Enjoying a quiet life even during a great recession? Evidence from the Greek olive oil industry

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ABSTRACT

The research investigates the link between market concentration and efficiency by analyzing the Greek olive oil industry data from 2006 to 2014. Unlike previous research on this issue, which focused on the impact of overall company efficiency on market power, we study the association between the three types of firm efficiency (profit, technical, and scale) and market concentration. Our theoretical framework and research assumptions were not predefined but were generated by modelling the data from the Greek oil olive sector through data mining techniques. The predicted causal relationships constructed in the preceding stage were investigated using partial least squares path modeling (PLS-PM) regression. The results show a significant negative relationship between market concentration and technical and profit efficiency. The paucity of completion resulted in prolonged firm inefficiencies, demonstrating that Greek enterprises, even during a severe recession, refrained from rigorous efforts to enhance technical and profit efficiency as they would in a competitive market, preferring instead to live a quiet life (QL). This study has several policy implications for regulators and policymakers, such as extending antitrust rules, which may enhance company efficiency and competitiveness.

Keywords: Efficiency, industrial concentration, Quiet life hypothesis, Greece, Partial least squares path modeling, Bayesian network.

JEL classification: L13, L25, L44, L52, L66, O25, O43

1. Introduction

At the end of the 2000s, the Greek government imposed an internal devaluation policy to improve firms' efficiency. Nonetheless, even though the basic salary fell by 20.8%, the contribution of net exports to recovering growth and employment was insufficient, and the Greek real GDP decreased by -23.1% from 2008 to 2019 (Word Bank data). During this period, the idea that Greece's economic reforms would achieve a significant acceleration in growth was increasingly called into question in public debate. Does competition failure due to high market concentration in the Greek industry impede economic reforms from gaining a substantial acceleration in growth? Rapid reduction of salaries seems reasonable to improve cost efficiency, but what if monopoly profits remain unchanged due to high market concentration and firms enjoy a quiet life (QL) without making intensive efforts to improve efficiency, as they would in a competitive market?

The paper attempts to answer these questions within the theoretical framework of firms' profitability in imperfectly competitive markets. Market power's effects on efficiency have been debated for decades (for this discussion, see Schmalensee 1989; Sutton 2007). Despite this lengthy literature, more field observations are necessary to adopt adequate policy objectives and choose the right tools for fostering efficiency.

An extensive analysis of the relationship between concentration, competition, and efficiency in the financial sector is provided by significant contemporary research in response to this demand. A negative link was discovered for American banks between profit efficiency and market power (Berger and Hannan 1998; Ariss 2010). Delis and Tsionas' research (2009) suggests that concentrated EMU banks are among the least profit-efficient financial institutions. Coccorese and Pellecchia (2010) published analogous findings for Italian banks, demonstrating that market power incurred inefficiencies that persisted long. Ferreira (2013) examined the relationship between efficiency and concentration for 27 European countries between 1996 and 2008 and concluded that market power resulted in bank inefficiencies because of less competition, supporting the quiet life hypothesis. Comparable results were reported by Asongu et al. (2019) for African banking and Setiawan et al. (2012) for the Indonesian food and beverages industry.

On the other hand, the Spanish industry (Gumbau and Maudos 2002) and the EU-15 banking sector (Maudos and de Guevara 2007) have not seen particularly notable effects of efficiency on market power. According to Färe et al. (2015), the quiet life is a reality only for some Spanish financial organizations, while this assumption was not

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confirmed according to Casu and Girardone's (2009) evidence for commercial banks in Germany, France, Italy, the UK, and Spain. They found that low competition, as the Lerner index shows, is positively associated with high efficiency, while efficiency does not affect competition. In the same direction, Giorgis Sahile et al. (2015) found that the more efficient banks in Kenya obtain market share and are the most profitable. The outcomes that were reported by Fu and Heffernan (2009) for the EU banking sector, Koetter et al. (2012) for American bank holding companies, Williams (2012) for Latin American banks and Kouki and Al-Nasser (2017) for African economies rejected the QL hypothesis. This substantial scholarly interest, however, focused primarily on the banks. Uncertainty exists regarding the current impacts of market power on the efficiency of firms across various industrial sectors.

The present research is the first to comprehensively and systematically address the linkages between concentration, competition, and different efficiency types in one industrial sector in Greece, the olive oil industry, from 2006 to 2014. This study contributes to the existing body of knowledge in various ways. Firstly, the paper assesses companies' technical and profit scores in the Greek olive oil sector from 2006 to 2014. This action is critical as it sheds more light on the implications of the economic reforms effectuated in Greece on various types of firm efficiency in an industrial sector where the country has a competitive advantage. Additionally, the article is devoted to examining the empirical validity of the QL hypothesis and determining if the imperfect market structure in the olive oil industry in the Greek context raises questions about enterprises' effectiveness and competitiveness. Several lessons may be drawn from whether competition failure due to high market concentration in an industrial sector in Greece incurred inefficiencies, making the production process less competitive.

