# Measuring market power in the Greek food and beverages manufacturing industry

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**Abstract:** This paper measures the degree of market power of the Greek food and beverages manufacturing industry over the period 1983–2007 at the three-digit SIC level. The present study also estimates the "deadweight" loss and the reduction of consumers' income due to the possible existence of market power in the Greek food and beverages manufacturing industry. Based on Bresnahan's (1989) conjectural variation model, three different approaches are used to investigate competitive conditions of the Greek food and beverages manufacturing industry. The first approach assesses the extent of market power of the whole industry over the period 1983–2007; the second approach tests the degree of market power in each one of the nine sectors of the industry over the whole period, i.e. 1983–2007; and the third one estimates the extent of market power for the whole Greek food and beverages manufacturing industry for specific sub-periods of the period 1983–2007. The methodology of Dickson and Yu (1989) is adopted to measure the welfare losses. The empirical results indicate the presence of some degree of market power in the whole Greek food and beverages manufacturing industry as well as in each one sector of the industry during the period 1983–2007 and, as a result, the existence of welfare losses. In addition, the empirical findings support the presence of some degree of market power for each sub-period of the period 1983–2007 in the whole Greek food and beverages manufacturing industry and the existence of welfare losses.
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## 1. Introduction

The food and beverages manufacturing industry has a very important role in the Greek manufacturing industry and generally in the Greek economy. According to the Hellenic Federation and Enterprises (SEV) and the Foundation for Economic and Industrial Research (IOBE), this sector has the highest contribution in all of the basic economic magnitudes of manufacturing pertaining to employment, value added and sales. In particular, IOBE in its 2010 annual report for the Greek manufacturing industry mentions that the Greek food and beverages manufacturing industry creates about 120,000 jobs which account for about 22% of total employees in manufacturing and holds about 21% of the total sales of the manufacturing industry. Also, the food and beverages manufacturing industry holds the highest share of the total value added which equals about 24% of the total value added.

The present study is based on the New Empirical Industrial Organization (NEIO) approach to measure the degree of market power of the Greek food and beverages manufacturing industry and estimate the "deadweight" loss and the reduction of consumers' income due to the possible existence of imperfect competition.

There is an international growing literature of NEIO studies that measures and tests for the degree of market power in the food and beverages manufacturing industry. In particular, a list of the studies using the NEIO approach to investigate competitive conditions in the food and beverages manufacturing industry around the world are the studies by Buyan and Lopez (1997) for food and tobacco products in the U.S.; Lopez, Azzam and Liron-Espana (2002) for the food sector in the U.S.; Hatirli, Ozkan, Jones and Aktas (2006) for the milk sub-sector in Turkey and Anders (2008) for food retailing in Germany. There is, however, a lack of recent research which measures the degree of market power in the Greek food and beverages manufacturing industry. The only study which investigates competitive conditions in the Greek manufacturing industry and more specifically in the Greek food and beverages manufacturing industry is that undertaken by Bourlakis (1992b). Also of great importance is the evaluation of welfare losses due to imperfect competition after the Harberger's (1954) first and seminal study. More recently, Peterson and Connor (1995) and Bhuyan and Lopez (1997) have estimated the welfare losses in the U.S. food and tobacco manufacturing industries.

In this paper, the conjectural variation approach (Bresnahan, 1982) is applied to empirically investigate the degree of market power in the Greek food and beverages manufacturing industry. In particular, three different approaches are used. The first approach assesses the extent of the market power of the whole Greek food and beverages manufacturing industry over the period 1983–2007, the second approach tests the degree of market power in each one of the nine sectors of the industry over the period under consideration, i.e. 1983–2007, and the third approach estimates the extent of market power for the whole industry for specific sub-periods of the period 1983–2007. In addition, the present study adopts the methodology of Dickson and Yu (1989) to estimate: 1) the net loss of welfare (this loss of welfare is the so-called "deadweight" loss or Harberger loss) due to the existence of oligopoly (Harberger, 1954), 2) the reduction of consumers' welfare due to the transfer of income from consumers to the monopolist (this reduction is known as the Tullock loss) in the case of oligopoly power (Tullock, 1967).

The remainder of the paper is organized as follows. Section 2 describes the methodology of the model used and Section 3 presents its specification and data variables. In Section 4 the results are analyzed, while Section 5 presents the conclusions of the study.

## 2. Methodology

The approach used in this paper in order to investigate the degree of market power in the Greek food and beverages manufacturing industry is developed by Bresnahan (1982) and Lau (1982), as expanded by Bresnahan (1989). Following Bresnahan's (1989) conjectural variation model of competition, a manufacturing industry is considered in which firms face a demand function $p \equiv p(Y,z)$, with $Y = \sum_i y_i$, and $i = 1,...,n$ where $p$ is the output price, $y_i$ represents the quantity supplied by firm $i$, n is the number of firms and $z$ is a vector of exogenous factors affecting the demand curve. Thus, the profit maximization problem of firm $i$ is given as:

$$\max \pi_i = p(Y,z)\cdot y_i - C(y_i, w_i) \tag{1}$$

where $C(y_i, w_i)$ is the cost function of firm $i$ and $w_i$ is a vector of input prices of firm $i$.

