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DETERMINING OPTIMUM LIVESTOCK (CATTLE) FLOW IN TURKEY USING SPATIAL EQUILIBRIUM MODEL

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ABSTRACT

The share of cattle meat production by agricultural regions in Turkey has shown significant variations from 1963 to date. This had a positive effect in some regions while some other regions were impacted negatively in terms of the cattle meat production and thus led to variations in the cattle meat production. Within this context, this study intends to determine the optimum livestock cattle between agricultural regions. Turkey Cattle Breeding Spatial Equilibrium Model in Turkey for 2016 was formulated for this purpose. This model formed by using the supply & demand functions and inter-regional transportation costs was analyzed by the GAMS software. According to the results of the analysis, it was established that in 2016; there was a cattle flow from Northeastern, Southeastern and Central - Eastern regions towards the other regions. In 2016, Marmara regions procured 48.8% of its cattle requirement and Aegean Region procured 26.4% of its cattle requirement from the Northeastern Region. The Mediterranean Region met 16.3% of its cattle demand from Northeastern Region, 29.5% of its requirement from Southeastern Region and 12.2% of its need from Central – Eastern Region. Black sea and Central Southern Regions met their cattle requirements from the Central eastern regions by 3.6% and 22.8% respectively.

Keywords: Spatial equilibrium model, cattle industry, production flow, Turkey.

INTRODUCTION

Within the period of 53 years, from 1963, which marks the beginning of the planned economic model to 2016, the production of cattle meat showed great changes in Turkey by the agricultural regions. This change has become especially apparent after 1982.While the share of the Northeastern (11%), Marmara (4.1%) and Black Sea (2.4%) regions in the total cattle meat production of Turkey declined in the period between 1963 – 2016, other regions such as Aegean (5.1%), Central Southern (4.6%), Central Northern (4.6%), Central Eastern (1.1%), Mediterranean (1.1%) and Southeastern (1.0%) increased their share within the same cake (Table 1).

Table 1. The Share of the Cattle Meat by the Agricultural Regions (%).

Agricultural Regions	Cattle Meat Production			Change	
	1963	1982	2016	1963-1982	1982-2016
Central Northern	9.2	10.2	13.8	1.0	3.6
Aegean	10.5	8.2	15.6	-2.3	7.4
Marmara	12.3	7.3	8,2	-5.0	0.9
Mediterranean	5.6	5.9	6.7	0.3	0.8
Northeastern	23.1	24.8	12.1	1.7	-12.7
Southeastern	8.2	13.3	9.2	5.1	-4.1
Black Sea	13.9	13.9	11.5	0.0	-2.4
Central Eastern	10.5	10.5	11.6	0.0	1.1
Central Southern	6.7	5.9	11.3	-0.8	5.4
Turkey	100.0	100.0	100.0	0.0	0.0

Source: Anonymous (1964); Anonymous (1975); Anonymous (1982); Anonymous (2017).

While the share of the Marmara and Aegean Regions in the total cattle meat production declined between 1963–1982, Southeast and Northeast Regions increased their share in this regard. Between 1982–2016 on the other hand, the shares of Northeastern, southeastern and Black Sea Regions in the cattle meat production dropped while central eastern and Aegean and Central Northern Regions increased their respective shares.

The cattle meat production after 1982 has shifted to Aegean and Central Regions of Turkey. During this period, Central Southern, Central Northern and Central Eastern Regions upped their shares within the cattle meat production sharply. It was found out that within the same period, the share of those regions within the total population decreased as well. Therefore, it is safe to say that the cattle meat production was directed towards the profitable regions. In this case, there is a flow of livestock between the regions in accordance with the supply and demand factors that lead to such a movement.

The fact that there is a livestock flow between the regions that are rich in assets and the other regions is a matter of economics and is related to establishing the supply – demand equilibrium and creating benefits. Knowing the flow of the livestock (cattle) and cattle meat between the regions is crucial for understanding the regional advantages and for shaping the future of cattle meat business in Turkey.

Majority of the cattle meat in Turkey had been produced in North Eastern Region until 80's. The share of this region in meat production after 80's significantly declined despite the fact that this region boasted far more meadows and had relative superiority over other regions in terms of labor cost and expertise of the farmers in the region. Such a decline in bovine meat production is of paramount importance because this leads to inter regional imbalances and prevents the efficient utilization of the resources.

In addition, the alternative agricultural production is almost nonexistent in Northeastern Region. The short vegetation period in the region limits the production of the herbal products. Other negative factors include the harsh climatic conditions, the inefficacies in marketing activities and the terrorist activities. After 1982, it has been observed that the production of the cattle meat has fallen sharply. In the end, this situation made the farmers living in the North Eastern Region disadvantageous compared to the farmers other regions. Therefore, the economic and social differences between East and West increased gradually. Such differences fueled the emigration from east to west and caused very serious problems for the regions that were the target of the emigration (Keskin, 2003).

