The olive oil and cotton lint sectors in the European Union

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Abstract

This paper examines and analyzes the impacts of the reformed CAP as well as the decisions of the new round of negotiations for the olive oil and cotton sectors in the European Union.

The aim of this study is to estimate the changes in supply (agricultural supply plus intermediate demand and final production), demand (consumption), price and stock formation (import, export, beginning and ending stocks, national price formation) for both the olive oil and cotton sectors. The model designed for this purpose is partial equilibrium and policy oriented.

The objectives of this model are to estimate changes in the production and consumption of the two products concerned, to determine how the reformed Common Agricultural Policy (CAP) and the new round of negotiations of the World Trade Organization (WTO) affect these two sectors, to analyze the evolution of export and import volumes, and finally to determine how this evolution will influence the welfare situation of the olive oil and cotton sectors.

Keywords: Olive oil, Cotton CAP, Trade, socio economic effects, partial equilibrium model, dynamic, multi market, synthetic, policy oriented simulation model

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1. Introduction

Our aim for this paper is to examine and analyze the impacts of the reformed CAP as long as with the decisions of the new round of negotiations for the sectors of olive oil and cotton in European Union.

The model designed for this purpose is a multi- product, partial equilibrium and policy oriented model. It can be used to analyze economic implications of alternative policy choices. And finally it examines the relationships within the agricultural sector and not the resource shifts between sectors. As the first stage of our research we have been focusing on the cotton lint sector.

Objectives of this model are to estimate changes in production and consumption of the two products concerned as long as to determine how the reformed CAP and the new round of negotiations for the WTO affect these two sectors. Also concerning the trade is to determine how the volume of exports and imports will change and how all these changes will influence the welfare situation for these two sectors.

For both cotton and olive oil we want to estimate the changes in supply (agricultural supply plus intermediate demand and final production), demand (consumption), price and stocks formation(import, export, beginning and ending stocks, national price formation).

European Union is the main producer and exporter of olive oil in the world having a competitive advantage against the other producing countries. What we concern most is to estimate how the E.U support policy for olive oil is affecting the world market of olive oil and more especially the countries gathered in the Mediterranean basin.

As base year we will use the marketing year of 2003- 2004 and we will make forecast for the next five years. The scenarios will include policies concerning the reformed CAP and the WTO agreements. A scenario of fully abolished of all the supporting policies will also be concerned.

Cotton is a product which has concern a lot the latest discussions of the World Trade Organization. It is an issue that has been very sensitive especially for the West Africa countries. For many countries the heavy protection of the sector (subsidies, export subsidies and other form of aid) has create an unfair competition among developed and developing countries.

Among the member states of the European Union Greece and Spain are the two most important producers of cotton. Greece and Spain produce over 99% of the cotton grown in the European Union, with the remaining fraction grown in Italy and Portugal. But in a world level EU production holds only the 2,5 % which is a very small percentage which doesn't allow for EU to have any control on the market.

On the other hand the cultivation of cotton is very important for the regions that are planted. We are aiming to estimate a completely liberalization of the sector and make the estimations for the welfare effects for these regions that cotton is the main plantation.

What we need to take into consideration before building the model is the policy variables that affecting the two sectors. Mainly we will take into account the 2003 reformed CAP. It is important to understand the structure of the policy implemented (or to be implemented) in order to introduce to your model the appropriate policy variables.

An important issue for developing the system of equations for cotton is the determination of the world price. The solution proposed is to use the cotton A index. The price equation for Spain (since Greece is the main producer in E.U.) is determined by the price of Greece and the self- sufficiency ratio for both Spain and Greece.

The Greek price will be determined by the world price (A index) and the policy variables (support and co responsibility levy).

The olive oil model is following the same logic as the model for cotton lint. The price equations for Spain and Greece (Since Italy is the main producer in E.U.) are determined by the price of Italy and the self sufficiency ratio for Spain, Greece and Italy.

The Italian price will be determined as the average of the estimated (based on the share of exports) price of the 5 main exporting markets for olive oil.

The cotton lint model

We will try to have a brief representation of the cotton lint equations and the main variables that includes.

The cotton area harvested is determined by the cotton share of grain area and the 4 arable crops irrigated area harvested.

Yield equations are very important due to the effect of technology change. Cotton lint yield is specified as a function of cotton lint trend yield, cotton five year average real producer price, irrigated, grain, vegetable, tree area and cotton area harvested.

The second step for the determination of the cotton market is to analyse cotton lint. Lint production is specified as an identity through the multiplication of cotton area harvested with the actual cotton lint yield. The cotton lint domestic use is determined through the inclusion of the lagged dependent variable, the cotton lint real price and a proxy for income which is the real GDP per capita.

The ending stocks are determined by the beginning stocks, the total cotton lint production and the seed cotton world price index (A index). Cotton producer price is a function of the seed cotton world price index (A index).

Concerning the equations for trade cotton lint imports are determined through domestic use, lagged beginning and ending stocks and cotton production. On the other hand exports are a function of cotton production, cotton lint imports, lagged ending stocks, ending stocks and domestic use.

The olive oil model

The supply side is modelled as two different components.

- The first is the agricultural production and refers to the production of non-processed olive oil at the farm-crusher gate, we call it raw material and its price is called raw material price; this is the level where the production aid and the intervention price applies.
- The second is the industrial production which refers to the final production of olive oil; therefore, by processing industry we mean either the bottling-wholesale taking directly the olive oil from the crusher (in the case of extra-virgin) or further industrial processing of the raw materials and the respective price is simply called olive oil price.

In any case, the model only refers to olive oil, not to olives (neither to table olives).

The processing industry buys raw materials of both national and foreign origin. It minimises costs with respect to this two inputs and has a strongly separable production function with respect to raw materials and homogeneous of degree one (i.e. constant returns to scale). Therefore, a dual representation of the processing industry technology is given by the unit cost function depending on import and domestic raw material prices and with regularity conditions imposed.

