

## Regional Impacts of Alternative Price Policies for Turkey's Dairy Sector\*

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**Abstract:** Regional impacts of agricultural policies have emerged as a key concern in Turkey for both domestic reasons and because of Turkey's desire to join the European Union. This study uses a spatial equilibrium model to analyze the regional impacts of 2 alternative dairy support policies that are currently being considered: a price premium policy and a target price/deficiency payment policy. Both policies are found to exacerbate the post-1980 trend toward a greater share of milk produced in the more prosperous western regions of Turkey. Regional disparity in milk production increases more under the target price policy than under the price premium policy.

**Key Words:** Spatial equilibrium model, price premium, target price, Turkish dairy industry

### Türkiye Sütçülük Sektöründe Alternatif Fiyat Politikalarının Bölgesel Etkileri

**Özet:** Tarımsal politikaların bölgesel etkileri, hem ülke içindeki ekonomik gerekçelerle hem de Türkiye'nin Avrupa Birliğine katılma arzusundan dolayı önemli bir endişe olarak ortaya çıkmıştır. Bu çalışma, son yıllarda dikkate alınan iki alternatif sütçülük destekleme politikasının bölgesel etkilerini analiz etmek için spatial bir denge modelini kullanmaktadır. Bunlar teşvik primi ve hedef fiyat/fark ödemesi politikalarıdır. Her iki politika da, 1980 sonrasındaki trendin Türkiye'nin gelişmiş batı bölgelerinde üretilen sütün payının daha büyük bir oranda artmasına katkıda bulunmuştur. Bölgeler arasındaki dengesizlik, süt teşvik primi politikasına göre hedef fiyat politikası altında daha fazla artmaktadır.

**Anahtar Sözcükler:** Spatial denge modeli, teşvik primi, hedef fiyat, Türkiye sütçülük sektörü

### Introduction

Turkey has been seeking entry into the European Union (EU). A key principle of the EU's policies is the reduction of disparities among the levels of development across regions, including rural areas (1). In particular, efforts are made to ensure that the Common Agricultural Policy (CAP) is compatible with balanced regional competitiveness (2).

While considering adjustments to its current agricultural policy to attain greater compatibility with CAP, Turkey also is concerned about regional disparities in its production of milk for domestic reasons (3-5). Since

1980, the regional distribution of milk production in Turkey has shifted mainly from eastern to western regions (Table 1 and Figure). In particular, the Southeast region, which was the leading producer of milk in 1980, now has the smallest share of milk production among Turkey's 9 regions. Reasons for the shift include a favorable climate in the west, population migration from east to west, and declining public and private investment in the east (3). The east to west shift has raised concern among politicians because per capita income in the western regions is 3.5 times higher than in the eastern regions (7).

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Table 1. Change in regional share of milk production, Turkey, 1980 to 1998.

Region	Regional Share (Percent)		Change in Share (Percentage Point)
	1980	1998	1980-1998
Marmara	5.6	11.2	5.6
Aegean	11.7	17.0	5.3
Mediterranean	8.1	11.2	3.1
Central-North	10.9	11.0	0.1
Central-South	9.6	9.4	-0.2
Central-East	10.6	9.5	-1.1
Black-Sea	13.6	11.1	-2.5
Northeast	13.5	9.7	-3.8
Southeast	16.4	8.8	-7.6
Turkey	100.0	100.0	0.0

Source:(6)

