Antitrust Legislation and Cooperation in Fish Marketing

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Abstract

The limited exemption from antitrust legislation enjoyed by the Israeli agricultural sector enabled collective marketing of fish by aquaculture producers. The cartel-like organization of fish marketing raised concerns that fish growers exploited market power to the detriment of consumers and total welfare. On the other hand, grower cooperation in marketing may increase producers' as well as total welfare if the marketing sector is imperfectly competitive. We use a simulation approach to evaluate the costs and benefits ensuing from cooperative selling in the aquaculture sector, compared to alternative market structures. Results indicate that despite far-reaching cooperation, fish farmers did not behave like a cartel and marketed quantities which were much closer to the competitive equilibrium than to an outcome expected for a producer cartel. On the other hand, we demonstrate important potential benefits from cooperation in the case of an imperfectly competitive marketing sector – commonly observed for many agricultural products. The Israeli aquaculture sector provides an example of the importance of a limited antitrust exemption for the agricultural sector.

Key words: Agriculture, Antitrust Regulation, Aquaculture, Collective Marketing, Cooperative, Market Power, Simulation

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Introduction

Until a few years ago, Israeli aquaculture producers marketed their production jointly. The organizational structure for collective marketing was the Fish Growers Organization (FGO), a voluntary producer organization and marketing cooperative. Far-reaching cooperation of fish farmers was enabled by the limited exemption of the agricultural sector from antitrust regulation.[1]

The cartel-like organization of fish marketing raised concerns that fish growers exploited market power to the detriment of consumers and total welfare. On the other hand, special characteristics of the agricultural sector may justify cooperation in marketing. Agricultural production is generally characterized by an atomistic structure with many farmers producing identical or very similar products. Joint marketing of agricultural products enables farmers to exploit economies of scale in marketing operations and information gathering. Further benefits from joint marketing may be obtained when markets are characterized by imperfect competition. Farmers sell their production to wholesale and retail sectors which are much more concentrated. In addition, many farm products are perishable, and short term supply is very inelastic. These characteristics may enable buyers to exercise market power and cause a decline of farmers' and consumers' welfare.

Similar to other agricultural products, short-term supply of fresh fish is inelastic and fresh fish is very perishable. We use a simulation approach to evaluate the costs and benefits ensuing from cooperative selling in the Israeli aquaculture sector. We compare actual industry results to outcomes expected for perfect competition, a producer cartel, a monopsonistic buyer and bargaining between two firms (a monopsonistic buyer and a grower cooperative). According to our results, fish farmers did not behave like a cartel and marketed quantities which were much closer to the competitive equilibrium than to an outcome expected for a producer cartel. On the other hand, we demonstrate important potential benefits from cooperation in the case of an imperfectly competitive marketing sector – commonly observed for many agricultural products. Our analysis provides empirical evidence supporting a limited antitrust exemption for the agricultural sector.

Rogers and Sexton (1994) assert that markets for raw agricultural products are likely to be structural oligopsonies. According to Dobson et al. (2003), increasing concentration in European food retailing increased retailer buyer power, enabling retailers to impose vertical restrains on producers and drive down producer prices. In markets for perishable products sellers are generally in a weaker bargaining

1 For a discussion of the agricultural exemption in Israeli antitrust regulation see Kachel and Finkelshtain (2005).

position compared to buyers because they have to sell their production in a short time period or realize considerable losses. Sexton and Zhang (1996) developed a model of price determination for fresh produce with completely inelastic supply in the short run for prices above marginal harvest costs. In their model, the available surplus (the difference between the derived demand function for a competitive marketing sector and harvest costs) is divided between farmers and buyers according to their relative bargaining power. Bargaining power of farmers is inversely related to total yield at time *t*, with farmers being able to obtain a larger share of the surplus if yield is low. Sexton and Zhang applied their model to the market for California iceberg lettuce and found evidence that buyers were successful in capturing most of the surplus. In a recent study, Sexton, Zhang and Chalfant (2005) investigated the markets for mature-green and vine-ripe tomatoes, and iceberg lettuce. Their results for iceberg lettuce confirm the result of the previous study. The results for tomatoes are inconclusive, and competitive behavior could not be rejected. Better organization of tomato growers compared to lettuce growers (e.g. most of Florida's tomatoes are marketed by a cooperative) and differences in the market chain (tomatoes are sold to re-packers while iceberg lettuce is directly sold to retail chains) provide probable explanation of the different results.

Another cause of market imperfection may be limited information about selling prices. Kachel (2003) developed a model characterizing contract choice in the Israeli citrus industry. The model shows that contract choice may decrease price competition among citrus exporters by limiting the amount of price information provided to growers. In equilibrium, at least one exporter chooses to offer growers a consignment contract providing no information on the price to be paid. Empirical results confirm the predictions of the theoretical model (see also Kachel et al., 2004).

