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Analysing the long-run relationship among oil market, nuclear energy consumption, and economic growth: An evidence from emerging economies

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ABSTRACT

The primary objectives of this paper is to scrutinize the long-run relationship and the causal linkage between oil consumption, nuclear energy consumption, oil prices and economic growth. For this purpose, Johansen cointegration technique is applied using time series data for four emerging economies: Russia, China, South Korea and India, over the period from 1965 to 2010. Johansen cointegration results indicate that there is a long-run relationship between the proposed variables in each country. Exclusion tests show that both energy sources enter the cointegration space significantly (except for Russia), which suggests that energy has a long-run impact on economic growth. Results of the causal linkage between the variables point that energy consumption (i.e., oil or nuclear) has either a predictive power for economic growth, or a feedback impact between with real Gross Domestic Product (GDP) growth in all countries. Hence, energy conservation policies might harmful negative consequences on the growth of economic for this group of countries.

1. Introduction

Over the past three decades, the inspiration of investigating the linkage that explains how energy consumption and economic growth are interrelated has witnessed a high interest among economists. The primary motive has been derived mainly by the latest threats associated with the global warming and fluctuations of crude oil prices, and security of energy supply.

The global warming problem is foremost a problem of excessive build-up of carbon dioxide (CO_2) emissions in the atmosphere, which is very likely due to the burning of fossil fuels. As world economy and population continue to grow, the amount of energy demand has also witnessed a considerable boom in last ten years. Organization of the Petroleum Exporting Countries' (OPEC) World Oil Outlook, 2012, reported that the worldwide energy demand; mainly accommodated by fossil fuels, covers 87% of the total need. Among these fossil fuels, oil is the most consumed for energy conversion, followed by coal, then natural gas. In 1997, the world produced approximately 130 quadrillion BTU (British thermal unit) of energy from oil, 80 quadrillion BTU from coal, and 70 quadrillion BTU from natural gas EIA (energy information administration). This has sparked global attention towards shrinking the reliance on fossil fuels, promoting energy saving policies, and finding different sources of clean energy [12]. In addition, historical data of crude oil prices demonstrate exceptional fluctuations over the past several years. WTI (West Texas intermediate) spot oil prices increased sharply up to $145 in July 2008, and then dropped noticeably to a very low level of $30 in December 2008. Hamilton [44] explains how the recent growing demand from emerging economies and instability in many oil-supplying countries of the Middle East and North Africa have proceeded this sharp increase in oil prices.[1]

The insights from analysing historical data reveal that emerging economies accounts for 32.9% of global oil demand, where China has the second largest share - after the US - with 12.5%, India stands at fourth place with 4.2%, Russia and South Korea are at fifth and tenth position, respectively. Demand for oil consumption in China and Russia have grown by 88% and 24%, respectively, from 2003 to

[1] Wu and Ni [96] finds that changes in oil prices have a contemporaneous and time lag effect on inflation using either symmetric or asymmetric models. Kilian and Vigfusson [55] also prove that oil price shocks explain a 5% cumulative reduction in the United States of America (US) real Gross domestic product (GDP) in the during the financial crisis.

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2013, which accordingly increased the CO_2 emissions from oil combustion by the same amount, as shown in many different studies such as Al-Mulali and Sab [5] and Lotfalipour et al. [67]. Therefore, these countries have a great motive to curb their air pollution by reducing the level of oil consumption. In this respect, energy policies for many of them has focused on building nuclear power plants, which does not only help reduce oil consumption, but also minimise the fluctuations in oil prices that are directly linked with oil demand [92]. After building a number of nuclear power plants, China successfully reduced its reliance on fossil fuels and increased the consumption of nuclear energy by 61.3% from 2008 to 2013.[2] According to their energy future plan, it will be the third largest nuclear generating capacity after the US and France by 2020.[3]

However, the main concern in conjunction with reducing crude oil consumption is the level of country's reliance on it to accelerate its economic growth. In order to assess the impact of promoting crude oil saving polices, some empirical studies have focused on investigating the relationship between oil consumption and economic growth (see Yoo; Zou and Chau [98,103], among others) Zhao et al.; Aktaş and Yılmaz [2,102] on the one hand. On the other hand, nuclear energy consumption - economic growth nexus has been visited by other economists (see Yoo and Jung; Yoo and Ku; Wolde-Rufael [94,99,100]; among others) to provide rational motives that encourage investors to put nuclear energy projects forward for many economical, environmental, and social reasons [22]. There are few papers that investigated the causal linkage between oil consumption, nuclear energy consumption, oil price, and economic growth using modern advances in time series econometrics associated with causality testing [62,63,75,76]. Nevertheless, there is no consensus yet neither on the existence nor on the direction of causality between them.

