Investigating market structure of the Greek food and beverages manufacturing industry: A Hall-Roeger approach

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Abstract

This paper investigates the market structure of the Greek food and beverages manufacturing industry over the period 1984–2007 at the three-digit SIC level. Based on the Hall-Roeger approach (1995), three models are used to investigate the competitive conditions in the industry. The first model (Hall-Roeger model) assesses the markup in the whole industry over the period 1984–2007. The second model (Hall-Roeger cross-sectional model) tests the extent of the markup for each of the nine sectors of the industry over the period 1984–2007, whereas the third (Hall-Roeger time-series model) estimates the markup for the whole industry for certain sub-periods of the period 1984–2007. The present paper also investigates factors affecting the markup in the Greek food and beverages manufacturing industry during the period 1984–2007. The empirical results indicate that the whole Greek food and beverages manufacturing industry, as well as each sector of the industry, operates in non-competitive conditions during the period 1984–2007. Furthermore, the industry operates in non-competitive conditions for certain sub-periods of the period 1984–2007. The findings also support the view that the sector size, capital intensity and the number of establishments influence the markup in Greek food and beverages manufacturing during the period 1984–2007.

Keywords: *Hall-Roeger, Food and beverages manufacturing industry, Markup*
JEL Classification: *D43, L00, L66*

Introduction

An industry, under conditions of perfect competition, equates its marginal cost to the market price of its product. The equality of marginal cost and price is a basic condition for the efficient allocation of resources. In contrast, under a monopoly or oligopoly, the allocation of resources is inefficient as price overwhelms marginal cost. This paper applies a test for market power, originally proposed by Hall (1988) and subsequently modified by Roeger (1995), to the Greek food and beverages manufacturing industry, since that industry plays a very important role in the Greek manufacturing industry and generally in the Greek economy.[3]

There is a growing literature of studies which applies the Hall-Roeger approach to investigate competitive conditions in manufacturing industries around the world. Such

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[3] 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.

studies are those 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.[4] There is, however, lack of recent research which evaluates the market structure of the Greek manufacturing industry and more specifically the Greek food and beverages manufacturing industry. The only studies which investigate competitive conditions in the Greek manufacturing industry as well as in the Greek food industry are those undertaken by Bourlakis (1986, 1992b, 1992c, 1997).

Also of great importance is the identification of factors that affect the level of markup, i.e. the price–cost margin. More recently, Connor and Peterson (1992) specified the determinants of markup for various US manufactured food products; Bhuyan and Lopez (1998) indirectly estimated the determinants of markup, since they identified factors which are mainly responsible for determining the magnitude of welfare losses in the US food and tobacco industries; Oustapassidis, Vlachvei and Notta (2000) indirectly studied the determinants of markup, since they examined the market power versus efficiency hypothesis in the Greek food manufacturing industry and Borg (2009) explored factors that are likely to influence the markup ratio in various Maltese sectors.

In this paper, the Hall-Roeger approach is applied in order to empirically investigate the market structure of the Greek food and beverages manufacturing industry. In particular, three different models are used. The first model (Hall-Roeger model) assesses the markup in the whole Greek food and beverages manufacturing industry over the period 1984─2007. The second model (Hall-Roeger cross-sectional model) tests the extent of markup for each one of the nine sectors of the industry over the period 1984─2007, and the third one (Hall-Roeger time-series model) estimates the markup for the whole food and beverages manufacturing industry for certain sub-periods of the period 1984─2007.

The remainder of the paper is organized as follows: Section 2 outlines the Hall-Roeger methodology used to measure the markup in the Greek food and beverages manufacturing industry and Section 3 presents its formulation and the data variables; Section 4 provides and discusses the formulation of the model which investigates factors affecting the markup in the Greek food and beverages manufacturing industry; Section 5 presents the empirical results obtained, while Section 6 offers a conclusion.

Hall-Roeger Methodology

[4] OECD is derived from the “Organization for Economic Co-operation and Development”.

The approach used in this paper in order to investigate the market structure of the Greek food and beverages manufacturing industry is based on a method developed by Roeger (1995), which is an extension of the work of Hall (1988). Hall applied a test for market power in 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) Solow residual (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. Following this approach, the markup is estimated in order to investigate the market structure of the Greek food and beverages manufacturing industry.