In markets with oligopsonistic buyer power the organization of growers into marketing cooperatives may increase their bargaining power and attain a market outcome that increases growers' welfare and even aggregate welfare. Economic theory shows that the outcome of bargaining between two firms can be preferable to the equilibrium of an oligopsonistic market from a welfare point of view (Nash, 1950). This view is supported by the policies of the European Union (EU), where producer organizations are recognized as key element in grouping supply in the fruit and vegetable sector, helping producers to face up to the increasingly concentrated retail sector. Since 1996, growers are encouraged to establish and join producer organizations by co-financing of so-called Operational Programs. In 2004, 34% of the fruit and vegetable production of the EU was marketed by producer organizations. In a current reform proposal, the EU recognizes that despite the financial support the organization level of fruit and vegetables producers is too low and varies strongly across member states and suggests further reforms to make producer organizations more attractive (Duponcel, 2006; Commission, 2007).

According to Rogers and Sexton (1994) “absent public intervention to promote competition in raw product markets, farmers’ main opportunities to foster competitive behavior in their selling markets are through developing means of countervailing power”, including bargaining associations and marketing cooperatives. In the United States, fruit and vegetable growers and milk farmers may organize as marketing orders which enable a legally enforceable cooperation of all growers in an industry. Most of the more than 30 currently existing federal marketing orders are used for industry research and promotion. In addition, some of them are authorized to use direct volume controls (either in regulating the flow to market, affecting market allocation, or setting a reserve pool). There are many more marketing orders with state-level authorization, none of them allowed to use direct volume or market flow controls (Chalfant and Sexton, 2002). Crespi and Chacón-Cascante (2004) examined market power exerted by the California almond board. They found that the almond board did not act as a profit-maximizing cartel. The board just exercised about a third of the potential market power in the domestic market and in export markets, despite being a near monopoly in the domestic market and the dominant supplier in world markets.

In addition to direct volume controls, marketing orders (and other producer organizations) may employ indirect means to control supply. An example is industry-wide quality standards which may be used to price-discriminate between a market for premium quality characterized by inelastic demand, and a secondary market with elastic demand. By controlling the grading error an industry can theoretically achieve the same price discrimination outcome as might be attained through the more direct forms of volume regulations (Chalfant and Sexton, 2002). Limited supply control afforded to grower organizations might be even welfare enhancing if it enables growers to organize themselves and produce a differentiated product which would not be produced otherwise. Lence et al. (2007) compare the welfare implications of various forms of legislation designed to encourage agricultural producers to geographically differentiate and collectively market their products. They show that it is essential to provide producer organizations with some leeway in controlling supply to enable them to cover fixed costs of establishing and marketing their differentiated product.

Several studies have attempted to measure the effect of cooperatives on market performance. The evidence from most of them is inconclusive with regard to the cooperatives' ability to exercise market power and increase prices for their products (see for example Wills, 1985; Petraglia and Rogers, 1991; Haller, 1992), with the exception of cooperatives in the US dairy sector. According to Masson and

Eisenstat (1980) and Madhavan et al. (1994), US dairy cooperatives succeeded in raising retail fluid milk prices by using price discrimination in the years before 1975. According to Crespi and Sexton (2003), the effect of US grower cooperatives and marketing orders on competition is limited: “Beyond milk, and, to a lesser extent, navel oranges, there is very little evidence of market power achieved through marketing orders.” Hueth and Marcoul (2003) suggest that cooperative bargaining associations of US farmers did not manage to negotiate significant price increases with processors and handlers of farm output but may be useful for price discovery and ensuring contract reliability.

To summarize, the literature on agricultural producer cooperatives provides little evidence for the exploitation of market power by grower cooperatives. On the other hand, there are well-founded concerns that buyers of agricultural products exploit their dominant position, providing a case for supporting grower cooperation in marketing their products in order to increase growers’ bargaining power.

Similar to fruit and vegetables, short-term supply of fresh fish is inelastic and fresh fish is very perishable, characteristics which may decrease the bargaining power of growers. The objective of our research is to conduct a cost-benefit analysis of cooperative selling in the aquaculture sector and compare cooperation to alternative market structures. We use a simulation approach which enables us to calculate costs and benefits for growers, traders and consumers for different market structures. As the basis for the simulation we estimate econometrically the demand functions for the main fish species grown by the Israeli aquaculture sector and use cost and yield data to evaluate the marginal cost of fish production.

Institutional background

Average per capita consumption of fresh and frozen fish in Israel is about 10 to 11 kg per year and is rather stable. In recent years (2002-2004), about 65,000 mt of fish were marketed per year, about 60% from imports (mainly frozen fish filets). Aquaculture accounts for about 75% of domestic production; the remainder is supplied by mariculture and fisheries in the Mediterranean and the Sea of Galilee (Department of Fisheries & Aquaculture, 2007). Domestic production is marketed mainly fresh. The main fish species grown in Israeli aquaculture are carp, tilapia and mullet, accounting for more than 90% of aquaculture production.

