

**FULL ARTICLE**

Market concentration in the Spanish turbot aquaculture sector: A regional analysis

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Abstract

This paper analyses the regional evolution of the market structure in the Spanish turbot industry, which is the leading turbot producer in Europe, using different concentration rates. The analysis is performed considering several factors that have influenced the evolution of the sector, the most important being the application of technology, business strategies and the institutional framework. The results confirm a process of concentration. Starting from an initial phase in which the sector was composed of a considerable number of small companies, this industry has evolved towards a situation in which only two large firms dominate the market.

KEYWORDS

business strategies, concentration index, market share, Spanish regions, turbot aquaculture

JEL CLASSIFICATION

R11; Q22; D43

1 | INTRODUCTION

Aquaculture is one of the food production sectors with one of the highest annual growth rate since the 1980s (FAO, 2018). It was also in the 1980s that initiatives on marine fish production were also carried out in Spain. The first intensive farming of finfish species like seabass and seabream was followed by turbot farming. Since 1983, when the first turbot company was founded, until today, Spain has led the turbot production in Europe, especially thanks to the impulse of one of its regions, Galicia. In 2018, Spanish turbot production was 7,450 tonnes, well



above the 2,400 tonnes produced by Portugal, the second largest European producer (APROMAR, 2018; FAO, 2020).

Most of the economic studies published on the Spanish turbot sector focus on the relative importance of market factors for turbot, as well as on innovation in cultivation technology or future production trends (Bjørndal & Fernandez-Polanco, 2013; Bjørndal & Øiestad, 2011; Bjørndal & Palmieri, 2008; Fernández-González, Pérez-Pérez, & Garza-Gil, 2020; Rodríguez-Rodríguez, Morrison, & Troncoso-Ojeda, 2017; Schneider et al., 2012). Within these previous works, reference has been made to the decrease in the number of companies or the progressive heterogeneity of the composition of the sector. However, none of them has focused on the analysis of market concentration.

The aim of this study is to investigate the evolution of the market concentration of the Spanish turbot sector, from its beginnings to the present day, as well as to respond analytically to the question of whether this sector is converging towards a duopoly. For that purpose, different concentration indices are used: the concentration ratio (CR1, CR2 and CR4), the Herfindahl–Hirschman index (HHI), the Rosenbluth–Hall–Tideman index (RHTI) and the domain concentration ratio (DCR). The results of these indices will be analysed in relation to technological advances, institutional issues and business strategies.

The article is structured as follows. In Section 2, the factors that determine its growth and the incidence of these factors in the production process are described. Reference is also made to the variability in the degree of development of the industry achieved in the different regions and to the motivations behind it, in particular the conditioning factors of the physical environment, the institutional framework existing in the various territories and the different business strategies followed in each region. Section 3 describes the methodology, the sources of information involved, the process used to define the data sample and the concentration indexes included in the analyses. Section 4 discusses the results of the evolution of the concentration indices. This evolution reflects the incidence of the different factors involved in the development of aquaculture and the trend of the market structure. The predominant companies adapt to the market circumstances by developing strategies that have led to the current business concentration. The technological advances in the industry are described, as they have played a prominent role in increasing productivity and growth of large companies, thus favouring the process of concentration. Finally, section 5 draws some conclusions.

2 | RESEARCH CONTEXT

In the European context, Spain is the leading region in the production of farmed turbot. In global terms, Spain was also the world's leading producer until China outstripped the Spanish turbot production in 2006. In quantitative terms, in 2018 the total turnover of companies in the Spanish turbot market reached €72.9 million (APROMAR, 2019).

The production process of turbot is strongly influenced by factors such as the physical environment in which it is produced (in particular the characteristics of the coastal water), the technology developed, the business strategies of the sector and the institutional framework that regulate aquaculture activity and authorize the construction of facilities dedicated to the cultivation of the species on the coast (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020).

In Spain, turbot cultivation started in three northern regions of the Iberian Peninsula: Galicia, Cantabria and the Basque Country, later joined by Asturias for a short period of time. Although several attempts at experimental cultivation have been made in the Mediterranean area, particularly in the regions of Catalonia, Valencia and Andalusia, the results have not been very satisfactory. Among the regions of northern Spain, Galicia has been the only one that has managed to consolidate this sector. Since 1994, Galicia has produced more than 80% of Spanish farmed turbot, increasing this percentage to the current 99%. The inability to compete with Galicia in terms of production and price has had its consequences. Asturias and the Basque Country have abandoned the cultivation of this species, while Cantabria now has only one turbot farm (Figure 1).



FIGURE 1 Spanish regions producing farmed turbot

The cultivation plants employ land-based cement tanks with open-circuit seawater pumping. Recirculating aquaculture systems (RAS) are rarely used at present (Bjørndal & Øiestad, 2011). In the case of turbot, the high initial investment and high operational costs of the RAS considerably increase the turbot production cost, affecting the profitability of the cultivation (Schneider et al., 2012). Plants that do not have a hatchery must import the juveniles for fattening. Companies that have their own hatchery, begin the production process by obtaining eggs from the broodstock. After the larval culture, weaning and nursery phases, the best adult specimens obtained are used as broodstock from 3 to 4 to 8–9 years old, and the rest are fattened up to commercial size (1.5–2 kg), which is reached in a period of 18–24 months.