Assuming 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 an index of the total factor productivity. Hall (1988) showed that the primal Solow Residual (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 while p_t is the price of output. The market power of the industry at time t is given by the β_t coefficient, which 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 of price over marginal cost, $\mu_t = p_t / mc_t$.[5] 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 the dual Solow residual (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:

[5] Note that when Lerner index is equal to zero, i.e. $\beta_t = 0$, the industry is under perfectly competitive conditions, whereas a positive value of Lerner index, i.e. $\beta_t > 0$ indicates a non-competitive industry.

$$\left(\frac{\Delta q_t}{q_t}+\frac{\Delta p_t}{p_t}\right)-\alpha_{lt}\left(\frac{\Delta l_t}{l_t}+\frac{\Delta w_t}{w_t}\right)-\left(1-\alpha_{lt}\right)\left(\frac{\Delta k_t}{k_t}+\frac{\Delta u_t}{u_t}\right)= \\ =\beta_t\left[\left(\frac{\Delta q_t}{q_t}+\frac{\Delta p_t}{p_t}\right)-\left(\frac{\Delta k_t}{k_t}+\frac{\Delta u_t}{u_t}\right)\right] \qquad (4)$$

The investigation of market power in the Greek food and beverages manufacturing industry is based on Eq. (4), which does not include any productivity shock variables.

Hall-Roeger Model Formulation and Data Variables

In order to allow direct estimation of the markup, we use the relationship between the Lerner index and the markup which is $\beta_t = 1-\left(1/\mu_t\right)$ and we rewrite the Eq. (4). Thus, Eq. (4) is written as:

$$\left(\frac{\Delta q_t}{q_t}+\frac{\Delta p_t}{p_t}\right)-\left(\frac{\Delta k_t}{k_t}+\frac{\Delta u_t}{u_t}\right)=\mu_t\left[\alpha_{lt}\left(\left(\frac{\Delta l_t}{l_t}+\frac{\Delta w_t}{w_t}\right)-\left(\frac{\Delta k_t}{k_t}+\frac{\Delta u_t}{u_t}\right)\right)\right] \qquad (5)$$

Based on Eq. (5) the data required to estimate the markup are the value of output, the value of capital and the wage bill. Eq. (5) can be presented in a more simple form by denoting the left-hand-side ΔY_t and the terms in the brackets on the right-hand-side ΔX_t. Thus, the first estimated model (Hall-Roeger model) from which the markup, μ, is inferred, is given by the following regression:

$$\Delta Y_t = \mu \cdot \Delta X_t \qquad (6)$$

where the variables used to estimate the model are defined as follows:

ΔY_t = Δ ln (total value added)- Δ ln (capital expenses)

ΔX_t = α_{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 in 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 of total value added. In addition, a value of μ equal to one indicates that the industry behave competitively because there are no markups. A value of μ greater than one indicates that the industry exercises some degree of market power, i.e. the prices are above marginal costs, because markups are positive.

A second model (Hall-Roeger cross-sectional model) is estimated to obtain separate estimates of μ among the sectors during the period under consideration, i.e. 1984–2007. In particular, the Eq. (6) is modified as follows:

$$\Delta Y_t = \sum_{s=151}^{159} \mu_s\left(DS_s \times \Delta X_t\right) \qquad (7)$$

where DS_s $\left(s=151,...,159\right)$ is a dummy variable, which is set to one for the s sector and zero otherwise and μ_s $\left(s=151,...,159\right)$ is the markup corresponding to the s sector (Table 1).[6]

[6] Sectors 30 and 37 are omitted due to lack of available data over the period 1984–2007.

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

A third model (Hall-Roeger time-series model) is estimated to evaluate competitive conditions for the whole industry for certain sub-periods of the period 1984‒2007.[7] In particular, Eq. (6) is specified as follows:

$$\Delta Y_t = \sum_{t=1}^{8} \mu_t \left(DT_t \times \Delta X_t \right) \tag{8}$$

where μ_t $(t = 1,...,8)$ is the markup corresponding to the sub-period t and DT_t $(t = 1,...,8)$ is a dummy variable, which is set to one for the sub-period t and zero otherwise. It is noted that the sub-period $t = 1$ corresponds to the years 1984‒1986, $t = 2$ to 1987‒1989, $t = 3$ to 1990‒1992, $t = 4$ to 1993‒1995, $t = 5$ to 1996‒1998, $t = 6$ to 1999‒2001, $t = 7$ to 2002‒2004 and $t = 8$ to 2005‒2007.

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

The three different models given by Equations (6), (7) and (8) are estimated by using a sample of panel data. The sample comprised annual data for the period 1984‒2007 for 9 three-digit SIC Greek food and beverages manufacturing sectors for

[7] Note that initially the model was developed to allow different markup estimates for the whole Greek food and beverages manufacturing industry for each year of the period under consideration but no results were obtained due to the limited data set so the model was developed to allow markup estimates for the whole Greek food and beverages manufacturing industry for eight sub-periods of the period 1984-2007.

large-scale industry (employing more than ten persons per establishment), i.e. SIC: 151-159, based on the Statistical Nomenclature of Economic Activity of 2003 (STAKOD_2003).[8] Table 1 presents the nine sectors of the Greek food and beverages manufacturing industry. Table 2 presents a summarized description of the variables used.

