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MODELING NATURAL GAS PRICES VOLATILITY

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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

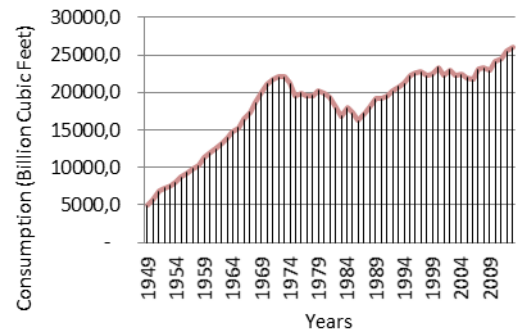
3.1. A General Outlook on the World Natural Gas Market

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).

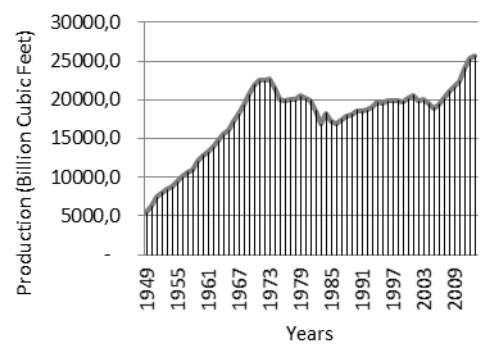
In 2011, crude oil, having a strategic position among the primary energy resources, met 33, 1 % of world energy demand, while natural gas provided 23, 8 %. After the second half of the 20th century, environmental pollution which increased particularly as a result of intense industrialization caused a 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.

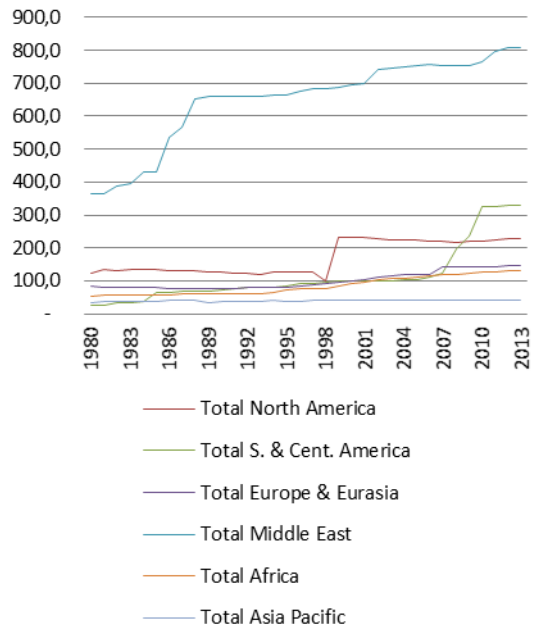


Graph 1. Annual Global Natural Gas Amount, (source: eia.gov)



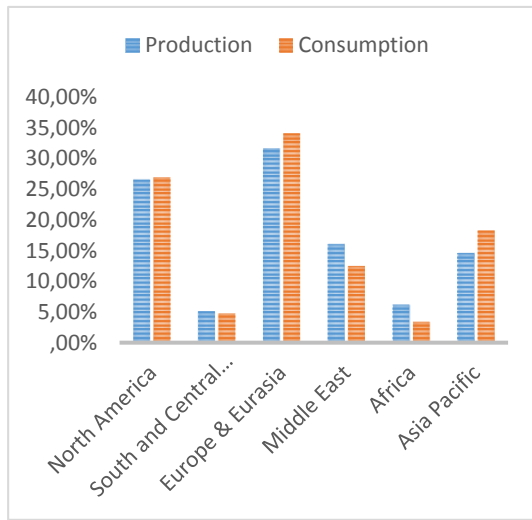
Graph 2. Annual Global Natural Gas Marketed Production (Wet) (source: eia.gov)

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

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, ($|\rho|<1$) 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: $\gamma<0$ ($\rho<1$) (no unit root in series) (stationary series)

H_0: $\gamma=0$ ($\rho=1$) (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;

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

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

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

To test the hypothesis;

4. Empirical Results

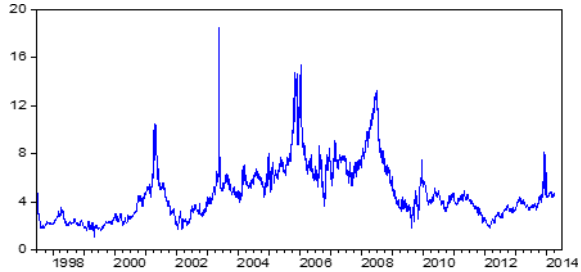
In this part of the study, Henry Hub Gulf ($/MMBTU) natural gas prices between January 1997 and December 2012 will be analyzed. Being one of the mostly used natural gas prices in international markets, it is approved to analyze these natural gas prices. Analyzing process consists of the following steps;

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.

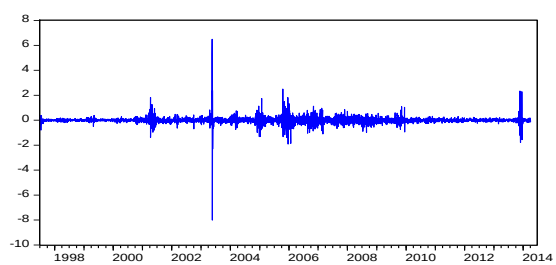
Finally, having estimated the proper ARCH and GARCH models for relevant research values, data will be generated for the conclusion.

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

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

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

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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INFORMATION TECHNOLOGY AUDIT AND THE PRACTICE OF THE TURKISH COURT OF ACCOUNTS

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Özet

Bilişim teknolojilerinin kamu ve özel sektörde yoğun kullanımı, fırsatlarla birlikte bilginin güvenliği, gizliliği, güvenilirliği ve bütünlüğü hususlarında birtakım güçlükleri de beraberinde getirmiştir. Aynı şekilde, iç kontrol ortamı ve denetim kanıtının doğasında ciddi değişikliklere yol açmıştır. Bu nedenle, denetimlerin başarılı bir şekilde yürütülebilmesi için yeni denetim prosedürlerinin oluşturulması zorunlu hale gelmiştir. Bu çalışma, genel hatlarıyla bilişim teknolojileri denetimini açıklamakta ve Türk Sayıştayının deneyimleri hakkında ayrıntılı bir izahat ve yüksek denetim örgütleri (YDK) için öneriler ortaya koymaktadır.

Anahtar Kelimeler: Bilişim Teknolojileri Denetimi, Türk Sayıştayı.

Jel Kodu: 038, H83,M42.

Abstract

Prevalent use of information technologies in both private and public sector has brought not only opportunities but also various challenges in terms of security, confidentiality, reliability and integrity of information. By the same token, it has led to a fundamental change in the internal control environment and nature of audit evidence. Hence, it has become compulsory to design new audit procedures in order for successful implementation of audits. This study broadly defines information technology audit and provides a comprehensive explanation of the experiences of the Turkish Court of Accounts and recommendations for supreme audit institutions (SAIs).

Keywords: Information Technology Audit, Turkish Court of Accounts.

Jel Code: 038, H83,M42.

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1. Introduction

Drastic changes in information technologies altering nature of internal control environment and audit for the last 15 years have led to the information revolution which has imposed an inevitable transformation at each and every aspect of our lives. Not only everyday lives have been profoundly influenced by innovations introducing mobility, connectedness, easiness, and high quality (ITIF, 2007) but also nature of the business environments has been significantly reshaped by the new rules of the business in today's world which has already become a global village. Changes in the traditional decision-making process have fueled the greed for timely, relevant, value-added, coherent, and accurate information and in turn increased the dependency in information technologies. Likewise, public sector organizations have kept pace with digital revolution in order to meet the growing expectations for high quality, easiness, and transparency in public services (Kayrak, 2012a). As a consequence, digital revolution has created a new world described by four "I"s: Information, Intelligence, Integration, and Innovation (Hinnsen, 2012).

2. Information Technology Risks And Controls

In the early phase of the digital revolution First usage of information systems in financial departments was automating payrolls and recording them on the accounting books (Akbaş, 2011). Afterwards, introducing various information systems such as transaction processing systems, office support systems, management information systems, decision support systems and strategic information systems helps organizations manage information in its journey from data to knowledge and wisdom created at different levels of business (Topkaya, 2011). Today, intense use of information technologies in the business processes turns out to be an indispensable prerequisite of competitiveness to survive and grow in the challenging business environments.

Producing, processing, storing, achieving huge amount of data from every segments of the business requires newest and flexible technologies; however, this does not necessarily add value to organizations due to the fact that complicated technologies and plethora amount of information may lead to complexity, duplication, intolerability, and confusion. By the same token, it is equally noteworthy to figure out that use of information technologies gives rise to detrimental impacts of IT-related risks which should be mitigated within the framework of business risk management while keeping in mind that 100 percent security cannot be reached at any information technology environment.

Table 1: Risks with an IT origin (ECA, 2011)

Risk	IT-related risk source
Individual errors become systematic	Automation replacing manual operations
Failure to identify the performer	Electronic transactions not logged
Unauthorised access and changes to data	Electronic data not properly secured
Loss (destruction) of data	Electronic data not protected
Disclosure of clasified information	Electronic data not properly secured

Defining threats and vulnerabilities is key to launch a risk assessment and treatment and for this reason it would be naive to define any IT controls without an IT risk assessment. It is crucial to assess the IT risk assessment procedures and figure out impact of IT on financial statement assertions and the level of risk (Schroeder and Singleton, 2010).

In an organization where business processes financial or non-financial are carried out by the help of information systems and where information assets are threaten by the IT-related risks, traditional internal control objectives are closely integrated with IT controls. That is to say, control

objectives in an information technology environment stay unchanged from those of a manual environment albeit the implementation may differ. For that reason, internal control objectives should be addressed IT-related business processes (ISACA, 2010).

IT controls may be categorized as preventive, detective and corrective controls as shown in the Table 2. Preventive controls help managements detect problems before they occur and prevent an error, omission or malicious act from occurring while detective controls detect and report the occurrence of an error, omission or malicious act. Corrective controls, on the other hand, are used to resolve problems and eventual errors discovered by detective controls and aimed at revising the system in a way to hinder the future occurrence of the same or similar problems (INTOSAI, 2007; ISACA, 2010; Kayrak, 2012a).

Table 2: IT controls

	Technical	**Administrative**	**Physical**
Preventive	Use of EncryptionSoftware, Intrusion Prevention Systems.	Employ Only Qualified Personnel, Segregate Duties	Locked Doors, Security Personnel.
Detective	Biometric Controls, Network Scanners	Audit Log Reviews, Compulsory Annual Leaves.	Physical Counting, Smoke Detector
Corrective	File Recovery from Backups	Insurance, Disaster Recovery Plan.	Hot-Warm-Cold Sites.

- Intense use of information systems in business processes has profoundly influenced the audit universe as well. It leads to alteration of the nature of audit evidence and trail; change the internal control environment; brings about suitable circumstances for fraudulent activities; and makes it compulsory to create new audit procedures (Ozkul, 2002; INTOSAI, 1996). In today's audit profession, the role of IT audit becomes very fundamental to avoid financial fiascos like Enron and WorldCom (Senft and Galleos, 2009) or IT incidents that adversely affects the reliability and integrity of data audited.

3. Information Technology Audit

3.1. Information Technology Audit: Definition and Objectives

Information technology audit was often called electronic-data processing (EDP) audit due to main use of information technologies to manage data in the past. The terms "Information technology (IT) audit" and "information system (IS) audit" have been used in the recent decades because of increasing role of IT in the business environment which influenced change in the terminology.

IT audit can simply be explained as an audit of an organization's IT systems, IT operations, IT governance and management and other related processes. According to the definition of Ron Weber, IT audit is "the process of collecting and evaluating evidence to determine whether a computer system (information system) safeguards assets, maintains data integrity, achieves organizational goals effectively and consumes resources efficiently" (Sayana, 2002 cited in Weber, 1988). Main goal of IT audit is to review and provide assurance about certain information criteria determined in accordance with the type, scope and objectives of the audit. The seven information criteria can be defined as follows (ISACA, 2007):

Effectiveness deals with information being relevant and pertinent to the business process as well as being delivered in a timely, correct, consistent and usable manner.

Efficiency concerns the provision of information through the optimal (most productive and economical) use of resources.

Confidentiality concerns the protection of sensitive information from unauthorized disclosure.

Integrity relates to the accuracy and completeness of information as well as to its validity in accordance with business values and expectations.

Availability relates to information being available when required by the business process now and in the future. It also concerns the safeguarding of necessary resources and associated capabilities.

Compliance deals with complying with the laws, regulations and contractual arrangements to which the business process is subject, i.e., externally imposed business criteria as well as internal policies.

Reliability relates to the provision of appropriate information for management to operate the entity and exercise its fiduciary and governance responsibilities.

While the main goal of IT audit is data integrity and security in general, efficiency and effectiveness of using IT assets are also an important concern for the IT audit (Pathak, 2005). IT auditor may focus on the abovementioned information criteria as a whole or partly depending on the audit objectives. To illustrate, if the audit focus is to review IT governance in an auditee, efficiency and effectiveness would be the main information criteria. In the same way, integrity, availability and confidentiality are the main information criteria to give assurance if the audit focus is information security (Kayrak, 2012a).

When IT audit is carried out as a part of financial audit, the main audit focus will be reliability, integrity, confidentiality and availability of information owing to the fact that financial audits concentrate upon reliability of financial statements and legality and regularity of underlying transactions. An IT audit in the context of a financial audit aims at (ECA, 2011):

Understanding the overall impact of IT on key business processes;

Assessing management controls on IT processes;

Understanding how the use of IT for processing, storing and communicating information affects internal control systems, inherent risk and control risk;

Evaluating the effectiveness of controls on IT processes which affect the processing of information.

Furthermore, efficiency and effectiveness of information will be assessed in the case of performing an IT audit as a part of performance audit. A performance audit may have an IT focus when (ECA, 2011);

The audit focuses on the performance of IT systems;

The audit examines the efficiency and effectiveness of a business process and/or programme where IT is a critical tool for the organization delivering those services;

Data reliability is to be assessed.

