Acreage Allocation Model Estimation and Policy Evaluations for Major Crops in Turkey

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Abstract

This study estimates a system of supply equations for major field crops in Turkey and evaluates alternative agricultural policies for crop supply control. The supply of major field crops in Turkey responds significantly to both own-price and substitute price changes. The Turkish wheat price or gross return is the most important factor determining area allocation in Turkish field crops. Moreover, adopting measures that improve the growth of wheat yields also affect the substitute crops supply unless the price or gross return ratio is readjusted between substitute crops.

Key Words: Supply Estimation, Field Crops Supply, Acreage System Estimation, Turkish Agriculture, Agricultural Policy Evaluation.

ACREAGE ALLOCATION MODEL ESTIMATION AND POLICY EVALUATIONS FOR MAJOR CROPS IN TURKEY

Introduction

In recent years, Turkey has imported significant quantities of oilseeds, vegetable oils, feed grains, protein feed, and livestock products. Recent baseline projections indicate that the trade gap for these commodities will increase unless domestic supply of these products increases more than the projected demand growth (KoH et al. 1998).

Turkey has reached its arable land limitation for field crops; thus, future growth in the supply of these commodities depends on the adoption of high-yielding seeds, increases in yields through better production techniques, the expansion of irrigated land, the reduction of fallow land, and the reduction of area allocated to other crops generating an excess supply. The latter option requires the estimation of a supply model to discover the substitution relationships between crops. Supply response studies are also useful tools for policymakers because they allow them to determine the impacts of the underlying agricultural policies (crop support prices, input subsidies, input restrictions, the impact of border measures, etc.) and alternative policy options on production and substitute products.

Supply studies of Turkish agricultural commodities are very limited. Kasnako lu and Gηrkan (1996), and Bayaner (1995) estimated supply models for most of the major crops. Ghatak and Albayrak (1994) estimated a supply model for wheat. All of these studies used a single-equation, partial adjustment, or error correction specification. None of these specifications considered the theoretical restrictions on supply, such as adding-up, homogeneity, and symmetry. Moreover, these types of studies include only a limited number of substitute crops in the supply equation.

The purposes of this paper are threefold: 1) to estimate a system of supply equations for major crops, 2) to establish a supply baseline for wheat, barley, sunflower seed, and cotton, and 3) to evaluate alternative policies, such as adoption of yield-enhancing technology and tariff changes. In the next section, an acreage allocation model is derived. Barten and Vanloot (1996) initially developed the model and it was modified by Holt (1998). The specification of the supply model, estimation procedure, and data are presented in this paper along with the empirical results, baseline, and policy simulations.

Acreage Allocation Model

Following Barten and Vanloot (1996) and Holt (1998), a representative farmer is assumed in this study. This farmer makes decisions about which crops to grow in a manner similar to that of an investor determining the composition of an investment portfolio. In other words, the representative farmer maximizes the certainty equivalent (CE) profit, B, subject to a total land constraint. Important risk factors in agriculture include output price and yield uncertainty. The farmer's allocation problem is stated as:

$$\max_{a} CE(\pi) = \left\{ \mathbf{a}'\mathbf{r}^{e} - \frac{1}{2}\lambda \mathbf{a}'\Sigma\,\mathbf{a} \mid a_{tot} - \mathbf{1}'\mathbf{a} \right\} \quad (1)$$

In Equation (1), **a** is a n-vector of acreage levels; and $\mathbf{r}^{e} = \mathbf{p}^{e'}\mathbf{y}' + \mathrm{cov}(\mathbf{P}^{e}, \mathbf{P}^{y}) - \mathbf{c}$ is an n-vector of expected net returns, with $\mathbf{p}^{e}$ representing a vector of expected unit prices; $\mathbf{y}^{e}$ denoting a vector of expected yields per hectare, **cov** $(\mathbf{p}^{e}, \mathbf{p}^{y})$ denoting a vector of covariance between prices and yields, and **c** representing a vector of per hectare production costs. The (n x n) matrix Σ is a symmetric, positive-definite second moment matrix of expected returns per hectare. Hence, $= \left[(\mathbf{P}'\mathbf{y} - \mathbf{P}^{e'}\mathbf{y}^{e})(\mathbf{P}'\mathbf{y} - \mathbf{P}^{e'}\mathbf{y}^{e})' \right]$. Finally, **λ** is a (positive) coefficient of absolute risk aversion, and $\mathbf{I}'\mathbf{a} = a_{tot}$ denotes the land constraint, where $\mathbf{I}' = (1,\ldots\ldots,1)$ is a (n x 1) summation vector and $\mathbf{a}_{tot}$ represent total acreage available to be planted. The Lagrangian function associated with the optimization problem in (1) is:

$$\max_{\{\mathbf{a},\mu\}} L(\mathbf{a},\mu) = \mathbf{a}'\mathbf{r}' - \frac{1}{2}\lambda \mathbf{a}'\Sigma\mathbf{a} - \mu[a_{tot} - \mathbf{I}'\mathbf{a}], \quad (2)$$

where $\mu \in R_{+}$ is a Lagrange multiplier associated with the constraint. The necessary first-order condition derived from (2) are:

