Performance of the Greek aquaculture industry

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Abstract

This paper examines the performance and growth of aquaculture farms during the last decade in Greece. The rapid development of technology, the extended market rivalry due to new farms and mergers and the improvement of quality standards in the market place a heavy strain on the strategy development process of aquaculture farms. Panel data for 102 Greek aquaculture farms that operated in the period 1991-98 are used to examine whether the size or other strategies used by firms are the most important determinants of performance in the case of Greek aquaculture farms. The results show that firm size along with capital intensity and efficient use of borrowed capital are the main determinants of the profitability of firms.

Résumé

Dans ce travail, on donne un aperçu du développement et de la performance des établissements d'aquiculture en Grèce, au cours de ces dix dernières années. L'avancement rapide des technologies, la concurrence croissante du marché, découlant de la présence de ces nouveaux établissements, ainsi que des normes de qualité plus exigeantes ont influé d'une manière significative sur le processus de développement du secteur aquicole. Des données relatives à 102 établissements aquicoles grecs, pour la période 1991-1998, sont passées en revue afin d'évaluer si la taille ou bien les diverses stratégies mises en œuvre par ces établissements représentent les principaux facteurs déterminants pour leur performance. Les résultats montrent que la taille tout comme l'importance du capital et l'utilisation efficace des prêts constituent les facteurs déterminants de la rentabilité dans ce secteur.

1. Introduction

The increased demand for fresh fish during the last decade both in Greece and in the European Union had as a result the inland and marine aquaculture to become a well-organized economic activity in a number of European countries and especially in Greek waters. Greece became the major producer of aquacultured fish in the European Union and in the Mediterranean area; the Greek aquaculture is characterized by a very high growth in production, an important rise in number of farms, and a high level of profitability.

It is clear that various strategies are becoming increasingly important for the development and enlargement of the industry as well as for the growth and profitability of each firm. In order to identify the existence of monopoly profits, market structure has been used as a key. The new empirical studies of the market performance draw the attention on the firm and especially on the critical factors such as strategies (differentiation, vertical integration, research and development), that cause firms to be profitable or not.

This work presents the aquaculture activity in Greece and explains in a more comprehensive way the factors that affect the high level of performance in this industry. Alternative methods have been applied to test hypotheses concerning the relationship between the level of firm profitability and its determinants.

2. Development of aquaculture in Greece

Greece is the largest aquaculture producer in the Mediterranean area especially referring to sea bream (Sparus aurata) and sea bass (Dicentrachus labrax). Greek production of sea bream and sea bass reaches 34% of the total Mediterranean production and about 51% of the EEC production. The latter is very important for the Greek economy since Greece takes the lead in a very few economic sectors with respect to other European Union countries.

Table 1. *Production and exports of sea bass and sea bream in Greece (1991-1998*

Year	Production of aquaculture (in tons)	Production of sea bass and sea bream (in tons)	Exports of sea bass and sea bream (in tons)
1991	13712	2460	1200
1992	23587	4800	2900
1993	30662	9500	5800
1994	36094	13500	8000
1995	42804	17600	11000
1996	53220	21000	15300
1997	54613	26000	16800
1998	-	36000	21180

Source: Agricultural Bank of Greece - Dept of animal production

The production of aquacultured fish increased substantially from 13.712 tons in 1991 to 54.613 tons in 1997, while the increase in the gross production value reached 7.7% for the same period (Table 1). Also the market share of aquaculture production to total fish production increased from 5% in 1990 to 30% in 1997, while the market share of sea fishing decreased from 93% in 1990 to 68% in 1997. Espe-

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cially the production of sea bass and sea bream increased from 2.460 tons in 1991 to 26.000 tons in 1997. The industry is characterised also by an increased export intensity. Exports increased from 1.200 tones in 1991 to 21.000 tones of sea bass and sea bream in 1998 (Table 1).