The strong expansion of turbot aquaculture in Spain has been favoured by the good behaviour of several of the above mentioned factors. As for the biophysical conditions, it is important to note that they differ considerably between the different Spanish regions. The northern Atlantic coast of the Iberian Peninsula has an appropriate water temperature range for turbot cultivation (optimal in the case of Galicia), while in the Mediterranean area and south Atlantic coast of the peninsula, the high summer water temperatures (up to 30° in Andalusia) make the cultivation of this species unviable. Within the Atlantic coast, the most appropriate values of both water temperature and water quality are recorded in Galicia. The upwelling phenomenon, which fertilizes the coasts with cold nutrient-rich water, is especially intense in this region (Giralt Paradell, Díaz López, Methion, & Rogan, 2020; Prego & Bao, 1997).

However, it is not only environmental factors that have consolidated the sector. The technological evolution of production has also allowed the viability of the culture in the long term, improving the economic profitability of this species. Initially, in Spain, fry were obtained from the natural environment but new fry production technologies remarkably increased the volume of production (Labarta, 2000). In addition, the promotion of technology transfer between research centres and companies, which focused primarily on technical production processes, resulted in reduced costs due to the creation of economies of scale (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020).



Business strategies are another important factor in this analysis. According to Ruiz Molina (1997), the first of these is the growth strategy, which has an impact on the Spanish turbot sector given the numerous mergers and absorption acquisitions of companies, in addition to the existence of associationism (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020). The second of them is the internationalization strategy, with a reduced impact on the Spanish turbot sector, although we can cite the case of Pescanova's failed implementation in Portugal. Third, the strategy of leadership in costs has had repercussions in the sector, as there exists a high effort in technology and R&D. Finally, commercial strategies have had the least impact on this sector, although recently product differentiation has been explored.

Finally, the institutional framework has also been a factor that has determined the evolution of the industry in the various Spanish regions. It is defined by the laws and aquaculture plans approved in each region and the business strategies designed by the aquaculture sector in each territory. These variables will be analysed in detail in Section 4.

3 | EMPIRICAL STUDY: METHODS AND DATA

3.1 | Data

The main database used in this work is SABI (Iberian Balance Sheet Analysis System) (SABI database, 2020), which contains economic and financial information corresponding to the annual accounts included in the Spanish Mercantile Register. From this database, company balance sheets, profitability ratios, profit and loss accounts and other information of interest such as corporate structure or company location are obtained.

The search carried out at SABI showed that this database did not contain information on most of the small turbot-farming companies in Spain. Due to the fact that the Galician turbot sector, the most important by far in Spain, includes small companies, in order to provide a rigorous analysis, the ARDAN database has been used as an alternative to SABI for small company data (ARDAN, 2020). ARDAN contains economic and financial information on 35,522 companies in Galicia.

Various filters in the SABI and ARDAN databases were used to define the sample. The first one is the one corresponding to NACE Rev 2 code 0321, which identifies the enterprises whose main activity is marine aquaculture. Subsequently, the search was limited to the Spanish regions that have produced aquaculture turbot: Andalusia, Asturias, Basque Country, Cantabria, Catalonia and Galicia. In order to limit the sample to those companies that have produced turbot, another filter was applied whereby the description of the company's activity included the word turbot or its translation in Spanish, *rodaballo*. As a result of the application of these filters in both databases, a sample of 33 companies was defined. This sample is not constant for the study period, since part of the companies in the sample became extinct or were absorbed by other turbot companies.

As SABI and ARDAN only contain data from 1993 onwards, other sources have been used. In the case of Galicia, data prior to that date are based on Fernández, De Llano, and García (1998) and Fernández-González, Pérez-Pérez, and Garza-Gil (2020), studies that contain the sales of each company from the beginning of the sector until the mid-1990s. For the Basque Country and Cantabria, the data are from the source Vázquez (1996).

3.2 | Methodology

Concentration indices are used to analyse the level of competition in a sector. These indices are based on the number of firms in the industry and the distribution of the market share of each of them. Thus, the value of the indices reflects the effects of mergers and acquisitions, the creation of dominant positions, and the consequences of



crises and industry restructuring (El Diri, Lambrinouidakis, & Alhadab, 2020; García, 1990; Nguyen, Woo, Beresford, & Pettit, 2020).

The following indices were used to determine the market structure of the Galician turbot sector: the concentration ratio based on three different numbers of companies, one-firm concentration ratio (CR1), two-firm concentration ratio (CR2) and four-firm concentration ratio (CR4); the Herfindahl–Hirschman index, the Rosenbluth–Hall–Tideman index and the dominance concentration ratio.

Concentration ratio sums up the market share of the k leading companies in the market. The index does not consider the $(n-k)$ remaining companies. The value of this index ranges from 0% to 100%. The greater the market share of the leading companies, the greater its value:

$$CR_k = \sum_{i=1}^k S_i, \tag{1}$$

where CR_k is the concentration ratio for n companies, k is the number of large companies in the sector, and S_i is the market share of i^{th} company ($i = 1, \dots, n$).

The Herfindahl–Hirschman index considers the market share of all companies in the sector, placing more importance on the larger ones, as it is a quadratic sum. A value of less than 100 points indicates a very competitive market; between 100 and 1,500 points, a deconcentrated market; between 1,500 and 2,500 points, a concentrated market, and more than 2,500 points, a highly concentrated market. The maximum value is 10,000 points, and it is obtained in monopoly cases:

$$HHI = \sum_{i=1}^N S_i^2, \tag{2}$$

where N is the total number of companies in the sector, and S_i^2 is the market share of the i^{th} company ($i = 1, \dots, n$) (ordered from highest to lowest).

