Acreage response for cotton regions in Turkey: an application of the bounds testing approach to cointegration

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Abstract

The aim of this paper is to determine the long and short run dynamics of acreage response for the major cotton-producing regions (Cukurova, Aegean, Antalya and Southeast) in Turkey by using the bounds testing procedure for cointegration analysis, within an autoregressive distributed lag framework. The analysis reveals that liberal policies and labour inadequacy in cotton harvest have led to a decline in the cotton production acreage in Cukurova, Aegean and Antalya regions in the long run. On the other hand, it is suggested that the cotton producers in the Cukurova and Antalya regions have limited cotton-producing areas as they perceive cotton price as risky. Yet, as more agricultural lands in the region are opened up for irrigation, the amount of land devoted to cotton production has been increasing. The price of cotton has led to a rise in the cotton production acreage, while the price of the competitive products in regions other than the Southeast (e.g. maize, tomato) and labour inadequacy during harvest have diminished the area devoted to cotton production. Consequently, it can be said that Turkey may not meet the cotton requirement of the textile industry with its own production and will be dependent on imports in the close future.

Key words: cotton, bounds test, cointegration analysis, Turkey

Résumé

Le but de ce travail est de déterminer la dynamique, à long et à court terme, de la superficie cultivée en coton dans les principales régions productrices de la Turquie (Cukurova, Egée, Antalya et Sud-est), en utilisant la procédure de test de cointégration par les bornes, dans un modèle autorégressif de retards distribués. L'analyse révèle que les politiques libérales et l'insuffisance de la main-d'œuvre employée dans la récolte du coton ont provoqué dans le temps une réduction de la superficie cotonnière dans les régions de Cukurova, de l'Egée et d'Antalya. Par ailleurs, on avance l'hypothèse que les producteurs de coton de la région d' Antalya et de Cukurova tendent à limiter l'étendue de leur production parce qu'ils perçoivent un risque lié au prix du coton. Cependant, suite à l'extension des terres agricoles irriguées dans la région, la superficie consacrée à la production cotonnière a augmenté. Le prix du coton a induit un accroissement des superficies cultivées en coton, alors que le prix des produits compétitifs (par exemple, le maïs et la tomate) provenant des autres régions et l'insuffisance de la main-d'œuvre employée dans la récolte ont causé une diminution de la superficie cotonnière. Par conséquent, on peut en conclure que la Turquie se trouve dans l'impossibilité de satisfaire les besoins de l'industrie textile nationale et de ce fait, il sera nécessaire d'avoir recours aux importations de coton dans un futur proche.

Mots-clés: *coton, bornes d'essai, test de cointégration, Turquie*

1. Introduction

Agricultural pricing policy plays an important role in the farm decisions in the allocation of resources. Supply response is used as an estimation technique to assessment of the pricing policies. It is therefore appropriate that public policy formulation mainly depends on the supply response.

Seed cotton is a very important commodity for the Turkish economy and the dynamic cotton price policy has precipitated the need to examine the price and supply relationship of cotton in Turkey. Reliable estimates of supply functions are necessary to reach the equilibrium level of output, to better utilize the scarce resources, to make better decisions for investment planning and to formulate policies stabilizing the farm prices and income. Although the economic behaviour of farmers can be influenced by social, physical, biological, psychological and legal factors, one of the major determinants of the supply response is income as an economic indicator. That is why cotton production creates a major source of income for many farmers' families. In addition, the cotton industry is an important source for employment in Turkey. Notwithstanding, cotton has been a major contributor to total agricultural growth in Turkey in the early 1990s.

The State intervention for cotton prices was abandoned within the framework of economic liberalisation policies, which speeded up as a result of the 1994 economic crisis. Subsequently, cotton production acreage started to decline in the Cukurova, Aegean and Antalya regions but this decline has been more than compensated by the increase in cotton acreage in the Southeast region. However, the domestic demand of the textile industry outstripped the supply of cotton and cotton imports have started to rise rapidly. So far the analysis of factors affecting sensitivity of supply in cotton production has gained importance for cotton producers and textile industry.

The previous studies on acreage response use classical regression analysis; most use Nerlove's restrictive adaptive expectations/partial adjustment model. However, the results may be spurious and there are doubts on the validty of reseach findings. This paper provides econometric estimations of the dynamic supply response model for the cotton production regions in Turkey between 1962 and 2007 by relying on recent time series econometric techniques. In this paper, cointegration analysis was used to test whether the obtained relationships are truly long-run or whether they are generated by spurious regressions.

The advantages and disadvantages of conventional tech-

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niques that are being used to test supply sensitivity have been reviewed by Askari and Cummings (1977) and Hallam and Zanoli (1993). The objective of these models is to estimate short and long-run supply elasticities. However, the functional specification of the model used here differs from those mentioned above as well as the econometric estimation procedure employed. It is concluded that model choice depends on data availability and a priori theoretical assumptions (Karagiannis and Stoforos, 1999).

According to recent econometric literature, in the recent years the mostly preferred cointegration methodologies for supply response estimations (Hug and Ashad, 2010; Ocran and Biekpe, 2008; Mohammed et al., 2007; Edet et al., 2007; Bressica and Lema, 2007; Elbeydi et al., 2007; Thiele, 2003; Muchapondwa, 2008).

