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The Stochastic Futures of the Natural Gas Prices: Russian Federation in Caspian Region

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Abstract

This study examines the convergence hypothesis of natural gas price series of Russian Federation and USA using both linear and nonlinear time series techniques Russian Federation and USA during the period of 1991-2011. Although the linear Augmented Dickey Fuller (ADF), Philips Perron (PP), test provide evidence of the existence of a unit root, which means that the series are nonstationary, KPSS test result support the null hypothesis of existence of the stationary series. A nonlinear test as an alternative approach to investigate whether there are nonlinearities in the series is also taken into consideration. KSS, the nonlinear testing procedure provide some supportive evidence of a nonlinear price convergence among the Russian Federation and USA.

Keywords: Nonlinear Unit Root Test; Convergence Hypothesis; Natural Gas Price.
JEL Codes: C12; C22; O47.

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1. Introduction

Natural gas, as the main raw material of various chemical products, satisfies a fundamental part of world's energy demand. Although natural gas was seen as an useless waste arising during the production process of oil in the past, nowadays it is extensively used as an valuable and strategic energy source around the world. Natural gas industry does not have a history as deep as oil industry, however, the consumption of this type of fossil fuel has unusually increased in recent years due to cheaper costs, efficiency, ecological cleanness, and availability in electricity production process. Indeed, natural gas is considered as a "transition fuel" in the transforming process of world energy sector transforms the traditional energy recourses to the renewable as nuclear power plants and hydrogen energy. Because of significant volume of oil and natural gas reserves and their export potential, the Caspian region have become a strong candidate for the world's energy storage of the 21st century. On the other hand, along with the collapse of the USSR in the early 1990s, new energy power conflicts started at the Caspian Basin and became the centre of conflicts of interest.

In the recent years, along with the transformation to one of the major natural gas suppliers in the world, the natural gas pricing policy of the Caspian region acquires currency. In this concept determining of the natural gas prices in Caspian countries as a member of former Soviet Union in market or non-computational circumstances has become an interesting research topic. The main objective of this study was to find out whether natural gas prices determined in this Russian Federation converge to the USA natural gas prices in sample period. For this purpose convergence hypothesis and nonlinear modeling approaches have been used.

The results of the study show that along with the collapse of USSR in 1991 and adopting the free market economic structure, the natural gas prices in Russian Federation converge to USA natural gas prices in 1991 - 2011 period. This finding which is compatible with the Law of One Price in the economics implies that the natural gas prices of the biggest natural gas supplier of the world – Russian Federation mirrors USA free market natural gas prices. Although short run natural gas prices of the former communist country seems to be designed by the state interference, in the long term, this effect has disappeared and the capitalist economic strategies predominated.

2. Geopolitics of Russia in Caspian Region

Five countries - Russian Federation, Iran, Azerbaijan, Kazakhstan and Turkmenistan – are located at the Caspian Basin. According to the Central Intelligence Agency (CIA Word Factbook, 2011), 85.2 trillion cubic feet of proved natural gas reserves are at the Caspian region which provides 46% of the world total proved natural gas resources. In other words, this region contains nearly half of the world's reserves. Giving that the major source of the public and export revenues of these countries come from the transactions in the energy sector hydrocarbon resources also play a crucial role for related economies in terms of development and growth. However, consequently the natural gas transportation pipelines were based on principles of division of labor and dependency in USSR's planned economic system provokes a conflict between the countries in the region concerning how to maintain natural gas transporting to the word market.

Russian Federation is one of the major exporters of crude oil and natural gas in the Caspian region as well as in the world. According to the U.S. Energy Information Agency, this country has 80.00 billion barrels of proved crude oil reserves, which is correspond to 4.86 % of the world total proved crude oil reserves and 1,688.00 trillion cubic feet proved natural gas sources, which is equivalent to 24.66% of the world total proved natural gas reserves. Since oil and gas account for more than 50% of the federal budget revenues, these hydrocarbon reserves play a crucial role in political and economic sustainability of Russian Federation. Accordingly, the loss of the control over crude oil and natural gas pipelines and transition system notably in Caspian region will affect Russian Federation negatively and destroy political and economic power. However, transporting of the energy resources to international markets by multinational oil and gas companies in some post-Soviet Caspian countries such as Azerbaijan, Kazakhstan and Turkmenistan might affect Russian Federation. Firstly, energy production sharing agreements of these countries with the large multinational companies could reduce significance of Russian Federation at exploration and production stage of the natural recourses. Secondly, foreign direct investment in the oil and gas industry could accelerate liberalization process in these post-Soviet countries and also significant amount of revenue purchasing from international markets will diverge them from Russian Federation[2]. Although influence of Russian Federation in production and cash flow phases decreased in comparison with Soviet period this country still powerful in transportation of Caspian energy resources to the international market.

