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The Journal of Operations Research, Statistics, Econometrics and Management Information Systems

Volume 2, Issue 1, 2014

2014.02.01.ECON.01

MODELING NATURAL GAS PRICES VOLATILITY

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Received: 01 April 2014
Accepted: 20 June 2014

Abstract

Researches done so far indicate that oil reserves around the word will most probably have been used up in 50 year's time. This fact has necessitated the researches and use of new energy sources which can be alternative to oil, the most commonly used energy source around the world. Unforgettable Chernobyl nuclear disaster in 1980s, in Ukraine, caused to see the energy glass half empty; and this negative viewpoint has got more acute after the radiation leakage in Fukushima power plant which was damaged in the earthquake in Japan, in 2011. Furthermore, hydroelectric power plants have provoked reaction from many eco-warriors and organizations as they cause ecological disequilibrium through floods in natural habitat. Moreover, it will be pointless to mention coal-fired thermal power plants, which created the term "year without summer" due to the air pollution they caused during Industrial Revolution in England between 18th and 19th centuries.

When the topic is energy and its production, market conditions, in which inputs enabling production are dealt in, get affected from various outside/exterior factors. Dynamics of these input markets which are based on delicate balances change constantly; and thus, these changes become influential on aforementioned input prices. Thinking markets selling oil and its derivatives, it becomes more comprehensible that dynamics are significant and related to each other. Without a doubt, one of the energy inputs which are closely dependent on these critical market conditions is natural gas prices.

In this study, stability of daily natural gas prices between 1997 and 2012 will be researched and its volatility will be tried to be modeled via ARCH&GARCH model family.

Keywords: Naturalgas Prices, Time Series Analysis, Box-Jenkins Method, Unit Root Tests, ARCH and GARCH Models, Volatility.

Jel Code: C01, C20, C50, C51

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Özet

Araştırmacılar, dünyadaki petrol rezervlerinin çok yüksek ihtimalle önümüzdeki 50 yıl içinde tükeneceğini ortaya koymuşlardır. Bu gerçek araştırmacıları, dünya genelinde petrolün alternatifi olarak kullanılabilecek bir enerji kaynağı arayışına itmiştir. 1980'de Ukrayna'nın Çernobil şehrinde yaşanan nükleer felaket, dünya üzerinde bu enerji türüne karşı bardağın boş tarafından bakılmasına sebep olmuş, bu olumsuz görüş 2011 yılında Japonya'da meydana gelen deprem sonrası Fukuşima santralinde meydana gelen sızıntıdan sonra daha da artmıştır.

Ayrıca hidro-elektrik santrallerin doğal yaşam alanlarına verdiği zararlar, bu enerji türüne karşı, çevre savunucuları ve örgütlerinin tepkilerine ve protestolarına sebep olmaktadır. Diğer taraftan 18 ve 19. yüzyıllardaki Sanayi Devrimi sırasında İngiltere'de "Yazsız Yıl"ın yaşanmasına sebep olan termik santrallerden bahsetmeye gerek bile yoktur.

Söz konusu enerji ve üretimi olunca, bu üretimi sağlayan girdilerin alınıp satıldığı piyasa koşulları birçok dışsal faktörden etkilenmektedir. Hassas dengeler üzerine kurulu bu girdi piyasalarının dinamikleri koşullara bağlı olarak sürekli değişmekte bu değişimlerde beraberinde söz konusu girdilerin fiyatları üzerinde etkili olmaktadır. Petrol ve türevlerinin alınıp satıldığı piyasalar düşünülünce dinamiklerin ne kadar hassas ve birbirine bağlı olduğu daha iyi anlaşılabilmektedir. Bu hassas piyasa koşullarına bağlı enerji girdilerinden bir tanesi de hiç şüphe yok ki doğalgaz fiyatlarıdır.

Bu çalışmada, (1997-2014) yılları arası günlük doğalgaz fiyatlarının durağanlığı araştırılarak, sahip olduğu volatilite ARCH&GARCH model ailesi ile modellenmeye çalışılacaktır.

Anahtar Kelimeler: Doğalgaz Fiyatları, Zaman Serileri Analizi, Box&Jenkins Metodu, Birim Kök Testleri, ARCH&GARCH Modelleri, Volatilite

Jel Sınıf Kodları: C01, C20, C50, C51

1. Introduction

Humankind has been aware of the presence of energy for millions of years. However, consuming or producing this energy for the actual purpose was not so rapid especially in the old-time. Even though mankind's taming these life sources and consuming them in accordance with their actual purpose took thousands, even ten thousand years in the time scale, the time when human really encountered with the energy dates back to just a few centuries.

