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A spatial equilibrium analysis for the possible regional impacts of the European Union full membership on the Turkey's dairy industry

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Abstract: In the study, the potential regional impacts of the European Union full memberships on the Turkey's dairy sector were analysed using a Spatial Equilibrium Model with 12 NUTS 1 regions as well as the European Union as being another region. According to the results, Turkey starts importing butter mainly to the Istanbul region and powder milk to the Black Sea regions, while exporting white cheese from Istanbul and plain yoghurt from the Central Anatolia and the North-eastern Anatolian regions. In the process of the European Union full membership, agricultural policies must focus on the enhancement of milk productivity to decrease the cost and to improve hygiene to meet the European Union standards for a smooth accession.

Keywords: dairy sector, European Union, spatial equilibrium model, Turkey

Turkey's accession to the European Union (EU) has a long history. The relations between Turkey and the EU started in 1959 with the membership application. This process has intensified with the Customs Union in 1996, the negotiation date on 17 December 2004 and finally the start of the full-membership negotiations on 3 October 2005.

It is reported by the experts and researchers and seen in the EU progress reports that one of the most challenging chapters in 35 chapters of *acquis communautaire* is the 11th chapter titled "Agriculture and Rural Development" (Yavuz et al. 2004; Eraktan and Ören 2005; EC 2014). The Agriculture and Rural Development chapter also consists of the harmonization negotiations in the terms of the EU Common Agricultural Policy (CAP). The CAP is one of the oldest partnership policies and also includes the dairy sector policies that contribute to the sustainable market conditions for milk producers and milk processors.

It is momentarily emphasized in the scientific researches and experts' comments that the harmonization of the Turkish dairy sector is relatively difficult considering the other sub-sectors in the terms of Turkish agricultural sector in the EU accession process and the Turkish dairy sector cannot compete with the EU dairy sector (Yavuz and Keskin 1996; Yavuz et al. 2004; Eraktan and Ören 2005; Güler 2006; Özden 2007). Thus, a comprehensive scientific research is needed to identify the possible solutions to overcome the problems in the EU harmonization process and to help the decision makers to pass this process by presenting more viable and alternative solutions.

For the Agriculture and Rural Development chapter, the introductory meeting took place on 5–8 December 2005 and a detailed meeting took place on 23–26 January 2006. The Chapter has not been opened to further negotiations due to the full-application of additional protocol according to the decision of

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11 December 2006 by the EU General Affairs and External Relations Council (MFEA 2014).

In the 2014 EU Progress Report, it is expressed that there is some progress in the terms of the agriculture and rural development legislation, the implementation of the pre-accession rural development program and the Farm Accountancy Data Network. However, the ban on the importation of live beef, beef meat and similar products has not been diminished yet, there is no strategy for the agricultural statistics to harmonize the agricultural support with the CAP and generally the preparations of the sector of agriculture and rural development are at an early stage (EC 2014).

Defining the possible implications of the Turkey's EU accession to the dairy sector is crucial in terms of a successful full-membership. In the case of a full membership, answering the questions of how the regional milk and milk products will be distributed among regions, in what regions the production will increase and decrease and how the milk and milk products will flow among the NUTS1 regions and between Turkey and the EU, will be a directive for defining the agricultural policies for both the pre-accession and post-accession period. In this vein, the study aims to analyse the how the dairy sector will be influenced on the level of NUTS 1 regions in the case of full membership to the EU by making use of the spatial equilibrium model.

TURKEY'S DAIRY INDUSTRY

The milk production in Turkey has increased from 9.8 million tons in 2000 to 18.2 million tons in 2013 by 85.7% (TURKSTAT 2014a). Turkey placed on the ninth position with 17.4 million tons in the 2012 world ranking for the milk production (FAO 2014). The cow milk keeps the highest percentage of the total milk production worldwide. In Turkey, 90.8% of the total milk is cow milk for the period of 2012–2013 (TURKSTAT 2014a). The processed milk under registration is 61.7 % of the total milk in the world, while only 53.8% in Turkey and 91.7% in the EU (IFCN 2011). In the regions of Western Marmara, Aegean, Western Anatolia, Eastern Marmara and Mediterranean, the where the raw milk market is advanced, 80% of total milk is under registration; whereas this percentage is relatively low (10%) in the regions of the North, Central and South-eastern Anatolia, where the raw milk market is underdeveloped (CMPUT 2012).

There are significant structural differences among the NUTS1 regions in Turkey in terms of the milk yield per cow, farm size, use of technology and milk quality (Yavuz and Keskin 1996). Therefore, the milk production showed considerable variation over time. Until 1980s, an important part of the milk used to be produced in the Eastern and South-eastern Anatolia regions; however, after the 1980s the milk production became an unprofitable sector due to the progressive disappearance of meadows and pastures, the lack of marketing opportunities and security concern (Tan 2001). Thus, the amount of animal production in the Eastern and South-eastern Anatolia significantly decreased. However, in the recent years with the agricultural support policies in these regions, the effort to return to the old days has a significant impact.