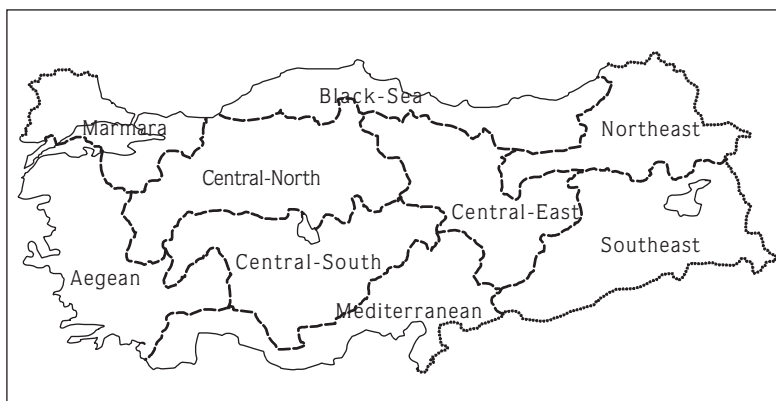


Figure. Agricultural Regions of Turkey

Because of the relatively high cost of transporting fluid and raw milk to balance regional differences in supply and demand, the impact of policy on the regional distribution of milk production has received particular attention among analysts. For example, Copus and Kelly (8) analyzed the regional impacts of livestock headage payments in Scotland. They concluded that the pre-1992 CAP livestock subsidy regime in Scotland had an effective, regional distributive effect by focusing support on economically lagging areas. The 1992 reforms significantly weakened this distributive effect, but the 1998 CAP proposal to pay a dairy cow premium as

compensation for the reduction in milk price supports would permit the CAP continue to play a role in reducing regional disparities. Several studies of US dairy policy also concluded that dairy policy differentially impacted regional prices and quantities (9-14).

In 1987, Turkey implemented a price premium policy to encourage the production of milk (15,16). Under this policy, producers receive a fixed payment, i.e. the price premium, for every kilogram of milk sold to a qualified milk-processing unit. Because of the latter condition, only 16.4% of raw milk produced in Turkey received the price premium in 1998. Furthermore, during the last half of

the 1990s the price premium increased substantially less than the price of raw milk (Table 2). As a result of these 2 considerations, the total value of milk price premium payments equaled only 0.76% of the total value of raw milk produced in Turkey in 1998 (18). Thus, the price premium policy currently has limited impact on Turkey's production of milk (19).

Given the current state of its dairy policy as well as its desire to join the EU, the Turkish government is evaluating alternative policy options for its milk production sector. Two options have emerged as the leading candidates. One is to increase the current price premium. The second is to replace the price premium policy with a target price policy. The latter policy pays farmers the difference between a government determined target price and the market price when the market price is less than the target price. This difference is called a deficiency payment.

The proposed enhanced price premium policy will provide the same level of public support for every kilogram of milk produced in Turkey. In contrast, the deficiency payment will vary by region. The reason is that, while the target price will be established at the national level and thus will be the same for all regions, market price will vary according to a region's supply-demand balance. As a result, the deficiency payment and thus the government's level of support per unit of output will be higher in the regions where price is lower. Therefore, the 2 leading policy options are hypothesized to have different impacts on milk production across regions. The objective of this study is to evaluate this hypothesis. Implications for Turkey's debate on dairy policy are drawn.

## Materials and Methods

To examine the regional impact of the 2 dairy policy options, a spatial equilibrium model of Turkey's dairy sector was constructed. Spatial equilibrium models have been commonly used to analyze the regional distribution of milk production (9-11,13).

Samuelson (20) was the first to formulate a spatial equilibrium model as a mathematical programming problem. In 1964, Takayama and Judge (21) presented a quadratic version of the spatial equilibrium model. The objective function was to maximize the area between the excess demand and excess supply curves minus transportation costs. Demand and supply curves were assumed to be continuous, well behaved, and linear. McCarl and Spreen (22) showed that the model simulated industry behavior under the assumption of a competitive market. Takayama and Judge's (21) model is followed in this study.

The specified model contains 9 regions, which are the standard agricultural divisions of Turkey (Figure). The model also contains 2 stages: a raw milk production stage where raw milk is supplied by region  $i$  and demanded by region  $l$  and a processing stage where milk products are supplied by region  $l$  and demanded by region  $j$ . Each region has 6 sets of supply and demand functions: a set for raw milk and a set each for the processed milk products of fluid milk, butter, cheese, yogurt and nonfat dry milk.