We introduce in the unit cost equation the lagged ratio between production in Spain and Greece and production in Italy as an argument to take into account cyclical behaviour of both prices and quantities over the three countries.

The price of imported raw material (the import price) is defined as a function of Spanish and Greek raw material prices and of a trend variable that should proxy the long-term specific behaviour of extra-EU exporters (besides Spain and Greece, Italy mainly imports raw material from Northern Africa, especially Tunisia). Therefore, import from Spain and Greece is crucial for the Italian olive oil industry. A levy for non-processed oil coming from third (non EU) countries should also be considered to define the import price. However, the main olive oil exporters to Italy (mainly Tunisia) are under a special regime of trade with the EU that makes the levy itself not very relevant.

The production depends on the proportional mark-up between the lagged olive oil price and the unit cost. Production also depends on the current level of the unit aid. As well in the yield equation below, the trend should take into account the technical change

The area used for the production of olive oil can be determined as the trend for producing olive oil and the 5-years olive oil real raw material price. In any case, agricultural policy applies on the supply side by affecting yields and not land allocation.

The consumer utility function is assumed weakly separable in oils and fats; so, optimal demand only depends on their relative prices and on pre allocated consumer budget to oils and fats. This budget depends on the GDP growth *per capita* and on a trend variable representing changes in consumer preferences. The demand model is therefore build as the associated system of demand functions specified as an Almost Ideal Demand System (AIDS).

Since an intervention arrangement is present in the E.U. for olive oil, stock demand depends on the beginning stock and on the difference between the farm level supply and the intermediate demand. But also the market and the intervention price are relevant, since the stock demand has to be inelastic whenever the market prices are above the intervention price and elastic otherwise.

The olive oil export supply is estimated by the propensity to export which is expected to depend on the difference on the one hand between the agricultural production and the intermediate demand and, on the other hand, between the total industry production and the total final consumption, plus the stocks variation.

By modelling export, import demand is derived as an identity such that any increase in net exports is partly attributed to increase in exports and the rest to decrease in import.

2. The world Cotton market

2.1 Production of cotton in the world

The cotton plant is cultivated as an annual plant in sufficiently hot regions, where there are no frosts but a wet season (for the plant's development) alternating with a dry season (for fruit ripening).

Its fruit is a pod containing oilseeds surrounded by cotton fibres (lint). Ginning separates the seeds and fibres. The seed can then be pressed to obtain oil (for consumption and for making soap) and oilseed cakes (for animal feed). The fibres (ginned cotton) are baled and classified in accordance with strict standards and then processed mainly by the textile industry.

The market outlets for cotton oil and cotton seed cake, the by-products of cotton, are almost entirely local. Since cotton fibre is the primary material that gives the cotton plant its value and since there is no international trade in unginned cotton and little such trade in cotton seed, any analysis of the world cotton market must focus on ginned cotton fibre.

2.2 Production- Consumption

Cotton is produced in many countries with northern hemisphere accounting for 90% of the total global output. More than the two thirds of cotton is produced by developing countries. During the last 4 decades cotton production grew at an annual average rate of 1.8% to reach 26 million tons in 2004 from 10.2 million tons in 1960. Most of this growth came from China and India which tripled and doubled their production, respectively, during this 40-year period. Other countries which significantly increased their share of cotton production were Turkey, Greece, and Pakistan. Some “new entrants” also contributed to this growth. Australia, for example, produced only 2,000 tons of cotton in 1960 while it averaged 650,000 tons during the last five years. Francophone Africa produced less than 100,000 tons in the 1960s and now produces almost one million tons. The United States and the Central Asia Republics (then the Soviet Union), the two dominant cotton producers during the 1960s, have maintained their output levels at about 3.5 and 1.5 million tons respectively, thereby halving their shares. A number of Central American countries which used to produce almost 250,000 tons of cotton, now produce virtually none. The share of East African cotton producers declined considerably during this period.

During the last five years, cotton production fluctuated between 19 and 26 million tons with no significant trend. China and the United States each accounted for approximately 20% of world output, followed by India (12 %), Pakistan (8%), and Uzbekistan (5%). Other significant cotton producers are the countries of Francophone Africa, Turkey, Brazil, Australia, and Greece which account for a combined 18 percent of global output. The remaining share is accounted for by a number of smaller producers.

As the technology used for area harvesting and the processing of cotton have improved throughout the last decade an increase of yield for every country can be noticed. Between 1960 and 2000 world cotton yields doubled, from 300 to 600 kilograms per hectare, implying an annual growth rate of 1.8 percent (Baffes, 2004). More recent developments in technology such as genetically modified seeds and precision farming are likely to further reduce the costs of producing cotton. In 2002, genetically modified cotton accounted for almost 30 percent of global cotton output.

The consumption pattern of cotton is primarily determined by the size of the textile industries of the dominant cotton consumers. China, the leading textile producer, absorbed more than one quarter of global cotton output during the late 1990s. Other major textile producers (and hence major cotton consumers) are India, the United States, and Turkey, which together (including China) account for three-quarters of global cotton consumption. A number of East Asian countries have emerged recently as important cotton consumers. For example, Indonesia, Thailand, Korea, and Taiwan consumed only 130 thousand tons in 1960 (1.2% of global consumption) while they consumed 1.5 million tons in 2002 (7.25% of global consumption). That is also reflected in the concentration pattern of consumption which increased by 2 percentage points during the 1990s.

Growth in the demand for cotton has been slow. Between 1960 and 2000, cotton demand has grown at the same rate as the population (1.8 percent per annum), implying that per capita cotton consumption has remained stagnant.

Stocks, which have historically fluctuated between 20 and 50 percent of global output, have affected the cotton market considerably, especially price variability. Major stockholders are the United States and China. Consequently, the stockholding policies of these two countries have affected the level and volatility of cotton prices. Two major cotton de-stocking episodes are associated with periods of considerable price variability: the 1985 shift in US policy from stockholding to price support and the 1999 reforms in China.