Table 1. The distribution of total milk production in Turkey by Nuts 1 region (thousand tons)

	1991		2001		2013	
	1000 Tons	(%)	1000 Tons	(%)	1000 Tons	(%)
Istanbul	247	2.41	142	1.50	87	0.48
Western Marmara	1 058	10.34	1 006	10.59	1 880	10.31
Aegean	1 125	11.00	1 205	12.69	2 839	15.58
Eastern Marmara	754	7.37	697	7.34	1 019	5.59
Western Anatolia	597	5.84	603	6.35	1 298	7.12
Mediterranean	1 236	12.08	1 115	11.74	1 796	9.85
Middle Anatolia	905	8.85	925	9.74	2 059	11.30
Western Black Sea	1 082	10.57	908	9.57	1 770	9.71
Eastern Black Sea	743	7.26	524	5.52	666	3.65
Northeast Anatolia	906	8.85	941	9.91	2 218	12.17
Middle East Anatolia	884	8.64	797	8.40	1 339	7.35
Southeast Anatolia	694	6.79	633	6.66	1 253	6.88
TURKEY	10 231	100.00	9 496	100.00	18 224	100.00

Source: TURKSTAT (2014a)

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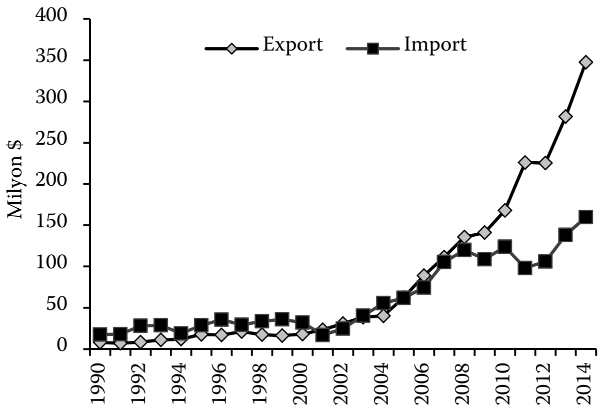

Figure 1. Milk and milk products trade in Turkey

Source: TURKSTAT (2014b)

The distribution of the total milk production in Turkey by the NUTS1 region is presented in Table 1. According to the statistics, approximately 20% of raw milk produced in Turkey is consumed in the place where produced. The milk supply to the market is processed by modern enterprises (27%) and by medium-sized enterprises or dairies (33%). 20% of milk is sold in the open market by a hand seller (Anonymous 2006a; PMPA 2010). According to these results, 60% of the total milk is under registration in Turkey. So, it is extremely hard to assess the actual production and consumption quantities in Turkey. Thus, only 47.6% (7.9 million tons) of cow milk produced in Turkey was used in the integrated dairies (NMC 2014). Nearly half of the total milk (44%) produced in Turkey is used for the production of cheese, 20% for the production of yoghurt, 19% for the production of butter and/or milk powder, 14% for the production of fluid milk and 3% for the production of other milk products (Anonymous 2006a, b).

Turkey's foreign trade volume of the milk and milk products was approximately 26 million $ in 1990; whereas it rose to 507 million $ in 2014. The milk and milk products export value in Turkey has increased from 8.1 million $ in 1990 to 347.5 million $ in 2014 by 4190.1% (Figure 1).

THEORETICAL FRAMEWORK OF THE SPATIAL EQUILIBRIUM

Enke (1951) and Samuelson (1952) developed the first quadratic programming problem that dealt with an endogenous price equilibrium model. This model maximizes the consumers' plus the producers' surplus by integrating the area underneath the demand curve minus the integral underneath the supply curve, subject to a supply-demand balance. Takayama and Judge (1964) later developed the spatial equilibrium model. Recently, more powerful algorithms and advanced computational capabilities have increased the scale of spatial equilibrium models through the quadratic programming applications. The theoretical framework can be expanded to incorporate multi-exporting and multi-importing regions, multimodal transportation, multi-commodity, and under a different market structure framework. It has been extensively used in agricultural economics to analyse the interregional market flows (Wigle 1991; Chavas et al. 1993; Yavuz et al. 1996; Kawaguchi et al. 1998; Guajardo and Elizondo 2003; Keskin 2003; Gomez-Plana and Devadoss 2004; Yavuz et al. 2004; Demir 2012).

Takayama and Judge (1972) developed the spatial equilibrium model to deal with such situations (McCarl and Spreen 1997; Guajardo and Elizondo 2003). Suppose that in the region i the demand for the good of interest is given by

$$P_{di} = f_i(Q_{di}) \tag{1}$$

where:
P_{di} = Demand price in the region i
Q_{di} = Demand quantity in the region i

Simultaneously suppose the supply function for the region i is

$$P_{si} = s_i(Q_{si}) \tag{2}$$

where:
P_{si} = Supply price in the region i
Q_{si} = Supply quantity in the region i

The quasi-welfare function results from subtracting the regional supplies from the regional demands:

$$W_i\left(Q^*_{si,}Q^*_{di}\right) = \int_0^{Q_{di^*}} P_{di}\, dQ_{di} - \int_0^{Q_{si^*}} P_{si}\, dQ_{si} \tag{3}$$

The transportation costs and tariffs are subtracted from the quasi-welfare equation to obtain the net welfare function

$$NW = \sum_i W_i\,(Q^*_{si}, Q^*_{di}) - \sum_i \sum_j C_{ij} T_{ij} \tag{4}$$

where:
C_{ij} = the transportation cost from the region i to j
T_{ij} = the quantity transported from the region i to j