$$\left[\frac{\partial L(\mathbf{a}',\mu)}{\partial \mu} \right] = \mathbf{r}' - M\,\mathbf{a} - \lambda \mathbf{I} = \mathbf{0}, \quad (3a)$$

and

$$\frac{\partial L(\mathbf{a},\mu)}{\partial \mu} = a_{tot} - \mathbf{I}'\mathbf{a} = \mathbf{0}, \tag{3b}$$

where M = λΣ is a positive definite matrix that differs from Σ, the second moment matrix, by a positive factor of proportionality, λ. Converting the system of n+1 linear first-order conditions in equations (3a) and (3b) into matrix form gives:

$$\begin{bmatrix} M & \mathbf{I} \\ \mathbf{I}' & 0 \end{bmatrix} \begin{bmatrix} \mathbf{a} \\ \mu \end{bmatrix} = \begin{bmatrix} \mathbf{r}^{e} \\ a_{tot} \end{bmatrix}. \tag{4}$$

Now, by applying the partitioned inverse rule to system in (4), we obtain the following solution for the n-vector of acreage decisions, **a.** :

$$\mathbf{a} = \mathbf{b}\, a_{tot} + s * \mathbf{r}^{e}, \tag{5a}$$

where

$$\mathbf{b} = M^{-1}\mathbf{I}'(\mathbf{I}'M^{-1}\mathbf{I})^{-1}. \tag{5b}$$

$$\mathbf{S}^{*} = M^{-1} - M^{-1}\mathbf{I}(\mathbf{I}'M^{-1}\mathbf{I})^{-1}\mathbf{I}'M^{-1}. \tag{5c}$$

Note that the matrix $\mathbf{S}^{*}$ is symmetric ($\mathbf{S}^{*} = \mathbf{S}^{*\prime}$) and that $\mathbf{S}^{*}\mathbf{I} = \mathbf{0}$ and $\mathbf{I}'\mathbf{S}^{*} = \mathbf{0}'$. Furthermore, $\mathbf{I}'\mathbf{b} = 1$ must hold. To obtain a system of n (linear) acreage allocation share equations, simply divide both sides of (5a) by a_{tot}, the total acreage variable. We then obtain,

$$\mathbf{v} = \mathbf{b} + s\mathbf{r}^{e} \tag{6a}$$

or

$$\upsilon_i = b_i + \sum_j s_{ij}\, r_j^{e},\ i = 1,\ldots\ldots,\ n \tag{6b}$$

where $s = s^* / a_{tot}$ and $\mathbf{v} = \mathbf{a}/a_{tot}$, a n-vector of acreage allocation (shares).

The system in (6) is an acreage allocation system. By making a suitable stochastic assumption, the system's parameters may be estimated econometrically. The theoretical properties of symmetry, homogeneity, and adding-up can be readily maintained in estimation. The parameters in the model can be interpreted in easily understood economic terms. The coefficient b_i represents the scale effects, and, therefore, shows how much more or less acreage will be planted to the i^{th} crop if total land availability increases. A positive value for s_{ij} indicates that an increase in expected return for i^{th} crop will increase the acreage planted to that crop. Similarly, a negative value indicates that an increase in the j^{th} crop's expected return will cause a decrease of the share of i^{th} crop in total planting. These coefficients can also be transformed into elasticity formulae as follows:

$$\varepsilon_{ij} = \frac{\partial a_i}{\partial P_j^e} \frac{P_j^e}{a_i} = r_j^e \frac{s_{ij}}{v_i}, \forall\, i,\ j, \quad \text{(price elasticities)} \tag{7}$$

and

$$\eta_i = \frac{\partial a_i}{\partial a_{tot}} \frac{a_{tot}}{a_i} = \frac{b_i}{v_i}, i = 1,....., \ n \quad \text{(scale elasticities).} \tag{8}$$

Model Specification and Data

Although Turkey's field crop production is diversified, including food grains, feed grains, industrial crops, oilseeds, tuber crops and others, five crops (wheat, barley, cotton, sunflower, lentils, and chickpeas) constitute approximately 85 percent of the total field crop area planted in 1993-97 (Table 2). The wheat and barley shares of total field crop area planted are about 52 and 18 percent, respectively. The shares for chickpeas, lentils, cotton, and sunflowers are 4.3, 3.8, 3.3, and 3.1 percent respectively. The annual average of total field crop area planted during the 1993-97 period is 18,664,000 hectares. The total field crop planted area during the 1970-80 period was almost constant (the annual average is 16,415,000 hectares), but it has increased since 1982 due to the decline in a follow land area. The increase of total field crop area is 13.7 percent from the 1975-79 to the 1993-1997 period. This is the result of a research and extension project on the utilization of fallow areas initiated in 1982.

In this study, the supply system includes six major crops (MCR): wheat, barley, cotton, sunflower, lentils, and chickpeas. Maize, sugar beets, tobacco, potatoes, dry beans, rye, and oats are the primary crops included in the other crops (OC) category. The share of other crops accounts for 15 percent of total planted area. The area planted to maize includes both first-crop maize production and maize production after wheat. Time series statistics are not available that separate the area planted for maize. It is not reasonable to include maize in the supply system because first-crop maize production must be a substitute for wheat, while second crop maize must be a complement to wheat. Consequently, for this study maize is not included in the supply system. Sugar beets were also excluded from the supply system because producers are not able to shift from one crop to another in the short run, due to the area restrictions placed on sugar beets that are grown under contract with processing plants operated by state-owned companies and state-regulated cooperatives. As part of the contract, the processor prescribes the optimal crop rotation for the region, sowing sugar beets on a field once every three or four years.