2.3 Trade in cotton

One-third of cotton production is traded internationally. The four dominant exporters namely the USA, Uzbekistan, Francophone Africa, and Australia account for more than two-thirds of the world's exports. Four major producers, China, India, Pakistan, and Turkey do not export cotton and occasionally import to supply their textile industries. Imports of cotton are more uniformly distributed than exports. During the 2002/03 season, the eight largest importers (Indonesia, India, Mexico, Thailand, Turkey, Russia, Italy, and Korea) accounted for over half of world cotton imports. Apart from Russia, which prior to 1990 was considered a major producer but not an importer because the Central Asian cotton production was considered an internal trade, most of the remaining cotton importers are new in the sense that they have been importing cotton to supply their newly-developed textile industries (Baffes 2004). For example, four East Asian textile producers (Indonesia, Thailand, Taiwan (China), and Korea) accounted for less than 3% of world cotton imports in 1960, as compared with 22% in 2002.

In terms of direction of trade flows, 44% of cotton exports went from industrial to developing countries during 2002/03. The shares for 1980/81 and 1990/91 were 38 and 31%. The shares of cotton exports from developing to developed countries increased from 13% in 1980/81 to 31% in 2000/01. This change in the pattern of trade flows reflects the growth of the textile industries in South-East Asia (See ANNEX, Table 1).

3. Challenges on the world cotton market. [1]

The world cotton sector faces several major challenges. All of these affect also developing and least developed producers particularly in Africa. Indeed cotton plays in a number of African countries a key role in the economy and development efforts.

A general overview of the state and trends of the world cotton market allows for a better understanding of the specific challenges and situation within which the African cotton sector operates and needs to develop.

Although at global level, international cotton trade represents a limited share of production (approximately 30%) some developing countries are heavily dependent on it: for example, between 30 and 40% of export earnings in Benin, Burkina, Chad, and Mali, come from cotton.

[1] Communication from the commission to the council and the European Parliament "Proposal for an EU-Africa partnership in support of cotton sector Development", Commission of the European Communities, Brussels COM(2004)

The West and Central African region, with about 12% of world exports, is an important player in the international cotton market, although well below the United States which accounts for 30%. Other important exporters comprise Uzbekistan (13%) and Australia (12%). China is the largest cotton producer as well as consumer, but only occasionally exports part of its production. On the other side, the European Union is a major importer of cotton, and about a third of its imports come from West and Central Africa. In addition South-East Asia, as well as Brazil, are becoming increasingly important importers due to their growing textile industries. This trend is expected to be amplified by the forthcoming liberalisation foreseen under the Agreement on Textiles and Clothing. Global cotton demand is only expected to grow moderately over the next decade, in line with population increase (1,8% annually) .

Cotton prices as those for most agricultural commodities show a long-term decreasing price trend and strong short term fluctuations. These have been significantly influenced by China's sporadic entry in the world market, both for imports and for exports, which highlights the need for deeper analysis of the characteristics of the world cotton market in order to better understand its determinants. Prices of agricultural commodities are determined by several factors, in particular: the level of demand, which reflects changes in the economic situation of major importers, as well as substitution effects from other similar products; the level of supply, which derives from the commodity chain structures in place, agro-technical capacity and local unpredictable natural conditions; and the level of stocks. The long term decline of cotton prices has averaged 0,2% per annum between 1960 and 1984, and has accelerated thereafter to 0,9% per annum between 1985 and 2002. It has been closely linked to increases in productivity and reduction in production costs, as well as to the competition of synthetic fibres.

Subsidisation regimes in several producing countries, in particular in the industrialised world, add to the general downward pressure on prices. There are different types of subsidies applied to cotton in the United States and the European Union and the Union is spending only a fraction of the amount put at the disposal of cotton producers in the US (€ 0,8 billion in the EU against € 2,9 billion in the US in 2001-02). Due to subsidisation, prices paid to domestic cotton farmers were 90% and 154% above world prices in 2001/02 in the US and EU respectively. This has direct impact on cotton production in both countries. Nevertheless, unlike the US, the EU is a minor player in terms of global production, accounting for just 2% of world output. Therefore the EU has only a marginal influence on price formation in international markets. However in terms of volume, EU production represents approximately 70% of West and Central African exports.

The 2001-02 marketing year witnessed particularly low prices, which, in West and Central Africa where there is no price support, have led to serious difficulties for the cotton sector. Price has raised sharply again more recently illustrating the dramatic short-term volatility with which cotton producers have to cope.

3.1 Context and problems of the African cotton sector

Cotton is a vital export commodity in a number of African countries. Two to three million producers and some 15 million people depend directly or indirectly on the cotton sector. Many of them belong to the poorest sectors of society. Price levels and stability directly affect their capacity to earn a living. Sudden recent fluctuations in price have highlighted the vulnerability of the African cotton sector.

While generally, cotton produced in Africa is competitive, in particular in West and Central Africa, there is potential for further strengthening its competitive position. In addition, the dynamic character of the domestic and international environment raises serious challenges for the future of the sector. In terms of external factors, as analysed above, the long term decline of prices and significant short term fluctuations, as well as heavy international competition influenced by trade distorting subsidies, are serious concerns that deserve consideration both at domestic and international level. As to domestic challenges, limited flexibility of the sector in meeting changing demands, and a slow rate of technological innovation have to be addressed as a matter of priority. If these international and domestic threats are not adequately recognised and tackled, a decline of the sector could result. This would imply severe consequences in terms of impoverishment of rural areas, intensification of migrations and even risks for the stability of the cotton- dependent countries.

During the preparation process leading to the World Trade Organisation (WTO) Ministerial Conference of Cancun, four of the West and Central African countries voiced concerns in WTO regarding the situation of their cotton sectors. The initiative put forward by these countries aims at obtaining specific negotiations within the Doha Development Agenda for cotton, focussing on two demands: 1) establishing a mechanism "for phasing out support for cotton production with a view to its total elimination", and, 2) as a transitional measure "until cotton production support measures have been completely eliminated cotton producers in Least Developing Countries should be offered financial compensation to offset the income they are losing, as an integral part of the rights and obligations resulting from the Doha round This initiative has met a lot of sympathy across WTO membership.