To complete the system, two sets of restrictions regarding supply and demand balances were incorporated to the net welfare equation. The first set of restrictions

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establishes that each regional demand is less than or equal to the domestic production plus imports,

$$Q_{di} \leq \sum_{i} T_{ij} \quad \text{for all } i \tag{5}$$

The second set of restrictions establishes that each regional supply is greater than or equal to the domestic consumption plus exports,

$$Q_{si} \geq \sum_{j} T_{ij} \qquad \text{for all } i \tag{6}$$

The model, which includes the objective function (4), restrictions (5) and (6), and the nonnegative conditions of the supply, demand, and the transport quantities, is as follows:

$$\text{Max} \sum i \left(\int_0^{Q_{di^*}} P_{di}\, dQ_{di} - \int_0^{Q_{si^*}} P_{si}\, dQ_{si} \right) - \sum_{i} \sum_{j} c_{ij} T_{ij} \tag{7}$$

Subject to

$$Q_{di} - \sum_{j} T_{ij} \leq 0 \ \text{ for all } i,$$

$$-Q_{si} + \sum_{j} T_{ij} \leq 0 \ \text{ for all } i,$$

$$Q_{di}, Q_{si}, T_{ij} \geq 0 \ \text{ for all } i \text{ and } j$$

The model formulation assumes that: Supply and demand equations are integrable and the commodity demand and factor supply functions are truly exogenous to the model (i.e. there are no income effects). Both consumers and producers are price takers and consequently none can individually influence the output or factor prices. If the demand equations have a negative slope and the supply functions have a positive slope, equilibrium is feasible. The associated Lagrangian maximization problem is in Eguation (8), where λ_{di}, ψ_{si} are the associated Lagrangian multipliers with the demand and supply restrictions. The Kuhn-Tucker's optimality conditions for the maximization problem can be expressed as follows:

$$\text{and } \partial L/\partial Q_{di} = P_{di} - \lambda_{di} \leq 0$$
$$(\partial L/\partial Q_{di}) Q_{di} = 0 \quad \text{if} \quad Q_{di} \geq 0 \tag{8a}$$

$$\partial L/\partial Q_{si} = -p_{si} + \psi_{si} \leq 0 \text{ and}$$
$$(\partial L/\partial Q_{si}) Q_{si} = 0 \quad \text{if} \quad Q_{si} \geq 0 \tag{8b}$$

$$\partial L/\partial T_{ij} = -c_{ij} + \lambda_{dj} - \psi_{si} \leq 0 \text{ and}$$
$$\left(\partial L/\partial T_{ij}\right) T_{ij} = 0 \quad \text{if} \quad T_{ij} \geq 0 \tag{8c}$$

The Lagrange multipliers (dual variables) are represented by λ and ψ. ψ_i represents the supply shadow price or the price at which the producers from the *i*th region can sell to the market. λ_i represents the demand shadow price or the price that the consumers are willing to pay for the good in the *i*th market. The first set of Equations (8a) implies that the demand price equals its shadow price in the region *i*, if the quantity demanded is positive and greater than zero. The second sets of conditions (8b) imply that the supply price is equal to the shadow price if the quantity supplied is positive. The last set of Equations (8c) implies that the demand shadow price is equal to the transportation cost plus the supply shadow price if the quantity transported is positive. The system solution presents the production and consumption for each region and trade between the different zones. The prices for each area are obtained by the dual variables in the solution.

APPLICATION OF THE MODEL

The model was designed for the 13 regions (Figure 2), which included the demand and supply relations under competitive markets. The model contains two stages. The first is a production stage where the farmers supply raw milk to processors who in turn manufacture dairy products. The second is a processing stage where the processors supply dairy products to retailers who sell the products to consumers. Therefore, each region has a production point, a processing point and a retail point. 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, yoghurt and milk powder (whole milk powder and skimmed milk powder).

For convenience, the inverse demand and supply function are used. Endogenous variables are price, quantity of demand and quantity of supply. Raw milk or dairy products are shipped between two regions

$$L = \sum_{i=1}^{n} \left[\int_0^{Q_{di^*}} P_{di}\, dQ_{di} - \int_0^{Q_{si^*}} P_{si}\, dQ_{si}) \right] - \sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij}\, T_{ij} + \sum_{j=1}^{n} \lambda_{di} \left[\sum_{j=1}^{n} T_{ij} - Q_{di} \right] + \sum_{i=1}^{n} \psi_{si} \left[Q_{si} - \sum_{j=1}^{n} T_{ij} \right] \tag{8}$$

Q_{di}, Q_{si}, λ_{di}, $\psi_{si} \geq 0$

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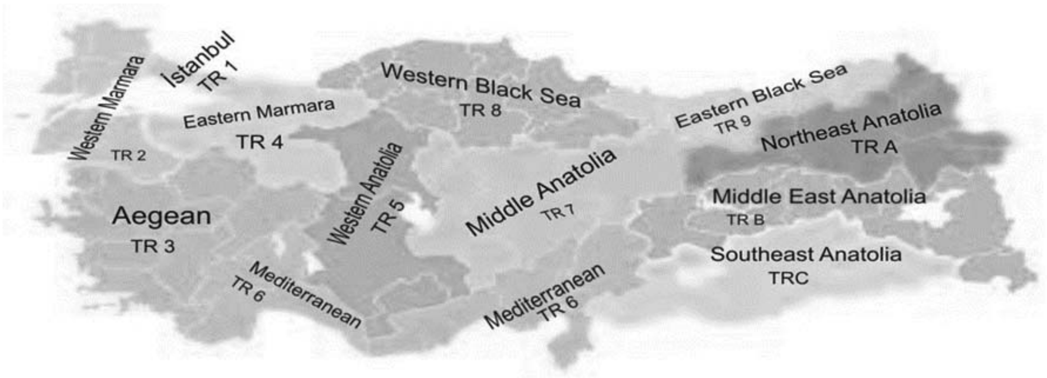

