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Is price significant in planning for sugar beet production? An example from Turkey

Şeker pancarı üretim planlamasında fiyat etkili midir? Türkiye'den bir örnek

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ABSTRACT

Sugar beet is a major staple for farmers in central and south-eastern Anatolia and interior Aegean of regions as it is the major natural sugar provider for Turkey. The sector has been controlled and supported until the World Trade Organisation (WTO) negotiations and privatization of the price setter public authorities. The supports were transferred to farmers via prices announced by the public authorities. But contracted farming has been maintained by the private sector as well in order to secure domestic sugar need. The price response of the sector was measured through time series analysis between 1960 and 2015 using secondary data. The traditional characteristics of the sector and attachments to the contracted farming were confirmed at the end of the analysis with 6% response of price to short run and 13% response of price to long run production.

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ÖZ

Şeker pancarı Türkiye'de başlıca doğal şeker kaynağı olması nedeniyle başta iç ve güneydoğu Anadolu ile iç Ege bölgelerindeki çiftçiler için temel bir üründür. Sektör, Dünya Ticaret Örgütü (DTÖ) müzakere süreci ve fiyat belirleyici kamu idarelerinin özelleştirilmesine kadar kontrol edilmekteydi. Bu dönemde sektöre sunulan destekler, kamu idaresi tarafından üreticilere açıklanan fiyat üzerinden iletilmekteydi. Ancak, iç pazarın şeker talebinin karşılanmasını garanti altına almak için, sözleşmeli tarım özel sektör tarafından da sürdürülmektedir. Sektörün fiyat değişimine verdiği cevap 1960 ve 2015 yılları arası için ikincil veriye dayalı zaman serisi analizi aracılığıyla incelenmiştir. Sektörün geleneksel özellikleri ve sözleşmeli tarıma bağlılıkları üretim arzının fiyat değişimine olan % 6 kısa vadeli ve % 13 uzun vadeli tepkisi ile tasdik edilmiştir. Ayrıca, kısa dönem denge bozukluklarının uzun dönemde yaklaşık % 90 oranında düzeldiği, yani arz değişiminin uzun döneme döndüğü anlaşılmaktadır.

1. Introduction

Agriculture, being a vital sector for Turkey contributes to overall GDP by around 10% and occupies 15% of total exports. More significantly, around 30% of the population is being involved in agricultural and food production activities. Considering the needs of the population as well as the needs of the food industry, one of the main staples essential for daily lives is sugar. Natural sugar can be supplied either from sugar cane or from sugar beet, when we exclude iso-glucose retrieved from corn. It is important to note that corn based sugar is not welcome in Turkish market due to its import-orientation and health considerations that take place around the world (Ozcan 2009). It is well known that sugar cane farming is more cost efficient. However, following some initial experiments, sugar cane farming did not produce desired output in Turkey due to Turkish Sugar Factories report (TSK 2004). Therefore, it was confirmed that sugar beet, which is around 25% more efficient than sugar cane in provision of sugar content is more appropriate for Turkish ecological conditions and domestic market meets their sugar needs from sugar beet (Gunaydın 2002; Erdal et al. 2007).

Turkey, being one of the major sugar beet based sugar producers, takes the fourth place in the world with 8% of the whole production while the third in the Europe with 10%. The country occupies 65% of Middle Eastern sugar market (Gunaydın 2002; Demirci 2003). Sugar beet farming is continued under irrigated conditions in central and south eastern

parts of Turkey. Contracted farming has been pursued through input subsidies and market price supports in order to secure domestic demand and compete with the declining world prices (Kiymaz 2002). Sugar beet has been supported for its sugar content only and pulp remedies of the industry are used to be delivered back to the farmers.