The first order condition of the profit maximization problem (1) is given as:

$$\frac{\partial \pi_i}{\partial y_i} = p + \frac{\partial p}{\partial Y}\cdot\frac{\partial Y}{\partial y_i} y_i - \frac{\partial C_i}{\partial y_i} = 0 \tag{2}$$

Rearranging Eq. (2), the following expression is obtained:

$$\frac{p - MC_i}{p} = -\left(\frac{\partial p}{\partial Y}\cdot\frac{Y}{p}\right)\cdot\left(\frac{\partial Y}{\partial y_i}\cdot\frac{y_i}{Y}\right) = -\frac{\theta_i}{h} \tag{3}$$

where $MC_i$ is the marginal cost of firm *i,* $h \equiv (\partial Y/\partial p)/(Y/p) < 0$ is the price elasticity of output demand and $\theta_i \equiv (\partial Y/\partial y_i)/(Y/y_i)$ is the conjectural variation elasticity of firm $i$ which represents the reaction of total industry to the change of output of firm $i$ and it is a measure of competition. When $\theta_i$ takes the value of zero for all firms, then the industry is under conditions of perfect competition, while the value of one indicates a monopolistic market. Values of $\theta_i$ between zero and one support the presence of Cournot oligopoly in the food and beverages manufacturing industry.

According to Bresnahan (1989), multiplying equation (3) by $y_i/C_i$, summing over $i$ and rearranging, the following expression, i.e. the supply function, is obtained:

$$S_y\left(1 + \frac{f}{h}\right) = \overline{MC} \tag{4}$$

where $S_y$ is the ratio of aggregate revenue to total cost, $\overline{MC}$ is the industry-level (weighted) marginal cost and $-\frac{f}{h} = \frac{p - \overline{MC}}{p}$. [1] According to Cowling and Waterson (1976), the average degree of competition parameter $f$ $(with \quad 0 \le f \le 1)$ measures the average deviation of firms' behavior from the monopolistic case and, if properly identified in the estimation process, expresses the true degree of market power exerted by firms, with $f = 1$ indicating monopolistic market power, $0 < f < 1$ Cournot oligopoly, and $f = 0$ perfect competition. Furthermore, a specified cost function, i.e. $C(y_i, w_i)$ and a cost share equation for labor are added to the empirical system in order to improve the precision of the estimates.

Following the methodology of Dickson and Yu (1989), the industry demand curve is represented by $Y = 1/p^{|h|}$, where $|h|$ is the absolute value of the demand elasticity, *h.* In addition, the weighted industry marginal cost curve $\left(\overline{MC}\right)$ is presented by $Y = \overline{MC}^{\varepsilon}$, where $\varepsilon$ is the inverse of the weighted industry marginal cost elasticity. Based on the Lerner

[1] $L = -f/h$, where $L$ is the Lerner index which is the relative mark-up or the price-cost margin.

index, $L=\left(p_o-\overline{MC}\right)\big/p_o=f\big/|h|$, the oligopoly price $\left(p_o\right)$ and the oligopoly output $\left(Y_o\right)$ are given as:

$$p_o=\left(\frac{|h|}{|h|-f}\right)Y_o^{1/\varepsilon} \tag{5}$$

$$Y_o=1\big/p_o^{|h|}=\left(\frac{|h|-f}{|h|}\right)^{\frac{|h|\varepsilon}{|h|+\varepsilon}} \tag{6}$$

The net loss of welfare (deadweight loss or Harberger loss) due to the existence of oligopoly is depicted by:

$$WL^H=\int_{Y_o}^{1}\left[\left(1/Y\right)^{1/|h|}-Y^{1/\varepsilon}\right]dY \tag{7}$$

The reduction of consumers' welfare due to the transfer of income from consumers to the monopolist in the case of an oligopoly (Tullock loss) is presented by:

$$WL^T=WL^H+\left[\left(1/Y_o\right)^{1/|h|}-Y_o^{1/\varepsilon}\right]Y_o \tag{8}$$

**3. Model Formulation and Data Variables**

The translog specification for the total cost function with two inputs, one output and symmetry and linear homogeneity restrictions imposed is given below:

$$\ln\left(\frac{C_t}{\overline{W}_{k,t}}\right)=a_0+a_y\ln\overline{Y}_t+\frac{1}{2}a_{yy}\left(\ln\overline{Y}_t\right)^2+g_{ly}\ln\overline{Y}_t\ln\left(\frac{\overline{W}_{l,t}}{\overline{W}_{k,t}}\right)+a_l\ln\left(\frac{\overline{W}_{l,t}}{\overline{W}_{k,t}}\right)+ \frac{1}{2}g_{ll}\ln\left(\frac{\overline{W}_{l,t}}{\overline{W}_{k,t}}\right)^2+x_t\mathrm{T}+x_{ty}\mathrm{T}\ln\overline{Y}_t+x_{tl}\mathrm{T}\ln\left(\frac{\overline{W}_{l,t}}{\overline{W}_{k,t}}\right) \tag{9}$$

where $C_t$ represents the industry-level cost, $W_{l,t}$, $W_{k,t}$ correspond to the two input prices, i.e. labor and capital respectively; $Y_t$ corresponds to the output quantity of industry; $T$ is the time trend. The convention for the translog function is followed by letting variables with upper bars, i.e. input prices and output, be normalized by their means to avoid possible multi-colinearity.