Figure 2. Nuts I regions

only if the transportation cost is less than or equal to the price difference between the two regions. The transportation cost is assumed to be a linear function of the distance. The supply of raw milk (milk products) in a region equals the quantity of raw milk (milk products) produced within the region plus net shipments into and out of the region. The region's supply of raw milk (milk product) equals its demand for raw milk (milk products). The amount of raw milk used to manufacture milk products equals the amount of milk products produced multiplied by the raw milk equivalent used to produce a unit of milk product.

Mathematical statements of the objective function and constraints discussed below are presented in Equations 9, 10 and 11, respectively. The model was solved using the General Algebraic Modelling System (GAMS).

Objective function – Eguation (9)

Constraints

$$q_i^{Rs} = \sum_{l=1}^{k} X_{il} \qquad q_i^{Rd} = \sum_{i=1}^{m} X_{il} \tag{10}$$

$$q_l^{Ns} = \sum_{j=1}^{n} X_{lj}^N \qquad q_j^{Nd} = \sum_{l=1}^{k} X_{lj}^N \tag{11}$$

$$q_i^R = q_l^N * D^N \qquad q_{i,}\, q_{l,} q_j \geq 0$$

where:

$\propto_l^{Rd}$ = Intercept of raw milk demand function for the region l

q_l^{Rd} = Quantity of raw milk demanded for the region l

β_l^{Rd} = Coefficient of raw milk demand function for the region l

$\propto_i^{Rs}$ = Intercept of raw milk supply function for the region i

q_i^{Rs} = Quantity of raw milk supplied for the region i

β_i^{Rs} = Coefficient of raw milk supply function for the region i

$\propto_j^{Nd}$ = Intercept of dairy product demand function for the region j and product N

q_j^{Nd} = Quantity of dairy product demanded for the region j and product N

β_j^{Nd} = Coefficient of dairy product demand function for the region j and product N

$\propto_l^{Ns}$ = Intercept of dairy product supply function for the region l and product N

q_l^{Ns} = Quantity of dairy product supplied for the region l and product N

β_l^{Ns} = Coefficient of dairy product supply function for the region l and product N

t_{il}^R = Cost of transporting raw milk from the region i to region l

X_{il} = Quantity of raw milk transported from the region i to region l

t_{lj}^N = Cost of transporting dairy product N from region l to region j

X_{lj}^N = Quantity of dairy product N transported from the region l to region j

D^N = Raw milk equivalent of one unit of dairy product N

The slope coefficient of price, β_i, in the supply and demand equations is computed from the elasticity ϵ_i of supply (demand) for the region i as follows:

$$\beta_i = \epsilon_i \times q_i/p_i \tag{12}$$

where:

$$\sum_{l=1}^{k}[\propto_l^{Rd} q_l^{Rd} - \frac{1}{2\beta_l^{Rd}(q_l^{Rd})^2}] - \sum_{i=1}^{m}[\propto_i^{Rs} q_i^{Rs} - \frac{1}{2\beta_i^{Rs}(q_i^{Rs})^2}] + \sum_{j=1}^{n}\sum_{N=1}^{z}[\propto_j^{Nd} q_j^{Nd} - \frac{1}{2\beta_j^{Nd}(q_j^{Nd})^2}] - $$
$$- \sum_{l=1}^{k}\sum_{N=1}^{Z}[\propto_l^{Ns} q_l^{Ns} - 1/2\beta_l^{Ns}(q_l^{Ns})^2] - \sum_{i=1}^{m}\sum_{l=1}^{k} t_{il}^R X_{il} \sum_{l=1}^{k}\sum_{j=1}^{n}\sum_{N=1}^{z} t_{lj}^N X_{lj}^N \tag{9}$$

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q_i = quantity of supply (demand) in the base year (2013)
p_i = supply (demand) price in the base year (2013)

Given the slope coefficient, the intercept term α_i is computed as follows:

$$\alpha_i = q_i - \beta_i \times p_i \quad (13)$$

Supply and demand functions are constructed by using the most recent elasticities estimated by other studies in Turkey and the EU (Koc and Tan 1999; Tan 2001; Mechemache et al. 2008; Requillart 2008; FAPRI 2014).