During the period 1990-98 the number of established aquaculture farms increased by 13.8% yearly. Table 2 shows that the number of farms increased from 139 in 1991 to 247 in 1998, and to 266 in 1999 according to the data of the Ministry of Agriculture.

Table 2. *Number of firms, concentration ratio and profitability 1991-1998*

Year	Number of firms	CR4(%)[1]	PR(%)[1]
1991	139	50,9	37,4
1992	133	40,5	38,6
1993	171	40,6	36,1
1994	189	42,0	36,0
1995	193	42,5	29,2
1996	205	34,7	27,2
1997	229	35,7	24,1
1998	247	42,2	29,6

Note: 1. Calculation of the variables has been made by the author

(Source: ICAP HELLAS)

The concentration ratio of the four leading farms (according to the author's estimations) reached 50% in 1991, while in the following years (1992-1995) it totalled 40%. In 1996 the concentration ratio of the four farms reached its minimum value, and it started to increase again. Over the last years this industry reckoned an increasing merger activity. It is interesting to note that three of the leading farms (NIREAS, SELONDA, SEA FARM IONIAN) expanded their activities during 1994-1998 by taking over other fourteen companies operating in the same market. Table 3 presents the merger activity of the three leading aquaculture farms. This industry is also characterised by a high level of profitability which varied from 38.6% in 1992 to 296% in 1998 as shown in Table 2.

Table 3. *Merger activity of the three leading aquaculture farms (1994-1998)*

Investor	Target
NIREAS	Hellas fisheries Thalassa food of Greece Ichthys s.a. Protefs Hios Fish Hatcheries Chephalonian Fisheries
SELONDA	Hydrocal Hydrokalliergeies Fokidos Argolida aquaculture Riopesca Sea farm Ionian (10%)
SEA FARM IONIAN	Palmpas Perco Ichthyo Selonda (10%)

Table 4. *Employees, market share and efficiency of the leading aquaculture farms, 1991-1998*

	Number of employees (1998)	market share % (1991-98)	market share % (1998)	efficiency % (1998)
NIREAS	535	15,8	24,4	7,79
SELONDA	210	5,9	6,80	6,42
SEA FARM IONIAN	60	4,7	5,8	26,7
CEPHALONIAN FISHERIES	62	6,8	4,6	3,5
EVRIPOS	75	4,1		17,5
HELLENIC FISH HATCHERIES	95	3,3	5,2	55,3
AQUA HELLAS	90	2,8		5,39

Notes: 1. Efficiency is measured as own capital over sales (Source :ICAP Hellas)

Most of the large farms have established research and development of ichthyogenetic units in order to be vertically integrated. According to the data from the Greek Agricultural Bank, in 1999 there were 33 ichthyogenetic units. The research for the production of new kinds of aquacultured fish is an important characteristic of the market and is crucial for the future development of farms. The Greek production of new pieces of sea bream and sea bass reached 42% and 31.6% of the EU and Mediterranean production respectively, in 1997.

There are significant differences between Greek aquaculture farms in terms of employee size and efficiency. As table 5 shows there are two farms (NIREAS and SELONDA) with more than 200 employees and one of them (NIREAS) has an average market share above 15% (15.8%); its market share reached 24.4% in 1998. The other six out of seven leading farms have an average market share lower than 7%. All the seven leading farms have their own ichthyogenetic units to produce the relevant new fish.

As to the differentiation strategy, advertising has never been used by these farms although some of the leaders have used brand products. This can be explained by the fact that aquaculture products are usually sold in bulk, without brand names through specific points such as open markets and super markets.

Since the aquaculture industry is well organised and with high performance, it is interesting to explain the critical factors that may affect profitability by using alternative econometric models.