According to the Department of Fisheries, there were about 73 aquaculture producers in Israel during most of the 1990s, some of them very small or not active. About 40 growers (mainly Kibbutzim) were members of the FGO; these growers produced more than 90% of the aquaculture output. Israeli aquaculture growers marketed their production collectively through the FGO for decades until the year 2000. The FGO operated a system of annual production quotas. The quotas were determined about a year in advance according to marketing forecasts for the coming year for each fish species. Each grower was allocated an annual quota, based on historical quantities. The quotas were not tradable. At the end of each year, limited quota adjustments were made.

The FGO appointed an exclusive marketing agent (Tnuva) for fresh fish. Selling prices were fixed by the FGO. Tnuva was paid a commission of about 10% of the selling price. A small part of the production was diverted to a processing plant owned by the FGO. Growers were allowed to sell small quantities of fish at "stalls" on their farm which were initially not included in the quota. These stalls provided some flexibility for growers to increase production. At the peak there were 16 stalls marketing about 10% of aquaculture production. After a few years with growing quantities of fish marketed outside the framework of the FGO, the joint marketing was terminated in April 2000.

Since then, 4 to 6 companies (some of them owned by growers) market about 90% of aquaculture production; in addition there are many small buyers. Fish growers are complaining that after the termination of joint marketing the profitability of aquaculture decreased markedly, with prices at times not covering production costs. There are complaints that consumer prices for fresh fish did not decrease to the same extent, indicating the possibility of imperfect competition in the marketing sector.

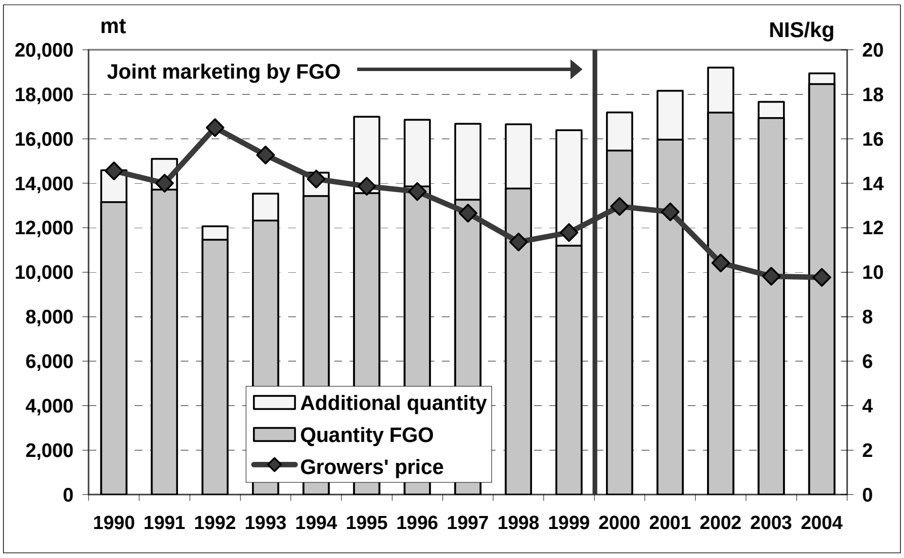
Figures 1 to 4 show the development of production quantities and grower prices (real prices, deflated with CPI, January 2005 = 100) for total aquaculture production and for carp, tilapia and mullet for the years 1990 to 2004.

Methodology

Our objective is to evaluate the costs and benefits of different market structures for growers, marketing firms, consumers and total economic surplus. In the first stage, we estimate derived demand functions for the main pond fish produced and consumed in Israel (carp, tilapia, mullet). We approximate long-term supply functions based on production costs in different regions in Israel. Demand and supply functions provide the basis for simulating equilibrium outcomes of different market structures.

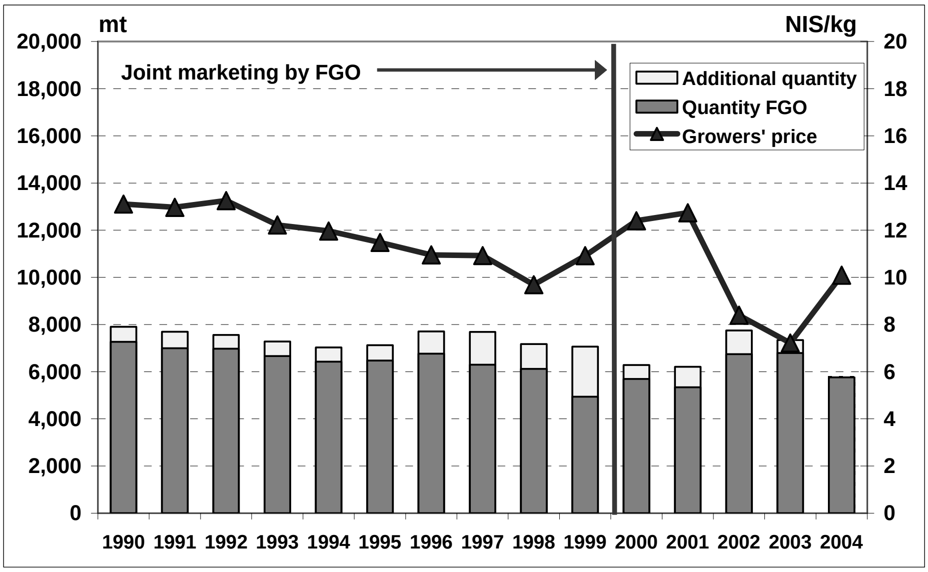
We compare the outcome obtained by a producer cartel and the case of a trade monopsony with the benchmark outcome of perfect competition. To account for the possibility that cooperation provides growers with countervailing bargaining power versus an imperfectly competitive marketing sector we simulate the outcome of a cooperative bargaining game based on Nash (1950).

