A Partial Equilibrium Analysis of Sunflower Market in Turkey

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Sunflower oil is the most preferred vegetable oil in Turkey. 35% of total consumption of vegetable oil is sunflower oil. Sunflower seed import is approximately 500-650 thousand tons while sunflower seed production is 800-850 thousand tons in the last years. The main objective of this study is to determine the reasons of deficiency of vegetable oil in Turkey and to suggest some solutions. For this objective, the prospective situation and the market structure of sunflower seed in Turkey has estimated. “One product partial equilibrium analysis” has been used to estimate the future market structure of sunflower seed. A simulation model from 2003 to 2015 has been created with partial equilibrium analysis. Turkey is a net importer of vegetable oils. Sunflower seed import is approximately 300 thousand tons while crude oil import is approximately 180 thousand tons in 2002. According to the results of simulation model, Turkey will continue to be a net importer for sunflower and other oil seeds. It has been estimated that the sunflower seed import will be approximately 1 million tons and crude oil import will be approximately 400 thousand tons at end of the simulation period (2003-2015).

Key words: partial equilibrium analysis; sunflower; econometric analysis; Turkey.

Türkiye’de Ayçiçeği Pazarının Kısımı Denge Analizi


Anahtar Sözcükler: kısmi denge analizi; ayçiçeği; ekonometrik analiz; Türkiye

Introduction

Vegetable oil seeds production can not supply the need of increasing population in Turkey. Therefore, vegetable oil sector depends on imported seeds and crude oils. Vegetable oil production is approximately 1 million tons in Turkey. 40% of this total production comes from domestic production while 60% is imported from international markets as in the form of seed or crude oil.

Turkey is a net importer of crude oil today while it was a net exporter in the 70s. Major reasons of this situation are short-term and inconsistent agricultural policies and insufficient macro production planning. Seed process capacity is approximately 6 million
tons in Turkey. Due to the insufficient domestic production and high import customs, firms have been crushed approximately 3 million tons oil seeds in order to produce to vegetable oil (Inan et al., 2002).

Main objective of this paper reveals the variation of sunflower market in the future. Estimated values and data are the most important sources for agricultural planners and policy implementers. By using this model, harvested area, production and foreign trade of sunflower has been estimated. A simulation model has been created for trend of the sunflower market between 2003-2015, which includes crude sunflower oil and meals. A one-product partial equilibrium model has been developed for analysis of sunflower market in Turkey.

Koc et al. (1999) examined the subsidies policy and custom taxes applied for sunflower, soybean and cotton. A model containing industry demand, import demand, supply, consumption and stock models is developed. Koc et al. (2001), used a simulation model called Turkey Agricultural Policy Simulation Model which was developed by AERI. They calculated the supply, demand and price of various agricultural products. Sengul et al. (2001), determined structural and political analysis of cotton using a partial equilibrium model. Lordkipanidze et al. (1996), analyzed to factors affecting canola import in US. Eenoo et al. (2000), used a partial equilibrium model for red meat trade in the World. This model contains US, Japan, Mexico, South Korea, Canada, Australia, New Zealand and the others as 8 regions. Conforti (2001), examined seven different simulation models. These are European Simulation Model (ESIM), FAO World Food Model (FAO WFM), Food and Agricultural Policy Research Institute–Center for Agricultural and Rural, Development (FAPRI-CARD), Modèle International Simplifié de Simulation (MISS), Sektorales Produktions und Einkommensmodell der Landwirtschaft der Europäischen Union (SPLE/EU), Static World Policy Simulation Model (SWOPSIM), World Agricultural Trade Simulation Model (WATSIM). Skokai (2001) examined the agricultural policy with an econometric model in last ten years. Moro et al. (2002) examined meat and milk market in Italy with partial equilibrium model.

Materials and Methods

Time series data has been used in this study, which was collected from TURKSTAT (Republic of Turkey, Prime Ministry Turkish Statistical Institute), SPO (State Planning Organization), FAO (Food and Agricultural Organization), Oil World Annual and Trakya Birlik for partial equilibrium analysis for the period of 22 years from 1980 to 2002.