Crop rotations commonly include wheat and other cereals, pulses, fodder crops, and sunflowers. Tobacco is also produced under the state monopoly regulation, so producers are not free to produce more tobacco, even if they enjoy relative gross return from tobacco production. Tobacco is not included in the supply system because of this regulation. Rye, oats, rice, potatoes and dry beans are largely produced in isolated regions rather than throughout Turkey. These commodities are not significant substitutes or complements for MCR.

The main agricultural support measures for crops in Turkey are producer support prices and input subsidies (fertilizer, seed, low interest agricultural credit, etc.). In addition to these policies, import restrictions and export subsidies have been applied to MCR. On average, price supports constitute the largest part of agricultural support measures (Yildirim et al. 1998). The Soil Product Office (TMO) was delegated to purchase wheat, barley, and some others crops at a fixed minimum price (that is, a floor price). TMO is also a price stabilizing institution in that it carries a buffer stock in order to stabilize producer and consumer prices. The buffer stocks of wheat exceeded 25 percent of the production in 1990.

The different state-operated Agricultural Sales Cooperatives and their Unions (ASCUs) are delegated to make support purchases for cotton, sunflower, lentils, chickpeas and some others crops at support prices. The government (Council of Ministers) determined the support prices of these commodities. During the data period under consideration (1970-96), wheat, barley, sunflowers and cotton benefited in some years from producer support and important input subsidies, such as for fertilizer. Lentils and chickpeas were also supported in some years by the TMO, but these commodities are primarily purchased and marketed by ASCUs . Currently fertilizer support prices are in effect for all of the crops at the same rate. Producer support prices are now in effect only for wheat and barley among MCR. Cotton producers also receive a deficiency payment equal to the difference between the target price and their selling price. This policy was introduced in 1993.

The government announces crop support and purchase prices after or during the harvest time, thus it is logical to assume that producers make allocation decisions based on past input and output prices and marketing conditions. Although the support price is high relative to prices for substitute crops, producers also consider marketing conditions, such as terms of payment for their product. In some years, producers receive their payments two to three months later than the delivery time, because government purchasing agencies do not explain the exact terms of payment when the price is announced. This payment condition can also affect the producer's acreage allocation decision. Given this specific market information, equation (6) is specified as the following short-run dynamic form:

$$\upsilon_i = b_i + v_{i,t-1} \sum_{j=1}^{6} s_{ji} r^{e}_{j,t-1} + \Theta D + \Psi T + \Phi FL + \varepsilon_i \qquad (9)$$

(i =wheat, cotton, sunflowers, barley, lentils and chickpeas),

As we defined in equation (1) and (6), r^e is the gross-return of the j^{th} crop, and the dependent variable is the quantity share of the i^{th} crop. The dynamic term was added to this system as an explanatory variable that represents crop rotation. Also, the second lag of the own-share is included in both the lentil and chickpea equations. D is a dummy variable used in the wheat and sunflower equations (D = 1 after 1980) that takes into account the area use shift due to the irrigation investment and other uses for wheat and marketing conditions for sunflower producers. T is a time trend used in the cotton equation; FL is a fallow land variable employed in the barley, lentils, and chickpea equations. Maintaining adding-up and symmetry restrictions, Equation (9) was estimated using three-stage least squares. To avoid singularity in the system and to satisfy the adding-up restriction, the rest of crop (OC) was dropped from the supply system. It is assumed that the dummy variable, time trend, and dynamic trend variables are proxies for the gross-returns of the excluded equation. Homogeneity was not imposed because an estimate of gross-returns for the omitted equation (OC) was lacking. But, all of the prices are deflated by wholesale price index (WPI). One can compute a price index for the omitted crops with the appropriate aggregation assumption, but the primary objective of this study is to set a baseline projection. This task requires a commodity price projection for the baseline. Given the lack of the price projection for some of the commodities, such as tobacco, dry beans, and potatoes, the author opted to forgo computing a price index for the excluded crops.

Equation (9) included yield (gross-return = yield multiplied by producer price), total area planted to field crops, and fallow land area. To obtain the future values of these variables, the author specified and estimated equations for total field crop planted area, fallow land, and yields. The yield equations are specified as a function of a time trend and dummy variable (rainfall and weather conditions). Total field crop planted area is specified as a function of its own-lag and fallow land. The fallow land equation is further specified as a function of its own-lag and a time trend variable. The yield equations were estimated using a log-linear form and ordinary least squares (OLS). The total field crop planted area and fallow land equations were estimated in a double-log form using OLS[1].

The area planted to crops, yields, production, prices, and price indices were taken from publications issued by the State Institute of Statistics Prime Ministry, Republic of Turkey (SIS).