The demand function is denoted by:

$$\ln Y_t=a+h\ln\left(\frac{p_t}{b_t}\times 100\right)+z_{159}\ln\left(\frac{I_t}{b_t\times POP_t}\times 100\right)+\sum_{s=151}^{158}z_s\left(DS_s\times\ln\left(\frac{I_t}{b_t\times POP_t}\times 100\right)\right) \tag{10}$$

where $h$ is the industry demand elasticity, $p_t$ is the output price, $b_t$ is a price deflator, $I_t$ is the Gross National Product, $POP_t$ is the population of Greece, $z_{159}$ is the income demand elasticity of sector 159 where sector 159 is the manufacture of beverages as referred to Table 1 and $DS_s$ *(s=151,…,158)* is a dummy variable, which is set to one for the $s$ sector and zero otherwise in order to account for possible differences in the income demand elasticity among the sectors of the food and beverages manufacturing industry. Note that the $s$ sectors are defined in Table 1. Furthermore, $z_s$ *(s=151,…,158)* refers to the change in the income demand elasticity of $s$ sector *(s=151,…,158)* with respect to the sector 159, i.e. the manufacture of beverages.

Applying Shephard's Lemma to the cost function (9), the cost share equation for labor is given as:

$$S_{l,t}=a_l+g_{ly}\ln\overline{Y}_t+g_{ll}\ln\left(\frac{\overline{W}_{l,t}}{\overline{W}_{k,t}}\right)+x_{tl}T \tag{11}$$

and the cost share equation for capital is the following:

$$S_{k,t} = a_k + g_{ky} \ln \overline{Y}_t + g_{kl} \ln\left(\frac{\overline{W_{l,t}}}{\overline{W_{k,t}}}\right) + x_{tk} T \tag{12}$$

Note that since the sum of the dependent variables over the two cost share equations (11) and (12) always equals 1 then only one factor share equation is linearly independent. As a result, it is necessary to omit one equation (equation for capital) to avoid singularity of the estimated covariance matrix.

Three different approaches are used in the present study to investigate competitive conditions in the Greek food and beverages manufacturing industry. The first approach is based on the estimated system of equations (9), (10), (11) and the following supply function (13) where a unique estimate of the degree of market power $\left(f_{15}\right)$ is obtained for the whole industry over the period 1983–2007:

$$S_{Y,t}\left(1+\frac{f_{15}}{h}\right) = a_y + a_{yy} \ln \overline{Y}_t + g_{ly} \ln\left(\frac{\overline{W_{l,t}}}{\overline{W_{k,t}}}\right) + x_{ty} T \tag{13}$$

where $S_{Y,t}$ is the ratio of the industry's aggregate revenue to total cost and $f_{15}$ is the conjectural variation elasticity for the whole food and beverages manufacturing industry.

The second approach investigates two related estimated equation systems. The first estimated system includes the equations (9), (10), (11) and the following supply function (14) where the $f$ parameter is allowed to change among the sectors of the food and beverages manufacturing industry while it is unchanged over time:

$$S_{Y,t} + \frac{f_{159}}{h} S_{Y,t} + \sum_{s=151}^{158} \frac{f_s}{h}\left(DS_s \times S_{Y,t}\right) = a_y + a_{yy} \ln \overline{Y}_t + g_{ly} \ln\left(\frac{\overline{W_{l,t}}}{\overline{W_{k,t}}}\right) + x_{ty} T \tag{14}$$

where $f_{159}$ is the conjectural variation elasticity of sector 159, i.e. the manufacture of beverages and $f_s$ $\left(s = 151,...,158\right)$ refers to the change in the conjectural variation elasticity of $s$ sector $\left(s = 151,...,158\right)$ with respect to sector 159. In addition, $DS_s$ $\left(s = 151,...,158\right)$ is a dummy variable, which is set to one for the $s$ sector and zero otherwise (Table 1). The empirical results of the aforementioned estimated system, provided in the next section, indicate that all of the sectors have the same conjectural variation elasticity, $f$, except that of sector 157, i.e. manufacture of prepared animal feeds. Thus, the supply function (14) is re-specified and a slightly modified system (second estimated system) is estimated under the second approach. More analytically, the second estimated system of the second approach contains the equations (9), (10), (11) and the following supply function (15) where the estimate of the degree of market power $\left(f_{16}\right)$ is the same for all sectors of the food and beverages manufacturing industry except that of sector 157 (manufacture of prepared animal feeds ):

$$S_{Y,t} + \frac{f_{16}}{h} S_{Y,t} + \frac{f_{157}}{h}\left(DS_{157} \times S_{Y,t}\right) = a_y + a_{yy} \ln \overline{Y}_t + g_{ly} \ln\left(\frac{\overline{W_{l,t}}}{\overline{W_{k,t}}}\right) + x_{ty} T \tag{15}$$

where $f_{16}$ refers to the conjectural variation elasticity which is the same across all sectors of the Greek food and beverages manufacturing industry except that of sector 157, $f_{157}$ is the change in the conjectural variation elasticity of the sector 157 with respect to the other sectors of manufacturing, i.e. $f_{16}$, and $DS_{157}$ is the dummy variable corresponding to sector 157.