Markup Model Formulation

The present paper also identifies factors that are likely to have affected the markup in the Greek food and beverages manufacturing industry during the period 1984–2007. One factor is the number of firms. The higher the number of firms, the more difficult the agreement among firms to increase price above marginal cost since the firms may have different costs or demand curves (Cabral, 2002). As a result, a negative relationship between the number of firms and the level of the industry's markup can be expected. Another factor that may influence the level of markup is the degree of capital intensity, defined as the ratio of gross capital stock to sales of each sector of the industry for each year of the period 1984–2007. In particular, the more capital intensive an industry, the higher the capital cost share, the higher the markup since more money is spent on research, development, innovation and advertising. The sector size is an additional factor that may affect the level of markup and is defined as the ratio of each sector's sales for each year of the period 1984–2007 to the total sales of all sectors for the whole period, i.e. 1984–2007. An increase in sales is expected to increase the markup. This is because an increase in sales, which is possible due to a rise in consumer demand, can lead entrepreneurs to increase price above marginal cost.

The markup model investigates factors affecting the markup in the Greek food and beverages manufacturing industry over the period 1984–2007 and uses the markup estimates $\left(\mu_s, \text{ s} = 151,...,159\right)$ obtained by the Hall-Roeger cross-sectional model (Eq. 7). The markup model is formulated as follows:

$$\ln \mu_{st} = \alpha_0 + \alpha_1 \ln ci_{st} + \alpha_2 \ln z_{st} + \alpha_3 \ln n_{st} + \alpha_4 t + u_{st} \tag{9}$$

where $\ln$ is the natural log operator, t is a time subscript, μ_{st} $\left(s = 151,...,159\right)$ is the estimated markup of sector s as obtained by the Hall-Roeger cross-sectional model (Eq. 7) for the period 1984–2007, ci_{st} $\left(s = 151,...,159\right)$ refers to capital intensity which is the ratio of gross capital stock to sales in each sector of the industry for each year of the period 1984–2007, z_{st} $\left(s = 151,...,159\right)$ corresponds to each sector's size and is the ratio of each sector's sales for each year of the period 1984–2007 to the total sales of all sectors for the whole period, i.e. 1984–2007, n_{st} $\left(s = 151,...,159\right)$ is the number of establishments corresponding to each sector for each year of the period under consideration, i.e. 1984–2007, t is a time variable and u_{st} $\left(s = 151,...,159\right)$ refers to random disturbances.[9] It is expected that $\alpha_1 > 0$, $\alpha_2 > 0$ and $\alpha_3 < 0$. Moreover, the variables required to identify factors that are likely to affect markup are sourced from the "Annual National Industrial Survey" (AIS) of the Hellenic Statistical Authority (EL.STAT.).

[8] SIC is derived from the "Standard Industrial Classification".
[9] Note that the number of establishments is used as a proxy for the firms' number.

Empirical Results

Hall-Roeger Approach

Three models are estimated in order to investigate the market structure of the Greek food and beverages manufacturing industry during the period 1984─2007. The first estimated model (Hall-Roeger model) corresponds to equation (6) and analyzes competitive conditions for the Greek food and beverages manufacturing industry over the period 1984─2007. The second estimated model (Hall-Roeger cross-sectional model) refers to equation (7) and investigates competitive conditions for each sector of the Greek food and beverages manufacturing industry over the period under consideration, i.e. 1984─2007. The third estimated model (Hall-Roeger time-series model) corresponds to equation (8) and analyzes competitive conditions for the whole Greek food and beverages manufacturing industry for certain sub-periods of the period 1984─2007. The aforementioned estimated models, i.e. Eq. (6), (7) and (8), are estimated using a panel data set since the data are both cross-sectional and time series. The econometric analysis is conducted using the Stata 10.0 software.

Table 3. Test results on the three models of the Hall-Roeger approach for the Greek food and beverages manufacturing industry over the period 1984─2007

Tests	**Hall-Roeger approach:**		
	Hall-Roeger model, Eq. (6)	**Hall-Roeger cross-sectional model, Eq. (7)**	**Hall-Roeger time-series model, Eq. (8)**
Hausman test [a]	0.00 [0.9734]	0.96 [0.9995]	0.07 [1.000]
Breusch and Pagan test (LM test) [b]	3.23 [0.0723]	1.58 [0.2087]	3.65 [0.0562]
Likelihood-ratio test [c]	108.23 [0.000]	105.25 [0.0000]	105.41 [0.000]
Wooldridge test [d]	6.545 [0.0337]	0.039 [0.8493]	3.077 [0.1175]