Macro variables such as Whole Sale Price Index, GNP, GNP deflator, population, US dollar exchange rate were taken from different publications and web sites of TURKSTAT and SPO.

Data of sunflower seed, crude oil and meal were taken from World Oil Annual that published by ISTA Meilke GmbH. However, other data downloaded from FAO website.

Partial equilibrium model of sunflower contains three main products such as sunflower seed, crude oil and meal. The behavioural equations of partial equilibrium model are harvested area of sunflower, yield, sunflower seed, crude oil and meal supply, crushing demand of sunflower seed, sunflower oil export, demand of crude oil consumption, demand of sunflower meal consumption and crude oil stock. In addition, stock demand of sunflower seed equation should be estimate, but there was not accurate data of sunflower seed stock. Consequently, stock of sunflower seed has been accepted as a fixed amount that is the average of last five years. Providing condition of market equilibrium, the import demand of sunflower seed, crude oil and meal has been calculated as residual equations. Behavioural and residual equations of partial equilibrium model of sunflower market have been given below.\(^1\)

\(^1\)Explanation of Coefficients

- \(Q^\text{supply}\): sunflower production
- \(A^*\): harvested area
- \(V\): sunflower seed yield
- \(Q^\text{crude}\): crude oil production
- \(\phi\): meal ratio in sunflower seed
- \(\rho\): meal ratio in sunflower oil
- \(Q^\text{miss}\): seed missed
- \(Q^\text{demand}\): total demand for seed
- \(Q^\text{seed}\): demand for seed
- \(T\): trend (1,2,3...)
- \(D_1, D_2\): dummy variables
- \(Q^\text{other}\): other usage of sunflower seed
- \(\text{Tefe}\): whole sale price index (1968=100)
- \(Q^\text{crushing}\): crushing quantity of seed
- \(Q^\text{pressing}\): pressing marj
- \(Q^\text{can}\): crude oil consumption
- \(\text{GNP per capita}\): gnp for per capita
- \(Q^\text{meal}\): meal consumption
- \(Q^\text{import}\): import demand
- \(Q^\text{export}\): export of sunflower seed
- \(Q^\text{import}\): import demand

\[ Q^\text{supply} = A^* \times V \]
\[ Q^\text{crude} = \phi \times Q^\text{seed} \]
\[ Q^\text{demand} = \rho \times Q^\text{crude} \]
\[ Q^\text{seed} = Q^\text{demand} - Q^\text{miss} \]
\[ Q^\text{crushing} = T \times Q^\text{seed} \]
\[ Q^\text{meal} = T \times Q^\text{crude} \]
\[ Q^\text{import} = T \times Q^\text{meal} \]
\[ Q^\text{export} = (1 - T) \times Q^\text{meal} \]

\[ Q^\text{pressing} = T \times (Q^\text{crude} - Q^\text{meal}) \]
\[ Q^\text{can} = T \times (Q^\text{crude} - Q^\text{meal}) \]
\[ Q^\text{import} = T \times (Q^\text{meal} - Q^\text{crude}) \]
price transfer equality
\[ P_{\text{domestic}} = (P_{\text{World}} \cdot \text{exr}.(1 + \text{tariff}) + C) \]

harvested area
\[ A = f(A_{t-1}, P_{\text{domestic}}, \cdot T) \]

sunflower seed yield
\[ V_s = f(AR(3), MA(3)) \]

import demand for seed
\[ Q^{\text{import}} = (Q_{\text{demand}} - Q_{\text{supply}}) \]

crushing demand for sunflower seed
\[ Q^{\text{Pr}} = f(Q_{t-1}^{\text{Pr}}, M) \]

meal supply
\[ Q^{\text{m sup ply}} = (Q^{\text{Pr}} \cdot \phi) \]

import demand for meal
\[ Q^{\text{import}} = (Q^{\text{demand}} - Q^{\text{supply}}) \]

import demand for oil
\[ Q^{\text{import}} = (Q^{\text{demand}} + Q^{\text{exp ort}} + Q^{\text{stock}}) - (Q^{\text{supply}} + Q^{\text{stock}}(t-1)) \]