Public authorities was mainly responsible in market arrangements and contraction processes with 80% market coverage until the issue of Sugar Law issued in 2001 (Demirci 2003). However, the privatization process had started in 2001 and was completed in 2014 (TSK 2016). With the major law change in 2001, it was intended to assure domestic demand and supply equilibrium. The main orientation was both to limit iso-glucose and similar sugar content use in the food industry and sugar imports and to disable stock generation leading lower market prices as well (Kiymaz 2002). Therefore, the policies were designed neither to support exports nor to accept imports of sugar on 2001.

It is also important to note that the market prices were used to be determined on yearly basis and announced for the consecutive production period. Specific quota implementations were issued for excess supply in order to cope with off-price exports at lower world prices. 1996 was also a critical year for policy challenges as the rising stocks were translated to rising compulsory exports on the expense of main public authority's loss as sugar was stocked by the authority after all supports were transferred to the farmers. This is also the year just after Turkey became a member of the World Trade Organisation in 1995 (Aydın 2010; Karli et al. 2005). All export supports were converted into subsidies afterwards and the privatization of the sector was put on the agenda.

With these market control mechanisms, it is still a question for researchers whether the prices had an effect on encouragement or discouragement of sugar beet farmers because there were significantly lower price periods as well. Accordingly, it was intended to analytically search the price impact and policy changes in sugar beet market using time series supply response analysis between 1960 and 2015. The main objective was to understand the effect of price on the quantity supplied and search effects of policies implemented. Specifically, the impacts of rising supplies and WTO membership in 1995 and the new legal base set forward on 2001 were also searched in the scope of the analysis. The analysis is also expected to set forward the traditional characteristics of sugar beet farming as well.

2. Materials and Methods

2.1. Material

Being a major staple, production of sugar beet is common in Turkey. Both the climatic conditions and traditional production knowledge and demand of powerful food and beverages industry leaded extensive production of sugar beet in Turkey. The data utilised for the analysis was withdrawn from Turkish Statistical Insitute's databases for 1980 and 2015. Looking at the main figures regarding production, we found out significant challenges. While the amount of land devoted to sugar beet cultivation was 203 thousand hectares in 1960, it rose to 272 thousand hectares in 2015. This almost stable amount of cultivation area, which rose by 36%, can be attributed to traditional production attitudes and increasing attention on food and beverages industries. The cultivation area was at its peak on 1998 with more than 500 thousand hectares, which started to decline afterwards with strict contracts as demonstrated in Figure 1. Yet, the average production land was 290 thousand hectares also indicated that the amount of production land has a variation mainly attributed to rainfall variations and hot summers (Yilmaz 2010).

The total production on the other hand was 4.4 million tonnes in 1960 which rose to 16.5 million tonnes in 2015 with 2.75 times increase as can be understood from Figure 2. This signs to a rise in the yield as expected, when the declination of land is considered with the rise in production. The yield per hectare rose from 21.61 tonnes per hectare in 1960 to 59.8 tonnes per hectare with 1.76 times in 2015. Besides, the average between these years was 11 million tonnes and this figure refers to the steady rise after 1980s.

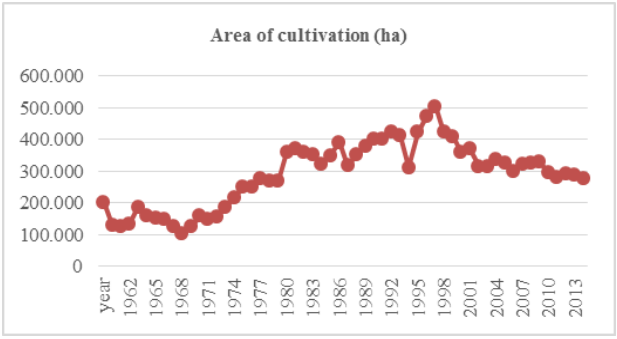

Figure 1. Amount of land devoted to sugar beet farming in hectares

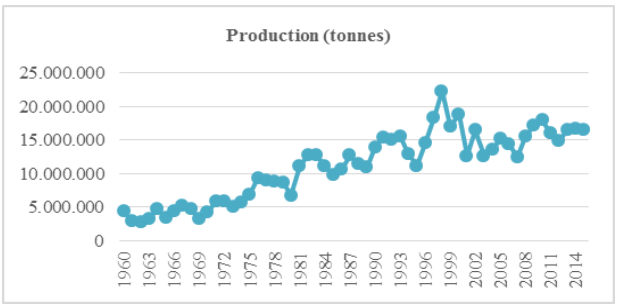

Figure 2. Amount of sugar beet production in tonnes.