During the period from 1982 to this day, the change in the cattle meat production by region has had positive effects for some regions while having negative effect on others. Revealing the causes of the change in the cattle meat production in Turkey and indicating what factors played significant roles in such a change is highly important.

There are important towards determining the optimum livestock flow. Wallace and Judge (1959) by the data from 1995 from 21 regions that share a border with each other, attempted to determine the optimum production flow, cattle meat regional equilibrium price and optimum livestock (cattle) price. Charles and Donald (1972) created a multi product model for cattle industry. In their study, the regional advantages in stock breeding industry were identified. A live stock breed and red meat flow chart was plotted for 29 regions determined for this purpose. Gülten (1975) analyzed the volume, time, points of departure and points of arrival as well as the reasons for the movement of the butchery meat between the provinces and agricultural regions in Turkey by breed between 1957 and 1970. In her conclusion, she reported a flow of butchery breed between the regions and provinces that were prominent in terms of animal production and the regions and provinces that led the meat consumption. Yavuz (1994) analyzed the factors that caused structural changes between the regions in 10 different regions, where the dairy product flow was present for the period of 1960–1991. The model, formed for this analysis comprised of two stages being production and processing, of 10 regions and of 5 groups of dairy products. In the study, the supply factors were reported as the most significant factors that led to the inter-regional structural changes, which were followed by the per capita income, population size and support policies.

When the previously conducted studies in this regard are taken into account, it can be seen that the empirical studies that aim to determine the optimum livestock flow in cattle industry for Turkey in general are not sufficient in general. Determining the optimum livestock (cattle) flow in Turkey by the agricultural regions in order to fill the aforementioned deficiency and to guide, the policy makers constitute the main goal of this study.

MATERIALS AND METHODS

Materials: In the model, the data related to supply factors was obtained from the statistics of Turkish Statistical Institute (TSI). The population, income and the change ratio were calculated based on the TSI population and Income Statistics in the same manner. In a similar fashion, the retail prices obtained by the breeders for livestock (cattle) were extracted from the summaries of TSI Agricultural Statistics and from the retail price indexes.

The consumption data, used in the model were obtained by utilizing the data belonging to the provinces that make up the regions since there is no data available at regional level. The transportation costs, which are crucial in terms of the inter regional livestock (cattle) flow, are the unit costs of transportation per km. the supply and demand elasticity, which are two of the main elements of the model was extracted from the studies, previously conducted regarding the subject matter.

Methods

The Theoretical Framework of the Spatial Equilibrium Model: The problem of spatial equilibrium is related to the applications, in which the price is inherently accepted. This problem is the indication of the transportation model with the assumption that the supply and demand are constant and can be explained follows. The production and / or the consumption often occur in different places that have a supply – demand relation with each other. In case the difference between the regional prices is higher than the transportation costs, the inter-regional trade will continue until the difference between the prices becomes equal to the transportation costs. The modeling of this state clears the questions like how much the regional production and consumption will be and at what level the trade shall be carried out.

The supply and demand functions (i) in a given region can be presented as in equations 1 and 2.

$$P_{si} = f_i(Q_{si}) \quad (1)$$

In here;

P_{si} : The supply price in region i,

Q_{si} : The amount, supplied in region i.

$$P_{di} = f_i(Q_{di}) \quad (2)$$

In here;

P_{di} : Demand price in region I,

Q_{di} : The amount, demanded in region I

The quasi welfare function for each region can be defined as the area between the supply and demand functions as in equation 3. (Figure 1) McCarl and Spreen, (1999):

$$W_i = (Q_{si}^*, Q_{di}^*) = \int_0^{Q_{di}^*} P_{di} dQ_{di} - \int_0^{Q_{si}^*} P_{si} dQ_{si} \quad (3)$$