Notes: The values in brackets are p-values.
[a] *Hausman test: H_o= Random Effect Model (REM) against Fixed Effect Model (FEM).*
[b] *The null hypothesis of Breusch and Pagan test (LM test) is H_o: Cross-sectional independence.*
[c] *Likelihood-ratio test (LR test): H_o=Homoscedasticity.*
[d] *Wooldridge test: H_o= No first-order autocorrelation.*

The first model, i.e. the Hall-Roeger model presented in Eq. (6), is estimated using the fixed and the random effects estimation approaches. The fixed effects estimation approach is conducted using the least squares dummy variable (LSDV) estimation technique which, in fact, is ordinary least squares (OLS) regressions with dummy variables. The random effects estimation approach is conducted by generalized least squares (GLS). Furthermore, the Hausman statistic, which tests the null hypothesis that the individual effects are uncorrelated with the explanatory variables, i.e. tests the random effects model (REM) against the fixed effects model (FEM), supports the REM (Table 3, Hall-Roeger model, Eq. (6)). Then, the Hall-Roeger model (6) is estimated using the random effects approach and the Lagrange Multiplier (LM) test which supports the presence of cross-sectional independence in the panel data at the 5% level of significance (Table 3, Hall-Roeger model, Eq. (6)). Also, the likelihood-ratio test (LR test), which is performed upon heteroscedasticity in the panel data, indicates the presence of heteroscedasticity at any conventional level of significance and the Wooldridge test, which checks for autocorrelation, supports the presence of autocorrelation in the panel data at the 5% level of significance (Table 3, Hall-Roeger model, Eq. (6)). Thus, this model is re-estimated with the feasible generalized least squares (FGLS) procedure so as to take into consideration the presence of heteroscedasticity and autocorrelation in the panel data.

Table 4. Empirical results of the three models of the Hall-Roeger approach for the Greek food and beverages manufacturing industry over the period 1984–2007

Ind. Var.	**Coef.**	**Hall-Roeger approach:**		
		Hall-Roeger model, Eq. (6)	**Hall-Roeger cross-sectional model, Eq. (7)**	**Hall-Roeger time-series model, Eq. (8)**
ΔX_t	μ	2.385^{***} (0.013)	–	–
$DS_{151} \times \Delta X_t$	μ_{151}	–	2.126^{***} (0.031)	–
$DS_{152} \times \Delta X_t$	μ_{152}	–	2.400^{***} (0.035)	–
$DS_{153} \times \Delta X_t$	μ_{153}	–	2.399^{***} (0.033)	–
$DS_{154} \times \Delta X_t$	μ_{154}	–	2.354^{***} (0.085)	–
$DS_{155} \times \Delta X_t$	μ_{155}	–	2.434^{***} (0.053)	–
$DS_{156} \times \Delta X_t$	μ_{156}	–	2.619^{***} (0.053)	–
$DS_{157} \times \Delta X_t$	μ_{157}	–	2.442^{***} (0.037)	–
$DS_{158} \times \Delta X_t$	μ_{158}	–	2.233^{***} (0.018)	–
$DS_{159} \times \Delta X_t$	μ_{159}	–	3.199^{***} (0.050)	–
$DT_1 \times \Delta X_t$	μ_1	–	–	2.399^{***} (0.022)
$DT_2 \times \Delta X_t$	μ_2	–	–	2.443^{***} (0.015)
$DT_3 \times \Delta X_t$	μ_3	–	–	2.349^{***} (0.213)
$DT_4 \times \Delta X_t$	μ_4	–	–	3.054^{***} (0.182)
$DT_5 \times \Delta X_t$	μ_5	–	–	2.144^{***} (0.690)
$DT_6 \times \Delta X_t$	μ_6	–	–	1.796^{***} (0.235)
$DT_7 \times \Delta X_t$	μ_7	–	–	2.211^{***} (0.360)
$DT_8 \times \Delta X_t$	μ_8	–	–	2.346^{***} (0.081)
No.of observations		216	216	216
Model test [a]		32727.76 [0.000]	56632.92 [0.000]	30237.02 [0.000]

Notes: The values in parentheses are standard errors, while those in brackets are p-values.
[a] F-test is used to test the joint significance of all regressors.
*** indicates 1% significance levels.

