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Full Length Research Paper

The virgin olive oil production in Mediterranean basin: An empirical approach

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The present paper surveys the production volatility of the virgin olive oil in Mediterranean countries. European Union (EU) is the leading world producer and consequently the survey of its volatility attracts great interest. Especially, countries in the Mediterranean basin are the substantial producers of this crop and provide them with a comparative and competitive advantage in international markets. In addition, the virgin olive oil is a major source of income and employment for the aforementioned countries. Entropy has been used in the study of the time series analysis. The results confirmed a strong positive correlation between the entropy and both forms of the standard deviation. In addition, the virgin olive oil production is quantified with the assistance of ARIMA (Autoregressive Integrated Moving Average) models. The estimation of ARIMA model for every country was found to provide the policy makers with a useful intervention tool for the virgin olive oil production.

Key words: Autoregressive integrated moving average (ARIMA) models, comparative analysis, EU, virgin olive oil.

INTRODUCTION

Food quality and safety have unveiled new trends in food consumption clearly forming the context of food policy measures and creating an advanced and strictly controlled state in the food supply chain. The Mediterranean diet is considered as the foremost actor of such trends, consisting of an indispensable part of the Mediterranean country's heritage that was conceived, developed and spread all around the world on the grounds of a single product, olive oil. Virgin olive oil is defined by the international oil Council and the EU regulation as a 100% natural product of olives (no additives, colorants, flavourings, or any other foreign matter allowed). This type of olive oil is a globally consumed and traded product linked to the European Union (EU) that provides 89% of the total consumption, and more closely to three specific countries of the Mediterranean basin (Spain, Italy and Greece) that hold 75% of the world's production in 2010 (IOOC, 2011). The olive tree which is considered as one of the most substantial crops for these countries produces a key product for comparative and competitive advantage in international markets, such as the virgin olive oil which constitutes a major source for agricultural income and rural employment is deliberately considered when drawing up any regional or territorial development policy. In 2007, the area under olive groves in the three countries added up to 4,057.270 ha (out of the 4,376.870 ha in the EU), corresponding to 9.7% of the utilized agricultural area. Almost 50% of the cultivations are located in Spain (2,208.040 ha), followed by Italy (23%, 1,019.000 ha) and Greece (19%, 830.230 ha). Other producing countries are Portugal and France with substantially less production (292.160 ha and 15.100 ha respectively) (Eurostat Database, 2011). Furthermore, 2.5 million producers which is roughly one third of all EU

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farmers are employed in the sector out of which 1,160 000 in Italy, 840.000 in Greece, 380.000 in Spain, and 130.000 in Portugal; a significant smaller number of growers were employed in France.

The olive oil market is very complex and is primarily characterized by a continuously increasing consumption that is expected to exceed production in the 2010 to 2011 crop year (IOOC, 2011). The same holds for exports though, their share on production is low due to the fact that olive oil tends to be consumed in the producing areas (Harwood and Aparicio, 2000). Exports have demonstrated a faster increase than production in the period after 1997, when the latter reached its lower levels. Intriguingly, in the past fifteen years (1995 to 2010), significant export fluctuations were observed stemming primarily from weather conditions and aggravated by olive tree's peculiarity (produce of substantial olive crops every second year). Other key features of the market include a concentrated regional production but a global trade of olive oil, dispersed crashing activities, high technological level of the processing industry, and the strong presence of multinational firms throughout the supply chain, despite, the increased profitability of small bottlers with effective implementation of marketing strategies. In addition, the EU market is highly protected with specific and mostly preferential access to a number of Mediterranean countries (Anania and D'Andrea, 2008), whilst a large producer countries (for example, Spain and Italy) may be dominant traders as well with the "exclusive" feature of exporters that produce no olive oil at all. As concerning market structure, the existence of a large number of important players in the market (domestic and international) generates various conflicts of interest inter-regionally and between countries, as well as, a significant intensification of horizontal and vertical competition along the product's marketing chain.

These developments in olive oil marketplace have created an increasing field of interest for researchers. In addition, production and exports fluctuations for the major producing countries during the last decade generated a volatile and fragile market environment (particularly for olive oil producers) that may be strongly determined by the implemented measures under the Common Agricultural Policy (CAP).

Based on these premises, the present study aims to identify possible determinants of production fluctuations of the major producing countries of the EU in order to more accurately address trends and prospects in the olive oil market. In particular, the objective of this paper is to estimate the potential policy factors that determine strong variations in production levels for Spain, Italy, Greece, Portugal and Malta. Subsequently, this study highlights recent trends in production and consumption of olive oil in the EU and the world along with policy developments in the sector, after which it provides a presentation of the recent findings in the literature and gives information about the data and methodology used. Furthermore, the results of the study are discussed and the paper concludes with the presentation of the most significant findings.

Olive oil market trends and policies

The EU is the larger producer of olive oil (80% of the total world olive oil production) and also accounts for 70% of world consumption and 50% of world trade. The main aim of EU olive oil policy is to maintain and strengthen its position in world markets by encouraging production of a high-quality product for the benefit of growers, processors, traders and olive cultivation is widespread throughout the Mediterranean region and is important for the rural economy, local heritage and the environment. According to IOOC (2011), trading in olive oil in 2010 rose almost by 6% when compared to 2009 in the six key import markets (Australia, Japan, Canada, Brazil, EU and USA), mainly due to the sharp increase in imports that offset the decline in US imports (largest importer). Olive production is the main source of employment and economic activity in many producing regions, and it has shaped the landscape in these countries over many centuries.

Primary exporting countries are Spain and Italy accounting for 90% of EU exports which indicates a strong position in the international olive oil market and a major determinant of international olive oil pricing. On the supply side, the concentration of production in five EU regions generates economies of scale and favors rural employment, while highlighting their significance in the world marketplace. As Mili and Rodríguez (2001) points out "the most representative market places are located within the EU, Jaen (Spain), Bari (Italy) and Heraklion/Messinia (Greece).

The sector consists of growers, cooperatives, pressing mills, refiners, blenders, and companies involved in various aspects of marketing. Three broad types of production can be distinguished: traditional groves, often of ancient olive trees; more managed traditional plantations involving a higher use of inputs; and intensive, generally recent plantations using more mechanisation and other technologies including irrigation. This mix of ancient and modern technologies helps explain the differing farm sizes, ownership characteristics and processing structures that exist within the EU. Obviously, large differences in production systems are evident within each producing region. The average holding size is as low as 1 ha, for example, Italy, though, olive holdings in Spain are larger (that is, 6 ha on the average).

The EU recognizes several grades of olive oil. Each of these grades of olive oil has its particular qualities and market value. The EU has always aimed to define clearly the different categories of olive oil so that consumers can

Table 1. Production and consumption in the world olive oil market.

Country	Production in tonnes (2010)	Production (%) (2010)	Consumption in tonnes (2010)	Annual consumption per capita (kg)
World	3.024.000	100	2.873.000	0.43
Spain	1.396.300	49.17	550.000	13.62
Italy	460.000	15.21	675.000	12.35
Greece	320.600	10.6	225.000	23.7
Syria	150.163	4.96	120.000	7
Tunisia	150.000	4.96	40.000	11.1
Turkey	147.600	4.88	110.000	1.2
Morocco	160.100	5.29	90.000	1.8
Portugal	58.700	1.94	87.500	7.1
France	5.900	0.19	113.700	1.34
USA	3.100	0.1	258.000	0.56
Rest	118.437	5.67	603.000	1.18

International Olive Oil Council (IOOC, 2011), author's calculations.

be sure of what they purchase and producers can achieve the full market value of their quality product. The latest EU classification has entered into force since the 1st of November, 2003.

The world olive oil market

Significant producing countries besides the Mediterranean basin are Tunisia, Turkey, Syria and Morocco. Their production overcomes 600.000 tons that approximately adds up to 25% of EU production and 20% of the total world production). Production in other regions of the world is much more limited than traditional countries. However, there is an increasing expansion for olive cultivation and olive oil production stimulated by the increased international demand (change in consumption patterns) and comparative advantage in production costs (Mili, 2004). In this way, new producing countries emerge in market places like Brazil, Argentina, USA, Chile, South Africa and China that could play a critical role in the world market providing attractive market opportunities as long as they reach substantial production levels.

On the demand side, the largest per capita consumption is observed in Greece with over 26 L per person per year followed by Spain and Italy with around 14 L and Tunisia, Portugal, Syria and Lebanon with around 8.1 L. Consumption levels in Northern Europe and North America are far more less with a tendency for a steady rise, despite the fact that most of the product is traditionally consumed within the producing country. Olive oil is currently considered as a high quality product alternative to other fats and edible oils enhancing its appreciation and value outside the Mediterranean basin. Table 1 provides a general picture of the world olive oil market.