Crushing demand of sunflower seed was determined as a function of own lagged value and crushing margin of sunflower seed. Crushing margin has calculated as;
\[ M^s = \left[ \frac{P^m \cdot \gamma^m + P^o \cdot \gamma^o}{P^s} \right] \] (I)

where \( P^m \) is meal price, \( P^o \) is crude oil price, \( P^s \) is sunflower seed price, \( \gamma^m \) is extraction ratio of meal and \( \gamma^o \) is extraction ratio of crude oil from sunflower seed at formula I. Extraction coefficient using for crushing margin calculation is 0.54 for meal and 0.42 for crude oil. These coefficients are accepted by FAPRI (U.S. Food and Agricultural Policy Research Institute). Crushing margin has reflected income ratio of extraction activity. This ratio must be higher than one for sustainable of extraction activity. Because of the insufficient and reliable price data of seed, crude oil and meal in domestic source, World market prices are transformed to domestic prices with given formula II.
\[ P_{\text{domestic}} = (P_{\text{world}} \cdot \text{exr}.(1 + \text{tariff}) + C) \] (II)

where \( P_{\text{domestic}} \) is domestic price of related product, \( P_{\text{world}} \) is Rotterdam price, exr is exchange rate of US dollar, tariff is custom tax of imported products and C is insurance cost and other costs from Rotterdam harbour to Turkish harbour.

Results

In this study, a simulation model has been developed for estimating trend of sunflower market between 2003-2015 in Turkey. Seven equations have been estimated for simulation
model. Table 1 shows harvested area model. Independent variables are lagged value of harvested area, lagged value of seed price and trend while dependent variable was sunflower harvested area.

Yield of sunflower seed has been explained by ARMA process. Table 2 shows coefficients of this model. Crushing demand has explained by own lagged value and crushing margin variables. Table 3 shows coefficients and critical values of this model.

Table 1. Sunflower Harvested Area Model Results

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>coefficient</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Sunflower Harvested Area)</td>
<td>2.1278</td>
<td>2.2711</td>
</tr>
<tr>
<td>Ln(Sunflower Harvested Area) (t-1)</td>
<td>0.6183</td>
<td>4.6824</td>
</tr>
<tr>
<td>Ln(Sunflower Price) (t-1)</td>
<td>0.2009</td>
<td>2.3358</td>
</tr>
<tr>
<td>Trend</td>
<td>-0.0063</td>
<td>-1.9344</td>
</tr>
<tr>
<td>R²</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>20.92</td>
<td></td>
</tr>
<tr>
<td>Breusch-Godfrey Autocorrelation LM Test</td>
<td>0.27</td>
<td></td>
</tr>
</tbody>
</table>

All coefficients are significant at 0.10

Table 2. Sunflower Seed Yield Model Results

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>coefficient</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Sunflower Seed Yield)</td>
<td>5.2617</td>
<td>23.8738</td>
</tr>
<tr>
<td>AR(3)</td>
<td>0.8887</td>
<td>17.0011</td>
</tr>
<tr>
<td>MA(3)</td>
<td>-0.9447</td>
<td>-44.9950</td>
</tr>
<tr>
<td>R²</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.69</td>
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</tr>
<tr>
<td>F</td>
<td>42.05</td>
<td></td>
</tr>
</tbody>
</table>

All coefficients are significant at 0.10

Table 3. Demand of Sunflower Seed Crushing Model Results

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>coefficient</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Crushing Amount of Sunflower Seed)</td>
<td>0.8370</td>
<td>1.88</td>
</tr>
<tr>
<td>Ln(Crushing Amount of Sunflower Seed (t-1))</td>
<td>0.8771</td>
<td>13.28</td>
</tr>
<tr>
<td>Ln(Crushing Margin)</td>
<td>0.7681</td>
<td>1.82</td>
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<tr>
<td>R²</td>
<td>0.92</td>
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<tr>
<td>Adjusted R²</td>
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<tr>
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<td>90.61</td>
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<tr>
<td>Breusch-Godfrey Autocorrelation LM Test</td>
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</table>

All coefficients are significant at 0.10

Per capita oil consumption model has been determined by own lagged value and lagged value of Gross National Product (per capita) variables. The coefficients and critical values of equations have been given in Table 4.
Table 4. Consumption of Sunflower Oil (per capita) Model Results