The empirical results of the estimation of the Hall-Roeger model are shown in Table 4 (Hall-Roeger model, Eq. (6)). According to the empirical results, the estimated μ coefficient $(\mu = 2.385)$ is statistically significant at any conventional level of significance and the model test, i.e. F-test, supports the statistical significance of the μ coefficient (Table 4, Hall-Roeger model, Eq. (6)). In addition, the Wald statistic (F-statistic) for testing the hypothesis $\mu = 1$ indicates that the null hypothesis can be rejected at any conventional level of significance implying the presence of non-competitive conditions for the Greek food and beverages manufacturing industry over the period 1984–2007. [10] Note that regarding to the empirical findings of the study by Rezitis and Kalantzi (2011), each sector of the Greek manufacturing industry operates under non-competitive conditions during the period 1984–2007 since the estimated markup coefficients are within the range (1.4526–3.4981). In particular, the estimated markup coefficient of the food and beverages industry is 2.6038, which is close to the estimated markup coefficient of the present paper, i.e. μ=2.385. Moreover, there is a variety of studies which investigates competitive conditions in the food and beverages sector around the world and implies the presence of non-competitive conditions. Such studies are those by Azzam and Pagoulatos (1990) and Azzam (1997) for the US beef-packing industry; Wannand Sexton (1992) for the California pear industry; Buyan and Lopez (1997) for the US food and tobacco industries; Milan (1999) for the Spanish food, drink and tobacco industries; Nevo (2001) for the Ready-to-Eat Cereal Industry; Hatirli, Ozkan, Jones and Aktas (2006) for the milk sub-sector in Turkey; Parsons (2007) for the Japanese beer industry; Martins, Scarpetta and Pilat (1996) for the manufacturing industries of 14 OECD countries; and Lopez, Azzam and Liron-Espana (2002) for the US food processing industry. Unfortunately, there is lack of studies estimating the markup level of the Greek food and beverages manufacturing industry. The only study which investigates the market structure of the Greek manufacturing industry at the two-digit and three-digit SIC level is that by Bourlakis (1997) in which the results indicate the persistence of market power during the period 1958-1984 and a positive association between past and current price-cost margins.

With regard to the second model, i.e. the Hall-Roeger cross-sectional model described by Eq. (7), the Hausman statistic supports the random effects approach as opposed to the fixed effects approach at any conventional level of significance (Table 3, Hall-Roeger cross-sectional model, Eq. (7)). Then, the Hall-Roeger cross-sectional model is estimated using the random effects approach and the LM statistic suggests that the null hypothesis of independence can not be rejected at any conventional level of significance (Table 3, Hall-Roeger model, Eq. (6)). Moreover, the LR test indicates the presence of heteroscedasticity and the Wooldridge test supports the absence of autocorrelation in the panel data (Table 3, Hall-Roeger cross-sectional model, Eq. (7)). The Hall-Roeger cross-sectional model is re-estimated with the FGLS procedure so as to take into consideration the presence of heteroscedasticity in the panel data.

Table 4 presents estimation results of the Hall-Roeger cross-sectional model (Hall-Roeger cross-sectional model, Eq. (7). According to the empirical findings, all the estimated $\mu_s\ (s = 151,...,159)$ coefficients are statistically significant at any conventional level of significance and their values are within the range (2.126-3.199). Moreover, the model test, i.e. F-test, supports the joint significance of all regressors (Table 4, Hall-Roeger cross-sectional model, Eq. (7)). In addition, the Wald statistic (F-statistic) for testing the hypothesis $\mu_s = 1\ (s = 151,...,159)$ indicates that the null hypothesis can be

[10] Wald statistics (F-statistics) are available from the authors upon request.

rejected at any conventional level of significance. These findings suggest that each sector of the Greek food and beverages manufacturing industry operates under non-competitive conditions during the period 1984‒2007.

Figure 1 depicts the markup in each sector of the Greek food and beverages manufacturing industry over the period 1984‒2007. According to Figure 1, the manufacture of beverages (SIC 159) ranks at the top with the highest markup $(\mu_{159} = 3.199)$ while the production, processing and preserving of meat and meat products (SIC 151) shows the lowest markup $(\mu_{151} = 2.126)$. Note that the markup estimates of all the sectors of the food manufacturing industry, i.e. $\mu_s\,(s = 151,...,158)$, do not present high variations and remain at relatively high levels, with the manufacture of grain milk products, starches and starch products (SIC 156) and the manufacture of prepared animal feeds (SIC 157) having the relatively highest markups ($\mu_{156} = 2.619$ and $\mu_{157} = 2.442$ respectively), while the production, processing and preserving of meat and meat products (SIC 151), the manufacture of other food products (SIC 158) and the manufacture of vegetable and animal oils and fats (SIC 154) have the relatively lowest markups ($\mu_{151} = 2.126$, $\mu_{158} = 2.233$ and $\mu_{154} = 2.354$ respectively). One of the main reasons that these sectors of the Greek food and beverages manufacturing industry appear to have high markups could be that most of them consist of a few large-scale firms with high market share, while the rest of the firms are small, inefficient and non-competitive.

