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Short communication

Are fluctuations in oil consumption permanent or transitory? Evidence from linear and nonlinear unit root tests

Sakiru Adebola Solarin [a], Hooi Hooi Lean [b,*]

[a] Faculty of Business, Multimedia University Malaysia, Malaysia
[b] Economics Program, School of Social Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

HIGHLIGHTS

- We examine the integration properties of total oil consumption in 57 countries.
- We apply new and powerful linear and nonlinear stationarity tests.
- Unit root is found in two third of the countries.
- Blueprints designed to reduce oil consumption are likely to have permanent effect.

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ABSTRACT

This paper examines the integration properties of the total oil consumption in 57 countries for the period of 1965–2012. A combination of new and powerful linear and nonlinear stationarity tests are employed to achieve the objectives of the study. We find that the oil consumption series in 21 countries follow a nonlinearity path while those in the other countries are linear in nature. Evidence of the presence of a unit root is found for the total oil consumption series in 38 countries while the series is stationary in the remaining 19 countries. An important insight is that the blueprints that were designed to reduce oil consumption are likely to have a permanent effect in most of the countries.

1. Introduction

Oil (petroleum) is one of the three major types of fossil fuels (the other two are natural gas and coal), which is widely utilized in various economic activities such as transportation, construction, industry, residential and electricity generation.[1] It is a liquid that can be directly consumed, but in most cases, the fuel is refined into petroleum products such as diesel fuel, gasoline, heating oil and jet fuel, which are then consumed. With the stagnation in oil production, the consumption of oil is displaying a consistent upward trend, which is facilitated by the rapid rise in population and the increasing demand of oil in developing countries. Today, the world is getting to its limit in oil production. Although there are several as yet unexploited sites that may have oil, but the large, easily accessible and relatively "inexpensive to extract" oil deposits are limited in numbers (Wu, 2008).[2]

On the contrary, oil consumption was rising rapidly over the years with potential high in the future.[3] Oil accounts for about 40 per cent of the world energy mix. As it stands today, the OECD countries which are used in our sample are still the main consumers of oil. However, this situation begins to change with the higher growth rates in the developing countries including those employed as the sample of this study. According to BP Statistical Review of World Energy (2013), about 89,773 thousand barrels of

* Corresponding author. Fax: +60 4 657 0918.
E-mail addresses: sasolarin@mmu.edu.my (S.A. Solarin), hooilean@usm.my (H.H. Lean).

[1] According to the Energy Information Agency, oil is a mixture of hydrocarbons that usually exists in liquid form in natural underground pools or reservoirs. It is often used interchangeably with petroleum.

[2] This is also largely true when considering other forms of oil. For instance, shale oil (which is an alternative to conventional oil) does not provide a better scenario. Many countries do not have significant oil shale resources, but for countries that have significant oil shale resources, the oil shale industry has not been developed because the cost of oil derived from the oil shale is higher than the conventional pumped oil. The lack of commercial viability of oil shale-derived oil has in turn inhibited the development of better technologies that might reduce its cost (Environmental Impact Statement, 2014).

[3] Oil consumption includes inland demand plus international aviation and marine bunkers and refinery fuel and loss as well as consumption of ethanol and biodiesel (BP Statistical Review of World Energy, 2013).

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oil and liquid fuels were consumed per day worldwide in 2012. This works out to nearly 32 billion barrels a year or a 17% rise compared to the consumption in 2000. Moreover, the usage of oil is known to generating the second highest emission after coal. The use of oil, especially in the transportation sector generates a large amount of carbon monoxide emissions and nitrogen oxide emissions. These emissions cause health concerns such as cardiac arrest and respiratory problems (Knittel, 2012).

Unfortunately, oil resources and oil deposit-rich regions are not evenly distributed across the world. Global oil resources are mainly concentrated in the Middle East, which accounts for a considerable percentage of the world's oil reserves, production and exporting of oil products and facilities. According to the recent statistics, 81% of the proven oil reserves in the globe are situated in OPEC, with a considerable portion in the Middle East, which account for 66% of the OPEC's total (OPEC Annual Statistical Bulletin, 2013). This asymmetric distribution of oil resources usually lead to heavy import bills and high consumption subsidies in the importing countries. For instance, developing countries such as India and Pakistan spend the equivalent of several billion dollars annually to import fuel. The annual oil consumption subsidies in non-OECD nations were estimated to be above US$250 billion (World Energy Outlook, 2006). They were at US$500 billion in 2011 globally and US$90 billion in the OECD alone (Overseas Development Institute, 2013). Over the years, the price of oil has increased with notable effect especially for the oil importing countries. The price of Brent crude oil was US$23.73 in 1990, raise to US$28.50 in 2000 and US$111.67 in 2011 (BP Statistical Review of World Energy, 2013).