In this study, instead of the Johansen method, the auto-regressive distributive lag (ARDL) method, which provides more efficient and consistent results in small samples, is preferred (Pesaran and Pesaran, 1997; Pesaran and Shin, 1999; Pesaran et al., 2001).

The main objective of this study is to determine the producer supply response in the four major cotton-producing regions in Turkey. The specific objectives of this paper are:

(1) To assess the price responsiveness of cotton producers in Turkey.

(2) To quantify the impact of trade liberalization on cotton production acreage.

The structure of the paper is as follows; the next section discusses cotton policies in Turkey briefly, section three provides model specification and data, it is followed by discussion of the methodology, section five discusses empirical findings and section six presents the conclusions.

2. Changes of Cotton Growing Areas and Price Policies in Turkey

Cotton growing areas in Turkey are mainly situated in Aegean, Antalya, Cukurova and Southeast Anatolia (Figure 1). In other words, cotton is mostly grown in the western and southern regions and mostly in the ecological areas around the valleys and river basins. The best cotton growing ecological environment, due to the length of the growing season, the minimum difference between day and night temperature and the high humidity, is situated in and around the river valleys of Gediz, Buyuk and Kucuk Menderes in the Aegean region; Aksu in the Antalya region; Seyhan and Ceyhan in the Cukurova region and Firat (Euphrates) and Dicle (Tigris) in the Southeast region. There have been changes in the areas of cotton production in Turkey since 1980. With the introduction of GAP (South-eastern Anatolia Development Project) Programme, and irrigation schemes, new areas have been opened up for cotton production and major cotton production has been shifted towards those new areas.

Cotton production in Turkey has been supported with two different approaches i.e. floor price and premium system. While the State intervenes in the market with an identity of merchant and purchases seed cotton from a floor price in the floor price system, in the premium system, the State does not intervene in the market and supports producers by paying a predetermined price premium per kg. In the premium system, the State helps the producer within the rules of free market economy without actually buying and selling the product.

Figure 1 - *Map of cotton regions in Turkey.*

Seed cotton has been included in the price support policies in Turkey since 1966-67. The main aim of the support policy has been identified as to prevent the crop to be sold low price and to improve the quantity and quality of the crop. Unions of Agricultural Sales Cooperatives have been established as the organisation in charge of the implementation of these policies.

Seed cotton is purchased by Taris in the Aegean region, Cukobirlik in Cukurova and Antbirlik in Antalya. Purchasing prices are determined prior to the harvest by the Council of Ministers each year and the outcome of the purchases as profit or loss returns to the State. If there is profit, this profit is transferred to the producers, who are the members of the cooperative as returns or is used to motivate production, with the permission of the Ministry of Industry and Trade. If there is a duty loss, it is met by the State. Those support policies have been carried out until 1987/88. Another policy was introduced in 1983/84 and 1986/87 to perform ranked price rise, when the purchasing prices were not satisfactory. This policy not only helped the producers not to lose income due to purchasing prices, but also motivated the production. Association of Agricultural Sales Cooperatives, using its own initiative implemented an additional price policy and shared the profit and loss over the support price in 1987/88. This policy aimed to buy more cotton from the market. Similar policies applied to other commodities, where there are no support prices, as a part of the liberal policies of the governments, during the period between 1987/88 and 1989/90. During this period of 1987/88 to 1989/90 similar policies applied to other commodities, as part of the liberal policies of the governments, and thus there were no support prices. Agricultural Sales Cooperatives bought seed cotton from the market as traders bearing the profit and loss in this period.

The premium system was implemented for the first time in 1993/94 season, yet the implementation was postponed due to budgetary problems and inadequacy of the level of record-keeping in agriculture. The premium system was started to be implemented regularly in 1998 and it is still continuing. Besides, additional payments have been made since 2003 in order to promote the use of certificated seeds.

Cotton, which was within the scope of state support purchases, has left out of the scope after the 1994 economic decisions. Subsequently, state intervention in the cotton market was abandoned and liberal policies were started to be implemented. Similarly, state intervention in wheat, barley and maize products were also removed. Table 1 demonstrates average prices and variation in prices of regional products before and after liberalisation. As the liberalisation policies started to be implemented, seed cotton prices fell because the government ended its policy of keeping them artificially high. This situation indicates that there is instability in cotton prices after liberalisation. It is also seen that average prices of wheat, barley and maize generally declined as a result of liberalisation policies, yet the variation in prices declined. Yet, the tomato prices of the Aegean region were not impacted by liberalisation policies earlier or under free market conditions.

