International Journal of Economics Research, Vol. 2, No.2, 2005: 207-215

Structural Changes and Trend Behaviour of the European Cotton

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ABSTRACT

This paper attempts to investigate the trend behaviour of European cotton production series and to examine possible structural changes. The unit root hypothesis is applied, in the presence of two endogenously determined structural breaks. Results demonstrate that the behavior of the European cotton production series could be treated as trend-segmented processes. Such information has very important implications for agricultural policy decisions.

JEL Classification: C22 C52 Q13 Q18

Keywords: Stationarity, Structural Breaks, European Cotton Market

Introduction

Cotton is considered as a crop of major importance in the global economy, as it provides substantial income returns to farmers, industry and trade employees, of more than seventy countries. In addition, several rural regions worldwide rely upon the prospects of a single crop and this crop is the cotton which garners revenues not only to local farmers but also to textile employees and to a large number of intermediaries, suppliers and users.

Within the European Union (E.U), cotton production, processing and trade activities could be considered as major economic activities. The strong European textile industry has transformed the E.U into one of the largest cotton importers in the

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world market. Thus, cotton crop attracts the concern of the E.U policy makers and cotton production is highly protected. In specific, the last twenty years cotton production is under a protective scheme of the Common Agricultural Policy (CAP), the Common Market Organization (CMO) for Cotton, (E.C. 1979, 1987,1995).

It is common sense that major institutional changes in the macroeconomic environment, such as the CAP, affect significantly the agricultural production and are likely to cause structural changes in the evolution of many macroeconomic time series. Besides, policy measures undertaken in the context of the adjustment process towards as well as within a new institutional scheme may generate shocks that could affect significantly the trend behavior of a wide range of economic variables.

In the context of empirical analysis, pre-testing for unit roots in the cotton production series, to trace out its long run features, is a matter of major importance, especially when research efforts focus on economic modeling and forecasting in the framework of cointegration analysis and Granger causality.

The existence of a possible unit root in the considered variable may induce the problem of a spurious regression. Actually, when regressors and dependent variables are of different orders of integration, this leads to inconsistent estimates (Granger and Newbold, 1974; Phillips, 1986).

A second issue of similar importance would be to evaluate whether cotton production could be characterized as a unit root (non-stationary) process or as a trend stationary process with shift(s) in the level and/or the slope in a deterministic trend. In case the results suggest stationarity about a broken trend, there are important implications for detrending the data series and modeling co-movements between cotton production and other related economic variables.

A last issue attributed in this study through the investigation of the integration properties of cotton series and the existence of possible structural brakes, is policy evaluation. For example, a change in the intercept of the testing model may indicate a jump in the level of the variable, due to policy actions while a change in the slope of the trend function may indicate a different growth path thereafter, of the examined variable which could be assessed as indication of effective policy measures.

Till now, research attempts on European cotton market, mainly focused on the estimation of the welfare effects of CAP application in the cotton sector (*Katranidis and Velentzas, 2000; Karagiannis et al., 1997* and *Lianos and Rizopoulos, 1988*). In fact, no research was directly oriented to assess cotton's trend behaviour through the examination of the statistical properties of the cotton production series.

In this study, an attempt is made in order to investigate the existence of structural changes in the European cotton production, to detect the dates these breaks occurred, to examine the relation between these breaks and policy changes introduced and mainly, to define whether European cotton production series is stationary or non-stationary. Two alternative models are considered and tested. Under the null

hypothesis, cotton production contains a stochastic trend and thus can be modeled as a random walk with drift. Under the alternative hypothesis cotton series contains a segmented trend. This permits large permanent shocks but otherwise assumes that shocks have temporary effects only. This will be a useful tool in the decision making process, providing important information to agricultural policy makers.

The remainder of the paper is organized as follows: In section two, an overview of the empirical methodology followed in this study is provided. Section three, refers to the data and the empirical findings of the analysis. The last section presents the concluding remarks and provides some policy implications.

Methodological Issues

Most macroeconomic data series are characterized by non-stationary properties. However, Perron (1989) claimed that the majority of macroeconomic variables are in fact stationary around a deterministic trend function. In particular, he showed that, failure to allow for an existing structural break, reduces the ability to reject a false unit root.

Perron's approach considers three models to account for possible structural breaks either in the level of the trend function, or in the slope or in both the trend level and the slope of the examined series.