3.2. IT Audit Methodology

While it is apparent that internal controls of the entities using complex IT systems mostly rely on IT controls, references to IT in international audit standards are rather marginal (Rechtman, 2009). Considering that international audit standards for SAIs (ISSAI) does not provide a comprehensive, up-to-date and exhaustive chapter for IT audit methodology, SAIs seem to implement different approaches toward developing IT audit methodologies. For instance, European Court of Auditors and National Audit Office of the United Kingdom preferred to launch a guideline for "financial audit in an IT environment" for the generalist auditors instead of preparing a purely technical IT audit guideline (ECA, 2011; NAO, 2002). However, the General Accountability Office of the USA prepared a separate IT audit guideline of "Federal Information System Controls Audit Manual" (GAO, 2009).

IT audit is carried out in accordance with the specific steps designed for planning, implementation and reporting of the audit work. While conducting an audit of IT systems, IT auditors are expected to comply with the following steps in accordance with a risk-based audit approach (Turkish Court of Accounts, 2013):

Determine the risks arising from the use of IT systems;

Identify the control mechanisms mitigating these risks;

Examine whether the required control mechanisms are established by the auditee, and if so, whether they are functioning effectively or not;

Assess internal control weaknesses;

Report the findings obtained in line with existing procedures.

IT auditors examine two types of controls in order to understand whether control mechanisms satisfactorily fulfill an expected level of maturity in accordance with needs of the business.

Firstly, general controls are related to structures, methods and procedures intended to ensure the continuity of the activities of all IT systems of the auditee. These controls create a reliable internal control environment for IT applications and application controls designed on those IT applications. That's why, they can be defined as controls relating to the environment within which IT applications are developed, maintained and operated (ISACA, 2010). General controls consist of the following areas:

Management controls

Physical and environmental controls

Network management and security controls

Logical access controls

Processing controls

System development and change management controls

Emergency and work continuity planning controls

Application controls, on the other hand, are designed at IT application level. They can be defined as "The policies, procedures and activities designed to provide reasonable assurance that objectives relevant to a given automated solution (application) are achieved" (ISACA, 2012). Pertaining to specific IT applications, application controls either manual (performed by users) or automated (performed by computer software) are procedures that are designed to ensure the integrity and confidentiality of data (ECA, 2011). They can be categorized as:

Input controls

Processing controls

Output controls

Data transmission controls.

IT audit methodology involves both compliance testing and substantive testing. While compliance testing is aimed at finding out whether IT controls are designed in line with management policies and procedure, substantive testing focuses on gathering evidences through testing auditee's data in relating to validity and propriety of transactions (Office of the Comptroller & Auditor General of India, 2006). IT auditors could follow either a system based approach or a direct substantive testing approach depending on the nature of audit. System based audit approach which includes both compliance and substantive testing concentrates on aspects of regularity, economy, efficiency and effectiveness besides evaluation of data integrity and data security. On the other hand, direct substantive testing approach requires selection and testing of a sample of transactions which will provide evidences to auditors in relating to validity and propriety of transactions (INTOSAI, 2002).

4. Experience of the Turkish Court of Accounts

4.1. Background Information

The experience of the Turkish Court of Accounts (TCA) relating to IT audit began more than a decade ago through applying data analysis techniques during compliance audits and IT audit of the Undersecretariat of Treasury in cooperation with an audit firm. On the other hand, first systematic and methodological approach to meet the rising needs for IT audit knowledge within the TCA and in the public sector could be accepted as the Twinning Project with the National Audit Office (NAO) of UK held between 2004 and 2007. Depending on the Twinning Project TCA drafted the first version of IT audit guideline, launched certain number of IT audits while improving data analysis knowledge (mainly ACL). As an

extension of the twinning project, the TCA signed a protocol with the Scientific and Technological Research Council of Turkey (TUBITAK) to further develop its theoretical knowledge and experience in the field. Signed in 2007, the protocol mainly aimed at developing IT audit guideline, delivering information system security trainings to the IT auditors of the TCA and launching joint IT audits in public institutions. Within the scope of the protocol following outcomes were achieved:

- Review of the IT audit guideline of the TCA,
- A four month training program on subjects such as IT audit, certificate on Certified Information System Auditor (CISA), information security management system, network and operating system security, databases, business continuity, COBIT, and common criteria and
- Pilot IT audits.

The TCA organized an "IT Audit Self-Assessment (ITASA) Workshop" in collaboration with the "IT Working Group" of the European Organization of Supreme Audit Institutions (EUROSAI) in 2013 and prepared an action plan to determine the future of IT audit in the Court. Based on the methodological works, experiences through independent IT audits, and recommendations of the ITASA, the final version of the IT audit guideline of the Court was officially accepted and published by the Presidency of the TCA upon the approval of the Information Technology Steering Committee in 2013.

4.2. IT Audit Guideline

The IT audit guideline is aimed at guiding the auditors on how an IT audit is planned, performed and reported. INTOSAI guidelines and standards, Information Security Standards (ISO27K), ISACA guidelines (mainly COBIT 4.1 and Assurance Guideline) and the manuals of other countries and relevant entities are the main references of the guideline. Prepared with the assumption that it would be used by the auditors specialized on IT auditing (not generalist auditors), the guideline do not provide very much conceptual. Basic IT controls for the generalist auditors are provided in the Regularity Audit Manual of the TCA (TCA, 2013b).

The IT Audit Guideline of the TCA provides three main parts: Firstly, "Audit Planning" part explains the steps to be taken by IT auditors such as understanding the entity and its IT systems, identifying the systems having effect on financial statements, conducting system risk assessment, determining the audit strategy, and preparing the audit program. Secondly, "Assessing System Controls" is composed of control areas and provides a comprehensive framework in order to help IT auditors prepare audit programs and assess existence and effectiveness of controls in those areas. Finally, third part focuses on reporting and monitoring the audit results (TCA, 2013).

4.3. Main Findings of the IT Audit Practice of the TCA

The TCA has carried out independent IT audits, IT audits as a part of regularity audit and IT audits as a part of value for money audit. The most common and critical findings of the pilot IT audits in the last 10 years can be summarized as (Kayrak, 2012b):

- Lack of IT strategic management with IT strategic plans and IT steering committees established at an appropriate level;
- Lack of written and approved policies, plans, and guidelines;
- Weak IT risk management and value management;
- Issues regarding compliance with IT laws and regulations;
- Lack of formal IT project management;
- Inefficient IT organizations with lack of defined IT roles and responsibilities;
- Weak design of application controls on financial application;
- Poor physical and environmental conditions imposing important risks on business continuity;

- Lack of policies and monitoring in access management, password management and account management;

Lack of appropriate business continuity plans (BCP) and disaster recovery plans (DRP).

4.4. Use of IT in TCA Audits

Auditors of the TCA make use of information technology as much as possible so as to improve quality of the TCA audits including regularity audit, performance audit and IT audit. Main IT systems that TCA uniquely implements are the audit management system and the computer assisted audit software.

4.4.1. Audit Management System of the TCA: SAYCAP

SAYCAP, the audit management system tool of the TCA, is a customized software product developed between 2011 and 2012. The Presidency of the TCA made the final decision in favor of using this tailor-made AMS tool due to its high level of adaptability and flexibility which enables to meet all the requirements of the sui generis nature of the TCA audits. SAYCAP has already helped the TCA achieve following benefits (TCA, 2012):

- Improving efficiency and effectiveness of regularity audits;
- Carrying out timely audits;
- Measuring the planned costs of audits in order to improve programming and budgeting processes;
- Providing a high level of standardization among the works of all audit teams completely in line with regularity audit manual;
- Establishing a better quality control review system including hot and cold reviews;
- Producing timely management information to help senior management monitor audits and take necessary decisions;
- Facilitating information sharing in a systematic way among the auditors.

According to the statistics of the audit year 2013, the TCA has carried out the regularity audit of 489 auditees by the help of SAYCAP which has helped the auditors prepare 98243 electronic working papers and determine 964 inherent or control risks during understanding the auditee step of audits.

SAYCAP automates all the steps of regularity audit of the TCA and can be used to implement IT audits and performance audits as well. Furthermore, SAYCAP is based on an audit procedure approach which requires creating working papers for each and every single step of the audit. As a part of regularity audits, 37 audit procedures related to audit step of "understanding the IT systems of the auditee" are created and added to the audit procedure library and auditors are supposed to follow these procedures during regularity audits and may also add new one when necessary. These audit procedures relating to policy and strategy controls, software development and change management controls, logical access controls, physical controls and application controls (TCA, 2013b) are designed for generalist auditors and that's why, auditors do not need to have in-depth IT audit knowledge and or IT skills to use them.

4.4.2. Computer Assisted Audit Software and System Design Project: SAYDAP

Currently, the TCA has an ongoing "Computer Assisted Audit Software and System Design Project" planned to be finalized at the end of 2013. The aim of the Project is to define the computer aided audit methodologies for the TCA and design and develop a flexible, modular and functional system which implements those methodologies. By the end of the Project following benefits will be fully achieved (TCA, 2013a);

- Regular data transfer from auditee in accordance with the regulation describing the methods, procedures and formats relating to the data gathering from the auditees;
- A portal for the auditees to upload their data;

- Automated data analysis on the off-line copies of auditee's data on a scheduled basis by the Application itself;
- Implementation of a vast variety data analysis techniques by the auditors;
- Carrying out basic data mining techniques such as nearest K neighbor, decision tree, forecasting and clustering analysis etc.

The first versions of the software have already been tested by the system analysts and a group of users and it is projected to use SAYDAP in the course of TCA audits of the year 2014.

5. Conclusion and Lessons Learnt

In today's world; rules, standards, expectations, values and risks are heavily affected by the information technologies. While people have easiness in getting accustomed to what Peter Hinnsen called this new phase digital revolution as "the new normal" (Hinnsen, 2012), public administrations including Supreme Audit Institutions do not act fast enough to achieve all the benefits of the IT transformation or get rid of the possible predicaments on their horizons. In today's world information is the biggest assets while change, flexibility, speed and innovative thinking are sidekicks of it. However, SAIs do not operate in isolated environment free from requisites of the new normal; in other words, they also need to adjust themselves to challenges of the information revolution both in terms of administrative processes and also auditing activities in the public sector.

According to Gartner, in 2012 total amount of IT investments are 3,6 trillion Dollar around the world (Gartner, 2012) and the pace of increase in IT investments will not likely to decrease in the near future. On the other side of the coin, data breaches, system failures and inefficient use of IT turn out to be common IT-related issues regardless of the development level of countries. This not only reveals insufficient IT management and governance practices but also give glints of where the future of audit goes. In parallel to this, researches point out that some auditors show continued interest in leveraging technology-enabled auditing as their top priorities for improvement (Protiviti, 2013).

Based on the experiences and lessons learnt of the TCA on IT audit, the following actions can be suggested to flourish IT auditing within the framework of supreme audit functions:

1. Is IT audit "the elephant in the room"?: Traditional approaches to the audit are no longer efficient enough to satisfactorily fulfill the roles and responsibilities of SAIs; hence, it crucially important not to overlook, ignore or leave unaddressed the growing needs for IT audit.

2. Make a fresh start - self-assessments: "IT Self-Assessment" and "IT Audit Self-Assessment" are the best ways to figure out the current situation of IT audit in SAIs and draw a clear roadmap for the future in harmony with one's own needs.

3. Need for IT auditor- start from scratch: Identifying generalist auditors who are capable and who are interested in becoming IT auditors is the best way to begin.

4. Establishing an appropriate level of IT organization: Best practices among SAIs show that either creating separate IT audit unit or distributing IT auditors in audit groups are main options.

5. Actions speak louder than words - time to start IT audits: Pilot audits in collaboration with some IT experts, audit firms or other public institutions would be preferred in the transition period.

6. Need for IT audit methodology: It is essential to have an IT audit guideline for SAIs but it is equally vital to implement a methodology in line with internationally accepted standards. ITAF™: A Professional Practices Framework for IS Audit/ Assurance, 2nd Edition; COBIT Assurance Guideline; COBIT 3, 4.1 and 5; ISO/IEC 27K; ISO/ IEC 15408 and ISO/IEC 38500; NIST SP 800, ITIL; TOGAF; PMBOK and PRINCE2 are some of the existing international frameworks which IT auditor can make use of in preparing IT audit guidelines and IT audit programs.

7. Improving awareness of stakeholders: SAIs could be key actors to highlight IT risks in the public sector and raise the awareness of people and Parliaments. This can be achieved through the IT

audits of most critical IT systems of the country so that findings of IT audits would be appealing to a large number of stakeholders.

8. Continuing professional education and training: Lack of expertise on IT audit is a common issue among SAIs with some exceptional cases such as the SAIs of Norway, Switzerland and UK. According to international standards, IT auditors are expected to maintain professional competence through appropriate continuing professional education and training (ISACA, 2013). This requires better training planning in SAIs to improve IT awareness, IT knowledge and skills in IT auditing.

9. Getting certified: Being Certified Information System Auditor (CISA) is the best to receive recognition from auditees, auditors, and other stakeholders. To do so, SAIs need to motivate and support IT auditors with necessary training activities and financial aids as well.

10. International cooperation and collaboration: International cooperation among SAIs in the form of symposiums, seminars, trainings and workshops is the best way to follow up the developments in the field of IT auditing and implement them in SAIs' policies and procedures.

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HAVACILIKTA ÜREYEN RUTİN OLMAYAN (NON-ROUTINE) İŞLERİN ADAM X SAAT TAHMİNİ: GERÇEK ZAMANLI BAKIM KARTLARINDA UYGULAMA

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Özet

Uçak bakım işlemlerinde rutin işlerin yanı sıra rutin olmayan (non-routine) işlemlerin ölçümü önemlidir. Bu sebeple uçak bakımında toplam iş yükünün rutin olarak yapılması belli anlaşma paketleri ile gerçekleşmektedir. Ancak rutin olmayan işler bir tahmin dahilinde yapılmaktadır. Bu çalışmada geçmiş uygulamalarda kullanılan verilerden yararlanılarak bir sonraki dönemde oluşabilecek rutin olmayan işler adam-saat bazında tahmin edilmeye çalışılmıştır. Çalışmanın temel amacı, rutin olmayan (non-routine olarak) işler için ne kadar adam-saat gerekeceğinin hesaplanmasıdır. Bu hesaplamalar ile işletmenin gelecek dönemlerde karşılaşabileceği problemleri çözebilmelerinin yanı sıra, işletmenin adam-saat çalışma birimleri ve maliyetlerini hesaplaması kolaylaşabilecektir.