The RHTI has similarities to the HHI, as it includes all companies in the sector and ranks them in order of their relative size. However, unlike the HHI, it assigns greater importance to companies with smaller market shares. The minimum value is close to 0, when the number of companies is very high, and the concentration is very low. The range of values is between 0 and 1, determining the existence of a perfectly competitive market and a monopoly, respectively;

$$RHT = \frac{1}{\left(2\sum_{i=1}^N iS_i\right) - 1}, \tag{3}$$

where N is the total number of companies in the sector, S_i is the market share of i^{th} company ($i = 1, \dots, n$) (ordered from highest to lowest), and i is the market share of i th company in the industry.

The dominance concentration ratio (DCR) is based on the HHI but, unlike the HHI, it reflects the relative contribution of each company to the market concentration. Its value is between a range of 0 and 1, with 0 representing a situation of perfect competition and 1 a monopolistic market. The index will approach its maximum value the greater the difference between the market shares of small firms and dominant firms:

$$DCR = \sum_{i=1}^N h_i^2 \text{ where } h_i = \frac{S_i^2}{HHI}, \tag{4}$$

where N is the total number of companies in the sector, S_i is the market share of i^{th} company ($i = 1, \dots, n$), and HHI : the value of the Herfindahl–Hirschman index for the period.



4 | RESULTS

4.1 | From monopoly to decline in market concentration

In the European context, Spain is a country with a great fishing and aquaculture tradition not only in terms of catches or production but also in terms of consumption. In 1985, 10.8% of the total food budget was allocated to the purchase of fish, which shows a country with a solid internal demand for this foodstuff (Ruiz & Ruiz Molina, 1991). However, the development of aquaculture in Spain was still in an early stage, with a scarce use of technology, without the incursion of large foreign groups and composed mostly of family-owned companies.

During the first years of the Spanish turbot industry, this sector was, *de facto*, a monopoly. In 1983, the first company in the sector (Insuiña S.L.) was created in Galicia, being the only company in the sector until 1985. Table 1 reflects this situation in all the calculated indices since these reach their maximum value, which corresponds to a monopolistic situation.

The Spanish turbot sector was characterized by a high initial investment that required between five and ten years to be profitable. In addition, the turbot growing cycle needed two and a half years for the product to reach its commercial size. This was a high barrier to entry in the market. However, in view of the success of the first Galician company, which in 1985 marketed its first production at €15/kg, the incorporation of new companies increased year after year (Fernandez-Polanco & Bjørndal, 2013). The attractive profitability of turbot had the effect of creating new turbot fish farming companies in Galicia, Cantabria and the Basque Country, where the biophysical conditions were more appropriate for this cultivation.

This surge of activity was mainly due to the incentive policy coming from the European Community, but mainly from the Spanish government (Kamstra & Nijhof, 1991). It is therefore important to analyse the role of the institutional factor in the expansion of fish farming in Spain. At the national level, the legal framework is composed of Law 23/1984 on Marine Cultivation and Law 22/1988 on Coasts. The approval of the Law 23/1984 on Marine Cultivation in 1984 indicated the beginning of the promotion of aquaculture by the public administrations (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020; González Laxe, Lipin, & Bretón de la Cal, 2004). Multi-year strategic aquaculture plans were established, for which the public administration approved economic aid to carry them out (González Laxe, 2003; Santaella, 1989). The objective was to promote the cultivation of fast-growing species with high commercial value and high resistance to pathologies. The turbot cultivation satisfied some of these requirements. However, the objectives were too ambitious for the technological development of the time (González Laxe, 2003). This meant that industrial progress in fish cultivation, although satisfactory, was less successful than expected in Spain.

However, in Galicia, faced with the need to promote the use of technology in turbot cultivation, the companies adopted the business strategy of growth through cooperation between companies. This strategy is based on associationism, a process that took place in the turbot sector when the associations AROGA and Mar Novo were created in Galicia in 1988 and 1989 respectively (Fernández-González, Pérez-Pérez, & Varela Lafuente, 2020). Their aim was to create synergies in production and, above all, gain access to the use of technology. In this way, there were important innovations in cultivation technology that reduced the cost of production. This fact increased the attractiveness of the sector and resulted in a growth in the number of firms in this industry. The most important advance in this stage was the improvement in the canalization of sea water thanks to the use of water pumps (Arnaiz, 1994). The introduction of semi-wet feed in 1988 also meant an important improvement in the production process (Fernández, 2013).

In 1990, the number of companies in the market was close to a dozen, with more than half of the companies concentrated in Galicia. This upward trend led to a peak in the number of firms in the turbot industry in 1992. This evolution is reflected in all the concentration indexes, which reach their lowest value, showing the maximum atomization that this industry presents. In the case of the HHI, its value for 1992 is 893.45 points. Between 1991 and 1993, the HHI reached a value of less than 1,100 points, indicating the existence of a deconcentrated market structure, a situation that would not be repeated. In this period, most of the companies that make up the sector are small