Empirical Result

Estimation results of Equation (9) are presented in Table 1. Most of the coefficients are significant at the 5 percent (65.5 percent) and 10 percent (5.5 percent) levels. The R^2 indicates that the model fit is adequate in each individual equation. D-W and Durbin (h) statistics indicate that there is no evidence of serial correlation. All of the own-gross return coefficients are significant, and they have the expected signs. Furthermore, most of the cross-return relationships between crops are the expected direction, and their respective coefficients are significant. The fallow land coefficient is negative, as we expected, because barley, lentils, and chickpeas are mostly grown in dry areas in rotation with other crops such as wheat. Farmers have reduced their fallow land by rotating crops mostly with lentils, chickpeas, and barley since 1982.

As we expected, the second lag of lentils and chickpeas that share coefficients also have negative signs because farmers do not plant lentils or chickpeas back-to-back in dry areas. The dummy variable has a negative sign in the wheat equation and a positive sign in the sunflower equation. The sign of the wheat dummy is consistent with what was expected because irrigated area has rapidly expanded since the 1980s, and non-farm use of land has also increased rapidly. Input-intensive crops such as cotton, vegetables, and fruits are more profitable in the irrigated area than wheat. As we cited before, wheat is produced throughout Turkey. The positive sign on the dummy variable in the sunflower share equation may be due to the marketing guarantee farmers receive from the state controlling institution. Elasticities calculated from the last five-year average are presented for significant parameters in Table 2.

All of the own gross-return elasticities have the correct sign, and cross-price elasticities have expected signs. If we assume that yield is constant, the respective supply elasticity is the own-price or cross-price elasticity for acreage. When the model is run for the policy simulation, it is possible to derive output elasticities with respect to price or gross-returns of crops from the model. This should be greater than the acreage elasticity (Sadoulet and Janvry, 1995). The dominance of small farms and climatic conditions across regions are the primary factors that may explain the inelastic area response elasticities of crops in Turkey. For example, in Turkey the small-scale farm's wheat production is mostly for consumption of the farm's residents (Bayaner, 1995). In the case of cotton and sunflowers, climatic conditions are very important for determining the maximum quantity of the area planted to these crops. In addition to these factors, asset fixity may also explain the observed level of price elasticity of supply in agriculture (Gηrkan, 1979; Just, 1993).

Except for the barley-sunflower and sunflower-barley cross elasticities, all of the cross elasticities have an expected sign. In recent years, barley planted area has substantially increased, particularly in sunflower growing regions (the European part of Turkey). The data from SIS indicates that barley planted area in this region has increased from 25 thousand hectares during the 1980-82 period to 90,000 hectares during the 1995-97 period. This European part of Turkey boasts a 60 percent share of total sunflower planted area in recent years. In this region, barley planted area is approximately 25 percent of sunflower planted area in recent years, while the sunflower area also expanded in this region. It is possible that some of the farmers in this sunflower growing region, at least in the last decade, rotate sunflowers with barley. If this is true, the complementary relationship is not a surprise. It is also possible that this complementary rotation relationship exists in some other provinces. We believe that we have obtained more precise and reasonable supply elasticities for the major crops than previous studies. Kasnako lu and Gηrkan (1996) estimated the long-run, own-price supply elasticity of wheat to be 0.58, and they found a complementary relationship between wheat and barley, sugar beets, tobacco, and cotton that is contradictory to the results of this study. Ghatak and Albayrak (1994) estimated the own-price supply elasticity of wheat at 0.17, Bayaner (1995) estimated the short-run own-price supply elasticity of wheat at 0.63, and the Food and Agricultural Organization (FAO) (1997) assumed a supply elasticity of wheat to be 0.6. Yildirim et al. (1998) used the FAO's assumed value for policy evaluation and welfare calculation for wheat policy in Turkey. If we consider the yield growth and production growth of wheat in the last decade, all of these own-price elasticities seem to be over estimated, except the elasticity provided by Ghatak and Albayrak (1994).

Baseline and Alternative Policy Simulation

In order to analyze the impact of the proposed changes in Turkey's domestic field crops supply policy, it was necessary to construct a baseline under the existing policy regime. The estimated equations described earlier were used to project future values for the endogenous variables. Projections of macroeconomic variables were either assumed or taken from the projections published by the Food and Agricultural Policy Research Institute (FAPRI) *World Agricultural Outlook.* The exchange rate and consumer price index were taken from the World Economic Outlook publication of the WEFA group. Table 3 provides a summary of the baseline assumptions for exogenous variables. Producer prices used in the equation for wheat, sunflowers, cotton, and barley were derived from FAPRI projections of the U.S. Gulf price for wheat, Rotterdam price for sunflower seed, Portland price for barley, and the Cotlook A Index price for cotton using price transmission equations with an elasticity of unity[2] Lentils and chickpea prices were assumed to increase proportional with the wholesale price index. A series of assumptions were made for estimating production.

Wheat seed use was assumed at a rate of 200 kg per hectare, and wheat loss is assumed to be 8 percent of estimated production (area planted multiplied by yield). The Ministry of Agriculture and Rural Affairs (MARA) assumes that wheat area planted is 90 per cent of the SIS data, loss is 8 percent of production, and seed use is 200 kg for per hectare. In this study, the SIS data was used for area planted for wheat. Similar assumptions were made for barley. Barley seed use was assumed to be 200 kg per hectare, and loss is 9 percent of estimated production.

