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Assessing competitive conditions and welfare losses in the Greek food and beverages manufacturing industry: An extended Hall-Roeger approach

Anthony N Rezitis
University of Western Greece

Maria A. Kalantzi
University of Western Greece

Abstract

This paper extends the Hall-Roeger methodology in order to investigate the market structure and to measure the degree of market power in the Greek food and beverages manufacturing industry over the period 1984–2007 at the three-digit SIC level. The present paper also estimates the net and the total welfare losses due to the possible existence of market power. The bootstrap method is applied to assign measures of accuracy to the statistical estimates. The empirical results imply the presence of imperfect competition as well as the existence of some degree of market power in the Greek food and beverages manufacturing industry over the period 1984-2007. The findings also support the existence of welfare losses.

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Contact: Anthony N Rezitis - arezitis@cc.uoi.gr, Maria A. Kalantzi - mkalan@cc.uoi.gr.
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1. Introduction

When one group of marketing agents has a higher purchasing power than the other one then market power exists, which constitutes a market failure and results in the inefficient resource allocation. Thus, the estimation of the degree of market power is imperative since it will provide useful information about the market functioning.

This paper extends the approach, which originally proposed by Hall (1988) and subsequently modified by Roeger (1995), in order to evaluate the market structure and measure the degree of market power in the Greek food and beverages manufacturing industry as well as provide estimates of the net and the total welfare losses due to the possible existence of imperfect competition. Note that the Greek food and beverages manufacturing industry plays an important role in the Greek manufacturing industry and generally in the Greek economy.[1]

The Hall-Roeger approach has been widely used in the literature for estimating the market structure in various sectors of the economy and especially the manufacturing sector around the world. In particular, the list of studies using the Hall-Roeger approach includes the studies by Shapiro (1987) and Norrbin (1993) for the US manufacturing industry; Martins et al. (1996) for the manufacturing sectors of 14 OECD countries; Ryan (1997) for the US and Japanese manufacturing industry; Hindriks (1999) for the Dutch manufacturing industry; Silva (1999) for the Australian manufacturing industry; Ceritiglou (2002) for the Turkish industrial sector; Gorg and Warzynski (2003) for the UK manufacturing industry; Boyle (2004) for the Irish manufacturing industry; Dobrinsky et al. (2004) for Bulgarian and Hungarian manufacturing firms; Badinger (2004) for 17 sectors (including five service sectors) of a sample of ten European countries; Dobbelaere (2004) for the Belgian manufacturing industry; Aldaba (2005) for the Philippine manufacturing industry; Crespi and Gao (2005) for the US rice milling industry and Wilhelmsson (2006) for the Swedish food industry.[2]

In addition, there are several studies which measure and test for the degree of market power in the food sector around the world. Such studies are those by Schroeter (1988), Azzam and Pagoulatos (1990) and Schroeter and Azzam (1990) for US meat packing; Morrison (1990) and Lopez, Azzam and Liron-Espana (2002) for the US food industries; Hazilla (1991) and Bhuyan and Lopez (1997) for the US food and tobacco industries; Wann and Sexton (1993) for the Californian pear industry; Milan (1999) for the Spanish food, drink and tobacco industries; Hatirli, Ozkan, Jones and Aktas (2006) for the milk sub-sector in Turkey; Perekhozhuk and Grings (2006) for the Ukrainian milk processing industry and Anders (2008) for German food retailing.

Also of great importance is the evaluation of welfare losses due to imperfect competition after Harberger's (1954) first and seminal study. There is a list of studies that estimate the welfare losses due to imperfect competition in food manufacturing industries, including those by Bhuyan and Lopez (1995, 1998) and Peterson and Connor (1995) for the US food and

[1] According to the 2010 annual report of the Hellenic Federation and Enterprises (SEV), the food and beverages manufacturing industry includes about 16,300 enterprises, representing about 17.1% of the total of manufacturing enterprises, and creates about 120,000 jobs, accounting for about 22% of the total of employees in manufacturing. In terms of turnover, the food and beverages industry holds about 21% of the total sales of the manufacturing industry whereas it holds the highest share of the total value added, equaling about 24% of the total value added.