Figure 1: The aquaculture sector in Israel – quantities and grower prices



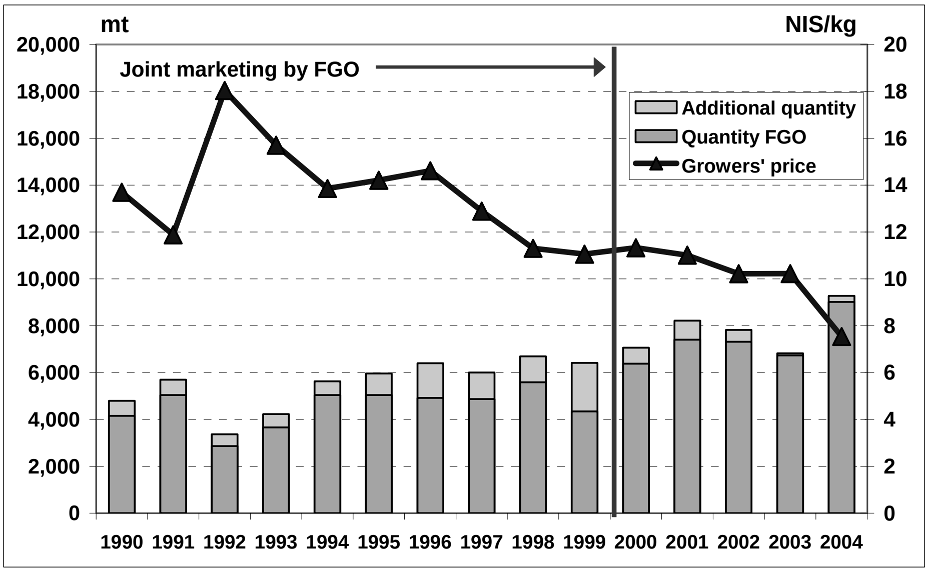
Data sources: FGO; Department of Fisheries & Aquaculture

Figure 2: Carp production in Israel – quantities and grower prices



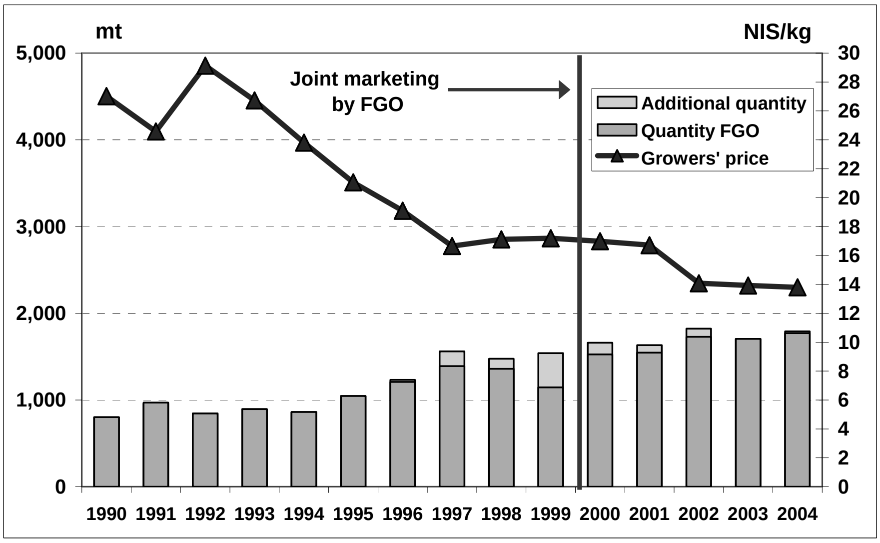
Data sources: FGO; Department of Fisheries & Aquaculture

Figure 3: Tilapia production in Israel – quantities and grower prices



Data sources: FGO; Department of Fisheries & Aquaculture

Figure 4: Mullet production in Israel – quantities and grower prices



Data sources: FGO; Department of Fisheries & Aquaculture

In the short term, supply of fresh fish is very inelastic – production decisions are taken more than a year in advance and the possibility to store fish in ponds is limited. To account for inelastic supply we also perform simulations based on completely inelastic short-term supply functions.