The baseline results are presented in Table 4. Wheat, barley, cotton, and sunflower production will continue to increase slightly under the baseline assumptions. This is partly due to yield growth per hectare and partly to an enlargement of total field crop area. Lentil and chickpea production will also continue to increase slightly during the simulation period. The area devoted to fallow land will continue to decline slightly during the simulation period.

We ran two scenarios to evaluate crop policies. In the first scenario the wheat and barley import tariff is reduced by 50 percent. Currently, the Turkish government imposes a 50 percent ad velorem tax on wheat and barley imports. This is well below the upper limit of 180 percent allowed by the WTO until 2004. In recent years, the Turkish government frequently changed the wheat and barley import tariffs. The import tariffs on wheat and barley were 45 and 20 percent in 1997, 15 percent for both in 1996, 20 and 28 percent in 1995, and 65 and 39 percent in 1994.

Table 1 and Table 2, show that wheat and barley account for more than 50 percent and about 20 percent of area planted to field crops. These two crops have a significant substitution relationship with each other and other crops. Consequently, a change in Turkey’s wheat and barley import policy is important for all field crops. The results of scenario 1 are presented in Table 5. The 50 percent reduction of the wheat and barley import tariff will cause only a slight drop in wheat production and increase in barley and chickpea production. The impact of the scenario on cotton, sunflowers and lentils are more significant. Cotton production will increase 8.5 percent in 2001 and about 7 percent during the rest of the simulation period. Sunflower production will increase 4.2 percent in 2001, 4.9 percent in 2002, and about 5.5 percent throughout the rest of the simulation period. This means that sunflower production will increase 52 tmt in absolute terms in 2007. Lentil production will increase 5.6 percent in 2001, 10.3 percent in 2003, and 8 percent in 2007. It is clear from the Table 5 that a wheat and barley policy change requires the policy maker to consider its impacts on substitute crops because the effects of the policy change are significant.

The second policy scenario analyzes the impact of policies that promote the adoption of yield increasing technology and production practices for wheat. After the mid 1980s, wheat yield growth has stagnated about 2 mt per hectare. Most farmers do not use high variety wheat seed; usually they use seed from their own production. This is not only the result of a scarcity of high-yielding seed varieties; most that variety seed goes into the wheat milling sector because farmers do not buy the seeds for planting. The reluctance of Turkish farmers to purchase high-yielding seed varieties may be due to the cultural rigidities and economic difficulties of small-sized subsistence farmers. Further research is required to determine underlying rigidities for the use of high-yielding seed varieties in Turkish agriculture. The scenario assumes that it is possible to accelerate 50 percent of the trend growth of wheat yields relative to the baseline. This growth rate may be accomplished by providing high-yielding seed use incentives to small-scale farmers along with a consulting service. The Union of the Agricultural Chambers (TZOB) initiated a consulting service pilot program on the cultivation management (sowing time, fertilizer application etc.) for small-scale farmers in 1992, in the Thracia region. TZOB agronomists noted that the program participant farmers obtained significantly higher yield and profit than non-participant farmers. The TZOB agronomists charged a small fee for their service. This type of program may be extended through the country.

The scenario institutes the changes in wheat yield trends during the 2000 production year. Results indicate that wheat production will increase 9.8 percent in 1999 and 13.2 percent in 2007. Wheat yield growth will impact all of the crops production, but the impact will be more significant on cotton, sunflowers, and barley. Cotton production will decline 3.5 percent in 2000, and the reduction in cotton output will reach 4.7 percent in 2007. Sunflower production also will decline 4.5 percent in 2000 and 9.1 percent in 2007.

Conclusions and Policy Implications

The supply of major field crops in Turkey responds significantly to both own-price and substitute price changes. We found that the wheat price or gross-return is the most important factor determining area allocation in Turkish field crops. Particularly, wheat price changes have a significant impact on the production of sunflowers, cotton, and barley. Adopting measures that improve the growth of wheat yields also affect the substitute crops supply unless price or gross return ratio re-adjusted between substitute crops. Policymakers can use the results of this study to evaluate the impact of support price and border measure on the supply. The results also allow to policy maker to establish production trade off between the grains and oilseeds. For instance, if policy maker wants to extend the production of sunflower and cotton, they can lower wheat price. Another important result is provided by model that the equal proportional changes of wheat and barley tariff works in favor of barley. This implies that proposed adjustment in the production requires tariff re-adjust at different rate.