4. The cotton sector in the European Union

Among the member states of the European Union Greece and Spain are the two most important producers of cotton. Greece and Spain produce over 99% of the cotton grown in the European Union, with the remaining fraction grown in Italy and Portugal. Farmers have exceeded their production quota in recent years, and subsequently received lower price subsidies.

Even though there are no significant yield differences between them, Greece is by far the largest supplier of cotton producing approximately 3 to 3,5 times more than Spain or 75-80% of the Community's total production. In Greece, cotton accounts for 9% of the country's total agricultural output, while the corresponding figure for Spain is only 1.5%. It should be noted the fact that in both countries the production of cotton is localized and it is concentrated into specific regions around the country. The three main production regions in Greece are Thessaly, Macedonia-Thrace, and Sterea Ellada. In Spain, the main production regions are Andalusia, particularly the provinces of Seville, Cordoba, and Valencia.

In both Greece and Spain, cotton is grown almost entirely on irrigated land using drip irrigation techniques, and harvesting machines which are now widely used due to the E.U. start-up and investment aids. The cotton sector in Greece is characterized by a large number of growers (71.600) and small, highly specialized farms, with an average area of 4.9 ha. Specialization is much more evident in the main production areas of Thessaly and Sterea Ellada. In Spain, the number of cotton growers is smaller (7.600) but cotton farms are apparently larger (an average area of 12,0 ha) and specialization is also strong.

The other important counterparts in the cotton sector are ginners. There are about 75 ginning firms in Greece, 20 of which are producer cooperatives involved in the industrial processing of raw cotton. Total ginning capacity is only slightly above actual Greek production, implying marginal under-utilization of existing capacity. In Spain there are 22 ginning firms, 10 of which are cooperatives. However, there is an over-capacity of ginning relative to supply.

5. The cotton model

What is necessary to be done before determining the farm and the structure of equations used for the analysis of cotton sector for E.U. is to describe, briefly, the sector policies applied in the European Union.

The Reformed CAP for cotton[2]:

The new reformed policy concerning cotton is totally different from the old scheme. The application of the new reformed scheme is obliged to start in 2006, which means that still the year 2005 the old scheme was applied.

For cotton, the Commission proposes putting into place a single farm payment system and new aid granted in the form of a cotton area payment. The single payment system would be equivalent to 60% of the current aid and Member States would allocate the remaining 40% as an area payment per hectare of cotton. So according to the regulation 864/2004 producers will get 96.6€/hectare for the decompounded part. This amount of money will be distributed to the farmers that had a

[2] http://europa.eu.int/scadplus/leg/en/lvb/l11088.htm

production and also according to the land use for the years 2000- 2002 which is the reference period.

Partial decoupling of aid will enable producers to adapt more easily to market demands. They will also be able to use production methods which are more environmentally friendly. European subsidies in the cotton sector will comply with World Trade Organization rules and will no longer distort competition on the world market to such a great extent. Cotton growing will become environmentally friendly because farmers will have to respect environmental legislation in order to benefit from aid. The new area payment per hectare of cotton will be granted for a maximum area of 425.360 hectares compared with 469.000 hectares at present.

5.1 Structure of the Model

5.1.2 Methodology

The model designed for this purpose is a multi- product, partial equilibrium and policy oriented model. It can be used to analyze the economic implications of alternative policy choices. In addition, it examines the relationships within the agricultural sector and not the resource shifts between sectors.

The equations of the model had been developed through the AG-MEMOD partnership model.

The objectives of this model are to estimate changes in the production and consumption of the two products concerned, to determine how the reformed Common Agricultural Policy (CAP) and the new round of negotiations of the World Trade Organization (WTO) affect these two sectors, to analyze the evolution of export and import volumes, and finally to determine how this evolution will influence the welfare situation of the olive oil and cotton sectors.

The functional representation of the conducted welfare analysis is:

(1) $\Delta PS = (P_{Mod} - P_w) * Q_{sw} + 1/2 (P_{Mod} - P_w) * (Q_{SD} - Q_{SW})$ (2)

$\Delta CS = -[(P_D - P_W) * Q_{DD} + 1/2 (P_D - P_W) * (Q_{DW} - Q_{DD})]$

(3) $\Delta T = -[(P_{Mod} - P_D) * Q_{SD} - (P_D - P_W) * (Q_{DD} - Q_{SD})]$

(4) $\Delta NW = \Delta PS + \Delta CS + \Delta T$

where, ΔPS is the change in producer surplus, ΔCS is the change in consumer surplus, ΔT the change in the taxpayers effect, ΔNW the change in the net welfare effect (dead weight loss), P the price and Q the quantity. The current producer prices plus any additional subsidies are reported with the subscript 'Mod'. The world prices with the subscript 'w' and the prices that are currently paid by consumers with the subscript 'D'.

5.2 Model equations

A brief description of the cotton lint equations and the main variables included will be presented.

The extend to which cotton is cultivated is determined by the share of cotton and the 4 arable crops (maize, wheat, barley, and sugar beet) harvested in the irrigated grain area.

Yield equations are very important due to technological changes. Cotton lint yield is specified as a function of the cotton lint trend, the five year average real producer price of cotton, and the irrigated grain, vegetable, tree area and cotton areas harvested.

The second step taken to investigate the cotton market is to analyze cotton lint. Lint production is specified as an identity by multiplying the cotton area harvested by the actual cotton lint yield. The cotton lint domestic use is determined by including the lagged dependent variable, the real price of cotton lint and the real GDP per capita.

The ending stocks are determined by the beginning stocks, the total cotton lint production and the seed cotton world price index (A index). The cotton producer price is a function of the seed cotton world price index (A index).