Due to the two-way causation between market structure, company behaviour, and performance, the study also employed a novel research methodology to prevent biases in interpreting the findings. Instead of empirically validating a solid theoretical framework, the background information for developing research assumptions was constructed through a data mining technique like a Bayesian network. The key benefit of this strategy is the capacity to enrich the theoretical framework by identifying the variability of company behaviour and social group actions in various settings. Last but not least, we may obtain precise estimates of each factor's influences and the relative effects among elements in the presence of endogeneity by testing the postulated causal links generated in the preceding stage through a partial least squares path modeling (PLS-PM) regression. To our knowledge, no literature on this topic uses a comparable methodology. The results show that quiet life is a reality for the Greek olive oil industry during the study period. Our sample companies were technical and profit inefficient and did not capitalize on economies of scale to reduce the cost of products. On the contrary, they enjoyed an easy life by abandoning intensive efforts to increase efficiency, as they would in a competitive market. This research provides important policy implications to the regulators and policymakers to strengthen the competition through structural changes and antitrust policies as they relate to the efficiency and competitiveness of firms.

The rest of the paper is organized as follows: Section 2 summarises the literature on concentration, competition, and efficiency. Section 3 sets out the research methodology and measurement of critical variables and explains the data. Section 4 presents the results of the empirical analysis. Finally, Section 5 concludes and develops policy implications.

2. Literature review

The theoretical framework of firms' profitability in imperfectly competitive markets has been built upon the amalgamation of four strands of literature: the paradigm of Structure-Conduct-Performance (SCP), quiet life (QL), relative market power (RMP), and efficiency structure (ES).

The SCP paradigm (Mason, 1939; Bain, 1956) attributes the higher firms' profitability in concentrated markets to their collusive behaviour and high barriers to entry. The theoretical proposition that served as the foundation for the chain of reasoning of this older generation of Industrial Organization (IO) economists is that market structure directly affects firms' economic behaviour, impacting their performance (Mason, 1939; Bain, 1956). Recent literature verifies the collusion assumption (Bikker and Haaf, 2002; Resende, 2007; Maudos and de Guevara, 2007; Beck et al., 2008; Anzoategui et al., 2010; Setiawan et al., 2012; Khan et al. 2018) and proposes an antitrust intervention for protecting the consumer interest.

The second line of research is based on Hicks's (1935) theory of a "quiet life, arguing that lower competition lessens companies' incentives to maximize operating efficiency, and therefore a negative relationship between concentration and efficiency is expected. The evidence on QLH is relatively scarce and controversial. A negative relationship was found between profit efficiency and market power measured by the Learner index for American manufacturing industries (Caves and Barton,1990) and banks in the USA (Berger and Hannan, 1998; Ariss, 2010). Banks of EMU appear to be the least profit efficient, according to evidence by Delis and Tsionas (2009). Comparable results were reported by Coccorese and Pellecchia (2010) for Italian banks and Asongu et al. (2019) for African banking, revealing that the market power incurred inefficiencies that persisted long.

Similarly, Ferreira (2013) examined the relationship between efficiency and concentration for 27 European countries between 1996 and 2008 and concluded that market power resulted in bank inefficiencies because of less competition, supporting the quiet life hypothesis. On the contrary, Färe et al. (2015) estimated that the quiet life was a reality only for some Spanish financial institutions. Gumbau and Maudos (2002) also found that the efficiency impact on market power is not particularly remarkable in the Spanish industry, while the same evidence was provided for the EU-15 banking by Maudos and de Guevara (2007). A rejection of the QLH was observed according to Casu and Girardone's (2009) results for commercial banks in Germany, France, Italy, the UK, and Spain. Similar outcomes were reported for the EU banking sector (Fu and Heffernan, 2009), the American bank holding companies (Koetter et al. 2012), as well as for the banks in Kenya (Sahile et al. 2015) and the Latin American banks (Williams 2012).

The third strand of literature verifies the validity of the relative market power (RMP) theory (Delorme et al. 2002; Garza-García 2012; Khan et al. 2018). It provides evidence that firms with outstanding market shares and diversified products exert market power to determine prices and make abnormal profits (Shepherd 1983; Rhoades 1985). The fourth stream of research shows the influence of efficiency gains on profitability and market concentration (Demsetz H. 1973; Peltzman 1977; Carter 1978). From this perspective, a firm's efficient structure implies more favourable prices to consumers, higher producers' profits, and a more significant consumer and producer surplus. Efficient companies' outstanding profits and market share gains result in a higher concentration (Koetter et al. 2012, Fu and Heffernan 2009; Casu and Girardone 2009). For that reason, antitrust policies should be avoided not to decrease the most efficient or innovative firms' efforts to reduce costs or enforce their products' innovation and quality.

3. Methodology

3.1 Modeling the relationship between concentration, firm conduct, and performance

Faced with an evolving experience resulting from the interrelations between market structure, company conduct, and performance, the causalities between the variables exploring the sources of monopoly rents remain uncertain. For this reason, instead of empirically validating a solid theoretical framework, we applied the methodological proposition of Wu et al. (2012) of constructing the background information for developing research hypotheses through data mining techniques.