Anahtar Kelimeler: Rutin, Rutin olmayan (non-routine), bakım kartı, adam-saat, tahmin.
Jel Kodu: C, C1, C13.

Abstract

The measurement of non-routine operations, as well as routine works, are important in aircraft maintenance operations. Therefore the total workload which made routinely has became with packages in aircraft maintenance. However, non-routine works have realized by using forecasting. In this study, non-routine works which may occur in the next period, was tried to forecast utilizing the data used in past practices on man-hour basis. The main purpose of the study,how much man-hour would require for non-routine works was figured out. As well as solving the problems which might encounter in the future periods by business, the man-hour units and cost accounts of business got easy by using these calculations.

Keywords: Routine, Non-routine ,job card, man-hour, forecast.
Jel Code: C, C1, C13.

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1. Giriş

THY Teknik Bakım Merkezi, THY filosuna bakım hizmeti vermek maksadıyla kurulmuş olup, son yıllarda, 3rd party müşterilere de bakım hizmeti vermeye başlamıştır. Önceleri THY bünyesinde bir Genel Müdür Yardımcılığı konumundayken 2006 yılında THY'den ayrılarak ayrı bir bakım şirketi olarak hizmet vermeye başlamıştır. Yaklaşık 120 uçaklık THY filosunun yanısıra, bölgedeki diğer Türk ve yabancı havayollarına hizmet verilmektedir. Verilen hizmetin içinde, uçakların motorların, iniş takımlarının ve komponentlerin overhaul (komple bakım) seviyesinde bakımları bulunmaktadır.

1.1. Bakım Kartları

Bakım kartı, bir üretim tesisi için yapılması gereken iş bilgilerini içerir. Ürünün miktarı, programlanması (zaman planlaması) ve ek talimatları içerir.

Her farklı görev için yapılması gereken iş talimatlarını içeren bakım kartları, teknisyenlere yardımcı olarak, her bir kart ne yapılacağını, hangi dökümantasyonların gerekli olduğunu belirtir.

1.2. Bakım Kartlarının Hazırlanması

Anlaşmalarla bakım sorumluluğu yüklenilen müşteri uçakları için; MPD kaynaklı bakım kartları, uçak imalatçısından sağlanan PDF ve SGML formatındaki AMM ve Task Card'lar kullanılarak dijital olarak bilgisayar ortamında hazırlanır ve bakım kartlarının otomatik olarak üretilmesi sağlanır. Bu sayede periyodik veya planlı bakımların daha efektif geçmesi sağlanır.

Bu kartlar sayesinde toplanan teknik bilgilerle ileride oluşması muhtemel sorunlar için önceden önlem alınabilmekte ve maliyetler azaltılabilmektedir. Böylece THY Teknik bakım sorumluluğundaki uçakların uçuş emniyeti en üst seviyede tutulmaktadır. Hazırlanan bakım kartları için gerekli olan malzeme ve takımlar tespit edilerek bakım öncesi temin edilmesi için gerekli işlemler yapılır. Bakım kartların referanslarına (MRBD, MPD, AMM, SIB, SIL, Task Card...) gelen revizyonlar takip edilerek bakım kartları ve ilgili bakım sistemi sürekli güncel tutulur (THY Teknik, 2014).

1.3. Rutin İş (Rutin Görev)

Görevlerin, belirlenen periyotlarla sürekli olarak yapılmasıdır.

1.4. Rutin Olmayan (Non-Routine) İş

Rutin olmayan görevler, planlananın dışında gelişen, havacılık sanayi içerisinde tanımlanmayan arıza ve aksaklıkların giderilmesi için yapılan işlere denir. Rutin olmayan (Non-routine) işler, belirli periyotlar ile yapılmaz. Gerekli görüldüğünde, sözleşme dışında gelişen olayların onarımı ve bakımında dikkate alınarak yapılır.

2. Rutin ve Rutin Olmayan (Non-Routine) İşlerin Tahmini

Kuruluşlar, kontrollerinde olmayan gelecekteki bazı olay ve durumları tahmin etmek isteyebilirler. Tahminler, karar verme süreçlerinin önemli bileşenleridir. Ekonomik zaman serilerinin gelecekte göstereceği seyri tahmin etmek, planlama ve karar alma açısından önemlidir. Doğru tahminler, işletmelere rehberlik ederken yanlış yapılan tahminler işletmelerin iflas etmesine sebep olabilir. Bu yüzden tahminler; üretim, finans ve diğer kurumsal faaliyetlerin planlanmasında önemli rol oynamaktadır.

2.1. Tahmin Yöntemleri

İstatistikte "tahmin", "kestirim" ve "öngörü" kavramları birbirlerine yakın anlamlar içermesine rağmen bu üç terim birbirlerinden farklı anlamlar ifade etmektedir.

Tahmin üç kısımdan oluşur.

- Zaman boyutlu öngörü (Forecasting)
- Kestirim (Prediction)
- Parametre tahmini (Estimation)

Herhangi bir zamanda gelecekle ilgili kestirimde bulunulmasına öngörü denir. Gelecek olayları ya da koşulları tahmin etmeye yardımcı olan öngörü zaman boyutludur.

Kestirim, eldeki verileri kullanarak bağımlı değişkenin gözlemlenememiş değerlerini tahmin etme işlemi olarak tanımlanır.

Parametre tahmininde ise, örnek istatistiklerden yararlanarak (örnek ortalaması, varyans vb.) yığın parametreleri hakkında tahminde bulunulur.

Nicel (kantitatif) tahmin modelleri iki ana gruptan oluşur :

- Nedensel modeller.
- Zaman serisi yöntemleri.

2.1.1. Nedensel Modeller

Sebep sonuç ilişkisini açıklamaya çalışan modellerdir (Orhunbilge, 1999). Nedensel modeller, bir değişkenin gelecekteki değerlerini tahmin etmekten çok değişkenler arasındaki ilişkinin açıklamasına yöneliktir. Daha çok bu modeller problemi matematiksel olarak ifade etmeye yarar (Fretchling, 1996).

2.1.2. Zaman Serisi Yöntemleri

Zaman serileri gözlem sonuçlarının zamana göre dağılımını gösterir. Amacı, geçmiş gözlem değerlerindeki veri kalıplarını kullanıp, istatistiksel model oluşturarak geleceği tahmin etmeye yararlar (Herbig vd., 1993).

2.1.2.1. Naive Tahmin Yöntemi

Bir tahmin yapmanın yanı sıra yapılmış olan bir tahminin üstünlüğünün olup olmadığını tespit etmekte kullanılır. Genellikle karmaşık modellerde uygulanır (Mclaughlin, 1983).

2.1.2.2. Naive (Trendli) Tahmin Yöntemi

Eğer tahmini yapılacak olan serinin kesin trendi gözleniyorsa, tahmin trendin yönüne göre yapılır;

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

$y_{t+1} = (t+1)$ dönemindeki tahmin değeri,

$y_t = t$ dönemindeki değer,

$y_t - y_{t-1} = t$ dönemiyle, bir önceki dönemin değerleri arasındaki farktır (Hanke ve Reitsch, 1992).

2.1.2.3. Hareketli Ortalamalar Yöntemi

Bu yöntem, geçmişteki verileri baz alarak bu verilerin ortalamasını bulup, bu ortalamaya göre gelecek dönem için değişkenlerin nasıl hareket edeceğini öngörmeye çalışır (Chen vd., 2003).

Basit Hareketli Ortalama

Basit hareketli ortalama tekniğinde son n dönemin ortalaması tahmini değer olarak alınır. Bu işlem,

$$M_{t+1} = \frac{y_t + y_{t-1} + y_{t-(m-1)}}{n} \qquad (2)$$

formülü ile hesaplanmaktadır.

$M_{t+1} = t+1$ dönemindeki tahmin değeri

$y_t = t$ dönemindeki gözlem değeri

$n =$ hareketli ortalamaya dahil edilen gözlem sayısıdır (Makridakis ve Wheelwright, 1989).

Her yeni değer gerçekleşmesinde en eski değer, hesaplamadan çıkarılarak son *m* dönemin değerlerinin ortalaması alınır. Hesaplanan bu ortalama bir sonraki dönemin tahmini değeridir.

Ağırlıklı Hareketli Ortalama

Basit hareketli ortalama yönteminden farklı olarak her döneme farklı bir ağırlık verilerek w_i değerleri, ağırlıkları göstermek üzere *t*+1 dönemdeki ortalamaları hesaplamaya çalışır. Bu işlem,

$$M_{t+1}^{w} = \frac{w_m y_t + w_{m-1} y_{t-1} + \ldots + w_1 y_{t-m+1}}{w_m + w_{m-1} + \ldots + w_1} \qquad (3)$$

formülü ile hesaplanmaktadır (Armutlulu, 2000).

2.1.2.4. Üstel Düzeltme Yöntemi

Hareketli ortalama yöntemindeki sakıncaları ortadan kaldırmak için kullanılan bir tahmin

yöntemidir. Bu yöntem tahminde kullanılan geçmiş dönem verilerinden yakın geçmişte gerçekleşenlere yüksek, veriler eskidikçe ise üstel olarak azalan ağırlıklar vererek en iyi tahmini yapmaya çalışır. Düşük maliyetlidir. Yeni dönemlerin tahminini hızlı bir şeklide yapabilir (Orhunbilge, 1999).

Tekli (Basit) Üstel Düzeltme Yöntemi

Bu yöntem literatürde Brown'un basit üstel düzleştirme yöntemi olarak da bilinmektedir.

$y_1, y_2, ... y_n$ belirgin bir trendi ve mevsimlik dalgalanması olmayan zaman serisinin basit üstel düzleştirme yöntemiyle tahmini aşağıdaki şekilde yapılmaktadır.

$$y_t^{'} = \alpha y_{t-1} + (1-\alpha) y_{t-1}^{'} \qquad (4)$$

Formülde $y_t^{'}$, t dönemi tahmini değeri, $y_{t-1}^{'}$, t-1 dönemi tahmini değeri ve α "Düzeltme Sabiti (Smoothing Constant)"dir. Bu yöntemde t dönemi tahmini α oranında bir önceki dönem değeri ile (1-α) oranında bir önceki dönem tahmin değerinden oluşmaktadır. α, 0<α<1 değerleri arasında değişebilmektedir. Hataların kareleri toplamını minimum yapan α değeri seçilerek tahminlerde kullanılmaktadır (Orhunbilge, 1999).

2.1.2.5. Regresyon

Sebep sonuç ilişkisini açıklamaya yarayan istatistiksel analiz tekniğidir. Temel amacı, modele alınan değişkenlerin modelin ne kadarını açıklayabildiğini göstermektir. Bağımlı ve bağımsız değişkenlerden oluşur.

3. Araştırmanın Metodolojisi

3.1. Araştırmanın Amacı

THY'de müşterilere verilen hizmetlerin en iyi şekilde verilebilmesi için müşterileri bulunduğu yerden, müşteriyi istediği yere taşımak üzere kullanılan uçaklarda rutin ve rutin olmayan (non-routine) işlemlerin tespit edilerek müşterilere en iyi hizmeti vermedir. Bu bağlamda hizmetin en iyi şekilde verilebilmesi için bakım kartlarının iş yükü karşılığı adam-saat cinsinden belirlenmesi, rutin ve rutin olmayan (non-routine) işlerin ayrımının yapılması tasarlanarak sapmaların belirlenmesidir.

Rutin kartlara ait adam-saat değerleri işlerin standart olması sebebiyle bakımdan bakıma az sapma gösterdiğinden tahmin edilebilmesi daha kolaydır. Rutin olmayan (non-routine) işlerin adam-saat değerleri ise birçok faktörden etkilendiğinden öngörülmesi rutin kartlara göre daha zordur.

3.2. Araştırmanın Kapsamı ve Sınırları

Turkish tekniği belirli zaman aralıklarında uçak bakımları ele alınarak belli bakım kartları bazında rutin ve rutin olmayan (non-routine) işlemler ele alınmıştır.

3.3. Problem

Havacılıkta toplam iş yükünü oluşturan rutin ve rutin olmayan (non-routine) işlerin adam-saat miktarlarının tahminini belirleme ve kapasite planlaması yapma problemin temelini oluşturmaktadır. Bu bağlamda kapasitenin doğru kullanımı, verimliliğin arttırılması ve sapmaların minimize edilmesi problemin temel amacıdır. Bu amacı gerçekleştirebilmek için tahmin modelleri kullanılmıştır.

3.4. Kullanılan Yöntem

Mevcut durumda rutin olmayan (non-routine) adam-saat tahminlerinde yaşanan sapmaların en aza indirilmesi kapasite planlarının doğruya yakın bir şekilde gerçekleştirilebilmesi ve verimliliğin artırabilmesi açısından büyük önem arz etmektedir. Seçilecek sayısal bir tahmin yöntemi aracılığıyla daha doğru gerçekleştirilebilecek bir rutin olmayan (non-routine) adam-saat tahminiyle sapmaların en aza indirilmesi mümkün olabilir. Bu amaçla çalışma kapsamında çeşitli tahmin yöntemleri denenmiş ve bunlar arasından en uygun olanı seçilmeye çalışılmıştır. Çözüm yöntemi olarak uygulaması gerçekleştirilen tahmin yöntemleri şunlardır :

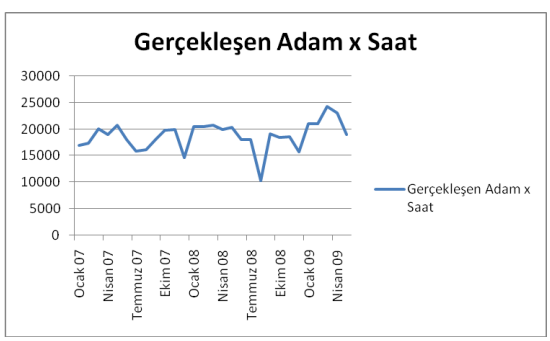
- • Naive Tahmin
- • Naive (Trendli) Tahmin
- • Basit Ortalama
- • Basit Hareketli Ortalama
- • Ağırlıklı Hareketli Ortalama
- • Üstel Düzeltme (α= 0,1)

3.5. Yöntemin Uygulanması

Tahmin projesi kapsamında uçak bakım müdürlüğü tarafından üretilen 29 aylık adam x saat verileri incelenmiştir. Tahmin analizi için yukarıda verilen yöntemler kullanılmıştır.

