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 Kısmi Denge Analizi

Ayçiçeği Türkiye'de en çok tüketilen yağ bitkisidir. Toplam bitkisel yağ tüketiminin %35'i ayçiçeği yağı olarak gerçekleşmektedir. Son yıllarda Türkiye'nin ayçiçeği üretimi 800 - 850 bin ton arasında değişmekte iken ayçiçeği ithalatı 500–650 bin ton arasındadır. Bu çalışmanın temel amacı Türkiye'deki bitkisel yağ açığının nedenlerini ortaya koyabilmek ve çözüm önerileri getirebilmektir. Bu amaçla, Türkiye'de en önemli yağlı tohum olan ayçiçeğinin pazar yapısı ve önümüzdeki yıllarda geçireceği süreç tahmin edilmiştir. Türkiye'deki ayçiçeği pazarının 2003-2015 yılları arasındaki trendini ortaya koymak üzere bir simulasyon modeli oluşturulmuş ve tek ürünlü kısmi denge modelinden yararlanılmıştır. Türkiye bitkisel yağlarda net ithalatçı konumdadır. 2002 yılı verilerine göre ayçiçeği tohumu ithalatı yaklaşık 300 bin ton civarında iken ayçiçeği hamyağ ithalatı 180 bin ton civarında gerçekleşmiştir. Analiz sonuçlarına göre Türkiye; ayçiçeği ve diğer yağlı tohumlarda net ithalatçı olmaya devam edecektir. Türkiye'nin simulasyon dönemi sonunda ayçiçeği tohumu ithalatının yaklaşık 1 milyon ton ve ayçiçeği hamyağ ithalatının ise yaklaşık 400 bin ton olacağı tahmin edilmektedir.

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* (SPEL/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].

1Explanation of Coefficients

Q^{s}_{supply}, sunflower production	φ, meal ratio in sunflower seed	Q^{Pr}, crushing quantity of seed
A^{s}, harvested area	Q^{s}_{miss}, seed missed	**M,** pressing marj
V^{s}, sunflower seed yield	Q^{s}_{demand}, total demand for seed	Q^{o}_{con}, crude oil consumption
Q^{o}_{supply}, crude oil production	Q^{s}_{seed}, demand for seed	$GNP_{percapita}$, gnp for per capita
δ, crude oil ratio in sunflower seed	**T,** trend (1,2,3...)	Q^{m}_{con}, meal consumption
Q^{m}_{supply}, meal production	**D1, D2,** dummy variables	Q^{s}_{import}, Q^{o}_{import}, Q^{m}_{import}, import demand
Q^{s}_{other}, other usage of sunflower seed	**Tefe,** whole sale price index (1968=100)	

price transfer equality

$$P^{domestic} = \left(P^{World}.exr.(1+tariff)+C\right)$$

crude oil consumption

$$Q^{o}_{con} = \left(Q^{o}_{percapita} * Population\right)$$

harvested area

$$A = f\left(A_{t-1}, P^{s}_{domestic,}, T\right)$$

seed supply

$$Q^{s}_{\sup ply} = \left(A^{s}.V^{s}\right)$$

sunflower seed yield

$$V^{t} = f\left(AR(3), MA(3)\right)$$

meal consumption

$$Q^{m}_{con} = f\left(Q^{m}_{\sup ply}, P^{m}_{domestic}, Q^{m}_{con,t-1}\right)$$

import demand for seed

$$Q^{s}_{import} = \left(Q^{s}_{demand} - Q^{s}_{\sup ply}\right)$$

per capita sunflower oil consumption

$$Q^{o}_{percapita} = f\left(\frac{GNP_{percapita(t-1)}}{Tefe}, Q^{o}_{percapita(t-1)}\right)$$

crushing demand for sunflower seed

$$Q^{\Pr} = f\left(Q^{\Pr}_{t-1}, M\right)$$

crude oil supply

$$Q^{o}_{\sup ply} = \left(Q^{\Pr}.\delta\right)$$

meal supply

$$Q^{m}_{\sup ply} = \left(Q^{\Pr}.\varphi\right)$$

total demand for seed

$$Q^{s}_{demand} = \left(Q^{\Pr} + Q^{s}_{seed} + Q^{s}_{miss} + Q^{s}_{other}\right)$$

import demand for meal

$$Q^{m}_{import} = \left(Q^{m}_{con} - Q^{m}_{\sup ply}\right)$$

oil export

$$Q^{o}_{\exp ort} = f\left(P^{o}_{domestic}, Q^{o}_{\sup ply}, Q^{o}_{stock,t-1}\right)$$

import demand for oil

$$Q^{o}_{import} = \left(Q^{o}_{demand} + Q^{o}_{\exp ort} + Q^{o}_{stock}\right) - \left(Q^{o}_{\sup ply} + Q^{o}_{stock(t-1)}\right)$$

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;

$$M^{s} = \left[\frac{P^{m}.\gamma^{m} + P^{o}.\gamma^{o}}{P^{s}}\right] \qquad \text{(I)}$$

where P^{m} is meal price, P^{o} is crude oil price, P^{s} is sunflower seed price, γ^{m} is extraction ratio of meal and γ^{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.

$$P^{domestic} = \left(P^{world}.exr.(1+tariff)+C\right) \qquad \text{(II)}$$

where $P^{domestic}$ is domestic price of related product, P^{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

Dependent variable: Ln(Sunflower Harvested Area)	coefficient	t statistic
Constant	2.1278	2.2711
Ln(Sunflower Harvested Area) (t-1)	0.6183	4.6824
Ln(Sunflower Price) (t-1)	0.2009	2.3358
Trend	-0.0063	-1.9344
R^2	0.81	
Adjusted R^2	0.77	
F	20.92	
Breusch-Godfrey Autocorrelation LM Test	0.27	