In this paper, we extend the existing literature by scrutinizing the long-run relationship between oil consumption, nuclear energy consumption, and economic growth in a number of emerging economies. Particularly, the investigation has been applied using Johansen cointegration approach among Russia, China, South Korea, and India using annual data from 1965 to 2010.

The purpose and contribution of this paper is in four folds. First, given that both oil and nuclear energy play important roles in designing effective energy policies that accounts for both economic growth and environmental protection, we examine how the variables; oil and nuclear energy consumption, real oil prices, and economic growth, are related in the long-run and assess the long-run causality between them. Second, this paper implements a multivariate model to improve the problem of the omission variable bias and allow for additional causality channels to be tested. Third, to our knowledge, this is the first paper that analyses the long-run relationship between the proposed variables for Russia, China, South Korea, and India. In order to account for individual country characteristics such as energy patterns and economic position, each country has been examined separately using a PVECM (parsimonious vector equilibrium correction model). Fourth, since the causal relationship between economic growth and energy consumption (i.e. either oil or nuclear) and that between oil prices and energy consumption may run in either or both directions, the estimations of the PVECM which we use to test the statistical causality hypothesis are more reliable than those from a single equation model. This has been done by examining the erogeneity of a given variable with respect to all cointegrating vectors. The empirical results of the relationship between nuclear energy, the oil market, and the real GDP play a significant role in the implementation of energy and environmental policies. It also shed light on the usefulness of any future strategic plans for nuclear energy progress in the emerging economies, which gives the motivation and the contribution of this study a meaningful picture.

In what follows, we first provide a literature review in Section 2. Section 3 describes the material and method. Section 4 shows the results and discussion, and a conclusion and policy implications are provided in Section 5. To reading convenience, the abbreviations are shown in Table 1.

2. Literature review

2.1. Oil price and economic growth

Given that crude oil plays a crucial role in the world economy, the impact of crude oil price fluctuations on economy has been a subject of great interest to economists since the 1970s. Researchers put forward a variety of transmission channels to explain how oil prices may influence economic activity (see Abel and Bernanke; Brown and Yuecal; Mork [1,17,74]; among others), [16]. Others noted that an increase in oil price yields inflationary pressures, which is associated with direct and indirect effects (see Álvarez et al. [6]; for more details).

Empirical investigations have generated growing impressions about the size of oil price impacts on aggregate economic activity. Some evidences are presented by Hamilton [42]; who suggests that exogenous shocks to oil prices have significant impacts on real economic activity in the US. Mork [73] also confirms that the negative correlation with oil price increases is persistent. Furthermore, researchers have not only shed the light on establishing a relationship between oil price fluctuations and economic growth, they have assigned major roles to each of them in a number of macroeconomic models [18,24,43,85,96]. For example Hall [39], exploits the information from oil prices in order to identify supply of and demand for labour. Others, such as Phelps [83] and Carruth et al. [19]; attempt to link oil price shocks with the natural rate of unemployment. In a discussion that focuses on real business cycle models, Kim and Loungani [56] show that oil prices can trim down the role of technology shocks, and hence lower irreversible investment throughout their effects on uncertainty [32].

Based on the above discussion, it is clear that crude oil prices are not only important factors for determining the level of crude oil consumption, they also contribute significantly in stimulating the economic growth of countries. Therefore, this factor has been included in our energy-growth models to minimize the problem of omitted variable bias in the final results.

2.2. Energy consumption and economic growth

Ever since the comprehensive study of Kraft and Kraft [59]; many researchers have scrutinized the causal relationship between energy consumption and economic growth. However, empirical works do not provide any precise answer, and there is still no consensus among economists whether there is a causal relationship or not and if it exists, there is no clear-cut answer about the direction of this causation [79]. The contradictory results may occur due to the differences in data sets, characteristics of the investigated countries, variables that are included in the studies, and the diversification in using econometric methodologies [72,79]. The findings from studies vary not only across countries, but depend

[2] For more information, see British Petroleum (BP) Statistical Review of World Energy, June 2014.

[3] Along with reducing the reliance on fossil fuels in China's industry, Lin and Wang [66] show that the increase in R& D intensity, labor productivity, enterprise scale, and energy price will help to reduce the energy intensity of China's iron and steel industry. They recommend that China's policy makers design effective future policy for promoting energy saving in these sectors.