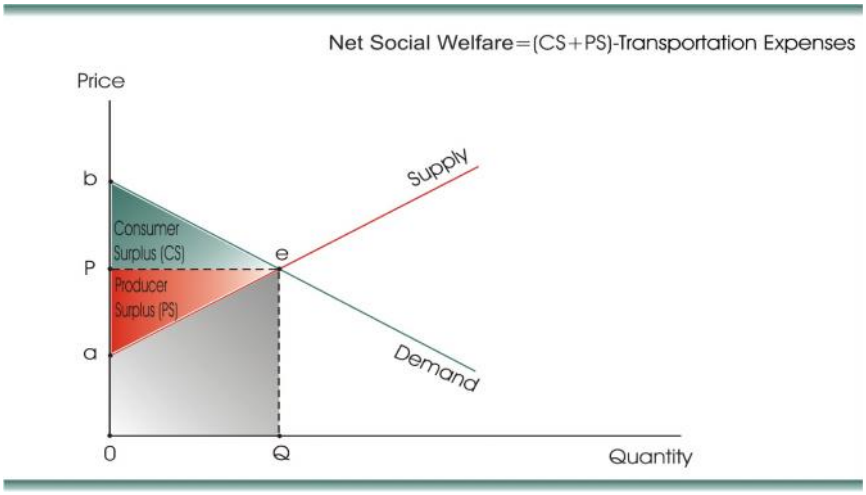

Figure 1. Target Function (Net Social Welfare)

The net social welfare area is derived by subtracting the shipment costs from the sum of the welfare functions in each region. The net wealth is, on the condition that T_{ij}, shows the amount of goods, transported from region I to region j and c_{ij} shows its cost;

$$NW = \sum_i W_i(Q_{di}, Q_{si}) - \sum_i \sum_j c_{ij} T_{ij} \quad (4)$$

By considering the net welfare function as the objective function and by adding the limiters as well; it is possible to formulate this model as an optimization problem. The indicated limiters contain a supply – demand equilibrium that is equal to the regional demand (or higher than it).

$$Q_{di} \le \sum_j T_{ij}$$ for all i's;

$$Q_{si} \le \sum_j T_{ij}$$ for all i's,

As the result, the problem equation turns to the one in Equation 5,

$$\text{Max} \sum_i \left(\int_0^{Q_{di}^*} P_{di} dQ_{di} - \int_0^{Q_{si}^*} P_{si} dQ_{si}\right) - \sum_i \sum_j c_{ij} T_{ij} \quad (5)$$

$$Q_{di} - \sum_j T_{ij} \le 0$$ for all i's,

$$-Q_{si} + \sum_j T_{ij} \le 0$$ for all i's,

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

This problem produces an equilibrium solution as long as the demand curve has a negative bias and the supply curve has a positive bias.

$$\partial L / \partial Q_{di} = P_{di} - \partial_{di} \leq 0 \qquad (\partial L / \partial Q_{di}) Q_{di} = 0$$
$$Q_{di} \geq 0$$
$$\partial L / \partial Q_{si} = -P_{si} - \partial_{si} \leq 0 \qquad (\partial L / \partial Q_{si}) Q_{si} = 0$$
$$Q_{si} \geq 0$$
$$\partial L / \partial T_{ij} = -c_{ij} - \partial_{dj} - \varphi_{si} \leq 0 \qquad (\partial L / \partial T_{ij}) T_{ij} = 0$$
$$T_{ij} \geq 0$$

In this case, the shadow price (∂_{di}) in the first limiter in region i is equal to the demand price is positive, if the Q_{di} is positive and the second shadow price (φ_{si}) is equal to the demand price if the Q_{si} is positive. The transportation movements ensure that the demand price in a given region is lower than (or equal to) the prices (supply price + transportation costs) of the all other regions.

The solution to this problem resents the level of supply by the regions, the level of consumption and the inter-regional trade. (T_{ij}, $i \neq j$) The price in each region is found as a dual variable.

The relations between the equilibrium prices can be explained in several ways;

1. If the demand in region I can be met, the local supply and demand prices ($T_{ii} \rangle 0$), are equal,
2. If the region i carries out imports from region j, ($T_{ij} \rangle 0$), the demand price in region j is equal to the costs of "the demand price + transportation costs" in region i.
3. If the region j does not export to region i, ($P_{dj} \langle P_{si} + c_{ij}$), no trade should be conducted since the price difference does not compensate the transportation costs.

Implementation of the Spatial Equilibrium Model in meat cattle breeding in Turkey: In the Spatial Equilibrium Model that was formulized for meat cattle breeding in Turkey, the livestock (cattle) flow between the regions for nine agricultural regions is discoursed by taking the production phase into account (Yavuz, 1994). In the production phase, the breeder supplies the cattle that he breeds to the market. The producer, on the other hand, demands the supplied cattle in order to turn it into meat and meat products. In the production phase, the supply and demand of the livestock (cattle) are taken into account.

Assumptions of the Model: The assumptions of the model, formed for the meat cattle breeding are as follows;

1. In the model, which contains nine agricultural regions, each region has production (i =1, 2,.....m), points. (m=9)
2. Each region has a supply and demand function for livestock (cattle).