**TABLE 1** Results of the concentration indices for the Spanish aquaculture turbot sector

	CR1	CR2	CR4	HHI	RHT	DCR
1983	100.00%	100.00%	100.00%	10,000.00	1.00	1.00
1984	100.00%	100.00%	100.00%	10,000.00	1.00	1.00
1985	45.39%	84.87%	100.00%	3847.82	0.42	0.20
1986	50.00%	87.50%	100.00%	4062.50	0.44	0.22
1987	60.00%	90.00%	100.00%	4600.00	0.50	0.29
1988	51.55%	87.89%	100.00%	4124.38	0.45	0.23
1989	34.57%	61.52%	89.22%	2373.97	0.26	0.25
1990	17.96%	32.34%	58.23%	1156.24	0.13	0.14
1991	23.70%	33.18%	52.13%	1069.83	0.10	0.27
1992	16.05%	25.29%	43.79%	893.45	0.10	0.12
1993	19.56%	32.55%	55.30%	1096.14	0.12	0.16
1994	41.44%	52.90%	68.37%	2126.80	0.17	0.54
1995	46.92%	62.56%	75.97%	2638.97	0.20	0.58
1996	57.10%	68.03%	81.74%	3560.47	0.26	0.64
1997	50.58%	67.26%	83.66%	3041.95	0.26	0.58
1998	58.78%	70.29%	84.09%	3736.19	0.27	0.69
1999	47.87%	60.06%	79.15%	2726.67	0.23	0.56
2000	53.59%	62.69%	77.56%	3161.52	0.22	0.68
2001	51.15%	59.33%	72.98%	2912.78	0.20	0.67
2002	29.47%	42.39%	62.42%	1444.16	0.14	0.34
2003	45.02%	59.64%	75.54%	2485.65	0.20	0.56
2004	44.02%	57.73%	76.52%	2395.08	0.19	0.56
2005	40.91%	62.05%	77.92%	2330.16	0.20	0.46
2006	56.16%	67.87%	81.65%	3446.88	0.24	0.71
2007	49.96%	68.53%	82.29%	2973.82	0.22	0.63
2008	40.00%	78.61%	87.26%	3159.38	0.27	0.39
2009	55.43%	82.22%	91.90%	3863.27	0.36	0.49
2010	66.73%	78.50%	90.06%	4696.98	0.36	0.66
2011	54.74%	82.48%	92.65%	3840.75	0.37	0.50
2012	47.21%	85.49%	95.45%	3755.48	0.38	0.37
2013	47.85%	83.91%	95.58%	3672.35	0.38	0.38
2014	50.18%	84.60%	94.81%	3767.46	0.37	0.40
2015	51.80%	84.40%	94.77%	3812.76	0.38	0.42
2016	48.47%	83.83%	94.57%	3671.31	0.36	0.39
2017	50.97%	86.20%	95.60%	3893.45	0.39	0.40
2018	46.75%	84.69%	95.53%	3695.83	0.37	0.37

^aSource: Own elaboration. Data from ARDAN (2020), Fernández et al. (1998), Fernández-González, Pérez-Pérez, and Garza-Gil (2020), SABI database (2020) and Vázquez (1996).

businesses, with low initial capital stock, and local founders. Moreover, this makes the amount produced by each of them very similar, leading to a homogeneous distribution of market shares (Table 2). This homogeneity makes HHI and RHT have the same tendency, as there are no major differences in the size of the companies. On the other hand, the lack of heterogeneity and dominance by large companies is reflected in both the dominance concentration index and the CR1, CR2 and CR4 indices, which acquire their minimum value in this period, also showing the evolution of the sector towards a more atomized market.

**TABLE 2** Market shares of Spanish aquaculture turbot companies

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000	2001	
GALICIA																			
Stolt Sea Farm S.A.											41.4%	46.9%	57.1%	50.6%	58.8%	53.6%	51.1%		
Insuaña S.L.	100.0%	100.0%	39.5%	50.0%	60.0%	51.5%	16.2%	10.8%	9.5%	5.5%	5.8%	5.0%	4.1%	4.1%	5.6%	6.1%	6.1%	6.8%	
Punta Moreiras S.L.								6.0%	9.5%	9.2%	9.7%	8.3%	5.7%	6.9%	9.7%	11.5%	7.6%	6.8%	
Piscícola Morrazo S.L.																			
Luso-hispana de acuicultura S.L.																			
Aquacría Arousa S.L.U.								27.0%	23.7%	9.2%	13.0%						1.5%	6.8%	
Prodemar S.A.										6.2%	19.6%								
Aquazul S.A.									9.5%	9.2%	13.0%				16.7%				
Granja Atlántica de Couso S.L.									3.8%	2.8%	2.8%				3.9%				
Marfish S.A.																			
Corporación Interalimentaria S.A.																			
Martesanal S.L.									4.7%	6.2%	2.7%	3.9%	15.6%						
Acudoro S.L.									0.9%	1.2%	0.6%	2.5%	2.8%	4.6%	6.7%	5.1%	7.3%	6.6%	
Insuamar S.L.								12.0%	9.5%	9.2%	9.7%	6.9%	5.6%	3.7%	4.2%	7.7%	9.1%	8.2%	
Cultivos de Peces S.A. (Cultipecsa)								3.0%	4.3%	3.7%	2.9%	3.3%							
Granja Marina Nastos S.L.										1.2%	1.3%	3.9%	1.8%						
Maricultura S.A.																2.0%	1.8%	1.6%	
Loitamar Sociedad Cooperativa Galega																			
Allesa 72 S.L.													0.6%			1.0%	0.9%	0.8%	

(Continues)