Increase in energy demand depending on the energy consumption results in production need to meet the popular demand. Various sources have been made use of to provide production. One of these commonly used sources is natural gas; the use of which has considerably increased particularly recently.

Obtrusive effects of environmental problems, desires to have alternate energy sources along with charming processing prices gradually make natural gas a more appealing energy source. Natural gas, despite not having gained the oil throne yet but taking firm steps to take it soon, appears in literature as today's appealing and reasonable energy source.

Natural gas, as mentioned earlier, depending on many factors, such as increasing environmental pollution in parallel with conservationist reactions, prices and financial reasons, has been mostly preferred for both heating and generating energy rather than coal and its derivatives especially in recent years.

Apparently, as with each globally alluring energy sources, natural gas gets its share from the other financial changes. Natural gas prices' not being dependent only on its market conditions and recently growing popularity are the leading factors affecting the price of this energy source. Though not like oil, natural gas has an unstable data structure.

The aim of this study is to model natural gas prices volatility, which is mostly affected by outer (exterior) conjunctures. As with each time series analysis, before modeling volatility in natural gas prices series, the stationarity analysis will be studied using ACFs and unit root tests.

After specifying the volatility, ARCH&GARCH modeling family, which are known as autoregressive models with changing conditional variances proposed by Engle (1982) and Bollerslev (1986) will be applied in the next step.

2. Literature Study

Although there are articles analyzing natural gas price volatility in literature, not many studies have tried to model aforementioned volatility via ARCH&GARCH model family. Particularly in technical literature of Turkey, there has not been a research done about natural gas volatility yet. When considered from this point of view, this study will be accepted as the first. Some of the similar studies in international literature are as follows;

Fazilah ve Sonal (2009) searched the relationship between daily natural gas and oil prices, and tried to define whether the prices of each topic had influence on each other's price volatility. Moreover, they studied what sort of effects were caused on prices being questioned by outside factors, such as crisis, stocking and reserve. As a result of their study, Fazilah ve Sonal modeled volatility indicating that natural gas and oil price volatility are closely dependent both on each other and on amount of stock the top producers had.

Pindyck (2004) studied the effects of turmoil top energy producers experienced on oil and natural gas prices volatility in the USA between 1990 and 2000. At the end of the study, Pindyck claimed that natural gas and oil prices volatility were mostly dependent on risk conditions.

Alterman (2012) investigated monthly volatility of natural gas prices between 2000 and 2012, yet did not model the volatility. Alterman defined the other materials having effects on natural gas price volatility, examined trends, and concluded that natural gas prices were particularly influenced by oil prices.

Duong (2008) studied reasons for natural gas volatility. As a conclusion, he suggested that effects of negative shocks in crisis periods were less than the effects of the positive ones. Stating that weekly, even daily conjunctures had influence on natural gas prices, Duong pointed out that volatility of natural gas prices in winter months was more than the summer months', and also speculations were not effective on the next-day natural gas prices.

Chevallier ve S´evi (2011) analyzed the relationship between trading volume and price volatility in oil and natural gas markets using high frequency series. According to the regression analysis, they proposed a positive relation between trading volume and price volatility. Furthermore, according to the result of their analyses which was based on the assumption that the relationship between volatility and trading volume was symmetrical (showing effects of shocks in crisis periods with trading volume), the interaction being questioned was not symmetrical. Asserting that the effects of negative shocks were higher than the positive ones', they explained the relationship.

Qin et. al. (2010) questioned the dynamic relation between the market basics and natural gas prices. At the end of the study they conducted which searched the hypothesis that natural gas prices indicated different proceedings; they stated that the claim presented was acceptable. In addition, they presented that natural gas prices volatility could be explained via GARCH type models. As another outcome of the study, they suggested that market basics were inefficient to explain natural gas prices volatility and this volatility was deeply influenced by lots of various external factors.