More specifically, the potential factors influencing profitability in the Greek olive oil sector were modelled as a Bayesian network (BN). The BN is a graphical model representing the probabilistic relationships between variables of interest. A BN structure is a directed acyclic graph (DAG) comprising nodes connected by arrows, which indicate causality. In a DAG, the connected nodes represent conditionally dependent variables, and the arcs indicate direct causal relations and dependencies between the related variables. A Bayesian Network S encodes the joint multivariate probability of random variables $\{X_1,...,X_n\}$. Let a node X_i in S means the random variable X_i and pa_i the parent nodes of X_i, from which dependency arcs come to the node X_i. Then, the joint probability of $\{X_1,...,X_n\}$ is computed by the multiplication of local conditional probabilities of all the nodes and given as follows:

$$P(X_1,...,X_n) = \prod_{i=1}^{n} P(X_i|pa_i)$$

Bayesian network's structure and connected parameters are an output of a data mining process that can provide inter-causal reasoning. This study estimates conditional probability distributions in the BN structure obtained from the Tree-Augmented Naïve Bayes (TAN) algorithm with a test mode of 10-fold cross-validation incorporated in the WEKA data mining package (Wu et al. 2012). The TAN is an extension of Naive Bayes because it removes the assumption that all the attributes are independent (Baesens et al. 2004). With the TAN algorithm application, a causal-effect graph is created, in which the only and most significant parent node for all other nodes is placed on the top in the DAG (Friedman et al. 1997). The TAN search algorithm's causal-effect graph is computed using the Chow–Liu method (Wu et al. 2012). This graph, calculated with the aid of the weka software, represents the actual causal relationships in the Greek industry between all the variables used as measures of the latent variables included in the PLS analysis. Thus, our research hypotheses were generated accordingly.

The BN represents a promising and practical way of identifying the variability of actors' behaviour and social groups' actions in space and time and formulating causal relationships among the variables when studying uncertainty phenomena (Wu et al. 2012). From a methodological view, the BN, further provides a way to avoid the risk of reverse causality bias. Furthermore, BN has the advantage of obtaining scientific knowledge on the reciprocal

relationships between firms' behaviour, performance, and market structure, without needing the application of the instrumental variables techniques, capable of providing consistent estimates only in extensive sample conditions, intense instrumental variables situations, and under restricted assumptions, often unrealistic for empirical research (Chao and Swanson 2005).

3.2 Testing the quiet life (QL) hypotheses

Some early studies tested the SCP relationships by estimating each factor's influence on profitability separately in different fixed-effect models (or random-effects) and controlling for the impact of other factors (Casu and Girardone 2009; Setiawan et al. 2012; Williams 2012). Nevertheless, this econometric approach, incapable of dissociating each factor's influence from the relative effects, reduced the decomposition results' reliability and accuracy, leading to confusion.

The current investigation followed previous research steps (Geroski1982, Delorme et al. 2002; Ressende 2007; Garcia 2012) and used a Structural Equation Modeling (SEM) approach as the most appropriate to demonstrate each factor's impact as well as the relative influences among elements in the presence of endogeneity. Specifically, a PLS-PM regression and a bootstrap resampling with 500 resamples are effectuated with the SmartPLS software developed by Ringle et al. (2005). Several reasons lead us to this selection. First, the PLS-PM regression is suitable for exploring phenomena without fully developed theoretical models (Chin 1998). It also has the following advantages: it can handle small sample sizes, place minimal restrictions on measurement scales, and about the statistical distributions of data sets (Ringle et al. 2005). Furthermore, it provides valid results when highly skewed distributions or the independence of observations is seriously violated, or multicollinearity exists among the independent variables (Chin 1998).

3.3 The measurement of a firm's efficiency

The traditional test of the SCP relationships is often relayed on indirect indices of firm efficiency. The calculation of a firm's efficiency by using the data envelopment analysis (DEA) or stochastic frontier analysis (SFA) methods (Berger and Hannan 1998; Delis and Tsionas 2009; Williams 2012; Casu and Girardone 2009; Nyangu et al. 2022) was an improvement over previous research relying on efficiency indirect and possible invalid indices. Despite this progress, the accuracy of the results cannot guarantee due to the possibility of parametric specification bias in the SFA and sampling variation and the omission of random error in the DEA (Simar and Wilson 2000). These methods have the additional disadvantage of not identifying the firm's internal procedures with less (or more) satisfactory performances because they treat firms as "black boxes" for which input and output parameters are central (Castelli et al. 2010).