Perron's unit root test allows for one known or "exogenous" structural break and the unit root null is tested against the trend-break stationarity alternative. Zivot and Andrews (1992) and Perron (1997), improved the testing approach a step further, using a sequential Dickey-Fuller test and allowing the data themselves to determine "endogenously" a break point rather than imposing it subjectively.

However, Lumsdaine and Papell (1997) showed that results regarding the test of the unit root hypothesis are sensitive to the number of breaks in an alternative specification. Just as failure to allow for one break can cause non-rejection of the unit root null by the ADF test, failure to allow for two breaks, if they exist, can cause non-rejection of the unit root null by the tests admitting only one break. More specifically, the Lumsdaine and Papell test, LP hereafter, involve regression of the following form:

$$\Delta Y_t = \mu + \beta T_t + \theta_1 DU1_t + \gamma_1 DT1_t + \theta_2 DU2_i + \gamma_2 DT2_t + \alpha Y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t$$

For t=1...T , and where c(L) is a lag polynomial of known order k and 1-c(L)L has all its roots lying outside the unit circle.

$DU1_t$ and $DU2_t$ are indicator dummies for a mean shift occurring at times TB1 and TB2, respectively and $DT1_t$ and $DT2_t$ are the corresponding trend shift variables, such that $DU1_t$ =1 if t>TB1 and $DU2_t$ =1 if t>TB2. $DT1_t$ =t-TB1 if t<TB1 and $DT2_t$ =t-TB2 if t<TB2. The value of k is selected following Campbell and Perron (1991).

Next, the absolute value of the t-statistic for α, over all possible distinct pairs of break dates, TB1 and TB2 is computed. If the t-statistic exceeds the associated critical

value, then the null hypothesis that the series Y_t is an integrated process without an exogenous structural break is rejected in favour of the alternative hypothesis that Y_t is trend stationary with two breaks at two distinct unknown dates. The estimated break dates are the values of TB1 and TB2 for which the absolute value of the t-statistic for á is maximized.

Two types of models are estimated. Model AA sets γ1=γ2=0, thus allowing for two breaks only in the intercept and model CC, which allows for two breaks to be in both the intercept and in the slope of the trend function.

Data and Results

The data used for the empirical analysis were provided by FAO and includes annual time series regarding the quantities of cotton production for Greece and Spain* since 1974 to 1999.

First, the standard ADF and Perron unit root tests, were performed for all the examined series, without taking into consideration the possibility of structural breaks. Results (Table 1), reveal that all the examined series have a unit root in levels while they are stationary in their first differences. In general, the findings support the evidence of the unit root hypothesis.

Table 1: Unit Root Test Results

	Dickey-Fuller			*Phillips-Perron*		
Greece	*lag*	*no-trend*	*trend*	*lag*	*no-trend*	*trend*
			In levels			
Production	2	-0.251	-2.356	2	-0.334	-2.728
			In first differences			
Production	1	-3.985*	-4.065*	1	-4.764*	-4.906*
Spain	*lag*	*no-trend*	*trend*	*lag*	*no-trend*	*trend*
			In levels			
Production	2	-1.805	-2.489	2	-1.881	-2.801
			In first differences			
Production	1	-3.482*	-3.644*	1	-6.211*	-6.304*

Note: *Significant at the 5% level.

* We are aware that the size of the sample is rather restrictive to carry out unit - root tests. Thus, the empirical analysis may be somewhat troublesome and any inference should be considered carefully.

Non-stationarity in the series level might appear due to possible existence of a structural break. In that case, the employed conventional unit root tests have low power and consequently they are not valid (Perron, 1989 and 1997; Zivot and Andrews, 1992). Actually, if indeed structural breaks exist in the series, the critical value is very low (in absolute term) and the null hypothesis of a unit root is often rejected. Consequently, whenever structural breaks are suspected, tests need to allow for safeguarding any misleading results.

So far, an inspection of the plots of the examined series make clear that some sort of shifts have occurred over the examined period. Figure 1 plots the Greek cotton output data and one could easily notice shifts in both the level and the slope of the series over the period 1980-1994. In figure 2, which plots the Spanish cotton output data, it is also clear that shifts and trend changes have occurred over the period 1979 - 1996.