Therefore, it was intended to analyse the reasoning behind the change in amount of production and to understand the impact of price and non-price factors on decision making process of the sugar beet producers. Accordingly, the secondary data withdrawn from Turkish Statistical Institute was analysed to estimate the price impact and the term structure of Turkish sugar beet farming. The data used refers to amount of sugar beet production in million tonnes, unit price and amount of land devoted to sugar beet cultivation in hectares between 1960 and 2015. The real farm-gate price per kilogram used was constant at 1960 prices in Turkish Lira due to Producer Price Index.

2.2. Methodology

Planning for production in mostly competitive market settings depends on evaluation of price expectations and relevant market situations. As evaluation becomes eligible for the producer, he/she also starts to think over production alternatives and change his/her future plans. The supply response modelling with reference to price expectations of the product, as well as relevant non-price factors providing market information, is one of the mostly utilised methodologies. This

Nerlovian supply function is specific for market planning as it uses output related factors apart from direct structural analysis conducted with reference to input market equilibrium. The initial form of the supply equation refers to estimation of the impact of price and non-price factors on the quantity produced based on the past data (Nerlove 1958).

$$Q_t^* = a + bP_t^* + cZ_t \quad (1)$$

$Q_t^* = level\ of\ output\ for\ time\ t$
$P_t^* = expected\ real\ price\ for\ time\ t$
$Z_t = non-price\ exogenous\ variables$

However, we need to consider unique features of agriculture and agricultural products in analysis and decision making. Agricultural producers, in fact like in many other sectors, cannot decide on the amount of production and the amount that they will bring to the market considering present prices. Because, the producer should have started planting the crop or even have received the harvest when they learn the market price. This is also valid for non-price factors. Producers cannot revise their production decisions considering a seasonal price shock, a climatic shift or a legal change. Accordingly, they need to observe the previous price levels and market movements to decide for current year's production. This calls for an adaptive expectations framework depending on the past information (Ozkan et al. 2011; Tripathi and Prasad 2009).

Besides, not a lot of producers decide to shift between products year after year as every crop needs different approaches and knowledge. Therefore, the decision is also related with the amount produced in the recent periods. Our main question is 'by how much?' This query refers to the elasticity interpretation of the production. Therefore, the following final form of the supply equation needs to be estimated and analysed with respect to adaptive expectations.

$$Q_t = a_0 + a_1P_{t-1} + a_2Q_{t-1} + a_3Z_t \quad (2)$$

Here, the subscripts t-1 refer to the previous term's price and quantity information and the parameters to be estimated are important for elasticity interpretation of the production. While parameter of lagged price variable, α_1 is read as the short-run price elasticity, $\alpha_1/1-\alpha_2$ refers to the long-run price elasticity (Ozkan et al. 2011; Tripathi and Prasad 2009).

However, it is important to briefly explain the single Ordinary Least Squares Estimation of the supply response function and propose purification methods to potential impediments of the estimation procedure. When the data is used in the level form, the data is expected to have a time information itself. This means using non-stationary data for elasticity estimation and the relationship set forward would mostly probably be statistically meaningless (Granger and Newbold 1974; Johansen 1988). Accordingly, an Error Correction Model (ECM) adjustment for the data is needed (Granger 1981; Engle and Granger 1987).