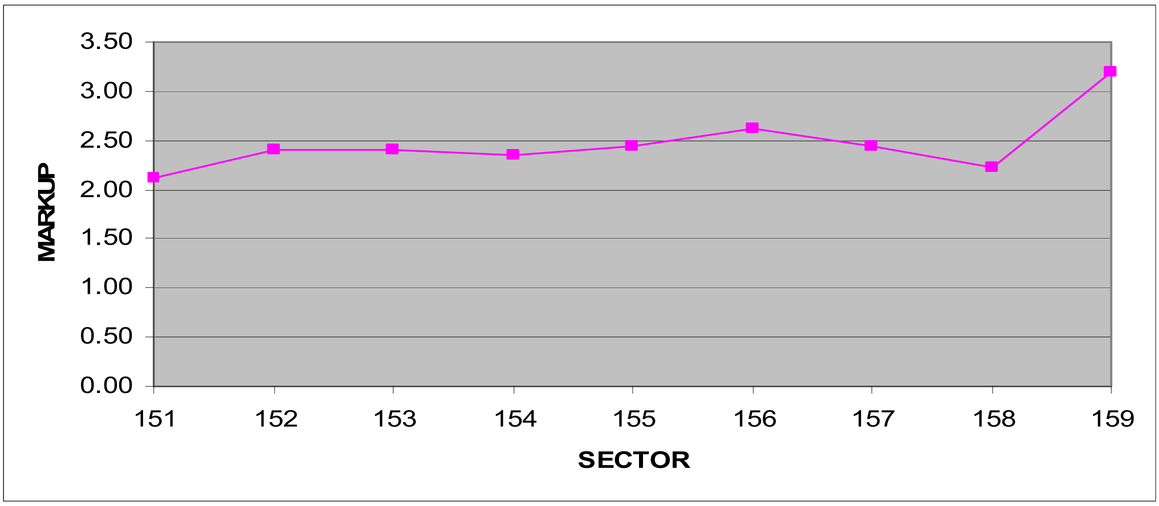

Figure 1. Markup for each sector of the Greek food and beverages manufacturing industry over the period 1984‒2007

With respect to the third model, i.e. Hall-Roeger time-series model presented in Eq. (8), the Hausman statistic supports the random effects approach at any conventional level of significance (Table 3, Hall-Roeger time-series model, Eq. (8)). So, the Hall-Roeger time-series model is estimated using the random effects approach and the LM statistic indicates the presence of independence at the 5% level of significance (Table 3, Hall-Roeger model, Eq. (6)). In addition, the LR test indicates the presence of heteroscedasticity and the Wooldridge test indicates the absence of autocorrelation in the panel data (Table 3, Hall-Roeger time-series model, Eq. (8)). Thus, this model is re-estimated with the FGLS procedure so as to take into consideration the presence of heteroscedasticity in the panel data.

The empirical results of the estimation of the Hall-Roeger time-series model are presented in Table 4 (Hall-Roeger time-series model, Eq. (8)). According to the empirical results, all the estimated μ_t $(t = 1,..,8)$ coefficients are statistically significant at any conventional level of significance and their values are within the range (1.796-3.054).[11] Moreover, the model test, i.e. F-test, supports the joint significance of all regressors (Table 4, Hall-Roeger time-series model, Eq. (8)). In addition, the Wald statistic (F-statistic) for testing the hypothesis $\mu_t = 1$ $(t = 1,...,8)$ indicates that the null hypothesis can be rejected at any conventional level of significance. These findings suggest that for each sub-period of the period 1984─2007, i.e. $t = 1,...,8$, the Greek food and beverages manufacturing industry operates under non-competitive conditions.

Figure 2 shows the markup in each sub-period of the period 1984─2007 for the whole Greek food and beverages manufacturing industry. According to Figure 2, during the period 1984-2001 there was a decrease in the markup with the exception of the period 1992-1995 when an increase was observed. Since 1987, there had been the gradual implementation of the Single European Market (SEM), which was completed in 1992. The implementation of the SEM resulted in the enhancement of free trade among Greece and the other European countries. This caused a fall of the profit margin as well as a drop in the markup. Note that, during that period, the Greek food sector consisted in its majority of small traditional processing firms and was characterized by a lack of awareness of new technologies. Also, very few food processing firms managed to obtain ISO 9000 in order to enhance their products' quality, improve their productivity and decrease their marginal costs.[12] However, the markup increased during the period 1992-1995, probably due to the fact that foreign businesses made significant investments in the Greek food and beverages manufacturing industry. This is because there were a number of acquisitions and joint ventures made by Europe's leading firms.[13] It is notable that the basic motivation of the aforementioned acquisitions and joint ventures was the entrance into new markets and their maintenance into them, rather than financial factors or the exploitation of economies of scale. As a consequence, there was a fall in the markup during the period 1995-2001. Finally, according to Figure 2, during the period 2001-2007, the markup increased, possibly due to the wave of mergers and acquisitions that took place in the Greek food and beverages manufacturing industry during the period 1998–1999 and the launch of the euro in