All coefficients are significant at 0.10

Table 2. Sunflower Seed Yield Model Results

Dependent variable: Ln(Sunflower Seed Yield)	coefficient	t statistic
Constant	5.2617	23.8738
AR(3)	0.8887	17.0011
MA(3)	-0.9447	-44.9950
R^2	0.71	
Adjusted R^2	0.69	
F	42.05	

All coefficients are significant at 0.10

Table 3. Demand of Sunflower Seed Crushing Model Results

Dependent variable: Ln(Crushing Amount of Sunflower Seed)	coefficient	t statistic
Constant	0.8370	1.88
Ln(Crushing Amount of Sunflower Seed (t-1))	0.8771	13.28
Ln(Crushing Margin)	0.7681	1.82
R^2	0.92	
Adjusted R^2	0.91	
F	90.61	
Breusch-Godfrey Autocorrelation LM Test	0.14	

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

Dependent variable: Ln(Consumption of Sunflower Oil (per capita)	coefficient	t statistic
Constant	-8.2479	-1.6483
Ln(GNP per capita(t-1))	0.3842	1.7199
Ln(Cons. of Sunflower Oil (per capita)(t-1))	0.2453	1.8932
R^2	0.76	
Adjusted R^2	0.74	
F	28.06	
Breusch-Godfrey Autocorrelation LM Test	0.06	

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 6 shows meal consumption model. Meal production, lagged value of meal consumption and lagged value of GNP have been independent variables of this model.

Table 5. Export of Sunflower Oil Model Results

Dependent variable: Ln(Export of Sunflower Oil)	coefficient	t statistic
Constant	1.0325	0.13
Ln(Price of Sunflower Oil)	-1.9251	-2.72
Ln(Sunflower Oil Production)	2.7335	3.07
Ln(Ending Stock of Sunflower Oil(t-1))	0.6964	2.05
R^2	0.79	
Adjusted R^2	0.75	
F	17.00	
Breusch-Godfrey Autocorrelation LM Test	0.51	

All coefficients are significant at 0.10

Table 6. Consumption of Sunflower Meal Model Results

Dependent variable: Ln(Consumption of Sunflower Meal)	coefficient	t statistic
Constant	-7.4299	-2.2638
Ln(GNP (per capita (t-1))	0.5761	2.0161
Ln(Sunflower Meal Production)	0.5549	5.7187
Ln(Consumption of Sunflower Meal (t-1))	0.3327	3.2528
R^2	0.98	
Adjusted R^2	0.97	
F	309.27	
Breusch-Godfrey Autocorrelation LM Test	0.15	

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).

Table 7. Ending Stock of Sunflower Oil Model Results

Dependent variable: Ln(Ending Stock of Sunflower Oil)	coefficient	t statistic
Constant	1.1969	1.73
Ln(Ending Stock of Sunflower Oil (t-1))	0.6968	4.09
R^2	0.48	
Adjusted R^2	0.45	
F	16.75	
Breusch-Godfrey Autocorrelation LM Test	0.57	

All coefficients are significant at 0.10

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.

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Table 8. Projection of World Prices and Macro Variables of Turkish Economy

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Increasing Rate														
Population	1,4	1,4	1,4	1,4	1,4	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
Whole Sale Price Index	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0
GNP (per capita)	-4,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5
Exchange rate	16,6	16,6	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0	5,0
	Rotterdam Prices of Sunflower Market ($/tons)														
Seed CIF	275	257	254	258	260	263	266	268	271	273	276	278	281	284	285
Crude Oil FOB	572	546	529	535	539	544	551	557	563	569	576	582	589	595	600
Meal CIF	117	113	122	127	129	133	136	139	141	144	147	150	152	155	157
	Domestic Prices of Sunflower Market ($/ton)														
Seed	278	322	319	323	325	329	332	334	338	340	343	346	349	352	353
Crude Oil	699	745	723	731	736	742	751	759	767	775	784	792	8001	809	815
Meal	150	147	156	161	163	167	170	173	175	178	181	184	186	187	191

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

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Sown area (1000 ha)	540	550	534	534	534	534	534	533	532	531	531	530	530	529	529	529
Yield (kg/da)	150	156	158	159	160	161	162	164	165	166	167	168	169	170	171	172
Production (1000 mt)	825	860	842	848	856	862	867	872	877	882	886	891	896	901	906	912
Crushing demand	1200	1229	1284	1336	1386	1432	1476	1519	1565	1606	1649	1691	1736	1777	1817	1859
Seed import	430	424	496	543	585	625	664	702	743	779	817	855	895	931	966	1003
Crude oil production	504	516	539	561	582	601	620	638	657	674	692	710	729	747	763	781
Crude oil demand	555	669	658	684	712	741	770	801	833	866	901	936	973	1012	1052	1094
Crude oil export	38	24	77	81	83	85	86	86	87	86	85	84	83	82	80	79
Crude oil import	74	184	197	204	214	225	237	250	263	278	293	310	328	348	370	393
Crude oil stock	40	47	48	49	50	51	51	51	51	52	52	52	52	52	52	52
Meal production	648	664	693	722	748	773	797	820	845	867	890	913	937	960	981	1004
Meal demand	706	728	759	778	797	817	834	851	867	883	899	913	928	942	955	969
Meal import	58	64	65	57	49	43	37	30	23	16	8	0	-9	-17	-26	-35

Source: Unakıtan, G. 2003. An Econometric Analysis of Demand, Supply and Foreign Trade of Sunflower in Turkey, Ph.D. Thesis, Trakya University, Graduate School of Natural and Applied Science