For convenience, inverse demand and supply functions are used. Endogenous variables are price, quantity of demand, and quantity of supply. Raw milk or dairy products are shipped between 2 regions only if transportation cost is less than or equal to the price

Table 2. Milk premium paid to farmers and raw milk price for years in which price premium was changed, Turkey, 1987-1998.

Year	Price Premium (Turkish liras)	Raw Milk Price (Turkish liras)	Ratio of Premium to Price (Percent)
1987	30	205	14.6
1989	70	566	12.4
1990	120	1,058	11.3
1994	2,000	8,497	23.5
1995	3,000	16,661	18.0
1998	5,000	107,281	4.7

Source:(15-17)

difference between the 2 regions. Transportation cost is assumed to be a linear function of distance.

The supply of raw milk (dairy product) in a region equals the quantity of raw milk (dairy product) produced within the region plus net shipments into and out of the region. A region's supply of raw milk (dairy product) equals its demand for raw milk (dairy product). Amount of raw milk used to manufacture a dairy product equals the amount of dairy product produced multiplied by the raw milk equivalent used to produce a unit of dairy product.

Mathematical statements of the objective function and constraints discussed above are presented in equations I and II, respectively. The model was solved using the General Algebraic Modeling System (23).

Objective function

$$\begin{aligned} & \sum_{i=1}^k [\alpha_i^{Rd} q_i^{Rd} - 1/2 \beta_i^{Rd} (q_i^{Rd})^2] \\ & - \sum_{i=1}^m [\alpha_i^{Rs} q_i^{Rs} + 1/2 \beta_i^{Rs} (q_i^{Rs})^2] \\ & + \sum_{j=1}^n \sum_{N=1}^z [\alpha_j^{Nd} q_j^{Nd} - 1/2 \beta_j^{Nd} (q_j^{Nd})^2] \\ & - \sum_{i=1}^k \sum_{N=1}^z [\alpha_i^{Ns} q_i^{Ns} + 1/2 \beta_i^{Ns} (q_i^{Ns})^2] \\ & - \sum_{i=1}^m \sum_{l=1}^k t_{il}^R XR_{il} \\ & - \sum_{l=1}^k \sum_{j=1}^n \sum_{N=1}^z t_{lj}^N X_{lj}^N \end{aligned} \tag{I}$$

Constraints

$$\begin{aligned} q_i^{Rs} &= \sum_{l=1}^k XR_{il} \\ q_l^{Rd} &= \sum_{i=1}^m XR_{il} \\ q_i^{Ns} &= \sum_{j=1}^n X_{ij}^N \\ q_j^{Nd} &= \sum_{l=1}^k X_{lj}^N \\ q_i^R &= q_i^N * D^N \\ q_i, q_l, q_j &\geq 0 \end{aligned} \tag{II}$$

where

- $\alpha_i^{Rd}$ : Intercept of raw milk demand function for region *l*
- $q_l^{Rd}$ : Quantity of raw milk demanded for region *l*
- $\beta_l^{Rd}$ : Coefficient of raw milk demand function for region *l*
- $\alpha_i^{Rs}$ : Intercept of raw milk supply function for region *i*
- $q_i^{Rs}$ : Quantity of raw milk supplied for region *i*

