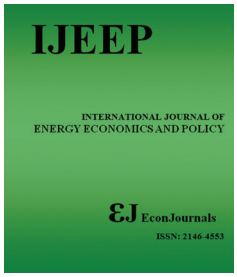

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Are Oil Shocks Permanent or Temporary? Panel Data Evidence from Crude Oil Production in 15 Countries

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ABSTRACT

In this paper we explore the unit root properties of crude oil production for 15 sampled countries employing the Lagrange multiplier (LM) panel unit root test with (and without) one structural break for the period 1990-2017. In case of applying LM univariate test without a structural break, the results are ambiguous and inconclusive with moderate support for stationarity. The results of LM panel unit root test with a structural break are significant and conclusive, stating that for a sampled panel, crude oil production is stationary.

Keywords: Crude Oil, Oil Shock, Unit Root, Panel Analysis, Lagrange Multiplier
JEL Classifications: C23, E23, Q43

1. INTRODUCTION

Stationary time series have a significant impact on the building of models evaluating and forecasting various economic variables. It is difficult to overestimate the importance of time series stationarity in the case of the energy market as well as the oil market. In case when the national economy is significantly dependent on the oil prices volatility, forecasting volatility and designing an adequate policy of national energy security is of high priority. Given the dependence of national budget revenues, national welfare, final consumption expenditures of various economic agents on energy consumption and dynamics of prices for various energy resources on the world markets, it is of great importance to adequately predict and simulate the effects of energy consumption shocks and oil price shocks on various macroeconomic variables.

An important property in building such models is the stationarity property of energy variables. For example, stationary energy consumption is important for macroeconomic policy in a country. If energy consumption in a country is stationary, energy demand management policies that are designed to optimize energy consumption will have only a temporary effect, since energy consumption will return to its trend after a short-term shock. Otherwise, if the data on energy consumption and dynamics of crude oil production does not contain a unit root, then the previous data on oil production and energy consumption are relevant in building forecasting models. If the production of crude oil contains a unit root, the oil shocks will have a permanent effect on the level of oil supply. Thus, the disruptions in crude oil production will have a permanent effect on economic activity in the country. However, if crude oil production series is stationary, negative or positive shocks in oil production will be temporary, transitive, and crude oil production will adjust to certain changes in the national economy and the supply of crude oil will return to its original equilibrium level within a short period of time. In this case, the disruptions in crude oil production will have only a temporary, transitive effect on economic activity in the country.

In this paper we investigate the stationarity properties of crude oil production in the 15 sampled countries for the period 1990-2017

to find whether shocks to crude oil supply are of permanent or temporary nature.

The remainder of the paper is organized as follows: Section 2 provides an overview of relevant literature; section 3 describes econometric modeling techniques and data used; section 4 presents an analysis of empirical results; section 5 presents the conclusion of the study.

2. LITERATURE REVIEW

To test the stated hypothesis, we refer to the relevant literature on the issue. As can be seen from Table 1, previous studies focus mainly on energy consumption and oil production and obtain mixed results depending on the type of the stationarity test employed for the study. The paper by Payne (2010) presents a literature review on the causal relationship between energy consumption and economic growth on the international empirical background We, following Kum (2012) employ LM univariate and panel data unit root test to strengthen the power of stationarity tests. Contrary to previous studies we use up to date time series and include Russia in the sample.

3. MATERIALS AND METHODS

The data used in the study include crude oil production for 15 countries for the period 1990-2017. The choice of the countries in the sample is dictated by data availability. Crude oil production data is obtained from International Energy Agency database and national statistical agencies, where necessary. The base period for the data is annual and converted into natural logs before analysis for stationarity. The sample includes Russian Federation, Kazakhstan, Turkey, Azerbaijan, Turkmenistan, Belarus, Ukraine, Denmark, Romania, Germany, Netherlands, France, Italy, the UK, Norway.

