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Forecasting of Corn Oil Price in Turkey

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Abstract: Oil seeds and vegetal oils always have been one of important sector in Turkey. For Turkey, forecasting vegetal oil price is necessary and useful. Because, price forecast of vegetal oils can provide important signal to farmers, processors, wholesalers, consumers and policy markers. Vegetal oil and oil seeds production of Turkey can not meet the demand. To meet this deficit, various raw vegetal oil and oilseeds have been imported. Corn oil is second most vegetal oil in vegetal oil consume of Turkey. Moreover the important share belongs to corn oil in total vegetal oil supply and total raw vegetal oil import of Turkey. This paper provides a method to predict corn oil price base on ARIMA (Autoregressive Moving Average Processes) methodology. ARIMA models have been applied to forecast commodity price. These models are based on time series analysis and provide reliable and accurate forecasts. This approach is suitable for short term price forecasting, i.e. a weeks, a month, a quarter, a year. In this study monthly corn oil price are used from January 1994 to December 2005. Monthly corn oil price of 2006 -2007 year are forecasted.

Key words: ARİMA models, vegetal liquid oil, corn oil, price forecasting, time series analysis.

INTRODUCTION

In recent years, consumer preference retired liquid oil in Turkey. Because, It is emphasized that unsaturated fat is more utility for humans health and liquid oils contains unsaturated fat a lot. The annual vegetal oil consumption per capita is 17, 69 kilos in Turkey. 12,03 Kilos of this consumption (% 68,00) is liquid oil form[7]. In developed country, this consumption is 24 kilos[9]. About 24 kilos oil consumption in a year requires well nourishment.

Corn oil is the second most consumption vegetal oil in Turkey. Total liquid oil consumption of Turkey in 2004 was 733 000 tons. The most important share like % 77,35 (567 000 tons)in liquid oil consumption belongs to sunflower oil[2]. The preference for sunflower oil use is followed by corn oil and olive oil[7]. Corn oil consumption of Turkey in same season is % 9, 29. This rate fluctuates at the % 10-15 consumption level.

When we consider the level of vegetal oil production in Turkey we see that the vegetal oil production can not meet demand. The vegetal oil deficit is increasing every year. To meet this deficit, vegetal oil, various raw vegetal oil and oil seeds have been imported. Turkey is an important raw vegetal oil and oilseeds importer. In spite of, Its oilseed product potential, Turkey products only %35, 25 of vegetal oil requirement with domestic raw material[13]. The percentage of capacity use is below 50 % in vegetal oil industry in Turkey.

In this article we try to forecast for corn oil price, because this product very important for consumer, processor, farmers and government in Turkey. We forecast price with ARIMA models, we find that our prediction for price fit the actual data well. Then we forecasted corn oil price for 2006-2007 years.

MATERIAL AND METHODS

This paper proposes ARIMA (Autoregressive Moving Average Processes) approach a forecasting monthly corn oil price in Turkey. ARIMA models have been already applied to forecast commodity price[5,6]. Proposed method is better than the conventional approaches in price spikes and volatilities. ARIMA models may be called self determining since they are based upon current and past observations of the particular data series in question and no exogenous variables are included. Thus, causal structures implied by economic theory are not included in univariate ARIMA models. For this reason, the authors are not

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suggesting that ARIMA models should replace traditional econometric models; rather, they should be considered as a supplementary forecasting procedure[11].

Our corn oil price series is a series of consumer price with same time interval (monthly). So form of our series is an equi-interval stochastic time series. In this study, real price was used. Real price is important in analysis because nominal price changes can just be caused by inflation. We utilized consumer price index to deflate the nominal price with 1994 the base data. The real price is calculated bellow;

Real Price = Nominal Price/ Consumer Price Index (1994=100) *100

In this study we utilized monthly data from January 1994, to December 2005, because short time data (monthly, weekly, i.e.) needed for ARIMA models.

Time series approach is very suitable for describing this kind of stochastic process and also easy to establish the forecasting model to forecast to price. Stochastic time series can be divided into stationary stochastic process and non-stationary stochastic process. There are three linear models to describe, stationary stochastic process: AR (p) (Autoregressive), MA (q) (Moving Average), mixed model ARMA (p,q)(Autoregressive Moving Average Processes) and are model ARIMA (p, d, q) for describing non-stationary stochastic process[14].