Kao and Hwag (2008) and Chen et al. (2009) are taking innovative steps by developing the two-stage methodology seen in Fig. 1, capable of providing accurate measures of the actual production process composed of stages. In this framework, there are n decision-making units (DMU_j, with j= 1,2 ..., n). The DMU have m inputs x_{ij} ($i = 1,2, ..., m$) into the first stage and D outputs z_{dj} ($d = 1,2, ..., D$). The first stage is based on pure technical efficiency, namely, the firm's ability to minimize input amounts for a given output. The second stage is devoted to profit efficiency, namely the firm's capacity to maximize profits by the created revenue (Seiford and Zhu, 1999; Kumar and Gulati, 2010).
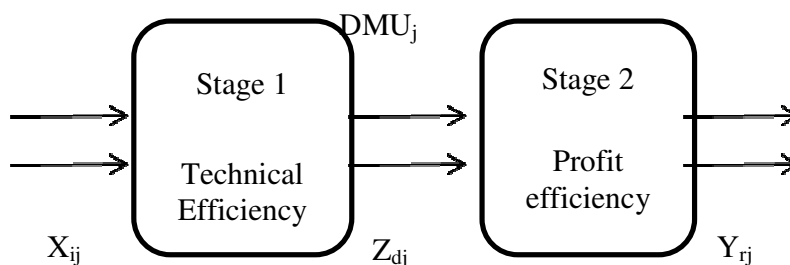

Fig. 1. A two-stage performance evaluation model.

In the first stage, one output and four inputs were employed. The selection of output and input variables followed previous studies. The cost of capital, calculated as the sum of depreciation and interest, the number of full-time employees, the cost of goods sold, and other operating expenses (Badunenko 2010), are used as the input

variables of the first stage. The total sales value is employed as the first stage's output (Caves and Barton,1990). The output of the first stage is input into the second stage and produces outputs y_{rj} (r = 1,2,..,s). In this study, the output in the second stage is the profit. More specifically, the total value-added as a profit proxy decreased by the total expenditure on salaries and depreciation (Boyer and Freyssenet, 2000).

Before the first step that the authors did for decomposing a firm's overall efficiency in various components and identifying the causes of inefficiencies within a company more accurately (Castelli et al. 2010), a non-parametric bootstrap test suggested by Simar and Wilson (2002) to examine returns to scale) was performed[2]. Using Simar and Wilson's bootstrap resampling method with 100 resamples for each year in the 9-year study period, we find that in the 9 cases, the null hypothesis that the technology exhibits globally constant return scales (CRS) is not valid. The given sample's olive oil manufacturing firms' underlying technology is globally or globally variant return scales (VRS).

Under this condition, the VRS model of Chen et al. (2009) is the appropriate formulation that should be chosen. According to this model, the overall efficiency score under the input-oriented VRS model is given by:

$$E_{0=}$$

$$\max \sum_{r=1}^{s} u_r y_{rj0} + \sum_{d=1}^{D} w_d z_{dj0} \tag{1}$$

s.t.

$$\sum_{d=1}^{D} w_d z_{dj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{d=1}^{D} w_d z_{dj0} \leq 0$$

$$\sum_{i=1}^{m} v_i x_{ij0} + \sum_{d=1}^{D} w_d z_{dj0} = 1$$

$$v_i, w_j, u_p \geq 0, d = 1,2, \ldots, n .$$

So by evaluating E_0 we can proceed to calculate the efficiency of the first stage E_0^1 (or E_0^2) and then derive the efficiency of the other stage E_0^2 (or E_0^1). These calculations are achieved by assuming that the relative contribution of stages 1 and 2 to the overall performance is w^1 and w^2 respectively and are given by:

$$w_0^1 = \sum_{i=1}^{m} v_i x_{ij0} / (\sum_{i=1}^{m} v_i x_{ij0} + \sum_{d=1}^{D} w_d z_{dj0})$$

$$w_0^2 = \sum_{d=1}^{D} w_d z_{dj0} / (\sum_{i=1}^{m} v_i x_{ij0} + \sum_{d=1}^{D} w_d z_{dj0}) \tag{2}$$

Therefore, in the case where stage 1 is considered more important, the first stage's efficiency score, E_0^1, is given by:

$$E_0^1 = _=$$

$$\max \sum_{d=1}^{D} w_d z_{dj0} \tag{3}$$

s.t.

$$\sum_{d=1}^{D} w_d z_{dj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{d=1}^{D} w_d z_{dj} \leq 0$$

$$\sum_{r=1}^{s} u_r y_{rj0} + (1 - E_0) \sum_{d=1}^{D} w_d z_{dj0} = E_0$$

$$\sum_{i=1}^{m} v_i x_{ij0} = 1$$

$$v_i, w_j, u_p \geq 0, j = 1,2, \ldots, n.$$

Then, the efficiency of the second stage, E_0^2, is calculated by the formula:

$$E_0 = w_0^1 E_0^1 + w_0^2 E_0^2 \tag{4}$$

A similar approach can be written by giving priority to stage 2. To estimate the efficiency, profit efficiency, and overall performance of the Greek olive oil industry, we adopted models (1)–(4) of Chen et al. (2009) to assess

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[2] The bootstrap-based test regarding return scales was not described here; interested readers can find detailed information in Simar and Wilson's original paper (2002).

profit and technical efficiency, as they are two crucial factors for a firm to gain a competitive advantage and improve its performance

