Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2019, 6(1):55-63**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Effective Prediction and Foresight of Energy Supply Security Model That Will Enable Turkey to Accomplish Its Growth Target

Selin ÇABUK

Cukurova University, Faculty of Engineering and Architecture, Department of Industrial Engineering, Adana, Turkey

Abstract The rapid population growth that accompanies industrial development as well as the need to promote life standards constantly increase the importance of energy in all countries that aim to develop. Energy must be secured to satisfy the demand for the economic growth of a country safely and at a reasonable price. In this study a security of energy supply model was created for Turkey using annual data from 1980 to 2015. Generalized Maximum Entropy (GME) was used for the efficient estimation of the model. Additionally, by utilizing this model, the energy supply security values of Turkey for 2016 to 2023 have been forecasted.

Keywords Energy Supply Security, Generalized Maximum Entropy (GME), Forecasting

Introduction

In recent years, the increasing energy demand, due to various reasons, has brought to the fore the concept of energy supply security. In order for a country to consume energy, it needs to keep its energy supply under constant control. Supply security is a measurable concept. How much of the energy a country uses can be produced from domestic sources? Which sectors (agriculture, industry, and service) are used intensively and from which sources is it provided energy? These are important indicators of the security of an energy supply. Countries need to find the optimum path between the unexpected disruptions in energy supply, the pressures caused by environmental problems, and the increased use of energy for growth and they need to develop policies accordingly. The oil crisis that emerged in the 1970s and the global warming problems of recent years have highlighted the importance of renewable energy sources in energy consumption. Thus, energy supply security can be examined in relation to the availability of energy, access to energy and the financial power required for energy consumption.

In this study, a causal regression model between the years 1980 and 2015 describing energy supply security for Turkey will be established. The explanatory variables to be included in the regression model are: oil prices; carbon dioxide emissions due to energy; renewable energy production; population; human development index; the rate of increase in real gross domestic product; industrial production index; capacity utilization rate etc. In the analysis period, the most effective estimations will be obtained based on the mean of error squares which will provide the assumptions of the regression model.

The generalized maximum entropy principle is used to overcome multicollinearity problems to achieve the most effective results that provide stable parameter estimates. The GME principle is applied after the re-parameterization, $y = XZp + Ww$, of the linear regression model $y = X\beta + e$.

Energy Supply Security

In parallel with the world's rapid population growth, industrial development, and the necessity of increasing the standard of living, the importance of energy has increased in all the countries of the world aiming at development [1]. However, as in many countries, in terms of self-sufficiency and energy resources, Turkey imports a large part of its necessary energy from abroad. This is due to the energy used by countries depends on its coal, oil, natural gas and renewable energy sources. It has been concluded that the environmental awareness of energy generation and consumption in the 1990s should be supported in order to prevent any negative impacts on the environment [2]. A certain level of economic growth is made by only consuming a certain level of energy. It is not possible to produce without energy [3]. In order to ensure that the needs of a country are met without interruption, good quality and sufficient energy should be provided at reasonable prices.

Energy, which is always important for the economy of the country, is also of particular importance in terms of international relations. Some countries that were once a part of the Soviet Union and have now gained independence are rich in energy resources and desire to supply these resources to the world market. Also the increasing share of two big countries like India and China in the world economy and their high and continuous growth rates, have affected both the energy supply and demand. Moreover, political uncertainties in the Middle East and North African countries, especially in terms of oil and natural gas resources; coupled with increased demand pressure, increases in oil and gas prices; sometimes it has led to declines as a result of the slowdown of the world economy. While these developments were taking place in the oil and natural gas markets in recent years, there have been developments in renewable energy, especially in wind and solar energy. These resources are unlimited and new technology increase renewable energy investments [4].

In addition to countries such as Japan and South Korea, China and India's rapid growth rates and energy consumption as non-OECD Asian nations are estimated to exceed OECD countries. Likewise, investments in renewable energy sources are expected to increase over time. Nevertheless, it is foreseen that the importance of fossil resources will continue.

Another important issue with regard to energy supply is the problem of safe and continuous delivery of oil and natural gas to the regions where there is high demand. This subject, which is mentioned by the energy roads concept, has gained as much importance as production. In this regard, new alternatives should be added to the transportation lines with large tankers and pipelines. Pipelines are considered to be the safest route for European shipments especially in the Middle East-Caucasus-Central Asia and Russia. Not only shipment, but also natural gas liquefaction, storage, and natural gas conversion are also areas to be invested in. Turkey plays an important role on this route because of its geographical location.