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>coefficient</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Consumption of Sunflower Oil (per capita))</td>
<td>-8.2479</td>
<td>-1.6483</td>
</tr>
<tr>
<td>Ln(GNP per capita(t-1))</td>
<td>0.3842</td>
<td>1.7199</td>
</tr>
<tr>
<td>Ln(Consumption of Sunflower Oil (per capita)(t-1))</td>
<td>0.2453</td>
<td>1.8932</td>
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<tr>
<td>$R^2$</td>
<td>0.76</td>
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<tr>
<td>Adjusted $R^2$</td>
<td>0.74</td>
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<td>F</td>
<td>28.06</td>
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<tr>
<td>Breusch-Godfrey Autocorrelation LM Test</td>
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</table>

All coefficients are significant at 0.10

Export model has been explained by oil price, oil production and lagged value of oil stocks variables. Table 5 shows the coefficients and critical values of the model.

Table 5. Export of Sunflower Oil Model Results

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>coefficient</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Export of Sunflower Oil)</td>
<td>1.0325</td>
<td>0.13</td>
</tr>
<tr>
<td>Ln(Price of Sunflower Oil)</td>
<td>-1.9251</td>
<td>-2.72</td>
</tr>
<tr>
<td>Ln(Sunflower Oil Production)</td>
<td>2.7335</td>
<td>3.07</td>
</tr>
<tr>
<td>Ln(Ending Stock of Sunflower Oil(t-1))</td>
<td>0.6964</td>
<td>2.05</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>17.00</td>
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</tr>
<tr>
<td>Breusch-Godfrey Autocorrelation LM Test</td>
<td>0.51</td>
<td></td>
</tr>
</tbody>
</table>

All coefficients are significant at 0.10

Table 6. Consumption of Sunflower Meal Model Results

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>coefficient</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Consumption of Sunflower Meal)</td>
<td>-7.4299</td>
<td>-2.2638</td>
</tr>
<tr>
<td>Ln(GNP (t-1))</td>
<td>0.5761</td>
<td>2.0161</td>
</tr>
<tr>
<td>Ln(Sunflower Meal Production)</td>
<td>0.5549</td>
<td>5.7187</td>
</tr>
<tr>
<td>Ln(Consumption of Sunflower Meal (t-1))</td>
<td>0.3327</td>
<td>3.2528</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.98</td>
<td></td>
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<tr>
<td>Adjusted $R^2$</td>
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<tr>
<td>F</td>
<td>309.27</td>
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<tr>
<td>Breusch-Godfrey Autocorrelation LM Test</td>
<td>0.15</td>
<td></td>
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</tbody>
</table>

All coefficients are significant at 0.10

Stock model of sunflower oil shows in Table 7. Stock variable has been explained by own lagged value.

Custom taxes ratio used for projection model has been valid in 25.06.2002 and these ratios still in force. These ratios are 12, 30 and 2 for import of sunflower seed, crude oil and meal respectively.

According to research of SIS Census at year 2000, it is accepted that population increase rates are 1.4% for 2000-2005 and 1.3% for after 2005. Wholesale price index, GNP and exchange rate of U.S. dollar were taken from 8th Development Planning published by SPO. Rotterdam prices of sunflower market were taken from World Agricultural Outlook 2003 published by FAPRI (Table 8).
According to simulation results, estimated sunflower sowing area will decrease from 550 thousands ha. to 529 thousands ha, although seed production is estimated to increase (Table 9). This increase has occurred because of an increase in average sunflower yield. It has been expected that, production of sunflower seed will increase to 912 thousand tons at the end of the simulation period.

It has been estimated that at the end of the simulation period, industry demand of sunflower seed will increase over 1.8 million tons. Seed process capacity will be approximately 6 million tons in Turkey. Due to the increase in crushing demand, raw material demand will increase. Sunflower seed import will increase approximately to 1 million tons at the end of the simulation period because of the insufficient domestic production of sunflower seed.