The application of the ARIMA methodology for the study of time series analysis is due to Box and Jenkins[5]. If Box-Jenkins Method is used, time series must be stationary. Non-stationary time series is transformed stationary time series by logarithmic transform or taking differences.

Steps in Box- Jenkins Approach to Forecasting and Used Tools: The procedure for Box-Jenkins methods involve four general steps, namely; model identification, model estimation, diagnostic checking and use of the fitted model to forecast future values. The first three steps are repeated until an adequate and satisfactory model is formed.

Differences Operator for non-stationary time series: If a time series values y_1, y_2, y_3…..,y_n indicate that these value are non-stationary, we can transform the non-stationary series values by taking the first difference of the non-stationary time series values. That is;

The differences of time series values y_1, y_2, y_3….., y_n are

$z_t = y_t - y_{t-1}$ where t = 2, ….., n[4]

Although taking first differences sometimes will transform non-stationary time series value into stationary time series values, we sometimes need to use other forms of differencing to produce stationary time series values.

We can produce stationary time series value by taking the second differences (the first differences of the first differences) of the original time series values. Therefore

The second differences of the time series values y_1, y_2, y_3….., y_n are

$Z_t = (y_t-y_{t-1})-(y_{t-1}-y_{t-2}) = y_t-2_{y_{t-1}}+y_{t-2}$ for t = 3,4,….,.n[4].

Autocorrelation and Partial Autocorrelation Function: The identification of the model involves the comparison of sample autocorrelation (r_k) and partial autocorrelation (r_{kk}) functions derived from the stationary time series.

Box-Jenkins forecasting models are tentatively identified by examining the behaviour of the Sample Autocorrelation Function (SAC) and Sample Partial Autocorrelation Function (SPAC) for the values of a stationary time series z_b, z_{b+1},….,z_n.

For the working series z_b, z_{b+1},….,z_n:
The sample autocorrelation at lag k is

$$r_k = \frac{C_k}{C_0} = \frac{\sum_{t=1}^{n-k}(X_t - \bar{X})(X_{t+k} - \bar{X})}{\sum_{t=1}^{n}(X_t - \bar{X})^2}$$

Where

$$\bar{X} = \frac{\sum_{t=b}^{n} X_t}{n-b+1}$$

The sample autocorrelation function (SAC) is a listing, or graph, of the sample autocorrelations at lags k=1,2,…..

For the working series z_b, z_{b+1},….,z_n
The sample partial autocorrelation (SPAC) at lag k is

r_1 if k=1

$$r_{kk} = \frac{r_k - \sum_{j=1}^{k-1} r_{k-1,j} r_{k-j}}{1 - \sum_{j=1}^{k-1} r_{k-1,j} r_{k-j}} \quad \text{if } k=2,3,\ldots$$ [4,8]

ARIMA (p,d,q) Models is bellow ;

$z_t = \varphi_1 z_{t-1}+\varphi_2 z_{t-2}+...+\varphi_p z_{t-p}+\partial_t-\theta_1\ \partial_{t-1}-\theta_2\ \partial_{t-2}-...-\theta_q\ \partial_{t-q}$

This equation is obtained by ARMA (p,q). $\Delta^d x_t = z_t$ is substituted instead of x_t In ARMA (p,q) equation by difference.

Δ : differencing operator
d : differencing degree
z_t : differenced series.

If Time series is be stationary by taking the first differences (d=1), working of differencing operator is same as fallowing;

$$\Delta x_t = z_t = x_t - x_{t-1}$$

This showing can write same as fallowing by B operator,

$$\Delta x_t = z_t = x_t - x_{t-1} = (1 - B)x_t$$

If Time series is be stationary when Its is differenced d times, working of differencing operator (D) is same as follow;

$\Delta^d x_t = z_t = (1 - B)^d x_t$[10].

While Differencing degree d=1, namely original value of the series are stationary in such a case, ARIMA (p,d,q) Models are transformed in to AR, MA ve ARMA Models. Because of ARIMA (p,d,q) Model is a flexible model.