The third approach is based on the estimated system of equations (9), (10), (11) and the following supply function (16) which allows $f$ to change for each sub-period of the period 1983–2007 but to remain the same among sectors:

$$S_{Y,t} + \frac{f_1}{h} S_{Y,t} + \sum_{t=2}^{8} \frac{f_t}{h} \left( DT_t \times S_{Y,t} \right) = a_y + a_{yy} \ln \overline{Y}_t + g_{ly} \ln \left( \frac{\overline{W_{l,t}}}{\overline{W_{k,t}}} \right) + x_{ty} T \qquad (16)$$

where $f_1$ refers to the conjectural variation elasticity of the sub-period $t=1$, i.e. the years 1983–1985, and $DT_t \ (t = 2,...,8)$ is a dummy variable, which is set to one for the sub-period $t$ and zero otherwise.[2] Note also that $f_t \ (t = 2,...,8)$ refers to the change of the conjectural variation elasticity of sub-period $t \ (t = 2,...,8)$ with respect to the sub-period $t = 1$, i.e. 1983–1985.

The sample comprised annual data for the period 1983–2007 for nine sectors at the three-digit SIC level of the Greek food and beverages manufacturing industry, i.e. SIC: 151-159, based on the Statistical Nomenclature of Economic Activity of 2003 (STAKOD_2003). The data used in the estimation was obtained by the Annual National Industrial Survey of the Hellenic Statistical Authority (EL.STAT.) The nine sectors of the Greek food and beverages manufacturing industry are presented in Table 1.

## 4. Empirical Results

The empirical results of the three different approaches used to measure the degree of market power in the Greek food and beverages manufacturing industry are presented in Table 2. The equation systems of the three different approaches are estimated using the non-linear three-stage least square (NL3SLS) estimation technique. The econometric analysis is conducted using Shazam 9.0 software.

The empirical findings of the three different approaches are plausible and consistent with economic theory in terms of the signs and the magnitudes of the coefficients and indicate that the translog cost function satisfies the restrictions of monotonicity and concavity at the sample mean (Table 2).[3] According to the first approach, the empirical results indicate that all the estimated coefficients of the translog cost function are statistically significant at any conventional level of significance (Table 2, First Approach). Furthermore, the results support that the cost shares of labor $(a_l = 0.7779)$ and capital $(a_k = 0.2222)$ are statistically significant at any conventional level of significance. These labor and capital share estimates are similar to the corresponding mean labor and capital cost shares calculated from the data, i.e. 0.7071 and 0.2929 respectively. The results of the supply function reveal that the conjectural variation elasticity $(f_{15} = 0.7104)$ is statistically significant at any conventional level of significance and its value is ranged between zero and one. These results imply the presence of some degree of market power in the Greek food and beverages manufacturing industry over the period 1983–2007. The estimated results of the demand function indicate that first, the price elasticity of output demand $(h = \text{-}0.7130)$ is statistically significant at any conventional level of significance; second, the income demand elasticity of sector 159

[2] It is noted that the sub-period 2 *(t=2)* corresponds to the period 1986–1988, the sub-period 3 *(t=3)* to the period 1989–1991, the sub-period 4 *(t=4)* to the period 1992–1994, the sub-period 5 *(t=5)* to the period 1995–1997, the sub-period 6 *(t=6)* to the period 1998–2000, the sub-period 7 *(t=7)* to the period 2001–2003 and the sub-period 8 *(t=8 )* to the period 2004–2007.

[3] The monotonicity restriction at the sample mean implies that $a_l>0$ and $a_k>0$, while the concavity restriction implies that the Hessian matrix is negative semidefinite, i.e. all Allen-Uzawa own-partial elasticities of substitution are negative at the sample mean.

$(z_{159} = 0.3969)$, i.e. the manufacture of beverages, is statistically significant; and third the change of the income demand elasticity of each one of the sectors of the food and beverages manufacturing industry, $z_s$ $(s = 151,...,158)$, with respect to sector 159, i.e. the manufacture of beverages, is statistically significant at any conventional level of significance. Furthermore, the results regarding scale economies imply the presence of increasing returns to scale. Finally, relative to the whole Greek food and beverages manufacturing industry, the Harberger loss is about €96.53 million in terms of 2007 value added (or 2.74% of the 2007 value added) whereas the Tullock loss is about €176.51 million in terms of 2007 value added (or 5.01% of the 2007 value added) (Table 3).

The empirical findings of the first estimated system of the second approach show that most of the estimated parameters of the translog cost function are statistically significant at any conventional level of significance (Table 2, Second Approach, First Estimated System). In addition, the results support that the cost shares of labor $(a_l = 0.7706)$ and capital $(a_k = 0.2294)$ are statistically significant at any conventional level of significance. Moreover, the results of the supply function show that only sector 157, i.e. the manufacture of prepared animal feeds, has a statistically different degree of market power from sector 159, i.e. the manufacture of beverages, since only the change in the conjectural variation elasticity of sector 157$(f_{157})$ with respect to sector 159 is statistically significant. These results are reinforced by the fact that the Wald test does not reject the null hypothesis which supports that all sectors, except sector 157, have the same degree of market power as that of sector 159.[4] The estimated results of the demand function indicate that first, the price elasticity of output demand $(h = \text{-}0.6782)$ is statistically significant at any conventional level of significance; second, the income demand elasticity of sector 159 $(z_{159} = 0.4029)$, i.e. the manufacture of beverages, is statistically significant; and third the change in the income demand elasticity of each one of the sectors of the food and beverages manufacturing industry, $z_s$ $(s = 151,...,158)$, with respect to sector 159, i.e. the manufacture of beverages, is statistically significant at any conventional level of significance. Furthermore, the results regarding scale economies imply the presence of increasing returns to scale.