[2] OECD is derived from the "Organization for Economic Co-operation and Development".

tobacco manufacturing industries; Bhuyan (2000) for the US food manufacturing industries; Goodwin and Shiptsova (2000) for the US poultry industry and Lavergne at al. (2001) for the French food industry. However, to our knowledge, this is the first study measuring the degree of market power based on the Hall-Roeger methodology and in continuation estimating the welfare losses.

In this paper, an extended approach of the Hall-Roeger methodology is applied in order to empirically investigate the market structure and degree of market power in the Greek food and beverages manufacturing industry over the period 1984-2007. More specifically, a demand function is added in the Hall-Roeger methodology so that the degree of market power and therefore the welfare losses, in the case of oligopoly power, can be estimated in the Greek food and beverages manufacturing industry. In addition, the present study adopts the methodology of Dickson and Yu (1989) to estimate, first, the net loss of welfare, i.e. deadweight loss or Harberger loss (Harberger, 1954), and second, the total welfare loss, i.e. Tullock loss, in the case of oligopoly power (Tullock, 1967).

Moreover, this study applies the bootstrap method for the estimation of confidence intervals, which will provide more robust and reliable estimates. Bootstrapping is a computer-based simulation method for assigning measures of accuracy to statistical estimates; see Efron (1979) and Efron and Tibshirani (1993) for a presentation of the method. It is a non-parametric statistical procedure that empirically measures the variability of any statistic without relying on traditional normality assumptions. In other words, bootstrapping is distribution-free so assumptions about the unknown true distributions of variables need not be made.[3] Because of these advantages, it is not surprising to find applications of bootstrapping in testing for market power in various sectors around the world. A list of studies that use the bootstrap method to investigate competitive conditions includes those by Maasoumi and Slottje (2003) for the US steel industry; Deodhar and Sheldon (1996) for the German banana market; Liu, Su and Kaiser (1995) for the US dairy industry; Argentesi and Filistrucchi (2007) for the Italian newspaper industry; Kothari and Shanken (1997) and Lyon, Barber and Tsai (1999) for finance.

The remainder of the paper is organized as follows: Section 2 outlines the methodologies used to measure the markup and the degree of market power in the Greek food and beverages manufacturing industry and to estimate the welfare losses; Section 3 presents the extended Hall-Roeger formulation and the data variables; and Section 4 presents the empirical results obtained, while Section 5 offers a conclusion.

2. Extended Hall-Roeger Methodology and Dickson–Yu Methodology

The extended approach developed in this paper to investigate the market structure of the Greek food and beverages manufacturing industry is based on a method developed by Roeger (1995), which is in turn an extension of the work by Hall (1988). Hall (1988) applied a test for market power in the US industry. His basic insight is that the traditional Solow residual (SR) should be independent of variation in the log-change of output in the absence of monopoly power. The main contribution of Roeger (1995) is that he showed how the differences between the production-based (primal) SR and the cost-based (dual) Solow residual (DSR) can be used to eliminate the unobservable productivity shock in order to obtain an unbiased estimate of market power.

[3] The idea of bootstrapping is that when a model has been fitted to data by an estimation procedure, then the difference between the fitted and the actual values, or the residuals, contains information about the stochastic structure of the model. The key idea is to resample the residuals and retain the stochastic structure of the problem and thus test the model against its own assumptions.

Assume that an industry produces output (Q_t) according to a homogenous production function F using two inputs, i.e. labor (L_t) and capital (K_t):

$$Q_t = \Theta_t F(L_t, K_t) \tag{1}$$

where Θ_t is a Hicks-neutral productivity term or else an index of the total factor productivity. Hall (1988) showed that the production-based (primal) SR can be defined as the difference between output growth and input growth weighted by their shares in total value added, under the assumption of constant returns to scale, imperfect competition in product markets but perfect competition in the input markets. As a result, the SR is given by Eq. (2).