Table 1 presents descriptive statistics for fish quantities and prices from aquaculture production marketed in Israel in the years 1990 to 2004.

Table 1: Fish quantities and prices – descriptive statistics
(Based on quarterly data from 1990 to 2004)

		Average	Standard Dev.	Minimum	Maximum
Grower price*	Carp	11.26	2.00	5.99	15.87
(NIS/kg)	Tilapia	12.86	3.71	6.80	28.92
	Mullet	19.92	5.43	12.49	33.43
Quantity	Carp	1,798	377	1,112	2,448
(1000 mt)	Tilapia	1,567	448	224	2,584
	Mullet	330	105	172	529
Quantity	Carp	314	81	171	489
(grams per cap.)	Tilapia	266	61	44	385
	Mullet	56	13	32	89

* Real prices (deflated with CPI, January 2005 = 100)
Data sources: FGO; Department of Fisheries & Aquaculture

Empirical estimation of demand function

We estimated inverse derived demand functions for carp, tilapia and mullet. Inverse derived demand for fish of species *v* is

$$w_v^t = f_v\ (q_1^t, ..., q_V^t, X_v^t)\,, \qquad (1)$$

where w_v^t is the grower price for fish of species *v*, $q_1^t, ..., q_V^t$ are per capita quantities of fish,[2] and X_v^t is a vector of exogenous variables expected to affect the demand of fish. Exogenous variables include dummy variables for main Jewish holidays (Passover, Jewish New Year), which are characterized by an increase in the demand for fish, and a linear trend variable.

In Israel, fresh pond fish is mainly sold in specialized fish shops, decreasing the short term substitutability with frozen fish (sold mainly in supermarkets) and chicken and beef (sold in supermarkets and butcher shops). According to consumer research prepared for the FGO at the beginning of this decade, most consumers buy either frozen or fresh fish, while only 16% of consumers buy frozen as well as fresh fish! We therefore anticipated that changes in prices for frozen fish fillet, chicken or beef will have no immediate impact on consumption of fresh pond fish. In line with our expectations, coefficients for consumer prices for frozen fish fillet, chicken and beef were insignificant in the preliminary estimations of derived demand and were not included in final estimations.

We estimated the system of demand equations with 3SLS to account for simultaneity and correlation of errors in different demand equations. Supply-side instruments include fish stocks in ponds, the price of fish feed, cost indices, and a dummy variable accounting for cold weather in winter 1992 which affected the supply of tilapia and mullet in 1992 and the first half of 1993. In addition, we used an index based on average production per 1000 m^2 pond area to take account of technical progress.

We employed quarterly data for the years 1990 till 2004. Data on marketed quantities,[3] prices, and fish stocks were obtained from the FGO. Prices for substitutes and cost indices are from the Central Bureau of Statistics (CBS). Feed prices were obtained from one of the main suppliers of fish food (Zemach). Price and cost data were deflated with the CPI (January 2005 = 1000). We included slope and intercept dummies for the period after the termination of joint marketing to account for the impact of changes in the competitiveness and efficiency of the marketing sector on the derived farm-level demand. Such changes may affect the level and elasticity of the derived demand, even if the consumers' level demand remains intact.

Table 2 presents the final estimation results. Results are based on linear specification of the demand functions. Other functional forms (logarithmic, log-linear) yielded similar demand functions in the range of the observed values.

2 Using per capita quantities instead of total quantities marketed enabled us to include a trend variable to account for changes in preferences. This trend variable was highly correlated with the population variable (r = 0.99).

3 Quarterly quantities reported by the FGO were adjusted based on total annual quantities (reported by Department of Fisheries & Aquaculture), in order to represent total quantities marketed.

The coefficients for own quantities are negative and significant at the 0.01 level for the two main fish species carp and tilapia and at the 0.05 level for mullet. The derived demand functions for tilapia and mullet did not change significantly after the end of joint marketing. For carp, the intercept dummy indicates a significant increase in the derived demand that may reflect increased efficiency of the marketing sector. The slope dummy is insignificant at the 5% level. We calculated own-price elasticities of demand for the period before and after the change in marketing, based on average prices and quantities observed in each period. Absolute elasticities in the period of the collective marketing were smaller than 1.0 for carp (-0.72) and larger than 1.0 for tilapia (-1.08) and mullet (-2.28). Estimated elasticities declined in the second period and are smaller than 1.0 for all three fish species.