According to the empirical results of the second estimated system of the second approach, all the estimated coefficients of the translog cost function are statistically significant at any conventional level of significance (Table 2, Second Approach, Second Estimated System). Furthermore, the results support that the cost shares of labor$(a_l = 0.7782)$ and capital $(a_k = 0.2218)$ are statistically significant at any conventional level of significance. Moreover, the results of the supply function reveal that first, the conjectural variation elasticity of all the sectors except sector 157, i.e. $f_{16}$, is statistically significant at any conventional level of significance; and second, the change of the conjectural variation elasticity of sector 157 $(f_{157} = -0.0004)$ with respect to the conjectural variation elasticity of all the other sectors $(f_{16} = 0.7714)$ is statistically significant at any conventional level of significance. Note that the conjectural variation elasticity of sector 157 is

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4 Wald test: the null hypothesis is $f151 = f152 = f153 = f154 = f155 = f156 = f158 = 0$ whereas the alternative is that at least one of the aforementioned sectors is different from zero. The Wald test used follows the chi-squared $(\chi^2)$ distribution with 7 degrees of freedom. The t-statistic and the p-value are 4.30 and 0.7452 respectively.

$0.7710 \left( f_{16} + f_{157} = 0.7710 \right)$. In addition, both conjectural variation elasticities of all sectors of the industry except sector $157 \left( f_{16} = 0.7714 \right)$ and that of sector $157 \left( f_{16} + f_{157} = 0.7710 \right)$, i.e. sector 157 the manufacture of prepared animal feeds, are ranged between zero and one which indicates the presence of some degree of market power for each sector of the Greek food and beverages manufacturing industry over the period 1983–2007.

The empirical results of the demand equation reveal that, first, the price elasticity of output demand $\left( h = \text{-}0.7742 \right)$ is statistically significant at any conventional level of significance; second, the income demand elasticity of sector 159 $\left( z_{159} = 0.3701 \right)$, i.e. the manufacture of beverages, is statistically significant; and third the change in the income demand elasticity of each one of the sectors of the food and beverages manufacturing industry, $z_s \left( s = 151, ..., 158 \right)$, with respect to sector 159, i.e. the manufacture of beverages, is statistically significant at any conventional level of significance. Furthermore, the results regarding scale economies imply the presence of increasing returns to scale. Finally, the Harberger loss is about €1.47 million in terms of 2007 value added (or 2.43% of the 2007 value added) for sector 157, i.e. the manufacture of prepared animal feeds, and €87.26 million (or 2.52% of the 2007 value added) for all other sectors, i.e. sectors 151–156 & 158–159, whereas the Tullock loss is about €2.58 million in terms of 2007 value added (or 4.25% of the 2007 value added) for sector 157 and €151.31 million (or 4.37% of the 2007 value added) for all other sectors of the Greek food and beverages manufacturing industry, i.e. sectors 151–156 & 158–159, (Table 3).

The empirical findings of the third approach (Table 2, Third Approach) show that all the estimated coefficients of the translog cost function are statistically significant at any conventional level of significance. In addition, the cost shares of labor$\left( a_l = 0.7817 \right)$and capital$\left( a_k = 0.2183 \right)$ are statistically significant at any conventional level of significance. Furthermore, the empirical findings of the supply function indicate that first, the conjectural variation elasticity $\left( f_1 \right)$ of the sub-period *t=1*, i.e. years 1983–1985, is statistically significant at any conventional level of significance and second, the change of the conjectural variation elasticity of each sub-period $\left( f_t, t = 2, ..., 8 \right)$ with respect to the conjectural variation elasticity of the sub-period $t = 1, f_1$, is statistically significant.[5] Moreover, the empirical findings indicate that the conjectural variation elasticity of each sub-period is ranged between zero and one implying the presence of some degree of market power for each sub-period of the period 1983–2007 for the whole Greek food and beverages manufacturing industry. Figure 1 depicts the degree of market power for the whole Greek food and beverages manufacturing industry for each sub-period of the period 1983–2007. According to Figure 1, the sub-period *t=1,* i.e. the years 1983–1985, presents the highest conjectural variation elasticity $\left( f_1 = 0.6612 \right)$ and as a result the highest degree of market power whereas the sub-period *t=8*, i.e. the years 2004–2007, shows the lowest conjectural variation elasticity $\left( f_1 + f_8 = 0.6596 \right)$ and as a result the

[5] More specific, the conjectural variation approach of the sub-period 1983–1985 is 0.6612 ($f_1=0.6612$), of the sub-period 1986–1988 is 0.6609 ($f_1+f_2=0.6609$), of the sub-period 1989–1991 is 0.6605 ($f_1+f_3=0.6605$), of the sub-period 1992–1994 is 0.6603 ($f_1+f_4=0.6603$), of the sub-period 1995–1997 is 0.6600 ($f_1+f_5=0.6600$), of the sub-period 1998–2000 is 0.6598 ($f_1+f_6=0.6598$), of the sub-period 2001–2003 is 0.6600 ($f_1+f_7=0.6600$), of the sub-period 2004–2007 is 0.6596 ($f_1+f_8=0.6596$).

