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Effects of energy production and CO_2 emissions on economic growth in Iran: ARDL approach

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ABSTRACT

This paper investigates the relation among energy production, CO_2 emissions and economic growth of Iran with additional variables such as domestic and foreign investment, inflation, population density and agricultural land. Annual time series data is used for the period of 1971–2011 according to data availability. Our main results are as: (1) there is long run relationship among the variables. (2) CO_2 emissions has positive relation with economic growth. (3) energy production has positive effect on the economic growth of Iran. (4) Domestic investment has more contribution than the foreign investment in the explanation of economic growth. (5) Speed of adjustment shows that system will move to equilibrium path quickly. Diagnostic tests confirm the perfectness of the model. DOLS and FMOLS shows the similar results. Further, variance decomposition and cholseky impulse response function also show similar findings.

1. Introduction

Energy is an important factor of production that plays vital role for the development of the business as an input during the production process. It increases living standard as well as productivity. The households and business decision cannot be made without energy planning. It would not be wrong to call energy as a life of an economy [1]. At one side, it's importance cannot be ignored and at second side, its supply is not certain [2]. It is also argued that energy production from oil and coal is responsible for carbon dioxide emissions and environmental pollution [3]. It has been argued that CO_2 emissions is increasing around the globe and global warming is becoming a challenge for this world [4]. Different economists focus on different countries with different proxies, methods and time periods to address this issue. Their results differ from each other and sometimes conflict (see for example, Al-Iriani [5], Chang et al. [6], Soytas et al. [7], Bartleet and Gounder [8], Arouri et al. [9], Managi and Jena [10], de Bruyn and Opschoor [11], Friedl and Getzner [12], Heil and Selden [13], Ang [14,15], Lean and Smith [16]). Thus, one country/group of countries resutls cannot be generalized on other country.

If we talk about the growth theories, they only focus on labor and capital as inputs for the economic growth and ignore the influence of other factors [17]. Recently, researchers start using energy as an important factor with labor and capital for the economic growth (see for example: Apergis and Payne [18–21], Ohler and Fitter [22], Ben Aissa et al. [23], Salim et al. [24]), however, environmentalists and policy makers pointed out that this energy is responsible for CO_2 emissions in the environment that is causing global warming. So, energy conservation policy is suggested to reduce CO_2 emissions from the environment. On the other hand, this energy conservation cause low economic growth [89]. Z. Ziabakhsh [84] rightly pointed out that greenhouse gases play important role for the earth climate system. The melting snow from glaciers rising average temperature around the globe are the eye witness about the heated atmosphere. It is fact that human activities are the main source of this warming since industrial revolution i.e. 1750. Energy demand is increasing worldwide and it is becoming the source of CO_2 emissions in the atmosphere. Further, CO_2 injection source is power plants and industrial organizations [84]. In this way, global warming and CO_2 emissions in the atmosphere become debatable issue. There is need to reverse this current trend to reduce global warming. In this scenario, carbon dioxide capture and storage can play important role in this reversal

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of CO_2 emissions. This method involves to capture carbon dioxide in the power plants and underground geological structure. In this carbon capture, laboratory and numerical models can play important [85,86].

The environmental economists and policy makers has tried to find the carbon dioxide emissions and economic growth relation to formulate the policy accordingly. However, the relation between CO_2 emissions and economic growth remain one of the debated issues with great concern from the last three decades [87] as it has great concern for policy purpose [88] but the results remain controversial till date [18–24]. The CO_2 emissions and growth relation can give us four possible options in this scenario. CO_2 can granger cause economic growth and not vice versa. In this situation, a country have to sacrifice economic growth to reduce CO_2 emissions [61]. If causality runs from economic growth to CO_2, then energy conservation policy can be formulated for higher economic growth without the consequence of CO_2 [3]. It is also possible that there is no causality between these two variables (neutrality hypothesis). In this situation, reduction in CO_2 will not be harmful for economic growth (Soytas et al. [7], Soytas and Sari [33], Pao et al. [90]). Fourth possible situation can be the bi-directional causality between CO_2 emissions and economic growth. In this situation, environmental degradation will happen. Environmental degradation is disturbance or undesirable change in the environment. It is the lessening of the limit of the earth to meet social and environmental needs [91,92]. Dasgupta et al. [93] pointed out that at the early stage of economic development, because of industrialization, environment degrades and pollution increases as income increases. However later, environment improves as economy relies on clean service. In this way, income itself can be the solution of environmental issues. This idea leads to environmental Kuznets curve (EKC) where economists argue that economic growth itself is the solution for environmental issues [94]. Owing these reasons, from the last three decades energy and macroeconomics variables relation is most debated and sensitive issue among researchers. However, their results remain mix and thus, policies remain insufficient to reduce CO_2 emissions from the environment. Knowing the importance of environment for human race and mix results from previous research motivate us to work on this paper to check the linkages between CO_2 emissions, energy production and economic growth for Iran.