Veriler incelendiğinde yaz aylarında üretilen adam x saat değerlerinde düşme gözlenirken kış aylarında üretilen adam x saat değerleri artmaktadır. Ayrıca Aralık 2007 ve Aralık 2008 de beklenenden daha düşük adam x saat üretildiği gözlenmektedir.

Bahsi geçen tüm yöntemlerle kabin içi bakım ve revizyon için tahminler gerçekleştirilmiş ve gerçekleşen değerlerle karşılaştırılmıştır. Son olarak örnek kartlardan olan E25-054 kartı için iki tahmin yöntemi karşılaştırılarak sonuçlar verilmiştir. Yöntem bazında karşılaştırmalar aşağıdaki grafik ve tablolarda sunulmuştur :



Şekil3. Gerçekleşen Adam x Saat Grafiği

Tablo3. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat Değerleri

Aylar	AdamxSaat
Ocak 07	16899,29
Şubat 07	17346,47
Mart 07	19994,48
Nisan 07	18973,75
Mayıs 07	20690,58
Haziran 07	17991,52
Temmuz 07	15878,19
Ağustos 07	16100,06
Eylül 07	18004,43
Ekim 07	19772,44
Kasım 07	19958,68
Aralık 07	14600,66
Ocak 08	20432,15
Şubat 08	20403,94
Mart 08	20726,46
Nisan 08	19909,07
Mayıs 08	20349,2
Haziran 08	18038,7
Temmuz 08	17977,44
Ağustos 08	10323,49
Eylül 08	19018,75
Ekim 08	18369,79
Kasım 08	18498,3
Aralık 08	15649,91
Ocak 09	20984,06
Şubat 09	20964,89
Mart 09	24207,57
Nisan 09	23037,19
Mayıs 09	18969,95
Ortalama	18761,08

3.5.1. Naive Tahmin

Naive yöntemi ile yapılan tahmin analizinde elde edilen istatistiki sonuçlar aşağıda verilmiştir. Adam saat verileri dalgalanma gösterdiğinden, hata yüzdelerinin (percent error) %20 ve yukarısında olduğundan, sapmaların yüksek olduğu Tablo 3.1.'de gözlenmektedir.

3.5.2. Naive (Trendli) Tahmin

Naive (trendli) yöntemi ile yapılan tahmin analizinde elde edilen istatistiki sonuçlar incelendiğinde sapmaların naive tahmine göre

daha da yüksek olduğu Tablo 3.2.'de gözlenmektedir.

3.5.3. Hareketli Ortalama

Hareketli ortalama yöntemi ile yapılan tahmin analizinde elde edilen istatistiki sonuçlar incelendiğinde, son 3 ayın verilerin ortalamasına göre analiz yapıldığından yine yazdan kışa ve kıştan yaza geçişlerde sapmaların yükseldiği ancak Ağustos 2008 dışında genel olarak yaz sonu ve kış sonu gibi aylardaki sapmaların nispeten daha az olduğu Tablo 3.3.'te gözlenmektedir.

3.5.3.1. Ağırlıklı Hareketli Ortalama

Ağırlıklı hareketli ortalama yöntemi ile yapılan tahmin analizinde elde edilen istatistiki sonuçlar hareketli ortalamaya göre daha az sapma içerdiği Tablo 3.4'te gözlenmektedir. Bunun sebebinin yaz-kış dönüşlerine bir önceki ağırlığının daha fazla olması nedeni ile tahmini bir önceki aya daha yakın olduğu düşünülmektedir.

3.5.4. Üstel Düzeltme

Üstel düzeltme yöntemi ile yapılan tahmin analizinde elde edilen istatistiki sonuçlar diğer yöntemlere göre nispeten az sapma gösterdiği Tablo 3.5'te görülmektedir. Bu yöntemde dikkat edilmesi gereken husus alpha değerinin seçimidir. Düşük alpha değerleri nispeten daha az sapma ile tahmin yapılmasını sağlamaktadır. Tablo 3.5'te α=0.1 iken, Tablo 3.6'da ise α=0.4 iken sonuçlar verilerek grafiklerle karşılaştırılmıştır

3.5.5. Regresyon

Regresyon ile yapılan tahmin analizinde elde edilen istatistiki sonuçlar ile hesaplanan değerler Tablo 3.7'de verilmiştir. Bu yöntemde dikkat edilmesi gereken husus alpha değerinin seçimidir. Düşük alpha değerleri nispeten daha az sapma ile tahmin yapılmasını sağlamaktadır.

Son olarak, gerçekleştirilen çalışma kapsamında Boeing 737-800 tipi uçaklara ilişkin non-routine adam-saat verileri değerlendirmeye alınmıştır. Bu doğrultuda Aralık 2006'dan Aralık 2008'e kadar Boeing 737-800 uçaklarına gerçekleştirilen C bakımlarından üreyen tüm non-routine kartlar analiz edilmiştir. Toplam 41 uçağa ait 47 C bakımı; bu 47 C bakımından üreyen 1.974 adet non-routine adam saat değeri ve 460 adet bakım kartı incelemeye tabi tutulmuştur. İncelenen tüm non-routine adam-saat değerlerinin toplamı 73.635 A/S'e tekabül etmektedir.

Çalışmaya kaynak teşkil etmek üzere incelenen bu 460 adet karttan en sık uygulanan kartlardan biri olan E25-054 bakım kartı tahminlere kaynak teşkil etmek üzere seçilmiştir. Seçilen E25-054 kartının yaptırdığı iş uçakta mutfak olarak kullanılan tüm bölümlere ilişkin muayene olup bu işlem esnasında doğabilecek her türlü rutin olmayan (non-routine) adam-saat iş yükü, kartın toplam üreyen rutin olmayan (non-routine) hanesine yazılmaktadır.

Bahsi geçen tüm yöntemlerle kabin içi bakım ve revizyon için tahminler gerçekleştirilmiş ve gerçekleşen değerlerle karşılaştırılmıştır. Son olarak örnek kartlardan olan E25-054 kartı için ağırlıklı hareketli ortalama ve üstel düzeltme (α=0,2 ve α=0,4 iken) tahmin yöntemleri uygulanarak benzer bir çalışma yapılmış ve bu üç tahmin yöntemine ilişkin sonuçlar incelenmiştir. Yöntem bazında karşılaştırmalar Tablo 3.8., Tablo 3.9., Tablo 3.10 gösterilerek Şekil 3.9., Şekil 3.10., Şekil 3.11. 'de sunulmuştur.

Ağırlıklı Hareketli Ortalama tahmin yöntemiyle E25-054 kartı için gerçekleştirilen tahminler ve bu değerlerin gerçek değerlerle karşılaştırması Tablo 3.8.'de gösterilerek Şekil 3.9'da sunulmuştur.

Üstel düzeltme tahmin yöntemiyle ve α=0,2 ve α=0,4 seçilerek E25-054 kartı için gerçekleştirilen tahminler ve bu değerlerin karşılaştırılması Tablo 3.9., Tablo 3.10. gösterilerek Şekil 3.10. ve Şekil 3.11.'de sunulmuştur.

Tablo3.1. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat ve Naive Tahmin Hesaplamaları

Tarih	Gerçekleşen	Naive Tahmin	Error (Hata)	Absolute Error (Mutlak Hata)	Squared Error (Hata Kare)	Percent Error (Hata Yüzdelikleri)
Ocak 07	16899,29					
Şubat 07	17346,47	16899,29	-447,18	447,18	199969,9524	2,58%
Mart 07	19994,48	17346,47	-2648,01	2648,01	7011956,96	13,24%
Nisan 07	18973,75	19994,48	1020,73	1020,73	1041889,733	5,38%
Mayıs 07	20690,58	18973,75	-1716,83	1716,83	2947505,249	8,30%
Haziran 07	17991,52	20690,58	2699,06	2699,06	7284924,884	15,00%
Temmuz 07	15878,19	17991,52	2113,33	2113,33	4466163,689	13,31%
Ağustos 07	16100,06	15878,19	-221,87	221,87	49226,2969	1,38%
Eylül 07	18004,43	16100,06	-1904,37	1904,37	3626625,097	10,58%
Ekim 07	19772,44	18004,43	-1768,01	1768,01	3125859,36	8,94%
Kasım 07	19958,68	19772,44	-186,24	186,24	34685,3376	0,93%
Aralık 07	14600,66	19958,68	5358,02	5358,02	28708378,32	36,70%
Ocak 08	20432,15	14600,66	-5831,49	5831,49	34006275,62	28,54%
Şubat 08	20403,94	20432,15	28,21	28,21	795,8041	0,14%
Mart 08	20726,46	20403,94	-322,52	322,52	104019,1504	1,56%
Nisan 08	19909,07	20726,46	817,39	817,39	668126,4121	4,11%
Mayıs 08	20349,2	19909,07	-440,13	440,13	193714,4169	2,16%
Haziran 08	18038,7	20349,2	2310,5	2310,5	5338410,25	12,81%
Temmuz 08	17977,44	18038,7	61,26	61,26	3752,7876	0,34%
Ağustos 08	10323,49	17977,44	7653,95	7653,95	58582950,6	74,14%
Eylül 08	19018,75	10323,49	-8695,26	8695,26	75607546,47	45,72%
Ekim 08	18369,79	19018,75	648,96	648,96	421149,0816	3,53%
Kasım 08	18498,3	18369,79	-128,51	128,51	16514,8201	0,69%
Aralık 08	15649,91	18498,3	2848,39	2848,39	8113325,592	18,20%
Ocak 09	20984,06	15649,91	-5334,15	5334,15	28453156,22	25,42%
Şubat 09	20964,89	20984,06	19,17	19,17	367,4889	0,09%
Mart 09	24207,57	20964,89	-3242,68	3242,68	10514973,58	13,40%
Nisan 09	23037,19	24207,57	1170,38	1170,38	1369789,344	5,08%
Mayıs 09	18969,95	23037,19	4067,24	4067,24	16542441,22	21,44%
Haziran 09	13990,5	18969,95	4979,45	4979,45	24794922,3	35,59%
Temmuz 09		13990,5				
			BIAS‡	MAD§	MSE**	MAPE††
			100,3031	2368,38931	11145841,93	14,11%

‡ BIAS= Nonresponse Error (Cevaplama Hatası)
§ MAD= Mean Absolute Deviation (Mutlak Değer Ortalaması)
** MSE= Mean Square Error (Hata Kare Ortalaması)
†† MAPE= Mean Absolute Percentage Error (Yüzdeliklerin Ortalaması)

Tablo3.2. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat ve Naive Tahmin Trend Hesaplamaları

Tarih	Gerçekleşen	Naive Trend	Error (Hata)	Absolute Error (Mutlak Hata)	Squared Error (Hata Kare)	Percent Error (Hata Yüzdelikleri)
Ocak 07	16899,29					
Şubat 07	17346,47					
Mart 07	19994,48	17793,65	-2200,83	2200,83	4843653	11,01%
Nisan 07	18973,75	22642,49	3668,74	3668,74	13459653	19,34%
Mayıs 07	20690,58	17953,02	-2737,56	2737,56	7494235	13,23%
Haziran 07	17991,52	22407,41	4415,89	4415,89	19500084	24,54%
Temmuz 07	15878,19	15292,46	-585,73	585,73	343079,6	3,69%
Ağustos 07	16100,06	13764,86	-2335,2	2335,2	5453159	14,50%
Eylül 07	18004,43	16321,93	-1682,5	1682,5	2830806	9,34%
Ekim 07	19772,44	19908,8	136,36	136,36	18594,05	0,69%
Kasım 07	19958,68	21540,45	1581,77	1581,77	2501996	7,93%
Aralık 07	14600,66	20144,92	5544,26	5544,26	30738819	37,97%
Ocak 08	20432,15	9242,64	-11189,5	11189,51	1,25E+08	54,76%
Şubat 08	20403,94	26263,64	5859,7	5859,7	34336084	28,72%
Mart 08	20726,46	20375,73	-350,73	350,73	123011,5	1,69%
Nisan 08	19909,07	21048,98	1139,91	1139,91	1299395	5,73%
Mayıs 08	20349,2	19091,68	-1257,52	1257,52	1581357	6,18%
Haziran 08	18038,7	20789,33	2750,63	2750,63	7565965	15,25%
Temmuz 08	17977,44	15728,2	-2249,24	2249,24	5059081	12,51%
Ağustos 08	10323,49	17916,18	7592,69	7592,69	57648941	73,55%
Eylül 08	19018,75	2669,54	-16349,2	16349,21	2,67E+08	85,96%
Ekim 08	18369,79	27714,01	9344,22	9344,22	87314447	50,87%
Kasım 08	18498,3	17720,83	-777,47	777,47	604459,6	4,20%
Aralık 08	15649,91	18626,81	2976,9	2976,9	8861934	19,02%
Ocak 09	20984,06	12801,52	-8182,54	8182,54	66953961	38,99%
Şubat 09	20964,89	26318,21	5353,32	5353,32	28658035	25,53%
Mart 09	24207,57	20945,72	-3261,85	3261,85	10639665	13,47%
Nisan 09	23037,19	27450,25	4413,06	4413,06	19475099	19,16%
Mayıs 09	18969,95	21866,81	2896,86	2896,86	8391798	15,27%
Haziran 09	13990,5	14902,71	912,21	912,21	832127,1	6,52%
Temmuz 09		9011,05				
			BIAS	MAE	MSE	MAPE
			193,8082	3990,943	29251116	22,13%

Tablo3.3. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat ve Hareketli Ortalama Trend Hesaplamaları