lowest degree of market power. In general, Figure 1 shows that the degree of market power gradually decreases during the sub-periods under consideration except that of the sub-period *t=7*, i.e. the years 2001–2003, where an increase in the degree of market power occurred$\left(f_1 + f_7 = 0.6600\right)$. In particular, while the conjectural variation elasticity gradually decreases and takes the value of 0.6598 $\left(f_1 + f_6 = 0.6598\right)$ for the sub-period t=6, i.e. the years 1998–2000, it becomes slightly higher and takes the value of 0.6600 $\left(f_1 + f_7 = 0.6600\right)$ for the sub-period *t=7*, i.e. the years 2001–2003.

Two important events took place which resulted in the gradual decrease in the degree of market power in the Greek food and beverages manufacturing industry during the period 1983–2007 except that of the period 2001–2003, i.e. the sub-period *t=1,..., 8* except that of *t=7*. The first event is the deregulation of international markets and the gradual abolition of protectionism since the mid-1980s which led to imports being gradually increased. The second event is the introduction of research, development and innovation in the Greek food industry through different Developmental Laws and Operational Programmes towards the 1990s which resulted in the increase in the competitiveness of some problematic and small-scale firms in the Greek food and beverages manufacturing industry. However, the degree of market power in the Greek food and beverages manufacturing industry slightly increased during the period 2001–2003, i.e. the sub-period *t=7*, probably due to the launch of the euro in 2000. The launch of the euro led some small-scale firms to exit the Greek food market since they could not operate in the Single European Market and the European Monetary Union.

The empirical findings of the demand equation imply that first, the price elasticity of output demand $\left(h = \text{-}0.6627\right)$ is statistically significant at any conventional level of significance; second, the income demand elasticity of sector 159 $\left(z_{159} = 0.3350\right)$, i.e. the manufacture of beverages, is statistically significant, and third the change in the income demand elasticity of each one of the sectors of the food and beverages manufacturing industry, $z_s\ \left(s = 151,...,158\right)$, with respect to sector 159, i.e. the manufacture of beverages, is statistically significant at any conventional level of significance. Furthermore, the results regarding scale economies imply the presence of increasing returns to scale. Finally, the Harberger loss is ranged between 2.71% for the sub-period *t=8*, i.e. the years 2004–2007, which equals €338.53 million in terms of value added and 3.40% for the sub-period *t=1*, i.e. the years 1983–1985, which is equal to €27.60 million in terms of value added whereas the Tullock loss is ranged between 5.29% for the sub-period *t=8*, i.e. the years 2004–2007, which is equal to €660.82 million in terms of value added and 6.34% for the sub–period *t=1*, i.e. the years 1983–1985, which is equal to €51.47 million in terms of value added (Table 3)**.**

## 5. Conclusions

The objective of this paper has been to measure the degree of market power in the Greek food and beverages manufacturing industry over the period 1983–2007. For this purpose, three different approaches of the Bresnahan's conjectural variation method are used. The first approach assesses the degree of market power of the whole Greek food and beverages manufacturing industry over the period 1983–2007. The second approach tests the degree of market power in each one of the nine sectors of the industry over the period under consideration, i.e. 1983–2007, and the third one estimates the extent of market power for the whole Greek food and beverages manufacturing industry for specific sub-periods of the period 1983–2007.

The empirical results of the first approach imply the presence of imperfect competition in the whole Greek food and beverages manufacturing industry for the period 1983–2007. The empirical findings of the second approach suggest the presence of a non-competitive market structure in each one of the nine sectors of the Greek food and beverages manufacturing industry for the period 1983–2007, with only sector 157, i.e. the manufacture of prepared animal feeds, showing a different degree of market power from all other sectors of the industry, i.e. sectors 151–156 & 157–158. Finally, according to the empirical findings of the third approach, each sub-period of the period 1983–2007, i.e. the sub-period $t=1,...,8$, appears to operate in conditions of imperfect competition in the whole Greek food and beverages manufacturing industry, with the sub-period $t=1$, i.e. the years 1983–1985, showing the highest degree of market power whereas the sub-period $t=8$, i.e. the years 2004–2007, the lowest degree of market power.

Two important events took place which resulted in the gradual decrease of the degree of market power in the Greek food industry during the period 1983–2007 except that for the period 2001–2003. The first is the deregulation of international markets and the gradual abolition of protectionism since the mid-1980s and the second is the introduction of research, development and innovation in the Greek food market through different Developmental Laws and Operational Programmes towards the 1990s. However, the degree of market power in the Greek food and beverages manufacturing industry was slightly increased during the period 2001–2003 probably due to the launch of the euro in 2000.