$$SR = \frac{\Delta Q_t}{Q_t} - \alpha_{lt}\frac{\Delta L_t}{L_t} - (1-\alpha_{lt})\frac{\Delta K_t}{K_t} = \beta_t\left(\frac{\Delta Q_t}{Q_t} - \frac{\Delta K_t}{K_t}\right) + (1-\beta_t)\frac{\Delta\Theta_t}{\Theta_t} \tag{2}$$

where $\alpha_{lt} = (W_t L_t / P_t Q_t)$ is the cost of labor as a share of total value added, W_t corresponds to the wage, P_t is the price of output, β_t coefficient is the Lerner index defined as $\beta_t = (P_t - MC_t)/P_t = 1-(1/\mu_t)$, where MC_t is the industry's marginal cost and μ_t is the markup. However, the estimation of Eq. (2) is problematic because of the inherent correlation between the right-hand-side productivity growth variable and the error term, providing biased markup estimates. Roeger (1995) pointed out that the difference between the change in price and the weighted change in factor inputs prices, or else the cost-based DSR, obtained from the cost function, could be used to solve this problem and can be defined as:

$$DSR = \alpha_{lt}\frac{\Delta W_t}{W_t} + (1-\alpha_{lt})\frac{\Delta U_t}{U_t} - \frac{\Delta P_t}{P_t} = -\beta_t\left(\frac{\Delta P_t}{P_t} - \frac{\Delta U_t}{U_t}\right) + (1-\beta_t)\frac{\Delta\Theta_t}{\Theta_t} \tag{3}$$

where U_t is the price of capital, i.e. the user cost of capital. Subtracting Eq. (3) from Eq. (2) cancels out the productivity shock, since it is part of both equations. Thus we have:

$$\left(\frac{\Delta Q_t}{Q_t} + \frac{\Delta P_t}{P_t}\right) - \alpha_{lt}\left(\frac{\Delta L_t}{L_t} + \frac{\Delta W_t}{W_t}\right) - (1-\alpha_{lt})\left(\frac{\Delta K_t}{K_t} + \frac{\Delta U_t}{U_t}\right) = \\ = \beta_t\left[\left(\frac{\Delta Q_t}{Q_t} + \frac{\Delta P_t}{P_t}\right) - \left(\frac{\Delta K_t}{K_t} + \frac{\Delta U_t}{U_t}\right)\right] \tag{4}$$

Using the relationship that $\beta_t = 1-(1/\mu_t)$, Eq. (4) can be written as:

$$\left(\frac{\Delta Q_t}{Q_t} + \frac{\Delta P_t}{P_t}\right) - \left(\frac{\Delta K_t}{K_t} + \frac{\Delta U_t}{U_t}\right) = \mu_t\left[\alpha_{lt}\left(\left(\frac{\Delta L_t}{L_t} + \frac{\Delta W_t}{W_t}\right) - \left(\frac{\Delta K_t}{K_t} + \frac{\Delta U_t}{U_t}\right)\right)\right] \tag{5}$$

Moreover, Eq. (5) can be presented in a simpler form by denoting the left-hand-side ΔY_t and the terms in the brackets on the right-hand-side ΔX_t as equation (6) presents.

$$\Delta Y_t = \mu_t \cdot \Delta X_t \tag{6}$$

where μ_t is the markup, ΔY_t = Δ ln (total value added)- Δ ln (capital expenses),
$\Delta X_t = \alpha_{lt}$ [Δ ln (labor expenses)- Δ ln (capital expenses)], α_{lt} = labor cost share in total value added = (labor expenses/total value added).
In other words, ΔY_t is the growth of total value added per unit of capital and ΔX_t is the growth rate of labor expenses per unit of capital weighted by the labor cost share in total value added.

In addition, an industry is considered in which firms face a demand function:

$$P_t = P_t(Q_t, z_t) \tag{7}$$

where P_t is the price of output, $Q_t = \sum_i q_{it}$ $(i = 1,...,n)$ where q_{it} represents the quantity supplied by firm i, n is the number of firms and z_t is a vector of exogenous factors affecting the demand curve. The first-order condition of the profit maximization problem of a firm *i* is the following:

$$\frac{\partial \pi_{it}}{\partial q_{it}} = P_t + \frac{\partial P_t}{\partial Q_t} \cdot \frac{\partial Q_t}{\partial q_{it}} q_{it} - \frac{\partial C_{it}}{\partial q_{it}} = 0 \tag{8}$$