Supply and demand functions for livestock (cattle) in production phase (equations -7)

$$q_i^s = \alpha_i^s + \beta_{1i}^s P_i^s + \beta_{2i}^s V_i^s + \beta_{3i}^s P_i^Y + \beta_{4i}^s P_i^W + \beta_{5i}^s P_i^C + \beta_{6i}^s P_i^R + \beta_{7i}^s T_i^s \quad \textbf{(6)}$$

q_i^s : The amount of meat supplied,

P_i^s : The price of cattle

V_i^s : The meat yield per cattle

P_i^Y : The Price of animal feed

P_i^W : Labor cost

P_i^C : Prices, acquired by the breeders,

P_i^R : The prices of the competitive products,

T_i^s : Trend

α_i^s : Intersection co-efficient

β_i^s : Estimators for the variables

$$q_l^d = \alpha_1^d + \beta_{1l}^d P_1^d + \beta_{2l}^d I_l^d + \beta_{3l}^d N_l^d + \beta_{4l}^d I_l^d \quad \textbf{(7)}$$

q_l^d : Amount of demanded cattle meat

P_1^d : The price of cattle

I_l^d : Income

N_l^d : Population

I_l^d : The price of the substitutions

3. The transportation cost is considered as linear when the livestock (cattle) is transported from the point of breed (i) to the point of production (I). In other case, the transportation cost is comprised of the sum of the initial fixed cost and the variable costs that linearly increase depending on the distance. In such a case, the transportation costs can be indicated as in Equation – 8;

For the livestock (cattle): $t_{il} = \alpha_{il} + \beta_{il} m_{il} + \beta_{il} f_{il}$ **(8)**

In this equation;

t_{il} : The transportation cost between the point of breed and the point of production.

m : Distance

f_{il} : Marked up cost of wastage

α : Fixed Costs

β : Variable Costs

Equilibrium Conditions

- **Conditions for arbitrage:** The arbitrage conditions that show the relationship between the livestock (cattle) price and the transportation costs can be expressed as in Equation – 9;

Livestock (cattle) $X_{il} \geq 0 : P_l - P_i \leq t_{il}$ (9)

In this equation;

X_{il} : The number of cattle, transported from region i to region

P_i : The cattle price in region i

P_l : The cattle price in region l

t : Transportation cost.

The relations in equation 9 show that the livestock (cattle) roaming can only be possible if the inter regional price differences are equal to (or higher than) the inter regional transportation costs. In case this condition is not met, the inter-regional transportation of the indicated products would lead to economic losses.

- **Equations, required for the Supply – Demand Equilibrium:** The amount of cattle, supplied in a given region is equal to the amount of cattle that this region transports to its own and to the other regions. In the same manner, the amount of demand for the cattle in a given region is equal to the number of cattle, demanded by its own and by the other regions. For a Supply – Demand Equilibrium in a given region, the amount of the supplied cattle should be equal to the number of cattle demanded.

In the Production Phase:

$$q_i^s = \sum_{l=1}^{k} X_{il} \qquad q_l^d = \sum_{i=1}^{m} X_{il} \qquad \textbf{(10)}$$

In this equation:

q_i^s : The number of cattle, supplied from region I,

q_l^d : The number of cattle, demanded by region I

X_{il} : Number of cattle, transported from region i to region

Marked up Cost of Wastage

$$f_{il} = (q_i^s * r_{il}) * p_i^s \qquad (11)$$

In this equation:

f_{il} : Marked up Cost of Wastage

q_i^s : The number of cattle supplied,

r_{il} : The marked up wastage ratio,

p_i^s : Cattle Price

The analysis of the Model: The Spatial Equilibrium Model, which was formed by using supply and demand functions and inter regional transportation costs, was analyzed by utilizing General Algebraic Modeling System (GAMS) software (Broke *et al.* 1992) on the data from 2016. In this study, in order to model the livestock (cattle) flow between the agricultural regions, a static equilibrium model of the markets, divided locally. The inter-regional flow is a function of the reaction of the breeders and producers from different regions to the price changes and transportation costs.

The Spatial Equilibrium Model, asserted by Enke (1951), was turned into a mathematical maximization problem by Samuelson (1952). The model was transformed into a quadratic model (as it is utilized in this study in its present form) by Takayama and Judge (1964) and was solved by Hazell and Norton (1986) by the iteration method. The target function of Takayama and Judge is maximizing the area that is calculated by subtracting the transportation costs from the area between the excess supply and excess demand curves (Yavuz, 2001). Since it is much useful, the solution equation of the model can be indicated (equation-12) mathematically with the inverse supply and demand functions.