Tarih	Gerçekleşen	Hareketli Ortalama	Error (Hata)	Absolute Error (Mutlak Hata)	Squared Error (Hata Kare)	Percent Error (Hata Yüzdelikleri)
Ocak 07	16899,29					
Şubat 07	17346,47					
Mart 07	19994,48					
Nisan 07	18973,75	18080,08	-893,67	893,67	798646,1	4,71%
Mayıs 07	20690,58	18771,57	-1919,01	1919,013	3682612	9,27%
Haziran 07	17991,52	19886,27	1894,75	1894,75	3590078	10,53%
Temmuz 07	15878,19	19218,62	3340,427	3340,427	11158450	21,04%
Ağustos 07	16100,06	18186,76	2086,703	2086,703	4354331	12,96%
Eylül 07	18004,43	16656,59	-1347,84	1347,84	1816673	7,49%
Ekim 07	19772,44	16660,89	-3111,55	3111,547	9681723	15,74%
Kasım 07	19958,68	17958,98	-1999,7	1999,703	3998813	10,02%
Aralık 07	14600,66	19245,18	4644,523	4644,523	21571597	31,81%
Ocak 08	20432,15	18110,59	-2321,56	2321,557	5389625	11,36%
Şubat 08	20403,94	18330,50	-2073,44	2073,443	4299167	10,16%
Mart 08	20726,46	18478,92	-2247,54	2247,543	5051451	10,84%
Nisan 08	19909,07	20520,85	611,78	611,78	374274,8	3,07%
Mayıs 08	20349,2	20346,49	-2,71	2,71	7,3441	0,01%
Haziran 08	18038,7	20328,24	2289,543	2289,543	5242009	12,69%
Temmuz 08	17977,44	19432,32	1454,883	1454,883	2116686	8,09%
Ağustos 08	10323,49	18788,45	8464,957	8464,957	71655491	82,00%
Eylül 08	19018,75	15446,54	-3572,21	3572,207	12760660	18,78%
Ekim 08	18369,79	15773,23	-2596,56	2596,563	6742141	14,13%
Kasım 08	18498,3	15904,01	-2594,29	2594,29	6730341	14,02%
Aralık 08	15649,91	18628,95	2979,037	2979,037	8874659	19,04%
Ocak 09	20984,06	17506,00	-3478,06	3478,06	12096901	16,57%
Şubat 09	20964,89	18377,42	-2587,47	2587,467	6694984	12,34%
Mart 09	24207,57	19199,62	-5007,95	5007,95	25079563	20,69%
Nisan 09	23037,19	22052,17	-985,017	985,0167	970257,8	4,28%
Mayıs 09	18969,95	22736,55	3766,6	3766,6	14187276	19,86%
Haziran 09	13990,5	22071,57	8081,07	8081,07	65303692	57,76%
Temmuz 09		18665,88				
			BIAS	MAD	MSE	MAPE
			106,5072	2827,883	11637856	17,01%

Tablo3.4. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat ve Ağırlıklı Hareketli Ortalama Trend Hesaplamaları

Ağırlıklı hareketli ortalama yönteminde ağırlıklar 3,2,1,6 şeklinde rastgele alınarak hesaplanmıştır.

Tarih	Gerçekleşen	Ağırlıklı Hareketli Ortalama	Error (Hata)	Absolute Error (Mutlak Hata)	Squared Error (Hata Kare)	Percent Error (Hata Yüzdelikleri)
Ocak 07	16899,29					
Şubat 07	17346,47					
Mart 07	19994,48					
Nisan 07	18973,75	18595,95	-377,805	377,805	142736,6	1,99%
Mayıs 07	20690,58	19042,78	-1647,8	1647,8	2715245	7,96%
Haziran 07	17991,52	20002,29	2010,767	2010,767	4043183	11,18%
Temmuz 07	15878,19	19054,91	3176,722	3176,722	10091561	20,01%
Ağustos 07	16100,06	17384,70	1284,638	1284,638	1650296	7,98%
Eylül 07	18004,43	16341,35	-1663,08	1663,083	2765846	9,24%
Ekim 07	19772,44	17015,27	-2757,17	2757,173	7602005	13,94%
Kasım 07	19958,68	18571,04	-1387,64	1387,64	1925545	6,95%
Aralık 07	14600,66	19570,89	4970,232	4970,232	24703203	34,04%
Ocak 08	20432,15	17248,63	-3183,52	3183,52	10134800	15,58%
Şubat 08	20403,94	18409,41	-1994,53	1994,532	3978157	9,78%
Mart 08	20726,46	19446,13	-1280,33	1280,33	1639245	6,18%
Nisan 08	19909,07	20569,90	660,8317	660,8317	436698,5	3,32%
Mayıs 08	20349,2	20264,01	-85,1883	85,18833	7257,052	0,42%
Haziran 08	18038,7	20265,37	2226,667	2226,667	4958044	12,34%
Temmuz 08	17977,44	19120,60	1143,155	1143,155	1306803	6,36%
Ağustos 08	10323,49	18393,15	8069,663	8069,663	65119466	78,17%
Eylül 08	19018,75	14160,68	-4858,08	4858,075	23600893	25,54%
Ekim 08	18369,79	15946,78	-2423,01	2423,012	5870986	13,19%
Kasım 08	18498,3	17245,06	-1253,24	1253,24	1570610	6,77%
Aralık 08	15649,91	18542,21	2892,295	2892,295	8365370	18,48%
Ocak 09	20984,06	17052,69	-3931,37	3931,373	15455696	18,74%
Şubat 09	20964,89	18791,72	-2173,17	2173,173	4722682	10,37%
Mart 09	24207,57	20085,45	-4122,12	4122,12	16991873	17,03%
Nisan 09	23037,19	22589,43	-447,765	447,765	200493,5	1,94%
Mayıs 09	18969,95	23081,93	4111,983	4111,983	16908407	21,68%
Haziran 09		21198,63				
			BIAS	MAD	MSE	MAPE
			-116,88	2466,646	9111812	14,58%

Tablo3.5. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat ve Üstel Düzeltme (α=0.1) Trend Hesaplamaları

Üstel Düzeltme yönteminde katsayı α=0.1 alınarak trend hesaplamaları gerçekleştirilmiştir.

Tarih	Gerçekleşen	Üstel (a=0,1)	Error (Hata)	Absolute Error (MutlakHata)	Squared Error (Hata Kare)	Percent Error (Hata Yüzdelikleri)
Ocak 07	16899,29					
Şubat 07	17346,47	16899,29				
Mart 07	19994,48	17301,752				
Nisan 07	18973,75	19725,2072	751,4572	751,4572	564687,9	3,96%
Mayıs 07	20690,58	19048,89572	-1641,68	1641,684	2695127	7,93%
Haziran 07	17991,52	20526,41157	2534,892	2534,892	6425675	14,09%
Temmuz 07	15878,19	18245,00916	2366,819	2366,819	5601833	14,91%
Ağustos 07	16100,06	16114,87192	14,81192	14,81192	219,3928	0,09%
Eylül 07	18004,43	16101,54119	-1902,89	1902,889	3620986	10,57%
Ekim 07	19772,44	17814,14112	-1958,3	1958,299	3834935	9,90%
Kasım 07	19958,68	19576,61011	-382,07	382,0699	145977,4	1,91%
Aralık 07	14600,66	19920,47301	5319,813	5319,813	28300410	36,44%
Ocak 08	20432,15	15132,6413	-5299,51	5299,509	28084792	25,94%
Şubat 08	20403,94	19902,19913	-501,741	501,7409	251743,9	2,46%
Mart 08	20726,46	20353,76591	-372,694	372,6941	138900,9	1,80%
Nisan 08	19909,07	20689,19059	780,1206	780,1206	608588,1	3,92%
Mayıs 08	20349,2	19987,08206	-362,118	362,1179	131129,4	1,78%
Haziran 08	18038,7	20312,98821	2274,288	2274,288	5172387	12,61%
Temmuz 08	17977,44	18266,12882	288,6888	288,6888	83341,24	1,61%
Ağustos 08	10323,49	18006,30888	7682,819	7682,819	59025706	74,42%
Eylül 08	19018,75	11091,77189	-7926,98	7926,978	62836982	41,68%
Ekim 08	18369,79	18226,05219	-143,738	143,7378	20660,56	0,78%
Kasım 08	18498,3	18355,41622	-142,884	142,8838	20415,77	0,77%
Aralık 08	15649,91	18484,01162	2834,102	2834,102	8032132	18,11%
Ocak 09	20984,06	15933,32016	-5050,74	5050,74	25509973	24,07%
Şubat 09	20964,89	20478,98602	-485,904	485,904	236102,7	2,32%
Mart 09	24207,57	20916,2996	-3291,27	3291,27	10832461	13,60%
Nisan 09	23037,19	23878,44296	841,253	841,253	707706,5	3,65%
Mayıs 09	18969,95	23121,3153	4151,365	4151,365	17233834	21,88%
Haziran 09	13990,5	19385,08653	5394,587	5394,587	29101564	38,56%
Temmuz 09		14529,95865				
			BIAS	MAD	MSE	MAPE
			213,7962	2396,205	11082158	14,44%

Tablo3.6. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat ve Üstel Düzeltme (α=0.4) Trend Hesaplamaları

Üstel Düzeltme yönteminde katsayı α=0.4 alınarak trend hesaplamaları gerçekleştirilmiştir.

Tarih	Gerçekleşen	Üstel (a=0,4)	Error (Hata)	Absolute Error (MutlakHata)	Squared Error (Hata Kare)	Percent Error (Hata Yüzdelikleri)
Ocak 07	16899,29					
Şubat 07	17346,47	16899,29				
Mart 07	19994,48	17167,598				
Nisan 07	18973,75	18863,7272	-110,023	110,0228	12105,02	0,58%
Mayıs 07	20690,58	18929,74088	-1760,84	1760,839	3100554	8,51%
Haziran 07	17991,52	19986,24435	1994,724	1994,724	3978925	11,09%
Temmuz 07	15878,19	18789,40974	2911,22	2911,22	8475200	18,33%
Ağustos 07	16100,06	17042,6779	942,6179	942,6179	888528,5	5,85%
Eylül 07	18004,43	16477,10716	-1527,32	1527,323	2332715	8,48%
Ekim 07	19772,44	17393,50086	-2378,94	2378,939	5659351	12,03%
Kasım 07	19958,68	18820,86435	-1137,82	1137,816	1294624	5,70%
Aralık 07	14600,66	19503,55374	4902,894	4902,894	24038367	33,58%
Ocak 08	20432,15	16561,8175	-3870,33	3870,333	14979474	18,94%
Şubat 08	20403,94	18884,017	-1519,92	1519,923	2310166	7,45%
Mart 08	20726,46	19795,9708	-930,489	930,4892	865810,2	4,49%
Nisan 08	19909,07	20354,26432	445,1943	445,1943	198198	2,24%
Mayıs 08	20349,2	20087,14773	-262,052	262,0523	68671,39	1,29%
Haziran 08	18038,7	20244,37909	2205,679	2205,679	4865020	12,23%
Temmuz 08	17977,44	18920,97164	943,5316	943,5316	890251,9	5,25%
Ağustos 08	10323,49	18354,85265	8031,363	8031,363	64502786	77,80%
Eylül 08	19018,75	13536,03506	-5482,71	5482,715	30060163	28,83%
Ekim 08	18369,79	16825,66402	-1544,13	1544,126	2384325	8,41%
Kasım 08	18498,3	17752,13961	-746,16	746,1604	556755,3	4,03%
Aralık 08	15649,91	18199,83584	2549,926	2549,926	6502122	16,29%
Ocak 09	20984,06	16669,88034	-4314,18	4314,18	18612146	20,56%
Şubat 09	20964,89	19258,38814	-1706,5	1706,502	2912149	8,14%
Mart 09	24207,57	20282,28925	-3925,28	3925,281	15407829	16,22%
Nisan 09	23037,19	22637,4577	-399,732	399,7323	159785,9	1,74%
Mayıs 09	18969,95	22877,29708	3907,347	3907,347	15267361	20,60%
Haziran 09	13990,5	20532,88883	6542,389	6542,389	42802852	46,76%
Temmuz 09		16607,45553				
			BIAS	MAD	MSE	MAPE
			139,276	2481,234	10115787	15,02%

Tablo3.7. Kabin İçi Bakım ve Revizyon İçin Gerçekleşen Adam x Saat ve Regresyon Hesaplanması

Aylar	**Sıra(X)**	**AdamxSaat(Y)**	**Tahmin**	**X^2**	**XY**
Ocak 07	1	16.899,29	18.050,23	1	16.899,29
Şubat 07	2	17.346,47	18.088,29	4	34.692,94
Mart 07	3	19.994,48	18.126,35	9	59.983,44
Nisan 07	4	18.973,75	18.164,41	16	75.895,00
Mayıs 07	5	20.690,58	18.202,46	25	103.452,90
Haziran 07	6	17.991,52	18.240,52	36	107.949,12
Temmuz 07	7	15.878,19	18.278,58	49	111.147,33
Ağustos 07	8	16.100,06	18.316,63	64	128.800,48
Eylül 07	9	18.004,43	18.354,69	81	162.039,87
Ekim 07	10	19.772,44	18.392,75	100	197.724,40
Kasım 07	11	19.958,68	18.430,81	121	219.545,48
Aralık 07	12	14.600,66	18.468,86	144	175.207,92
Ocak 08	13	20.432,15	18.506,92	169	265.617,95
Şubat 08	14	20.403,94	18.544,98	196	285.655,16
Mart 08	15	20.726,46	18.583,04	225	310.896,90
Nisan 08	16	19.909,07	18.621,09	256	318.545,12
Mayıs 08	17	20.349,20	18.659,15	289	345.936,40
Haziran 08	18	18.038,70	18.697,21	324	324.696,60
Temmuz 08	19	17.977,44	18.735,26	361	341.571,36
Ağustos 08	20	10.323,49	18.773,32	400	206.469,80
Eylül 08	21	19.018,75	18.811,38	441	399.393,75
Ekim 08	22	18.369,79	18.849,44	484	404.135,38
Kasım 08	23	18.498,30	18.887,49	529	425.460,90
Aralık 08	24	15.649,91	18.925,55	576	375.597,84
Ocak 09	25	20.984,06	18.963,61	625	524.601,50
Şubat 09	26	20.964,89	19.001,66	676	545.087,14
Mart 09	27	24.207,57	19.039,72	729	653.604,39
Nisan 09	28	23.037,19	19.077,78	784	645.041,32
Mayıs 09	29	18.969,95	19.115,84	841	550.128,55
Haziran 09	30	13.990,50	19.153,89	900	419.715,00
Toplam	**465**	**558062**		**9455**	**8735493**
	b=38				
	a=18012				
	Temmuz 2009 Tahmini =19153,89351				