Table 1 - *Domestic producer prices of cropped acreage patterns in Turkey (1987=100).*

Commodity Producer Price	Region	Period of Government Controls (1962-1994)		Post Liberal Period (1995-2007)	
		Mean	CV[a] (%)	Mean	CV[a] (%)
Cotton	Cukurova	4.30	14.90	3.78	31.03
	Aegean	4.59	16.34	4.41	30.86
	Antalya	4.55	16.31	4.42	29.31
	Southeast	4.30	14.90	3.74	33.13
Wheat	Cukurova	1.26	22.59	1.17	14.19
	Aegean	1.33	19.69	1.22	15.57
	Antalya	1.22	23.60	1.24	18.40
	Southeast	1.25	23.41	1.21	19.30
Barley	Cukurova	1.02	19.24	1.11	16.95
	Aegean	1.31	37.12	0.96	22.76
	Antalya	1.23	40.62	1.03	11.39
	Southeast	1.02	18.35	0.96	15.68
Maize	Cukurova	1.30	23.79	1.06	10.45
	Antalya	1.32	21.25	1.69	30.91
	Southeast	1.28	22.16	1.23	12.78
Tomatoes	Aegean	1.31	38.33	1.33	31.73

[a] The Coefficient of variation (CV) is a ratio of standard deviation to the mean.

The effect of liberalisation policies on regional cotton crop areas is shown in Table 2. Compared to the State supported price policy era, the cotton cropping acreage declined in Cukurova, Aegean and Antalya regions after liberalisation as it is observed from the table. This era is a period when price variation and price instability had risen. On the contrary, the cotton acreage had risen in the Southeast region due to mainly the rise in the amount of land suitable for irrigation to produce cotton. In addition, new areas have been opened up for cotton production, the lower production costs, cheap labour and lower density of diseases and pests in the cotton production played an important role in the increase in the Southeast region.

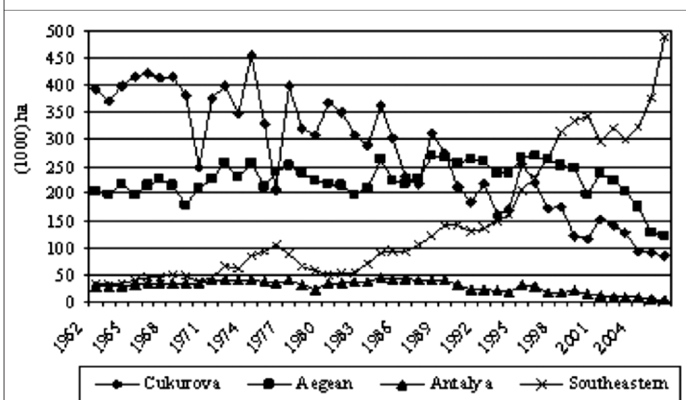
Table 2 - *Cropped acreage patterns in Turkey (1000 ha).*

Region	Entire Period		Government Controls		Liberal Period	
	Mean	CV[a] (%)	Mean	CV[a] (%)	Mean	CV[a] (%)
Cukurova	268.96	41.30	319.53	26.11	140.59	37.72
Aegean	222.87	41.30	228.92	10.33	207.48	27.11
Antalya	27.96	42.18	33.72	20.36	13.34	64.13
Southeast	150.20	84.49	79.22	48.58	330.40	26.05

[a] The Coefficient of variation (CV) is a ratio of standard deviation to the mean.

Cotton production in Antalya constituted 4 % of total production in Turkey even though there were many competitive products in the region. National cotton price instability and the expansion of the tourism sector in Antalya have led to a reduction in the area devoted to cotton production (Figure 2). Increased returns from tourism, greenhouse vegetables and maize production and a shift to citrus production with high returns in that sector has also led to a fall in the area devoted to cotton production. In addition, cotton production became less attractive due to the amount of efforts needed for production and the continuous inflation on the prices of inputs required (Ozkan, 1997).

Figure 2 - *Interregional changes in cotton areas.*



The cotton production area in Cukurova has increased until the 1980s, yet started to decline in the 1980 production year. The main reasons behind this can be mentioned as the introduction of 2[nd] crop, more profitable wheat and maize production, and instability in cotton prices. In addition, the cotton cultivation activities becoming widespread in the Southeast Region due to the rise in irrigation and inadequacy of labour in Cukurova appeared as threats. Accordingly, cotton production areas were devoted to more profitable products that demanded less labour.

The Aegean region is a region where the highest quality of Turkish cotton seed is produced. Yet producers have decided not to produce here due to the rise in labour payments for cotton harvesting and cotton price instability. After the removal of state intervention in cotton prices, the cotton production acreage started to decline rapidly. The cotton production lands have been converted into production areas for more profitable products such as fresh fruit and vegetables. Specifically, productions of olive, grape and fig have become widespread, which are promoted by the State.

The cost of cotton production is lower in the Southeast region in comparison to the other regions, as there is available cheap labour for the harvest of cotton and density of diseases and pests is lower in the region. In addition, new agricultural lands getting opened up for irrigation specifically in the region in opposition to other cotton regions led to a rise in cotton production areas.

3. Empirical specification and the data

It is not possible to carry out an analysis for short time periods which relies on annual data when the research tries to tackle supply response. Therefore, the dynamic characteristics of supply response can only be reflected with the support of time series analyses (Sadoulet and Janvry, 1996). Due to this principle, a period of 46 years (between years 1962 and 2007) has been taken as a basis for research.