ECM estimation enables using stationary variables which are adjusted for time and this modification does not lead any change in the interpretation of short-term response of quantity to price (Granger 1981). When the economic relationship between quantity supplied and price are defined as following equation 3 and dependent and independent variables are considered to be co-integrated even when they are non-stationary on level, there is a possibility of estimation of the system. ECM methodology refers to estimation of the short run supply relationship within a linear combination of the variables and incorporation of error terms to the equation (Dickey and Fuller 1981). The error terms are directly expected to include past data to the system which in the end is expected to purify the time information in the supply functions of products that carry over past relationships to present decisions. Finally, the ECM approach with inclusion of the lagged dependent variable is an autoregressive distributed lag model augmented and it is a modified version of a stable long-run relationship of the variables (Banerjee et al. 1998; Mohammad et al. 2007; Ozkan et al. 2011).

$$Q_t = a + bP_t + u_t \quad (3)$$

$$\Delta Q_t = a + b\Delta P_t + cu_{t-1} + u_t \quad (4)$$

$$\Delta Q_t = \alpha_0 + b\Delta P_t - c(Q_{t-1} - a - bP_{t-1}) + u_t \quad (5)$$

$$Q_t = (\alpha_0 + ca) + bP_t - bP_{t-1} + (1-c)Q_{t-1} + cbP_{t-1} + u_t \quad (6)$$

$$Q_t = (\alpha_0 + ca) + bP_t + (1-c)Q_{t-1} + (cb-b)P_{t-1} + u_t \quad (7)$$

Depending on the set forward methodology, the static long-run supply function of the sugar beet is defined as following:

When Q_t is million tonnes of sugar beet production in Turkey from 1960 to 2015, P_t is price per kilogram and A_t is cultivation lands in million hectares respectively.

$$Q_t = a + bP_t + cA_t + u_t \quad (8)$$

Respecting adaptive expectations framework the static equation is shaped as following.

$$Q_t = a + bQ_{t-1} + cP_{t-1} + dT_t + \varepsilon_t \quad (9)$$

The relevant variables are:

Q_t= Sugar beet production in year t in million tonnes

Q_(t-1)= Sugar beet production in year t-1 in million tonnes

P_(t-1)= Real producer price for sugar beet per kg in year t-1

T_t= Time trend from 1 to 55.

Here the price variable, which was considered in real terms, was taken in TL per kg terms for the ease of the interpretation. The impacts of stock rise and attributed domestic price change in 1996 and two consecutive years, which are in relation with the WTO membership attained and the Sugar Law issued on 2001, was measured by two structural dummy variables initially. However, no significant relationship was detected between the amount of production and policy changes, which is attributed to the stability of the production market. Therefore, the data between 1960 and 2015 was estimated and analysed using E-Views 5 statistical program.

2.3. *Stationarity Testing and Integration*

First the time character of the data was visually checked by correlograms and Q-statistics attached and the findings were shown in Table 1. The probability of estimated Q-statistics and

partial correlation coefficients that die directly after the first lag are interpreted as a preliminary proof of the first order autocorrelation for the static variables.

Table 1. Q-statistics.

Variable	Q-stat	p(Q)
Q_t	46.250	0.00
Q_{t-1}	45.122	0.00
P_{t-1}	49.478	0.00

In addition, all variables were tested for their levels and first differences in order to determine the degree of integration and the test results were demonstrated in Table 2. The quantitative dependent variables of the dataset were tested for their stationarity using ADF unit root tests (Dickey and Fuller 1981).

$$\Delta X_t = \alpha_0 + \delta X_{t-1} + \sum \beta \Delta X_{t-1} I + e_t \quad (10)$$

Here ΔX_t is the first difference of the variable and δ is the test coefficient.

Table 2. ADF Stationarity Testing Results.

Variable	Estimated ADF	ADF – 1%	ADF – 5%	p-value
Q_t	-1.69	-3.57	-2.93	0.43
Q_{t-1}	-1.66	-3.57	-2.93	0.44
P_{t-1}	-1.28	-3.57	-2.93	0.64
$D(Q_t)$	-6.89*	-2.62	-1.95	0.00
$D(Q_{t-1})$	-6.83*	-2.62	-1.95	0.00
$D(P_{t-1})$	-5.87*	-2.62	-1.95	0.00

*, Significant at 1% - Critical value of ADF tests are based on MacKinnon (1996).