The ability to reduce the dependency on imported oil will be a significant gain to the importing countries in terms of security, price and economic welfare, especially in the developing countries. There are several policies that have been introduced to reduce oil consumption. These include the Corporate Average Fuel Economy (CAFE) standards which place a minimum average fuel economy limit to the new vehicles sold by automobile companies in a particular period (Knittel, 2012). Another major policy is the renewable portfolio standard which required utilities to produce or buy a minimum level of renewable energy in a bid to deemphasize the usage of fossil fuels. These policies are designed to have long-term impact to the industry.

Given the growth of oil consumption, it is important to consider whether the policies aim to reducing oil consumption will have a permanent or a transitory effect. The unit root hypothesis can be used to determine which effect is likely to hold. If the oil consumption series is found to be integrated of order zero (stationary), this implies that shocks to oil consumption are temporary. As such, any long-term policy meant to reduce oil consumption will not be effective as the oil consumption will quickly return to its long run growth path. On the other hand, if oil consumption is integrated of order one (nonstationary), this implies that shocks to oil consumption are permanent. Consequently, policies designed to engineer permanent reduction in oil consumption will be effective.

There has been a surge in studies that investigate the unit root properties of energy consumption. However, most papers have concentrated on aggregate energy consumption or consumption of some specific forms of energy with very limited exercise on oil consumption (see Smyth, 2013). The aim of this paper is to examine the integration properties of oil consumption for 57 countries using newly introduced linear and nonlinear unit root tests. We contribute to the existing literature from two angles. First, we include more countries in our analysis of integration properties of oil consumption. The few studies on oil consumption have concentrated in the U.S. and do not examine nonlinearity in the series (see Apergis and Payne, 2010; Lean and Smyth, 2009). The use of oil differs across countries and as such, policies that are viable in the U.S. may not necessarily be valid for other countries as the current level of petroleum use, the availability of oil resources (and even the quality) and the local acceptance differ across countries. For instance, the U.S. consumes more petroleum-based liquid fuel per capita than any other OECD nations (Knittel, 2012).

Second, we provide nonlinearity investigation on integration properties of oil consumption. There are evidences that both energy production and consumption are characterized by nonlinearities (Smyth, 2013). Among several other factors, oil consumption is primarily determined by economic conditions (Wu, 2008). Economic activity undergoes the cycles of growth, stagnation and decline. Consumption of oil falls when the economy enters recession and it rises when the economy is expanding. The shifts between the periods of recessions and expansion occur gradually instead of instantaneously. Instead of the conventional structural break models, these dynamics are well captured by nonlinear functional approach (Camarero et al., 2011).

Furthermore, the implementation of any linear model is only valid when linearity test has failed to detect nonlinearity in the series. Liew et al. (2003) and Yilanci and Eris (2012) documented that linear econometrics approaches may not be suitable in the nonlinear data-generation process. Kilian and Vigfusson (2009) further demonstrated that if the series is linear and should one mistakenly estimate a nonlinear specification, the estimated parameters will be asymptotically biased. On the other hand, if the series follows a nonlinear process and one mistakenly estimates a linear specification, the resulting estimators are asymptotically biased (Hamilton, 2011). Therefore, there is a prudent need to conduct both linear and non-linear unit root tests in the study depending on the nature of the series.

The balance of the paper is ordered as follows. We review the literature in the next section. Data and methodology are discussed in Section 3. Section 4 presents the results, and conclusions are provided in Section 5.

2. Literature review

Starting with Narayan and Smyth (2007), studies that examined unit root properties of energy consumption are expanding. We provide a brief highlight of the main development in this literature (see Table 1 for the summary) because an elaborate discussion has been undertaken by Smyth (2013). The earlier set of studies used univariate unit root tests with (out) structural breaks to examine the aggregate energy consumption. Narayan and Smyth (2007) examined the unit root properties of energy consumption per capita in 182 countries, over the period 1979–2000 using both univariate and panel unit root tests. Based on univariate unit root tests, Narayan and Smyth (2007) noted that only about one-third of countries reject the null of a unit root in energy consumption per capita. Premised on panel unit root tests with structural break, the results indicate that energy consumption per capita is integrated of order zero.

Chen and Lee (2007) reexamined the stationarity of energy consumption for 104 countries for the period 1971–2002. The results provided evidence for stationarity of the energy consumption per capita. In the same vein, Hsu et al. (2008) utilized panel techniques for 84 countries for the period 1971–2003 with mixed evidence. Mishra et al. (2009) looked at the stationarity of energy consumption in a panel of 13 pacific Island countries during the period 1980–2005. The results demonstrate mixed findings while the test with structural breaks supports stationarity.

In spite of their novelty, the foregoing papers failed to taking care of nonlinearity in the series as well as the different components of energy. Hasanov and Telatar (2011) addressed the issue of