Rearranging Eq. (8), the following expression is obtained:

$$\frac{P_t - MC_{it}}{P_t} = -\left(\frac{\partial P_t}{\partial Q_t} \cdot \frac{Q_t}{P_t} \right) \cdot \left(\frac{\partial Q_t}{\partial q_{it}} \cdot \frac{q_{it}}{Q_t} \right) = -\frac{\theta_{it}}{h_t} \tag{9}$$

where MC_{it} is the marginal cost of firm *i*, $h_t \equiv (\partial Q_t / \partial P_t) / (Q_t / P_t) < 0$ is the price elasticity of output demand and $\theta_{it} \equiv (\partial Q_t / \partial q_{it}) / (Q_t / q_{it})$ is the conjectural variation elasticity of firm *i*, which is defined as the proportional change in the industry output to a unit change in the output of firm *i* and it is a measure of competition. The left-hand side of equation (9) equals Lerner index, $\beta_{it} = (P_t - MC_{it}) / P_t$, which is the relative markup or the price-cost margin. When equation (9) is aggregated over all the firms in the industry in terms of the Lerner index and the conjectural variation elasticity, both at the industry level, equation (10) results:

$$\beta_t = -\frac{f_t}{h_t} \tag{10}$$

where β_t is the industry-level weighted average Lerner index and f_t is the industry-level weighted average conjectural variation elasticity.[4] Therefore, using the relationship between the Lerner index (β_t), the markup (μ_t) and the industry-level weighted average conjectural variation elasticity (f_t), which is $\beta_t = 1 - (1/\mu_t) = -f_t / h_t$, Eq. (6) can be written as:

$$\Delta Y_t = \left[h_t / (h_t + f_t) \right] \cdot \Delta X_t \tag{11}$$

where h_t is the price elasticity of output demand and f_t is the industry-level weighted average conjectural variation elasticity. According to Cowling and Waterson (1976), the industry-level weighted average conjectural variation elasticity (f_t), which provides the average degree of competition, with $0 \le f_t \le 1$, 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. Note that $f_t = 0$ corresponds to perfect competition and $f_t = 1$ to a monopolistic market, whereas $0 < f_t < 1$ corresponds to the Cournot oligopoly. The separate estimation of the f_t and h_t parameters is of great interest since a change in the Lerner index (β_t) and in turn in markup (μ_t) might be attributed to the change in the elasticity of output demand (h_t) rather than to the industry-level weighted average conjectural variation elasticity (f_t). The extended Hall-Roeger approach developed in this paper consists of the simultaneous estimation of the demand equation (7) and the modified Hall-Roeger equation (11) via a nonlinear three-stage least squares estimation technique allowing the separate estimation of the f_t and h_t parameters and thus identifying directly the degree of market power (f_t).

[4] Note that the weights being the market shares of the firms in the industry

In order to estimate the welfare losses, the Dickson and Yu methodology (Dickson and Yu, 1989) is used. The industry demand curve is represented by $Q_t = 1/P_t^{|h_t|}$, where $|h_t|$ is the absolute value of the output demand elasticity, h_t. In addition, the weighted industry marginal cost curve $\left(\overline{MC_t}\right)$ is presented by $Q_t = \overline{MC}_t^{\varepsilon}$, where ε is the inverse of the weighted industry marginal cost elasticity. Based on the Lerner index, $\beta_t = \left(P_t - \overline{MC_t}\right)/P_t = f_t/|h_t|$, the oligopoly price (P_o) and the oligopoly output (Q_o) are given as:

$$P_o = \left(\frac{|h_t|}{|h_t| - f_t}\right) Q_o^{1/\varepsilon} \tag{12}$$

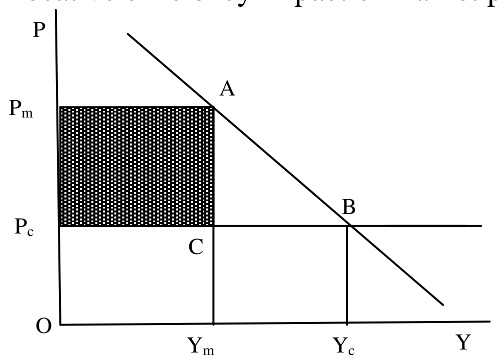
$$Q_o = 1/P_o^{|h_t|} = \left(\frac{|h_t| - f_t}{|h_t|}\right)^{\frac{|h_t|\varepsilon}{|h_t|+\varepsilon}} \tag{13}$$

Note that f_t and h_t parameters correspond to the industry-level weighted average conjectural variation elasticity and the price elasticity of output demand respectively and are obtained from the aforementioned analysis.