Target Function:

$$\sum_{l=1}^{k}\left[\alpha_l^d q_l^d - 1/2\beta_l^d (q_l^d)^2\right] - \sum_{i=1}^{m}\left[\alpha_l^s q_l^s - 1/2\beta_l^s (q_l^s)^2\right]$$

$$+ \sum_{j=1}^{n}\sum_{N=1}^{z}\left[\alpha_j^d q_j^d - 1/2\beta_j^d (q_j^d)^2\right] - \sum_{j=1}^{n}\sum_{N=1}^{z}\left[\alpha_j^s q_j^s - 1/2\beta_j^s (q_j^s)^2\right]$$

$$- \sum_{i=1}^{m}\sum_{l=1}^{k} t_{il} X_{il} - \sum_{l=1}^{k}\sum_{j=1}^{n}\sum_{N=1}^{z} t_{lj} X_{lj} \qquad \textbf{(12)}$$

Limitations:

$$q_i^s = \sum_{l=1}^{k} X_{il} \qquad q_l^d = \sum_{i=1}^{m} X_{il}$$

$$f_{il} = (q_i^s * r_{il}) * p_i^s$$

The Process of the Model: The process of the model is comprised of three sections. They are;

1. Transportation cost functions,
2. Supply functions,

3. Demand functions

Transportation cost functions: In this study, a province from each of the agricultural regions, where the livestock (cattle) is transported, was selected and it was assumed that the livestock flow occurred between the selected provinces by truck. Factors such as the population density, cattle meat production and the strategic significance were taken into account in the selection process. The transportation hubs by the agricultural regions and their distances from each other are shown in Table 2.

Table 2. The transportation hubs by the agricultural regions and their distances from each other (km).

Agricultural Regions	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Central North (Ankara)	0								
(2) Aegean (İzmir)	580	0							
(3) Marmara (İstanbul)	453	566	0						
(4) Mediterranean (Adana)	556	896	939	0					
(5) Northeast (Erzurum)	877	1457	1225	813	0				
(6) Southeast (Diyarbakır)	911	1422	1364	527	325	0			
(7) Black Sea (Samsun)	419	999	737	747	571	820	0		
(8) Central East (Sivas)	443	1023	893	499	434	480	340	0	
(9) Central South (Konya)	258	546	665	356	955	882	642	521	0

Source: Anonymous (2016).

The equation regarding the livestock (cattle) transportation costs is given below;

$$t_{il} = (f_s * m_{il}) + f_{il} \quad \textbf{(13)}$$

In this equation;

t_{il} : The transportation cost of the cattle from region i to region 1. (TRY/ton/km)

f_{il} : The marked up cost of wastage (TRY)

f_s : The transportation cost for cattle (TRY / ton)

m : Distance (km)

Supply Functions: In order to analyze the inter-regional structural changes of the livestock breeding in Turkey, long-term changes should be taken into account. The long term is a period, in which the producers may adjust all kinds of supply in response to the changes in demand. The supply elasticity is higher in the long term compared to the short term (Yaylalı, 1994). In this study, by using the supply and demand elasticity of the bovine, supply and demand parameters were calculated. The supply elasticity of livestock (cattle) was extracted from the previously conducted work (Anonymous,1983; Koç and Yurdakul, 1994; Koç, 1995; Kasnakoğlu, 1997 and Koç *et al.* 2001). Since there is no study in Turkey in which the supply elasticity is calculated regionally; the regional elasticity was estimated by taking the own consumption of the regions as well as their relations with the market into account.

The supply co-efficient of the livestock (cattle) is calculated via the equations, given in Equations 14 and 15.

$$\beta^s = \in^s * \frac{q^s}{p^s} \quad (14)$$

$$\alpha^s = q^s - \beta^s * p^s \quad (15)$$

Within those equations;

β^s : Supply function co-efficient,

α^s : Supply function constant,

$\in^s$: The price elasticity of the supply,

q^s : The amount of supply within the indicated year,

p^s :The supply price within the indicated year.

Demand Functions: Just like in the supply functions, the elasticity in the demand functions was derived from the previously conducted works. (Anonymous, 1983; Koç and Yurdakul, 1994; Koç, 1995; Kasnakoğlu, 1997 and Koç *et al.* 2001). The demand co-efficient and constant was calculated via the equations in Equations 16 and 17.

$$\beta^d = \in^d * \frac{q^d}{p^d} \quad (16)$$

$$\alpha^d = q^d - \beta^d * p^d \quad (17)$$

Here:

β^d :Demand function co-efficient,

α^d : Demand function constant,

$\in^d$:The price elasticity of the demand,

q^d :The amount of the demand in the indicated year,

p^d : The demand price within the indicated year.

The findings of the study and discussion

Evaluation of the model: In order to test the reliability of the model, the data obtained from the data were compared with the real data and a sensitivity analysis was conducted. According to the results, it was found that the ratio of the shares of the cattle meat production that were extracted from the model to the real share of the cattle meat production varied between 92.7% and 108.3% in 2016 (Table 3). The model data for northeast region being more than the real data (108.3%) can be considered significant in the sense that it shows that the production may increase in case the information and product flow within the market becomes absolutely possible and free.