Regarding trade equations, cotton lint imports are determined by domestic use, lagged beginning and ending stocks and cotton production. On the other hand, exports are a function of cotton production, cotton lint imports, lagged ending stocks, ending stocks and domestic use.

An important issue for developing the system of equations for cotton is the determination of the world price. The solution proposed is to use the cotton A index.

The cotton price index (often referred as the A index) is an average of the five less expensive out of 14styles of cotton traded in North Europe, originating from: Memphis (USA), California/Arizona (USA), Mexico, Paraguay, Turkey, Syria, Greece, Uzbekistan, Pakistan, India, China, Tanzania, Africa “Franc Zone” and Australia. These are prices that the agent would quote for the particular type of cotton. To account for the fact that agent’s quotation is likely to be above the price at which the actual transaction takes place, the index takes the five lowest priced styles.

5.2.1 Representation of the equations

5.2.1.1 Data and methodology

Collection of data

For the estimation of the model we used data series acquired from the data sets of Food and Agricultural Organization of the United Nations (FAO), the Eurostat database and the USDA foreign agricultural service Production, Supply and Distribution (PSD Online). The data series for some variables start from the year 1961 until recent years (2005). Unfortunately because of missing data and unavailable time series the rest of the variables were limited in a smaller range of years including mainly the marketing years from 1975 to 2000.

Another important issue that should be discussed concerning the construction of the data set used for the estimation of the model is that there where some important differences in the values that each data base, previously mentioned, was providing. In order to overpass this difficulty we had decided to use the data sets that had been used more often for previous studies of the sector. This was to secure the credibility of the data and also the statistical significance of the results.

Methodology

The software used for this analysis had been the E-views version 5.0. For the majority of the equations the Least squares method had been used. Least squares method is a mathematical optimization technique which, when given a series of measured data, attempts to find a function which closely approximates the data (a "best fit"). It attempts to minimize the sum of the squares of the ordinate differences (called residuals) between points generated by the function and corresponding points in the data. Specifically, it is called least mean squares (LMS) when the number of measured data is 1 and the gradient descent method is used to minimize the squared residual. LMS is known to minimize the expectation of the squared residual, with the smallest operations (per iteration). But it requires a large number of iterations to converge.

The equations that had been estimated with the above method are the following: cotton lint price equation, cotton lint area equation, cotton lint share of arable land, cotton lint ending stocks, cotton producer price, cotton lint imports and exports, the EU cotton farm price and the EU cotton lint exports. For these equations the results received from the method were quite satisfactory with a high R-squared and a less than 0.05 p-value for the variables.

For the estimation of the equations of cotton lint yield and domestic use we used the Generalized Method of Moments. The generalised method of moments is a very general statistical method for obtaining estimates of parameters of statistical models. It is a generalization, developed by Lars Peter Hansen, of the method of moments. The method is also closely related to the classical theory of minimum chi-square estimation. The method was used in the cases were the LMS method was proven not to be the appropriate one for the necessary estimations.

5.2.1.2 The model equations

Cotton lint price equation

The equation we received is represented as follow:

CLPFHSP = 22.50 + 0.68*CLFRPGR + 0.10*CLSSFGR - 0.26*CLSSFSP

As it was expected the cotton lint price for Greece which is determined by the world price (A index) and the policy variables (support and co responsibility levy) has a strong positive influence for the determination of the Spanish cotton lint price. The paradox in this equation is that even though it should exist a positive relation with the self sufficiency ratio for the Spanish cotton lint and the formation of Spanish price it is existing the opposite and the same for the self sufficiency ratio for Greece.

Arable irrigated area harvested

I4HAGR=b$_1$I4EGRGR-b$_2$G3EGRGR-b$_3$V2EGRGR +b$_4$O3AHAGR+ intercept

I4EGRGR: Adjusted 4 irrigated areas expected real gross returns
G3EGRGR: Adjusted 3 grain area expected real gross returns
V2EGRGR: Adjusted 2 vegetables area expected real gross returns
O3AHAGR: 3-oilseed area

The irrigated are harvested under the four arable crops (cotton, tobacco, sugar beet and maize), is determined by the expected real gross returns of the adjusted irrigated area, the expected real gross return of the 3 grain area, 2 vegetables area, 2 tree crops area, the cereal set aside rate and the 3 oilseed area.

Even though we received a satisfactory value for R-squared and Durbin-Watson Stat. from the first estimation, we notice that our p value for the variables of the adjusted 4 irrigated areas expected real gross returns (I4EGRGR), the adjusted 3 grain area expected real gross returns (G3EGRGR), and the adjusted 2 vegetables area expected real gross returns (V2EGRGR) is not statistically significant. So proceeding to a second estimation and omitting the variable of adjusted 4 irrigated areas expected real gross return we received the following equation.

I4AHAGR = 362.66 + 0.001*G3EGRGR + 1.92-005*V2EGRGR + 0.70*O3AHAGR

Cotton lint share of arable land

CTASHGR=b$_1$CTRGMGR-intercept

Identity:
CTRGMGR=CTEGMGR/I4EGMGR

CTEGMGR: Expected cotton gross returns. In calculating the expected gross market return variable, a three year weighted average of market prices is multiplied by a trend yield.

I4EGMGR: For the “4 irrigated arable expected gross return”, commodity prices are weighted by the share of the commodity in the total block area.

The equation that we received is as follows:

CTASHGR= -0,35CTRGMGR+0,78

This equation needs to be more carefully examined an estimated again. Is the less statistically significant equation with a small R-Square and a higher p-value than 0,05. Moreover it has the opposite relations that were expected to present.

Cotton lint yield equation

CLYHAGR= + b_1CTPP5GR- b_2 (I4+G3AHAGR)-b_3CTAHAGR+intercept

CTPP5GR: Cotton 5yr average producer real price
(I4+G3AHAGR): Irrigated and grain area
CTAHAGR: Cotton area harvested

Equation:
LOG(CLYHAGR) = 25.02 + 0.28*LOG(CTPF5GR(-1)) - 3.53*LOG(I4AHAGR+G3AHAGR) - 0.39*LOG(CTAHAGR)

The equation works and combines with the theory as it was expected to be.