Energy Supply Security Model

The aim of our study is to estimate the energy supply for the years 2016 to 2023. An econometric model was created in order to achieve this goal. Annual data are used for the period of 1980 to 2015 which is the working period. For this purpose instead of "energy supply", the phrase "Energy Supply Security" (ESS), is used. In our study for the variable of ESS for Turkey, seven descriptive variables have been determined.

The following linear model has been formed:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + \beta_6 X_{6t} + \beta_7 X_{7t} + u_t \quad (1)$$

Here,

Y_t : Security of Energy Supply (Thousand Tons of Oil Equivalent)

X_{1t} : Gross Domestic Product Growth Rate in Constant Prices (Based on Constant Local Currency)

X_{2t} : Total CO_2 Emissions from the Consumption of Energy (Million Metric Tones)

X_{3t} : Human Development Index

X_{4t} : Total Population (Million People)

X_{5t} : Retail Gasoline Price (Constant 2015 Dollars / Gallon)

X_{6t} : Industrial Production Index (2015=100)

X_{7t} : Total Renewable Energy (Thousand Toe)

The variables used in this study, in which the 1980-2015 data is used, can be explained as follows: Price is the most important variable that is expected to affect the ESS. Because the energy supply is demanded from a variety of sources, pricing energy is not an easy task. In practice, “weighted price” can be used. However for this you can act on the weight of the resources of energy has been supplied. For Turkey in energy supply, because weighted petroleum sources have been used, oil prices have been used.

On the other hand, renewable energy supply has been included in the model in recent years. Due to the low share of renewable energy supply in total energy supply, its affect on price has not been taken into consideration in this study. ESS is an important variable in a country’s economic growth rate, therefore a high correlation is expected to occur between ESS and the real growth rate. The sector where energy is used the most is in industrial production. Indeed up to 70% of electrical energy is demanded by industry alone. Thus, for a sustainable and growing economy, ESS for industry is also included in the model as an industrial production index. This variable determines both the capacity utilization and production in industry. Two other important variables are: Human Development Index, which will be used to measure the level of welfare as a result of ESS; and the emission of CO_2. CO_2 emission is a variable that is expected to be limited during production and the use of resources. These days where global warming has gained importance, it’s a variable to which must be paid attention. When associated with energy supply, CO_2 is expected to decrease even if the energy supply is increased. Thus it can be an indicator of the level of technology in energy production and consumption. In the process of the application of the model and the estimate, with decisions submitted to parliament in 2008, Turkey was ready to sign the Kyoto Protocol [5]. Turkey officially joined the protocol in 2009. Therefore, after that year, D_tX_{2t}, variable was added to the model and it was tried to determine whether there is a structural change related to CO_2 emissions in β_2 slope parameter of ESS variable model. The relationship between ESS-CO_2 release can be seen as follows: Although the increase in ESS, as mention above, has an increasing affect on CO_2 emissions, the use of advanced technology should reduce this release. (The economic crisis that began in 2008, and the adoption of the Kyoto Protocol, in which the proxy variable was used. The relationship between ESS and energy price is expected to be positive. Similarly, the real growth rate with ESS should be positive economic growth also increases as ESS increases. Industrial production and capacity utilization should be positively correlated with economic growth. However, only industrial production among these variables which are expected to have a high correlation with each other in the study. As ESS increases, industrial production and capacity utilization are expected to increase. Likewise the increase in the rate of ESS increases the general welfare level of the country and accordingly, the Human Development Index. As for the relationship between the variables themselves if oil prices are increasing CO_2 emissions are expected to fall. Similarly the relationship between the change in oil prices and the use of renewable energy should be in the same direction:

The increase in oil prices leads to an increase in renewable energy supply and a decrease in oil prices leads to a decrease in the supply of renewable energy. However, increases in oil prices are realized in short periods, while increases in renewable energy supply are seen in longer periods due to investment period, so there is a time inconsistency between increase in oil prices and renewable energy supply increases. Oil prices and real growth rate are in the opposite direction. Increases in oil prices reduce the real growth rate, while the increase in renewable energy supply may not compensate for this decline. Oil prices and industrial production and capacity utilization can be explained in the same way as real growth. Increases in oil prices reduce the real growth rate, while the increase in renewable energy supply may not compensate for this decline. Since the increase in oil prices will increase oil supply, CO_2 emissions during production increase, but CO_2 emissions are reduced as industrial production and capacity utilization is reduced. The increase in oil prices will decrease the human development index.