The standard approach to test for a unit root involves performing ADF unit root tests (Dawson and Strazicich, 2010). However, Augmented Dickey-Fuller (1979) type models do not allow to analyze the impact of structural changes in the economy. Perron (1989) proved that failure to allow for an existing break leads to a bias that decreases the ability to reject a false unit root null hypothesis. Perron proposed allowing for one known, or exogenous structural break in the ADF unit root test to fix this problem. Following Perron (1989), many authors including, Zivot and Andrews (1992) and Perron (1997) suggested determining the break point endogenously from the data. Lumsdaine and Papel (1997) modified the ZA model to accommodate two structural breaks. On the other hand, all these endogenous tests were criticized for their treatment of breaks under the null hypothesis.

Given the breaks are absent under the null hypothesis of unit root there may be a tendency for these tests to suggest evidence of stationarity with breaks. Lee and Strazicich (2003) propose a two break minimum Lagrange multiplier (LM) unit root test in which

Table 1: Literature review

Author(s)	Countries	Test type	Period	Results
Narayan and Smyth (2005)	Australia	Zivot Andrews	1966-1999	Non-stationarity
Lee (2005)	18 developing countries	Several Panel Unit Root Tests	1975-2001	Non-stationarity
Al-Iriani (2006)	Six Gulf Cooperation Council countries	Several Panel Unit Root Tests	1971-2002	Non-stationarity
Soytas and Sari (2006)	Turkey	ADF, Df-GLS, PP, KPSS, NP	1968-2002	Conflicting results between the tests due to different lag selection
Zachariadis and Pashourtidou (2007)	Cyprus	Perron (1989)	1960-2004	Non-stationarity
Narayan and Smyth (2007)	182 countries	Univariate and panel unit root tests	1979-2000	Stationary
Chen and Lee (2007)	104 countries	Carrion-i-Silvestre et al. (2005) test	1971-2002	Stationary
Narayan et al. (2008)	60 countries	Im et. al (2005) panel unit root test with one structural break	1971-2003	Stationary
Hsu et al. (2008)	84 countries	Panel SURADF unit root test	1971-2003	Non-stationarity
Mishra et al. (2009)	13 Pacific Island countries	Carrion-i-Silvestre et al. (2005) test	1980-2005	Stationary
Narayan et al. (2010)	Australia and its six states	Lee and Strazicich (2003) two-break unit root test	1973-2007	Stationary
Apergis et al. (2010a)	50 US states	Panel unit root and stationarity tests with endogenously determined structural breaks	1980-2007	Stationary
Apergis et al. (2010b)	50 US states	Panel unit root and stationarity tests with endogenously determined structural breaks	1980-2007	Stationary
Kum (2012)	15 East Asia & Pacific Countries	LM panel unit root test with one structural break	1971-2007	Stationary
Ozcan (2013)	17 Middle East Countries	Univariate and panel LM unit root tests	1980-2009	Non-stationary for univariate unit root test, stationary for LM unit root test

LM: Lagrange multiplier

Table 2: LM unit root test results

Country level	LM statistic without break	LM statistic with one break
Russian Federation	−5.964*** (1)	−7.132*** (0) [1998]
Kazakhstan	−4.851*** (2)	−6.852*** (0) [1998]
Turkey	−6.894*** (1)	−6.671*** (0) [1999]
Azerbaijan	−4.583*** (0)	−7.962*** (1) [1999]
Turkmenistan	−1.229 (3)	−6.131*** (0) [1998]
Belarus	−1.074 (5)	−6.583*** (0) [1998]
Ukraine	−2.109 (2)	−7.809*** (1) [2009]
Denmark	−5.843*** (1)	−5.532*** (0) [2008]
Romania	−0.375 (3)	−6.763*** (1) [2009]
Germany	−6.283*** (1)	−5.953*** (0) [2008]
Netherlands	−3.215** (4)	−7.053*** (0) [2009]
France	−6.156*** (2)	−6.152*** (1) [2009]
Italy	−3.907*** (4)	−7.071*** (0) [2009]
UK	−3.195** (3)	−6.793*** (0) [2009]
Norway	−5.739*** (2)	−6.352*** (1) [2009]
Panel	−12.486***	−35.157***