- $\beta_i^{Rs}$ : Coefficient of raw milk supply function for region *i*
- $\alpha_j^{Nd}$ : Intercept of milk product demand function for region *j* and product *N*
- $q_j^{Nd}$ : Quantity of milk product demanded for region *j* and product *N*
- $\beta_j^{Nd}$ : Coefficient of milk product demand function for region *j* and product *N*
- $\alpha_i^{Ns}$ : Intercept of milk product supply function for region *l* and product *N*
- $q_i^{Ns}$ : Quantity of milk product supplied for region *l* and product *N*
- $\beta_l^{Ns}$ : Coefficient of milk product supply function for region *l* and product *N*
- $t_{il}^R$ : Cost of transporting raw milk from region *i* to region *l*
- $XR_{il}$ : Quantity of raw milk transported from region *i* to region *l*
- $t_{lj}^N$ : Cost of transporting milk product *N* from region *l* to region *j*
- $X_{lj}^N$ : Quantity of milk product *N* transported from region *l* to region *j*
- $D^N$ : Raw milk equivalent of one unit of milk product *N*

The proposed enhanced price premium policy and target price policy were incorporated into the spatial equilibrium model using equations III and IV, respectively. The effective price received by milk producers in region *i* under the price premium policy equaled the price in region *i* plus the price premium. In the case of the target price policy, the effective price received by farmers for a unit of raw milk in region *i* could be no lower than the target price. If the cash price is less than the target price, a deficiency payment from the government makes up the difference between the cash price and the target price.

$$P_{epi} = P_i + R \tag{III}$$

$$P_{eti} \geq P_t \tag{IV}$$

where

- $P_{epi}$ : Effective price received under the price premium policy by farmers in region *i*
- $P_i$ : Price received by farmers in region *i*
- $R$ : Price premium

$P_{eti}$ : Effective price received under target price policy by farmers in region  $i$

$P_t$ : Target price

The slope and intercept coefficients of the supply and demand functions were computed using elasticities, quantities and prices:

$$\beta = \epsilon (q / p) \quad (V)$$

$$\alpha = q - \beta p \quad (VI)$$

The base year for solving the model was 1998 because it was the latest year for which production and consumption information was available at the time the analysis was conducted. Most of the data were obtained from publications of Turkey's State Institute for Statistics. Own price and income elasticities were obtained from previous studies (24-27). Own price elasticity of supply for raw milk varied from 0.50 to 0.90 among the regions. Own price elasticity of demand for raw milk was assumed to be the same (-0.50) for all regions. Own price elasticities of supply for fluid milk, butter, cheese, yogurt and dry milk were 0.50, 0.60, 0.64, 0.50 and 0.70, respectively, and were assumed to be the same for all regions. Own price elasticities of demand for these products also were assumed to be the same for all regions, and equaled -0.26, -0.64, -0.31, -0.11 and -0.23, respectively. Transportation cost was computed using the distance between each region's central point.

## Results

Comparing the values derived from the spatial equilibrium model to the actual values is one way of assessing the internal validity of the model. At the regional level, the ratio of raw milk production derived from the model to the actual quantity produced in 1998 ranges from 99.3% to 107.2% (Table 3). The ratio of raw milk prices derived from the model to the observed prices in 1998 varies from 98.4% to 110.6% among the regions. Robustness of the model is evaluated by decreasing supply and demand elasticities by 0.10. While numerically different, the qualitative nature of the results does not change. Taken together, these findings suggest that the model generates a reasonable approximation to Turkey's regional distribution of milk production in 1998.

The level of price support at the national level is assumed to be the same for both the enhanced price premium policy and the target price policy: 16% higher than the average price derived from the base model solved without any equation for the government program. The reason for choosing 16% is that it is the average for the 5 price premium levels that existed from 1987 through 1995 (Table 2). Use of this level of price support implies a target price of 130,000 Turkish liras and a price premium of 17,888 Turkish liras, both at 1998 prices. In contrast to the price premium policy that existed from 1987 until the present, these support levels would be available to each kilogram of milk produced.

Table 3. Comparison of actual and model-derived milk production and price, Turkey, 1998.