TABLE 2 (Continued)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GALICIA																	
Stolt Sea Farm S.A.	29.5%	45.0%	44.0%	40.9%	56.2%	50.0%	40.0%	55.4%	66.7%	54.7%	47.2%	47.8%	50.2%	51.8%	48.5%	51.0%	46.7%
Insuña S.L.	12.9%	14.6%	13.7%	21.1%	11.7%	18.6%	38.6%	26.8%	11.8%	27.7%	38.3%	36.1%	34.4%	32.6%	35.4%	35.2%	37.9%
Punta Moreiras S.L.	3.7%					1.7%	2.5%						1.6%	1.6%	1.7%	1.5%	1.7%
Piscicola Morrazo S.L.	6.2%	5.8%	3.9%	4.0%	3.0%	3.2%	3.6%	3.6%	4.3%	3.8%	3.7%	4.4%	3.8%	3.9%	4.0%	3.5%	4.1%
Luso-Hispana de acuicultura S.L.	1.8%	1.5%	3.1%	3.2%	2.4%	1.3%	2.2%	2.1%	2.5%	1.3%	2.2%	2.6%	2.2%	2.3%	2.3%	2.1%	2.4%
Aquacría Arousa S.L.U.	12.3%		2.3%	2.8%	6.0%	2.6%	3.8%	6.1%	7.2%	6.4%	6.2%	7.3%	6.4%	6.5%	6.7%	5.9%	6.8%
Prodemar S.A.																	
Aquazul S.A.																	
Granja Atlántica de Couso S.L.																	
Marfish S.A.																	
Corporación Interalimentaria S.A.																	
Martesanal S.L.																	
Acudoro S.L.	6.2%	7.3%	11.5%	10.2%	7.8%	6.4%	4.8%	3.6%	4.3%	3.8%							
Insuamar S.L.	7.4%	5.8%															
Cultivos de Peces S.A. (Cultipecsa)																	
Granja Marina Nastos S.L.																	
Maricultura S.A.	1.7%																
Loitamar Sociedad Cooperativa Galega			2.2%	3.9%	5.2%	7.4%											
Allesa 72 S.L.	0.7%																
Grovense de Mejillones S.A.																	

(Continues)



TABLE 2 (Continued)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ibergaliza S.A.																	
Engordes comerciales marinos S.A.																	
L.																	
Cultivos Mariños Vilanova S.																	
Punta alada S.L.																	
Corelsa servicios S.A.						2.3%											
ANDALUSIA																	
Acuicultura de Estepona S.L.		0.0%	0.3%														
CATALONIA																	
Cultivius S.L.					0.0%	0.1%											
ASTURIAS																	
Culmanor Asturias S.L.	0.5%	2.0%	3.8%	1.7%	0.7%	0.7%	1.5%										
BASQUE COUNTRY																	
Experimental culture. Basque Country																	
Culmanor S.A.	7.7%	8.6%	7.3%	5.6%	2.9%	2.1%				0.3%	0.5%						
Orrua Ibaasondo Arraiak S.A.	5.8%	4.8%	5.3%	3.3%	1.7%	1.0%	1.0%										
CANTABRIA																	
Rodecan S.L.	3.6%	4.5%	2.5%	3.3%	2.4%	2.3%	1.9%	2.4%	3.1%	2.0%	1.8%	1.9%	1.4%	1.3%	1.4%	0.9%	0.4%
Tinamenor																	

*Source: Own elaboration. Data from ARDAN (2020), Fernández et al., (1998), Fernández-González, Pérez-Pérez, and Garza-Gil, (2020), SABI database (2020) and Vázquez (1996).



Spanish turbot aquaculture faced a severe crisis in 1992, which would have consequences on market concentration. The high investments made by the companies, mostly small companies, generated a high production that could not be absorbed due to the lack of a consolidated commercial network (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020). For this reason, the bankruptcy of a large part of the sector could not be avoided and a restructuring of the industry took place, that was more severe in Galicia than in Cantabria or the Basque Country. As a result, a third of the companies in the sector closed down (Fernández, 2013). This reorganization of the industry is reflected in the rising values of all the indices calculated.

4.2 | The beginning of a highly concentrated sector

At the beginning of the 1990s, aquaculture in Spain was an atomized sector formed mostly by family-owned companies, and the use of technology was not as developed as in other sectors. Spain's entry into the European Union, in 1986, helped to stimulate the expansion of Spanish aquaculture. Part of the European funds, together with the financial support of the Spanish regions themselves, boosted this industry. Turbot culture, along with seabass and seabream aquaculture on the Spanish Mediterranean coast, was one of the fastest growing aquaculture sectors in Spain (Ruesga Benito et al., 2005).

However, the beginning of the 1990s was not a prosperous time for small businesses in the turbot sector. The consequences of the 1992 crisis and the arrival of foreign capital would lead to a greater concentration of the market. The entry into the Spanish turbot sector of a large company like Stolt Sea Farm S.A. had a significant effect on the level of market concentration, which was reflected in the significant increases in value of all indices in 1994. According to the CR1 index, in its first year of activity this company achieved a market share of 41.44%. Furthermore, the effect of its entry is also reflected in the value of CR4, which exceeds 65%, indicating a concentrated market. This situation is also reflected in the strong growth of HHI. Its value for 1994, which practically doubled the figure of the previous year, confirms the great impact of the Norwegian company on the Spanish turbot sector. On the other hand, the RHT index, which gives greater importance to small companies, experiences a smaller increase than the HHI, as these have lost market share. The largest increase is seen in the dominance index, which is more than triple the value of the previous year. This high value also reflects a large difference between the market shares of the dominant company and the rest of the companies.