In ARIMA (p,d,q) model p or q may be zero. In such a case, Model demotes AR(d,q) or MA(d,q) models.

RESULT AND DISCUSSION

Identification of stationary in Corn Oil Price Series: The period investigated in the study covers the years between 1994 and 2005 in Turkey. The data used in this study obtained from Republic Of Turkey, Prime Ministry Turkish Statistical Institute. Because of obtain Box and Jenkins Model best fit corn oil price series, we are analyzed corn oil price series whether or not stationary, previously. Stationary of series can apprehend with the assistance of figure or "Rule of Thumb Test".

Hypothesis is as following;

H_o: $\rho_k = 0$ H_1: $\rho_k \neq 0$

Here, ρ_k is autocorrelation coefficient of time series in lag of k however; r_k is autocorrelation coefficient of sample in same lag.

If is a = 0,05 $|r_k| > \frac{2}{\sqrt{n}}$, H_0 is rejected, otherwise,

H_0 is accepted[12].

In such a case, Boundary value used to test autocorrelation coefficient is in the following,

$$\frac{\pm 2}{\sqrt{n}} = \frac{\pm 2}{\sqrt{144}} = \pm 0.14$$

If the autocorrelations are within these bounds, they are not significantly different from zero at 5% significance level.

Box-Jenkins approach, cannot be directly applied if the series is not stationary. It is important to know whether the data contain any trend and seasonal components. We analyzed whether there is an upward or downward trend in price movement and we also check for seasonality. Our price series is on monthly base. Price series contains trend and doesn't have any seasonality. Beside, so as to investigate of stationary, time series figure belong to corn oil price has been draw.

In Box-Jenkins methodology of ARIMA modeling, it must be first established that a given time series is stationary before trying to identify the orders of AR

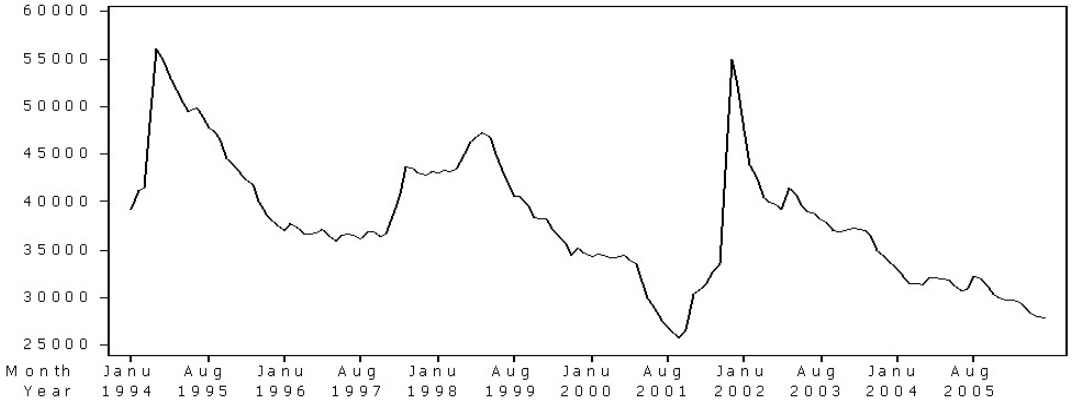
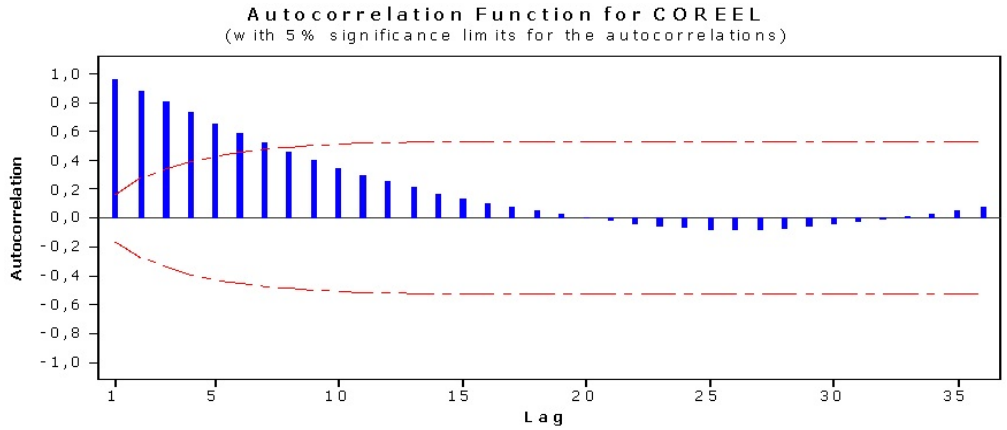
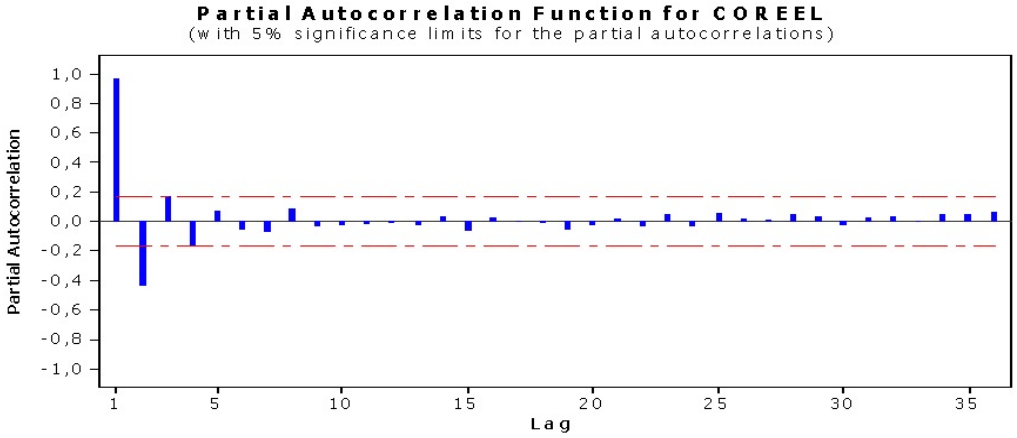