Table 1. Parameter estimates of the area planted share of crops, 1970 to 1996

	Share of Wheat	Share of Cotton	Share of Sunflowers	Share of Barley	Share of Lentils	Share of Chickpeas
Constant	0.24	0.040	0.013	0.14	0.053	0.019
	(6.4)*	(15.8)*	(4.1)*	(3.5)*	(5.5)*	(6.2)*
Own share [t-1]	0.59		0.37	0.37	0.85	1.07
	(8.5)*		(3.6)*	(2.2)*	(7.6)*	(11.0)*
Own share[t-2]					-0.40	-0.25
					(-5.5)*	(-2.7)*
Ln GR_w [t-1]	0.055	-0.015	-0.015	-0.032	0.001	-0.0019
	(4.4)*	(-3.9)*	(-4.2)*	(-3.8)*	(0.03)	(-0.8)
Ln GR_c[t-1]	-0.015	0.016	0.001	0.0001	-0.002	-0.0008
	(-3.9)*	(6.8)*	(0.7)	(0.02)	(-1.23	(-0.9)
Ln GR_s[t-1]	-0.015	0.0012	0.004	0.009	0.0003	0.0029
	(-4.2)*	(0.7)	(2.0)**	(3.0)*	(0.2)	(3.0)*
Ln GR_b[t-1]	-0.032	0.0001	0.009	0.029	-0.085	0.0001
	(-3.8)*	(0.02)	(3.0)*	(3.4)*	(-2.7)*	(0.03)
Ln GR_l[t-1]	0.0005	-0.0018	0.0003	-0.008	0.008	-0.0018
	(0.03)	(-1.2)	(0.2)	(-2.7)*	(3.2)*	(-1.9)**
Ln GR_{ch}[t-1]	-0.0019	-0.0008	0.003	0.0001	-0.0018	0.0044
	(-0.8)	(-0.9)	(3.0)*	(0.03)	(-1.9)**	(5.3)*
Time trend		-0.0005				
		(-6.8)*				
Fallow land				-0.00001	-0.00001	-0.000002
(1000 hectare)				(-2.4)*	(-5.5)*	(-6.7)*
Dummy	-0.021		0.007			
	(-6.73)*		(5.3)*			
Adjustment coefficient	0.41		0.63	0.63	0.55	0.18
DIAGNOSTIC						
R^2	0.89	0.81	0.78	0.68	0.95	0.99
D-W		2.03				
D(h)	0.33		0.42	0.18	0.13	0.55

The crops in the table account for 85 percent of the total planted field crops area. In the parenthesis are t values. * and ** indicate that coefficient is significant at 5 percent and 10 percent level respectively.

Table 2. Long-run area response elasticity of crops with respect to gross return, 1970 to 1996

	Wheat	Cotton	Sunflowers	Barley	Lentils	Chickpeas
Wheat	**0.26**	-0.07	-0.07	-0.15	+	-
Cotton	-0.45	**0.47**	+	+	-	-
Sunflower	-0.75	+	**0.22**	0.47	+	0.15
Barley	-0.28	+	0.25	**0.25**	-0.07	+
Lentils	+	-	+	-0.41	**0.39**	-0.09
Chickpea	-	-	*0.38*	+	*-0.24*	**0.57**
Scale elasticity (sr)	*0.47*	*1.21**	*0.41*	*0.74*	*1.39*	0.43
Scale elasticity (lr)	1.16		0.65	1.18	2.53	2.39
Share 1	0.531	0.039	0.027	0.174	0.022	0.019
Share 2	0.515	0.033	0.031	0.186	0.038	0.043

Indicates scale elasticity. + and - indicates the direction of relationships between crops, because of the coefficient are not statistically significant, the cross-price elasticity for these crops are not presented. Note: Elasticity was calculated from the average of the last five year sample. Share 1: average of sample periods, Share 2: average of last five years.

Table 3. Baseline: Macroeconomic and exogenous variable assumptions

	1999	2000	2001	2002	2003	2004	2005	2006	2007
	Macroeconomic Variables								
Wholesale Price Index (1968=100)	9,914	14,910	20,203	26,446	33,243	41,720	52,358	65,709	82,465
Exchange Rate (U.S. $/ TL)	413	620	843	1,096	1,371	1,713	2,142	2,677	3,346
	International Prices (U.S.$/ton)								
U.S. Wheat (FOB Gulf)	150	151	157	159	160	162	164	166	171
Sunflower Seeds (CIF Rotterdam)	248	247	251	253	258	259	265	268	268
Barley (Portland)	132	136	137	138	139	140	142	144	144
Cotton (CIF Northern Europe)	1,631	1,648	1,665	1,683	1,698	1,703	1,719	1,734	1,734
	Domestic Producers Prices (U.S.$/ton)								
Wheat	217	222	233	238	243	248	252	258	267
Sunflower Seeds	451	449	456	460	469	471	481	487	487
Barley	189	197	199	202	205	207	210	215	216
Cotton Lint	686	697	707	718	726	730	739	748	750
Lentils	569	631	698	728	762	766	769	772	775
Chickpeas	1,015	1,125	1,244	1,297	1,358	1,366	1,371	1,377	1,382
	Tarriff Rates								
Wheat	50	50	50	50	50	50	50	50	50
Sunflower Seeds	29	29	29	29	29	29	29	29	29
Barley	50	50	50	50	50	50	50	50	50
Cotton Lint	0	0	0	0	0	0	0	0	0

Note: The lentils and chickpeas domestic prices are calendar year prices. The rest of the domestic prices are marketing (crops) year prices.