EU Olive oil policy developments

The existing market structure and recent developments in consumer needs determine in different ways the objectives of the implemented policy measures under the CAP regime. The baseline on which CAP has moved after the last major reform (Fischler, 2003) entails improvement in olive oil production quality to enhance competitiveness, whilst encouraging olive producers to respond to market signals and consumer needs. The Common Market Organisation (CMO) for oils and fats was created in the year 1966 when only Italy (as a major olive oil producer) was a member of the EU, implemented in a state of shortage to deal with challenges in the market for vegetable oils in the six Member States. Drogue (2006) argues that though CMO measures were indispensable in balancing the olive oil market, they have driven producers to increase systematically their production motivating behaviors, which aggravated the CAP budget. This was the main cause for significant and successive reforms of the CMO mostly after the subsequent accession of other Mediterranean countries that were important olive oil producers (Greece in 1981 and Spain and Portugal in 1986). Policy amendments, which aimed to sustain market price and provide aid to producers, predominantly involved the increase in producer prices and the lessening of trade barriers with other EU countries. Additional supporting measures included the limitation of production areas eligible for aid, set of minimum prices, and implementation of export subsidies and establishment of public and private storage to absorb surpluses from the market.

The last reform of the CMO for olive oil in 2003/2004 introduced further significant changes aiming to offer agriculture a more competitive posture and enhanced market orientation and not only the traditional response to supply criteria. Another main objective was income stabilization, since olive oil producer's income have undergone many variations mainly due to weather uncertainty. Certainly, production subsidies facilitated income stability that obtained a more long-term perspective through the decoupling of subsidy payments. Apart from encouraging producers by means of a fair income, consumption is not depressed due to the lower price of seeds oil (Dorgue, 2006). Besides that, a key feature of the reformed CMO for olive oil is the increased focus on product quality. Olive oil is priced higher than other common edible oils and when coupled with the early abolishment of consumption grants that affected consumer demand (Tzouvelekas et al., 2000) increases consumer's expectations for pure unstained quality. Nowadays, it seems that the olive oil market is first and foremost segmented on the basis of quality differentiation attenuating the significance of prices (Anania et al., 2007). This poses additional challenges for the major producing countries in the Mediterranean basin that have seen major fluctuations in the recent years in their production and producer prices due to weather conditions, price variations, increased dependence in couple subsidies and the increase in world supply with higher rates of demand (Mili and Rodríguez 2001).

LITERATURE REVIEW

Gonzalez et al. (1998) describes a predictive model for the harvest of olives destined for olive oil, using olive groves in the province of Seville (Southern Spain). The study was carried out between 1987 and 1996, monitoring airborne olive pollen with a Cour trap, and using agronomic data (size of harvest expressed in kg/ha) and meteorological observations (rainfall before and after olive pollination, days of rainfall during harvesting, and maximum temperatures during pollination). The data were subjected to simple and multiple regression analysis.

Graaff et al. (2008) mentioned that the European Union spent about two billions of ECU per year, on subsidies for the olive oil sector, out of which Spain received about 35%. For the rain-fed areas in Southern Spain, the olive oil sector is critical, and so are these subsidies. The European Commission has formulated two options to change the subsidy system, but these do not take the production systems and environmental aspects into account. Many olive plantations are affected by soil erosion. This paper analyses the olive tree production systems in Southern Spain, the subsidy systems and the soil erosion problems. It then raises the question whether the subsidies could not be provided in a different way, in order to make olive tree cultivation more sustainable by reducing soil erosion and flood hazard.

Mili and Rodriguez (2001), forecasts the main trends and likely developments affecting the Spanish olive oil export business over the next decade. A Delphi survey was conducted in 1999, with a highly qualified panel of experts from the olive oil sector who, over two rounds of mailings, contributed their judgments about export prospects for the Spanish olive oil sector. Issues discussed include expected trends in world olive oil supply and demand, the likely implications of the major impending changes in the macro-economic and regulatory setting, the characteristics of potential markets, the strengths and weaknesses of the Spanish olive oil export industry, and the key international marketing variables for the future.

Siskos et al. (2001), argues that the agribusiness industries face a stiff competition originating mainly from the EU trade barrier's removal and the rapidly changing marketing environment of the single European market. Therefore, certain need has been identified towards the development and proper utilization of updated market research tools and methodologies in the field of agricultural marketing.

The aim of this paper is to demonstrate the usefulness of multi-criteria approach in analyzing consumer's preference data and its ability to support new product development processes by agricultural firms.

Migdalas et al. (2004) reported that Greece is a major international olive oil producer. Olive oil varieties constitute the major crops for Greek farmers growing certain oriental olive oil varieties. Currently, the olive oil sector in Greece is undergoing substantial changes and the response of farmers and consumers to this will be a vital factor in its success. Throughout the application of the common agriculture policy (CAP), mechanisms such as production aid, subsidies and marketing orders were employed to support both producers and consumers. A possible reform of CAP aimed at eliminating or reducing production aid or any kind of subsidies could have a considerable effect on producer and consumer marketing behaviour.

Baourakis et al. (2002), have as an objective assessing of the viability of Greek companies that operates in the field of agricultural food-production and marketing. More specifically, they present the basic operational framework within which the agricultural organizations of co-operatives operate, while they survey the main features of the juice market.

Crescimanno et al. (2002), identifies the main structural factors of the organic olive oil sector in Sicily, and the effects of the European sustainable development policy (EEC Regulation, 2092/91, EEC Regulation, 2078/92). In addition, they surveyed the trade marketing of olive oil organic producers including the initiatives to exploit European branding, typicalness, and European recognition of PDO (Protected Denomination of Origin).

Martínez et al. (2002) confirmed that despite a rapid growth in olive oil consumption recently, the culinary use of olive oil is still relatively new to UK consumers, and is still regarded as a set of particular attributes rather than as everyday cooking oil. To increase sales and attract new users, olive oil needs to be seen by UK consumers as ‘an everyday’ cooking oil, and enter into direct competition with standard vegetable oils.

According to Ward et al. (2003), Germany consumers have differentiated their use of olive oil by country-of-origin, with Spain, Italy, and Greece being important competing suppliers. Demographics, product characteristics, and information sources affect the probability of buying olive oil by origin. Multinomial logit models are estimated and used to confirm the potential profits (or losses), while the important role of promotions to Spain’s olive oil is underlined. The importance of the aforementioned variables is ranked for each country and odds ratios are used to compare the relative profits among the major suppliers.

Gil et al. (2004) analyzed the importation of virgin olive oil to European Union countries, paying special attention to the Spanish export contribution. The method used is based on the estimation of an import demand system. The novelty of the paper lies not on the modeling approach but on the explicit consideration of the univariate characteristics of series that is included in the analysis. Since prices are non-stationary, co-integration among them was tested.

Canada et al. (2005) surveyed the interrelations between the establishment of territorial quality certification systems (Protected Designations of Origin or PDOs), diffusion of innovations through local agro-food chains, and the role of the institutions overseeing geographical designations. Empirical analysis was applied to olive oil PDOs in Spain and this entailed a detailed case study of the ‘‘Sierra Magina’’ PDO in Andalusia.

Scarpa et al. (2005) underlined the importance of region of origin (ROO) as a quality indicator and EU recognition of territorial specificity in food products, but there is still an abundance of work investigating the importance of regional (both national and territorial) identity in consumer perceptions for specific food product categories. Employing nationwide discrete choice data for Italy, we investigated the strength of the ROO attribute across three food product categories. Moreover, in addition to treating taste heterogeneity as conditional on socio-economic factors, we employed recent advances in discrete-choice modelling to test for unobserved heterogeneity in consumer preferences for domestic and territorial origin of production certification.

Allen et al. (2006) surveyed the impact of different olive cultivation practices on the nature of the ground flora of olive groves in the region of the Psiloritis massif and Messara Plain in central and Southern Crete, Greece. In lower, flatter areas are areas of both traditional and intensive forms of olive cultivation. In more marginal upland areas, there are traditional terraced olive groves, some of which are being abandoned. The relationship between the vegetation composition of the ground flora and environmental variables was established by means of TWINSPAN1 and ordination analysis using survey data from nineteen sites across the region.

Ballabio et al. (2006) reported that the Classification and Influence Matrix Analysis (CAIMAN) is a new classification method that was recently proposed based on the influence matrix (also called leverage matrix). Depending on the purposes of the classification analysis, CAIMAN can be used in three outlines: (1) D-CAIMAN is a discriminant classification method, (2) M-CAIMAN is a class modelling method allowing a sample to be classified, not classified at all, or assigned to more than one class (confused) and (3) A-CAIMAN deals with the asymmetric case, where only a reference class needs to be modelled.

Matsatsinis et al. (2007) made an attempt to determine effective push-pull marketing strategies concerning olive oil in Greece based on the analysis of consumers’ and distributors’ values and the comparison of importance that each group gives to different product characteristics.