Table 2. Estimated supply and demand equations

Region	Supply	Demand	Supply	Demand
	Raw milk		Fluid milk	
TR1	$-0.1211 + 0.016288Q_{si}$	$3.2700 - 0.000739Q_{di}$	$-1.8520 + 0.0115Q_{si}$	$11.3885 - 0.0210Q_{di}$
TR2	$-0.1022 + 0.000605Q_{si}$	$2.7600 - 0.002695Q_{di}$	$-1.8820 + 0.0223Q_{si}$	$11.5338 - 0.0917Q_{di}$
TR3	$-0.0967 + 0.000381Q_{si}$	$2.6100 - 0.000844Q_{di}$	$-1.8820 + 0.0120Q_{si}$	$11.5338 - 0.0304Q_{di}$
TR4	$-0.1144 + 0.001240Q_{si}$	$3.0900 - 0.001374Q_{di}$	$-1.8220 + 0.0207Q_{si}$	$11.2431 - 0.0407Q_{di}$
TR5	$-0.1056 + 0.000960Q_{si}$	$2.8500 - 0.001239Q_{di}$	$-1.8320 + 0.0183Q_{si}$	$11.2915 - 0.0400Q_{di}$
TR6	$-0.1033 + 0.000678Q_{si}$	$2.7900 - 0.000915Q_{di}$	$-1.8920 + 0.0155Q_{si}$	$11.5823 - 0.0309Q_{di}$
TR7	$-0.4071 + 0.000740Q_{si}$	$2.8500 - 0.002356Q_{di}$	$-1.7720 + 0.0161Q_{si}$	$11.0008 - 0.0740Q_{di}$
TR8	$-1.0600 + 0.001303Q_{si}$	$3.1800-0.002263Q_{di}$	$-1.8020 + 0.0180Q_{si}$	$11.1462 - 0.0646Q_{di}$
TR9	$-1.4900 + 0.004838Q_{si}$	$4.4700-0.005605Q_{di}$	$-1.8720 + 0.0459Q_{si}$	$11.4854 - 0.1172Q_{di}$
TRA	$-0.8700 + 0.000882Q_{si}$	$2.6100 - 0.003785Q_{di}$	$-1.8420 + 0.0459Q_{si}$	$11.3400 - 0.1338Q_{di}$
TRB	$-0.9600 + 0.001887Q_{si}$	$2.8800 - 0.002443Q_{di}$	$-1.8820 + 0.0270Q_{si}$	$11.5338 - 0.0796Q_{di}$
TRC	$-1.0100 + 0.002239Q_{si}$	$3.0300-0.001198Q_{di}$	$-1.8720 + 0.0217Q_{si}$	$11.4854 - 0.0370Q_{di}$
EU	$-2.3940 + 0.000022Q_{si}$	$4.3560-0.000028Q_{di}$	$-7.8969 + 0.00028Q_{si}$	$5.34630 - 0.0001Q_{di}$
	Butter		Cheese	
TR1	$-12.2400 + 2.1291Q_{si}$	$49.1488-1.7271Q_{di}$	$-5.5463 + 0.0833Q_{si}$	$70.7400 - 0.2890Q_{di}$
TR2	$-7.8200 + 13.6237Q_{si}$	$45.9969 - 6.9807Q_{di}$	$-4.5866 + 0.4096Q_{si}$	$81.0510 - 1.4302Q_{di}$
TR3	$-8.9133 + 1.5165Q_{si}$	$45.2025 - 2.2726Q_{di}$	$-4.3875 + 0.0891Q_{si}$	$63.9365 - 0.3738Q_{di}$
TR4	$-10.8133 + 3.1361Q_{si}$	$43.6650 - 3.0184Q_{di}$	$-4.9388 + 0.1701Q_{si}$	$70.0639 - 0.5631Q_{di}$
TR5	$-11.0667 + 4.2571Q_{si}$	$42.9988 - 2.9062Q_{di}$	$-4.8319 + 0.1631Q_{si}$	$55.8229 - 0.4387Q_{di}$
TR6	$-10.4667 + 3.4317Q_{si}$	$44.9719 - 2.2914Q_{di}$	$-4.6125 + 0.1163Q_{si}$	$65.4155 - 0.3875Q_{di}$
TR7	$-8.2733 + 17.6329Q_{si}$	$46.3813 - 5.9582Q_{di}$	$-4.3875 + 0.2411Q_{si}$	$52.0197 - 0.7770Q_{di}$
TR8	$-9.2533 + 7.3838Q_{si}$	$44.7925 - 4.9540Q_{di}$	$-4.2413 + 0.1532Q_{si}$	$52.6113 - 0.6766Q_{di}$
TR9	$-10.7467 + 5.2887Q_{si}$	$44.4081 - 8.6532Q_{di}$	$-4.5225 + 0.3104Q_{si}$	$50.8787 - 1.1527Q_{di}$
TRA	$-6.6276 + 2.8227Q_{si}$	$40.1031 - 9.0393Q_{di}$	$-4.2806 + 0.6036Q_{si}$	$51.6394 - 1.3534Q_{di}$
TRB	$-10.9933 + 6.7229Q_{si}$	$43.9213 - 5.7900Q_{di}$	$-4.3425 + 0.2121Q_{si}$	$52.0619 - 0.7980Q_{di}$
TRC	$-10.8200 + 4.1545Q_{si}$	$44.3056 - 2.7230Q_{di}$	$-4.1456 + 0.0680Q_{si}$	$47.9629 - 0.3427Q_{di}$
EU	$-31.3152 + 0.01945Q_{si}$	$35.9243 - 0.0120Q_{di}$	$-12.6646 + 0.00232Q_{si}$	$44.5573 - 0.0031Q_{di}$
	Yoghurt		Milk powder	
TR1	$-2.9910 + 0.0238Q_{si}$	$38.7491 - 0.0779Q_{di}$	$-3.9204 + 0.5586Q_{si}$	$48.9198 - 1.4750Q_{di}$
TR2	$-3.0020 + 0.0286Q_{si}$	$36.8318 - 0.3198Q_{di}$	$-3.9204 + 3.3767Q_{si}$	$48.9198 - 6.3703Q_{di}$
TR3	$-2.9500 + 0.4290Q_{si}$	$37.4373 - 0.1077Q_{di}$	$-3.9204 + 0.4290Q_{si}$	$48.9198 - 2.1103Q_{di}$
TR4	$-2.9020 + 0.0409Q_{si}$	$36.2264 - 0.1432Q_{di}$	$-3.9204 + 0.5683Q_{si}$	$48.9198 - 2.9016Q_{di}$
TR5	$-2.9810 + 0.0400Q_{si}$	$37.3364 - 0.1443Q_{di}$	$-309204 + 0.6056Q_{si}$	$48.9198 - 2.8370Q_{di}$
TR6	$-2.8480 + 0.0224Q_{si}$	$36.8318 - 0.1073Q_{di}$	$-3.9204 + 0.6111Q_{si}$	$48.9198 - 2.1387Q_{di}$
TR7	$-2.9790 + 0.0227Q_{si}$	$38.4464 - 0.2825Q_{di}$	$-3.9204 + 2.1218_{Qs}i$	$48.9198 - 5.3922Q_{di}$
TR8	$-2.8360 + 0.0227Q_{si}$	$34.0064 - 0.2151Q_{di}$	$-3.9204 + 1306800Q_{si}$	$48.9198 - 4.6425Q_{di}$
TR9	$-2.8760 + 0.0549Q_{si}$	$35.8227 - 0.3993Q_{di}$	$-3.9204 + 1306800Q_{si}$	$48.9198 - 8.1785Q_{di}$
TRA	$-2.8040 + 0.0365Q_{si}$	$39.7582 - 0.5126Q_{di}$	$-3.9204 + 1306800Q_{si}$	$48.9891 - 9.4606Q_{di}$
TRB	$-2.6940 + 0.0395Q_{si}$	$36.6300 - 0.2762Q_{di}$	$-3.9204 + 1.1037Q_{si}$	$48.9891 - 5.5331Q_{di}$
TRC	$-2.8260 + 0.0316Q_{si}$	$36.8318 - 0.1295Q_{di}$	$-3.9204 + 1306800Q_{si}$	$48.9891 - 2.5798Q_{di}$
EU	$-3.8240 + 0.00094Q_{si}$	$12.8431 - 0.0009Q_{di}$	$-8.7054 + 0.00898Q_{si}$	$54.8307 - 0.0412Q_{di}$