In the research, four different types of time series data have been taken as the main data, which are namely price risk, prices of cotton and competitive crops, labour wage and area of cultivation. Data on cross prices and cropped area are taken from the Turkish Statistical Institute (TSI, 1997 and 2007). The cotton price series used in the research are retrieved from Union of Agricultural Sales Cooperatives in Turkey. Deflated nominal prices (1987=100) are used to estimate acreage supply response. According to these calculations, the factors affecting seed cotton growing areas are described in the following functional representation:

$$AC = f(Gs, P, L, Z) \quad (1)$$

where is cotton cropped area, is government subsidy on cotton, is average price of seed cotton and prices of the competitive crops, L is the wage of labour, is all other acreage supply determinants and random effects.

As it is known, producers always have different expectations on price level, as opposed to the real prices. The prices routinely monitored are the market prices or farm gate prices. When producers decide to produce, they take into account prices that would appear after the harvest. Due to the fact that decisions are often made based on the previous year's prices, formulation of expectations is an important issue in the analysis of agricultural supply response. Accordingly, the Nerlove-type acreage supply response model for annual crop was used in this study (Nerlove, 1956, 1958 and 1979).

In addition to that, the quantities obtained could differ greatly when compared with the estimates due to the corrections made during the identification of the variable factors. When commodity prices change, the adaptation of new crop pattern by the producers can take a few years. Therefore, before drawing the model according to the real data, those corrections related to lag factors should be taken into account (Nerlove, 1956).

Starting from that, Nerlove-type acreage response functions can be written as:

$$LnAC_{it} = \beta_{0i} + \beta_{ii} LnP_{it-1} + \beta_{ij} \sum_{j=1}^{n} LnP_{ijt-1} + \beta_{ii} LnAC_{it-1} + \Phi_{ii} R_{it} + \rho_{ii} LnLW_{it} + \Omega_{ii} D2 + \varepsilon_{it} \quad (2)$$

where ln is the natural log, i refers to cropped area for regions, AC_{it} is annual cotton cropped area (1.000 ha) in region i at time t, P_i is own-price, are the cross prices and j indexes wheat, barley and maize (or tomatoes), is labour wage taken as a proxy based on wage rate, D2 = 1 is the dummy variable representing the impact of the political change or liberalization such that D2 = 1 for the years 1994-2007 and D2 = 0 elsewhere. ε_{it} is a zero–mean serially independent random variable with finite variance, β are the parameters of acreage supply response. Since cotton production is risky, the response to price risk (R_{it}) is measured by a weighted moving average of the standard deviation from own-prices over the past three periods. The analysis period is considered long enough for annual crop producers to respond to price shocks.

The measure of price risk is defined following Adesina and Brorsen (1987) as:

$$R_{it} = \left[\sum_{j=1}^{n} \theta_j \left(\frac{P_{it-j} - P_{it-j-1}}{P_{it-j-1}} \right)^2 \right]^{1/2} ; \; i = 1,2,\ldots,4 \quad (3)$$

where R_{it} is the price risk for cotton in region i at time t and θ_j are the weighting factors. In this study, the declining weights of 0.6, 0.3 and 0.1 used by Adesina and Brorsen (1987) are based on adopted naive expectations.

4. Econometric methodology

The Autoregressive Distributed Lag (ARDL) time series model, which is estimated through least squares method, is implemented for the cotton acreage supply response model. In order to analyse the dynamic interactions in this model and long term relationships between the variables, the bounds test approach developed by Pesaran et al. (2001) is used. The bounds test approach does not require a preliminary unit root test for the variables included in the model in contrast to the Johansen cointegration test. The model can be implemented regardless of whether the regressors in the model are integrated of order I (1) or bilaterally cointegrated.

This test is relatively more efficient in small or finite samples, as is the case for this study. Bounds test approach is valid for trend stationary and difference stationary regressors. Meanwhile, this approach can be implemented when the explanatory variables are endogenous and appropriate to correct the serial correlation of residuals simultaneously.

Bounds test approach can be applied in two steps. Existence of a long run relationship between the variables in the model is searched in the first step, and the short-term and long-term coefficients of the model are estimated in the second step (Narayan and Smyth, 2005). The calculation of short-term and long-term parameters is explained by Pesaran et al. 2001. One of the recent developments in the time series literature is searching existence of a cointegration relationship between model variables by the ARDL procedure. The implementation of this procedure can be explained briefly as follows. In order to implement the bounds test, a vector of z_t is accepted, $z_t = (y_t, x_t)$. Here, is the dependant variable and x_t is a vector of regressors. The data generation process of z_t becomes autoregressive of degree p. Δy_t is modelled as a conditional error correction model for the cointegration test. With the error correction model it becomes possible to perform the parameter stability test for short run coefficients and to determine the convergence rates to the long-term equilibrium for the model (Halicioglu, 2007).

$$\Delta y_t = \beta_0 + \beta_1 t + \pi_{yy} y_{t-1} + \pi_{yx.x} x_{t-1} + \sum_{i=1}^{p} {}_i\vartheta_i \Delta y_{t-i} + \sum_{j=0}^{q} \phi_j^{'} \Delta x_{t-j} + \theta w_t + \mu_t \quad (4)$$