Oueslati et al. (2008) examined the commercial potential of olive oils from three consecutive crop years derived from the main autochthonous olive varieties; Chemlali Tataouine, Fakhari Douirat, Zarrazi Douirat and Dhokar Douirat grown in the arid region of Tataounine (Tunisia) with regards to stability and nutrition aspects.

Graaff et al. (1999) demonstrated and discussed the alternative future scenarios for olive orchards in the five Olivero regions as well as, their socio-economic and environmental effects. The ultimate objective of the EU Olivero project was to improve the quality of life of the rural population and to assure the sustainable use of the natural resources of land and water in the sloping and mountainous olive production systems (SMOPS) areas in Southern Europe.

Duarte et al. (2008) examined the traditional olive orchards accounting for a large share of the area under olives in the EU, particularly, in marginal areas, like those analyzed in the OLIVERO project. In general, traditional olive growing can be described as a low-intensity production system, associated with old (sometimes very old) trees grown at a low density, giving small yields and receiving low inputs of labour and materials. Though, such systems are environmentally sustainable, their economic viability has become an issue since EU policies favour more intensive and competitive systems. Orchards that have not been intensified seem to be threatened by the recent reform of the EU olive and olive oil policy, as income support has been decoupled from production. The main purpose of this paper is to identify the present constraints to traditional olive growing, and to recommend some private and public interventions to prevent its abandonment.

Finally, Graaff et al. (2008) made an ex-ante assessment of the application of cross compliance for soil erosion control (natural cover crops and terrace maintenance) in hilly and mountainous olive groves in Tras-os-Montes in Portugal.

DATA METHODOLOGY

The data employed in our study concerns production of virgin olive oil in Mediterranean countries. The data were retrieved by FAO organization while the reference period extends from 1961 to 2006. The data employed referred to the production of virgin oil in the following European countries; Greece, Cyprus, Malta Italy, Portugal and Spain as the countries that participated in the sample. As far as the methodology is concerned, a comparative analysis was conducted involving variance and entropy for every time series employed corresponding to a producer country. The main objective is to survey the volatility of each time series regarding the deviation of the values from the mean and the deviation of the frequency distribution from the uniform frequency distribution. Then, an ARIMA model was conducted in order to describe the behavior of the time series that can provide a satisfactory forecasting tool for the producers.

Entropy and variance: Comparative analysis

When the random variable X has a continuous distribution, and p_X (x) is the density function of the random variable X, the entropy is provided by the following relationship:

$$H(X) = -\int p_X(x)\log p_X(x)dx \qquad (1)$$

Arafat et al. (2003) considered that a measure of uncertainty should have the following properties:

(i) Symmetry, that is H (X) = H (−X);
(ii) Valuation: H (X ∪ Y) + H (X ∩ Y) = H (X) + H (Y).

These authors discussed on the combined methods of uncertainty and concluded that entropy can be a good measure of describing uncertainty. The assumption that the data and the residuals follow a normal distribution is very common in regression analysis. Thus, the equation used to estimate parametrically the entropy of a normal distribution, NH (X), is given by Equation 2:

$$NH(X) = \int p_X(x)\log\sqrt{2p}\sigma dx + p_X(x)\frac{(x-\bar{x})_2}{2\sigma^2}dx = \log(\sqrt{2\pi e}\sigma) \qquad (2)$$

Where σ is the standard deviation.

The variance is a measure of dispersion and its simplicity remains its major advantage. Historically, the variance has had a primordial role in the analysis of uncertainty and risk. However, according to Maasoumi (1993), entropy can be an alternative measure of dispersion and Soofi (1997), argued that the interpretation of the variance as a measure of uncertainty must be done with some precaution.

The entropy is a measure of disparity of the density p_X (x) from the uniform distribution. It measures uncertainty in the sense of the "utility" of using p_X (x) rather than the uniform distribution. The variance measures an average of distances of outcomes of the probability distribution from the mean. According to Ebrahimi et al. (1999), both of these measures reflect concentration but their metrics for concentration are different. Unlike the variance, this measures concentrates only around the mean and the entropy measures diffuseness of the density irrespective of the location of concentration.

Ebrahimi et al. (1999), examined the role of variance and entropy in ordering distributions and random prospects, and concluded that there is no universal relationship between these measures in terms of ordering distributions. These authors found that under certain conditions, the order of the variance and entropy is similar when continuous variables are transformed and shown (using a Legendre series expansion) that the entropy depends on more parameters of a distribution than the variance. The Legendre series expansion revealed that entropy may be related to high-order moments of a distribution, which, unlike the variance, could offer a much closer characterization of p_X (x), since it uses more information about the probability distribution than the variance.

Maasoumi et al. (2002) argued that in case the empirical probability distribution is not perfectly known, the entropy is an alternative measure for the uncertainty, predictability and goodness-of-fit. This result may account for the fact that entropy is a function of many moments of the distribution, and as such, it is more general than the traditional methods based on the variance. In this context, McCauley (2003) argued that entropy represents the disorder and uncertainty of a stock market or a particular stock, since the entropy has the ability to capture the complexity of the systems without requiring rigid assumptions that can bias the results obtained.

It is important to present some properties of the variance (and standard deviation) and entropy as measures of uncertainty. The standard deviation is a convex function, thus, it satisfies the Jensen inequality E [σ(X)] ≥ σ [E(X)]. This property allows the variance and the standard deviation to be used as a measure of risk in stock portfolios, since they take into account the effect of diversification. The entropy, on the other hand, is a concave function that has a maximum for the majority of the probability distributions, and this fact leads us to presume that entropy will not satisfy the effect of diversification. However, we must underline that entropy is not a function of the values of the variables but of the probability itself while the property H (X, Y) ≤ H (X) + H(Y) may well prove to be hopeful in this field.

The statistical analysis of these time series revealed that we must reject that the empirical distributions are normal since they present high levels of kurtosis and skewness. This result was determined by the empirical probability distributions p_{PR} (PR) of the variable (PR), which denotes the production of sheep meat for each country and which are given by the following functions per country:

Greece: $y = -3E\text{-}10X^2 + 0.0002\,X - 10.249$, $R^2 = 0.9254$

Cyprus: $y = -4.807\ln X + 44.866$, $R^2 = 0.4656$

France: $y = 39.315\,e^{-0.0006X}$, $R^2 = 0.9131$

Italy: $y = 6^E\text{-}17\,X^3 - 2E\text{-}10X^2 + 0.0002\,X - 26.381$, $R^2 = 0.8454$

Malta: $y = 3.426\,e^{0.2214X}$, $R^2 = 0.1578$

Portugal: $y = 3E + 06\,X^{-1.2016}$, $R^2 = 0.4547$

Spain: $y = 3E + 06\,X^{-0.9906}$, $R^2 = 0.461$

The next step of our analysis involves the performance of a comparative analysis between the entropy and the standard deviation for each country included in our data set and for the EU. The Empirical Entropy H (PR) is denoted with (EE), while it was estimated using Equation 2, measured in nats and finally, was

Table 2. Logarithmically standard-deviation log(s), normal entropy (NE) and logarithmically absolute empirical entropy log (absEE), for all the countries and for the EU.

Country	log (s)	(NE)	Log (absEE)
Greece	4.96	5.58	7.03
Cyprus	3.06	3.68	4.68
France	3.02	3.64	3.98
Italy	5.17	5.79	7.46
Malta	0	0.62	1.33
Portugal	4.36	5.05	6.25
Spain	5.46	6.08	7.07

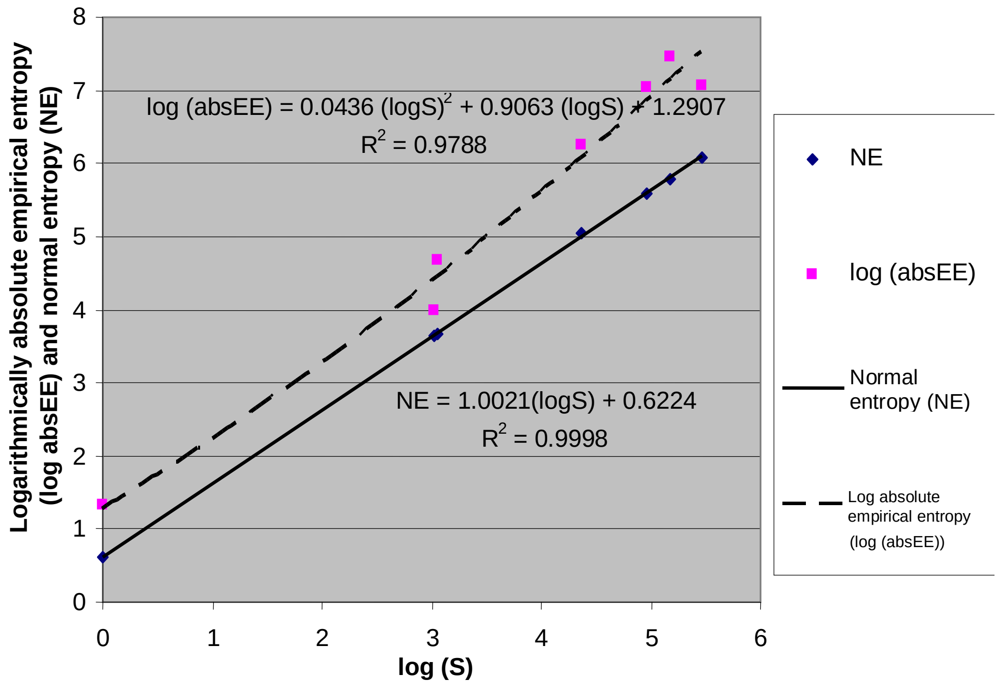

Figure 1. Logarithmically absolute empirical entropy log (absEE) and normal entropy (NE) compared to log (s).