3. Material and Method

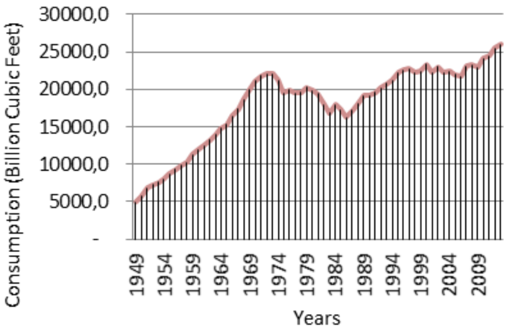
3.1. A General Outlook on the World Natural Gas Market

Natural gas, major raw material of various chemical products, meets an essential part of world energy consumption. Its history dates back to hundred years earlier. Historical recordings show that it was first used in China 900 B.C. As it was easy to carry, process and stock, common use of natural gas was in the early 1800s. With the use of natural gas pipeline transportation, increasing natural gas consumption in 1920s also rose after the World War II. The USA was the first to use natural gas to generate energy. While natural gas provided 10 % of world energy consumption in 1950s, in the present day it meets 24 % of energy consumption. It is estimated that known natural gas reserves have a lifespan of 70 years. Known natural gas reserves are equivalent to oil reserves (naturalgas.org).

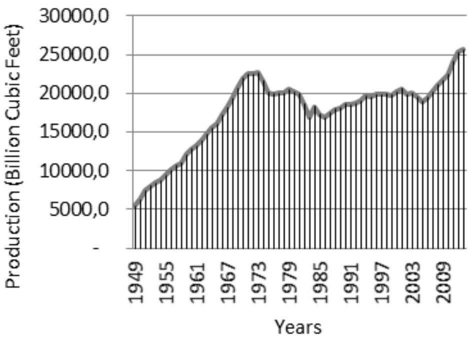
In 2011, crude oil, having a strategic position among the primary energy resources, met 33, 1 % of world energy demand, while natural gas provided 23, 8 %. After the second half of the 20th century, environmental pollution which increased particularly as a result of intense industrialization caused a growing demand for natural gas, a relatively clean fuel. To the first energy projection for 2030 of International Energy Agency (IEA), coal and natural gas demands are expected to increase significantly. It is anticipated that annual increase in world energy demand with 2, 4 % average in the last twenty years will have dropped back to 1,6 % annually until 2030, shares of gas and non-fossil fuels in energy consumption will mount up in proportion to fossil fuels, and oil will have the lowest rate of increase, annually 0,7 % (T.P.O 2011 Oil and Natural Gas Sector Report).

According to T.P.A's 2011 report, LNG liquid natural gas trading volume around the world continued to enlarge 10 % in 2011. Growth in LNG importation resulted from increases in Japan, specifically with the nuclear crisis, in developing south hemisphere markets, as well as in developed markets such as U.K., South Korea, and Taiwan. LNG demand in Europe rose in the first half of the year; however, it had an inclination/tendency to fall in the second half. Demand increase in Asian markets considerably lessened excessive amount of LNG in markets. Production amount has been constantly on the rise particularly since 1980 in order to meet increasing demands.

As seen from Graph 1., natural gas consumption amount in 2013 almost tripled the amount in 1980. This condition, as mentioned before, resulted from the fact that natural gas is a clean and obtainable energy source. Graph 2. demonstrates natural gas production between 1980 and 2013 by years. To meet the increasing consumption need, production amount almost tripled as consumption amount.



Graph 1. Annual Global Natural Gas Amount, (source: eia.gov)



Graph 2. Annual Global Natural Gas Marketed Production (Wet) (source: eia.gov)