Table 3. The comparison of the real data with the data from the model for the inter-regional cattle meat production shares (%).

Agricultural Regions	2016		
	Real	Model	Ratio
Central North	13.8	12.8	92.7
Aegean	15.6	16.4	105.1
Marmara	8,2	7,9	96.3
Mediterranean	6.7	6.5	97.0
Northeast	12.1	13.1	108.3
Southeast	9.2	9.1	98.9
Black Sea	11.5	12.0	104.3
Central East	11.6	11.7	100.8
Central South	11.3	10.5	92.9
Turkey	**100.0**	**100.0**	

Source: Original calculations.

Sensitivity test was carried out in order to test the supply elasticity used in the model. Based on this, the shares of regional eat production for three different elasticity groups were calculated as per year. Group I: The supply elasticity, used in the basic model, Group II: 10% more than the Group I and Group III: 10% less than Group I. According to the results of the analysis, the coverage ratio of the regional cattle meat production share, calculated via the elasticity values of Groups II and III for the regional cattle meat production share, determined by the elasticity values, used in the main model varies between 96.8%-102.1%. This shows that the results, derived from this model are reliable.

Optimum Livestock (Cattle) Flow: Knowing the optimum livestock (cattle) flow between the agricultural regions is crucial in terms of defining the regional advantages. Within this context, the optimum livestock (cattle) flow for 2016 was determined and was presented in Figure 2 and Table 4.

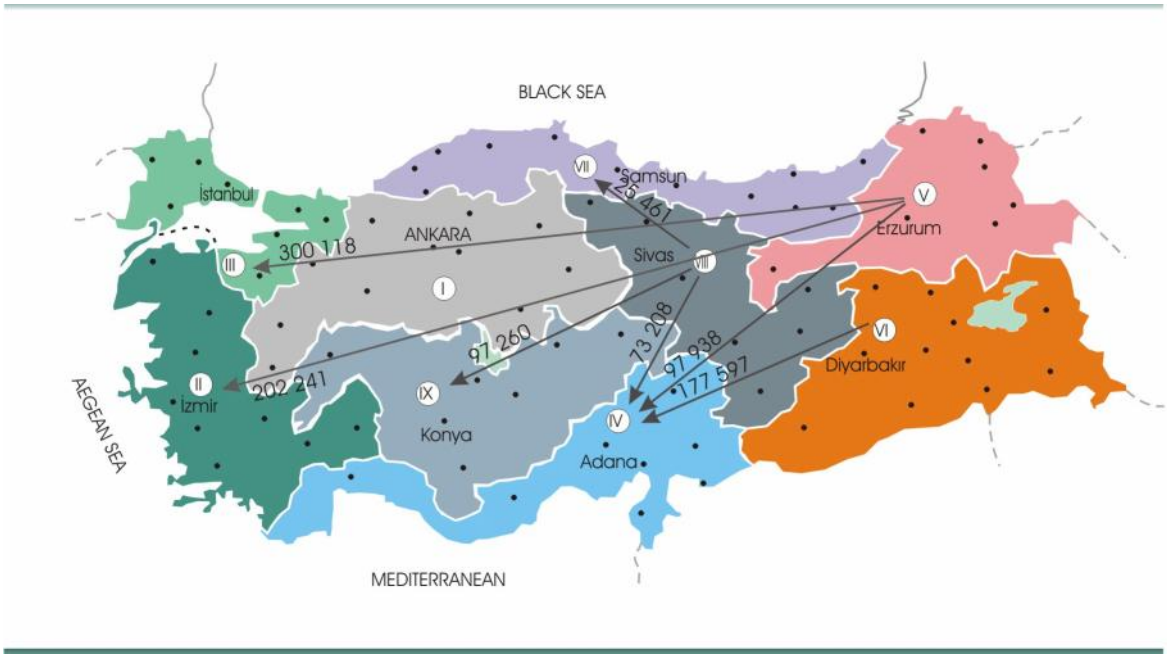

Figure 2. Optimum livestock (cattle) flow in 2016.

in 2016, there is a flow of cattle from Northeastern, Southeastern and Center eastern regions to the other regions. The region with the highest flow is the Southeastern region (600.292 head).

Table 4. The transportation amount of livestock (cattle) between the hubs by the agricultural regions.