The net loss of welfare, i.e. the deadweight loss or Harberger loss, due to the existence of an oligopoly is represented by the triangle ABC in Figure 1 and is described as follows:

$$WL^H = \int_{Q_o}^{1} \left[\left(1/Q_t\right)^{1/|h_t|} - Q_t^{1/\varepsilon} \right] dQ_t \tag{14}$$

Figure 1
Allocative efficiency impact of market power



The total welfare loss in the case of an oligopoly, i.e. the Tullock loss, is represented by the area $P_m ABP_c$ in Figure 1 and is described as follows:

$$WL^T = WL^H + \left[\left(1/Q_o\right)^{1/|h_t|} - Q_o^{1/\varepsilon} \right] Q_o \tag{15}$$

3. Extended Hall-Roeger Model Formulation and Data Variables

Based on the theoretical model developed in the previous section, the system of equations (7) and (11) is estimated so that the competitive conditions in the Greek food and beverages manufacturing industry can be investigated. In particular, a modified version of equation (11) and the demand equation are estimated simultaneously in order to provide the extent of market power and markup for the whole industry over the period 1984-2007. The modified version of equation (11) is given as:

$$\Delta Y_t = \left[h / \left(h + f \right) \right] \cdot \Delta X_t \qquad (16)$$

where h is the price elasticity of output demand and f is the industry-level weighted average conjectural variation elasticity corresponding to the whole industry over the period 1984-2007. The demand function is specified as:

$$\ln Y_t = a + h \ln \left(\frac{P_t}{b_t} \times 100 \right) + \sum_{s=151}^{159} z_s \left(DS_s \times \ln \left(\frac{I_t}{b_t \times POP_t} \times 100 \right) \right) \qquad (17)$$

where h represents the price elasticity of output demand, P_t is the output price, I_t is the gross national product, b_t is a price deflator and POP_t is the population of Greece. DS_s $(s = 151,...,159)$ is a dummy variable, which is set to one for the s sector and zero otherwise and z_s $(s = 151,...,159)$ refers to the income demand elasticity of the s sector (Table 1). The aforementioned variables, i.e. I_t, b_t, POP_t, P_t, are discussed analytically in Appendix A. It is expected that the income, i.e. I_t, has a positive effect on the demand whereas the price, i.e. P_t, has a negative effect on the demand.

The aforementioned system of equations, i.e. Eq. (16) and (17), is estimated by the nonlinear three-stage least squares estimation technique because the coefficient of the demand elasticity is common in both equations. The bootstrap was applied in order to assign measures of accuracy to the statistical estimates. Resampling was carried out for B=1000, i.e. 1000 pseudo-samples were used. Also, the sample comprises annual data for the period 1984–2007 for 9 three-digit SIC levels 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 9 sectors of the Greek food and beverages manufacturing industry are presented in Table 1.

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

An analytical description of the variable sources is presented in Appendix A. In addition, descriptive statistics of the variables used in the estimation are reported in Table 2.

Table 2
Description of variables

Description of Variables	Symbol	Mean	Standard Deviation	Minimum	Maximum
Producer price index (1995=100)	P	89.13	42.45	15.00	175.63

Output (Thousand €)	Q	189600.00	157070.00	14024.00	638350.00
Man-hours worked (Thousand hours)	L	12762.00	8691.80	1716.40	35030.000
Wage (€/hour)	W	4.95	3.32	0.53	15.26
Gross capital stock (Thousand €)	K	327120.00	275420.00	45623.00	1255200.00
User cost of capital	U	0.0769	0.0472	0.0001	0.1764
Gross national product (Billion €/year)	I	97312.00	65094.00	12400.00	221670.00