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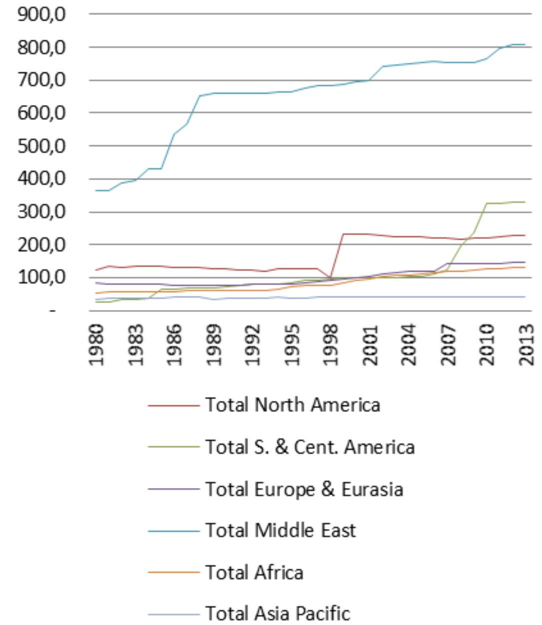
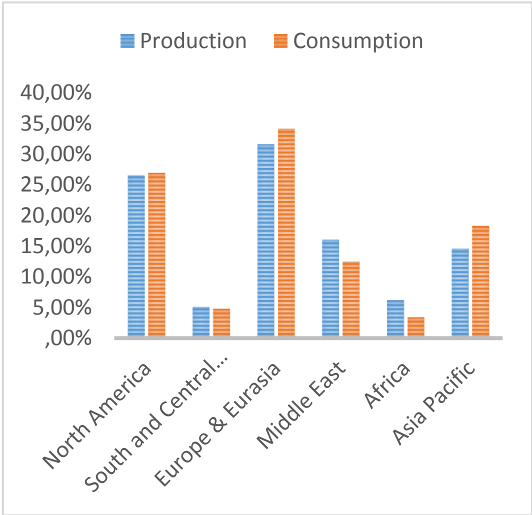
In other hand if is it necessary to look reserves natural gas by the country, 76 trillion m3 (41%) of natural gas reserves are in Middle East countries, 59 trillion m^3 of reserves are found in Russia and countries of Commonwealth of Independent States (CIS), and there are 31 trillion m^3 (17%) in Africa/ Asia Pacific countries. Graph 3. depicts natural gas reserve amounts regarding areas by milliard cube.



Graph 3. Natural Gas Reserve Amounts Regarding Areas, 1980-2013 (trillion cube) (Source: BP Statistical Review of World Energy Outlook 2013)

The fact that most of reserves are located in Central Asia and Russia has made these areas production centers. As of 2013, shares of production areas in total production are presented in Graph 4. World natural gas production and consumption shares of all areas as of 2011 can be seen in Graph 4.



Graph 4. World natural gas production and consumption shares of areas (Source: BP Statistical Review of World Energy Outlook)

As is seen from graph 3, both production and consumption are dense mainly in Asia and Europe, and mostly in North America. Among the reasons for the situation, the closeness of these areas to reserves and the intensity of industrial activities especially in some countries such as North America, Europe and Asia (Japan, China, and India) can be stated.

3.2. Box & Jenkins Method

Box-Jenkins method is one the ways used to forecast univariate time series. Short-term prediction, this new and successful method of methodology, shows a methodical approach to set up intermittent and stationary time series models of research values acquired by equal time intervals and to make predictions. Whether the series consisting values acquired by equal time intervals are intermittent or stationary are vitally important hypotheses assumptions of Box-Jenkins method.

Box – Jenkins method makes reliable future estimation possible combining moving average with autoregressive process after it stabilizes series using differencing method. Box-Jenkins approach is one of the most-frequently preferred methods to analyze time series data and used to model

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stationary time series. While setting the model of time series, selection of the most proper (p, d, q) values is a problem. Box –Jenkins method is applied to determine these values.

General ARIMA (p, d, q) model statement is as follows (Enders, 2004);

$$w_t = \varphi_1 w_{t-1} + \varphi_2 w_{t-2} + \ldots + \varphi_p w_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q} \quad (1)$$

Δ: Differencing operator

d: Differencing level

(w_t): Differentiated series

3.3. Unit Root Tests

When autoregressive process AR(1) from the first level are discussed, the process is defined as follows: (Gujarati, 2004)

$$y_t = \rho y_{t-1} + \varepsilon_t \quad (2)$$

In 2 Model, y_t means market value of time series; y_{t-1} shows value of series in the previous period, and ρ is the root of characteristic equation in AR process.

In this model, think that H_0: ρ=0 (the series has no unit root and is stationary) hypothesis will be tested. Under H_0 hypothesis, ρ parameter in the equation above can be estimated with Least Squares.

Moreover, ε_t term in the model is the error term, and this error term has normal distribution features like $E(\varepsilon_t) = 0$ and $Var(\varepsilon_t) = \sigma^2 v \cdot \varepsilon_t$ error term is called as error term (white noise) (Gujarati, 2004, p;802).

Gujarati (2004) (2) stated that if ρ is smaller than one as absolute value, (|ρ|<1) y_t series is stationary and least squares estimator of y_t is effective. Besides, whether estimated value of ρ, ρ student t statistic calculated comparing ρ estimation to standard error is significantly different from zero or not.