Checking out the unit roots and cointegration level of the variables, the short-run equilibrium of the supply response was estimated through difference estimation. This procedure is called as Vector Error Correction (VEC). As well as the price effects, VEC modelling provides inferences with regards to the non-price time data of production. In other words, with analysis of the short-term dynamics, it becomes possible to consider how much of the production is attributed to the traditional character of agricultural production.

Therefore, as the dependent and independent variables of the static equation were found non-stationary on level and stationary when their difference were taken, it is important to check whether these non-stationary variables were co-integrated. The error terms of the static equation were checked with reference to Johansen Cointegration test (Griffiths 2008) and findings were indicated in Table 3.

Table 3. Outputs of Cointegration Test.

Dependent variable: D(e)	
e(-1)	-0.99
t(p(t))	-7.22 (0.00)

Therefore, the non-stationary static equation variables seemed to be integrated of order 1, which means that the first difference estimation would make it possible to comment over short term dynamics of the supply equation. The short-run supply function accordingly is as following.

$$D(Q_t) = \beta_0 + \beta_1 D(Q_{t-1}) + \beta_2 D(P_{t-1}) + \beta_3 ECM + u_t \quad (11)$$

Here, the variables were estimated in their first difference and the error correction coefficient retrieved from the static long-run relationship was included in the model as an estimator.

3. Results and Discussion

The estimated long run relationship is as following, of which the parameter statistics were demonstrated in Table 4.

Table 4. Long-run relationship estimates.

Variable	Parameter Estimate	Standard Error	t-Statistic	p-value
Q_{t-1}	0.55	0.12	4.57	0.00
P_{t-1}	0.06	0.21	0.29	0.77
T_t	0.12	0.03	3.07	0.01
α_0	1.77	0.72	2.46	0.02
R^2	0.86	F-statistic	102.76 (0.00)	
D-W	1.97	Mean dependent V.	11.26	

$$Q_t = 1.77 + 0.55*Q_{t-1} + 0.06*P_{t-1} + 0.12*T_t \quad (12)$$

Therefore, more than 50 % of the production is related with producers' traditional efforts. This means that more than 50% of producers prefer to continue producing sugar beet irrespective of any price alterations or policy changes looking at the coefficient of previous year's production amount, which is 0.55. This is mostly related with characteristics of sugar beet production and contracted farming structure. In addition, the rise observed year after year is referred with the time trend and around 12% and this rise can be related with both population changes, rising interest in food and beverages industries with specific reference to export orientation and corresponding yield improvements which also means developing farming methodologies. Besides, increasing demand of food industries also leaded to extension of sugar beet farming in accordance with privatization of the industry. The trend parameter also covered the impacts of structural changes of 1995, WTO membership and 2001 Sugar Law issue. Therefore, there appeared no need to indicate the insignificant dummy variables and they were changed with the time trend as mentioned previously.

In addition, even when we take the unit of price as per kilograms, it was understood that the short-term impact of price changes in production is 6% considering the consecutive price coefficient indicated in the above output equity (12), while long-term impact is 13% retrieved through calculations (Ozkan et al. 2011; Tripathi and Prasad 2009). This is an understandable figure as it is not so easy to shift from sugar beet to substitutes due to irrigation characteristics of sugar beet in Turkey (Erdal et al. 2007) and it is the only natural sugar source produced in Turkey that can be used as input for the industrial purposes. The contracted farming implemented in the industry with prepaid supports seemed to act as a stabilizer even after transformation of the sector.

In addition, it is also important to consider short-term dynamics of sugar beet supply. This means underlying traditional characteristics of producers and how they insist on sugar beet farming regardless of price signals or policy changes referred. The short run relationship mostly refers to the difference of previous term's production and unexplained traditional structure of sugar beet farming. The estimates were demonstrated in Table 5.