3. Methodology and Data

3.1. Linear Unit Root Tests

Nahar – Inder (2002), Augmented Dickey and Fuller (1979, 1981) Phillips and Perron (1988) techniques are used to examine weather price series are stationary or not. The Phillips-Perron (P-P) test has an advantage over the augmented Dickey-Fuller (ADF) test. The P-P test gives robust estimates when the series has serial correlation and time dependent heteroscedasticity, and the regime changes during the time period. Other test suggested by Kwiatkowski, Phillips, Schmidt, and Shin (1992) is a Lagrange Multiplier test (KPSS) of the null hypothesis of stationarity against the alternative of a unit root, unlike the most unit root tests that treat non-stationarity as the null hypothesis. Such characteristic of the KPSS is argued to enable a confirmatory analysis in unit root testing[3].

3.2. Nonlinear Unit Root Tests: Kapetanios Shin and Snell Test (KSS) (2003) Unit Root Test

Let y_t follow a univariate exponential smooth transition autoregressive (ESTAR)[4] model of order 1:

$$y_t = \beta y_{t-1} + \gamma y_{t-1}\left[1-\exp(-\theta y_{t-d}^2)\right] + \varepsilon_t , \tag{1}$$

which after reparameterising can be written suitably as

$$\Delta y_t = \phi y_{t-1} + \gamma y_{t-1}\left[1-\exp(-\theta y_{t-d}^2)\right] + \varepsilon_t , \tag{2}$$

where $\phi = \beta - 1$.

The global stationarity of the process y_t can be established by testing the null hypothesis $H_0 : \theta = 0$ against the alternative $H_1 : \theta > 0$. However, testing the null hypothesis directly is not feasible since the parameter γ is not identified under the null. In order to solve this problem, Kapetanios et al. (2003) use the method of Luukkonen et al. (1998) for replacement the transition function by its suitable Taylor approximation to obtain a t-type test statistic. By using Taylor approximation the following auxiliary regression is obtained:

$$\Delta y_t = \delta y_{t-d}^3 + e_t , \qquad (3)$$

where e_t comprises original shocks ε_t as well as the error term resulting from Taylor approximation. The test statistic for $\delta = 0$ against $\delta < 0$ is obtained as follows:

$$t_{NL} = \hat{\delta} / s.e.(\hat{\delta}) ,$$

where $\hat{\delta}$ is the OLS estimate and s.e. ($\hat{\delta}$) is the standard error of $\hat{\delta}$.
In the more general case when errors are serially correlated, the auxiliary regression augmented by p^{th} order lag of dependent variable. The extended model can be seen as follows:

$$\Delta y_t = \sum_{j=1}^{p} \rho_j \Delta y_{t-j} + \delta y_{t-d}^3 + e_t \qquad (4)$$

3.3. Estimation Results

In this study, we use data on natural gas prices for Russian Federation and USA cover the period of 1991 to 2011. The data were obtained from www.indexmundi.com in 2011.

Table I: Descriptive Statistics

	USA	***RF***
Mean	4.953	4.812
Median	4.737	4.754
Maximum	6.357	6.196
Minimum	4.096	3.722
Std. Deviation	0.571	0.588
Skewness	0.726	0.205
Kurtosis	2.335	2.000
Jarque-Bera	26.021	11.92
Probability	0.000	0.003
Sum.	1213	1178
Observations	245	245

Before performing unit root tests, we took natural logarithms of the series. Table I provide some basic descriptive statistics of the considered series. The Jarque – Bera value in this table implies non normal distribution for both countries. As it can be seen from this table while USA price series distribution is moderately skewed[2], Russian Federation price series distribution is approximately symmetric[3]. Since natural gas price distributions of these countries are with kurtosis smaller than the normal distributions[4], compared to a normal distribution, central peak of these distributions are lower and broader, and tails of these distributions are shorter and thinner.

[2] If skewness is between −1 and −½ or between +½ and +1, the distribution is moderately skewed.
[3] If skewness is between − ½ and + ½, the distribution is approximately symmetric.
[4] A normal distribution has kurtosis exactly 3 (excess kurtosis exactly 0).

In Figure 1 we provide plots of the data As we can infer from the logarithmic value a preliminary information indicating that natural gas price series the countries converge to a common mean over the sample period.