Here, π_{yy} and are multipliers for long term. β_0 is the drift and is the time trend. w_t is a vector of exogenous factors. The lag value of Δy_t, the lag value and the original value o-fare Δx_t used for modelling short term dynamic structure. The bounds testing procedure, in which the non-existence of a level relationship between y_t and x_t is searched, is conducted by removal of y_{t-1} and x_{t-1} lag level variables from the model. Later, in order to test inexistence of a conditional level relationship between y_t and x_t, the following hypotheses need to be mentioned.

$$H_0 : \pi_{yy} = 0\,, \ \pi_{yx.x} = 0^{'}\,,$$

$$H_1 : \pi_{yy} \neq 0\,, \ \pi_{yx.x} \neq 0^{'} \ \text{or} \ \pi_{yy} \neq 0\,, \ \pi_{yx.x} = 0^{'} \ \text{or} \ \pi_{yy} = 0\,, \ \pi_{yx.x} \neq 0^{'}.$$

These hypotheses are tested by the utilisation of standard statistics. The critical values for test are retrieved from the paper of Pesaran et al. printed in 2001, as the distribution of the statistics is not standard. There are boundaries for critical values that show all the regressors can only be I (1) or I (0) or all are cointegrated. If the calculated statistics lies outside the critical boundaries, the decision regarding cointegration can be given regardless of being acknowledged of the integration degree of regressors. If the estimated statistics is larger than the higher boundary of the critical value, the H_0 hypothesis claiming non-existence of cointegration is rejected. If the estimated statistics is less than the lower boundary of critical value, the hypothesis fails to be rejected.

5. Empirical Results

In the first step of the ARDL analysis, a long –run relationship in the theoretical model is examined. As yearly data were used, maximum lag length was taken as 2 in the ARDL analysis. In order to determine the appropriate lag length p and whether a linear trend is required, the conditional model is estimated with and without a linear trend for p=2 under OLS.

$$\Delta AC_{it} = \beta_{0i} + \sum_{j=1}^{p} \beta_{1ij} \Delta AC_{it-j} + \sum_{j=0}^{p} \beta_{2ij} \Delta CP_{it-j} + \sum_{j=0}^{p} \beta_{3ij} \Delta WP_{it-j} + \sum_{j=0}^{p} \beta_{4ij} \Delta BP_{it-j}$$
$$+ \sum_{j=0}^{p} \beta_{5ij} \Delta MP_{it-j} + \sum_{j=0}^{p} \beta_{6ij} \Delta R_{it-j} + \beta_{7i} D2_{it} + \beta_{8i} AC_{it-1} + \beta_{9i} CP_{it-1} + \beta_{10i} WP_{it-1} \quad (5)$$
$$+ \beta_{11i} BP_{it-1} + \beta_{12i} MP_{it-1} + \beta_{13i} R_{it-1} + \beta_{14i} t + u_{it}$$

The lag length was determined by using Akaike (AIC) and Schwartz (SBC) info criterion. In order to calculate the parameters of ARDL model appropriately, the residuals are required not to be serially correlated. The models with and without trend are estimated in order to determine the number of differences, AIC and SBC info criteria were calculated for each lag and the findings are shown in Table 3. In addition, the existence of serial correlation in the residuals was searched by using Langrage Multiplier (LM) test (Johnston and Diardo, 1997). As it is seen from Table 3 in both 'with' and 'without'-trend models, the lowest AIC and SBC criteria were found under p=2 for Antalya, while the lag length was found as 1 for other regions. Simultaneously, in serial correlation LM test for both with and without trend models, no serial correlation was detected for p=2 for Antalya and p=1 for other regions. Accordingly, as no differentiation was found regarding time trend in either of two models, inclusion of trend in the model could not be decided upon.

Table 3 - *Statistics for selection the lag length.*

Models		With deterministic trends				Without deterministic trends			
	p	*AIC*	*SBC*	*Xsc²(1)*	*Xsc²(2)*	*AIC*	*SBC*	*Xsc²(1)*	*Xsc²(2)*
Cukurova	1	-0.644	0.046	0.073 (0.787)	3.973 (0.137)	-0.078	0.571	4.329 (0.038)	7.380 (0.025)
	2	-0.417	0.566	1.4483 (0.223)	4.742 (0.093)	-0.194	0.748	2.316 (0.128)	4.762 (0.093)
Aegean	1	-1.467	- 0.778	0.201 (0.654)	3.038 (0.219)	-1.437	- 0.788	0.028 (0.868)	1.404 (0.496)
	2	-1.344	- 0.361	0.459 (0.498)	14.356 (0.000)	-1.386	- 0.444	0.496 (0.481)	15.480 (0.000)
Antalya	1	-0.872	- 0.183	9.086 (0.003)	15.976 (0.000)	-0.652	- 0.003	11.757 (0.001)	16.865 (0.000)
	2	-1.257	- 0.274	3.236 (0.072)	5.086 (0.079)	-1.047	- 0.105	3.424 (0.064)	4.735 (0.094)
Southeast	1	-0.071	- 0.242	0.041 (0.839)	0.138 (0.933)	-0749	- 0.059	0.178 (0.673)	0.283 (0.868)
	2	-0.954	- 0.070	0.056 (0.813)	4.244 (0.120)	-0.744	0.239	0.003 (0.997)	3.510 (0.173)

SC(2) in the second line are test statistics for Breusch-Godfrey autocorrelation. The numbers in parenthesis are probability values (p value) for the null hypothesis of inexistence of serial correlation.