Table 4. Baseline: Area allocation, yield, and production

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Area (Thousand ha)									
Total Field Crop	18,469	18,500	18,533	18,568	18,603	18,638	18,672	18,705	18,738
Fallow Land	4,976	4,898	4,813	4,726	4,641	4,559	4,479	4,402	4,328
Wheat	9,042.5	9,013.2	8,983.4	8,985.4	8,986.3	8,990.4	9,007.1	9,019.7	9,036.2
Barley		3,634.6	3,631.2	3,621.5	3,617.2	3,613.1	3,607.1	3,602.8	3,598.0
Cotton Lint	741.3	739.5	737.1	734.0	730.7	726.7	721.7	715.6	708.3
Sunflower	574.5	589.6	578.7	591.8	579.0	591.4	577.7	589.3	575.2
Lentils	615.2	615.4	618.4	622.9	627.5	632.1	636.6	641.3	646.7
Chickpeas	756.6	768.0	777.9	785.1	789.9	793.4	796.2	798.6	801.2
Yield (Kg/ha)									
Wheat	2,016.1	2,034.1	2,052.2	2,070.5	2,089.0	2,107.6	2,126.4	2,145.3	2,164.5
Barley	2,227.8	2,231.3	2,234.7	2,238.1	2,241.5	2,245.0	2,248.4	2,251.9	2,259.9
Cotton Lint	1,136.4	1,155.3	1,172.5	1,187.6	1,200.0	1,209.1	1,214.1	1,214.1	1,217.2
Sunflower	1,560.9	1,574.0	1,585.2	1,594.2	1,600.6	1,604.0	1,604.0	1,610.2	1,614.3
Lentils	977.5	978.4	980.0	982.3	985.4	989.3	994.2	1000.2	1007.4
Chickpeas	1,000.4	1,000.6	1,000.4	1,001.3	1,001.4	1,002.5	1,002.3	1,003.0	1,004.5
Production (tmt)									
Wheat	18,231.0	18,333.9	18,436.0	18,604.5	18,772.3	18,948.2	19,152.7	19,350.3	19,558.6
Barley	8,132.6	8,109.8	8,114.5	8,105.4	8,108.1	8,111.3	8,110.2	8,113.2	8,131.0
Cotton Lint	842.4	854.3	864.2	871.7	876.9	878.7	876.2	868.9	862.1
Sunflower	896.8	928.0	917.3	943.4	926.8	948.7	926.6	948.9	928.6
Lentils	601.3	602.2	606.0	611.9	618.3	625.3	632.9	641.4	651.4
Chickpeas	756.9	768.5	778.2	786.1	791.1	795.4	798.0	801.0	804.8

Table 5. Scenario 1: The tariff reduction on wheat import

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Wheat Gross-Return	178.3	224.6	339.8	453.5	582.4	747.4	960.3	1,239.8	1,621.4
Change from Base	0.00%	-20.41%	-17.17%	-17.17%	-17.17%	-17.17%	-17.17%	-17.17%	-17.17%
Wheat Area	9,043.0	9,013.2	8,886.0	8,847.2	8,823.8	8,813.2	8,821.0	8,828.1	8,841.3
Change from Base	0.00%	0.00%	-1.08%	-1.54%	-1.81%	-1.97%	-2.07%	-2.12%	-2.16%
Wheat Production	18,232	18,334	18,236	18,318	18,433	18,575	18,757	18,939	19,137
Change from Base	**0.00%**	**0.00%**	**-1.08%**	**-1.54%**	**-1.81%**	**-1.97%**	**-2.07%**	**-2.12%**	**-2.16%**
Barley Gross-Return	172.6	220.4	315.0	416.3	529.7	664.7	849.3	1,089.8	1,366.1
Change from Base	0.00%	-20.07%	-16.94%	-16.94%	-16.94%	-16.94%	-16.94%	-16.94%	-16.94%
Barley Area	3,650.4	3,634.6	3,645.8	3,638.8	3,635.4	3,631.7	3,625.8	3,621.7	3,616.9
Change from Base	0.00%	0.00%	0.40%	0.48%	0.50%	0.51%	0.52%	0.52%	0.53%
Barley Production	8,132.6	8,109.8	8,147.3	8,143.9	8,148.9	8,153.1	8,152.5	8,155.6	8,173.8
Change from Base	**0.00%**	**0.00%**	**0.40%**	**0.48%**	**0.50%**	**0.51%**	**0.52%**	**0.52%**	**0.53%**
Cotton Area	741.3	739.5	799.8	785.8	782.7	778.7	773.8	767.9	760.6
Change from Base	0.00%	0.00%	8.50%	7.06%	7.11%	7.16%	7.22%	7.30%	7.38%
Cotton Production	842.4	854.3	937.7	933.3	939.2	941.6	939.5	932.3	925.8
Change from Base	**0.00%**	**0.00%**	**8.50%**	**7.06%**	**7.11%**	**7.16%**	**7.22%**	**7.30%**	**7.38%**
Sunflower Area	574.5	589.6	602.9	620.7	609.8	622.9	609.4	621.2	607.2
Change from Base	0.00%	0.00%	4.19%	4.89%	5.30%	5.31%	5.49%	5.41%	5.56%
Sunflower Production	896.8	928.0	955.7	989.5	976.0	999.1	977.5	1,000.2	980.2
Change from Base	**0.00%**	**0.00%**	**4.19%**	**4.89%**	**5.30%**	**5.31%**	**5.49%**	**5.41%**	**5.56%**
Lentils Area	615.2	615.4	652.9	681.1	692.2	693.0	691.7	693.1	697.9
Change from Base	0.00%	0.00%	5.58%	9.34%	10.32%	9.64%	8.66%	8.07%	7.92%
Lentils Production	601.3	602.2	639.8	669.1	682.1	685.6	687.7	693.2	703.0
Change from Base	**0.00%**	**0.00%**	**5.58%**	**9.34%**	**10.32%**	**9.64%**	**8.66%**	**8.07%**	**7.92%**
Chickpeas Area	756.7	768.0	785.6	799.6	808.9	814.4	817.5	819.6	821.7
Change from Base	0.01%	0.00%	0.98%	1.85%	2.40%	2.64%	2.68%	2.63%	2.55%
Chickpeas Production	757.0	768.5	785.9	800.7	810.0	816.4	819.4	822.1	825.4
Change from Base	**0.01%**	**0.00%**	**0.98%**	**1.85%**	**2.40%**	**2.64%**	**2.68%**	**2.63%**	**2.55%**