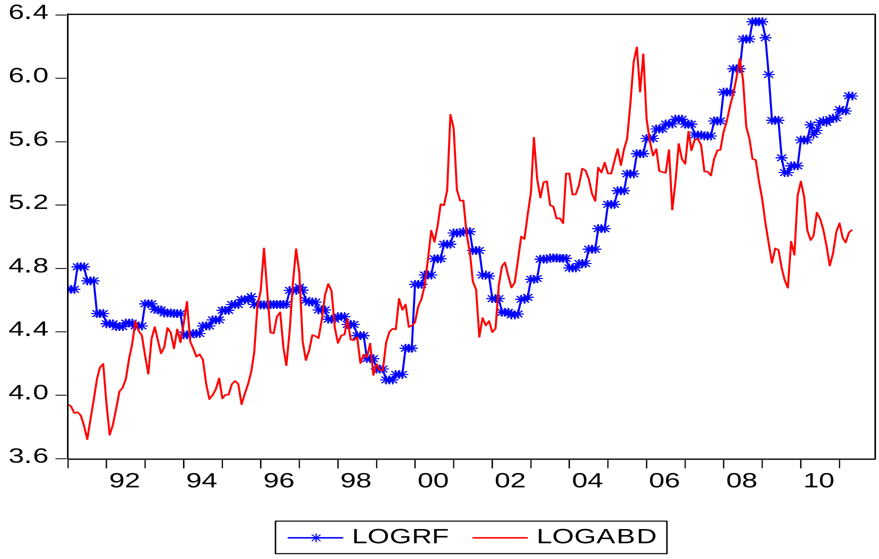

Figure 1: Log of Natural Gas Price Series for Russian Federation and USA

We first tested the stationarity of natural gas prices the Nahar – Inder stationarity test. We create a demeaned and difference of series of Russian Federation and USA natural gas prices series and then the equation (1) is used to test whether it converge to USA price series, which assumed to have a best performance.

$$w_{it} = \beta_0 + \beta_1 t + \beta_2 t^2 + \ldots + \beta_{k-1} t^{k-1} + \beta_k t^k + u_{it}, \quad i = 1, \ldots, N \qquad (5)$$

Table 2. Nahar- Inder Test Results

	Coefficient	Stand. Error	t-Statistics	Prob.
Constant	0.598	0.068	8.791	0.000
Trend	-0.006	0.002	-2.373	0.018
(Trend)2	-4.53E-05	2.31E-05	-1.965	0.050
(Trend)3	3.14E-07	6.21E-08	5.051	0.000
R2		0.592		
Adapted R2		0.587		

Due to declining in standard deviation in the monthly price series of these countries as time goes on, we can conclude that these series have σ- convergence as defined by Sala-i Martin (1996)[5].

Then ADF test is implemented in two ways fixed and fixed with trend. According to

[5] Sala-i-Martin, X.,1996

the results of this test the null hypothesis of nonstationarity could not be rejected at the 5% significant level (Table: III). The PP test was applied in the same way and nevertheless null hypothesis of nonstationarity could not be rejected at the 5% significant level in both cases fixed and fixed with trend (Table: III). Finally KPSS is applied and according to this test results the null hypothesis of stationarity could not be rejected at the 5 % significant level which imply controversial result with Nahar – Inder, ADF and PP tests.

Table 3. Linear Unit Root Test Results

	ADF		***PP***		***KPSS***	
	Intercept	Intercept + Trend	Intercept	Intercept + Trend	Intercept	Intercept + Trend
First Difference	-2.729	-2.724	-2.850	-2.808	0.402	0.403

Note : Critical Values for the 5% significant level; **ADF** Intercept: -2,8731 Intercept + Trend: -3,4283, **PP** Intercept: -2,8731, Intercept + Trend: -3,4283, **KPSS** Intercept: 0,4630 Intercept + Trend: 0,1460. Lag length determined by AIC.

In order to use, KSS, which takes into account asymmetric adjustment with smooth structural changes in the data generating process, the stationarity of ESTAR data production process is tested. The equation below is tested in two way mean-adjusted and trend- adjusted.

In both cases test statistics is obtained which are smaller than critic value at the10 % significant level implying that this nonlinear series is stationary.

Table 4. Nonlinear Unit Root Test Result

	KSS	
	Demeaned	De-trended
First Difference	-2.921*	-3.392*

Note: Statistical significant for the % 6 significant level.

After demeaned and de trended series the results obtained from Table IV shows that considered series are stationary in the context of nonlinear framework.

3. Conclusion

This study examines the convergence hypothesis for natural gas price series of Russian Federation and USA during the period covered from 1991 to 2011. The paper employs both a linear and nonlinear time series techniques. Although on the whole estimation results of linear ADF, PP tests and nonlinear unit root test procedures are able to reject a unit root in series, the linear KPSS tests fails to do so, providing some controversial results. In conclusion the existence of possible structural changes and nonlinearities should be taken into account during the convergence hypothesis.

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