Fig. 1: Corn Oil Price in Turkey (monthly) (January1994-December2005).



Lag	ACF1	TSTA1	LBQ1	Lag	ACF1	TSTA1	LBQ1	Lag	ACF1	TSTA1	LBQ1
1	0,957072	114,849	134,669	13	0,207452	0,7849	687,938	25	-0,079900	-0,2987	701,770
2	0,879766	62,734	249,263	14	0,169374	0,6381	692,577	26	-0,082813	-0,3094	702,992
3	0,803938	46,097	345,633	15	0,134876	0,5067	695,542	27	-0,080363	-0,3001	704,152
4	0,727529	36,656	425,119	16	0,102736	0,3853	697,275	28	-0,072693	-0,2713	705,110
5	0,653498	30,226	489,712	17	0,075388	0,2824	698,216	29	-0,058708	-0,2190	705,740
6	0,584094	25,449	541,688	18	0,052368	0,1961	698,674	30	-0,043156	-0,1609	706,084
7	0,514310	21,464	582,280	19	0,028430	0,1064	698,810	31	-0,028106	-0,1048	706,231
8	0,451244	18,257	613,758	20	0,003012	0,0113	698,811	32	-0,010613	-0,0396	706,252
9	0,397187	15,710	638,326	21	-0,020051	-0,0750	698,880	33	0,008028	0,0299	706,264
10	0,345949	13,455	657,103	22	-0,041195	-0,1542	699,173	34	0,026867	0,1001	706,402
11	0,296541	11,391	671,004	23	-0,058064	-0,2173	699,758	35	0,049067	0,1829	706,866
12	0,250905	0,9552	681,031	24	-0,071023	-0,2657	700,642	36	0,075390	0,2809	707,973

Fig. 2: Autocorrelation Function Graph of Corn Oil Price.