Furthermore, the present study estimates the net welfare loss (deadweight loss or Harberger loss) and the reduction of consumers' welfare due to the transfer of income from consumers to the monopolist (Tullock loss) in the case of imperfect competition. According to the first approach, the empirical results indicate that, for the whole Greek food and beverages manufacturing industry, the Harberger loss is about 2.74% whereas the Tullock loss is about 5.01%. The findings, regarding the second approach, imply that the Harberger and the Tullock losses are 2.43% and 4.25% respectively for sector 157 whereas for all other sectors of the food and beverages manufacturing industry, the Harberger and the Tullock losses are 2.52% and 4.37% respectively. Finally, the empirical results of the third approach reveal that the Harberger loss is ranged between 2.71% for the sub-period 2004–2007 and 3.40% for the sub-period 1983–1985 while the Tullock loss is between 5.29% for the sub-period 2004–2007 and 6.34% for the sub-period 1983–1985.

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**Table 1. Classification of sectors**

| SIC | Sector description |
|---|---|
| 151 | Production, processing and preserving of meat and meat products |
| 152 | Processing and preserving of fish and fish products |
| 153 | Processing and preserving of fruits and vegetables |
| 154 | Manufacture of vegetable and animal oils and fats |
| 155 | Manufacture of dairy products |
| 156 | Manufacture of grain milk products, starches and starch products |
| 157 | Manufacture of prepared animal feeds |
| 158 | Manufacture of other food products |
| 159 | Manufacture of beverages |

**Table 2. Empirical results of the conjectural variation model of Greek food and beverages manufacturing industry over the period 1983-2007**

| | First Approach | Second Approach | | Third Approach |
|---|---|---|---|---|
| Coef. | Estimated System: Equations (9), (10), (11), (13) | First Estimated System: Equations (9), (10), (11), (14) | Second Estimated System: Equations (9), (10), (11), (15) | Estimated System: Equations (9), (10), (11), (16) |
| Cost | | | | |
| $a_0$ | 18.5820$^{***}$(435.310) | 18.5790$^{***}$(402.810) | 18.5850$^{***}$435.53) | 18.4200$^{***}$ (347.57) |
| $a_y$ | 0.6812$^{***}$(22.505) | 0.6588$^{***}$(15.071) | 0.6791$^{***}$ (22.513) | 0.4287$^{***}$ (5.898) |
| $a_{yy}$ | 0.1030$^{***}$(8.720) | 0.0284 (0.525) | 0.0905$^{***}$ (7.174) | 0.1041$^{***}$ (8.840) |
| $g_{ly}$ | 0.0635$^{***}$(12.216) | 0.0599$^{***}$(11.381) | 0.0645$^{***}$ (12.565) | 0.0450$^{***}$ (6.969) |
| $a_l$ | 0.7779$^{***}$(51.072) | 0.7706$^{***}$(48.463) | 0.7782$^{***}$ (50.960) | 0.7817$^{***}$ (52.457) |
| $a_k^{\alpha}$ | 0.2222$^{***}$(14.585) | 0.2294$^{***}$(14.430) | 0.2218$^{***}$ (14.527) | 0.2183$^{***}$ (14.651) |
| $g_{ll}$ | 0.0755$^{***}$(16.165) | 0.0759$^{***}$(16.233) | 0.0757$^{***}$ (16.181) | 0.0755$^{***}$ (16.753) |
| $g_{kl}^{\alpha}$ | -0.0755$^{***}$(-16.165) | -0.0759$^{***}$(-16.233) | -0.0757$^{***}$ (-16.181) | -0.0755$^{***}$ (-16.753) |
| $g_{ky}^{\alpha}$ | -0.0635$^{***}$(-12.216) | -0.0599$^{***}$(-11.381) | -0.0645$^{***}$ (-12.565) | -0.0450$^{***}$ (-6.969) |
| $x_t$ | -0.0211$^{***}$(-7.832) | -0.0186$^{***}$(-5.911) | -0.0209$^{***}$ (-7.737) | -0.0098$^{***}$ (-2.890) |
| $x_{ty}$ | 0.0048$^{***}$(2.947) | 0.0041$^{**}$(2.478) | 0.0048$^{***}$ (2.975) | 0.0233$^{***}$ (4.770) |
| $x_{tl}$ | -0.0052$^{***}$(-4.633) | -0.0049$^{***}$(-4.351) | -0.0052$^{***}$ (-4.642) | -0.0066$^{***}$ (-6.304) |
| Supply | | | | |
| $f_{15}$ | 0.7104 $^{***}$(3.106) | — | — | — |
| $f_{16}$ | — | — | 0.7714$^{***}$ (3.440) | — |
| $f_{151}$ | — | -0.0005 (-1.474) | — | — |
| $f_{152}$ | — | -0.0007 (-1.265) | — | — |
| $f_{153}$ | — | -0.0002 (-0.584) | — | — |
| $f_{154}$ | — | -0.0002 (-0.699) | — | — |
| $f_{155}$ | — | -0.0001 (-0.606) | — | — |
| $f_{156}$ | — | -0.0003 (-1.037) | — | — |
| $f_{157}$ | — | -0.0008$^{*}$(-1.693) | -0.0004$^{**}$ (2.130) | — |
| $f_{158}$ | — | -0.0001 (-0.997) | — | — |
| $f_{159}$ | — | 0.6760$^{***}$ (3.158) | — | — |
| $f_1$ | — | — | — | 0.6612$^{***}$ (2.830) |
| $f_2$ | — | — | — | -0.0003$^{*}$ (-1.884) |
| $f_3$ | — | — | — | -0.0007$^{**}$ (-2.444) |
| $f_4$ | — | — | — | -0.0009$^{**}$ (-2.415) |