3.4 The variables in the PLS –PM regression

One latent variable, profitability (PROF), represents the dependent variable in the PLS-PM regression. Two measurement variables constructed PROF: i) the annual proportionate changes in the price-cost margin, which equals the ratio of total sales decreased by the total cost (material, labour cost, overhead costs, and other costs) to sales (Asongu et al. 2019), and ii) the ratio of the price-cost margin of each company in each year to the average price-cost margin of the total sample firms during the period 2009-2014 (Boyer and Freyssenet 2000). The demand elasticity was not included in the regression due to the non-availability of data. Under this limit, we followed the Cowling and Waterson (1976) proposition to assess the effect of changes in the variables of interest on the industry's profitability with the assumption that the demand's elasticity remains relatively constant during the study period (2009-2014),

The independent variables in the PLS-PM regression are four latent variables: industrial concentration (CON), overall efficiency (OE), scale efficiency (SE), and product differentiation (Divers). OE comprises TE and PE, estimated through the Chen et al. model (2009). SE was calculated by applying Simar and Wilson's method (2002). Product differentiation (Divers) was constructed by two measurement variables, the advertising/sales ratio and the prestige from known brands' consumption, often employed by prior studies (Delorme et al. 2002).

The measurement of market power

The SCP and the NEIO research methodology, each with its advantages and defects, are the primary methods for measuring market power. The SCP approach proposes using market concentration indices, such as Hirschman-Herfindahl index, as a proxy for market power by assuming that the higher the market concentration, the higher the market power (Delorme et al. 2002; Resende 2007; Garza-García 2012; Setiawan et al. 2012; Nyangu et al. 2022). While the NEIO research methodology deduces market power from observing firms' conduct and, more explicitly, comparing some form of price mark-up over a competitive benchmark (Maudos and de Guevara 2007; Koetter et al. 2012; Williams 2012; Casu and Girardone 2009; Färe et al. 2015; Khan et al. 2018; Nyangu et al. 2022). However, the absence of price information hinders us from inferring the level of competition directly from firms' behaviour using non-structural measures (Panzar–Rosse H-statistic (1982) or Lerner Index, 1934). Under this limit, we constructed a latent variable for market concentration (CON) which was built by two measuring variables: the changes in the aggregate of the four most significant industry companies' market shares (C4) and the Hirschman-Herfindahl index (Graddy 1980).

3.5 Data collection and sample

This research's database covers the period from 2006 to 2014, when since 2008, Greece has sustained a significant economic recession, and from 2011, economic reforms occurred in the Greek economy. With the selection of this period, we can, firstly, include in the PLS-PM analysis the impact of the economic reforms on firms' conduct and their performance and study, secondly, some aspects of the subject that are less investigated, such as firms' conduct in more concentrated markets during an economic recession that a country has rarely seen.

Our dataset was compiled from both primary and secondary sources. Data were drawn from the annual balance sheets of companies, and information that was not readily available (such as the number of employees etc.) was collected through a questionnaire survey conducted from December 2018 until March 2019 by Panteion University of Athens. Specifically, 195 Greek oil manufacturing firms randomly selected, operating in different regions of Greece, were contacted, and 82 of them provided us with the relevant information (a response rate of 42.0 %). Our sample included three size groups of firms. The first group consisted of the seven most prominent companies with a market share of over 87 %. The other two groups comprised several medium-sized (i.e., 50–249 employees) and small companies (i.e., fewer than 49 employees) selected randomly by size. Our panel data was balanced and included 738 observations. It is worth noting that the DEA convention was satisfied, stating that the minimum number of DMU should be greater than three times the number of inputs plus outputs. Our sample size also is consistent with the rule of thumb specified in the PLS path modelling literature. The sample size is ten times the most significant number of structural paths directed at any construct (Chin 1998).

4- Empirical results
4.1 Market concentration and efficiency measures

The bootstrap test by Simar and Wilson (2002) was initially performed to determine the production technology type in the Greek oil olive industry. The results show that we can reject the null hypothesis of the constant scale of return (CRS) at any conventional significance level after conducting 100 bootstrap replications because the p values were less than 0.01 for each year in the 9-year study period. Under the condition of globally variable returns to scale

Table 1 The average technical efficiency, profit efficiency, overall efficiency scores and concentration ratio for the period 2006-2014

Years	OE			w1	w2	$E^{1}*$			$E^{2}*$			E^{1}			E^{2}			C4
	Mean	Min	Std.-Dev			Mean	Min	Std.-Dev	Mean	Min	Std.-Dev	Mean	Min	Std.-Dev	Mean	Min	Std.-Dev	Mean
2006	0.70	0.43	0.19	0.62	0.38	0.90	0.55	0.10	0.38	0.01	0.31	0.90	0.55	0.10	0.39	0.01	0.31	58.10
2007	0.70	0.22	0.21	0.65	0.35	0.86	0.18	0.15	0.40	0.01	0.32	0.85	0.18	0.16	0.42	0.01	0.31	63.74
2008	0.63	0.22	0.20	0.64	0.36	0.81	0.24	0.17	0.31	0.03	0.26	0.81	0.24	0.17	0.31	0.08	0.25	68.30
2009	0.67	0.26	0.20	0.63	0.37	0.86	0.34	0.15	0.33	0.03	0.27	0.85	0.34	0.15	0.35	0.02	0.28	63.58
2010	0.72	0.35	0.18	0.60	0.40	0.89	0.20	0.18	0.42	0.01	0.29	0.81	0.20	0.26	0.50	0.01	0.32	62.09
2011	0.70	0.32	0.19	0.62	0.38	0.89	0.37	0.14	0.41	0.01	0.32	0.89	0.36	0.14	0.42	0.04	0.31	61.50
2012	0.70	0.25	0.19	0.61	0.39	0.90	0.29	0.15	0.35	0.00	0.30	0.89	0.29	0.16	0.36	0.00	0.29	61.58
2013	0.64	0.22	0.19	0.62	0.38	0.84	0.27	0.15	0.34	0.00	0.29	0.82	0.22	0.17	0.37	0.02	0.31	60.66
2014	0.71	0.36	0.20	0.59	0.41	0.90	0.50	0.12	0.45	0.01	0.32	0.91	0.50	0.12	0.44	0.01	0.32	59.84
Mean	0.69	0.22	0.20	0.62	0.38	0.87	0.18	0.15	0.38	0.00	0.30	0.86	0.18	0.17	0.40	0.00	0.30	62.15