Table 2: Fish demand - estimation results (Dependent variable: price in NIS/kg)

	Carp		Tilapia		Mullet	
Explanatory variables:	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
Constant	26.38	8.53**	28.21	6.67**	48.20	9.34**
Quantity Carp (grams/cap.)	-0.048	-4.76**	-0.000	-0.01	-0.020	-1.13
Quantity Tilapia (grams/cap.)	-0.000	0.97	-0.052	-7.90**	-0.028	-4.72**
Quantity Mullet (grams/cap.)	0.114	2.94**	-0.028	-0.48	-0.190	-2.50*
Quantity * Dummy Change	-0.021	-1.74	0.001	0.06	-0.196	-1.25
Passover/Jewish New Year	5.18	5.20**	1.64	1.08	6.18	3.33**
Food scare (Malachite green)	-0.431	-0.36	-3.76	-2.14*	-4.21	-1.90
Trend	-0.318	-5.76**	-0.011	-0.17	-0.264	-2.64**
Dummy Change	7.79	2.55*	-1.35	-0.24	16.72	1.62
R^2	0.64		0.75		0.85	
R^2 (adjusted)	0.58		0.71		0.83	
DW	1.95		1.66		2.26	
No of observations	59		59		59	
Own price elasticity of demand:	Before change	After change	Before change	After change	Before change	After change
Average quantity (grams/cap.)	340	259	251	298	51	66
Average price (NIS/kg)	11.77	10.16	14.14	10.10	22.20	15.00
Elasticity	-0.72	-0.57	-1.08	-0.67	-2.28	-0.59

* significant at 0.05 level, ** significant at 0.01 level

Demand for all fish species increases in quarters including the Passover Holiday or Jewish New Year. The increase is significant for carp and mullet. Carp is used to prepare traditional Jewish food consumed at Jewish Holidays. A dummy variable included to measure the impact of the publication that tilapia growers used a banned chemical suspected to cause cancer (Malachite green) indicates a large temporary decline of tilapia demand.[4] For carp and mullet, the coefficient for the dummy variable has the expected negative sign but is not significant for carp and significant at the 10% level for mullet.

Estimation results indicate that tilapia is a substitute for mullet. The coefficient for quantities of mullet has the expected negative sign in the demand equation for tilapia but is not significant. Contrary to expectations, quantities of tilapia have no significant impact on the price of carp (and vice versa). It seems that the importance of carp in the traditional Jewish cuisine decreases its substitutability with other fish. The coefficient for mullet quantities in the demand equation for carps is significant but not negative like expected.

The coefficient of the trend variable is negative in all three demand equations but not significant for tilapia. It indicates a decline in demand over time for carp and mullet. Despite little short-term substitutability between fresh pond fish and chicken or frozen fish, results indicate changes in consumption patterns in the long term, with consumers shifting away from purchasing and preparing fresh whole fish to more convenient and cheaper alternatives like frozen fish and chicken.

Supply of pond fish

We approximated long-run supply functions for carp, tilapia and mullet, based on production costs in the main production region (Beit Shean and Jordan Valley) and productivity per area of fish pond in different production regions. About 60% of pond fish is produced in the Beit Shean region and the Jordan valley, and detailed cost calculations for this area are available.[5] To estimate production costs in other areas, we assumed that variable production costs (food, fingerlings, labor, packing, insurance) per kg fish are identical in all regions, while maintenance costs of ponds are identical per ha of pond area. According to extension officers of the Ministry of Agriculture these assumptions are reasonable. Maintenance costs include mainly

4 After the media published the use of Malachite green by tilapia growers in November 2003 the Health Ministry prohibited the marketing of pond fish for a week. The demand for tilapia in the aftermath of the scare declined during several months. The dummy variable accounting for the effect of the scare has the value of 1 in the last quarter of 2003 and the first quarter of 2004.

5 For detailed cost data see Kachel and Finkelshtain (2006).

water, energy, vehicle costs and spare parts and account for close to 40% of total production costs. The calculation of maintenance costs per kg of fish is based on data of production per ha pond area in the different production regions.

Table 3 presents cost data (not including capital cost) for different production areas calculated based on these assumptions and corresponding cumulated production quantities attainable at prices covering these costs.[6] We assumed that for additional increases in production investment is necessary which will take place in the most efficient area. The data in Table 3 represent a stepwise supply function, based on the assumption that production costs in the same area are identical for all fish farmers. To obtain more realistic supply functions we fitted linear regression functions to the data. These functions were adjusted for each year of the simulation period based on changes in productivity (quantity produced per ha of fish pond) and input price changes.

Table 3: Fish supply – cost and production quantities

	Cost (NIS/kg)			Cumulated production (mt)		
Area	Carp	Tilapia	Mullet	Carp	Tilapia	Mullet
Beit Shean + Jordan valley	8.47	9.43	11.13	3,303	5,122	1,156
Gilboa area	9.90	10.95	12.82	4,336	6,340	1,654
Galilee	9.97	11.01	12.90	5,792	6,771	1,703
Coastal area	10.26	11.32	13.24	8,120	8,417	2,006
Investment in Beit Shean + Jordan valley	10.52	11.59	13.54	9,744	10,101	2,408

Simulation results

Collective marketing of growers can improve the bargaining power of growers if the marketing sector is imperfectly competitive. On the other hand, growers organized in a marketing cooperative may exploit market power to the detriment of consumers and total welfare. In order to examine the impact of cooperative fish marketing we simulate the outcome of various market structures. Since it is not clear what is the appropriate length of supply-run to consider in

6 The quantities in the Table are based on production quantities in 2002 plus 10% (in 2003 and 2004 quantities decreased somewhat).

monopsony/oligopsony analysis, it is our strategy is to simulate the two extremes – long-run (elastic) supply and short-run (perfectly inelastic) supply.