applied in the numerical integration with the trapezoid method. The normal entropy NH (PR) was calculated, denoted with (NE), under the assumption that the normal probability distribution p ^{PR} (PR) of the variable (PR) is valid. Furthermore, it determined the correlation between the logarithmically standard deviation logs and the hypothetical Normal Entropy (NE) as well as, the correlation between the logarithmically standard deviation logs and that of the logarithmically absolute Empirical Entropy log (absEE). The main objective of this effort is to study the evolution of the entropy and standard deviation relation with the real probability distributions as well as with the hypothetical normal probability distribution in the countries of the EU.

Table 2 presents the results obtained for the logarithmically absolute Empirical Entropy log (absEE), Normal Entropy (NE) and logarithmically standard - deviation logs. According to the results given earlier, there is a strong positive correlation between the entropy in both forms of the standard deviation. In particular, a better positive correlation between the logarithmically standard deviation logs and the Normal Entropy (NE) is presented. Figure 1 presents the results of this relationship. As we can see from Figure 1, there is a strong and positive relationship between the Normal Entropy (NE) and the log(s), (R^2 = 0.9947). The next step involves the performance of a comparative analysis between the logarithmically absolute empirical entropy, the normal entropy and Logarithmically Standard-deviation for each country

ARIMA modeling

Under the CAP regime, modeling the behavior of the olive oil production in Mediterranean countries is interesting as an extensive study. The model behavior was based on ARIMA modeling; a well known and old methodology. ARIMA models are extensively used, considering that in most time series the value observed at time t may depend on values observed at previous time points, leading to

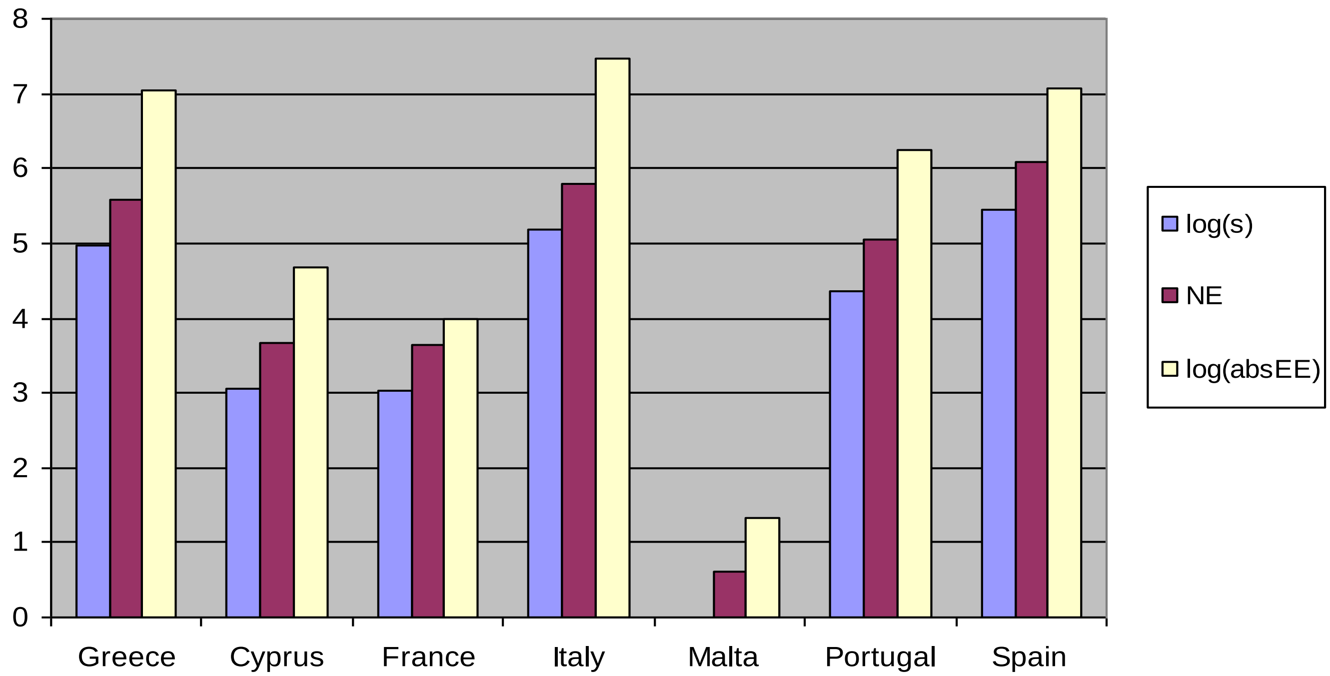

Figure 2. Logarithmically empirical entropy ln (EE), Normal entropy (NE) and logarithmically Standard-deviation ln (s) for each country and for EU.

violations of independence assumptions.

The model that describes the olive oil production in each country differs from one another, a result that illustrates the existence of additional factors affecting the olive oil production. Spain, France, Portugal, Italy, Greece, Malta are the countries used in our survey. For every country, a different ARIMA model was estimated given the special conditions valid in every oil market studied, while model evaluation is also included in our survey. Figure 2 presents the logarithmically empirical entropy ln (EE) and additionally Normal entropy (NE) and logarithmically Standard-deviation ln (s) for each country and for EU.

RESULTS

Greece

The time series of Greece according to the results of Anderson test follows the normal distribution. (Test Anderson = 0.398, p = 0.353 and Figure 1). According to Figure 3, it becomes evident that the time series studied presents an increasing trend as well as, few peaks and declines.

To be more specific, the highest values are recorded for the years 1961, 1963, 1980, 1982, 1991 and 2003 with the lowest values recorded in the following years; 1962, 1990, 2001 and 2004 (as outliers were chosen the values outside of the 95% confidence intervals). What must also be mentioned is the fact that the ups are followed by lows and vice versa.

This behaviour can be described adequately by the following relationship:

$$\omega_{i0} I_{it} + \omega_{i1} I_{it-1}, \quad i = 1,2$$

Where (I_{1t}) is a variable that describes the ups and (I_{2t}) the low values, while the variables ω_{i0}, ω_{i1} have opposite signs (Box and Tiao, 1973). The appropriate ARIMA model that fits to our data is the following:

$$(1-\phi B)(1-B)z_t = \theta_0 + (1-\theta_2 B^2 - \theta_{10} B^{10} - \theta_{13} B^{13})\alpha_t$$

The intervention variables included in our survey are provided by the following relationships:

$$LOW_t = \begin{cases} 1, \ t = 1962, 1990, 2001, 2004 \\ 0, \ t = elsewhere \end{cases}$$

$$UPP_t = \begin{cases} 1, \ t = 1961, 1963, 1980, 1982, 1991, 2003 \\ 0, \ t = elsewhere \end{cases}$$

The next step involved the calculation of the adjusting values as suggested by the model and the 95% confidence intervals. All the results are depicted in Figure 3 indicating that our model has a good fit to our data. The results of the model estimation are presented in Table 3.