Lag	PACF1	TSTA1	Lag	PACF1	TSTA1	Lag	PACF1	TSTA1
1	0,957072	114,849	13	-0,024516	-0,2942	25	0,048328	0,5799
2	-0,431122	-51,735	14	0,032166	0,3860	26	0,016121	0,1934
3	0,168855	20,263	15	-0,055150	-0,6618	27	0,010648	0,1278
4	-0,165357	-19,843	16	0,022997	0,2760	28	0,044769	0,5372
5	0,064712	0,7765	17	0,002705	0,0325	29	0,036310	0,4357
6	-0,053397	-0,6408	18	-0,011963	-0,1436	30	-0,021749	-0,2610
7	-0,065898	-0,7908	19	-0,054295	-0,6515	31	0,021422	0,2571
8	0,085689	10,283	20	-0,026648	-0,3198	32	0,031531	0,3784
9	-0,034790	-0,4175	21	0,018475	0,2217	33	-0,001379	-0,0165
10	-0,028138	-0,3377	22	-0,031914	-0,3830	34	0,038330	0,4600
11	-0,018282	-0,2194	23	0,040512	0,4861	35	0,038175	0,4581
12	-0,010485	-0,1258	24	-0,030534	-0,3664	36	0,058964	0,7076

Fig. 3: Partial Autocorrelation Function Graph of Corn Oil Price.

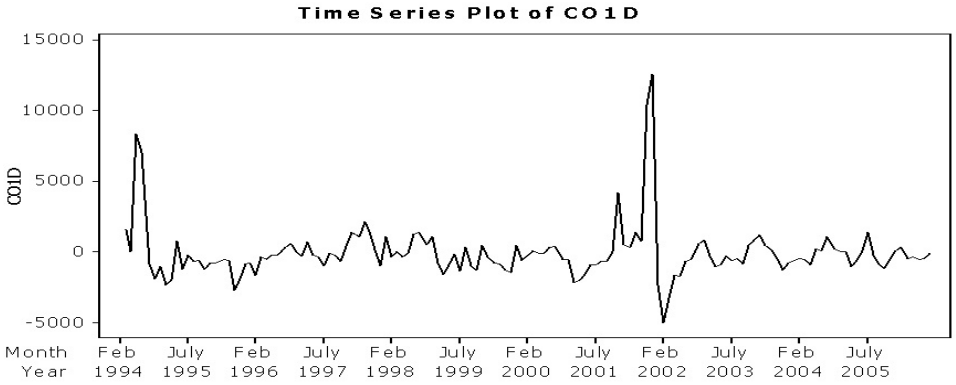
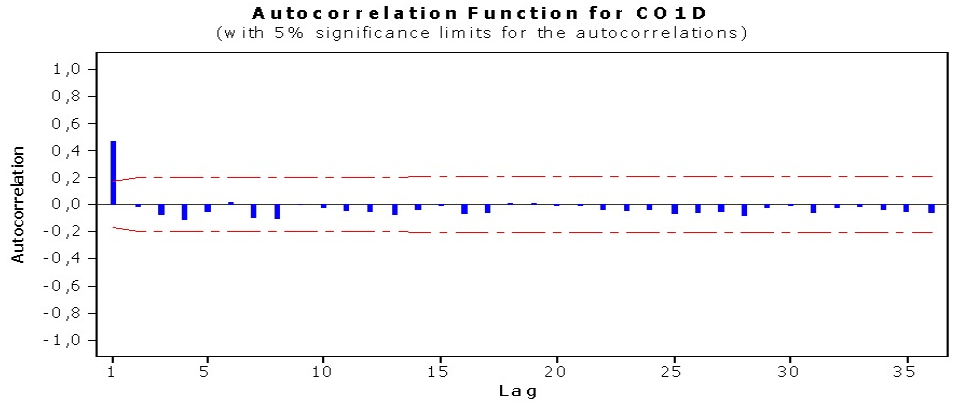


Fig. 4: Corn Oil time Series Value Taken First Difference.