Tablo 3.8. E25-054 Kartı İçin Gerçekleşen Adam x Saat ve Ağırlıklı Hareketli Ortalama Trend Değerleri

JE25-054			Gerçek	Ağırlıklı Hareketli Ortalama	
				Ağırlık	Tahmin
JGN	1	2008-3	23,41	0,2	N/A
JGP	1	2008-3	4,25	0,4	N/A
JGS	1	2008-3	47,99	0,6	N/A
JFF	6	2008-4	78,71	0,8	N/A
JGO	1	2008-4	28	1	N/A
JGT	1	2008-4	13	1,2	N/A
JGV	1	2008-4	29,9	1,4	N/A
JFI	6	2008-5	201,11	1,6	N/A
JFJ	6	2008-6	113,97	1,8	N/A
JGU	1	2008-6	33,57		78,95
JFK	6	2008-7	71,81		73,65
JFL	6	2008-7	77,65		75,78
JFN	6	2008-8	163,39		77,58
JFT	6	2008-8	96,97		95,86
JFM	6	2008-9	158,99		98,98

Tablo3.9. E25-054 Kartı İçin Gerçekleşen Adam x Saat ve Üstel Düzeltme (α =0,2) Trend Değerleri

JE25-054			Gerçek	Üstel Düzeltme (α =0,2)
JGN	1	2008-3	23,41	N/A
JGP	1	2008-3	4,25	N/A
JGS	1	2008-3	47,99	N/A
JFF	6	2008-4	78,71	N/A
JGO	1	2008-4	28	N/A
JGT	1	2008-4	13	N/A
JGV	1	2008-4	29,9	N/A
JFI	6	2008-5	201,11	N/A
JFJ	6	2008-6	113,97	N/A
JGU	1	2008-6	33,57	113,97
JFK	6	2008-7	71,81	97,89
JFL	6	2008-7	77,65	92,67
JFN	6	2008-8	163,39	89,67
JFT	6	2008-8	96,97	104,41
JFM	6	2008-9	158,99	102,92

Tablo3.10. E25-054 Kartı İçin Gerçekleşen Adam x Saat ve Üstel Düzeltme (α =0,4) Trend Değerleri

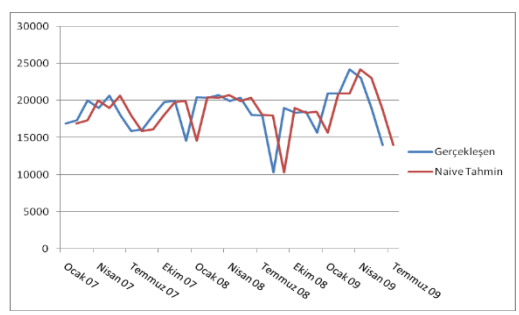
JE25-054			Gerçek	Üstel Düzeltme (α =0,4)
JGN	1	2008-3	23,41	N/A
JGP	1	2008-3	4,25	N/A
JGS	1	2008-3	47,99	N/A
JFF	6	2008-4	78,71	N/A
JGO	1	2008-4	28	N/A
JGT	1	2008-4	13	N/A
JGV	1	2008-4	29,9	N/A
JFI	6	2008-5	201,11	N/A
JFJ	6	2008-6	113,97	N/A
JGU	1	2008-6	33,57	113,97
JFK	6	2008-7	71,81	81,81
JFL	6	2008-7	77,65	77,81
JFN	6	2008-8	163,39	77,75
JFT	6	2008-8	96,97	112,00
JFM	6	2008-9	158,99	105,99

3.6. Model Değerlendirmesi

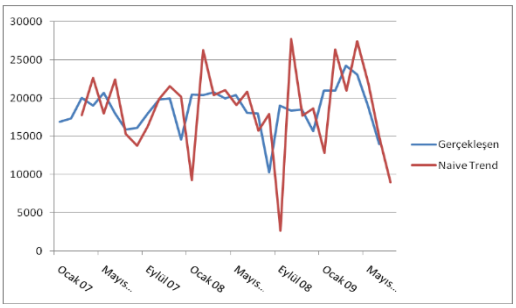
Tablo 3.11. Tahmin modellerine ilişkin sonuçların karşılaştırılması

	BIAS	MAD	MSE	MAPE
Kabin içi bakım ve revizyon için gerçekleşen adam x saat ve naive tahmin hesaplamaları	100,3031	2368,38931	11145841,93	14,11%
Kabin içi bakım ve revizyon için gerçekleşen adam x saat ve naive tahmin trend hesaplamaları	193,8082	3990,943	29251116	22,13%
Kabin içi bakım ve revizyon için gerçekleşen adam x saat ve hareketli ortalama trend hesaplamaları	106,5072	2827,883	11637856	17,01%
Kabin içi bakım ve revizyon için gerçekleşen adam x saat ve ağırlıklı hareketli ortalama trend hesaplamaları	-116,88	2466,646	9111812	14,58%
Kabin içi bakım ve revizyon için gerçekleşen adam x saat ve üstel düzeltme (α=0.1) trend hesaplamaları	213,7962	2396,205	11082158	14,44%
Kabin içi bakım ve revizyon için gerçekleşen adam x saat ve üstel düzeltme (α=0.4) trend hesaplamaları	139,276	2481,234	10115787	15,02%
Kabin içi bakım ve revizyon için gerçekleşen adam x saat ve regresyon hesaplanması	b=38 a=18012 **Temmuz 2009 Tahmini =19153,89351**			

Tahmin modellerine ilişkin sonuçlar Tablo3.11.'de verilmiştir. En küçük yüzdelik ortalama ile (Mean Absolute Percentage Error) kabin içi bakım ve revizyon için gerçekleşen adam x saat ve naive tahmin hesaplamaları % 14,11 en iyi modeli, kabin içi bakım ve revizyon için gerçekleşen adam x saat ve üstel düzeltme (α=0.4) trend hesaplamaları %14,44 ile en iyi ikinci modeli oluşturmaktadır.



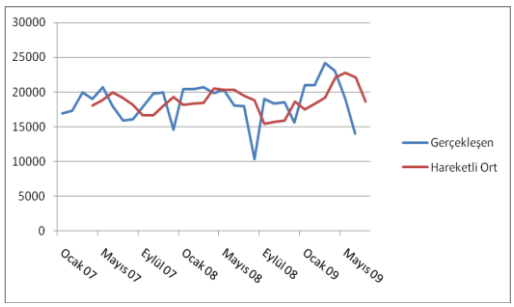
Regresyon tahmini, kabin içi bakım ve revizyon için gerçekleşen adam x saat ortalamasının 19153,89351 olması modeli en iyi açıklayan durumu göstermektedir.



Şekil 3.2. Gerçekleşen Adam x Saat Naive Tahmin Trend Grafiği

Şekil 3.1.'de, gerçekleşen adam x saat değerleri ile naive değerlerinin birbirine yakın olduğu gözlenmektedir

Şekil 3.2.'de, Ocak 2008 ve Şubat 2008'de, Eylül 2008 ile Ekim 2008'de ayrıca Ocak 2009, Şubat 2009,Nisan 2009'da kabin içi bakım ve revizyon trendine bakıldığında aşırı sapmaların ve dalgalanmaların gözlendiği trend grafiğinden anlaşılmaktadır. Veriler incelendiğinde, yaz ve kış aylarındaki sapmaların yaz tatiline girişler, müşterilerin kış aylarında uçak şirketlerini tercih etme eğilimlerinin azalması, yazın bilet fiyatlarının artması gibi sebeplerle açıklanabilir.

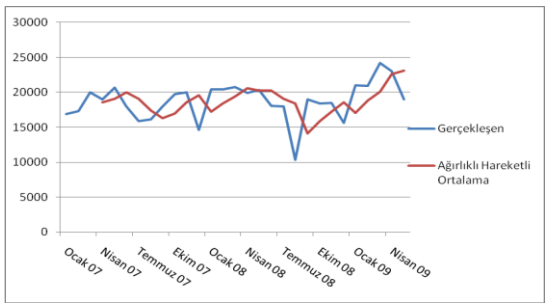


Şekil 3.3. Gerçekleşen Adam x Saat Hareketli Ortalama Trend Grafiği

Yukarıdaki grafikte, Ağustos 2008'de, Mayıs 2009, Haziran 2009'da ve Mart 2009'da kabin içi bakım ve revizyon trendine bakıldığında aşırı sapmaların ve dalgalanmaların gözlendiği trend grafiğinden anlaşılmaktadır.

Ağustos 2008'de kabin içi bakım gerçekleşen adam x saat değeri ile hareketli ortalama değeri arasında en yüksek değer olan % 82'lik sapma meydana gelmiştir.

Veriler incelendiğinde, Ağustos ayında izne ayrılmak isteyen çalışan sayısındaki artış firmanın kabin içi bakım ve revizyon organizasyonunu etkilemektedir. Mart 2009'da ise kışın çok fazla uçuşun olmaması buna karşılık uçakların yerde kaldığı sürede bakım yapılması sapmayı arttırmıştır.

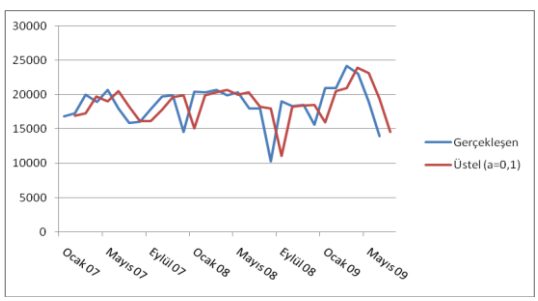


Şekil 3.4. Gerçekleşen Adam x Saat Ağırlıklı Hareketli Ortalama Trend Grafiği

Şekil 3.4.'te, Temmuz 2007, Aralık 2007, Ağustos 2008, Mart 2009 ve Mayıs 2009'da kabin içi bakım ve revizyon trendine bakıldığında aşırı sapmaların ve dalgalanmaların gözlendiği trend grafiğinden anlaşılmaktadır.

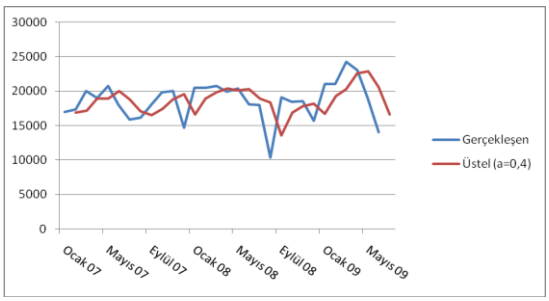
Ağustos 2008'de kabin içi bakım gerçekleşen adam x saat değeri ile hareketli ortalama değeri arasında en yüksek değer olan % 78'lik sapma meydana gelmiştir. Ağustos 2008'de, gerçekleşen adam x saat değeri 10000 saatlik bakım iken, ağırlıklı hareketli ortalama ile 15000 saatlik bakıma çekilmesi gerektiği gözlenmiştir.

Veriler incelendiğinde, Ağustos ayında izne ayrılmak isteyen çalışan sayısındaki artış firmanın kabin içi bakım ve revizyon organizasyonunu etkilemektedir. Mart 2009'da ise kışın çok fazla uçuşun olmaması buna karşılık uçakların yerde kaldığı sürede bakım yapılması sapmayı arttırmıştır.

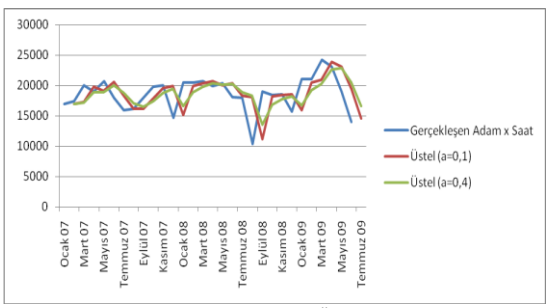


Şekil 3.5. Gerçekleşen Adam x Saat Üstel Düzeltme (α=0.1) Trend Grafiği

Yukarıdaki grafikte, kabin içi bakım ve revizyon trendine bakıldığında gerçekleşen adam x saat değerleri ile üstel düzeltme (α =0.1) tahmin değerleri birbirine yakın olduğu gözlenmektedir.



Şekil 3.6. Gerçekleşen Adam x Saat Üstel Düzeltme (α=0.4) Trend Grafiği



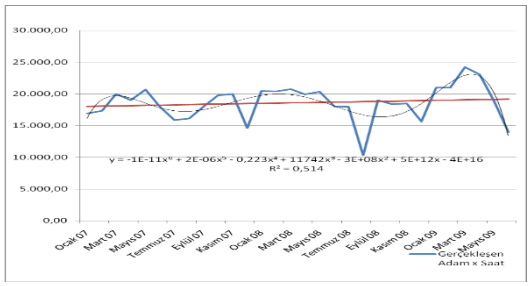
Şekil 3.7. Gerçekleşen Adam x Saat Üstel Düzeltme (α=0.1 ve α=0.4 iken) Trend Grafiği

α=0.4 iken, gerçekleşen adam x saat değerleri ile üstel düzeltme tahmin değerleri birbirine yakındır. Alpha değeri arttığında, gerçek değerler ile tahmin değerleri arasında dalgalanmalar gözlemlenecektir.

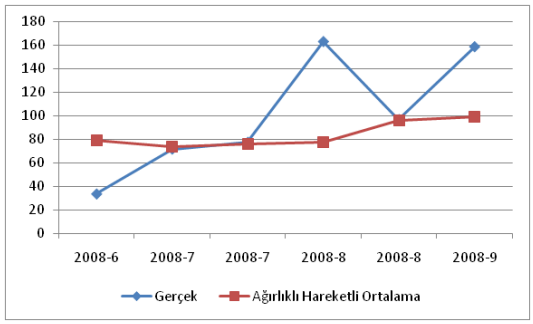
α= 0.1 ve α= 0.4 iken, gerçekleşen adam x saat değerleri ile üstel düzeltme tahmin değerleri (α= 0.1 ve α= 0.4) birbirine oldukça yakındır. α= 0.1 iken MAD =2396,205 iken, α=0.4 olduğu durumda MAD=2481,234 olduğu görülmüştür. Bu durum bize α katsayısının büyüdükçe sapmanın arttığını göstermiştir.