Numbers in the parentheses are the optimal number of lagged first-differenced terms included in the unit root test to correct for serial correlation. The 1% (*), 5% (**) and 10% (***) critical values for the LM test without a break are −3.63, −3.06, and −2.77, respectively. The corresponding critical values for the panel LM test are −2.326, −1.645 and −1.282 respectively. The 1%, 5% and 10% critical values for the minimum LM test with one break are −4.239, −3.566 and −3.211, respectively. LM: Lagrange multiplier

the alternative hypothesis unambiguously implies the series is trend stationary (Glynn and Perera, 2007). In contrast to the ADF test, the LM unit root test has the advantage that it is unaffected by breaks under the null. (Amsler and Lee, 1995). The LM unit root test can be explained using the following data generating process. e_t is crude oil production and Z_t includes exogenous variables, ε_t being an error term. The LM unit root test allows for structural breaks in the spirit of Perron (1989). The break minimum LM unit root can be described as follows. According to the LM, a unit root test statistic can be obtained from the following regression:

$$e_t = \delta Z_t + X_t, X_t = \beta X_{t-1} + \varepsilon_t \quad (1)$$

For equation (1), Δ is the first difference operator; $\overline{S_t} = e_t - \widehat{\Psi}_x - Z_t\widehat{\delta}_t$ t = 2,…, T; $\widehat{\delta}_t$ are coefficients in the regression of Δe_t on ΔZ_t; $\widehat{\Psi}_x$ is given by $e_t - Z_t\delta$. If crude oil price production has a unit root for country i then φt = 0, which is the null hypothesis tested using the t-test against the alternative hypothesis that φt < 0. The panel LM test statistic is obtained by averaging the optimal univariate LM unit root t-test statistic estimated for each country. This is denoted as LM_i^{τ}

$$LM_{barNT} = \frac{1}{N}\sum_{i=1}^{N} LM_i^{\tau} \quad (2)$$

Im et al. (2005) constructed a standardized panel LM unit root test statistic by letting $E(L_T)$ and $V(L_T)$ denote the expected value and variance of LM_i^{τ} respectively under the null hypothesis. Im et al. (2005) then compute the following expression:

$$\Psi_{LM} = \frac{\sqrt{N}(LM_{barNT} - E(L_T))}{\sqrt{V(L_t)}} \quad (3)$$

The numerical values for $E(L_T)$ and $V(L_T)$ are in Im et al. (2005). The asymptotic distribution is unaffected by the presence of structural breaks and is standard normal.

4. RESULTS AND DISCUSSION

Results of testing the hypothesis of the study are presented in Table 2. Results include the statistic for both LM unit root with and without breaks.

The results of the unit root tests as shown in Table 2 give support to the stationarity of series for Russian Federation, Kazakhstan, Turkey, Azerbaijan, Denmark, Germany, Netherlands, France, Italy, the UK and Norway. In other words, shocks to crude oil production have transitory effect for these countries. Yet, in cases of Turkmenistan, Belarus, Ukraine and Romania we can't detect stationarity of oil production and reject the unit root null hypothesis. Table 2 also shows that using LM unit root test with one structural break is significant countries of the sample. This result supports that the shocks to crude oil production have transitory effect for the sampled countries.

5. CONCLUSION

Stationary time series have a significant impact on the building of models evaluating and forecasting various economic variables. If the production of crude oil contains a unit root, the oil shocks will have a permanent effect on the level of oil supply. Thus, the disruptions in crude oil production will have a permanent effect on economic activity in the country. However, if crude oil production series is stationary, negative or positive shocks in oil production will be temporary, transitive, and crude oil production will adjust to certain changes in the national economy and the supply of crude oil will return to its original equilibrium level within a short period of time. In this case, the disruptions in crude oil production will have only a temporary, transitive effect on economic activity in the country. In this paper we investigate the stationarity properties of crude oil production in the 15 sampled countries for the period 1990-2017 to find whether shocks to crude oil supply are of permanent or temporary nature. The sample includes Russian Federation, Kazakhstan, Turkey, Azerbaijan, Turkmenistan, Belarus, Ukraine, Denmark, Romania, Germany, Netherlands, France, Italy, the UK, Norway.

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