income and CO_2 emissions, and no Granger causality between energy use and income in the United States. But they found that energy consumption Granger causes the CO_2 emissions in the long run. Soytas and Sari [46] found the same link between income and CO_2 emissions in Turkey. Applying the testing bounds to the cointegration procedure in a multivariate model, Halicioglu [47] found that there is a bidirectional Granger causality between CO_2 emissions and income in Turkey. This result is conflicting with the conclusions of Soytas and Sari [46].

Applying a multivariate model of economic growth, energy use, carbon emissions, capital, and urban population, Zhang and Cheng [48] found a unidirectional Granger causality running from GDP to energy consumption and a unidirectional Granger causality running from energy consumption to CO_2 emissions in the long run in China. Chang [49] used multivariate cointegration Granger causality tests to investigate the correlations between carbon dioxide emissions, energy consumption and economic growth in China. The results of the study show that Economic growth induces a higher level of energy consumption and CO_2 emissions with a feedback effect. This result is conflicting with the conclusions of Zhang and Cheng [48]. The empirical results of Gosh [50] fail to establish long run equilibrium relationship and long term causality between carbon emissions and economic growth; however, there exists a bidirectional short run causality between them. This study also establishes a unidirectional short run causality running from economic growth to energy supply and energy supply to carbon emissions.

In all the research strands, there are a limited number of examples that examine the above-considered nexuses in Iran. Zamani [51] examined the causal relationship among overall GDP, industrial and agricultural value-added, and consumption of different kinds of energy using vector error correction model for the case of Iran during 1967–2003. A long run unidirectional relationship from GDP to total energy and bidirectional relationship between GDP and gas as well as GDP and petroleum products consumption for the whole economy was discovered.

A wide range of econometric techniques and procedures have been utilized to test the validity of the relation between output-energy and output-environmental pollutants. The results and