Dickey Fuller (DF), Corrected Dickey Fuller (ADF) Tests and Phillips-Perron Tests

In unit rooted time series, at least one of the characteristic equation roots of series should be "1" as absolute value. In literature there are various methods to test whether series include unit root or not, or are stationary. However, the most commonly used one in practice is DF test method, which is based on least squares estimator distribution of parameters. DF unit root test can be applied only if process has only one unit root, and if this case can be eliminated.

There are two hypotheses to test the presence of unit root. They are;

H_1: γ<0 (ρ<1) (no unit root in series) (stationary series)

H_0: γ=0 (ρ=1) (unit root in series) (non-stationary series)

Dickey and Fuller (1979) accepted the hypothesis that residuals are independent and have normal distribution in the test they developed. Yet, the hypothesis that e_t*s* are independent is not always valid. Modeling a time series model needed to be set at p. level (p>1) with AR(1) process will cause residuals to be auto-correlated; that means they will have a relationship. To eliminate this problem, lag values of time series being questioned should be included in the model. To reach the equations which will be handled in extended Dickey-Fuller test (ADF), it is adequate to add lag values of y_t

It is accepted that, in DF tests, error terms are independent, and has normal distribution and fixed variance. In the researches, this present relationship is not taken into consideration. Phillips ve Perron (1988) moderated the hypothesis which was accepted within the scope of DF procedure with the help of the method they had developed (Phillips ve Perron, 1988);

When the following equation models are examined;

$$y_t = m_0 + m_1 y_{t-1} + e_t \quad (3)$$

$$y_t = m_0^* + m_1^* y_{t-1} + m_2^* \left(t - \frac{T}{2} \right) + e_t \qquad (4)$$

T represents the number of observation in equations. As $e_t E(e_t) = 0$, it is not necessary for residual terms not to be in serial correlation or to be homogenous. Phillips and Perron (PP) test, in contrary to DF test, lets delicate dependence and heterogeneity between residual terms. PP test;

$$y_t = y_{t-1} + e_t \qquad (5)$$

for data produced as in equation 4, zero hypothesis trial is applied against m^* and m_i coefficients.

3.4. ARCH&GARCH Models

ARCH model was developed by Engle (1982). He rejected the constant variation hypothesis which was presented in time series models and indicated that errors were without constant variables through a study examining inflation data in the U.K. with use of ARCH process, various extensions were also proposed / suggested.

To explain the ARCH models functioning, take a regression model with a k variable as an example,

$$y_t = \beta_1 + \beta_2 x_{2t} + \ldots \beta_k x_{tk} + \varepsilon_t \qquad (6)$$

In other words, ε_t has a zero means and distributes normally with variance. While error term's having zero means is one of the hypotheses of classic least squares method, taking variation of error term in t period as a function of error term square in (t–1) period is one of the changes which ARCH model has made. In ARCH model, conditional variation is a function of error terms squares lag values. Engle (1982) explained conditional variation of error term in t period adding lag values of ε_t^2 itself to the model as below;

$$h_t = \sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \qquad (7)$$

And this process is called as ARCH (1) process. Hereby, conditional variation depends on only one lag value of error term square. A profound shock occurred in t-1 period causes a maximum (conditional) variation in t period.

The model giving the forecast value of conditional variation in t+1st period is as in equation 8;

$$h_{t+1} = \alpha_0 + \sum_{t=1}^{p} \alpha_i \varepsilon_{t+1-p}^2 \qquad (8)$$

Engle (1982) proposed the simple model in the following as an example of multiplicative conditional heteroscasticity type;

$$\varepsilon_t = v_t \sqrt{\alpha_0 + \alpha_1 \varepsilon_{t-1}^2} \qquad (9)$$

Here, v_t variation is described as a white noise process equal to one, and v_t and ε_{t-1} are independent of each other. Moreover, under v_t and ε_{t-1} limitations, α_0 and α_1 get constant values.

GARCH models appeared in 1986 through generalization of ARCH models by Tim Bollerslev. They are also known as Generalized ARCH models. GARCH models, in fact, are modeling conditional error variation of v_t process as ARMA process. The reason why GARCH is commonly used and preferred to ARMA model is its having less parameters in structure. Thus, the chance of ignoring the limitation of parameters' not being negative gets lower. According to GARCH model, conditional variation is dependent on lag values of error squares in previous period and on previous period values of previous period conditional variance of dependent variable.

Another important point of researches is to examine ARCH effect. The most known of it is ARCH-LM test shown that below.