Agricultural Regions	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Central North (Ankara)	596 155								
(2) Aegean (İzmir)		710 417							
(3) Marmara (İstanbul)			314 878						
(4) Mediterranean (Adana)				252 199					
(5) Northeast (Erzurum)		202 241	300 118	97 938	155 620				
(6) Southeast (Diyarbakır)				177 597		310 497			
(7) Black Sea (Samsun)							698 689		
(8) Central East (Sivas)				73 208			25 461	315 902	97 260
(9) Central South (Konya)									427 400

Source: Original calculations.

The Marmara region acquires 48.8% of its cattle demand and Aegean region meets 26.40% of its cattle demand from the Northeastern region. Mediterranean region (16.3%), Northeastern region (29.5%), Southeastern region (12.2%) meet their cattle demand from the Central Eastern region. The Black Sea and Central Southern regions meet their cattle demand from the Middle Eastern regions with the respective rates of 3.6% and 22.8% (Table 4).

According to the results of the analysis, it was established that there was a flow of livestock (cattle) from southeastern and central eastern regions to the other regions in 2016. Gülten (1975) reports that Marmara, Mediterranean and the Central Northern regions were at

the top of the list in terms of the net cattle intake between 1957–1970. The same study indicates that the Northeastern, Southeastern and Central Eastern regions take the top ranks in terms of net cattle export. In the same manner, Keskin (2003) suggests that the shares of Northeastern, Southeastern and Black Sea regions in cattle meat production declined as there was a flow of live cattle from the Northeastern, Southeastern and Central Eastern regions to the other regions in 2000's. The indicated results showed parallel conclusions with the findings of this study.

It was determined that there was a cattle meat flow from Mediterranean, Aegean, Southeastern, Central Eastern and central Southern regions to other regions in 2016. However, such findings are only significant as long as the inter-regional optimum flow occurs for the aforementioned animal products.

The results of the study demonstrated that the excess in demand in an agricultural region, resulted from the increase in population cannot be met with the production of that particular region alone and the inter-regional transportation plays a major role in this regard. Therefore, it was also determined that a significant amount of livestock (cattle) may be transported from the eastern regions to the western regions.

Due to the fact that TSI employed different methods to compile data after 80's, (Talim and Saner, 1995) which resulted sudden and important changes in data set used for this study, and the fact that the model used in this study does not cover all real effects just like any other model, the results should be interpreted with maximum care.

RESULTS

In Turkey, the production of cattle meat by agricultural region showed significant changes from 1963 which marked the beginning of the planned economy era to this day. This indicated changes became much more evident. In the period between 1960 – 1982, the share of Marmara and Aegean regions in total cattle meat production declined significantly while the shares of Southeastern and Northeastern regions increased in this regard. In the period between 1980 – 2016 on the other hand, the shares of Northeastern, Southeastern and Black Sea regions in the cattle meat production dropped sharply while Aegean, Central Eastern and Central Northern regions increased their shares. In post 82 period, the cattle meat production has shifted to the Aegean and Central regions of Turkey. It was also determined that the shares of those indicated regions within the total population decreased within the same period. Therefore, it is safe to say that the cattle meat production was shifted to the regions, where it is profitable. In this case, the livestock (cattle) flow in Turkey by the agricultural regions and the supply and demand factors that cause such flow become highly important.

The majority of the cattle meat in Turkey used to be produced in Northeastern region until 80' while the share of this region after 1980 in the meat production decreased significantly. This decline in the cattle meat is important because in Northeastern region, the alternative agricultural production is virtually nonexistent. The short vegetation period in the region limits the production of the herbal products. When coupled with the climate conditions, the inefficacies in marketing activities and the terrorist activities after 1982, it is observed that the production of the cattle meat fell sharply. In the end, this situation made the farmers, living in the North Eastern Region disadvantageous compared to the farmers from the other regions. Therefore, the economic and social differences between East and West increased gradually. Such differences fueled the emigration from east to west and caused very serious problems for the regions that were the target of the emigration.

According to the results, there was a low of livestock (cattle) in 2016 from northeastern and central eastern regions to the other regions. In 2016, Marmara region met 48.8% of its cattle demand and Aegean region met 26.40% of its cattle demand from the Northeastern region. Mediterranean region (16.3%), Northeastern region (29.5%), Southeastern region (12.2%) meet their cattle demand from the Central Eastern region. The Black Sea and Central Southern regions meet their cattle demand from the Middle Eastern regions with the respective rates of 3.6% and 22.8%. However, such findings are only significant as long as the inter-regional optimum flow occurs for the aforementioned animal products. The results of the study demonstrated that the excess in demand in an agricultural region, resulted from the increase in population cannot be met with the production of that particular region alone and inter regional transportation plays a major role in this regard. Therefore, it was also determined that a significant amount of livestock (cattle) may be transported from the eastern regions to the western regions.