3. Model specification

Following the relevant literature on the industrial organisation (e.g. Martin, 1993) and the empirical models (Hay and Morris, 1991; Oustapassidis, 1998) that have been used by other studies, the following model may be estimated:(1)

$$PR = a0 + a1MS + a2MS2 + a3LEV + a4KS + a5D + a6LNT$$

where:

MS is the market share of each firm. Following other empirical

studies the square value of the market share MS2 may also be used in order to investigate if the relationship is non-linear.
LEV is the leverage variable that controls the effectiveness of the borrowed capital
KS is the capital intensity variable,
D is a dummy variable which takes the value of 1 in case of farms with their own ichthyogenetic unit and the value of 0 otherwise, and
LNT is the logarithm of firm's assets and is included to control differences in the firm size.

It has been argued that the market share rather than the concentration ratio is the main determinant of market performance and competition (Geroski,1988). This is why almost all the studies that have been carried out with farm-level data associate market share with profit rates (Scott and Pascoe,1986; Oustapassidis, 1998). Market share is expected to affect profitability positively up to a point above which an increase in the market share leads to a decrease in profitability.

Table 5. *Mean values of variables (1991-98)*

	mean values
PRS	33,05%
MS	2,16%
LEV	493%
KS	477%

The leverage variable shows if firms have used the borrowed capital efficiently. If leverage means greater risk and greater risk implies a greater profitability, the estimated coefficient of the total liabilities over net worth is expected to be positive, meaning that the firms that have borrowed more are more profitable, all else equal (Martin, 1993) ($a3 > 0$). However, there are studies that found a negative effect of borrowed capital on profitability, which shows that either the cost of borrowing is higher than the benefits of investments, or firms had not used the borrowed capital efficiently (Oustapassidis, 1998).

Another variable that can affect the price elasticity of demand and create barriers to entry is the capital sales ratio. The higher the capital intensity, the greater the positive effect on profit margins of the firm (Hay and Morris, 1991; Vlachvei and Oustapassidis, 1998) ($a4 > 0$). However, if the ratio becomes very high then, due to inefficiency, the effect on profits may become negative ($a4 < 0$).

The variable which shows the farms that are vertically integrated and use new technology to produce inputs for the aquaculture production is expected to have a positive impact on profitability, since these farms have a comparative advantage relating to the decrease of transaction costs, better control of the input quality and the possibility of investment in research and development of new kinds of aquacultured fish. All the above are expected to result in an increase of their profit margins ($a5 > 0$). The logarithm of the firm's assets is included to control differences in the firm size and is expected to be positive ($a6 > 0$).

Table 6. *Determinants of profitability in Greek aquaculture farms,1991-98*

	OLS regression coefficients		
Variables	PR (1)	PR (2)	PR (3)
MS market share	8,46 (3,89)[1]*	3,03 (2,92)*	5,88 (2,32)
MS^2 Square of market share	-37,38 (-2,83)*		-25,26 (-1,72)
KS Capital intensity	0,025 (27,60)*	0,025 (27,18)*	0,025 (27,83)
LEV Leverage	0,006 (2,65)*	0,006 (3,01)*	0,005 (2,25)
D	0,05 (0,66)	0,14 (1,79)**	
LNT Logarithm of firm's assets			0,007 (1,99)
R^2	0,81	0,80	0,81
No of observations	360	360	359

Notes:
1. t-ratios in parentheses
2.* and ** denote statistical significance at 5 % and 10% level, respectively

3.1. Data

In this empirical study, firm-level panel data are used to test the relationship between the price-cost margin and the structural factors that affect profitability. The sample utilised in the estimation of the models consists of aquaculture farms with more than 10 employees that operated between 1991 and 1998 and available data for at least three years during the study period. Thus, data of 102 farms are used by the author to construct variables that are presented in this paper. The total number of observations due to missing data is 360. Annual data for each company are drawn from a database, based on both the balance sheets and income statements. In contrast to other countries, where firm-level data are not easily available, all Greek manufacturing firms are obliged to publish their annual balance sheets and income statements. The relevant data are available on an annual basis from a proprietary service company (I-CAP, 1991-98).