Region (000 tons)	Amount of Raw Milk			Price of Raw Milk		
	Actual (000 tons)	Model (Percent)	Ratio (000 TLs)*	Actual (000 TLs)*	Model (Percent)	Ratio
Marmara	1,121	1,119	99.8	106.8	106.6	99.8
Aegean	1,697	1,732	102.1	106.1	108.5	102.3
Mediterranean	1,119	1,173	104.8	105.4	111.0	105.3
Central-North	1,099	1,134	103.2	106.5	111.3	104.5
Central-South	939	1,007	107.2	97.6	107.9	110.6
Central-East	942	987	104.8	104.8	111.9	106.8
Black-Sea	1,203	1,194	99.3	118.4	116.5	98.4
Northeast	968	1,007	104.0	105.8	114.4	108.1
Southeast	882	898	101.8	114.0	118.1	103.6
Turkey	9,970	10,251	102.8	107.3	111.8	104.2

Source: original calculations

\*TLs: Turkish liras

Compared with the level of milk production obtained under the base model, milk production in Turkey increases 12.4% under the target price policy and 11.6% under the enhanced price premium policy (Table 4). These increases occur because the government subsidies provide an incentive to produce more.

Under the enhanced price premium policy, the increase in production relative to the base model ranges from 7.9% to 14.5% across the regions (Table 4). Under the target price policy the range is larger: from 5.0% to 19.6%. Under both policy options, production increases are smallest in the Southeast, Northeast and Black Sea regions, while production increases are highest in the Marmara, Aegean and Mediterranean regions. These differential regional changes in production are the same as those that have been occurring since 1980 (Table 1).

To test the sensitivity of these results to different levels of government support, price support at the national level also was set at 11% and 21%. Although the results change numerically, the qualitative nature of the results does not change.

## Discussion

Because of its desire to join the European Union and for domestic reasons, Turkey is evaluating changes in its dairy policy. Two policy options have emerged as leading candidates: (1) continuation of its current price premium policy, but at a higher level of support, and (2) a target price policy that pays farmers the difference between the

national target price and the local cash price. Both policies will stimulate an increase in milk production in all regions. The largest increase will occur in those regions that have experienced the greatest increase in their share of Turkey's milk production since 1980 while the smallest increase will occur in those regions that have experienced the largest decline in their share of Turkey's milk production since 1980. Thus, both policy options reinforce historical trends in the regional redistribution of Turkey's production of milk.

Our results confirm the expectation that a target price policy will have a greater impact on the regional distribution of milk production than a fixed payment policy such as Turkey's proposed price premium policy. The reason is that the price premium policy pays a fixed amount of support for each kilogram of milk produced. In contrast, the deficiency payment per kilogram of milk produced and thus the level of government support will vary with each region's market price.

Given Turkey's commitment to using policy to reduce regional disparities as well as the importance of reducing regional disparities within the context of potentially joining the European Union, the findings of this study imply that Turkey's dairy policy makers and actors need to consider that both of the leading policy options will increase the disparity in the regional distribution of milk production. Both policies favor the more prosperous western regions of Turkey. Turkey's dairy policy makers and actors also need to consider that the disparity will increase more under the target price policy.

Table 4. Comparison of milk production under enhanced price premium and target price policies, Turkey, 1998.

Region	Base Model (000 tons)	Enhanced Price Premium Policy (000 tons)	Ratio to Base Model (Percent)	Target Price Policy (000 tons)	Ratio to Base Model (Percent)
Marmara	1,119	1,280	114.4	1,338	119.6
Aegean	1,732	1,982	114.4	2,037	117.6
Mediterranean	1,173	1,343	114.5	1,351	115.2
Central-North	1,134	1,262	111.3	1,266	111.6
Central-South	1,007	1,124	111.6	1,154	114.6
Central-East	987	1,100	111.4	1,099	111.3
Black-Sea	1,194	1,288	107.9	1,261	105.6
Northeast	1,007	1,091	108.3	1,077	107.0
Southeast	898	971	108.1	943	105.0
Turkey	10,251	11,441	111.6	11,526	112.4

Source: original calculations



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