Table 2 Percentage distribution of firms by the average technical, profit and overall efficiency for the years 2006-2014

	Overall Efficiency					E1(based on 1)					E2(based on 1)				
Years	>70	71-80	81-90	>91	Total	>70	71-80	81-90	>91	Total	>70	71-80	81-90	>91	Total
2006	67.1	3.7	2.4	26.8	100.0	2.5	13.9	29.1	54.4	100.0	2.5	13.9	34.2	49.4	100.0
2007	59.8	8.5	4.9	26.8	100.0	13.9	21.5	20.3	44.3	100.0	12.7	26.6	17.7	43.0	100.0
2008	73.2	7.3	0.0	19.5	100.0	22.8	25.3	15.2	36.7	100.0	22.8	27.8	15.2	34.2	100.0
2009	64.6	8.5	6.1	20.7	100.0	14.1	19.2	15.4	51.3	100.0	17.9	15.4	17.9	48.7	100.0
2010	56.1	11.0	7.3	25.6	100.0	11.5	9.0	14.1	65.4	100.0	26.9	10.3	16.7	46.2	100.0
2011	61.0	12.2	3.7	23.2	100.0	11.1	8.6	25.9	54.3	100.0	12.3	8.6	24.7	54.3	100.0
2012	52.4	19.5	6.1	22.0	100.0	10.8	4.8	24.1	60.2	100.0	9.6	6.0	24.1	60.2	100.0
2013	70.7	6.1	3.7	19.5	100.0	14.3	26.2	21.4	38.1	100.0	20.2	21.4	22.6	35.7	100.0
2014	57.3	9.8	3.7	29.3	100.0	6.0	10.8	26.5	56.6	100.0	6.1	9.8	24.4	59.8	100.0
MO	61.8	9.2	3.9	25.0	100.0	12.7	16.5	19.0	51.9	100.0	15.2	15.2	21.5	48.1	100.0

OE stands for Overall Efficiency, and w1 and w_2 for the weights that capture each stage's importance. $E^{1}*$ and E^{2*} stood for the technical efficiency and profit efficiency measures when priority was given in the first stage, and E^{1} and E^{2} for the technical efficiency and profitability measures prioritized in the second stage.
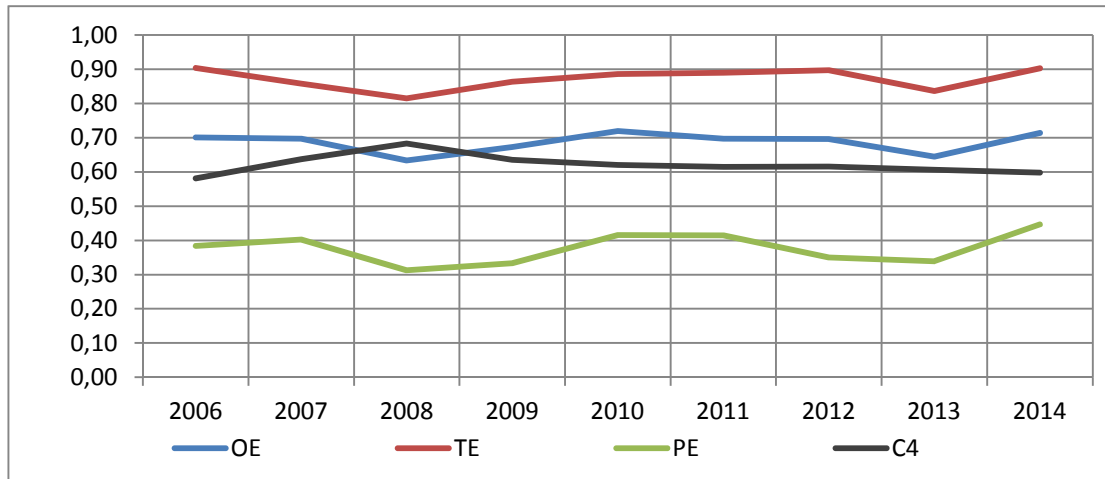
Fig. 2 The average market concentration ratio and technical (TE), profit (PE) and overall efficiency (OE) scores for the period 2006-2014

(VRS), the overall efficiency (OE), technical (TE) and profit efficiency (PE) scores of olive oil manufacturing firms in Greece were estimated via the VRS model of efficiency decomposition proposed by Chen et al. (2009).