The statistical data regarding the animal production activities varies in different sources. Implementing right policies and allocating resources for a field of activity with no certain figures and scale known at the present time, is not a rational approach. That is why; the animal assets by type per province should be registered accurately as a priority. Developing and implementing policies that would ease the optimum livestock (cattle) flow, determined according to the results of the analysis is important in terms of the rational utilization of the national resources as it may also be considered as a factor that may overcome the developmental differences between the regions.

The hardest problem that was encountered during the study was the lack of supply and demand elasticity of the livestock, cattle meat and cattle products in literature by provinces. In order to shed a light on the similar subsequent studies, it would be beneficial to calculate the supply and demand elasticity of the agricultural products regionally and to conduct further studies in this regard.

REFERENCES

Anonymous. (1964). Turkish Statistics Institute. Agricultural Structure and Production (1960-1962). Publication No: 455, Ankara.

Anonymous. (1975). Turkish Statistics Institute. Agricultural Structure and Production (1970-1972). Publication No: 725, Ankara.

Anonymous. (1982). Turkish Statistics Institute. Agricultural Structure and Production (1980). Publication No: 985, Ankara.

Anonymous. (1983). Research for the development of animal products. The Final Report (Animal Products – Supply and Demand) State Planning Organization, Volume 4, Ankara.

Anonymous. (2016). Turkey Highway Map. General Directorate for Highways Area VIII Regional Directorate, Erzurum- Turkey.

Anonymous. (2017). Organization for Economic Co-operation and Development, https://data.oecd.org/, (20.05.2017).

Broke, A., D. Kendrick and A. Meeraus (1992). GAMS, A Users' Guide, Release 2.25, The Scientific Pres, South San Francisco.

Charles, Y.L. and A.W. Donald (1972). A Spatial Analysis of Beef Feeding and Slaughtering with Emphasis on the South. Sothern Cooperative Series, Southern.

Enke, S. (1951). Equilibrium Among Spatially Separated Markets: Solution by Electric Ana- logue, Econometrica, 19(1), 40-47.

Gülten, S. (1975). Economic Analysis of the Butchery Animal Assets in Turkey. Atatürk University Publication No: 420, Faculty of Agriculture Publication No: 198, Research No: 127, Erzurum.

Hazell, B. P. R. and R. D. Norton (1986). Mathematical Programming for Economic Analysis in Agriculture. Macmillan, New York.

Kasnakoğlu, H. (1997). Recent Developments in the Livestock Sector in Turkey and Review of Livestock/Feed Relationships and Implications for Food Security. Middle East Technical University, Department of Economics, Ankara.

Keskin, A. (2003). The Analysis of the Inter Regional Structural Change of Cattle Breed via Spatial Equilibrium Analysis, Ph.D. thesis (unpublished).Ataturk University, Institute of Science, Erzurum.

Koç, A. (1995). The Econometric Analysis of the Red Meat Supply and Demand in Turkey and the Examination of the Red Meat Industry and its operation. Ph.D. thesis (unpublished). Çukurova University, Institute of Science, Adana.

Koç, A., V. Uzunlu and A. Bayaner (2001). Agricultural Product Projections in Turkey 2000-2010. Institute of Agricultural Research Publication No: 54. Ankara.

Koç, A. and O. Yurdakul (1994). Türkiye'de Kırmızı Et Arz ve Talep Analizi. Çukurova Üniversitesi Ziraat Fakültesi, Tarım Ekonomisi Bölümü, Adana.

McCarl, B.A. and T.H. Spreen (1999). Applied Mathematical Programming Using Algepraich System. Agricultural Economics Texas A and M University, Texas.

Samuelson, P.A. (1952). Spatial Price Equilibrium and Linear Programming. The American Economic Review, 42, p. 283-303.

Takayama, T. and G.G. Judge (1964). Spatial Equilibrium and Quadratic Programming. J. Farm Economics, 46, p. 67-93.

Talim, M. and G. Saner (1995). The Structural Status and the Problems of Animal Breeding Enterprises in Turkey, the Symposium on the Structural and Economic Problems of İzmir, İzmir.

Wallace, T.D. and G.G. Judge (1959). Spatial Price Equilibrium Analyses of the Livestock Economy. Department of Agricultural Economics, Oklahoma State University, Technical Bulletin: T-79, Oklahoma.

Yavuz, F. (1994). A Spatial Equilibrium Analysis of Regional Structural Change in the U.S. Daily. Ph.D. thesis (published). The Ohio State University, U.S.A.

Yavuz, F. (2001). Agricultural Policies II –General policies and International Agriculture Atatürk University, Lecture Notes, Faculty of Agriculture , Publications No: 186, Erzurum.

Yaylalı, M. (1994). Microeconomics, Beta Brint house, Publication No: 484, İstanbul.