Additionally, Figure 4 presents the Box – Cox plot for the time series of Greece and Figure 5 illustrates the initial

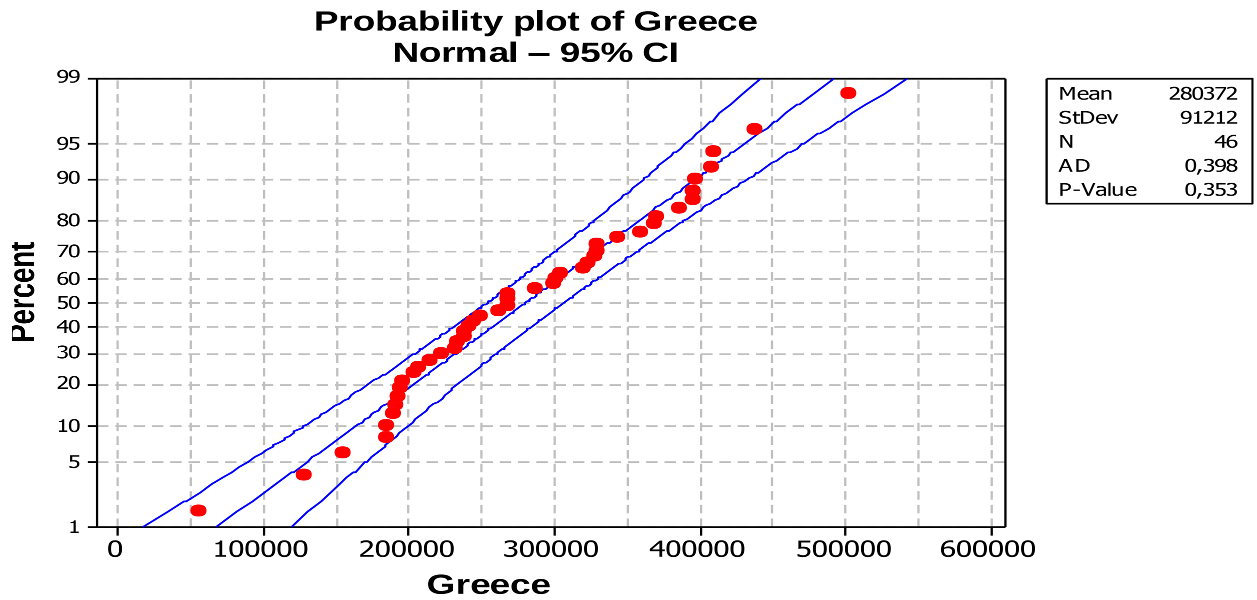

Figure 3. Probability plot of Greece.

Table 3. ARIMA model estimation results for Greece.

Coefficient	Value
φ_1	4,833.40089
φ_2	-0.90496
θ_1	-1.49995
θ_{12}	-0.65390
ω_{10}	-94,684.42559
ω_{11}	74,842.97178
ω_2	86,616.55359
ω_3	-68,101.76555

Model evaluation: R^2 = 0.997962; SSR=0.1709; SEE=0.0709.

time series, the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in Greece.

Spain

The time series of Spain was characterized by an intense heteroscedasticity while it is not in accordance with the normal distribution based on the result of Anderson test (1.608 and p<0.005). The greatest differences involve the maxima for the observations in the years 2001, 2003 and the minima in the year 1967. The aforementioned are evident in Figure 1. Consequently, we applied the Box – Cox transformation with $\lambda = 0.11$.

In Figure 7, the results of the transformation are evident, while Figure 6 presents the probability plot. The appropriate ARIMA model for our data is the following (after a number of trials):

$$\left(1-\varphi_1 B-\varphi_2 B^2\right)\left(1-B\right)z_t = \left(1+\theta_1 B+\theta_{12} B^{12}\right)\alpha_t$$

We also employed the intervention variables I_1, I_2 και I_3 in order to adequately describe peaks and recessions that correspond to the following dates:

$$I_1=\begin{cases}1, t=1963\\0, t\neq 1963\end{cases}\quad I_2=\begin{cases}1, t='81,'83,'85,'88,95\\0, elsewhere\end{cases}\quad I_3=\begin{cases}1, t='97,'01,'03\\0, elsewhere\end{cases}$$

The final form of the model is the following:

$$z_t=\omega_{10}I_{1t}+\omega_{11}I_{1t-1}+\omega_2 I_{2t}+\omega_3 I_{3t}+\frac{\left(1+\theta_1 B+\theta_{12}B^{12}\right)\alpha_t}{\left(1-\varphi_1 B-\varphi_2 B^2\right)\left(1-B\right)}$$

The results of the model estimation are presented in Table 4.

According to the aforementioned results based on the value of R^2 in which the model is satisfactory, all the coefficients are statistically significant with the exception of φ_1, φ_2, θ_{12}. Figure 8 depicts the raw data, the transformed time series and the upper and lower limits of 95% confidence intervals.

Italy

The time series of Italy follows the normal distribution given the results of Anderson test (test Anderson = 0.308, p = 0.548). The ARIMA model for this time series has the

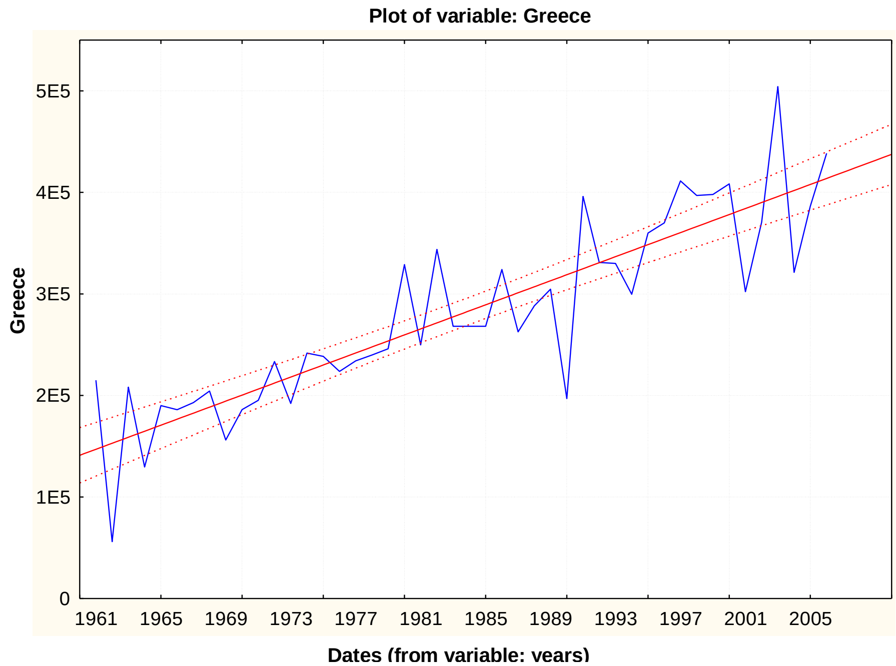

Figure 4. Box – Cox plot for the time series of Greece.

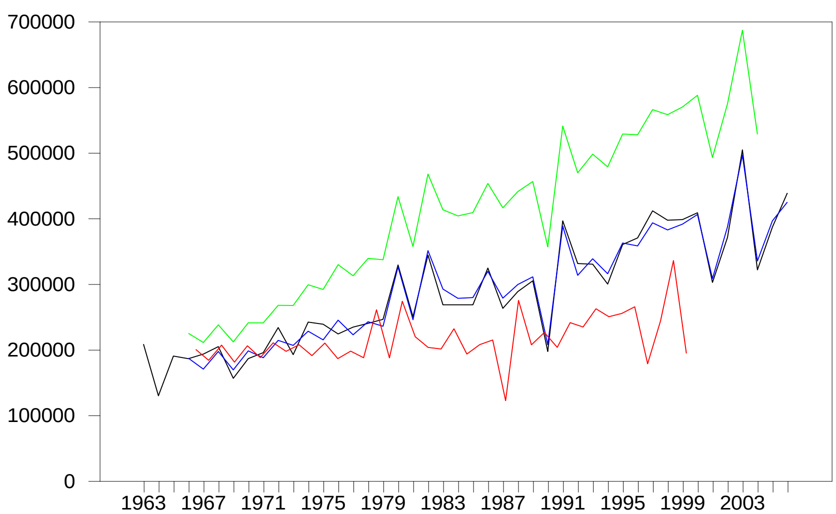

Figure 5. The initial time series the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in Greece.

following form:

$$z_t = \omega_1 I_{1t} + \omega_{20} I_{2t} + \omega_{21} I_{2t-1} + \omega_3 I_{3t} + \omega_4 I_{4t} + \frac{\theta_0 + \left(1 + \theta_2 B^2 + \theta_{10} B^{10}\right)\alpha_t}{\left(1 - \varphi_1 B\right)\left(1 - B\right)}$$

$$I_1 = \begin{cases} 1, t = '83 \\ 0, t \neq '83 \end{cases} \quad I_2 = \begin{cases} 1, t = '90 \\ 0, t \neq '90 \end{cases} \quad I_3 = \begin{cases} 1, t = '63, '67, '71, '75, '77, '80, '99 \\ 0, elsewehere \end{cases} \quad I_4 = \begin{cases} 1, t = '04 \\ 0, t \neq '04 \end{cases}$$

The results of the model estimation are presented in Table 5.