Following other market performance studies (e.g. Martin, 1993, Oustapassidis, 1998), the dependent variable is measured by means of the ratio of gross accounting profits to the annual firm sales. Market share is the annual ratio of the firm's sales to the annual industry sales. Similarly, leverage is measured as the ratio of total liabilities over net worth and it shows the dependence of the firm on borrowed capital. The capital intensity variable has been calculated as firm's total assets over firm's sales, while dummy variable which is used to show the vertical integration of the firms takes the value of one if the farm has its own ichthyogenetic unit and the value of 0 otherwise. Table 5 shows the mean and standard deviation values of profitability, market share, leverage, and capital intensity over the study period.

4. Model estimation and results

The empirical findings from OLS panel analysis of the three alternative models are shown in table 6. The first model includes market share and its square value, capital intensity, leverage and dummy. The second model does not include the square value of market share, while the third model includes the square value of market share while the dummy variable is excluded. The logarithm of the firm's assets is included in the third model.

The results of the three models are consistent. The sign of the market share shows that the size of the firm affects positively and significantly an increase in profit margins, while the square value of market share has a negative and significant sign. The latter shows that as the market share increases, the profit per unit of sales increases up to a critical value. If the market share continues to increase to higher levels, profit margins start to decline. However, according to the results, aquaculture farms have to reach a critical value of the market share equal to 22.6% (-8.46/37,38) for profitability to decline, which is a very high level and none of the farms has reached this size.

The coefficient of capital intensity variable has also a positive and significant sign which shows that firms with high assets to sales ratio take advantage of economies of scale and increase their profits through the production of products with high value added. The coefficient of leverage is found to be positive and significant which suggests that firms which use borrowed capital effectively can increase their profit margins. Most of the firms have used borrowed capital intensively as it appeared by the mean values. The coefficient of dummy variable, which shows the effect of the vertical integration strategy to the increase of profitability, is positive but not significant.

The results of the second model are similar. The only difference is that when the square value of market share is omitted, the coefficient of dummy variable becomes positive and significant at least at 10% level of significance, which shows that firms that invest in technology and in the production of inputs through the strategy of vertical integration have significant possibilities to increase their profitability. The third model includes also another variable which is the size of firms in terms of total assets. The results show that large firms have higher rates of return all else equal.

The results obtained of random effect model are consistent. Table 7 reports results for two alternative models.

Table 7. *Panel data results of random effect model*

Variables	PR	PR
MS Market share	6,24 (2,13)[1]*	3,46 (2,60)*
MS^2 Square of MS	-17,33 (-1,08)	
KS Capital intensity	0,025 (28,03)*	0,025 (27,93)*
LEV Leverage	0,005 (2,31)*	0,005 (2,33)*
C Constant	0,06 (1,02)	0,09 (1,73)
R^2	0,81	0,80
No of observations	360	360

Notes:
1. t-ratios in parentheses
2. * denotes statistical significance at 5% level.

The results show that the effect of market share on profitability is positive and significant, while the square value has a negative and insignificant sign. The coefficients of both capital intensity and efficient use of borrowed capital are also found to be positive and significant determinants of firm profitability in the case of Greek aquaculture farms.

5. Conclusions

This study examines the performance of the Greek aquaculture industry during the last decade. Data show that this industry is characterised by high level of profitability and growth in terms of production and number of farms. Aquaculture is also an industry where Greek farms are the leaders among European countries.

In order to identify the main determinants of farm performance in this industry, a sample of 102 Greek aquaculture farms have been used, while both panel OLS and random effect model have been applied.

The results show that as the market share increases, the profit per unit of sales increases up to a critical value. If market share continues to increase to higher levels, profit margins starts to decline. Also firms with a high ratio of assets to sales take advantage of economies of scale and increase their profits while firms, which use borrowed capital effectively, can increase their performance.

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