During this period, business strategies have marked the evolution of the sector. The most successful business strategy for Stolt Sea Farm S.A. and Pescanova-Insuiña S.L. has been the strategy of external growth, that is, expanding through mergers and acquisitions by absorption, especially in the case of Stolt Sea Farm S.A. (Ruiz Molina, 1997). Through a series of strategic acquisitions, Stolt Sea Farm S.A. concentrated almost half of the production of the Spanish sector already in its first year of activity (750 tonnes among a total of 1,539 tonnes) (Fernández et al., 1998). On the other hand, in Cantabria and the Basque Country there was no increase in the number of turbot companies, nor did foreign capital enter the sector. This fact led to an increase in the difference between turbot production in Galicia and in the other regions.

The strategy of cooperation between companies was consolidated in Galicia. Its objective of promoting technological change led to the incorporation of technological improvements, such as the use of dry extruded feed, water recirculation techniques (replacing the open cycle), advances in vaccines and improvements in the oxygenation of incoming water (Labarta, 2000; Merchie et al., 1996; Person-Le Ruyet, 2001). But the technological improvement that has helped most to consolidate the dominance of large companies, has been the progress in the supply of fry. Insuiña-Pescanova S.A. and Stolt Sea Farm S.A. were the first companies to start fry production in Spain, and also the first to achieve self-sufficiency in the supply of fry (Bjørndal & Øiestad, 2011; Fernández-González, Pérez-Pérez, & Garza-Gil, 2020). In this way, large companies in the sector established a strategy of cost leadership, which has proven to be successful.

The two large companies in the sector are also initiating another strategy: the strategy of internationalization of the sector. In this case, the type of internationalization would be the one oriented to increase the commercialization



of turbot in European Union countries (Ruiz Molina, 2001). Despite the efforts made, this strategy has not been consolidated. Neither in the 1990s nor in later stages of the sector has more than a quarter of Spain's turbot production been exported (Bjørndal & Øiestad, 2011).

In 1996, concentration rates showed a high increase. These results are a consequence of a new crisis in the Spanish turbot sector. They are due to the fact that, although the marketing network had improved since 1992, it had not done so sufficiently to absorb the increase in production caused by the entry of Stolt Sea Farm S.A. into the Spanish market. On the other hand, between 1988 and 1997, the annual rate of change of turbot prices decreased by 8% (González Laxe, 2002). The consequences of this price variation on small companies were much more serious than on large companies. The explanation comes from the fact that the fixed costs of small companies barely fell, since this type of company did not benefit as much as large companies from technological advances and, therefore, suffered a decrease in operating margins (González Laxe, 2002).

In addition, a large part of Spanish turbot production was for domestic consumption, so Galicia's production competed with that of Cantabria and the Basque Country in supplying turbot to Spanish market (Iborra Martín, 2010). As a consequence of the crisis, a small number of firms closed, and the total production of the sector was reduced from 2,189 tonnes in 1996 to 1,799 tonnes in 1997 (APROMAR, 2004). This situation mainly affected small and medium-sized firms, which experienced the effects of this crisis for several years. Galicia, as its production depended on two large companies, experienced the crisis to a lesser extent. However, Cantabria and the Basque Country, with a market made up of a reduced number of small and medium-sized companies, suffered a very sharp decline in production until 2001. The reduction in the market share of small companies reinforced the dominance of the leading company (Stolt Sea Farm S.A.). This is reflected in a market share of the leading company of nearly 60% and a dominance index of 0.64 points.

At this stage, the evolution of the institutional framework of the different regions does not produce relevant developments affecting market concentration. During the 1990s, Asturias and the Basque Country approved laws on sea fishing and marine aquaculture. These laws, like the new fisheries law of Galicia in 1993, which replaces the 1985 law, focused mainly on the fisheries sector and did not cause major changes in the governance situation of the different regions, which continued to benefit from the economic allocations of the multiannual aquaculture plans (JACUMAR, 2013; Polanco, Ruesga, & Polanco, 2000).

4.3 | The consolidation of the oligopoly

Since 2000, the marine aquaculture sector in Spain is facing its maturity and is in a process of strong industrialization (Ruiz Molina, 2001). Its structure is dual, as small and large companies coexist. Investment in R&D, both public and private, has strengthened this industry (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020). It must be remarked that knowledge in aquaculture management, whether biological, economic or technological, is high, especially in contrast to the previous stages of the sector (González Laxe, 2001).

In 2002, concentration rates showed a general decline, with the fall in the value of the DCR being particularly deep. This is explained by the growth in production of companies located in the Spanish Cantabrian area, as firms in the Basque Country and Cantabria were recovering from the 1996 crisis. In addition, in 2002, the first production from the region of Asturias was marketed. On the other hand, in Galicia, there was an ecological disaster due to the *Prestige* oil spill. The companies closest to the area of the sinking had much more harmful effects due to the spill. Some of them went bankrupt or closed due to economic losses and others discarded part of their production, as was the case of Stolt Sea Farm S.A. As a result, its market share was reduced by more than 20 points. However, Stolt Sea Farm S.A. did not lose its dominant position due to this crisis, but rather, following its external growth strategy, strengthened it in the following years. Both Stolt Sea Farm S.A. and Pescanova-Insuiña S.L. acquired some of the small Galician companies most affected by the spill, which is reflected in the recovery of the concentration index values. In 2004, the strong recovery of Stolt Sea Farm S.A. allowed it to open Europe's largest turbot cultivation plant in Galicia, which is reflected in the increase in the value of CR1 and DCR in 2006.