Cotton lint domestic use

The cotton lint domestic use is determined through the inclusion of the lagged dependent variable, the cotton lint real price and a proxy for income which is the real GDP per capita.

CLUDCGR=b_1CLPFRGR+b_2RGDPCGR+b_3TREND+ intercept

CLPFRGR: Cotton lint real price (GDP deflator)
RGDPCGR: Real GDP per capita (GDP deflator)

Equation:
CLUDCGR = -81.85 - 0.0001*CLPFRGR - 0.001*RGDPCGR + 87.26*TREND

Irrelevant to the theory that suggests the entire coefficients positive our estimation resulted to the opposite where all the coefficients have a negative sign.

Cotton lint ending stocks

The cotton lint ending stocks are determined by the beginning stocks, the total cotton lint production and the seed cotton world price index (A index)

CLCCTGR=b$_1$CLCCTGR(-1)+b$_2$CLSPRGR-b$_3$AINDEX-b$_4$(CLUXTGR-CLSMTGR) +intercept

CLCCTGR(-1): Cotton lint beginning stocks
CLSPRGR: Cotton lint production
AINDEX: Seed cotton world price index (reference price)
CLUXTGR-CLSMTGR: Net exports

Equation:
CLCCTGR = -117.48 + 0.74*CLCCTGR(-1) + 0.69*CLSPRGR + 0.37*AINDEX(-1) - 0.60*(CLUXTGR-CLSMTGR

Again in this case although we received results that are satisfactory in statistical level we have signs on the coefficients that are expressing the opposite relations from those that have been expected to be presented.

Cotton producer price

Cotton producer price is a function of the seed cotton world price index (A index).

CTPPRGR=b$_1$CTWPIGR-b$_2$PENA+intercept

CTWPIGR: Seed cotton world price
PENA: Penalties received for exceeding the NGQ

Equation:
CTPPRGR = 1.00 + 0.35*CTWPIGR - 0.97*PENA

As it was expected the penalties that are received for exceeding the NGQ has a strong influence to the formation of the cotton producer price.

Cotton lint imports

Cotton lint imports are determined through domestic use, lagged beginning and ending stocks and cotton production.

Equation:
LSMTGR = 0.36*CLUDCGR - 0.08*CLSPRGR - 0.10*CLCCTGR(-1)

The equation agrees to the theory.

Cotton lint exports

Cotton lint exports are a function of cotton production, ending stocks and domestic use.

Equation:
CLUXTGR = 0.95*CLSPRGR - 0.50*CLUDCGR - 0.47*CLCCTGR

The equation is well builded.

E.U. cotton farm price

CLPFME5=b $_1$CLPFEGR+b $_2$CLPFEES

CLPFEGR: Greek cotton price
CLPFEES: Spanish cotton price

Equation:
PRICEEU = 4.22 + 0.73*PRICEGR + 0.22*PRICESP

From the above equation and the coefficients of the variables it is easily for someone to realize that Greece is the country member inside the European Union which is influencing more than Spain the formation of price for cotton.

E.U. cotton lint net exports

CLUXNE5=b $_1$CLPXWE5+b $_2$(CLSPRE5+CLCCTE5(-1)-CLUDCE5)

+intercept

CLPXWE5: E.U cotton lint export price/equivalent world price
CLSPRE5: E.U. 15 production
CLCCTE5(-1): E.U. 15 beginning stocks
CLUDCE5: E.U. 15 domestic use

Equation:
CLUXNE5 = -1274869.9 - 10654.96*AINDEX + 1.11*CLSPRE5 + 5.29*CLCCTE5 - 0.07*CLUDCE5 + [MA(1)=-0.99,BACKCAST=1961]

The two last equations presented are referred to the EU level concerning the volume of exports and the farm price. Although the EU cotton lint exports is a well build equation it needs some more testing and arrangements of the variables as there are some opposite relations than those expected to present.

6. Conclusions

Even though many equations fit in the model and represent the theory, the model is based on, a lot of parameters need to be taken into consideration and examined again. One of the main problems is the quality of the data, and the different sources of extraction. Our future study will reconsider the issue of data collection and will try to build a homogenous by source data base. Moreover we will extent our model including the equations for the olive oil sector and introduce more specific policy parameters.

ANNEX

Table 1 Global cotton trade ('000 TONS)

	1960	**1970**	**1980**	**1990**	**1999**	**2000**	**2001**	**2002**	**2003**
EXPORTS									
US	1,444	848	1,29	1,697	1,47	1,472	2,395	2,591	2,862
Uzbekistan	381	553	616	397	893	800	810	798	643
Australia	0	4	53	329	696	849	662	575	360
Mali	2	19	35	114	201	125	126	167	262
Greece	33	0	13	86	310	244	290	275	223
Burkina Faso	0	9	22	73	95	112	123	155	197
Syria	97	134	71	91	252	212	180	120	170
Cτte d'Ivoire	0	7	42	81	160	150	109	83	144
Tajikistan	—	—	—	200	83	110	117	140	141
Benin	1	14	8	58	136	140	148	162	128
Zimbabwe	0	32	55	38	121	118	67	76	95
World	**3,667**	**3,875**	**4,414**	**5,081**	**6,107**	**5,857**	**6,47**	**6,618**	**6,932**
IMPORTS									
China	65	108	773	480	30	52	98	685	1,5
Indonesia	7	36	106	324	450	570	460	500	470
Pakistan	1	1	1	0	103	101	191	186	425
Turkey	0	1	0	46	575	383	624	516	400
Thailand	4	46	86	354	371	342	443	410	391
Mexico	0	1	0	43	404	410	450	501	361
Korea, Rep.	51	121	332	447	332	304	352	325	310
Italy	218	178	193	336	307	300	271	260	230
Taiwan	47	160	214	358	313	226	333	265	201
India	204	155	0	0	348	350	425	350	200
Japan	800	796	697	634	276	240	227	215	169
Russia	0	238	28	37	279	373	292	310	141
Brazil	0	4	2	108	340	131	55	123	75
World	**3,804**	**4,086**	**4,555**	**5,222**	**6,05**	**5,747**	**6,159**	**6,577**	**6,932**

Source: ICAC, *Cotton: Review of the World Situation, various issues*

1. Representation of the model equations

Cotton lint price equations

For the estimation of the coefficients we used the econometric software E-Views 5.0. The included observations had been 28 after adjustments made by the software and the method used for the specific estimation had been the method of Least Squares.