In the last section, the possible relationships between the explanatory variables in the model are discussed. The relationship between explanatory variables will be determined in the application section. In the case of a significant relationship, the most common generalized maximum entropy estimation method will be used in this study in order to obtain stable parameter estimations in the estimation phase of the model.

Estimation of Energy Supply Security Model and Findings

Turkey formally joined the Kyoto Protocol in 2009. In order to see this effect, the structural change variable, $D_t X_{2t}$, is added to the model created in the previous section. This variable is intended to determine whether there is a structural change related to carbon dioxide emission. In addition, the trend variable has been added to determine the annual changes in ESS. The model created after these definitions is given by the equation (2).

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \lambda_2 D_t X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + \beta_6 X_{6t} + \beta_7 X_{7t} + \beta_8 T + u_t \quad (2)$$

In the previous section, the relationship between the variables in the model and EAG and also to each other was given. After estimating the regression model described above, it is necessary to check whether the necessary assumptions are ensured, which it is the purpose of generating correct policies from the estimation results. The reason for the deviations from the assumptions is the sample used. When generating the sample, since the data of the variables in the model are non-experimental and the observations are obtained from the institutions, one of the most important problems we face will be the problem of multicollinearity. Linear regression models with multiple explanatory variables are called multiple regression models. The criterion used to explain the relationship between the variables in the multiple regression model is the correlations between the variables. This relationship being high is termed an ill-conditionality problem. When there is ill-conditionality between the explanatory variables, the variances of these parameter estimates are quite large when using the classical unbiased estimators (such as the least-squares method) for parameter estimations. Large variances will lead to large confidence intervals and a lack of confidence in hypothesis testing. Because this situation will cause instability in parameter estimation, this is one of the important assumptions to be examined. The instability will mean that a very small change in the sample would result in very different values obtained in the parameter estimates. If this parameter is used for policy implementation purposes, it will lead the researcher to wrong decisions because there are unpredictable estimates. For this reason, our model (2) was estimated by the Least Squares Method and the correlation matrix of the variables used was also calculated. The correlation matrix for these variables is given in Table 1.

Table 1: Correlation Matrix of Variables in Model (2)

	Correlations									
y	1.000	0.149	0.990	0.732	0.989	0.991	0.589	0.990	0.690	0.991
x1	0.149	1.000	0.113	0.120	0.139	0.129	0.165	0.198	0.255	0.125
x2	0.990	0.113	1.000	0.683	0.985	0.988	0.523	0.970	0.656	0.989
dx2	0.732	0.120	0.683	1.000	0.696	0.691	0.619	0.761	0.695	0.688
x3	0.989	0.139	0.985	0.696	1.000	0.996	0.534	0.968	0.662	0.996
x4	0.991	0.129	0.988	0.691	0.996	1.000	0.509	0.970	0.684	1.000
x5	0.589	0.165	0.523	0.619	0.534	0.509	1.000	0.659	0.198	0.517
x6	0.990	0.198	0.970	0.761	0.968	0.970	0.659	1.000	0.697	0.970
x7	0.690	0.255	0.656	0.695	0.662	0.684	0.198	0.697	1.000	0.672
trend	0.991	0.125	0.989	0.688	0.996	1.000	0.517	0.970	0.672	1.000

When the correlations in Table 1 are examined, it is seen that there are high correlations very close to the number 1 among some variables. This situation indicates the problem of ill-conditioning problem. Ill-conditioning is measured by "condition number (κ)". The condition number is calculated by the formula $\kappa = \sqrt{\lambda_{\max} / \lambda_{\min}}$ after calculating the eigenvalues (λ) of the correlation matrix. The condition number using the eigenvalues of the correlation matrix in Table 1 is calculated as κ = 2.11E + 10. This value being greater than 100 indicates that there is a high degree multicollinearity. In this case, as previously mentioned, the estimation of unstable parameters emerges when conventional estimation techniques are used. As a matter of fact, the estimations obtained by applying the least squares (OLS) method to model (2) are given in Table 2.