According to the results presented in Table 5, the R-square depicts a satisfactory model. Figure 9 illustrates the initial time series, the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in Italy. The result that should be stressed for all the aforementioned countries (Spain, Greece, Italy) is the common behavior of the olive oil production for the countries employed in our survey. To be more specific, an increasing trend is evident for the time series during

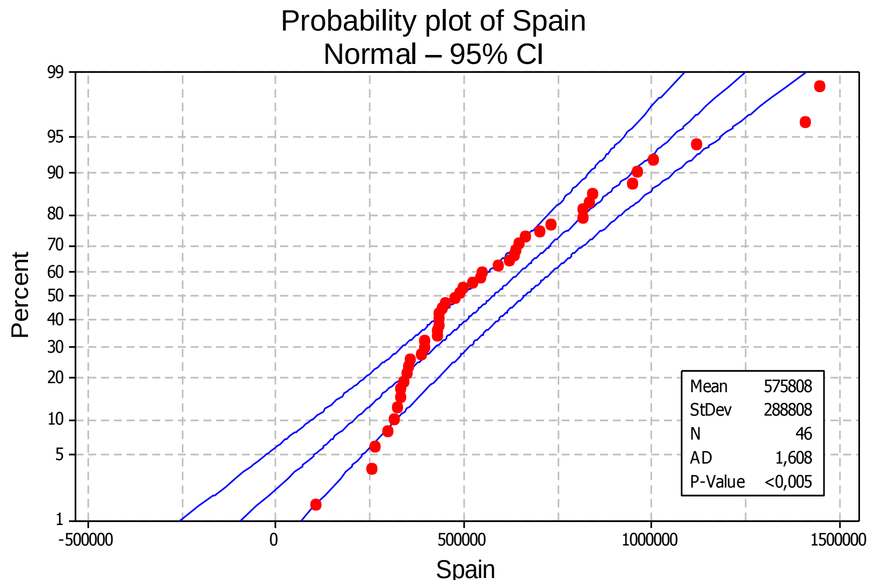

Figure 6. Probability plot of Spain.

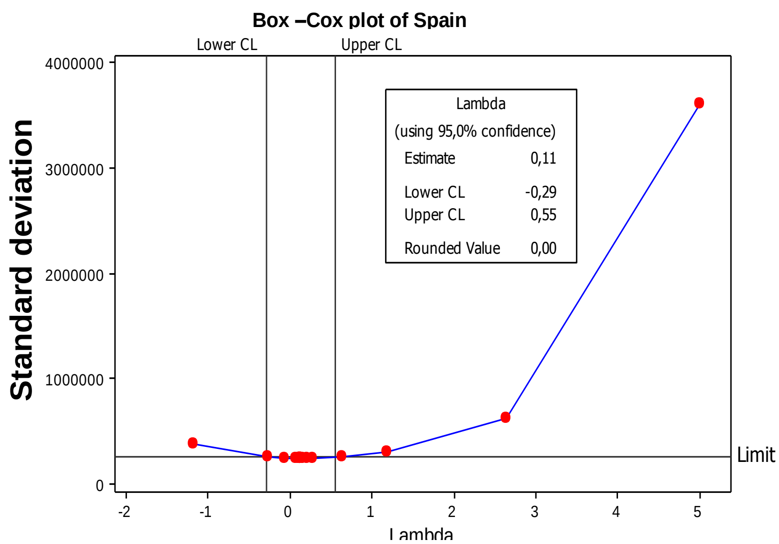

Figure 7. Box – Cox plot for the time series of Spain.

Table 4. ARIMA Model estimation results for Spain.

Coefficient	Value
φ_1	-1.0063
φ_2	-0.5024
θ_1	-0.4481
θ_{12}	1.1349
ω_{10}	0.2351
ω_{11}	-0.3862
ω_2	-0.2351
ω_3	0.3681

Model evaluation: R^2 = 0.999778; SSR = 0.1709; SEE = 0.0709.

the decades of the 1960s and 1970s, they are stabilized during the 80's and an increasing trend can be observed after the year 1993 in the olive oil production of all the countries studied. In Greece, the increasing trend is much more intense while in year 1963, there was a peak year for all three countries. Within the 80's a slight decreasing trend is obvious for Spain.

Malta

The time series of the olive oil production in the case of Malta presents a constant decrease since 1988 and after

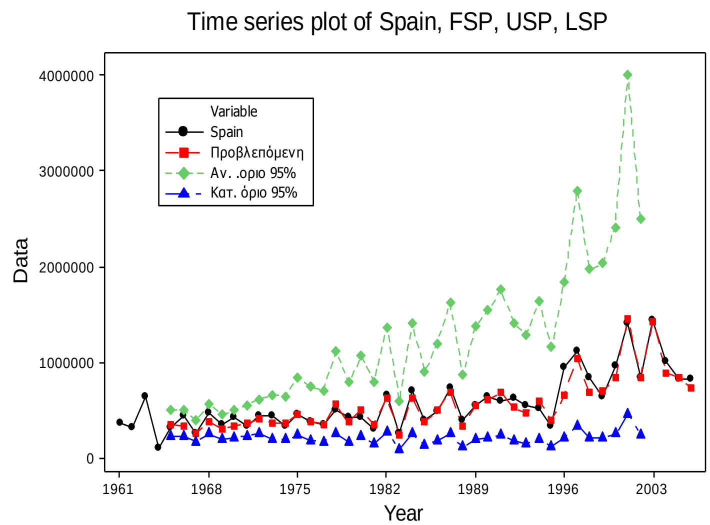

Figure 8. The initial time series the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in Spain.

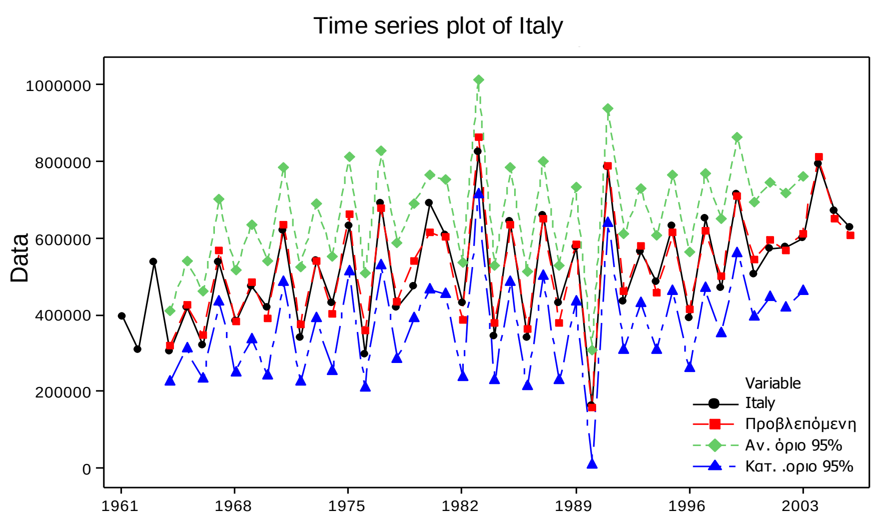

Figure 9. The initial time series the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in Italy.

given a shore term increase in the preceded 5-year time period. In addition a few pulses are observed in disperse time periods for the years 1964, 1974,1977 and a slight decline in the years 1970,1973, 1972. Thus, a Box-Cox transformation was applied taking the coefficient λ = 1.43 and the model is taking the following form:

$$z_t = \omega_1 I82 + \frac{\omega_2}{1-B} I88 + \frac{\omega_3 + \omega_4 B}{1-\delta_1 B}\frac{U}{1-B} + \frac{\omega_5}{1-\delta_2 B}\frac{L}{1-B} + \frac{(1+\theta_1 B + \theta_4 B^4)\alpha_t}{(1-B)(1-\phi_4 B^4)}$$

where,

$$I82 = 1, '82 \leq t \leq '87 \quad I88 = 1, '88 \leq t \quad U = 1, t = '64, '74, '77 \quad L = 1\, t = '70, '72, '73$$

The model estimation has given the following results presented in Table 6

Based on the results of the model estimation we may conclude the following about Malta:

1. Within the time period 1982 to 1987, an increase in the 40.6%
2. Since the year 1988 and till the end of the time period studied (15 years in total)) a constant linear decrease is observed with an average of 6.1%.
3. The sudden increases in the years 1964, 1974 and 1977 are accompanied by declines of the same size (ω3 to ω4) that descend exponentially (Figure 10).

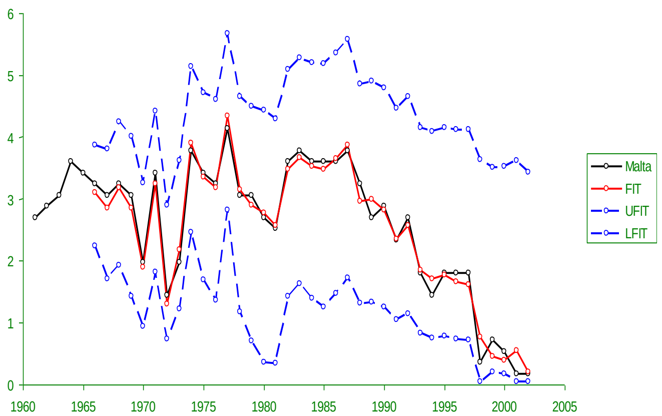

Figure 10. The initial time series, the estimated time series, the upper and lower bounds of 95% confidence intervals of olive oil production in Malta.