Aşağıdaki grafikte belirleme katsayısının ($R^2 = 0.514$) olduğu görülmektedir. Belirleme katsayısının yeterince yüksek olmaması, faktörlerin çok açıklayıcı bir özelliğe sahip olmadığını, bağımsız değişkenin (sıra değerlerinin) bağımlı değişkeni (adam x saat değerlerini) yeterince açıklayamadığını gösterir.

Bu da bize faktörlerin yönetim tarafından başarılı bir şekilde tespit edilemediğini ifade eder.

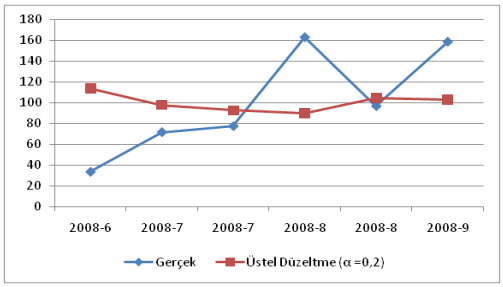


Şekil3.8. Gerçekleşen Adam x Saat Regresyon Grafiği



Şekil 3.9. E25-054 Gerçek Değerler ve Ağırlıklı Hareketli Ortalama Tahmin Değerleri

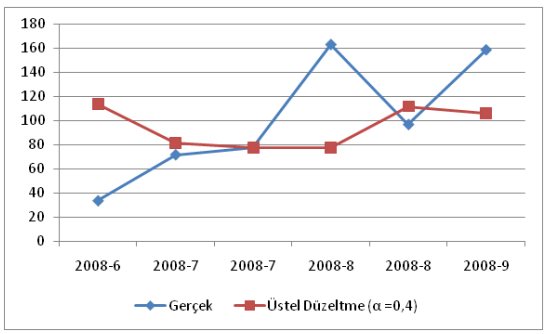
Yukarıdaki grafikte, Ağustos 2008'de, gerçekleşen adam x saat değeri 160 saatlik bakımın üzerinde iken, ağırlıklı hareketli ortalama ile 80 saatlik bakıma indirilmesi gerektiği gözlenmiştir. Haziran 2008, Ağustos 2008'de ve Eylül 2008'de E25-054 kartına ilişkin, aşırı sapmaların ve dalgalanmaların gözlendiği trend grafiğinden anlaşılmaktadır.



Şekil 3.10. E25-054 Gerçek Değerler ve Üstel Düzeltme (α =0,2) Tahmin Değerleri

Yukarıdaki grafikte, Haziran 2008'de, gerçekleşen adam x saat değeri yaklaşık 40 saatlik bakım iken, üstel düzeltme ile (α =0,2) ile yaklaşık 120 saatlik bakıma çekilmesi gerektiği gözlenmiştir.

Haziran 2008, Ağustos 2008'de ve Eylül 2008'de E25-054 kartına ilişkin, aşırı sapmaların ve dalgalanmaların gözlendiği trend grafiğinden anlaşılmaktadır.



Şekil3.11. E25-054 Gerçek Değerler ve Üstel Düzeltme (α =0,4) Tahmin Değerleri

Yukarıdaki grafikte, Haziran 2008'de, gerçekleşen adam x saat değeri yaklaşık 40 saatlik bakım iken, üstel düzeltme ile (α =0,4) ile yaklaşık 120 saatlik bakıma çekilmesi gerektiği gözlenmiştir.

Haziran 2008, Ağustos 2008'de ve Eylül 2008'de E25-054 kartına ilişkin, aşırı sapmaların ve dalgalanmaların gözlendiği trend grafiğinden anlaşılmaktadır.

4. Sapmaların Sebepleri

Adam x saat üretimini temel bileşenleri, personel ve personelin yapabileceği iştir. Adam x saat değerlerindeki dalgalanmaların temel sebepleri aşağıda sıralanmıştır.

- • Personel sayısındaki değişiklikler
- • İzinli/raporlu/eğitimdeki personel sayıları
- • Fazla mesai yapılması
- • Kapasiteden daha az iş yükü bulunması.

Yaz ve kış ayları arasındaki sapmalar, yıllık izin kullanımı ile açıklanabilmektedir. Yaz mevsimindeki yüksek yolcu talebi nedeni ile havayolları bakımlarını mümkün mertebe kış mevsiminde yapmak istemektedir. Kapasiteden daha az iş yükü oluştuğu için tüm personelin izinlerini yaz mevsiminde kullanmasına özen gösterilmektedir. Kış mevsiminde ise iş yükü zaman zaman kapasitenin üzerine çıkabilmekte ve fazla mesai ile adam x saat üretimi artmaktadır.

Aralık 2007, Ekim 2008, Aralık 2008 aylarındaki sapmalar incelendiğinde bu aylarda Ramazan ve Kurban Bayramı tatillerinin bulunduğu tespit edilmiştir. Resmi tatillerde personelin çalışması durumunda ciddi miktarda fazla mesai ödemesi yapılması gerektiğinden, bayram tatillerinde sınırlı sayıda personel çalıştırılmış ve adam x saat üretimi düşmüştür.

5. Çalışmanın Kısıtları

Havacılık sektöründe faaliyet alanlarının fazla olması nedeniyle tüm faaliyetleri aynı anda ele almak mümkün olmamaktadır. Bu tür zorluklar göz önüne alınarak çalışma belli alanlarla sınırlandırılmıştır. Bu sınırlandırma çalışmaya genel manada kısıt oluşturmaktadır. Ayrıca rutin ve rutin olmayan (non-routine) işlerin sadece adam x saat bazında ele alınarak belli kartları incelemesi diğer bir kısıtı oluşturmaktadır. Bu çalışmada, mevcut durumda rutin olmayan (non-routine) adam x saat tahminlerinde yaşanan sapmaların en aza indirilmesi kapasite planlarının doğruya yakın tahmin edilebilmesi için diğer alanlardaki rutin ve rutin olmayan (non-routine) işlemlerin gerektiği gibi incelenememesi de bir kısıt olarak düşünülebilir. Gelecekte yapılabilecek çalışmalarda yukarıdaki kısıtlar göz önüne alınarak bir çalışma yapılırsa literatüre katkı sağlamış olabilir.

6. Sonuç Ve Tartışma

Savunma, havacılık ve uzay teknolojileri, yolcu taşımacılığı gibi daha birçok alanda faaliyet gösteren ve ulusal ve uluslar arası özelliği öne çıkan havacılık sektörü ve bu sektör ile ilgili kurum ve kuruluşlar, gelişen teknolojiyi yakından takip etmek, değişimleri hızla bünyesine taşımak ve daha yaygın bir hizmet ağı oluşturmak gibi

yüksek performans gerektiren bir çalışma sistemi geliştirmek zorundadırlar.

Yapılan çalışma kapsamında farklı tahmin yöntemleri E25-054 ve JE25-054 kartlarına uygulanmış ve tahmin değerleriyle gerçekleşen değerler makale içerisinde karşılaştırılarak bir değerlendirme yapılmıştır. Doğru sonuçlar ve düşük sapmalar gerçekleştirebilmek için gerçekleşen değerlerlerle tahmin edilen değerler sürekli kontrol edilerek meydana gelen sapmalar düzeltilmelidir.

Bu çalışma kapsamında değerlendirilen kartın gerçekleşme değerleri çok farklı yönlerde ve büyük oranlarda sapmalar içerdiğinden bu değerlerin ortaya çıktığı süreçlerin iyi bir şekilde analiz edilmesi gerekir. Bu süreçlerin kontrol edilebilirliği ve doğruluğu sağlandığı ölçüde tahminler de o oranda doğru gerçekleşecektir.

Uygulama sonucuna bakıldığında tahmin yöntemlerinin sürecin kontrol altında yürüdüğü dönemlerde gerçeğe yakın sonuçlar verdiğini göstermektedir. Özellikle α sabitinin 0,2 seçildiği üstel düzeltme yöntemiyle yakın sonuçlar elde edilebilmektedir. Ancak gerçekleşen değerlerin yüksek oranda saptığı ve sürecin kontrol dışı değerler ürettiği durumlarda tahminler geçerliliğini yitirmektedir. Tahminlerin doğru sonuçlar verebilmesi için bu sapmalara neden olan faktörler gözden geçirilmesi ve sapmaya sebep olan durumların ortadan kaldırılması gerekir.

Yapılan çalışmada gerçekleşen değerler üzerinde gözlemlenen kontrol dışı sapmalar uygulamada aşağıdaki faktörlerle gösterilmiştir:

1. Muhtelif kaygılardan ötürü hatalı Adam x saat girişleri.
2. Aynı kartın uygulanması sonucu bulgunun giderilmesine yönelik rutin olmayan (non-routine) işlem gereği yapılan işlemin farklı olması.
3. Rutin olmayan (non-routine) işlem saatinin ilgili rutin karta yazılması.
4. Geçmiş verilerin kirli olmasından kaynaklanan tahmin hataları (Kart bazından tahmin olmadığı için paket bazında tahmin gerçekleştiriliyor).
5. Aynı bölgede iş yaptıran başka kartların bulunması.
6. Özellikle üçüncü parti (THY dışı) müşteri uçaklarının uçak yaşı, tipi, bakım sayısı ve bölge iklim şartlarına göre değişiklik göstermesi.
7. Yukarıda sayılan nedenlerden ötürü gerçekleşen toplam rutin olmayan (non-routine) adam x saat miktarı da özellikle kartların çoğunluğunda sapmaların aynı yönde gerçekleşmesi durumunda plan değerinden çok farklı değerlere ulaşabilmektedir.
8. Buna ek olarak yine toplam bakım olarak değerlendirildiğinde sonradan eklenen işlerin sistem üzerinden ayrıştırılamaması nedeniyle ilk plandan büyük oranda sapmalar gözlemlenebilmektedir.

Bu maddelerin analiz edilmesi doğrultusunda süreçlerin kontrol altına alınması ve gerçekleşen değerlerin daha dar bir aralıkta toplanmasının sağlanması aynı oranda tahminlerin de doğruluğunu artırabilir.

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JOINPOINT REGRESSION ANALYSIS AND AN APPLICATION ON ISTANBUL STOCK-EXCHANGE*

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Özet

Joinpoint Regresyon Analizi, trendde meydana gelen istatistiksel olarak anlamlı değişmelerin en uygun noktalarını belirlemede kullanılan istatistiksel metotlardan biridir. Bu çalışmanın amacı Joinpoint regresyon analizini borsa verilerine uygulamak ve bu metodun performansını gerçek ve tahmin edilen değerleri karşılaştırarak belirlemektir. Bu amaçla Nisan-Mayıs 2013 ayları için Ulusal BIST 30 endeks değerlerine ilişkin veri seti derlenerek Joinpoint analizi ile incelenmiştir. Joinpoint paket programı aracılığı ile doğrusal ve doğrusal olmayan tekniklere göre çözümleme yapılarak bu tekniklerden hangisinin daha uygun olduğu Hata Kareler Ortalaması (HKO) değerlerine göre belirlenmiştir. Gelecek dönemler için yapılan tahminler ile bu dönemlerde gerçekleşen değerlere göre tahmin edilen değerlerin gerçek değerlerden biraz yüksek olduğu gözlemlenmiştir ama bu sonuç Joinpoint regresyon analizinin gelecek dönem tahminlerini gerçekleştirmek için bir zaman serisi verisine uygulanabileceğini göstermektedir.

Anahtar Kelimeler: BIST 30, Joinpoint Regresyon Analizi, Trend

Jel Kodu: C1, C4, C5.

Abstract

Joinpoint Regression Analysis is one of the statistical methods used to identify the best-fitting points if there is a statistically significant change in the trend. The aim of this study is to apply joinpoint regression analysis in the stock market and compare the performance of this method according to actual data set and estimated values. For this purpose, we collected the data set from the National Istanbul Stock Exchange (ISE) 30 index for April-May 2013 and examined that data set via Joinpoint Regression Analysis. We applied linear and nonlinear techniques with the help of Joinpoint software and determined the best technique according to their Mean Square Errors (MSE). With the projection for the future months and the actual results, we see that the estimated values are a little higher than the actual values However, this shows that we may apply Joinpoint regression to a time series data set in order to forecast future values.

Keywords: Istanbul Stock-Exchange 30, Joinpoint Regression Analysis, Trend

Jel Code: C1, C4, C5.

∗ This study is a part of Huriye Telli's MS thesis supervised by Sinan Saraçlı at Afyon Kocatepe University Institute of Science, 2013.

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1. Introduction

Regression Analysis is a method that models the relationship between the dependent and the independent variable(s) with mathematical expressions. This relationship between variables is actually a causal relationship expressed by a mathematical function.

Regression analysis is applied to estimate the average value of the dependent variable by the help of the data set of the all variables and to test whether or not the independent variables in the model are statistically significant on the dependent variable (Çankal, 2010).

Like many other statistical methods, regression analysis needs to meet some assumptions. Least Squares Technique is one of the most used techniques to estimate the parameters in regression analysis (Gazeloğlu, 2012). This technique is also suitable to use in the case of the assumption of constant variance (Albayrak, 2008).

In Regression Analysis numbers of independent variables may be one, and often two or more. Hence, if this relationship between the variables is linear and the number of independent variables is one, this model is called "Simple Linear Regression Model". Simple linear regression model is given in Equation 1. (Vural, 2007)

$$Y_i = \beta_0 + \beta_1 X_i + e_i \qquad (1)$$

The Joinpoint Analysis was used to identify the best-fitting points where a statistically significant change in the trend occurred (Cayuela *et al.*, 2004). Joinpoint Regression, also known as piecewise linear regression, is increasingly used to identify the timing and extent of changes in time series (Goovaerts and Xiao, 2011). Segmented line regression, also known in the literature as multiphase regression with the continuity constraint, broken line regression, piecewise linear regression, has been successfully applied to describe these trend data, and various statistical techniques have been developed for inference problems (Kim *et al.*, 2004).