TR1: Istanbul, TR2: Western Marmara, TR3: Aegean, TR4: Eastern Marmara, TR5: Western Anatolia, TR6: Mediterranean, TR7: Middle Anatolia, TR8: Western Black Sea, TR9: Eastern Black Sea, TRA: Northeast Anatolia, TRB: Middle East Anatolia, TRC: Southeast Anatolia, EU: European Union

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Table 3. Comparison of actual and model-derived milk production

Region	Actual		Model		Ratio
	1000 Tons	%	1000 Tons	%	%
Istanbul	74.36	0.05	81.86	0.05	102.04
Western Marmara	1 690.68	1.07	2 062.26	1.21	113.06
Aegean	2 538.77	1.61	3 182.32	1.87	116.19
Eastern Marmara	923.03	0.59	1 036.83	0.61	104.12
Western Anatolia	1 099.78	0.70	1 302.78	0.77	109.80
Mediterranean	1 524.96	0.97	1 823.69	1.07	110.85
Middle Anatolia	1 834.57	1.16	1 982.25	1.17	100.15
Western Black Sea	1 626.62	1.03	1 676.87	0.99	95.55
Eastern Black Sea	615.97	0.39	525.83	0.36	92.31
Northeast Anatolia	1 973.70	1.25	2 122.64	1.25	99.68
Middle East Anatolia	1 017.66	0.65	1 045.82	0.62	95.26
Southeast Anatolia	902.17	0.57	923.43	0.54	94.87
EU	141 695.32	89.96	152 173.16	89.55	99.54
TOTAL	157 517.58	100.00	169 939.73	100.00	

The estimated supply and demand equation for the regions are presented in Table 2. Transportation costs estimates were collected from the International Transporters Association companies in Turkey.

RESULTS AND DISCUSSION

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 the raw milk production derived from the model to the actual quantity ranges from 92.31 to 116.19% (Table 3). Robustness of the model is evaluated by the increasing and decreasing supply and demand elasticities by 10%. Taken together, these findings suggest that the model generates a reasonable approximation to Turkey and the EU distribution of milk production in 2013.