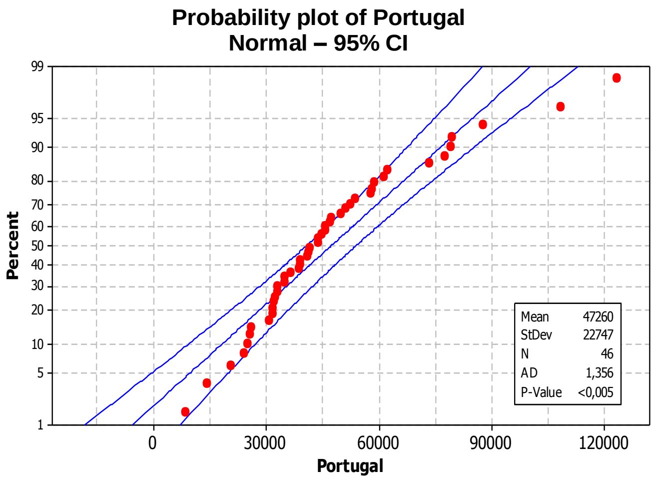

Figure 11. The probability plot of Portugal.

4. The declines for the years 1970, 1972 and 1973 are absorbed exponentially with periodic changes ($\delta 2 < 0$). The aforementioned results are also illustrated in the following Figure 10 on which are presented the raw data, the transformed time series and the upper and lower limits of the 95% intervals.

Portugal

The olive oil production in Portugal behaves in a similar way with the others (till the year 1980 a declining trend was evident interrupted by slight peaks (that is, in the year 1963) and then is stabilized.

This behavior implies heteroscedasticity necessitating the application of a Box-Cox transformation taking λ = 0.25 (Figures 11 and 12). The model used to describe the behavior of the transformed time series (z_t) is the following:

$$z_t = \omega_1 I_{1t} + \omega_2 I_{2t} + \frac{(1+\theta_3 B^3 + \theta_4 B^4)\alpha_t + \theta_0}{(1-\phi B)(1-B)}$$

Where:

$$I_{1t} = \begin{cases} 1, & t = 1979, 1982, 1991 \\ 0, & other\ dates \end{cases} \quad I_{2t} = \begin{cases} 1, & t = 1983, 1988 \\ 0, & other\ dates \end{cases}$$

The results of the model estimation are presented in the following Table 7. Figure 13 depicts the raw data, the estimated values and the upper and lower 95% confidence interval limits.

France

The evolution of the olive oil production in France differs from the others and presents an increasing trend till the year 1969, then it becomes stable till the mid-1980, while since 1989, an intense and constant increasing drift was evident and modeled through a step intervention variable such as:

$$s89 = \begin{cases} 1, & t >= '89 \\ 0, & t < '89 \end{cases}$$

Given that the time series is not in accordance with the normal distribution, a transformation was applied by using λ = 0.56 Figures 14 and 15 provide an evidence for this finding. The model fitting to the data is presented by the following equation:

$$z_t = \frac{\omega_{10} + \omega_{12} B}{1-\delta B}\left(\frac{I_{1t}}{1-B}\right) + \omega_{20}\frac{I_{2t}}{1-B} + \omega_{30}\frac{S89_t}{1-B} + \frac{(1+\theta_1 B + \theta_2 B^2)\alpha_t}{(1-B)(1-\phi B - \phi_{10} B^{10})}$$

Where:

$$I_{1t} = \begin{cases} 1, t = '69, '76, '03, '05, '06 \\ 0, t = other\ dates \end{cases}, \quad I_{2t} = \begin{cases} 1, t = '61, '64, '70 \\ 0, t = other\ dates \end{cases}$$

To be more specific, the variable I1t corresponds to values greater than 3000 and I_{2t} corresponds to values (<1000). The model estimation gave the following results presented on Table 8 and 9.

The aforementioned results confirmed the equality of the coefficients ω_{10} and ω_{12}, that implies that all the instant increases are counter balanced in the following year by an equal size drops while the existence of the denominator (δ) confirms that the impact of those instant annual peaks are absorbed gradually with time (Figure 17 of Box and Tiao, 1973). On the contrary the (I_2) seems to be constant and stable (Figures 18 and 19) (Box and

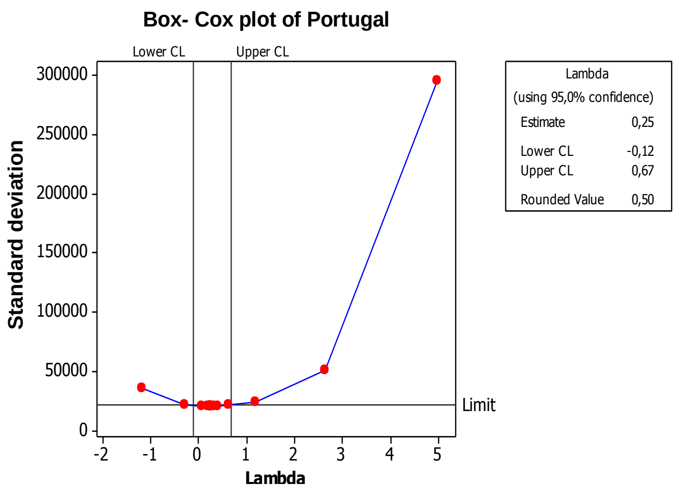

Figure 12. Box-Cox plot for the time series of Portugal.

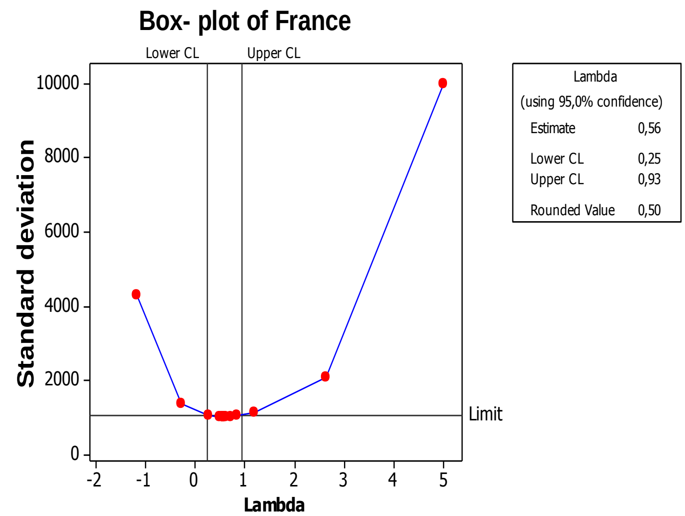

Figure 15. Box-Cox of France.

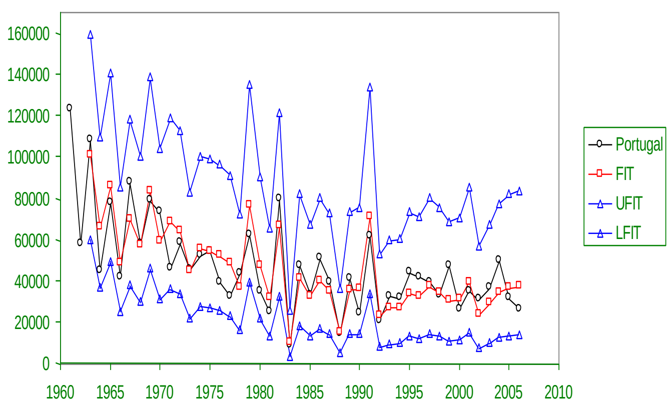

Figure 13. The initial time series the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in Portugal.

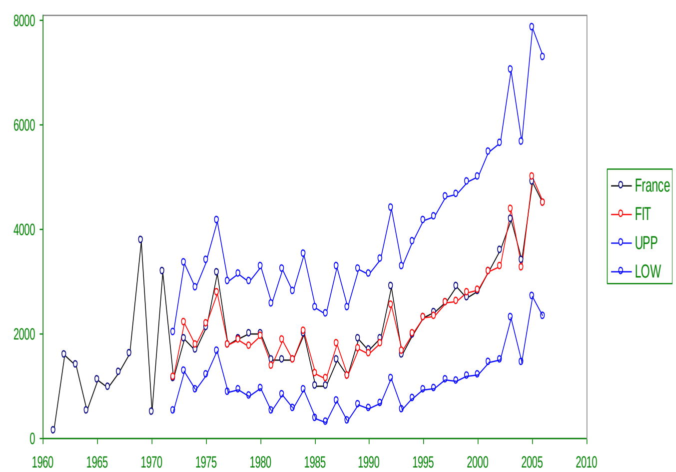

Figure 16. The initial time series the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in France.