Table 1 shows that a high market concentration characterized the Greek olive oil market, as the share of global market sales earned by the four most prominent companies in this industry (the so-called C4) approached, on average, about 62,15% from 2006-to 2014 (see also Figure 2). As Table 1 demonstrated, the OE of the firms operating in this market registered at 0.69, indicating room for improvement. Profit inefficiency amounted to about 0.60-0.62 during the study period, while concerning technical inefficiency, the exact output of this industry could have been produced for different years by using 9%–19% less than the observed inputs.

Encouraging is that OE grew slightly by 1.43% between 2006 and 2014 when the average four-firm concentration ratio had a higher increasing trend of 3% in the same period. However, OE deteriorated by -9.64% in 2008 compared to 2006, when the sector's four largest firms (C4) rapidly increased their market share by ten percentage points (from 58.10% in 2006 to 68.30% in 2008). Then, as the competition has risen since 2009, OE experienced low progress.

Lastly, it should be noted that before the global financial crisis, the average level of OE was high (0.70) in the years 2006-2007, then fell to 0.63 in 2008. From 2009-2010 it improved to 0.72, but when economic reforms effectuated in 2011, the OE worsened again, reaching 0.64 in 2013 and increasing only in 2014 to 0.71.

In light of the above, Greece's reforms do not substantially improve efficiency in this sector. The structural weaknesses of the Greek economy seem to be not addressed and remain the most crucial factor behind the difficulties of adjusting to intense international competition.

4.2 The research model and our hypotheses

The current study emphasized and supported the Bayesian network's application for shedding light on the causal relations among interest variables (Wu et al. 2012). The causal diagram resulting from the Bayesian network is exhibited in Fig. 3. It should be noted that before applying the PLS approach, the causal directions obtained by the TAN search algorithm should be reversed (Wu et al. 2012). Based on this diagram, our hypotheses are created accordingly.
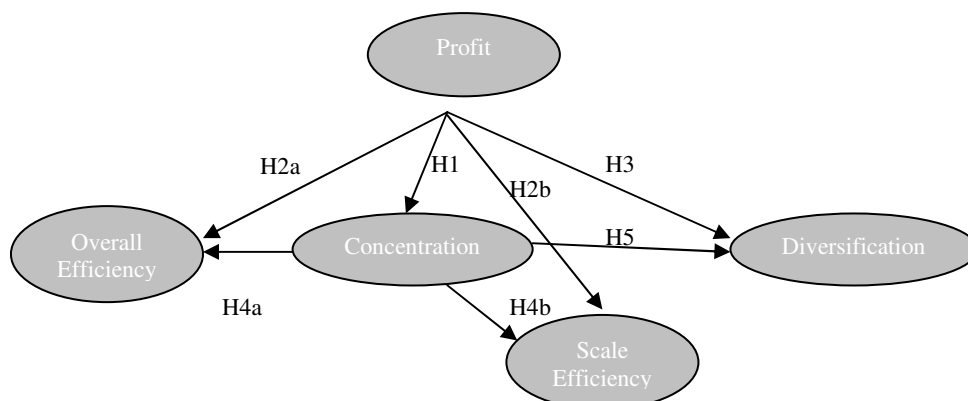

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Fig.3 Causal diagram acquired by Bayesian Network TAN classifier.

The Bayesian network findings suggest that seven crucial relationships may be valid in the specific spatial and temporal horizon, namely Greece's olive oil manufacture from 2006 to 2014. Four of these assumptions show a direct effect on the profits of concentration (H1), overall efficiency (H2a), scale efficiency (H2b), and product diversification (H3). Thus, the SCP, the RMP, and ES hypotheses described in the literature must be part of our research model (see Section 2). Additionally, three assumptions that indicate the impact on the concentration of overall efficiency (H4a), scale efficiency (H4b) and diversification (H5) were also formulated. The sources of concentration are the subject of dispute between economists. The literature on this controversy was dominated for a long time by opposing Hicks's and Chicago's approaches, known as the quiet life theory and efficiency paradigm respectively (see Section 2).

4.3 Testing the structural model

Figure 4 shows the hypothesis testing results by employing PLS path modeling. Based on them, we observed that the combination of four factors examined, market concentration (CONC), overall efficiency (OE), scale efficiency (SE), and product differentiation has a moderate predictive ability of 31.6 % for the profits (PROF).