Table 2: Estimation of Least Squares Method of Model (2)

	Beta Cap	**Standard Error**
Constant	13879.6524	67982.8497
x1	-14.9574	56.9640
x2	114.7800	25.6161
dx2	0.9983	3.1527
x3	-8685.1145	32442.4317
x4	-0.0003	0.0016
x5	2430.7948	1217.5588
x6	224.2556	102.8813
x7	0.0010	0.0004
Trend	1451.3717	1438.8933
MSE	5677746582	

Looking at the OLS estimates in the Table 2, it is observed that some parameter estimates are negative. In the case of severe multicollinearity, as previously mentioned, if the classical estimation techniques are applied to the model, the estimations of the parameters obtained are unstable. In the case of instability, parameter estimates are obtained differently from their expected values, or even differently their sign [6]. The estimates of x_1, x_3 and x_4 parameters in Table 2 are negative sign while being expected to be positive, which indicates this. In our study, the generalized maximum entropy (GME) estimator, which has been widely used in recent years in the case of ill-conditionality, has been used in order to eliminate this problem and to obtain more stable predictions. [7-8].

The GME principle aims at selecting the distribution with GME in all probability distributions and having the data in the model.

Generalized Maximum Entropy (GME) Method

Model (2) can be written as a matrix form in model (3).

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{u} \tag{3}$$

In this model;

$\mathbf{y} : T \times 1$ dimensional dependent variable observations vector

$\mathbf{X} : T \times K$ dimensional explanatory variables matrix

$\boldsymbol{\beta} : K \times 1$ dimensional unknown parameters vector

$\mathbf{u} : T \times 1$ dimensional error vector.

Golan, Judge and Miller [7] re-parameterized unknown parameters and errors to predict with GME as model (4) using the parameters $\boldsymbol{\beta}$ and error variable and $\mathbf{u}$ in the regression model (3) and discrete random probability variables together with compact (tight) support where $\boldsymbol{\beta} = \mathbf{Zp}$ and $\mathbf{u} = \mathbf{Vw}$ [9].

$$\mathbf{y} = \mathbf{XZp} + \mathbf{Vw} \tag{4}$$

In this model;

$\mathbf{y} : T \times 1$ dimensional dependent variable observations vector

$\mathbf{X} : T \times K$ dimensional explanatory variables matrix

$\mathbf{Z} : K \times KM$ dimensional compact support matrix

$\mathbf{p} : KM \times 1$ dimensional weights (probabilities) vector,

$\mathbf{V} : T \times TJ$ dimensional support points matrix,

$\mathbf{w} : TJ \times 1$ dimensional unknown weights (probabilities) vector.

Together with the re-parameterized model (4), under the constraints (5) and (6), which define that the sum of probabilities used in the parameter and error variable to be equal to one;

$$(\mathbf{I}_K \otimes \mathbf{i}'_M)\mathbf{p} = \mathbf{i}_K \tag{5}$$

$$(\mathbf{I}_T \otimes \mathbf{i}'_J)\mathbf{w} = \mathbf{i}_T \tag{6}$$

The GME problem can be formulated with the objective function (7) as follows.

$$\max H(\mathbf{p}, \mathbf{w}) = -\sum_{k=1}^{K}\sum_{m=1}^{M} p_{km} \ln p_{km} - \sum_{t=1}^{T}\sum_{j=1}^{J} w_{tj} \ln w_{tj} \tag{7}$$

The Lagrange function is constructed with the equation (7) and the equations (4), (5) and (6) considered as objective function and constraints respectively and after the necessary condition are taken;

$$\Omega_k^p\left(\hat{\boldsymbol{\lambda}}\right) = \sum_{m=1}^{M} \exp\left(-\sum_{t=1}^{T} \hat{\lambda}_t z_{km} x_{tk}\right) \tag{8}$$

and

$$\Psi\left(\hat{\boldsymbol{\lambda}}\right) = \sum_{j=1}^{J} \exp\left(-\hat{\lambda}_t v_{tj}\right) \tag{9}$$

to be

$$\hat{p}_{km} = \frac{\exp\left(-\sum_{t=1}^{T} \hat{\lambda}_t z_{km} x_{tk}\right)}{\Omega_k^p\left(\hat{\boldsymbol{\lambda}}\right)} \tag{10}$$

and

$$\hat{w}_{tj} = \frac{\exp\left(-\hat{\lambda}_t v_{tj}\right)}{\Psi\left(\hat{\boldsymbol{\lambda}}\right)} \tag{11}$$

When the obtained predictors are substituted in place of;

$$\hat{\boldsymbol{\beta}} = \mathbf{Z}\hat{\mathbf{p}} \tag{12}$$

$$\hat{\mathbf{u}} = \mathbf{V}\hat{\mathbf{w}} \tag{13}$$

(12) and (13) GME estimators have been obtained [11]. The GME estimates of the model (2) obtained by the implementation of the GME estimation method are given in Table 3.