The coefficient estimates indicated in equation 13 explains around 37% of the variation in the quantity produced. This seems to be low, yet it still brings up information about the production characteristics.

Table 5. Short-run relationship estimates.

Variable	Parameter Estimate	Standard Error	t-Statistic	P-value
$D(Q_{t-1})$	0.34	0.25	1.37	0.18
D(Pt-1)	0.33	0.38	3.57	0.00
ECM(-1)	-0.91	0.27	-3.34	0.01
α_0	0.12	0.25	0.50	0.62
R^2	0.37	**F-statistic**	9.57 (0.00)	
D-W	2.1	**Mean Dependent V.**	0.25	

$$D(Q_t)= 0.12 + 0.34*D(Q_{t-1}) + 0.33*D(P_{t-1}) - 0.91*ECM \quad (13)$$

The inter-period production changes between year t-1 and t-2 affect the concurrent change by 34% considering the coefficient of $D(Q_{t-1})$This refers partly to the traditional characteristics and the finding is compatible with the long-run. Accordingly, it can be inferred that sugar beet producers have to take long term decisions depending on the product characteristics and the contracts they have with either the public authority or the private sugar provider of today.

Inter-period price changes on the other hand, affect the yearly production quantity differentials significantly. Considering the per kilogram price of sugar-beet, 1 Turkish Lira differential affects production change between year t and t-1 by 0.33. This means the short-term response of sugar beet to its own price is inelastic. Yet, the differential of 1 Turkish Lira is considerably high for a relevant change for sugar-beet producers. So, the estimates are in conformity with the long-term interpretations.

The estimate of the error correction coefficient was -0.91. The estimated value indicates the speed of adjustment from short-run to long-run equilibrium and it is significant at 1%. The disequilibrium encountered in sugar beet production resulting from non-price factors like climatic factors rarely or contracting policy differences of the legal changes as appeared in the beginning of 2000s were offset in one production period by around 90% and the disequilibrium is purified towards the long-run equilibrium. The negative sign of the ECM coefficient estimate should be read with regards cyclical decision making of producers respecting non-price factors. The inter-period production differences seemed to get affected negatively by non-price factors respecting the ECM series. And a negative sign of ECM coefficient refers to positive movement towards long-run equilibrium. Being a main staple and being essential for the productive food and beverages industries, sugar beet production is permanently secured and it is considered as a continuous activity by the farmers as well as the agricultural policy makers.

4. Conclusion

Sugar beet is mainly produced through contracted farming in Turkey. With pre-arrangements and market price adjustments in competition with the world, Turkey had proven to be one of the few countries that are close to self-sufficiency. The production system under coordination of public authorities until the mid of 1990s is needed to be released with the free trade arrangements. Following, non-quantity based supporting system requirements, privatization of the industry and increasing number of substitutes as corn based sugar had appeared as challenges of the sector. Accordingly, these challenges set forward the need to analyse the impact of price changes and policy alterations on production decisions of farmers. Main question behind is whether the market price was effective on farmers' production decisions.

Therefore, the aggregate supply response of sugar beet was analysed for Turkish sugar beet production with respect to 1960 and 2015 using a time series methodology with secondary data. The results had indicated that, the traditional structure of sugar beet farming is more effective than the price alterations announced or radical changes appeared in support systems. The contracted farming, once managed by public and is being maintained by private sector serving both to table sugar providers and food and beverages industry, is the traditional attachment of farmers to sugar beet production. The producers are bound their activities, respond to a price shift of 100% by 6% in the short run and 13% in the long run and try to maintain their production activities. Therefore, sugar-beet production in Turkey appeared out as price inelastic both for the short and long run. However, there is more need to analyse the response and assessment of farmers to the policy changes, specifically those who are involved in the sector for more than a decade, through face to face studies to measure the future potential of the industries attached to sugar production.

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