However, it is necessary to clarify that the opening of this new turbot plant is an isolated event in recent decades. The institutional framework for the management of the coastline presented an increasingly restrictive planning for the construction or expansion of marine aquaculture plants. This situation is particularly restrictive in Galicia. The expansion of the Marine Protected Area (MPA), along with increasing rivalry in the use of the coastline, restricted the expansion of turbot farming (Fernández-González, Pérez-Pérez, & Varela Lafuente, 2020). Faced with this scenario, large companies located in Galicia reinforced their external growth strategy since, if they could not obtain the necessary permits for new construction, it was the most feasible way to expand production.

As discussed in Chu, Anderson, Asche, and Tudur (2010), in the aquaculture sector, the institutional factor may influence growth more than innovation, technological improvements and market opportunities. This is precisely what is happening in the last phase of the Galician turbot sector, where the absence of a renewed institutional framework has slowed down the allocation of rights to occupy coastal spaces, conditioning the growth of the industry. Since 2008 no plant has been built and only one has been extended, being its owner Pescanova-Insuiña S.L. This situation implies the creation of a new market entry barrier. In 2009, motivated by the institutional blockade, the internationalization strategy of Pescanova-Insuiña S.L. began with the opening of a turbot plant in Mira (Portugal). However, due to the multiple logistical problems and the poor results achieved, this can be considered a failed internationalization strategy. During the eight years that the activity of this plant lasted, its impact has not been significant for the Spanish market, given the low production reached.

In this period the cost leadership strategy of the two big companies in the market is consolidated. There have been several technological advances in this period: the use of tunnel boring machines for the collection of seawater, the introduction of RAS, the automation of feeding or genetic control to reduce the time of the reproduction cycle (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020). The companies with genetic selection plans are only Stolt Sea Farm S.A. (including its subsidiary Alrogal S.A.) and Insuiña-Pescanova S.L. (Taboada et al., 2014). As for the RAS, only one company, Stolt Sea Farm S.A., employs it (Expansión, 2020).

Recently, Stolt Sea Farm S.A. has initiated a commercial strategy to differentiate its product with the creation of the *King Turbot* trademark, through which it will commercialize its product outside its traditional markets. In this way, although Stolt Sea Farm S.A. sells its fresh, whole turbot, like the rest of the sector, it aims to differentiate itself with a higher quality turbot at a slightly higher price than the €8–9/kg at which turbot has been sold for decades (APROMAR, 2004, 2019). Farmed turbot is a very homogeneous product, so it can be a successful strategy. In addition, cultivated turbot lacks a clear substitute product that would generate competition affecting prices. Wild turbot is 120% more expensive and other fish products, such as seabream and seabass, are not clear substitutes for turbot either, as their prices are over 2€ lower (Bjørndal & Guillen, 2017). There are other flatfish on the market with organoleptic characteristics closer to turbot, such as sole, although their limited production volume means that they cannot function as substitutes for the moment.

After the 2002 crisis, Galicia's leadership was reinforced, going from producing 81% of Spanish production in 2002 to 90% in 2008. This is the result of the fact that, while Galicia increased its production, the production of the rest of the Spanish regions decreased. Since 2008, as can be seen in Table 3, the top four companies in the industry are in Galicia. The absence of a dynamic of change among the dominant positions is largely due to the conditions of regulation of the sector in Galicia. The last ten years have been characterized by an oligopolistic trend in which variations in concentration rates have been moderate.

Despite the fact that the sector has behaved in a very stable manner in recent years, the external growth strategy has led not only to an increase in market share of the large firms but also to an increase in average production. Proof of this is that average production per company has increased from 108.1 tonnes in 1992 to 1,054.3 tonnes in 2018. This figure is, in part, a consequence of the decrease in the number of firms in the Spanish turbot sector, as neither the attempts to create new companies have prospered, nor the already consolidated companies have been able to overcome the crisis. On the one hand, although there were new initiatives to cultivate turbot in the Mediterranean regions, none of them have been successful. Andalusia only produced turbot between 2003 and 2004, with a total of 15.66 tonnes, while Catalonia did not reach 6 tonnes between 2006 and 2007. On the other



TABLE 3 Leading companies in the Spanish aquaculture turbot sector

	1983	1988	1998	1998	1998						
1°	Insuiña S.L.	Galicia	! Pescanova-Insuiña S.L.	Galicia	= Aquazol S.A.	Galicia	!	Stolt Sea Farm S.A.	Galicia	!	
2°		Experimental culture. Country	Basque Country	Basque Country	!	Prodemar	Galicia	!	Piscícola Morrazo S.L.	Galicia	↑
3°		Rodecan S.L.	Galicia	Galicia	!	Granja Atlántica de Couso	Galicia	!	Insuamar S.L.	Galicia	↑
4°						Piscícola Morrazo S.L.	Galicia	!	Pescanova-Insuiña S.L.	Galicia	↑
	2003	2008	2008	2013	2018						
1°	Stolt Sea Farm S.A.	Galicia	= Stolt Sea Farm S.A.	Galicia	=	Stolt Sea Farm S.A.	Galicia	=	Stolt Sea Farm S.A.	Galicia	=
2°	Pescanova-Insuiña S.L.	Galicia	↑ Pescanova-Insuiña S.L.	Galicia	=	Pescanova-Insuiña S.L.	Galicia	=	Pescanova-Insuiña S.L.	Galicia	=
3°	Culmanor S.A.	Basque Country	! Acuidoro S.L.	Galicia	↑	Aquacría Arousa S.L.U.	Galicia	=	Aquacría Arousa S.L.U.	Galicia	=
4°	Acuidoro S.L.	Galicia	↑ Aquacría Arousa S.L.U.	Galicia	↑	Piscícola Morrazo S.L.	Galicia	↑	Piscícola Morrazo S.L.	Galicia	=