Table 3: Estimation of Generalized Maximum Entropy (GME) of Model (2)

	Beta Cap	**Standard Error**
Constant	-43823.8053	3037.9291
x1	2.0738	3.5003
x2	10.3415	2.0117
d1x2	0.6316	0.2014
x3	847.6471	2085.1192
x4	0.0013	0.0001
x5	952.6173	155.9091
x6	107.1426	12.8277
x7	0.0006	0.0005
Trend	1074.0463	64.4072
MSE	4307481167	

When looking at the Mean Squared Error (MSE) in the last lines of Table 2 and Table 3, the MSE of the GME estimator was significantly smaller than the MSE of the OLS estimator. This is evidence that the GME estimator is a more efficient predictor and the predicted parameter estimates are stable. In addition, when we look at the parameter estimates in Table 3, the positive value of all of the coefficients indicates that they are obtained with the appropriate signs.

1980- 2015 period, the average level of growth that occurred for Turkey, if assumed to be continued in 2016-2023 period, the necessary energy supply security value for this period will be was estimated in the following way.

Firstly, by using annually observations of all explanatory variables in model (2) for the period 1980-2015, trend equations were estimated by OLS and using these trend equations, annual forecast values of each variable for the period 2016 - 2023 were calculated. When these calculated values are substituted in the model (2) predicted by GME, the forecast annual values of Turkey's energy supply security for the period 2016-2023 have been obtained. These values are given in Table 4.

Table 4: Turkey's Annual Energy Supply Security Period Forecast for the period 2016-2023 (thousand tons of oil equivalents)

Year	GME
2016	125987.2377
2017	128777.1768
2018	131567.116
2019	134357.0551
2020	137146.9942
2021	139936.9333
2022	142726.8724
2023	145516.8115

Table 5: Annual data relating to the variables in the energy supply security model for the period 1980-2015

Year	y	x1	x2	x3	x4	x5	x6	x7
1980	31973.0	-0.80	75.031	0.500	43975921	2.95	25.0	8716224
1981	32049.0	4.40	72.000	0.500	44988356	2.97	27.0	8867277
1982	34388.0	3.40	82.053	0.500	46025357	2.60	29.2	9225708
1983	35697.0	4.80	89.159	0.500	47073422	2.37	31.6	9129921
1984	37425.0	6.80	96.053	0.500	48114105	2.23	35.1	9279806
1985	39399.0	4.30	113.106	0.540	49133883	2.14	32.7	9019885
1986	42472.0	6.90	128.849	0.540	50128489	1.61	34.2	9258818
1987	46883.0	10.00	133.433	0.540	51100878	1.64	38.0	9877526
1988	47910.0	2.10	121.334	0.540	52053704	1.59	39.4	10825931
1989	50705.0	0.30	148.208	0.540	52992429	1.70	40.6	9878976
1990	52987.0	9.30	151.712	0.576	53921699	1.89	44.6	9656948
1991	54278.0	0.90	156.199	0.580	54840531	1.81	46.0	9635871
1992	56684.0	6.00	163.944	0.586	55748875	1.75	48.3	9999139
1993	60265.0	8.00	167.976	0.594	56653729	1.68	51.2	10620083
1994	59127.0	-5.50	172.615	0.596	57564132	1.65	48.0	10379694
1995	63679.0	7.20	185.639	0.604	58486381	1.67	52.2	10775330
1996	69862.0	7.00	200.451	0.613	59423208	1.76	55.0	11225254
1997	73779.0	7.50	209.689	0.621	60372499	1.74	61.1	11227062
1998	74709.0	3.10	216.803	0.632	61329590	1.47	62.0	11478065
1999	74275.0	-3.39	217.731	0.641	62287326	1.60	59.8	10700158
2000	80500.0	6.64	231.294	0.653	63240121	2.02	63.2	10101207
2001	75402.0	-5.96	217.311	0.658	64191474	1.91	58.0	9376493
2002	78331.0	6.43	216.494	0.668	65143054	1.75	63.2	10041702
2003	83826.0	5.61	220.494	0.675	66085803	2.01	68.8	10020025
2004	87818.0	9.64	222.774	0.681	67007855	2.32	75.0	10782298
2005	91362.0	9.01	250.274	0.687	67903406	2.74	86.2	10129875
2006	99590.0	7.11	270.755	0.697	68763405	3.00	92.5	10358552