After the appropriate lag length for regional cotton production models is determined, the bounds test proposed by Pesaran et al. 2001 to test the long-run relationship, in other words existence of a cointegration relationship, is used. In the bounds test, with the following hypotheses,

$$H_0 : \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = \beta_{12} = \beta_{13} = 0$$
$$H_1 : \beta_8 \neq \beta_9 \neq \beta_{10} \neq \beta_{11} \neq \beta_{12} \neq \beta_{13} \neq 0$$

The significance of lagged level coefficients is tested jointly by F test. In addition, whether, β_8, the coefficient of AC_{t-1} is equal to zero ($H_0 : \beta_8 = 0$) is tested with t test.

The findings of the bounds test were demonstrated in Table 4. The lag length detected in Table 3 to be used in the bounds test should be sensitive to sample size and degree of VAR (Bahmani-Oskooee and Bohl, 2000). Accordingly, p=2 lag length is selected for first differences of every variable in both two models with and without trend and F-statistics is calculated in order to jointly test lags of level variables. The F-statistics and t values calculated for all lag degrees are valid for six independent variables and 5 % level of significance. As it is seen from Table 4, the critical values of F and t statistics calculated for all regions is higher for the first lag for regions other than Antalya.

These findings prove the existence of a long-term relationship between variables for p=2 lag length for Antalya and for p=1 lag length for other regions. Simultaneously, this situation demonstrates that there is no problem of spurious regression for the analysis to be conducted with level values of three variables. In deciding for the model 'with' or 'without' time trend, the calculated F-statistics, (F_{III}) and t-statistics (t_{III}) indicate that the models without trend can be appropriate. Accordingly, it is decided to use models without trend for analyses of short term and long term.

Table 4 - *The results of the bound test.*

Models	p^*	With deterministic trends F_{IV}	F_V	t_V	Without deterministic trends F_{III}	t_{III}
Cukurova	1	4.218^c	3.900^b	1.755^a	3.878^c	-4.423^c
	2	0.939	1.085	0.625	1.351	-2.618
Aegean	1	3.144^b	2.412^a	-0.744^a	4.261^c	-4.543^c
	2	1.221	1.383	0.315	1.643	0.332
Antalya	1	1.638	2.781	0.277	1.591	0.889
	2	2.700^b	3.485^b	-1.352^a	3.923c	-4.988^c
Southeast	1	3.719^c	2.509^a	2.978^a	4.556^c	2.015^a
	2	1.527	1.449	2.631	0.725	4.483

k=6; critical values: F_{IV} (2.63,3.62) and F_V (2.87, 4.00); F_{III} (2.45, 3.61) t_V (-3.41,-4.69) t_{III} (-2.86, -4.38)

c, that it lies above the 0.05 upper bound; b, that it falls within the 0.05 bounds; a, the statistics lies below the 0.05 lower bound.

After the long run relationship between eight variables is detected with the bounds test approach, the following ARDL (m,n,q,r,s,w) model is estimated with consideration of p=2 for Antalya cotton production area and with p=1 for other cotton production areas, respectively. The most appropriate ARDL degree for estimated models depends on minimisation of Akaike info criterion. The degree of cotton production area supply sensitivity ARDL models were determined as ARDL(1,0,0,0,0,1,0,1) for Cukurova, as ARDL(1,0,0,0,0,0,1,0) for Aegean, as ARDL(1,2,2,2,2,2,0,1) for Antalya and as ARDL (1,0,0,1,0,0,0,0) for Southeast Region.

$$AC_{it} = \beta_{0i} + \sum_{j=1}^{m} \beta_{1ij} AC_{it-j} + \sum_{j=0}^{n} \beta_{2ij} CP_{it-j} + \sum_{j=0}^{q} \beta_{3ij} WP_{it-j} + \sum_{j=0}^{r} \beta_{4ij} BP_{it-j} + \sum_{j=0}^{s} \beta_{5ij} MP_{it-j} + \sum_{j=0}^{w} \beta_{6ij} R_{it-j} + \beta_{7i} D2 + \varepsilon_{it} \quad (6)$$

The long-term parameter estimations of supply sensitivity models calculated for each cotton production region are provided in Table 5. Accordingly, from the parameter estimates of cotton production acreage supply response, the ARDL model for Cukurova region has the expected signs. Variables of cotton price, maize price, price risk and labour wage are found as significant. Keeping other factors constant, a 1% rise in cotton price is expected to increase cotton production area by 0.44%. The limited sensitivity of cultivation area against cotton price can be attributed to cotton floor price instability. It is expected that a 1% rise in cotton price risk lead to a decline in cotton production area by 1.7%. A rise in maize price by 1% can approximately lead to a decline in cotton production area by 0.90% in the long run.