Note: !: New company in the sector; =: Same position as previous period; ↑: Higher position than in the previous period; ↓: Lower position than in the previous period.^a Source: Own elaboration. Data from ARDAN (2020), Fernández et al., (1998), Fernández-González, Pérez-Pérez, and Garza-Gil, (2020), SABI database (2020) and Vázquez (1996).



hand, the effects of the 2002 crisis and the consequences of the 2007 economic crisis, negatively affected the profitability of Cantabrian companies. Thus, the only Asturian company stopped trading in 2008, while the two companies in the Basque Country stopped growing turbot in 2010 and 2012, respectively. For its part, turbot continues to be grown in Cantabria, although there is only one company on the market, which produced only 0.5% of Spain's turbot production in 2018.

At present, all the indices show a high value corresponding to a highly concentrated market. The CR1 index is close to 47%, which shows that the leading company has almost half of the market share in the sector. On the other hand, the CR2 index reaches 84%. It should be noted that the HHI shows a value well above 2,500 points since 2006, reflecting a very high level of concentration that is maintained over time.

5 | CONCLUSIONS

The progressive increase of concentration in the Spanish turbot sector is a fact confirmed by all the concentration indices analysed in this study. During its first years, after a brief period of monopoly, the market structure of this sector consisted of small homogeneous companies in terms of production and market share, as presented by Kamstra and Nijhof (1991), which is reflected in the low values of all the concentration indices. At the beginning of the 1990s, therefore, the market was atomized and had the lowest concentration rates in the history of the sector.

Nowadays, unlike other Spanish aquaculture sectors such as mussels or seabass and seabream sector, the turbot industry is highly concentrated (Polanco et al., 2000; Ruesga Benito et al., 2005). While it shares characteristics with other aquaculture sectors such as limited internationalization, a low percentage of exports, or lack of product differentiation, the turbot sector is differentiated by its high degree of concentration (Ruiz Molina, 2001).

The 1992 crisis was a turning point in the Spanish turbot industry, as the trend towards atomization was definitively broken and replaced by an increasingly intense dynamic towards market concentration. On this point, Galicia stands out from the rest of the turbot-producing regions (Cantabria and the Basque Country) as it has benefited more from the horizontal integration process and technological advances. These two factors are an important part of business strategies.

One of the factors that has most promoted concentration in this industry has been business strategies, all of which have taken place in Galicia (Ruiz Molina, 1997). In the early days of the sector, the associationism of Galician companies led to a strategy of cooperation. However, it has been Stolt Sea Farm S.A. and Pescanova-Insuiña S.L. who have benefited most from the cost strategy and the external growth strategy implemented by each of them. Access to and implementation of technology in their plants, such as improvements in feeding, immunization of the specimens or the supply and the use of RAS, have increased the productivity and average size of each turbot hatchery (Fernández-González, Pérez-Pérez, & Garza-Gil, 2020).

The institutional framework is a factor that must also be analysed in relation to the concentration of the turbot sector in Spain. At the beginning of this sector, Law 23/1984 on Marine Cultivation and Law 22/1988 on Coasts, as well as the multi-year plans, guaranteed a common starting point for all Spanish regions (González Laxe et al., 2004). However, as Fernández-González, Pérez-Pérez, and Varela Lafuente (2020) explain, the institutional framework has been a constraining factor for Galicia in its last stage. For the last 15 years, the failure to pass an aquaculture law or a strategic plan for the sector in Galicia has meant that no new concessions have been processed on the Galician coast. This fact has hindered the expansion of the dominance of the Galician firms in the Spanish market.

For their part, the Cantabrian regions (Asturias, Cantabria and the Basque Country) have been limited in their ability to compete with the business strategies of the large Galician turbot companies. These were medium or small-sized companies, where the financing capacity and degree of technology transfer was not as high. In this way, the comparative advantage of the large Galician companies became greater and greater over time. While they were emerging stronger from the crisis, small companies, including Galician ones, were experiencing so many difficulties that they were unprofitable and closed.



The result of the concentration rates carried out in this analysis describes a highly concentrated sector, a market that has evolved into an oligopoly. Currently, only the two big companies in the sector concentrate 85% of the market share and the concentration ratios (CR1, CR2 and CR4) contain only Galician companies since 2008, excluding the Asturian, Basque and Cantabrian companies.

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Resumen. Este artículo analiza la evolución regional de la estructura del mercado en la industria española del rodaballo, la mayor productora de rodaballo en Europa, mediante el empleo de diferentes índices de concentración. El análisis se realizó teniendo en cuenta varios factores que han influido en la evolución del sector, entre los más importantes el uso de tecnología, las estrategias empresariales y el marco institucional. Los resultados confirman un proceso de concentración. Partiendo de una fase inicial en la que el sector estaba compuesto por un gran número de pequeñas empresas, esta industria ha evolucionado hacia una situación en la que tan sólo dos grandes empresas dominan el mercado.

抄録: 本稿では、ヨーロッパの主要なターボット生産者であるスペインのターボット養殖産業における市場構造の地域的進化を、異なる濃度率を用いて分析した。このセクターの発展に影響を与えたいくつかの要因を考慮して分析を行う。最も重要なのは、技術の応用、事業戦略、制度的枠組みである。分析の結果から、集中化の過程が確認された。この産業が生まれた当初はかなりの数の小企業で構成されていたが、現在では2大企業のみが市場を支配する状況に発展した。