Raw milk flow

After full memberships to the EU, when examined the optimum raw milk flow, it is seen that there would be no flow between EU and Turkey and the flow direction among the NUTS1 regions has not

Table 4. Optimum raw milk flow by region after full memberships to EU (thousand tons)

Region	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC	EU	**Total Supply**
TR1	82													82
TR2	730	834		499										2 062
TR3	778		2 405											3 182
TR4				1 037										1 037
TR5					1 303									1 303
TR6						1 824								1 824
TR7	479				234	227	1 042							1 982
TR8	460							1 216						1 677
TR9									526					526
TRA	371								157	571		1 023		2 123
TRB											976	70		1 046
TRC												923		923
EU													152 173	152 173
Total Demand	2 900	834	2 405	1 536	1 537	2 051	1 042	1 216	683	571	976	2 016	152 173	169 940

TR1: Istanbul, TR2: Western Marmara, TR3: Aegean, TR4: Eastern Marmara, TR5: Western Anatolia, TR6: Mediterranean, TR7: Middle Anatolia, TR8: Western Black Sea, TR9: Eastern Black Sea, TRA: North East Anatolia, TRB: Middle East Anatolia, TRC: South East Anatolia, EU: European Union

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Table 5. Optimum fluid milk flow by region after full memberships to EU (thousand tons)

Region	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC	EU	**Total Supply**
TR1	356													356
TR2	26	101		30										157
TR3			303											303
TR4				190										190
TR5					217									217
TR6						257								257
TR7					8	43	118					38		207
TR8	48							138						186
TR9									79	10				89
TRA										58		19		77
TRB											116	18		135
TRC												173		173
EU													32 546	32 546
Total Demand	431	101	303	220	224	300	118	138	79	68	116	248	32 546	34 892

Explanation see Table 4

changed (Table 4). Whereas, the raw milk flow among the NUTS1 regions has risen to 5,028 million tons increasing by 5.1% and the raw milk production to 17,706 million tons increasing by 7.3% compared to the pre-accession period. The studies revealed that after the full memberships to the EU, the milk production quantity would be increased by 15% (Koc et al. 2008), 1% (Karaca and Philippidis, 2008) and 3% (Leeuwen et al. 2011).

Fluid milk flow

After the full memberships to the EU, there would be no trade of fluid milk between the EU and Turkey and there would be no significant change in the fluid milk direction between the NUTS1 regions (Table 5). Whereas, the production quantity of fluid milk (2.436 million ton) and the tradable amount of fluid milk (240.2 thousand tons) would decline by 5.2 and 2.1%, respectively. The major reason of this decline could be the Turkey's higher comparative advantage compared to the EU in terms of cheese and yoghurt. For this reason, after the full memberships to the EU, some quantity of the increasing raw milk would be allocated to cheese and yoghurt.

Butter flow

After the full memberships to the EU, which is one of the biggest butter producers in the world, significant changes may occur in the regions of Turkey (Table 6). The EU has a higher comparative advantage than Turkey. Thus, the EU will have seized the Turkey butter market. Many regions which were export-oriented in the pre-accession period will then become import-oriented after the full membership. In the pre-

Table 6. Optimum butter flow by region after full memberships to EU (thousand tons)

Region	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC	EU	**Total Supply**
TR1	4.018				0.717	5.050	2.078	1.273						13.136
TR2		0.930												0.930
TR3			10.375											10.375
TR4				7.801										7.801
TR5					5.784									5.784
TR6						6.898								6.898
TR7							0.713							0.713
TR8								1.736						1.736
TR9									3.103		0.689			3.792
TRA										2.488	1.128	1.052		4.668
TRB											2.720			2.720
TRC												4.724		4.724
EU	14.346	3.153	1.801	0.876	2.257		2.042	2.496				4.007	1 579.058	1 610.036
Total Demand	18.364	4.083	12.176	8.677	8.758	11.948	4.833	5.505	3.103	2.488	4.537	9.783	1 579.058	1 673.313

Explanation see Table 4

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accession period, the amount of the tradable butter is 12.9 thousand tons, after the full memberships it will increase by 233.3% to 43 thousand tons. In the pre-accession period to the EU, the total amount of butter is 86.2 thousand tons, after the full memberships it will decrease by 26.6% to 63.3 thousand tons. However, the butter demand will have raised by 9.4% from 86.2 thousand to 94.3 thousand tons. Turkey currently has a deficit in the trade of the butter-milk flavoured solid lubricant and oils.

Cheese flow

Regarding cheese, there are some product differences between Turkey and the EU in terms of milk and milk products equivalents. White cheese is generally produced and consumed in Turkey whereas in EU, it is cheddar cheese. Thus, in this study the prices of white cheese in Turkey are analysed compared to the Gouda cheese (fat 45–48 %) prices in the EU.

Turkey has a higher advantage in the cheese trade and this provides a chance for Turkey to export cheese in the post-accession period, because cheese prices in the EU are higher than that of Turkey. After the full memberships, the EU will provide 96.8% of its cheese demand from its own production and import 1.7% from Istanbul, 0.2% from Aegean, 0.07% from the Eastern Marmara and 1.2% from the South-eastern Anatolia (Table 7). In the pre-accession period, the amount of cheese subject to the regional trade is 109.6 thousand tons. After the full memberships, it will increase by 296.3% to 434.4 thousand tons. In the pre-accession period, the total amount of cheese produced in Turkey was 1.107 million tons, after the full memberships it will increase by 18.7 % to 1.314 million tons. Leeuwen et al (2011) reported that after full membership, the Turkey's total cheese production would be increased by 4.8%. Turkey now has a surplus in foreign cheese trade. In 2012, the surplus was 94 million $ and in 2013, it was approximately 112 million $ (TURKSTAT 2014b). Turkey exports cheese to the Saudi Arabia, Iraq, Kuwait, United Arab Emirates, Jordan, Qatar and Azerbaijan, however, provided the required quality, hygiene and product diversity, Turkey can export to the EU. These are the verified data provided by the model.