3.5. ARCH-LM Test

ARCH test aims at determining whether the effect named as ARCH effect exists in observation values being studied. In literature, there are numerous tests having been developed for this task. However, most of package software uses Lagrange Multipler method known also as ARCH-LM test in literature.

It is possible to apply LM test using least squares errors for ARCH models. In the hypothesis which will be developed for LM test, alternative hypothesis indicating errors with ARCH effect is tested instead of research zero hypothesis explaining that errors have white noise process determining the presence of ARCH effect . The LM test has the following steps (Nargeleçekenler, 2006);

For a univariate model,

$$y_t = \mu + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \varphi_q y_{t-q} + \varepsilon_t \qquad (10)$$

the model is estimated with Least Squares. Error squares of estimated model, ε_t^2 , are provided.

Using these values, $LM = (T-p)R^2$ is calculated statistically estimating regression equation with constant term as in follows;

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \ldots + \alpha_q \varepsilon_{t-q}^2 + v_t \qquad (11)$$

$$H_0 : \beta_1 = \beta_2 = \ldots\ldots = \beta_n = 0$$

$$H_1 : \textit{At least one } \beta_j \neq 0 \ (\textit{no homoscedasticity})$$

To test the hypothesis;

4. Empirical Results

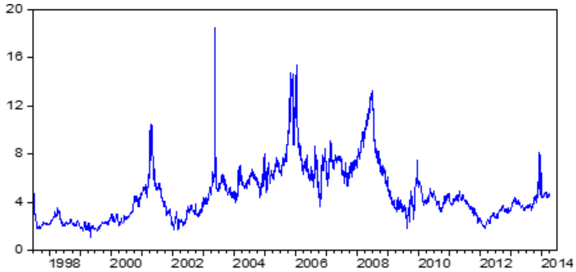
In this part of the study, Henry Hub Gulf ($/MMBTU) natural gas prices between January 1997 and December 2012 will be analyzed. Being one of the mostly used natural gas prices in international markets, it is approved to analyze these natural gas prices. Analyzing process consists of the following steps;

Initially , central tendency of the series will be searched studying Cartesian Graphs of the series. Then, volatility of series will be examined with the help of auto-correlation and unit root methods.

Afterwards, ARIMA model group will be defined to model relevant research values in hand by means of Box-Jenkins.

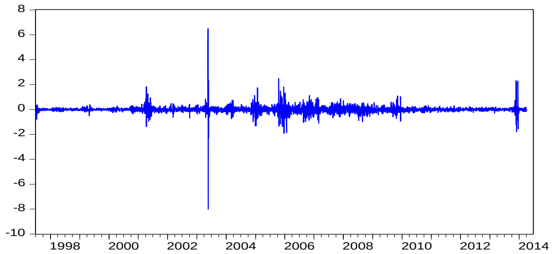
Finally, having estimated the proper ARCH and GARCH models for relevant research values, data will be generated for the conclusion.

E-views 7 package program has been used for these practices.



Graph 5. Henry Hub Gulf Natural Gas ($/MMBTU) Daily Prices, Jan 7, 1997- June 24, 2014 (Source : eia.gov)

When Cartesian graph indicating natural gas prices is examined, it is seen that prices do not have a tendency towards increase or decrease; on the contrary, they have a fluctuating manner. Another remarkable point in the series is the extreme values in series on some dates.



Graph 6. Henry Hub Gulf Natural Gas ($/MMBTU) Daily Prices Profit Series Graph, Jan 7, 1997- June 24, 2014

It can be said that volatility is present in 2000, 2004, 2005, 2006 and 2009 when profit graph of first differenced natural gas prices series is examined. However, to get the final result, ARCH-LM test needs to be done. Nevertheless, stationarity analysis should be applied before examining ARCH effect.

Unit root test results at various levels for ADF ve PP tests are given in Table 1.

Table 1. Unit root test results

Test	Model	p	AIC
ADF	At level no trend no intercept	0,1458	0,352
	At level with intercept no trend*	0,02	0,352
	At level with trend and intercept	0,037	0,352
	1 differencing no trend no intercept *	0,00	0,352
	1 differencing with intercept no trend*	0,00	0,353
	1 differencing with trend and intercept *	0,00	0,353
PP	At level no trend no intercept	0,129	0,43
	At level with intercept no trend*	0,012	0,427
	At level with trend and intercept	0,01	0,424
	1 differencing no trend no intercept *	0,00	0,43
	1 differencing with intercept no trend*	0,00	0,428
	1 differencing with trend and intercept *	0,00	0,428

H_0: The series has unit root (It is not stationary)

To test the hypothesis, ADF and PP tests were used, and at 5% significance level, it was seen that first differentiated series usually does not have unit root; that means it is stationary.