From this Figure, it is also clear that the hypothesis of a positive effect on profitability of overall efficiency (H2a) and the scale efficiency (H2b) are supported at $p<0.001$ and at $p < 0.1$ since their standardized coefficients are statistically significant, with H2a (β=0.448, t= 16.0184, $p<0.001$) and H2b (β=0.048, t= 1.65986, $p<0.1$). Moreover, diversification (DIVERS) permits meaningful interpretations of profits as its path coefficient is positive and more than 0,25, suggesting the acceptance of the H3 hypothesis (β=0.285, t= 6.90970, $p<0.01$). Furthermore, the collusion hypothesis (H1) also prevails because concentration is significantly correlated with profits (β=0.073, t=1.98836, $p>0.05$). Hence, the evidence of this study confirms the links suggested by the theories of SCP, relative market power and efficiency structure. Looking at causal relations between the potential determinants of concentration, we discover that concentration exhibits a slight ability to be explained by this model (R^2 = 0,010%), and in particular, by three factors, overall efficiency (H4a) and scale efficiency (H4b) and product diversification (H5). Specifically, the empirical evidence revealed that H5 should be rejected, as diversification was found to have an insignificant negative relationship with concentration (β=-0.000, t= 0.008922, $p>0.1$).

Another interesting finding is that the correlation of overall efficiency with concentration is statistically significant but negative (β=-0.090, t=2.1852, $p<0.05$), indicating that the H4a hypothesis is rejected. A statistically insignificant negative influence of scale efficiency on concentration (β=-0.031, t=1.282, $p>0.1$) is also signalled, leading us to reject hypothesis H4b. These results verify the assumption of the quiet life theory.
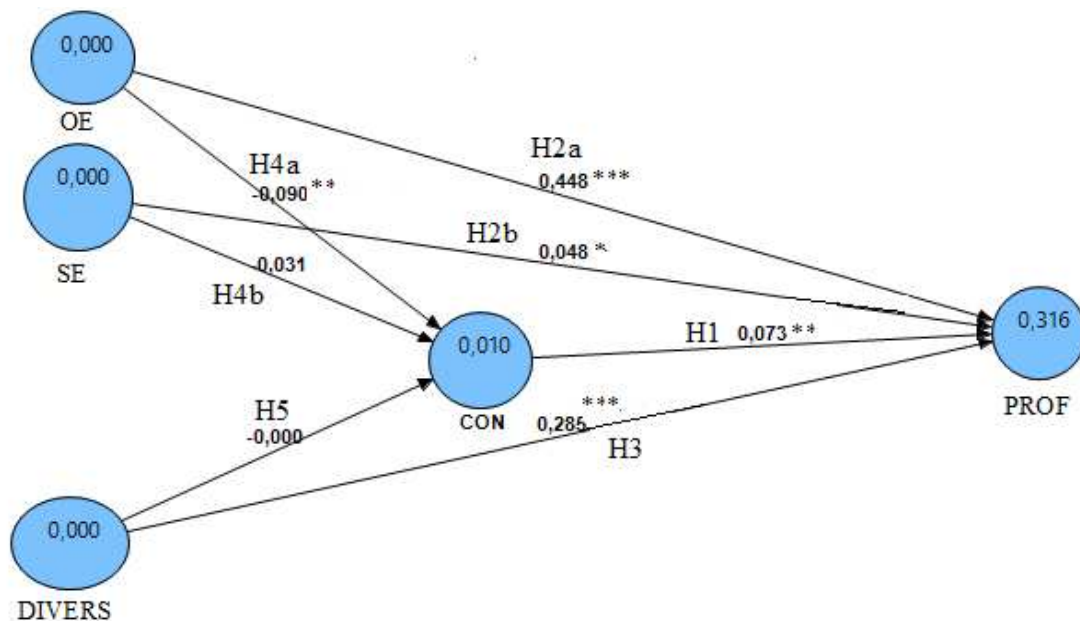
* significant at p < 0.10; ** significant at p < 0.05; *** significant at p < 0.001

Fig.4 The results of PLS path modeling

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5. Conclusion

Whether increased firm concentration leads to inefficiency due to increased market power is critical in developing anti-competitive policies. The paper investigates this question by examining the relationship between market concentration and efficiency. In particular, the article discusses the dynamics and effects of concentration on the different types of firm efficiency: technical, scale, and profit efficiency. For this purpose, we employed a new research methodology which might be used in future research to identify the interaction between firms' behaviour, performance, and market structure in Greece's olive oil industry from 2006 to 2014.

Several policy implications and regulations arise from this study. According to the research, one factor contributing to this industry's companies' higher profitability was their anti-competitive conduct. Although effective resource management and product differentiation increased profits within Greece's olive oil manufacturing enterprises, these features were not the primary sources behind industrial concentration. Instead, the findings supported the QLH by demonstrating a negative link between efficiency and concentration. The olive oil manufacturing companies that opted for a peaceful existence continued to be both technically and profitably inefficient. They have also been discovered to fail to exploit economies of scale to reduce the cost of production. As a result of the evidence concerning the effects of market concentration on various types of efficiency, anti-competitive actions are necessary to prevent companies from gaining excessive profits. The restoration of Greek industry competitiveness necessitates the adoption of regulations that support the competitive function of the market. Higher completion could enhance technical and organizational changes in the production process, encourage managers to reduce cost inefficiencies and waste in resource use, and find new products if combined with the promotion of an integrated government policy of productive reconstruction at the micro-region level.

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