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Are fluctuations in coal consumption per capita temporary? Evidence from developed and developing economies

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ABSTRACT

This paper investigates the unit root properties of coal consumption per capita for the 47 developed and developing countries for 1965–2010 period. To examine the stationary properties of coal consumption per capita, Lagrange multiplier (LM) unit root test with one break and two breaks Crash model has been utilized. According to empirical results, the coal consumption is stationary in almost all the countries analyzed. Thus, if the coal consumption is mean (or trend) reverting, then it follows that the series will return to its mean value (or trend path) and it might be possible to forecast future movements in the coal consumption based on past behaviors of the series. For the policy makers, it is not necessary to pay attention to coal consumption excepting for Indian and Italian. However, for the researchers it is important to take into account the stationarity property of coal consumption and also structural breaks (should be modeled) in their future studies.

Contents

1. Introduction

Human civilization is basically a main determinant of energy consumption. That's why energy demand has strong implications for human civilization's social–economic–political sphere. The empirical investigation of unit root properties of energy consumption is very important because it not only helps us in designing the relationship between economic growth and energy consumption but also energy-environment relationship. It is warned by International Energy Agency (IEA) that rising energy demand due to economic growth, industrialization and urbanisation increases CO_2 emissions every year rapidly and all allowable CO_2 emissions should be locked by utilizing the existing energy-efficient infrastructure (IEA, [1]). Energy sources such renewable and non-renewable play important role in stimulating economic activity in an economy (Shahbaz et al. [2], Zeshan and Ahmad, [3]). In renewable energy, sunlight, wind, tides, plants and geothermal heat are major sources of energy (IEA, [1]). A natural process is involved to derive renewable energy which is replenished consistently. Renewable energy is directly derived from the sun, heat generated deep within the earth as well as electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and bio-fuels and hydrogen are also considered as renewable resources. In 2012, growth rate of wind power with worldwide installed capacity of 282, 482 MW. This source of energy is used in

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Europe, Asia as well as in the United States. The photovoltaic (PV) capacity worldwide was 100,000 MW as well as PV power stations are wised operated in Germany and Italy. The 354 MW SEGS power plant has been working in the Mojave Desert and solar thermal power stations are also operating in the USA and Spain. Brail uses ethanol fuel from sugar cane, and ethanol now provides 18% of the country's automotive fuel which is the largest renewable energy program in the world. The USA also uses this source of renewable energy to meet its domestic demand. Biomass is another source of renewable energy which is used by almost 44 million household in household-scale digesters for lighting and/or cooking. Hydropower is generated from water which is the most abundant energy source on globe but less than natural gas reserves. The production hydroelectricity was 3500 billion kilowatt-hours in 2011 and production would be doubled by 2010 (IEA, [1]). Geothermal energy is internal heat of earth and it is used for heating and cooling buildings. Geothermal installed capacity is 11,224 MW in 2012 and electricity generation from geothermal sources is double times greater than electricity generated from solar energy sources. Ocean's tides from the gravitational pull of the moon and the sun upon the earth is also termed as renewable energy.

Non-renewable energy is comprised of coal, crude oil, natural gas and uranium which are mainly made up of carbon. World oil consumption was 87.421 million barrels per day in 2000 which has been risen to 88.9 million barrels per day but petroleum demand has been declined due to hike in petroleum prices and financial crisis in USA and Europe in 2012 (IEA, [1]). Petroleum demand has increased to 4.4 million barrels per day in Asian region but rapid industrial growth in China and India has increased 2.8 million barrels per day and 800,000 bbl/d, respectively. Globally, demand for natural gas consumption rose to 113 Tcf (Trillion cubic feet) in 2010 from 53 Tcf in 1980 [1]. In North America, gas demand was 29% in 1980 and declined to 25% in 2010. Natural gas consumption was increased more than ten-fold from 1.3 Tcf in 1980 to 13.2 Tcf in 2010 in the Middle East due rapid economic growth. In Asian region, natural gas demand has increased more than eight-fold from 2.2 Tcf to 19.2 Tcf for last three decades. Asian natural gas demand approached the level of Europe and the Former Soviet Union in 2010. Globally, coal demand continued to grow in 2011. The growth in coal consumption is due rapid use of coal. In 2011, global coal consumption was 3724.3 million tons of oil equivalents (mtoe) which was 5.4% higher than coal demand in 2010. A 8.4% equalent to 2625.7 mtoe coal was consumed by OECD countries in 2011 which is 70.5% of global coal consumption. In Asia, growth in coal consumption was more than 9% in 2011 in China and India due rapid industrialization and hence economic growth [1]. China's coal consumption had grown by 325 million tons equalent to 87% of global coal consumption in 2011 and it was 2.3 billion tons i.e. 82% of global coal consumption in 2000. In 2012, China's coal demand accounts for 47% of world coal consumption.