After unit root analysis, it was tried to determine ARIMA models to create data for ARCH&GARCH models, and at the end of analysis, Table 2. was generated for the proper models among the tested models.

Table 2. ARIMA model groups

Model	AIC
ARI(1,1)	0,426
ARIMA(2,1,2)*	0,352
ARIMA(2,1,1)	0,398
ARIMA(1,1,2)	0,353

Although error criterion values were very close to each other at the end of trials to find the most appropriate ARIMA model, it was decided that the most appropriate model is ARIMA (2,1,2).

After this stage, it was questioned if the series had ARCH effect or not, and ARCH-LM test results for various lag length are given in Table 3.

Table 3. ARCH effect condition for various lag length

Lag length	ARCH Effect	p Value
k=1	Available	0,00
k=2	Available	0,00
k=3	Available	0,00
k=4	Available	0,00
k=5	Available	0,00

$$H_0: \beta_1 = \beta_2 = \ldots\ldots = \beta_n = 0$$

$$H_1: \textit{At least one } \beta_j \neq 0 \ (\textit{no homoscedasticity})$$

At the end of the examinations for hypothesis like above, it was observed that till 5 lag, at 5% significance level, there was volatility effecting series.

After this point, volatility modeling studies were carried and results are given in Table 4.

Table 4. ARCH&GARCH model results

Model	AIC
ARCH(1)	-0,291
ARCH(2)	-0,516
ARCH(3)	-0,651
GARCH(1,1)	-0,841
GARCH(2,1)	0,353
T-ARCH(1) DAS=1	-0,300
T-ARCH(2) DAS=1	-0,551
T-GARCH(1,1) DAS=1	-0,844
E-GARCH(1,0) DAS=1*	0,003*
E-GARCH(2,0) DAS=1	-0,333
E-GARCH(2,2) DAS=2	-0,857
P-GARCH(1,0) DAS=1	-0,300

Among the tested models, it was seen that E-GARCH (1,0) model with 1 asymmetry level from E-GARCH model group was also the one assuming that the model with least error criterion as absolute value had no symmetrical effects on shocks (crisis) series. It was also noticed that basic ARCH models suggested proper models for the series in question. In T-GARCH type models regarding leverage effect, in modeling volatility in series being questioned presents significant results.

The series did not have ARCH effect for 1 lag in ARCH-LM tests applied to determine the fact that whether the model which had been decided to be the most appropriate one among the tested models could eliminate ARCH effect in series or not.

After trying E-GARCH(1,0) model ARCH-LM test results for 1 lag given below. It's shown that the best model which was chosen can fit ARCH effect.

Heteroskedasticity Test: ARCH

F-statistic	0.205134	Prob. F(1,4367)	0.6506
Obs*R-squared	0.205219	Prob. Chi-Square(1)	0.6505

5. Discussion and Conclusion

Natural gas price volatility, having values depended on various exterior effects, indeed, is not an unexpected situation. Nearly all of the countries around the world use natural gas as energy source, and gradual increases in demand for the source correspondingly cause changes in natural gas prices.

First of all, when Cartesian Graph was examined, it was found out that general trend of the series was towards stability. As emphasized many times in the study, ACF tests detected that these prices which were based on extremely delicate balances were influenced by the previous period values not maybe by trend effect

When profit series is studied, volatility clusters were observed especially in 2000 and 2004. Even though volatility presence was monitored visually, precise presence of volatility was proved with ARCH-LM tests. Moreover, in studies with Box & Jenkins method, it was pointed that first differentiated series could be represented as a model with autoregressive and moving average to the second level.

Finally, the models thought to be appropriate among the proposed ones to model natural gas price volatility were tried. Although ARCH&GARCH family models were observed to have yielded proper results among the tried models, E-GARCH models which supposed that crisis effects were not symmetrical in series were studied to have given the most proper results. Furthermore, T-GARCH type models trying to model rapid decreases and increases in crisis periods were also noticed to have presented proper results; in other words, crisis were effective/influential on natural gas prices. However, it should immediately be stated that high autocorrelation in series caused reappearance of ARCH effect as the lag length rose.

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