Yoghurt flow

Yoghurt has also some product differences between Turkey and the EU in terms of milk and milk products equivalents. Yoghurt is produced and presented to costumers in simple and large packaging in Turkey; however, in the EU, it is produced and presented to customers in small packages as the fruit or plain yoghurt. Therefore, in this study, the analyses have been made considering the plain yoghurt prices in Turkey and the EU.

Turkey has a higher advantage in the yoghurt trade and this provides a chance for Turkey to export yoghurt after the full membership, because yoghurt prices in the EU are higher than in Turkey. After the full membership, the EU would provide 94.6% of its yoghurt demand from its own production and would import 0.52% from the Western Marmara, 0.47% from Aegean, 1.53% from the Central Anatolia, 1.67% from the Western Black Sea and 1.23% from the North-eastern Anatolia (Table 8). In the pre-

Table 7. Optimum cheese flow by region after full memberships to EU (thousand tons)

Region	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC	EU	**Total Supply**
TR1	67												165	232
TR2		47												47
TR3	16		133										19	168
TR4				99									7	106
TR5	14				95									109
TR6	17					132								149
TR7	9						49							58
TR8	33							57						89
TR9	19								32					51
TRA										24				24
TRB	19									3	47			70
TRC												99	112	210
EU													9 275	9 275
Total Demand	195	47	133	99	95	132	49	57	32	28	47	99	9 578	10 589

Explanation see Table 4

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Table 8. Optimum yoghurt flow by region after full memberships to EU (thousand tons)

Region	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC	EU	**Total Supply**
TR1	313													313
TR2	42	101		46									45	234
TR3	41		306										41	388
TR4				176										176
TR5					181									181
TR6					11	302								313
TR7					34		120						133	287
TR8								137					145	282
TR9	44								79					122
TRA										69			107	176
TRB					3						117	41		161
TRC												209		209
EU													8 221	8 221
Total Demand	439	101	306	221	228	302	120	137	79	69	117	251	8 693	11 063

Explanation see Table 4

accession period to the EU, the amount of yoghurt subject to the regional trade is 462.5 thousand tons, after the full membership it would increase by 58.2% to 731.9 thousand tons. In the pre-accession period, the total amount of yoghurt produced in Turkey was 2.461 million tons, after the full membership it will have increased by 15.5% to 2.842 million tons. When the Turkey's yoghurt trade is examined, it is seen that Turkey has a surplus. In 2012 and 2013, the export was approximately 8 million $, the import was 14 thousand $ (TURKSTAT 2014b).

Milk powder flow

After the full membership to the EU, which is one of the biggest milk powder producers in the World, significant changes may occur in the regions of Turkey. The prices of milk powder in the EU are low; so the EU has the competitive advantage. Thus, the EU holds an important part in the milk powder market (Table 9). In the pre-accession period, the amount of milk powder subject to the regional trade in Turkey is 37.7 thousand tons, after the full membership it would increase by 13.9% to 42.9 thousand tons. In the pre-accession period, the total amount of milk powder produced in Turkey was 142.8 thousand tons, after the full membership it would decrease by 14.8% to 121.3 thousand tons. These results show that the EU has a higher advantage than Turkey in the milk powder production.

CONCLUSIONS

According to the results under the EU full membership scenario where Turkey becomes a member

Table 9. Optimum milk powder flow by region after full memberships to EU (thousand tons)

Region	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC	EU	**Total Supply**
TR1	22.244						0.293			1.485				24.022
TR2		2.355												2.355
TR3		2.480	18.271											20.751
TR4		1.213		13.287			2.693					4.566		21.759
TR5					13.565							6.829		20.394
TR6						17.966						2.017		19.983
TR7							3.665							3.665
TR8								0.000						0.000
TR9									0.000					0.000
TRA										0.000				0.000
TRB											6.936	1.447		8.383
TRC												0.000		0.000
EU	3.902						0.483	8.288	4.693	2.570			1 090.625	1 110.561
Total Demand	26.146	6.048	18.271	13.287	13.565	17.966	7.134	8.288	4.693	4.055	6.936	14.859	1 090.625	1 231.873

Explanation see Table 4

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of EU, it is determined that butter and powder milk would be imported from the EU to Turkey, while Turkey exports white cheese and plain yoghurt to the EU and no trades in raw milk and fluid milk occur. The İstanbul, Aegean, Eastern Marmara and Southeastern Anatolia regions would export white cheese to the EU, while the plain yoghurt product would be exported from the Western Marmara, Aegean, Central Anatolia, Western Black Sea and Northeastern Anatolian regions to the EU. On the other hand, imports of butter and milk powder would flow into the Istanbul and Black Sea regions, respectively.

In the process of the preparation for the EU full membership, agricultural policies focusing on the hygiene and productivity in the raw milk production should be taken into account in order to decrease the cost and to meet the EU standards. The policies regarding the quality, hygiene and product diversity for cheeses and yoghurt, in which Turkey has a comparative advantages, should be taken into consideration for smooth and better results in the process of the accession to the EU.

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