2. Material and Method

The Joinpoint Regression Software is a Windows-based statistical software package that computes and analyzes non-linear, piecewise trends of time series. The software fits models to the data that allow for testing of whether an apparent change in trend is statistically significant. These models are usually referred to as joinpoint models. It is important to understand that goal of the Joinpoint Regression Program is not to provide models that best fit the data, but models that best summarize the behavior or the data trend (Marrett, 2010).

There are five steps involved in generating any Joinpoint trend analysis;

Step 1: Create an input data file for Joinpoint,

Step 2: Set parameters in Joinpoint,

Step 3: Execute Joinpoint,

Step 4: View Joinpoint results, print models, export graphs and data,

Step 5: Summarize Joinpoint results for interpretation (Marrett, 2010).

The identification of changes in the recent trend is an important issue in the analysis (Kim *et al.*, 2000). Simple Linear Joinpoint Regression Model is given in Equation 2.

$$E\left[y_i \mid x_i\right] = \beta_0 + \beta_1 \cdot x_i + \gamma_1 (x_i - \tau_1)^+ = + \ldots + \gamma_n (x_i - \tau_k)^+ \qquad (2)$$

x_i , i = 1, 2, … ,n; $x_1 < \ldots < x_n$ time variable, y_i , i = 1, 2, … ,n are the response variable. β_0 shows constant coefficient in Equation 2 and β_1 shows slope coefficient.

In modeling trends over time, it is important to be able to detect when statistically significant changes in the trend occur. Joinpoint analysis is widely applied to detect these changes points (joinpoints) and determine the trends between joinpoints (Jiang et al., 2010).

Nonlinear Joinpoint Regression Model is given in Equation 3.

$$E\left[y_i \mid x_i\right] = e^{\beta_0 + \beta_1 \cdot x_i + \gamma_1 (x_i - \tau_1)^+ + \ldots + \gamma_n (x_i - \tau_k)^+} \qquad (3)$$

$\beta_0, \beta_1, \gamma_1, \ldots, \gamma_n$ are regression coefficients in Equation 2 and 3, τ_k; $k < n$, is the *k-th* unknown Joinpoints (Kim et al., 2000). Equation applies to eliminate negative values during the prediction of the observed values in Equation 4. If $(x_i - \tau_k)$ is negative, this value is zero and if $(x_i - \tau_k)$ is positive, this value is accepted as $(x_i - \tau_k)$.

$$(x_i - \tau_1) = \begin{cases} > 0 & (x_i - \tau_k)^+ = (x_i - \tau_k) \\ \leq 0 & otherwise \end{cases} \quad (4)$$

This model assumes a linear trend between joinpoints and continuity at the joinpoints. The joinpoint regression model has the same underlying assumptions as simple regression. If the year(s) when changes in the trend occur (joinpoints) are known, then linear regression techniques can be used to estimate the regression parameters. However, in most instances, the exact years for the joinpoints are unobservable.

The challenge in cancer trend analysis is to determine the locations of the joinpoints if they exist; and to determine the optimal number of joinpoints for the most appropriate model (Jiang et al., 2010).

There are three major decisions in any joinpoint analysis;

1. The form of the mean function (Data distribution: Normal or Poisson; Equation: linear or nonlinear),
2. The location of the joinpoints given the number of joinpoints,
3. The optimal joinpoint model (Jiang *et al.*, 2010).

The first step is determined by the form of the data. The next step in fitting the model is to determine the range of the number of joinpoints to be tested; usually between 0 and 9. Then for each given number of joinpoints the location of the joinpoints is determined. To determine the location of the joinpoints, either the Grid Search method or Hudson's method can be applied. The grid search method creates a "grid" of all possible locations for joinpoints specified by the settings, and tests the sum square of errors (SSE) at each one to find the best possible fit. Hudson's method does a continuous testing between observed values to find the best model. In Hudson's method, each fitted sub-model has a local least square, and the overall least squares of the model is found when a complete curve to be fitted consists of two or more sub models. The third step is to find the optimal model, i.e. the optimal number of joinpoints, and the optimal locations of related joinpoints. (Jiang et al., 2010).

Permutation tests and Bayesian Information Criterion (BIC) test may be applied to determine the most appropriate model in the joinpoint regression (Duyar, 1995). BIC is based on goodness of fit test. Calculation of BIC is given in Equation 5.

$$BIC(k) = \ln\{SSE(k)/Obs\} + \{[2\cdot(k+1)]/Obs\}\cdot\ln(Obs) \quad (5)$$

Where SSE is the sum of squared errors of the k-JoinPoint regression model, 2*(k+1) is the number of parameters of the k-JoinPoint model and Obs is the number of observations. The k-JoinPoint model with the minimum value of BIC(k) is selected as the final model (Pickle et al., 2007).

The sequential method to determine the optimal model using the permutation test is described below;

k_1, the maximum number of joinpoints, k_0 the minimum number of joinpoints;

$H_0 : k_0$ is the best model.

$H_1 : k_1$ is the best model.

$0 \leq k_0 \leq k_1$, and calculate $\alpha' = \frac{\alpha}{k_1 - k_0}$ for a given significant level α

2) If p $> \alpha'$, don't reject H_0 and set $k_1 = k_1$-1,

If p $\leq \alpha'$ then H_0 is rejected, set $k_0 = k_0$ + 1 and calculate new $\alpha' = \frac{\alpha}{k_1 - k_0}$

3) Go back to do step 1 and 2 until $k_1 = k_0$ + 1 (Jiang et al., 2010).

The formula used to calculate the percent change is given in Equation 6.

$$P.C. = 100 * e^{\beta} - 1 \qquad (6)$$

In Equation 6, β is the slope coefficient of each section.

3. Application

In the application part of the study, the daily closing values of the stocks at the 2th quarter of the months of April and May in 2013 for National ISE 30 index was examined to estimate the values for June 2013. The estimated values are also compared with the real ones.

The survey was conducted with a total number of 43 days (21 days for April and 22 days for May in 2013) excluding weekends and public holidays. The data set which obtained from the official site of Istanbul Stock Exchange was compiled in a text file and then transferred to Joinpoint regression software. Analyses are concluded both for linear and nonlinear Joinpoint regression models.

Figure 1. The graphical representation for closing data of National ISE 30 Index in April- May

Whether the changes in the trends of ISE-30 index in April-May 2013 are statistically significant or not, the breaking times and graphs of these trends, model estimates and daily percent changes (DPC) are given in Table 1.

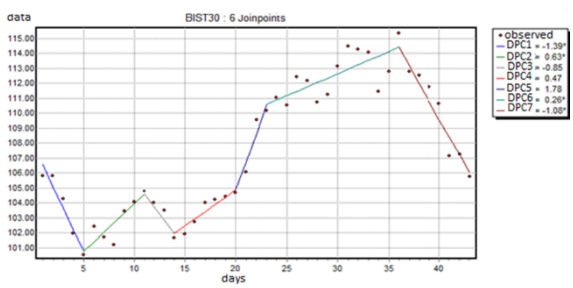

Table 1. Model and the parameters for ISE 30 Index.

Parameter	Value
Model	ln(y) = xb / y = xb
Dependent variable	Daily closing data
Independent variable	Days (Days belonging to April-May in 2013)
Heteroscedastic errors option	Constant variance
By variable	Groups (ISE 30)
Number of Joinpoints	min=0 ve max=9
Minimum number of observations between two joinpoints	10
Method	Grid Search
Model Selection Method	Bayesian Information Criterion
Significance level	0,05

4. Findings

The scatterplot and the trend lines for National ISE 30 Index for April-May 2013 are given in Figure 1. The results of the analysis show that after some fluctuations in April there is an increase with an amount of 1.78% at the end of the April. After an increase in May with an amount of 0.26% it can be seen that after May 22, there is a decrease with an amount of -1.08% in the total index.

Nonlinear joinpoint Regression Model, according to parameter estimates for April and May is given in Equation 7. The detailed results of the analysis are also given in Table 2.

$$E[y_i \mid x_i] = e^{\begin{array}{l}(4{,}68 - 0{,}01x_i + 0{,}02(x_i - 5) - 0{,}01(x_i - 11) \\ +0{,}01(x_i - 14) + 0{,}01(x_i - 20) - 0{,}02(x_i - 23) \\ -0{,}01(x_i - 36))\end{array}} \qquad (7)$$

Table 2. Results for Nonlinear Joinpoint Regression Model

Standard Parameter						
Cohort	Parameter	Parameter estimates	Standard Error	Z value	Probability	MSE
ISE30	Constant 1	4,683081	0,011339	412,992596	0,000000	0,00008
ISE30	Slope 1	-0,014032	0,004141	-3,388868	0,002526	
ISE30	Slope 2- Slope 1	0,020296	0005071	4,002180	0,000560	
ISE30	Slope 3- Slope 2	-0,014833	0,013417	-1,105525	0,280363	
ISE30	Slope 4- Slope 3	0,013246	0,013417	0,987249	0,333793	
ISE30	Slope 5- Slope 4	0,012979	0,013417	0,967395	0,343410	
ISE30	Slope 6- Slope 5	-0,015035	0,013116	-1,146305	0,263456	
ISE30	Slope 7- Slope 6	-0,013491	0,001913	-7,050813	0,000000	
Test Statistics						
Cohort	Model	Number of Joinpoint	Number of Parameter	Degrees of Freedom	SSE	BIC
ISE 30	#1	0 Joinpoint	2	41	0,0317903	-7,0348560
ISE 30	#2	1 Joinpoint	4	39	0,0165874	-7,5104305
ISE 30	#3	2 Joinpoint(s)	6	37	0,0077217	-8,1001004
ISE 30	#4	3 Joinpoint(s)	8	35	0,0056628	-8,2352841
ISE 30	#5	4 Joinpoint(s)	10	33	0,0036137	-8,5095150
ISE 30	#6	5 Joinpoint(s)	12	31	0,0029564	-8,5353500
ISE 30	#7	6 Joinpoint(s)	14	29	0,0024110	-8,5643233 *
ISE 30	#8	7 Joinpoint(s)	16	27	0,0022394	-8,4632364
ISE 30	#9	8 Joinpoint(s)	18	25	0,0020562	-8,3736408
ISE 30	#10	9 Joinpoint(s)	20	23	0,0018726	-8,2922279
The selected final model has 6 joinpoint.						

The results of Bayesian Information Criterion values indicate that the final selected model has 6 joinpoint.

Linear Joinpoint Regression Model, according to parameter estimates for April and May is given in Equation 8. The detailed results of the analysis are also given in Table 3.

$$E\left[y_i \mid x_i\right] = 108,02 - 1,45x_i + 2,10(x_i - 5) - 1,53(x_i - 11) + 1,36(x_i - 14) + 1,43(x_i - 20) - 1,61(x_i - 23) - 1,49(x_i - 36) \quad (8)$$

Table 3. Results for Linear Joinpoint Regression Model

Standard Parameter						
Cohort	Parameter	Parameter estimates	Standard error	Z value	Probability	MSE
ISE 30	Constant 1	108,020953	1,243206	86,888986	0,000000	0,99188
ISE 30	Slope 1	-1,451426	0,453955	-3,197292	0,004004	
ISE 30	Slope 2- Slope 1	2,096154	0,555979	3,770204	0,000994	
ISE 30	Slope 3- Slope 2	-1,527801	1,470982	-1,038627	0,309775	
ISE 30	Slope 4- Slope 3	1,363997	1,470982	0,927270	0,363415	
ISE 30	Slope 5- Slope 4	1,425030	1,470982	0,968761	0,342742	
ISE 30	Slope 6- Slope 5	-1,612738	1,438039	-1,121484	0,273654	
ISE 30	Slope 7- Slope 6	-1,493279	0,209773	-7,118562	0,000000	
Test Statistics for the number of Joinpoint						
Cohort	Model	Number of Joinpoint	Number of Parameter	Degrees of Freedom	SSE	BIC
ISE 30	#1	0 Joinpoint	2	41	371,3961790	2,3310088
ISE 30	#2	1 Joinpoint	4	39	190,7380213	1,8395798
ISE 30	#3	2 Joinpoint(s)	6	37	87,6198435	1,2366260
ISE 30	#4	3 Joinpoint(s)	8	35	63,8955907	1,0958084
ISE 30	#5	4 Joinpoint(s)	10	33	41,5241008	0,8397716
ISE 30	#6	5 Joinpoint(s)	12	31	35,4030696	0,8552357
ISE 30	#7	6 Joinpoint(s)	14	29	28,7645525	0,8225205 *
ISE 30	#8	7 Joinpoint(s)	16	27	26,8953358	0,9302691
ISE 30	#9	8 Joinpoint(s)	18	25	24,5636540	1,0145236
ISE 30	#10	9 Joinpoint(s)	20	23	22,1702821	1,0869480
The selected final model has 6 joinpoint.						

Because the MSE value of the nonlinear joinpoint regression analysis is lower than the MSE value of linear model, we can say that the nonlinear joinpoint model is more appropriate to conclude the estimations for June.

Estimations for June 2013 by the help of the data set for April - May are given in Table 4. By examining Table 4, it can be seen that the actual values are smaller than the estimated values.

Table 4. Estimates and the actual values for June, 2013 by the help of the data set of April and May in 2013

Cohort	April - May 2013 (Estimated values June 3-4-5 2013)						Actual values (June in 2013)		
	y = xb			ln(y) = xb					
	3	4	5	3	4	5	3	4	5
ISE 30	105,02	103,83	102,64	113,30	112,17	111,05	94,83	99,20	97,60

5. Conclusion

The results of the analysis indicate that Joinpoint regression analysis can be used to make some estimations for the stock market. The estimated values in this study are similar, but a little higher than the actual values of the related data set.

According to the data set for April-May 2013 there aren't many fluctuations in April. However, there is an increase in May. There is a serious decrease after May 20.

During this period, after the declaration of U.S.A Federal Reserve chairman, that they stop injecting money into the economy, there had been a negative impact on the Istanbul stock market.

Also the Istanbul stock market had been badly affected because of the Gezi Park Protests.

It can be said that there had been a statistically significant decrease in the closing values of traded companies in the stock exchange related with these events.

The estimated values in April are a little higher than the actual data set for closing values of the National ISE 30 index than in May. However, the estimated values in May and June are a little lower than the actual values because of the economic and political events which occurred during these months.

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