[11] It is noted that the markup of the sub-period *t=1*, i.e. years 1984─1986, is 2.399 ($\mu_1=2.399$), that of the sub-period *t=2*, i.e. years 1987─1989, is 2.443 ($\mu_2=2.443$), that of the sub-period *t=3*, i.e. years 1990─1992, is 2.349 ($\mu_3=2.349$), that of the sub-period *t=4*, i.e. years 1993─1995, is 3.054 ($\mu_4=3.054$), that of the sub-period *t=5*, i.e. years 1996─1998, is 2.144 ($\mu_5=2.144$), that of the sub-period *t=6*, i.e. *years 1999─2001*, is 1.796 ($\mu_6=1.796$), that of the sub-period *t=7*, i.e. years 2002─2004, is 2.211 ($\mu_7=2.211$) and that of the sub-period *t=8*, i.e. years 2005─2007, is 2.346 ($\mu_8=2.346$).

[12] ISO 9000 series was first introduced as a part of the Total Quality System (TQS) in 1987 and revised in 1994.

[13] 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.

2000, which led some firms to exit the market since they could not operate in the European Monetary Union.

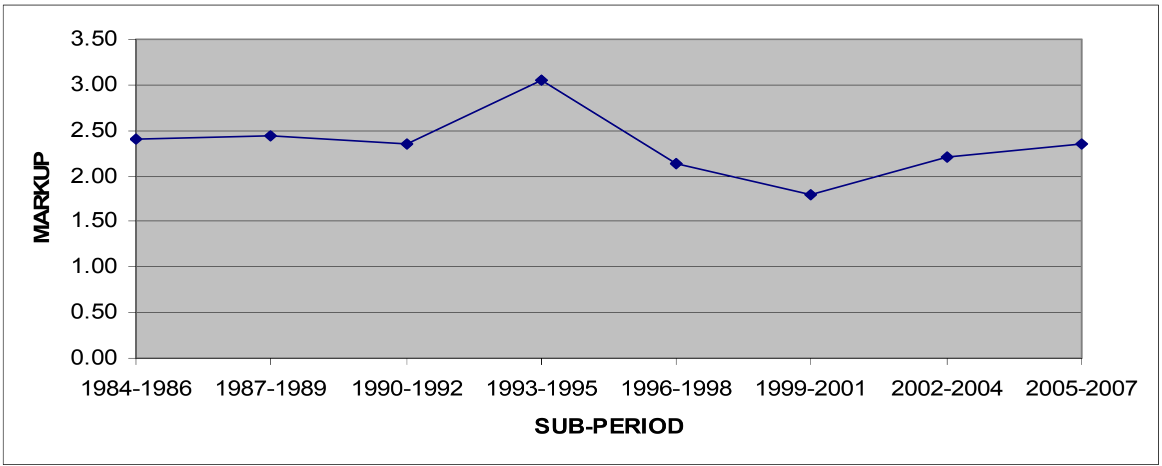

Figure 2. Markup for the Greek food and beverages manufacturing industry for certain sub-periods of the period 1984─2007

Markup Model

The markup model, i.e. Eq. (9), is estimated to identify factors that are likely to affect the level of markup in the Greek food and beverages manufacturing industry over the period 1984─2007. This model is estimated using OLS. The Breusch–Pagan (BP) test supports the presence of heteroscedasticity while the Durbin-Watson (DW) test indicates the existence of autocorrelation in the data set.[14] Thus, the markup model is re-estimated with the FGLS procedure so as to take into consideration the presence of autocorrelation and heteroscedasticity in the panel data set. The econometric analysis is conducted using the Stata 10.0 software.

Table 5. Regression results of the markup model for the Greek food and beverages manufacturing industry over the period 1984─2007

Independent Variable	**Notation**	**Expected Sign**	**Estimated Coefficient, Eq. (10)**
Constant			1.3864^{***} (41.420)
Capital intensity	$\ln ci_{st}$	+	0.0466^{***} (16.320)
Sector size	$\ln z_{st}$	+	0.0529^{***} (19.530)
Establishments	$\ln n_{st}$	-	-0.0149^{***} (-5.990)
Time trend	t		-0.0064^{***} (-12.06)
Model test [a]			630.98 [0.000]

Notes: The values in parentheses are t-statistics while those in brackets are p-values.
[a] *F-test is used to test the joint significance of all regressors.*
*** indicates 1% significance levels

[14] The estimated regression explains 46% of the variability of $\ln \mu_{st}$ (R^2=0.46). The Breusch–Pagan (BP) test statistic is 27.43 [0.000], whereas the Durbin-Watson (DW) test statistic is 0.1340.