Table 6. Scenario 2: Yield trend change of wheat

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Wheat Gross-Return	178.3	309.7	452.3	606.3	782.1	1,008.2	1,301.1	1,687.2	2,216.5
Wheat Yield	2,016.1	2,232.7	2,262.6	2,293.0	2,323.7	2,354.8	2,386.4	2,418.3	2,450.7
Change from Base	**0.00%**	**9.76%**	**10.25%**	**10.74%**	**11.23%**	**11.73%**	**12.23%**	**12.73%**	**13.23%**
Wheat Area	9,042.5	9,013.2	9,077.5	9,140.3	9,182.1	9,215.3	9,254.1	9,284.5	9,316.4
Change from Base	0.00%	0.00%	1.05%	1.72%	2.18%	2.50%	2.74%	2.94%	3.10%
Wheat Production	18,231.0	20,124.1	20,539.2	20,958.4	21,336.3	21,700.3	22,083.5	22,452.9	22,832.0
Change from Base	**0.00%**	**9.76%**	**11.41%**	**12.65%**	**13.66%**	**14.52%**	**15.30%**	**16.03%**	**16.74%**
Barley Area	3,650.4	3,634.6	3,575.7	3,542.5	3,526.6	3,515.3	3,503.9	3,494.8	3,485.4
Change from Base	0.00%	0.00%	-1.53%	-2.18%	-2.50%	-2.70%	-2.86%	-3.00%	-3.13%
Barley Production	8,132.6	8,109.8	7,990.6	7,928.6	7,905.0	7,891.9	7,878.3	7,870.0	7,876.6
Change from Base	**0.00%**	**0.00%**	**-1.53%**	**-2.18%**	**-2.50%**	**-2.70%**	**-2.86%**	**-3.00%**	**-3.13%**
Cotton Area	741.3	739.5	711.4	707.1	702.5	697.2	690.9	683.6	674.9
Change from Base	0.00%	0.00%	-3.48%	-3.67%	-3.86%	-4.06%	-4.27%	-4.48%	-4.71%
Cotton Production	842.4	854.3	834.1	839.7	843.1	843.0	838.8	830.0	821.5
Change from Base	**0.00%**	**0.00%**	**-3.48%**	**-3.67%**	**-3.86%**	**-4.06%**	**-4.27%**	**-4.48%**	**-4.71%**
Sunflower Area	574.5	589.6	552.9	555.1	537.0	546.2	529.9	539.3	523.1
Change from Base	0.00%	0.00%	-4.45%	-6.20%	-7.25%	-7.66%	-8.27%	-8.49%	-9.06%
Sunflower Production	896.8	928.0	876.5	884.9	859.6	876.1	849.9	868.4	844.4
Change from Base	**0.00%**	**0.00%**	**-4.45%**	**-6.20%**	**-7.25%**	**-7.66%**	**-8.27%**	**-8.49%**	**-9.06%**
Lentils Area	615.2	615.4	618.6	623.4	628.1	632.7	637.1	641.9	647.2
Change from Base	0.00%	0.00%	0.04%	0.08%	0.09%	0.10%	0.09%	0.09%	0.09%
Lentils Production	601.3	602.2	606.2	612.4	618.9	625.9	633.5	642.0	652.0
Change from Base	**0.00%**	**0.00%**	**0.04%**	**0.08%**	**0.09%**	**0.10%**	**0.09%**	**0.09%**	**0.09%**
Chickpeas Area	756.6	768.0	774.7	778.2	780.3	782.1	783.9	785.9	788.3
Change from Base	0.00%	0.00%	-0.41%	-0.87%	-1.22%	-1.43%	-1.54%	-1.59%	-1.62%
Chickpeas Production	756.9	768.5	775.0	779.2	781.4	784.0	785.7	788.3	791.8
Change from Base	**0.00%**	**0.00%**	**-0.41%**	**-0.87%**	**-1.22%**	**-1.43%**	**-1.54%**	**-1.59%**	**-1.62%**

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Endnotes

1. The result of these additional three equations was not presented. It is available in the TAPAM technical report (Koç, et al. 1998)
2. These price transmission estimation results are available in KoH et al. 1998.