Figure 1: Greek Cotton Production

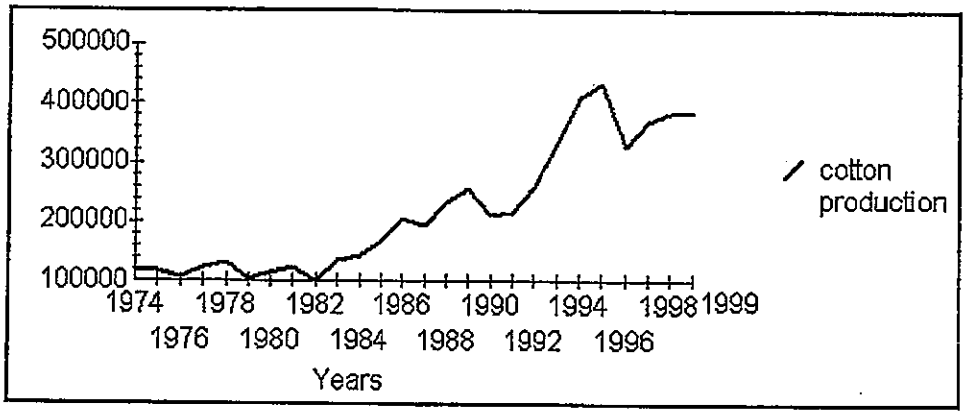
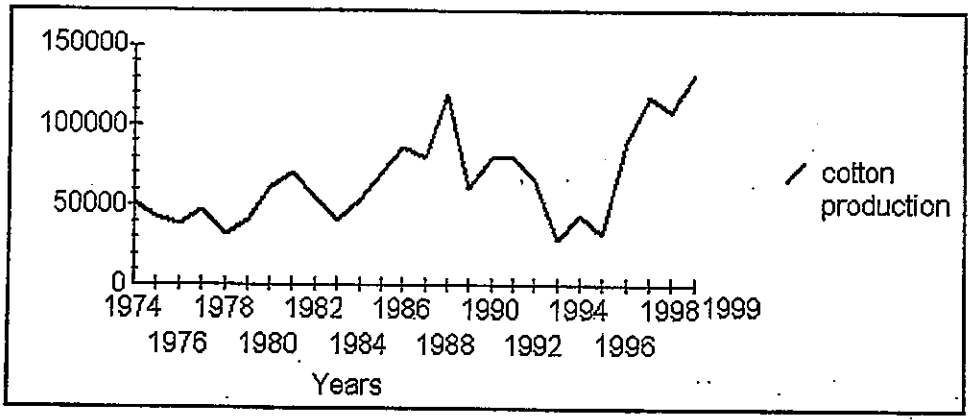


Figure 2: Spanish Cotton Production



Considering the above remarks, the methodology proposed by Lumsdeine and Papell (1997, hereafter LP) was used, allowing to test the unit root hypothesis in the presence of two endogenously determined structural breaks. For the purposes of our analysis, models AA and CC, as defined earlier, were estimated. Model AA allows two breaks in the intercept while model CC allows the two breaks to be in both the intercept and the slope of the trend function (Tables 2 and 3).

Table 2: MODEL AA

$\Delta Y_t = \mu + \beta T_t + \theta_1 DU1_t + \theta_2 DU2_t + \alpha Y_{t-1} + \Sigma^k_{i=1} c_i \Delta y_{t-1} + \varepsilon_t$

				t-statistics		
Series	*TB1*	*TB2*	α	θ_1	θ_2	*lags*
Greece						
Sign of break dummy				(+)	(+)	
Production	1981	1991	6.9[b]	3.22[a]	2.14[b]	2
Spain						
Sign of break dummy				(-)	(+)	
Production	1983	1986	7.48[a]	1.84[c]	1.99[b]	2

Table 3: MODEL CC

$\Delta Y_t = \mu + \beta T_t + \theta_1 DU1_t + \gamma_1 DT1_t + \theta_2 DU2_t + \gamma_2 DT2_t + \alpha Y_{t-1} + \Sigma^k_{i=1} c_i \Delta y_{t-1} + \varepsilon_t$

				t-statistics				
Series	*TB1*	*TB2*	α	θ_1	γ_1	θ_2	γ_2	*lags*
Greece								
Sign of break dummy					(+)	(+)	(+)	(+)
Production	1981	1992	7.55[a]	3.48a	1.84c	0.43	4.83a	2
Spain								
Sign of break dummy				(-)	(+)	(+)	(+)	
Production	1983	1986	10.53[a]	1.31	0.75	2.45b	.35	2

Notes: [a] Significant at the 1% level.
[b] Significant at the 5% level.
[c] Significant at the 10% level.