This situation can be attributed to the implementation of the 2nd crop project (wheat + maize) in the region and supports provided for maize production as an alternative crop. Another factor leading to decline in cotton production areas is the rise in labour wages during harvest. A 1% rise in labour wages in the long run can lead to a reduction in cotton production acreage by 0.80%. Rise in cotton harvesting prices and lack of finding an adequate number of labourers are found as effective factors in the decline of the regional cotton production acreage. The dummy variable inserted in the model in order to determine the effect of change in cotton pricing policies is found significant at 1%. This situation indicates that removal of state intervention in cotton prices in 1994 and the decline in producer prices thereafter led to decline in cotton production acreage.

Long-term coefficients of cotton price, tomato price and labour wage are found significant in cotton production acreage supply sensitivity ARDL model for the Aegean region (Table 5). A 1% rise in cotton prices can lead to a rise in cotton production area by 0.83%. This finding indicates that rise in cotton price may increase the cotton production area significantly. The high quality of cotton seeds produced in the region and the determination of cotton price in the Izmir Merchantile Exchange, which is situated in the region, lead to an actualisation of the price which is larger than that for other regions.

The prices of wheat and barley inserted in the model are found to be ineffective on cotton production acreage. As the amount of land devoted for maize production is low in the region, "price of tomato" was included in the model in exchange for the price of maize. According to the results of the analysis, a 1% rise in tomato prices leads to a 0.57% decline in cotton production area. Subsequently, tomato is a competitive crop for cotton in the Aegean region. As is the case for the other two regions, % rise in wages of cotton labours is expected to reduce the amount of land devoted for cotton production by 0.26%. This finding indicates that the amount of labour demanded in the harvest of cotton is a restrictive factor for cotton production. Due to the estimation results, the dummy variable explaining the changes in price policy in cotton production is found to be significant at 5% level of significance. This finding refers to the conclusion that policies aiming to reduce state intervention in determination of cotton price were effective in reduction of cotton production areas in the Aegean region.

Long-term coefficients for the Antalya region in cotton production acreage supply sensitivity ARDL model are demonstrated in Table 5. As the long-term coefficients are seen in the table, the variables other than wheat price are found to be important at 1% level of significance. As the producers in the region apply cultivation in turn between wheat and cotton, it can be said that both prices of wheat and cotton can be effective in the rise of cotton production area. As production of maize is supported, the area devoted for maize production has also risen in Antalya region. So far, as it is seen from the model outputs, rising maize prices in the long run leads to decline in the cotton production acreage in Antalya by 1.5%. Similarly, a rise in cotton price risk leads to a reduction in cotton production areas by 3.5%. Rising employment opportunities in specifically tourism region leads to a decline in labour supply for cotton harvest. Besides, the rise in labour wages due to inadequacy of labour supply leads to a decline in cotton acreage by 1.7%. The dummy variable inserted in the model to explain the changes in price policy in cotton production is found to be significant at 1% level of significance. Accordingly, it can be said that the policies followed since 1994 were effective in the decline of cotton production areas.

According to estimated long-term coefficients of ARDL model for Southeast region, three variables in the essence of prices of cotton, wheat and barley are found to be significant (Table 5). As wheat and cotton are cultivated in turn in the region, a rise in prices of cotton and wheat is effective in the rise of cotton cultivation area. On the contrary, a rise in the price of barley leads to a decline of cotton acreage by 5.2 %. Accordingly, it can be said that the only substitute for cotton in the region is barley. Yet, due to the rise in the amount of irrigated land in the region, the rise of cotton production area is expected to persist. Besides, as the labour is an abundant factor for the region in contrast to other regions, labour is not a restrictive factor in cotton harvest.

Table 5 - *Estimated long-run coefficients using the ARDL approach for model: ARDL selected based on the Akaike Criterion, 1962–2007.*

Regressor	Cukurova (1,0,0,0,0,1,0,1) Coefficient	Aegean (1,0,0,0,0,0,1,0) Coefficient	Antalya (1,2,2,2,2,2,0,1) Coefficient	Southeast (1,0,0,1,0,0,0,0) Coefficient
$\ln CP_t$	0.441**	0.830*	2.010*	0.811*
$\ln WP_t$	0.159	-0.072	3.173*	3.734**
$\ln BP_t$	-0.211	-0.028	0.231	-5.189***
$\ln M(T)P_t$	0.899*	-0.567**	-1.548*	3.427
R_t	-1.702**	-0.168	-3.511*	-3.488
$\ln LW_t$	-0.798*	-0.258**	-1.732*	2.143
$D2$	-0.200*	-0.168**	-2.952*	0.075
Constant	7.499*	4.776*	5.143*	-6.001

* Statistical significance at 1% level; ** Statistical significance at 5% level; *** Statistical significance at 10% level.

The short-term dynamics of the cotton acreage response model are demonstrated in Table 6. When the short term coefficients of ARDL model for Cukurova region are inspected, it is understood that the price risk variable is not significant in contrast to long term coefficients. The coefficients of cotton price, maize price, labour wage and dummy variables have expected signs and they are significantly effective on cotton production acreage. When the short-term and long-term coefficients of ARDL model for Aegean region are compared, it is seen that the variables other than the dummy variable are effective. It is estimated that price policy changes for cotton have no impact on cotton production area in the short term.