The empirical results of the estimation of the markup model, i.e. Eq. (9), are presented in Table 5. According to these findings, all the coefficients of the explanatory variables are statistically significant at any conventional level of significance and have the expected signs. In particular, capital intensity $(\ln ci_{st})$ has a positive effect on markup $(\alpha_1 = 0.0466)$ which means that the higher the capital intensity of the sectors of the food and beverages industry during the period 1984‒2007, the higher the markup in the Greek food and beverages manufacturing industry during the period under consideration, i.e. 1984‒2007. The sector size $(\ln z_{st})$ also positively affects the markup $(\alpha_2 = 0.0529)$ which means that the bigger the sectors in the food and beverages market during the period 1984‒2007, the higher the markup. Furthermore, the establishments $(\ln n_{st})$ negatively influence the markup $(\alpha_3 = -0.0149)$ implying that the higher the number of establishments, the lower the markup in the Greek food and beverages manufacturing industry over the period 1984–2007. In addition, the empirical results indicate that the markup in the industry under consideration, i.e. the Greek food and beverages manufacturing industry, decreases over time $(\alpha_4 = -0.0064)$. The findings also support the view that sector size $(\ln z_{st})$ has a major impact on the markup in the Greek food and beverages manufacturing industry during the period 1984–2007, followed by capital intensity $(\ln ci_{st})$ and the number of establishments $(\ln n_{st})$. Finally, the model test, i.e. F-test, supports the joint significance of all regressors.

Conclusions

This paper investigates the market structure of the Greek food and beverages manufacturing industry over the period 1984‒2007 at three-digit SIC level. Three different models based on the Hall-Roeger approach are used. The first model (Hall-Roeger model) assesses the markup in the Greek food and beverages manufacturing industry over the period 1984‒2007. The second model (Hall-Roeger cross-sectional model) tests the extent of the markup for each of the nine sectors of the industry over the whole period, i.e. 1984‒2007, and the third one (Hall-Roeger time-series model) estimates the markup for the whole Greek food and beverages manufacturing industry for certain sub-periods of the period 1984‒2007.

The empirical results indicate that the markup in the Greek food and beverages manufacturing industry during the period 1984‒2007 is 2.385 $(\mu = 2.385)$ implying the presence of non-competitive conditions for the whole industry over the period 1984‒2007. In addition, the findings support the view that each sector of the Greek food and beverages manufacturing industry appears to have been operating under imperfect competition in the period 1984‒2007, with the production, processing and preserving of meat and meat products (SIC 151) showing the lowest markup $(\mu_{151} = 2.126)$ while the manufacture of beverages (SIC 159) appears to have the highest markup $(\mu_{159} = 3.199)$. In general, all the sectors of the Greek food and beverages manufacturing industry appear to have relatively high markups because of the existence of high concentration ratio in each sector.

Finally, the empirical results indicate that the whole Greek food and beverages manufacturing industry appears to have been operating under non-competitive conditions for each sub-period of the period 1984─2007. In particular, the markup tended to decrease during the period 1984-2001, due to the free trade and the strong competition, which was caused by the implementation of the SEM combined with the lack of competitiveness and efficiency of the Greek food and beverages manufacturing industry. However, the wave of acquisitions and joint ventures during the period 1989-1991 resulted in the increase of markup during the period 1992-1995. In addition, the mergers and the acquisitions which took place in the Greek food and beverages manufacturing industry during the period 1998–1999 and the launch of the euro led the markup to increase during the period 2001─2007.

Moreover, the present paper investigates factors affecting the markup in the Greek food and beverages manufacturing industry during the period 1984─2007. The empirical results indicate that sector size, capital intensity and the number of establishments influences the markup in the Greek food and beverages manufacturing industry during the period 1984─2007, with the sector size having the greatest impact.

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Data Appendix

The bulk of the data used in this study has been 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 have as follows:

q is the value added in 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 which is the producer price index in manufacturing (1995=100), as reported in the AIS.

l is the 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 in the OECD.

w is the wage rate per man-hour and is obtained by dividing the remuneration of 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 in 1995 constant prices for each investment good, 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 good, are the following: the gross asset formation in 1995 constant prices which is obtained from AIS, a capital benchmark (the gross capital stock for the year 1981 is used) as reported in the AIS and a rate of depreciation for each investment good. A depreciation rate of 5% for machinery and furniture, 3% for buildings and installations and 9% for transport means has 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 weighted average of 5% for machinery and furniture, 3% for buildings and installations and 9% for transport means.[15]

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