4. Empirical results

The empirical results are presented in Table 3. The findings are plausible and consistent with economic theory in terms of the signs and the magnitudes of the coefficients. In addition, the bootstrap average estimates of all the estimates are close to the original estimates (Table 3).[5]

Table 3

Empirical results of the extended Hall-Roeger model in the Greek food and beverages manufacturing industry over the period 1984-2007

Estimated System: Equations (16) and (17)			
Parameter	Estimate	Bootstrap average estimate	Bootstrap confidence intervals [a]
a	6.8320** (2.351)	6.7770	CI-90%: [6.072,12.104]
h	-0.4022** (-1.844)	-0.4067	CI-95%:[-0.897, -0.156]
z_{151}	0.3481** (2.270)	0.3511	CI-95%:[0.025, 0.606]
z_{152}	0.3025** (1.985)	0.3056	CI-90%:[0.036, 0.512]
z_{153}	0.3735** (2.436)	0.3766	CI-95%:[0.050, 0.628]
z_{154}	0.3403** (2.223)	0.3432	CI-95%:[0.018, 0.587]
z_{155}	0.3865** (2.534)	0.3895	CI-95%:[0.074, 0.634]
z_{156}	0.3542** (2.327)	0.3573	CI-95%:[0.043, 0.616]
z_{157}	0.3250** (2.133)	0.3278	CI-95%:[0.009, 0.575]
z_{158}	0.3983*** (2.609)	0.4013	CI-95%:[0.079, 0.139]
z_{159}	0.4114*** (2.693)	0.4144	CI-95%:[0.089, 0.658]
f	0.2370** (1.903)	0.2396	CI-95%:[0.058, 0.435]
Markup (μ)[b]			
μ	2.4349***	2.4338	CI-99%:[2.363, 2.505]

Notes: Values in parentheses are t-statistics.
[a] CI-99% indicates 99% confidence interval, CI-95% indicates 95% confidence interval, CI-90% indicates 90% confidence interval. The numbers in brackets indicate the lower and the upper bounds of the confidence interval.
[b] The markup (μ) for the whole Greek manufacturing industry for the whole time period is equal to $\mu = h/(h+f)$ and obtained by applying the Wald test, which follows the chi-squared (χ^2) distribution with one degree of freedom.

[5] The original estimates rather than the bias-corrected estimators are used because the bias of each estimate is small compared with the estimated bootstrap standard error (Efron and Tibshirani, 1993).

According to the empirical results, the price elasticity of output demand is -0.4022 $(h = -0.4022)$ and is statistically significant at the 5% level of significance, which is supported by the bootstrap confidence interval. Moreover, the findings show that all the income demand elasticities $(z_s$ for $s = 151,...,159)$ are statistically significant, which is verified by the bootstrap application, and are within the range 0.3025-0.4114 with the manufacture of beverages (SIC 159) presenting the highest income demand elasticity $(z_{159} = 0.4114)$. Furthermore, the estimated f coefficient $(f = 0.2370)$ is statistically significant at the 5% level of significance, which is supported by the bootstrap confidence interval. In addition, the Wald statistic (F-statistic) for testing the hypothesis $\mu = 0$ indicates that the μ parameter equals to 2.4349 $(\mu = 2.4349)$ and is statistically significant at any conventional level of significance, which is also verified by the bootstrap application.[6] The aforementioned results reveal that the whole Greek food and beverages manufacturing industry operates under conditions of imperfect competition, i.e. presents some degree of market power, over the period 1984–2007. Note that during the period 1984-2007 there were several events which led the whole Greek food and beverages manufacturing industry operating in non-competitive conditions. Firstly, there were a number of acquisitions and joint ventures made by Europe's leading firms during the period 1989-1991 in the Greek food and beverages manufacturing industry. For instance, in the brewing industry, Grand Metropolitan acquired Metaxa and the French food BSN acquired Henninger Hellas in 1989. Also, Swiss Confectionery Giants Nestle and Jacobs Suchard acquired three of the leading Greek confectioners (Loumidis, Ion, Pavlidis) in 1990 and the Italian food company Barilla purchased the Greek pasta producer, Misko, in 1991. Secondly, a wave of mergers and acquisitions took place in the industry during the period 1998–1999, and thirdly, there was the launch of the euro in 2000, which led some firms to exit the market since they could not operate in the European Monetary Union. Finally, relative to the whole Greek food and beverages manufacturing industry, the Harberger loss is about €3.88 million in terms of 2007 value added (or 0.11% of the 2007 value added) whereas the Tullock loss is about €34.18 million in terms of the 2007 value added (or 0.97% of the 2007 value added) (Table 4).