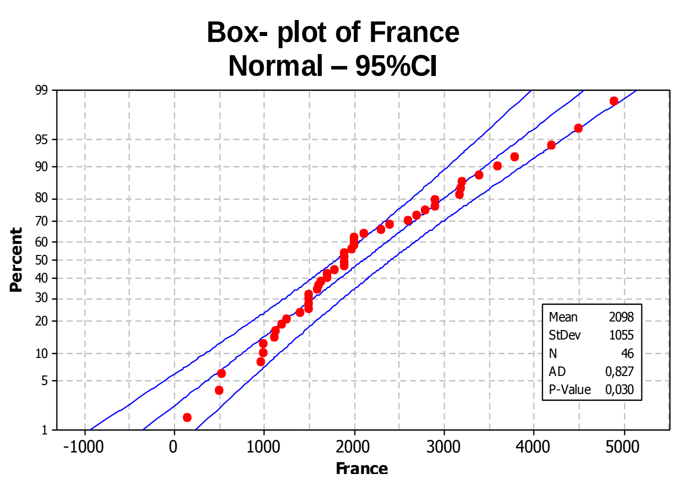

Figure 14. Probability plot of France.

Tiao, 1973). Finally, since the year 1989, an annual increase that reaches 5% on average per year has been recorded Figure 16 depicts the initial time series, the fitted time series and the upper and lower bounds of the 95% confidence intervals for the olive oil production in France.

Cyprus

The time series of Cyprus was characterized by a great volatility. For instance in the year 1961, a sharp decrease was evident while peaks were recorded in the years1967, 1988, 2002 and also significant decreases in the years

Table 5. ARIMA model estimation results for Italy.

Coefficient	Value
φ_1	-0.9894
θ_2	-2.0600
θ_{10}	1.041
θ_0	5225.3
ω_1	248890.3
ω_{20}	-250050
ω_{21}	184104.4
ω_3	123046.4
ω_4	211818.4

Model evaluation: R^2 = 0.997168; SSR = 35979517477; SEE = 32530.3

Table 6. ARIMA model estimation results for Malta.

Coefficient	Value
ω_1	2.423
ω_2	-0,330
ω_3	3.970
ω_4	-3.432
ω_5	-2.429
δ_1	0.305
δ_2	-0.768
φ_4	-0.360
θ1	-1.371
θ_4	2.065

Model evaluation: R^2= 0.995; SSR = 3.802; SSE = 0.375 .

Table 7. ARIMA model estimation results for Portugal.

Coefficient	Value
φ	-0.7565
θ_0	-0.0877
θ_3	-0.2881
θ_4	-0.3574
ω_1	2.9454
ω_2	-3.6067

Model evaluation: R^2 = 0.9969; SSR = 30.8199; SEE = 0.9006.

Table 8. ARIMA model estimation results for France.

Coefficient	Value
Φ	-0.6256
φ_{10}	-0.1229
θ_1	-0.7500
θ_2	-1.3514
δ	-0.4031
ω_{10}	12.7555
ω_{12}	-12.5079
ω_{20}	-9.8272
ω_{30}	3.275

Model evaluation: R^2 = 0.9980; SSR = 406.8662; SSE = 3.9558.

Table 9. ARIMA model estimation results for Cyprus.

Coefficient	Value
φ_1	-0.6115
φ_2	-0.3929
φ_3	-0.3945
ω_{10}	5.8635
δ	-0.584
ω_{20}	-8.4871
ω_{21}	5.4343

R^2 = 0.9833; SSR = 308.75; SSE= 2.97.

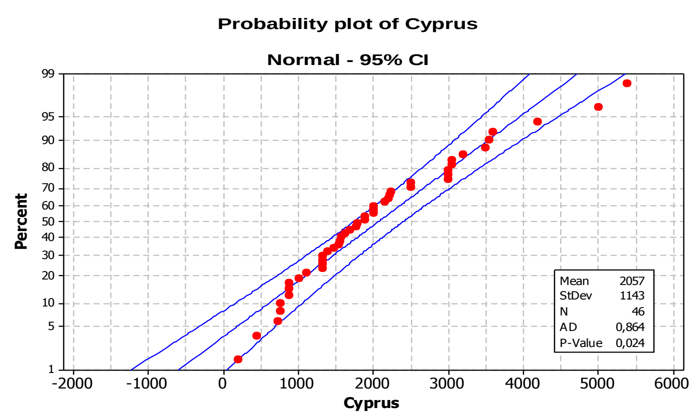

Figure 17. Probability plot of Cyprus.

1973, 1974, 1987 and 1991. The time periods included in this time range are relatively stable. Consequently, a transformation is needed for the time series with λ=0.4 and the appropriate model is the following:

$$z_t = \frac{\omega_{10}}{1-\delta B}\frac{I_{1t}}{1-B} + (\omega_{20}+\omega_{21}B)\frac{I_{2t}}{1-B} + \frac{\alpha_t}{(1-B)(1-\phi_1 B-\phi_2 B^2-\phi_3 B^3)}$$

where:

$$I_{1t} = \begin{cases} 1, & t = '61, '65, '67, '88, '02 \\ 0 & \end{cases} \qquad I_{2t} = \begin{cases} 1, & t = '62, '64, '73, '83, '03 \\ 0 & \end{cases}$$

This result implies that I_1 describes the peaks and I_2 describes the declines in the olive oil production. The consequences from the I_1 descend exponentially with time, implying that (k) years after its initial appearance are described by the following relationship:

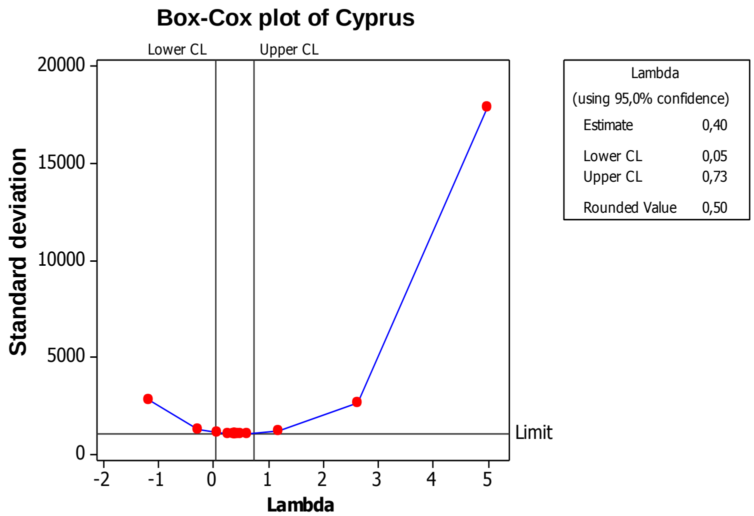

Figure 18. Box–Cox plot for the time series of Cyprus

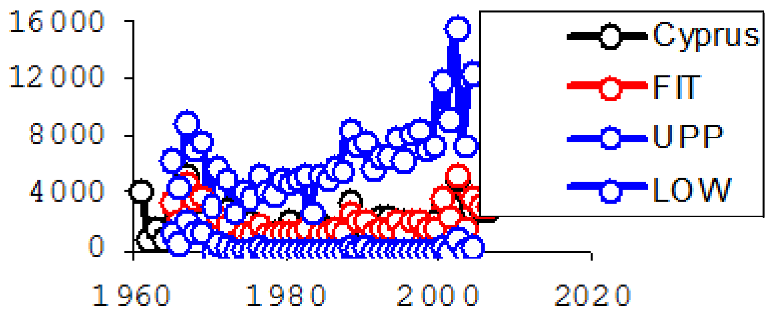

Figure 19. The initial time series the estimated time series the upper and lower bounds of 95% confidence intervals of olive oil production in Cyprus.

$$U_k = \left(1-\delta^k\right)\frac{\omega_{10}}{1-d} = 3.702\left(1-\delta^k\right)$$

After some ups and downs (δ<0) its value converges to 3.702. This increase though seems to become zero since the falls as described by' I_2, two years after its initial stabilize to the value –3.053 = $\omega_{20}+\omega_{21}$. To be more specific, the sudden increase or decreases are the results of this situation given that the causes of this situation cancel each other.

Figures 17 provide the probability plot for the time series of Cyprus. Figure 18 depicts the Box – Cox plot for the time series of Cyprus. Figure 19 presents the evolution of the initial time series, the transformed data and the upper and lower limits of the 95% confidence interval.

Conclusion

Olive oil production is a major source of income particularly for Mediterranean countries. Thus, it is quite important to study the volatility of the olive oil production in those countries and also to model this volatility with time series analysis. Modeling production can provide us with a useful tool for forecasting and to become capable of managing the olive oil production in order for the supply demand condition to be satisfied. Another issue equally important in this study is the CAP regime related to the pricing policy implemented on the olive oil. The producer price is a significant determinant for the olive oil production and consequently, it affects its volatility.

Furthermore, the volatility of olive oil production may well be interpreted by CAP reform or even changes in olive oil quality produced throughout time for the same country. If the status quo of low producer prices continues for a third year, then it would be a fair excuse for producers to follow alternative and more profitable production paths. The situation becomes more critical within the context of a more strict and systematic quality control along with the development and implementation of traceability throughout the chain; indispensable for protection of both producers and consumers.

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