Lag	ACF1	TSTA1	LBQ1	Lag	ACF1	TSTA1	LBQ1	Lag	ACF1	TSTA1	LBQ1
1	0,469628	5,61593	32,2050	13	-0,073717	-0,71340	39,5769	25	-0,070466	-0,67384	42,6164
2	-0,015571	-0,15511	32,2407	14	-0,037304	-0,35973	39,8006	26	-0,058267	-0,55543	43,2181
3	-0,074103	-0,73804	33,0540	15	-0,006109	-0,05886	39,8066	27	-0,050448	-0,47986	43,6730
4	-0,106656	-1,05825	34,7509	16	-0,063100	-0,60793	40,4567	28	-0,080275	-0,76235	44,8349
5	-0,053718	-0,52886	35,1845	17	-0,055960	-0,53775	40,9720	29	-0,028189	-0,26662	44,9794
6	0,015997	0,15719	35,2232	18	0,012347	0,11841	40,9973	30	-0,007602	-0,07187	44,9900
7	-0,089493	-0,87921	36,4443	19	0,007459	0,07153	41,0066	31	-0,055075	-0,52064	45,5516
8	-0,097901	-0,95665	37,9164	20	-0,007701	-0,07385	41,0166	32	-0,027920	-0,26344	45,6972
9	-0,003466	-0,03366	37,9182	21	-0,011629	-0,11150	41,0396	33	-0,018178	-0,17144	45,7595
10	-0,023548	-0,22864	38,0047	22	-0,037481	-0,35936	41,2803	34	-0,031312	-0,29524	45,9460
11	-0,039872	-0,38700	38,2544	23	-0,039963	-0,38281	41,5563	35	-0,047064	-0,44349	46,3712
12	-0,053659	-0,52028	38,7102	24	-0,032808	-0,31395	41,7439	36	-0,060530	-0,56960	47,0812

Fig. 5: Autocorrelation and Paterial Autocorrelation Figures.

and MA processes. In Box-Jenkins approach, this is done by visual analysis of the sample's autocorrelations (AC) and partial autocorrelations (PAC). Figure 2 shows the AC and PAC of the corn oil price. The sample autocorrelations of the undifferenced series exhibit smooth patterns at high lags, so it is likely that the price series is not stationary. Hence, differencing may be necessary.

Autocorrelation and partial autocorrelation functions are computed for price series of corn oil with 36 lag and given in figure 2 and Figure 3. When, this figures have been analyzed, it can be seem that a lot of auto correlation and partial auto correlation coefficients are out of confidence interval. This figures show that corn oil price series isn't stationary.

We tested various transforms with the assistance Minitab statistic program. Corn oil price series was be stationary by taking the first differences and figure of series has been given above.

Autocorrelation and partial autocorrelation figures of same series were given Figure 5. As shown in Figure 5, Most of autocorrelation coefficients are within confidence interval. Only several values are out of confidence interval.Figure.5. Autocorrelation and Partial Autocorrelation Figures.

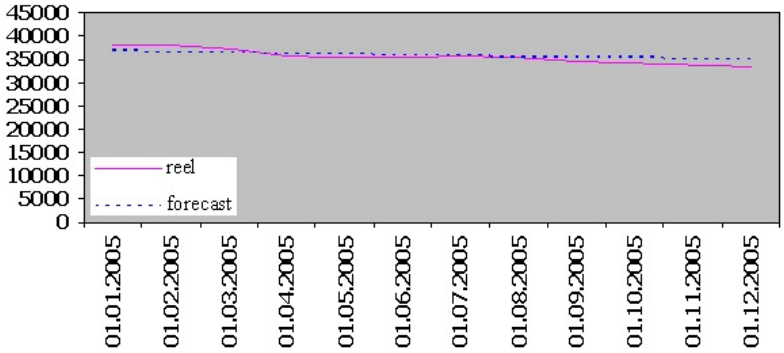


Fig. 6: Actual Corn Oil Price and Forecasts.

Table 1: Final Estimates of Parameters

Type	Coefficient	SE Coeefficient	T	P
AR 2	-0,5203	0,0726	-7,17	0,000
MA 1	0,9901	0,0052	188,84	0,000
Constant	-11,039	0,342	-3,59	0,000

Differencing	: 1 regular difference
Number of Observations	: Original Series 144, after differencing 143
Residuals	
Sum of Squares	: 402117782
Mean Squares	: 2892934
Degrees of Freedom	: 139

Table 2: Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	18,2	22,0	28,2	31,9
DF	8	20	32	44
P-Value	0,020	0,342	0,659	0,913

Table 3: Corn Oil Prices (Reel and Forecast) and Lower and Upper Limits (2005)