What makes Iran as our case study interesting? There are several reasons to take Iran in our study as Iran depends on oil products to fulfil the domestic needs as well as for export. Iran is energy super power, most energy intensive country in the world and leading member of OPEC. Iran is oil based economy and is perceived among high income countries based on oil production and its large share of revenues is from oil resources i.e. oil exports. Iran's carbon dioxide emissions is closely related with industrial, social and economic factors. Further, history reveals that its inflation crosses double digits in most of the years and FDI inflow remained very low in most of the years. These facts encourage us to work on this paper.

Growth and energy production relation is important to explore for Iran as it is important for Iran to produce more energy from its oil sources as oil is the main source for its consumption and revenues. However, this production can be responsible for greenhouse gas emissions in the environment. In this situation, it is necessary to check the relationship between energy production, CO_2 emissions and growth to give possible suggestions for policy purpose. So, this study offers the opportunity by making the linkages between energy production from oil, CO_2 emissions and economic growth for Iran. In previous studies, researchers focus on domestic capital, labor force, and energy consumption only as the determinants of growth (for example, Apergis and Payne [18–21], Ohler and Fitter [22], Ben Aissa et al. [23], Salim et al. [24]). Given the recent trend and importance of energy for the growth, the aim of this paper is to examine the relation between energy production from oil, CO_2 emissions and economic growth of Iran. We use explanatory variables such as domestic investment, foreign investment, inflation, population density area, agriculture land area as inclusion of omitted variables make results unbiased, consistent and more trustworthy [25]. These variables are included as the possible determinants of economic growth. Up to our knowledge these variables are not previously used in any study particularly for Iran.

Our study differ from existing studies and contribute in the existing literature in the several ways as it has contributation in the term of variables choice as well as the techniques employed. For example, we add explanatory variables that can have special influence and meaning in the explanation of economic growth of Iran and are ignored in other studies. So, our model is not built just by focusing on the specific variables that are commonly used in previous studies namely economic growth, CO_2 emission, energy, domestic investment (capital) and labor force (see for example [9,14,18–24]) but we pointed that there are also other factors that have important contribution in the explanation of economic growth. So, we use domestic and foreign investment together to see weather domestic investment has more contribution than foreign investment or vice versa in the explanation of economic growth of Iran as in this global village, foreign factors (like FDI) should not be ignored for growth and development of an economy. Instead of labor force, we use population density variable to see how congested environment can influence the economic growth of Iran whether it can have positive impact or negative influence on the economic growth of Iran. Iran has nature granted oil resources, so, we added agriculture land area to see whether Iran's land is appropriate for agriculture or for industrial purpose. Inflation is also added as explanatory variable to see whether it is harmful for the economy in the long run or not. These variables are calibrated from different studies as they can be the possible determinants of growth [32,70,77,81,82]. Owing these facts, the objective of this study is to fill the gap by discussing the effects of energy production and CO_2 emissions on the economic growth of Iran with latest techniques. Additional variables such as domestic investment, foreign investment, inflation, agriculture land area are include as inclusion of omitted variables is necessary for trustworthy results [25].

If we talk about the methods to check the linkages among the variables, we use most recent, an appropriate and advance technique i.e. Autoregressive Distributed Lag (ARDL) approach given by Pesaran et al. [26]. This technique has several advantages on other techniques i.e. OLS, Engle and Granger and Johansen Co-integration. OLS is only suitable if all variables are I(0). Engle and Granger [43] is suitable for two variables. Johansen co-integration [44] is possible for same order of integration i.e. I(1) and for large sample size. ARDL does not overcome these order of integration and sample size issues but it has several other advantages. For example: (1) It can be used in case of small sample size. (2) One need not to be worry about the stationary of the data as ARDL can be used whether variables are stationary at level i.e. I(0) or I(1) or mixture of both. So, stationary property of the data is less important while using ARDL. (3) It captures the appropriate number of lags in data generating process. (4) It provides unbiased estimates in the long run. (5) The error correction model can be obtain from bound testing approach through simple OLS transformation and the ECM shows short run to long run adjustment mechanism without the loss of long run information. (6) In case of some endogenous regressors, ARDL provides unbiased estimates in the long run. Pesaran et al. [26] given method can be used irrespective whether variables are integrated of purely order zero i.e. I (0) or purely order one i.e. I(1) or mixture of both i.e. I(0) and I(1). So, in this way, generally, it can be said that checking the unit root property of the