Simulated quantities based on long-run supply functions for a perfect competitive equilibrium, a producer cartel and a trade monopsony are presented in Figure 5 and are compared to the actual quantities marketed. Results indicate that in the period of joint marketing the actual quantities marketed were much higher than expected for a producer cartel but lower than the competitive quantities (especially low quantities in 1992 and 1993 can be explained by an exceptionally cold winter which affected the production of tilapia and mullet). After the end of the joint marketing the actual production quantities increased to non-sustainable levels, causing losses to growers. Simulation results for a monopsonistic trader indicate a relatively small decline in production compared to perfect competition, which can be explained by the very elastic long-term supply functions employed for simulating long-run equilibrium results.

Figure 5: Comparison of simulation results – quantities (long-run equilibrium)

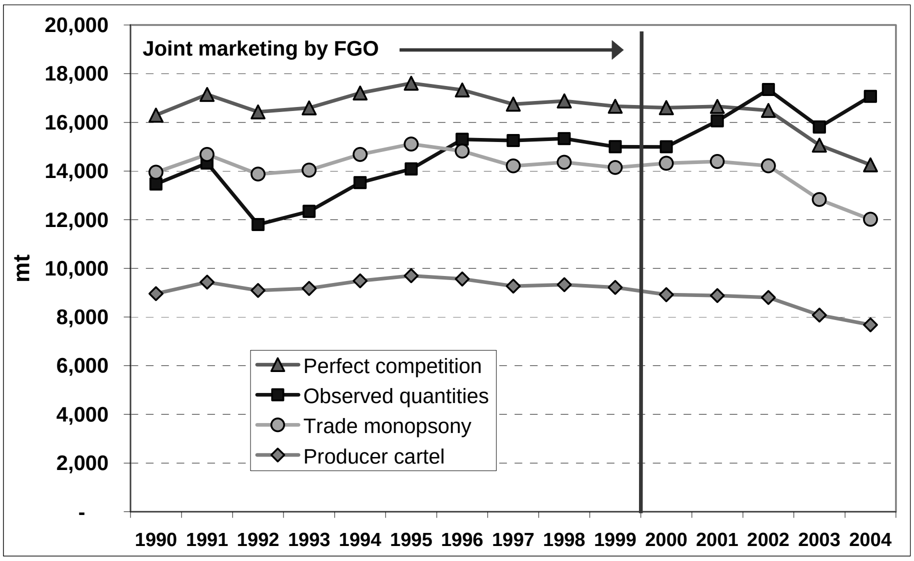


Table 4 presents the aggregated simulation results for carp, tilapia and mullet for the years 1990–1999 (joint marketing by fish growers) and the period after the termination of joint marketing (2001– 2004). An evaluation of the results in both periods yields similar general conclusions. The main changes are observed for the results based on actually observed quantities and prices. Welfare calculated for the actually observed outcomes is smaller than the competitive benchmark in both periods, resulting from lower production quantities in the period of joint marketing and higher production quantities in the second period. The loss in total welfare compared to perfect competition is much lower in the second period but producer surplus declined very much (and is even negative in some years). The changes in producer surplus and total welfare are less dramatic for the various simulated market structures.

Table 4: Simulation results – long-run equilibrium (yearly average)

	Observed quantities /prices	Perfect competiion	Producer cartel	Trade monopsony	Bargaining solution
Period 1990-1999					
Quantity (mt)	14,043	16,893	9,323	14,386	16,893
Selling price p^n (NIS/kg)*	13.17	12.15	20.39	14.82	12.15
Grower price w (NIS/kg)	13.17	12.15	20.39	11.63	11.22
Values in 1000 NIS:					
Revenue grower	184,950	205,263	190,122	167,246	189,503
Producer surplus	46,377	31,876	101,215	23,231	15,938
Consumer surplus	107,182	150,379	45,549	108,887	150,379
Profit trade	0	0	0	45,934	15,938
Total welfare	153,559	182,255	146,764	178,052	182,255
Welfare loss	-28,696		-35,492	-4,203	0
Period 2001-2004					
Quantity (mt)	16,570	15,616	8,361	13,362	15,616
Selling price p^n (NIS/kg)*	10.08	11.25	19.26	13.67	11.25
Grower price w (NIS/kg)	10.08	11.25	19.26	10.79	10.41
Values in 1000 NIS:					
Revenue grower	167,098	175,644	161,043	144,198	162,546
Producer surplus	6,569	26,474	87,021	19,454	13,237
Consumer surplus	146,768	134,323	39,449	100,783	134,323
Profit trade	0	0	0	38,491	13,237
Total welfare	153,337	160,797	126,470	158,728	160,797
Welfare loss	-7,460		-34,328	-2,070	0

* Selling price = Consumer price minus marketing costs

With perfect competition, fish farmers produce about 17,000 mt pond fish per year in the first period (and somewhat less in the second). Fish farmers receive the equilibrium price of 12.15 NIS/kg; generating revenues of 205 million NIS and a producer surplus of 32 million NIS. With perfect competition, the price received by growers is identical to the selling price (consumer price minus marketing costs).