Studying reported results in Table 2, it can be realized that model AA provides evidence against the unit root null hypothesis, for both countries. Yet, interesting variations can be noticed on the date breaks. Thus, around Greece's accession to E.U (+1 or -1 year period) a point break was identified, for the examined Greek cotton output series, underscoring the introduced changes through CAP implementation and cotton's CMO introduction. More specifically, the two breaks were detected in

1981 and 1991 and in both cases there are upward shifts in the level of production. The shift in 1981 is significant at the 1 per cent level while the shift in 1991 is significant at the 5 per cent level.

In the case of Spain, the test indicates that the breaks occurred in 1983 and 1986. In particular, the implementation of CAP in 1986 caused an upward shift in the level of Spanish cotton production, while in 1983 the shift is downward. The shift in 1983 is rather weakly significant (only at the 10 per cent level), while that of 1986 is significant at the 5 per cent level of significance.

The results provided by model CC are reported in Table 3. In the case of Greece, the unit root null hypothesis was rejected for Greek cotton series and the CAP implementation date (÷2 or -2 years period) was identified as a significant break point. More specifically, the breaks were detected in 1981 and 1991. In 1981, there is a significant, at the 1 per cent level, upward shift in the level of production, as well as an upward change in the trend of production, significant at the 10 per cent level. In 1991, the shift in the level of production is not statistically significant, while there is a highly significant, at the 1 per cent level, upward change in the trend of production.

With regard to the case of Spain, the results do not support the unit root null and indicate that the structural breaks in cotton production occurred in 1983 and 1986. The break in 1983 indicates a statistically insignificant downward shift in the level of production, while that of 1986 indicates a positive shift, at the 5 per cent level of significance. With regard to changes in the trend of the production series, in both dates they were found statistically insignificant.

In general, the findings of this study reveal the followings: For both counties, accession to the E.U affected significantly the domestic cotton production. This is not surprising, due to the fact that the implementation of the general rules of CAP altered the protective scheme in the entire agricultural sector. Instead, the detection of a structural break in 1992, could be considered surprising, since 1992 CAP Reform had not considered the cotton's CMO. This fact demonstrates the broader effects of CAP Reform and reveals the interdependencies between crops sectors, a fact that is of great importance for agricultural policy makers. Besides, the results provide evidence that cotton production series in Greece and Spain should be treated as segmented trend-stationary processes. The latter result further implies that the trend behavior of cotton production series is less volatile and any changes either in the CAP general rules or in specific CMO had caused rather transitory effects in cotton's production series behaviour.

Conclusions

In this research, an attempt was made to illustrate the trend behavior of the cotton production series, for the two European cotton producers, Greece and Spain. The methodology proposed by Lumsdaine and Papell (1997), was applied to test the unit root hypothesis in the presence of two endogenously determined structural breaks.

According to empirical findings two structural breaks have occurred in the production series, for both countries. These detected breaks coincide with the dates of the accession to E.U and the implementation of the general rules of CAP in the whole agricultural sector. Therefore, the application of CAP has caused significant impacts on European cotton market, which was expected since CAP has changed the entire protective scheme. Regarding the second detected break in 1992, we should mention that 1992 CAP Reform had not considered the cotton's CMO. This fact possibly demonstrates the broader effects caused by the respective CAP Reform and consequently policy makers should take into consideration the interdependencies among the agricultural crops and the respective markets when new policies are introduced.

In addition, the cotton production series for both countries are characterized as segmented trend-stationary processes and not as difference-stationary processes. This result implies that the trend behavior of cotton production series is not volatile and the detected shocks had caused transitory effects in cotton's production series behaviour. Therefore, any changes either in the CAP general rules or in the specific CMOs had caused rather transitory effects in the European cotton production. This information could be considered as an important indicator for the future evolution and the trend behavior of cotton production series, when new policy measures and institutional changes are planning.

Consequently, the process of investigating the existence of structural breaks, identifying the correlation of these breaks with policy changes and examining the stationarity of the production series, could be considered as a useful tool in the decision making process, especially in cases concerning the vulnerable agricultural markets and the specific sectors such as cotton.

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