Table 4

Estimated Harberger and Tullock losses in the Greek food and beverages manufacturing industry over the period 1984-2007

Extended Hall-Roeger model	
Value added[a]	41762.44
2007 Value added[a]	3523.14
Harberger loss[b] (WL^H)	0.11
Tullock loss[b] (WL^T)	0.97
Harberger loss[c]	3.88
Tullock loss[c]	34.18

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

[6] Wald test follows the chi-squared (χ^2) distribution with one degree of freedom for testing the null hypothesis ($\mu=0$). The result is 2.4349 (0.000), where the value in bracket is p-value.

5. Conclusions

This paper extends the Hall–Roeger methodology in order to investigate the market structure and to measure the degree of market power in the Greek food and beverages manufacturing industry over the period 1984–2007 at the three-digit SIC level. In particular, the present study, applying the bootstrap procedure, assesses the degree of market power and the markup of the whole Greek food and beverages manufacturing industry over the period 1984–2007 and estimates the welfare losses.

The empirical results reveal that the degree of market power is about 0.24 and the markup is about 2.44, implying the presence of non-competitive conditions for the whole Greek food and beverages manufacturing industry over the period 1984–2007, which is testified by the bootstrap application. The number of acquisitions and joint ventures during the period 1989-1991, the wave of mergers and acquisitions during the period 1998–1999 as well as the launch of the euro in 2000 verify that the whole Greek food and beverages manufacturing industry can operate in non-competitive conditions during the period 1984–2007. Moreover, the findings indicate that there are welfare losses and more specifically, the net welfare loss is 0.11% and the total welfare loss is 0.97%.

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Appendix A
Data Set

The bulk of the data used in this study has been mainly obtained from the Annual National Industrial Survey (AIS) of the Hellenic Statistical Authority (EL.STAT.) and the Organization for Economic Co-operation and Development (OECD). In particular, the variables used are as follows:

Q is the value added at 1995 constant prices and is created by dividing the value added in current prices, as reported in AIS, by the producer price index (P) in manufacturing (1995=100), as reported in the AIS.

P is the producer price index in manufacturing (1995=100), as reported in the AIS.

b is the consumer price index (1995=100), as reported in the AIS.

I is the Gross National Product at 1995 constant prices and is obtained by dividing the Gross National Product in current prices, as reported in the Economic and Financial Affairs of the European Commission, by the Gross Domestic Product deflator, as referred in the AIS.

POP is the population of Greece, as reported in the AIS.

L is man-hours and is obtained by multiplying the annual number of employees, as reported in AIS, with the number of working hours per year, as referred to in the OECD.

W is the wage rate per man-hour and is obtained by dividing the remuneration of the employed (Source: AIS) by the total man-hours (*L*).

K is the gross capital stock. A perpetual inventory method is employed to estimate the level of gross capital stock at 1995 constant prices for each investment asset, i.e. buildings and installations, transport means as well as machinery and furniture. The data required for the implementation of this method, for each investment asset, are the following: the gross asset formation at 1995 constant prices which is obtained from AIS, a capital benchmark (the gross capital stock for the year 1981) as reported in the AIS and a rate of depreciation for each investment asset. Depreciation rates of 5% for machinery and furniture, 3% for buildings and installations and 9% for transport means have been assumed.

U is the user cost of capital and is defined as $u_t = n_{t-1} * r_t + n_t * \mu_t + (n_t - n_{t-1})$, where n_t is the price of new capital and calculated as suggested by Zanias (1991), r_t is the rate of return on capital obtained from the Bank of Greece (http://www.mof-glk.gr/dhmosio_xreos/epitokia.htm) and μ_t is the average rate of depreciation calculated as a weighted average of 5% for machinery and furniture, 3% for buildings and installations and 9% for transport means.