The equation we received is represented as follow:

CLPFHSP = 22.50 + 0.68*CLFRPGR + 0.10*CLSSFGR - 0.26*CLSSFSP

Variable	**Coefficient**	**Std. Error**	**t- Statistic**	**Prob.**

C	22.50937	13.48247	1.669529	0.1080
CLFRPGR	0.689111	0.148271	4.647644	0.0001
CLSSFGR	0.104766	0.031479	3.328099	0.0028
CLSSFSP	-0.263963	0.099117	-2.663138	0.0136

R-squared = 0.606927 **Adjusted R-squared** = 0.557793
Durbin-Watson stat = 2.061223 **Prob(F-statistic)=** 0.000044

Arable irrigated area harvested (I4HAGR

Building this equation to the E-views software we received the following results concerning the above equation. The included observations had been 25 and the method used had been the Least Squares.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	370.0888	23.92583	15.46817	0.0000
I4EGRGR	0.000118	0.000305	0.385265	0.7041
G3EGRGR	0.001195	0.001540	0.775726	0.4470
V2EGRGR	1.55E-05	1.26E-05	1.232244	0.2321
O3AHAGR	0.753578	0.269921	2.791846	0.0113

R-squared = 0.960074 **Adjusted R-squared** = 0.952089
Durbin-Watson stat = 1.409878 **Prob(F-statistic)=** 0.000000

Even though we received a satisfactory value for R-squared and Durbin-Watson Stat. we notice that our p value for the variables of the adjusted 4 irrigated areas expected real gross returns (I4EGRGR), the adjusted 3 grain area expected real gross returns (G3EGRGR), and the adjusted 2 vegetables area expected real gross returns (V2EGRGR) is not statistically significant.

Equation:
4AHAGR = 370.08 + 0.0001*I4EGRGR + 0.001*G3EGRGR + 1.54-005*V2EGRGR + 0.75*O3AHAGR

If from the previous build and estimated equation we omit the I4EGRGR variable we receive the following results. The included observations had been again 25 and the method used had been the Least Squares.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	362.6685	13.90380	26.08413	0.0000
G3EGRGR	0.001780	0.000249	7.154304	0.0000
V2EGRGR	1.93E-05	7.71E-06	2.502222	0.0207
O3AHAGR	0.705704	0.234708	3.006732	0.0067

R-squared = 0.959778 **Adjusted R-squared** = 0.954032
Durbin-Watson stat = 1.415504 **Prob(F-statistic)=** 0.00000

According to this we conclude to an equation for the depended variable I4AHAGR having the following form.

I4AHAGR = 362.6684652 + 0.001779721789*G3EGRGR + 1.927963483e-005*V2EGRGR + 0.7057037296*O3AHAGR

Cotton lint share of arable irrigated area (CTASHGR)

The included observations had been 25 and the method used had been the Least Squares.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.789313	0.391845	2.014353	0.0558
CTEGMGR/I4EGMGR	-0.359129	0.399345	-0.899296	0.3778

R-squared = 0.033968 **Adjusted R-squared** = -0.008033
Durbin-Watson stat = 0.200915 **Prob(F-statistic)=** 0.377814

Cotton lint yield (CLYHAGR

For the estimation of the above equation we used the Generalized Method of Moments and the equation had been expressed in a logarithmic form. The included observations had been 22 after adjustments.

Kernel: Bartlett, Bandwidth: Variable Newey-West (1), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 1 weight matrix, 2 total coef iterations
Instrument list: LOG(CTPF5GR(-1)) LOG(I4AHAGR+G3AHAGR) LOG(CTAHAGR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.02769	8.689097	2.880355	0.0100
LOG(CTPF5GR(-1))	0.284912	0.101518	2.806524	0.0117
LOG(I4AHAGR+G3AHAGR)	-3.530437	1.137072	-3.104850	0.0061
LOG(CTAHAGR)	-0.394908	0.168713	-2.340710	0.0310

R-squared = 0.431743 **Adjusted R-squared** = -0.008033
Durbin-Watson stat = 1.644532 **J-statistic** = 8.24E-28
Equation:
LOG(CLYHAGR) = 25.02 + 0.28*LOG(CTPF5GR(-1)) - 3.53*LOG(I4AHAGR+G3AHAGR) - 0.39*LOG(CTAHAGR)

The cotton lint yield has a positive relation with the Cotton 5yr average producer real price and a negative relation with the irrigated and grain area and also with the cotton area harvested.

Cotton lint domestic use (CLUDCGR)

The incuded observations in this case had been 28 and the method used for the estimation had been again the Generalized Method of Moments.

Kernel: Bartlett, Bandwidth: Variable Newey- West (18), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 1 weight matrix, 2 total coef iterations

Instrument list: CLPFRGR RGDPCGR TREND

Variable	Coefficient	Std. Error	t- Statistic	Prob.
C	- 81.85496	17.01750	- 4.810047	0.0001
CLPFRGR	- 0.000117	5.06E- 05	- 2.308482	0.0299
RGDPCGR	- 0.001534	0.000103	- 14.84063	0.0000
TREND	87.26659	8.145548	10.71341	0.0000

R- squared = 0.662117 **Adjusted R- squared** = 0.619882
Durbin- Watson stat = 1.684721 **J- statistic** = 2.84E- 29
Equation:
CLUDCGR = - 81.85 - 0.0001*CLPFRGR - 0.001*RGDPCGR + 87.26*TREND

Irrelevant to the theory that suggests the entire coefficients positive our estimation resulted to the opposite where all the coefficients have a negative sign.