Month-Year	Reel	Forecast	Lower Limits	Upper Limits
Jan.05	38244,6	36856,4	33522,0	40190,7
Feb.05	37969,7	36691,6	30862,9	42520,3
Mar.05	37135,7	36489,3	28741,0	44237,6
Apr.05	35955,5	36275,9	27153,6	45398,2
May.05	35410,1	36066,4	26010,3	46122,4
June.05	35463,0	35867,9	25202,5	46533,4
July.05	35733,2	35683,4	24633,2	46733,6
Agu.05	35228,3	35512,9	24225,9	46800,0
Sep.05	34784,2	35355,1	23924,8	46785,4
Oct.05	34201,8	35208,1	23691,8	46724,4
Nov.05	33711,9	35069,9	23501,7	46638,0
Dec.05	33613,0	34938,5	23338,3	46538,6

Table 4: Corn Oil Prices Predict: From 2006 January to 2007December in Turkey

Month -Year	Reel	Lower Limits	Upper Limits	Month -Year	Reel	Lower Limits	Upper Limits
Jan.06	33624,2	30289,8	36958,6	Jan.07	33329,3	21708,7	44949,9
Feb.06	33680,6	27852,0	39509,3	Feb.07	33222,6	21588,2	44857,0
Mar.06	33744,1	25995,8	41492,4	Mar.07	33112,9	21468,6	44757,3
Apr.06	33794,1	24671,8	42916,4	Apr.07	33001,2	21349,2	44653,3
May.06	33821,2	23765,1	43877,2	May.07	32888,2	21229,8	44546,7
June.06	33822,7	23157,2	44488,1	June.07	32774,4	21110,4	44438,5
July.06	33799,7	22749,5	44849,9	July.07	32660,1	20990,9	44329,3
Agu.06	33755,2	22468,1	45042,2	Agu.07	32545,6	20871,4	44219,7
Sep.06	33692,7	22262,4	45123	Sep.07	32430,9	20751,9	44109,9
Oct.06	33615,8	22099,6	45132,1	Oct.07	32316,2	20632,3	44000,0
Nov.06	33527,9	21959,7	45096,1	Nov.07	32201,5	20512,8	43890,1
Dec.06	33431,6	21831,5	45031,8	Dec.07	32086,8	20393,3	43780,2

1.2. Identification of Appropriate Model for Corn Oil Price Series and Forecasting of Future Time Series Value: In process of choosing the best model, we wrote automatic ARIMA modeling of a non-seasonal time series. Non-seasonal Box-Jenkins Models, using the SAC and SPAC to tentatively identify an appropriate model and forecasting future time series values by using estimated model[4]. Historical data are used to tentatively identify an appropriate Box–Jenkins model. AR (2) and MA (1) namely ARIMA (2,1,1) are appropriate model for corn oil price series in Turkey. Results of model go as follows.

Table 3 shows reel prices and predicted price belongs to 2005 year. In addition, lower limits and upper limits of values are take place in table 3.

We produce corn oil price for 2006 and 2007. These prices was predicted by our price forecasting model ARIMA (2,1,1), taking the historical price of Turkish Markets. Table 4 shows the price from January 2006 to December 2007 in Turkish Market.

In Figure 6, the actual price and forecasts are represented. We can see in the graphs, in general the forecast performance Figure 6: Actual Corn Oil Price and Forecasts.

Conclusion: In this study, ARIMA methodology is applied to corn oil price forecasting.

ARIMA techniques have been used for commodity price forecasting, with good results. Turkey hasn't got a stable policy and planning about production of fatty plants and oil seeds. Turkey is an important vegetal oil importer. Second important share belongs to corn oil in total vegetal oil demand and supply. Therefore we analyzed movement of corn oil price and predicted 2006-2007 monthly corn oil prices in Turkey. We intended to stand Turkey vegetal oil sector in good stead. Our result showed that corn oil price will fluctuate very lightly but will not exhibit to important change in 2006-2007 years in Turkey. This result can be signal that import of corn oil seed and raw oil will go ahead in Turkey. Because, In the near future, it is

not seemed impossible increase of production of oilseeds in Turkey, If It isn't doing require arrangement deal with oil seeds.

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