It has been estimated that, with the effects of the increasing crushing demand, crude oil production will increase. Production of crude oil was about 500 thousand tons in 2000, while the estimated amount at the end of the simulation period is 781 thousand tons. However, this production is inadequate for requirement of the rapid growth population. The estimation of sunflower oil consumption per capita will increase over 13 kg/year at the end of the simulation period. In addition, according to the SIS, in 2015 population is estimated as 81 million in Turkey. These estimation results point out that crude oil demand will increase 1.1 million tons. Turkey will continue to import crude oil for balancing the production deficit. Crude oil import amount has been estimated 393 thousand tons in 2015 while it was 184 thousand tons in 2001. Crude oil import demand has been calculated regarding crude oil export and stock. It has been estimated that, the amount of crude oil stock will not change. On the other hand, crude oil export will fluctuate around the 85 thousand tons.

Increasing crushing demand will also increase meal production as crude oil production. Meal production will reach to 1 million tons in 2015. In addition, meal demands will increase from 700 thousand tons to 969 thousand tons. Meal import demand calculated as negative for after the 2010. Meal production will be supplied by domestic production at end of the simulation period.

Discussion

In this study, econometric models have analyzed sunflower market and results reveal trend of this market in Turkey. According to econometric analysis, it seems that, Turkey will continue to be a net importer of sunflower seed and crude oil.

Due to the increasing sunflower seed yield, sunflower production will increase. On the other hand, increase in sunflower production could not supply vegetable oil demand. Although sunflower production will reach to 900 thousand tons, crushing demand will reach to 1.8 million tons. It has been estimated that, crude oil consumption will be approximately 1 million tons, total vegetable oil consumption will be 2.5 million tons and crude oil import will be approximately 400 thousand tons at end of the simulation period.

One of the reasons of the vegetable oil deficit is low producer prices. Sunflower seed prices do not encourage production. Prices have been determined under the inflation rate in certain years. Especially, prices were under the
production cost, which has been affected economic crisis at 1994 in Turkey. To eliminate this problem, production costs should be calculated annually and product prices should be determined as provided adequate income to producers.

Other problems of the sunflower seed production are structural. These problems are very serious not for only oil seed production but also other agricultural productions. Major problem is fragmented lands and small size of areas per farm. Small production area has increased production costs, which it is divided by heritage rules. Irrigation and land reformation are other serious problems. Development of irrigation would affect the yields positively.

Low price parity between oil seeds and the other agricultural products and price fluctuation have negative effects to oil seeds production.

Increasing of oil seed production will eliminate the vegetable oil deficit of Turkey. Increasing of production is depending on solving the structural problems and increasing of sown areas.

References

Oil World Annual. 2002. ISTA Mielke GmbH.
Table 8. Projection of World Prices and Macro Variables of Turkish Economy

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Whole Sale Price Index</th>
<th>GNP (per capita)</th>
<th>Exchange rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>1.4</td>
<td>5.0</td>
<td>-4.5</td>
<td>16.6</td>
</tr>
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<td>2002</td>
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<td>5.0</td>
<td>6.5</td>
<td>16.6</td>
</tr>
<tr>
<td>2003</td>
<td>1.4</td>
<td>5.0</td>
<td>6.5</td>
<td>5.0</td>
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<td>2004</td>
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<td>6.5</td>
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<td>2006</td>
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<td>5.0</td>
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<td>2014</td>
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<td>5.0</td>
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<tr>
<td>2015</td>
<td>1.3</td>
<td>5.0</td>
<td>6.5</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Note: Increasing rates of wholesale price index, GNP and U.S. dollar exchange rate have given as real.

Table 9. Projection of sunflower market 2000-2015 in Turkey

<table>
<thead>
<tr>
<th>Year</th>
<th>Sown area (1000 ha)</th>
<th>Yield (kg/da)</th>
<th>Production (1000 mt)</th>
<th>Crushing demand</th>
<th>Seed oil production</th>
<th>Crude oil demand</th>
<th>Crude oil export</th>
<th>Crude oil import</th>
<th>Crude oil stock</th>
<th>Meal production</th>
<th>Meal demand</th>
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<tbody>
<tr>
<td>2000</td>
<td>540</td>
<td>150</td>
<td>825</td>
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<td>555</td>
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Note: Increasing rates of wholesale price index, GNP and U.S. dollar exchange rate have given as real.