2007	107625.0	5.03	303.571	0.705	69597281	3.16	100.4	9603181
2008	106273.0	0.85	303.573	0.709	70440032	3.61	99.3	9311196
2009	106138.0	-4.70	299.653	0.715	71339185	2.58	88.9	9915388
2010	109266.0	8.49	292.436	0.737	72326914	3.02	100.0	11626044
2011	114480.2	11.11	319.060	0.750	73409455	3.75	109.6	11222426
2012	120984.0	4.79	315.225	0.754	74569867	3.80	112.4	12154682
2013	120290.0	8.49	304.555	0.759	75787333	3.62	116.2	13086960
2014	123937.0	5.17	316.965	0.764	77030628	3.40	120.3	12084639
2015	129267.5	6.06	343.000	0.767	78271472	2.45	123.8	15521354

Y: Energy Supply Security
X1: Real GDP growth rate
X2: CO_2 emissions due to energy
X3: Human Development Index
X4: Population
X5: Oil Price
X6: Industrial Production Index
X7: The amount of renewable energy

Conclusion

In our study, Turkey's average growth rate for the period 1980- 2015 was examined by establishing a regression model that determines the security of energy supply during the period 2016- 2023. Real GDP growth rate, CO_2 emissions caused by energy, human development index, population, oil price, industrial production index, and renewable energy amount and trend variables was used as determinants of the variable of supply security in the model

Turkey formally joined the Kyoto Protocol in 2009. The structural change variable was added to the model to determine whether there is a structural change in CO_2 for the period 2009-2015.In the stage of estimating the model, GME estimation method was used to overcome the problem of ill-condition due to the explanatory variables that are highly correlated with each other. It is concluded that this estimator, which is shown to have a lower mean squared error, is an efficient estimator. When we looking at the estimated values obtained with this estimator, it is seen that all predicted values are stable estimates with expected signs. Turkey's energy supply security forecasting estimated by this model were calculated and presented as table.

If Turkey's average growth level for the 1980- 2015 period will continue in the 2016-2023 period, the amount of energy supply security in 2016 will be 125987.2377 thousand tons of petroleum equivalent and in 2023 the energy supply security amount will be 145516.8115 thousand tons of petroleum equivalent.

Turkey's average growth rate that will guarantee the supply of energy, increasing supply from renewable energy sources will reduce both the amount of resources it consumes for oil imports and the reduction of CO_2 emissions, and will increase the quality of growth. However, the share of energy obtained from renewable energy sources in total supply is about 6.5 percent and this share will need to be increased.

References

[1]. Mehr M.N., Samavati F.F., Jeihoonian M., (2011). Annual energy demand estimation of Iran industrial sector by Fuzzy regression and ARIMA. Eighth International Conference on Fuzzy System and Knowledge Discovery, pp. 593-597.

[2]. Yılmaz, A., (2012). Factors Effect Sectoral Energy Consumption in Turkey and Alternative Energy Policies, AMÜ, SBE, IKT-DR-2012-0001, PhD Thesis.

[3]. Ghosh, S., (2002). Electricity consumption and economic growth in India, Energy Policy, Vol. 30. s.125-129.

[4]. Erdal, L., (2012). Renewable Energy Investments and Potential for Green Jobs in Turkey, Sosyalve Beşeri Bilimler Dergisi, 4, 1, 171-181.

[5]. Kıvılcım, İ., (2013). Avrupa Birliği'nin Yeterliliğive Türkiye'nin Konumu, 2020'ye Doğru Kyoto-Tipi İklim Değişikliği Müzakereleri, İktisadi Kalkınma Vakfı, 268.

[6]. Soofi, E. S., (1990). Effects of collinearity on information about regression coefficients. Journal of Econometrics, 43, 255- 274.

[7]. Golan, A., Judge, G., & Miller, D. (1996). Maximum entropy econometrics: robust estimation with limited data. John Wiley & Sons, New York, USA.
[8]. Shannon, C. E., (1948). A mathematical theory of communication. Bell System Technical Journal 27, 379-423.
[9]. Pukelsheim, F., (1994). The three sigma rule. The American Statistician, 48(2), 88-91.
[10]. Campbell, R. C., & Hill, C. R., (2006). Imposing parameter inequality restrictions using the principle of maximum entropy. Journal of Statistical Computation and Simulation, 76(11), 985-1000.
[11]. Fraser, I., (2000). An application of maximum entropy estimation: The demand for meat in the United Kingdom. Applied Economics 32, 45-59.