| | | | | |
|---|---|---|---|---|
| $f_5$ | — | — | — | -0.0012** (-2.421) |
| $f_6$ | — | — | — | -0.0014** (-2.391) |
| $f_7$ | — | — | — | -0.0012** (-2.216) |
| $f_8$ | — | — | — | -0.0016** (-2.273) |
| Demand | | | | |
| a | 19.6640***(7.820) | 19.4330***(8.186) | 20.1900*** (8.133) | 19.9770*** (7.794) |
| h | -0.7130***(-3.106) | -0.6782***(-3.157) | -0.7742*** (-3.440) | -0.6627*** (-2.830) |
| $z_{151}$ | -0.1715***(-14.612) | -0.1710***(-13.841) | -0.1695*** (-14.603) | -0.1717*** (-14.608) |
| $z_{152}$ | -0.2941***(-24.530) | -0.2883***(-23.547) | -0.2915*** (-24.368) | -0.2878*** (-23.912) |
| $z_{153}$ | -0.0924***(-7.968) | -0.0822***(-6.681) | -0.0924*** (-8.098) | -0.0839*** (-7.209) |
| $z_{154}$ | -0.2141***(-18.443) | -0.2157***(-17.595) | -0.212*** (-18.432) | -0.2196*** (-18.920) |
| $z_{155}$ | -0.0759***(-6.663) | -0.0748***(-6.201) | -0.0758*** (-6.774) | -0.0770*** (-6.722) |
| $z_{156}$ | -0.1564***(-13.536) | -0.1552***(-12.736) | -0.1553*** (-13.624) | -0.1529*** (-13.200) |
| $z_{157}$ | -0.2298***(-19.516) | -0.2351***(-19.293) | -0.2364 *** (-19.820) | -0.2282*** (-19.353) |
| $z_{158}$ | -0.0373***(-3.276) | -0.0354***(-2.954) | -0.0378*** (-3.386) | -0.0366*** (-3.202) |
| $z_{159}$ | 0.3969**(2.005) | 0.4029**(2.102) | 0.3701* (1.881) | 0.3350* (1.670) |
| Scale Economies (SCE) [b] | 0.2568***(12.463) | 0.2876***(8.687) | 0.2583*** (12.582) | 0.2583*** (12.582) |

[a] $a_k=1-a_l$, $g_{kl} = -g_{ll}$, $g_{ky} = -g_{ly}$. The corresponding values in parentheses are "t-ratios" obtained by applying the Wald test statistic, [b] $SCE = 1-\left(\partial \ln\left(C_t/\overline{W}_{k,t}\right)/\partial \ln \overline{Y}\right) = 1-\left(a_Y + xty*13\right)$ at the point of approximation. The corresponding values in parentheses are "t-ratios" obtained by applying the Wald test statistic.
*** indicates 1% significance levels, ** indicates 5% significance levels, * indicates 10% significance levels.

**Table 3. Estimated Harberger and Tullock losses in the Greek food and beverages manufacturing industry over the period 1983-2007**

| Approaches | Sectors/ Time periods | Harberger loss [a] ($WL^H$) | Tullock loss [a] ($WL^T$) | Value added [b] | 2007 Value added [b] | Harberger loss [c] | Tullock loss [c] | Harberger loss [d] | Tullock loss [d] |
|---|---|---|---|---|---|---|---|---|---|
| First Approach | 151-159 | 2.74 | 5.01 | 41972.69 | 3523.14 | 96.53 | 176.51 | — | — |
| Second Approach ($2^{nd}$Estimated System) | 151-156& 158-159 | 2.52 | 4.37 | 40819.40 | 3462.55 | 87.26 | 151.31 | — | — |
| | 157 | 2.43 | 4.25 | 1153.29 | 60.59 | 1.47 | 2.58 | — | — |
| Third Approach | 1983-1985 | 3.40 | 6.34 | 811.86 | — | — | — | 27.60 | 51.47 |
| | 1986-1988 | 3.22 | 6.07 | 1416.70 | — | — | — | 45.62 | 85.99 |
| | 1989-1991 | 3.00 | 5.73 | 2535.86 | — | — | — | 76.08 | 145.31 |
| | 1992-1994 | 2.93 | 5.63 | 4624.16 | — | — | — | 135.49 | 260.34 |
| | 1995-1997 | 2.84 | 5.49 | 5451.29 | — | — | — | 154.82 | 299.28 |
| | 1998-2000 | 2.78 | 5.39 | 6733.66 | — | — | — | 187.2 | 362.94 |
| | 2001-2003 | 2.83 | 5.48 | 8176.80 | — | — | — | 231.4 | 448.09 |
| | 2004-2007 | 2.71 | 5.29 | 12491.87 | — | — | — | 338.53 | 660.82 |

[a] The estimated Harberger and Tullock losses are ratios, [b] The value added is in million Euros, [c] The Harberger and Tullock losses are in terms of 2007 value added and in million Euros, [d] The Harberger and Tullock losses are in terms of value added and in million Euros.

**Figure 1. Degree of market power for the whole Greek food and beverages manufacturing industry for specific sub-periods of the period 1983-2007**