The long-term and short-term coefficients for the ARDL model for Antalya region demonstrates similar patterns in terms of significance. Besides, the short-term coefficients for the model of this region are smaller than long term coefficients. There are differences between long term and short-term coefficients of ARDL model of Southeast region. The price of barley, which is effective in the long run, is found to be insignificant in the short run. On the contrary, the price risk variable, which was insignificant in the long run, is found to be significant in the short run. This finding reveals that producers in the Southeast region respond to price changes in the short run.

As it is seen from Table 6, the estimated cotton production acreage supply response ARDL models for all regions are compatible with respect to short term expectations. The diagnostic tests, tests for serial correlation, functional compatibility and variance heterogeneity and normality tests of the regional models are found to be supportive in this sense.

The short term variable is a one period lag value of the residual series retrieved from the long term relationship. The coefficient obtained from OLS estimation of the short term model is called the error correction coefficient. The error correction coefficient shows how fast the imbalance due to policies implemented in cotton production, can be corrected. The error correction coefficient estimated for cotton production areas in the short term models has negative sign and is significant at 1 % level of significance. This finding also verifies that there is a long-term relationship between variables of all regional ARDL models.

The error correction coefficients are found as -0.67 and -0.59 for the models estimated for the Cukurova and the Aegean regions, respectively. It is understood that the pace of re-establishing the equilibrium after a shock, which has the probability to occur due to factors related with policy

Table 6 - *Error correction representation for the selected ARDL for regions.*

Regressor	Cukurova (1,0,0,0,0,1,0,1) Coefficient	Aegean (1,0,0,0,0,0,1,0) Coefficient	Antalya (1,2,2,2,2,2,0,1) Coefficient	Southeast (1,0,0,1,0,0,0,0) Coefficient
$\Delta \ln CP_t$	0.296***	0.492*	0.255	0.022*
$\Delta \ln CP_{t-1}$			0.555*	
$\Delta \ln WP_t$	0.107	-0.043	0.128	0.376***
$\Delta \ln WP_{t-1}$			0.394*	
$\Delta \ln BP_t$	-0.142	-0.016	-0.370	-0.240
$\Delta \ln BP_{t-1}$			-0.230	
$\Delta \ln M(T)P_t$	-0.605**	-0.028**	0.222	0.149
$\Delta \ln M(T)P_{t-1}$			-0.457*	
ΔR_t	-0.415	-0.336	0.988*	-0.123**
ΔR_{t-1}			-0.917**	
$\Delta \ln LW_t$	-0.587*	-0.023*	-0.509*	0.086
$D2$	-0.537**	-0.153	-0.264***	0.002
Constant	5.044*	2.831*	1.512*	-0.164
EC_{t-1}	-0.673*	-0.593*	-0.294*	-0.027*
Diagnostic tests				
R^2	0.867	0.832	0.988	0.976
$\bar{R}^2$	0.828	0.789	0.978	0.970
$\chi^2_{Reset(1)}$	2.344 (0.115)	2.625 (0.152)	1.578 (0.209)	0.093 (0.761)
$\chi^2_{LM(1)}$	0.859 (0.354)	0.011 (0.919)	1.965 (0.161)	2.289 (0.131)
$\chi^2_{White(1)}$	2.499 (0.114)	1.346 (0.246)	1. 766 (0.184)	1.285 (0.257)
$\chi^2_{Norm(2)}$	2.544 (0.280)	0.173 (0.917)	3.167 (0.205)	0.196 (0.907)

* Statistical significance at 1 % level; ** Statistical significance at 5 % level; *** Statistical significance at 10 % level.

and/or seasonal impacts, is rather high. The error correction coefficients for Antalya and Southeast regions are -0.29 and -0.03, respectively. Accordingly, only 3 % of an instability occurred following a political and/or seasonal shock converges to the long-term equilibrium.

6. Conclusions

We estimated the acreage response model for major cotton producing regions namely Cukurova, Aegean, Antalya and Southeast in Turkey by using the cointegration analysis which incorporates both general dynamic structure Nerlovian models and the potential problem of spurious regression.

In the Cukurova region ARDL model, only the cotton price is found effective in the rise of cotton production areas, yet price of maize, price risk and labour wages are found to be effective in reduction of cotton production areas. Regarding the Aegean region only cotton price variable is found to be effective in the rise of cotton production acreage. Tomato prices and labour wages have negative impact on cotton production acreage. In the Antalya region, all variables taking place in the model other than the price of barley are found to be effective in cotton production area. Wheat price and cotton price are found as positively effective on the cotton production area, while the direction of the impacts stemming from maize price, price risk and labour wages are found to be negative.

The amount of new irrigable agricultural lands and labour force abundance lead to a permanent rise in the amount of cotton cultivation areas in the Southeast region. Prices of cotton and wheat lead to rising amount of cotton cultivation areas in the region, while the price of competitive product, barley, has an inverse effect. Furthermore, the analysis results indicate that removal of state intervention resulted in deprivation of the cotton production areas in the three regions excluding Southeast region. Although this decline of cotton cultivation area is more than compensated for by the increases in the Southeast region, the cotton demand of the textiles sector has outstripped domestic supply of cotton in the country. Consequently, Turkey has lost its position as a cotton exporter and turned into a net importer of cotton.

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