Non-renewable energy sources such as coal, natural gas and oil i.e. fossil fuels are cheap and abundantly available. Coal is considered second source of energy after oil and source of electricity generation in 21 century. This provides a rational for researchers to investigate the stationarity properties of coal consumption per capita using data of 47 developed and developing countries. We have applied Lagrange multiplier (LM) structural break unit root test. It is very important for policy makers to know whether fluctuations in coal consumption are transitory or permanent from various aspects. First, if coal consumption is to be found stationary then fluctuations in energy consumption are transitory. If coal consumption follows stationary process then long run energy policies would not be effective. Coal consumption tends to return to its original symmetric path following shocks in energy markets. In such an environment, governing bodies should not implement redundant goals. Fluctuations in coal consumption are considered permanent if coal consumption has unit root problem. In such environment, coal consumption is consistent stable with path dependency. Path dependency of coal consumption implies that world energy markets innovation would affect permanent impacts. Furthermore, the degree to which the coal sector is linked with other sectors of the economy is also of significance as permanent shocks to coal consumption may well be transmitted to other sectors of the economy as well as to macroeconomic aggregates.

Third, the distinction between temporary and permanent shocks to coal consumption influences the modeling of energy demand and forecasting. Forecasts of coal consumption play a vital role in formulating energy policies. Safe and efficient energy supply for economic growth can be possible after knowing the reliable forecasts of energy consumption in the future. If coal consumption is stationary, then the past behavior of coal consumption serves a role in the generation of forecasts. On the other hand, if coal consumption is non-stationary, then the past behavior of coal consumption serves little or no use in forecasting. Fourth, the distinction between transitory or permanent shocks in coal consumption is very important to model the relationship between energy (coal) consumption and economic growth.

Table 1 provides summary of existing studies investigating whether fluctuations in energy consumption are permanent or transitory. These studies have applied various approaches to test the stationarity properties of energy consumption and provided ambiguous results.[2] Recently, Apergis et al. [5] investigated the unit root properties of coal consumption in 50 US states using several panel unit root tests [6–8]. Our study contributes in existing literature by investigating the unit root properties of coal consumption by applying Lee and Strazicich [9,10] unit root test with one and two structural breaks stemming in the series. Our results are more reliable and efficient due to superiority of Lee and Strazicich [9,10] unit root test over traditional unit root tests.

The aim of our study is to investigate the stationarity properties of coal consumption using data of 47 countries for 1965–2010 period.[3] To examine the stationary properties of coal consumption per capita, Lagrange multiplier (LM) unit root test with one break and two breaks Crash model and one and two break trend models have been employed. We have provided the trend of coal consumption in sample countries (see Fig. 1).

2. Methodology and data

There are various unit root tests available to test the stationarity properties of macroeconomic variables. These unit root tests are like ADF by Dickey and Fuller, [36]; PP by Phillips and Perron [37] and Perron [38]. These tests found to give misleading results (i.e. biased towards the non-rejection of null hypothesis when structural breaks are present in the data series). Following Perron [39] and Zivot and Andrews [40] proposed to determine the structural breaks stemming in the series endogenously. Lumsdaine and Papel [41] pointed out the importance of unit root test with two structural breaks in the series by modifying Zivot and Andrews [40] unit root test. These unit root tests were criticized by statisticians due to the usage of structural breaks in their null hypothesis. These tests do not consider the presence of structural break in the null hypothesis and suggest that variable is found to be stationary in the presence of structural break. Therefore, in the present study we have adopted Lee and Strazicich [9,10] test of unit root that allows us to test for at most two endogenous breaks and uses the Lagrange multiplier (LM) test statistics.[4] Let us consider the following data generating process (DGP):

$$y = \delta Z_t + e_{t,}, \quad e_t = \beta e_{t-1} + \varepsilon_t \tag{1}$$

[2] See the study of Smyth [4] for a extensive literature survey on the integration properties of energy consumption variables.

[3] Availability of data has restricted our analysis to 47 countries.

[4] Lee and Strazicich [9,10] unit root test avoids all issues discussed above.