Cotton lint ending stocks (CLCCTGR)

Building this equation to the E-views software we received the following results concerning the above equation. The included observations had been 30 after adjustments and the method used had been the Least Squares.

Variable	Coefficient	Std. Error	t- Statistic	Prob.
C	- 117.4895	34.51392	- 3.404120	0.0022
CLCCTGR(- 1)	0.749228	0.120574	6.213842	0.0000
CLSPRGR	0.699448	0.087599	7.984625	0.0000

AINDEX(-1)	0.378924	0.285134	1.328931	0.1959
CLUXTGR-CLSMTGR	-0.60916 2	0.091576	-6.651959	0.0000

R-squared = 0.852532 **Adjusted R-squared** = 0.828938
Durbin-Watson stat = 1.495960 **Prob(F-statistic)** = 0.000000
Equation:
CLCCTGR = -117.48 + 0.74*CLCCTGR(-1) + 0.69*CLSPRGR + 0.37*AINDEX(-1) - 0.60*(CLUXTGR-CLSMTGR)

Cotton producer price (CTPPRGR)

Applying the method of the least squares in a sample of 25 included observations we received the following results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.005532	0.013239	75.95262	0.0000
CTWPIGR	0.351315	0.021161	16.60218	0.0000
PENA	-0.97202 4	0.026729	-36.36599	0.0000

R-squared = 0.983646 **Adjusted R-squared** = 0.982160
Durbin-Watson stat = 1.265762 **Prob(F-statistic)** = 0.000000
Equation:
CTPPRGR = 1.005531917 + 0.351315263* CTWPIGR - 0.9720242671*PENA

Cotton lint imports (CLSMTGR

The method used is the Least Squares and the included observations had been 27 after the adjustments.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	59.67023	10.59640	5.631180	0.0000
CLUDCGR+CLCCTGR+CLSPRGR+CLCCTGR(-1)	-0.06636 7	0.019963	-3.32449 3	0.0027

R-squared = 0.306562 **Adjusted R-squared** = 0.278825
Durbin-Watson stat = 1.330285 **Prob(F-statistic)** = 0.002734

Increasing the sample size and the data set we did one more estimation for the equation of imports and we conclude to the following.

Again the method used is the Least Squares but now the included observations have increased from 27 to 44.

Variable	Coefficient	Std. Error	t-Statistic	Prob.

CLUDCGR	0.364922	0.025723	14.18671	0.0000
CLSPRGR	-0.08099 6	0.015255	-5.309621	0.0000
CLCCTGR(-1)	-0.10642 0	0.048071	-2.213808	0.0325

R-squared = 0.729065 **Adjusted R-squared** = 0.715849
Durbin-Watson stat = 1.958486
Equation:
LSMTGR = 0.36*CLUDCGR - 0.08*CLSPRGR - 0.10*CLCCTGR(-1)

Cotton lint exports (CLUXTGR)

The method used is the Least Squares and the included observations had been 27 after the adjustments.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CLSPRGR	0.999992	1.00E-05	99877.09	0.0000
CLSMTGR	1.000001	6.41E-05	15602.45	0.0000
CLCCTGR(-1)	0.999997	3.16E-05	31625.49	0.0000
CLUDCGR	-1.00000 1	2.54E-05	-39308.57	0.0000
CLCCTGR	-0.99996 6	3.18E-05	-31470.07	0.0000

R-squared = 1.000000 **Adjusted R-squared** = 1.000000
Durbin-Watson stat = 2.252989

Like in imports after some adjustments we conclude to the following.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CLSPRGR	0.952968	0.041722	22.84101	0.0000
CLUDCGR	-0.50826 3	0.061264	-8.296287	0.0000
CLCCTGR	-0.47537 4	0.134643	-3.530633	0.0010

R-squared = 0.955207 **Adjusted R-squared** = 0.953074
Durbin-Watson stat = 1.838527
Equation:
CLUXTGR = 0.95*CLSPRGR - 0.50*CLUDCGR - 0.47*CLCCTGR

E.U. cotton farm price (CLPFME5

Applying the method of the least squares in a sample of 26 observations in the E-views software we received the following estimations for the coefficients of the equation of the EU farm price in EU 15 level.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.226801	1.344404	3.143996	0.0045
PRICEGR	0.732672	0.015312	47.85062	0.0000

PRICESP	0.220915	0.011578	19.08114	0.0000

R-squared = 0.994097 **Adjusted R-squared** = 0.993584
Durbin-Watson stat = 1.543488 **Prob(F-statistic)=** 0.000000
Equation:

PRICEEU = 4.226801301 + 0.7326723717*PRICEGR + 0.2209151704*PRICESP

From the above equation and the coefficients of the variables it is easily for someone to realize that Greece is the country member inside the European Union which is influencing more than Spain the formation of price for cotton.

E.U. cotton lint net exports (CLUXNE5)
Using the method of the least squares in a sample of 30 observations after the necessary adjustments from the software of E-views we received the following estimations for the coefficients of the equation of net exports in EU 15 level.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1274870.	289175.5	-4.408638	0.0002
AINDEX	-10654.97	5529.374	-1.926975	0.0659
CLSPRE5	1.119434	0.153844	7.276414	0.0000
CLCCTE5	5.294055	0.742628	7.128817	0.0000
CLUDCE5	-0.077647	0.213527	-0.363639	0.7193
MA(1)	-0.997385	0.091454	-10.90589	0.0000

R-squared = 0.708443 **Adjusted R-squared** = 0.647702
Durbin-Watson stat = 1.751616 **Prob(F-statistic)=** 0.000009
Equation:

CLUXNE5 = -1274869.9 - 10654.96*AINDEX + 1.11*CLSPRE5 + 5.29*CLCCTE5 - 0.07*CLUDCE5 + [MA(1)=-0.99,BACKCAST=1961]

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