According to simulation results, a producer cartel should produce much lower quantities compared to the competitive equilibrium – about 9,300 mt per year (first period). In this case, revenues received by fish farmers are lower but nevertheless producer surplus increases substantially compared to the competitive equilibrium because of cost savings. Consumer surplus is much lower, and welfare declines by 35 million NIS. Surprisingly, fish quantities produced under cooperative marketing are much higher than the optimal quantities for a producer cartel indicated by simulation results. On average, fish farmers produced about 14,000 mt carp, tilapia and mullet per year during the nineties. Our simulation results are based on a static model which does not take into account dynamic effects influencing cartel stability. Dynamic game-theoretic models explaining collusive behavior are usually characterized by multiple equilibria (Jacquemin and Slade, 1989). The perfect cartel outcome maximizing joint profits might not be sustainable if it is difficult to deter cheating or entry. However, according to Rotemberg and Saloner (1986), for a given level of punishment for deviation there will be always a stable outcome with profits low enough so that no firm finds it profitable to deviate. Cooperation in the Israeli aquaculture sector is voluntary, therefore a large increase in producer prices obtained by restricting production quantities will increase the incentive to cheat or quit the cartel. It may also induce imports of chilled or frozen whole fish competing with domestic fish production. Probably the FGO recognized that the level of output maximizing joint profits is not sustainable in the longer run and decided on higher production quantities representing a more stable outcome. In addition, it seems that growers were not easily convinced to accept decreases in their individual production quotas and efficient growers struggled for a quota increase, creating pressure to increase production quantities above the level maximizing joint profits.

To illustrate the damage that may be caused by an imperfectly competitive marketing sector we simulate equilibrium results for a single marketing company buying all fish produced by fish growers. The monopsony trader will pay growers a lower price compared to the competitive equilibrium, causing a decline in producer surplus, compared to the competitive equilibrium, of about 9 million NIS to 23 million NIS while trade profits amount to about 46 million NIS (first period).[7] The decline in total welfare is relatively small (4.1 million NIS), mainly because in the

7 We assumed that the single marketing company has no monopoly power in selling fish.

medium and long run the fish supply function is quite elastic. In the short run, an imperfectly competitive marketing sector may lead to a much larger decline in grower prices and producer surplus because short-run supply of pond fish is very inelastic. Simulation results for short-run perfectly inelastic supply are presented below.

Simulation results based on a Nash bargaining game

The previous section shows that without the possibility of growers' cooperation in the marketing of fish, marketing firms may exploit market power to the detriment of growers and consumers. Joint marketing of growers can improve the bargaining power of growers if the marketing sector is imperfectly competitive. Economic theory shows that the outcome of bargaining between two firms can be preferable to the equilibrium of an oligopsonistic market from a welfare point of view (Nash, 1950). We employ the cooperative bargaining game of Nash to simulate the impact of collective bargaining of growers when the marketing sector is imperfectly competitive.

If sellers as well as buyers have market power production quantities and prices are determined in a cooperative bargaining game. Nash (1950) showed that for two firms ($i = 1,2$) we can derive the solution of the bargaining game by maximizing the product of the utility of both firms, $\max(U_1 - d_1)(U_2 - d_2)$, where U_i is the utility each side obtains from an agreement, and d_i is the utility firms achieve without agreement—the threat points.

For the aquaculture sector, the Nash bargaining game depicts a market structure with one buyer while all growers are organized in a marketing cooperative. In the long run the outcome of the bargaining game between a grower cooperative and a single buyer is determined by the maximization of function

$$\max_{Q,w}\left(wQ - C(Q)\right)\left(p^n Q - wQ\right), \qquad (2)$$

where the utility of fish growers is the revenue from selling fish (wQ) minus production costs $C(Q)$. The utility of the buyer is the revenue from marketing fish net of marketing costs ($p^n Q$) minus the cost wQ of buying fish from the producer cooperative. It is assumed that without the agreement growers will not produce fish and the marketing firm will not trade fish, therefore the utility from not conducting the agreement is zero for both players ($d_i = 0$ for $i = 1,2$). First order conditions are

$$p^n = \frac{\partial C(Q)}{\partial Q} \quad \text{and} \quad w = \frac{p^n}{2} + \frac{C(Q)}{2Q}. \qquad (3)$$

These conditions characterize the solution of the cooperative bargaining game.

Production quantities are established by equating the selling price net of marketing costs (p^n) to marginal production costs, and are identical to quantities produced under perfect competition. Growers receive lower prices compared to perfect competition. According to Nash's bargaining solution, the surplus received by producers in the competitive equilibrium is equally divided between the producer cooperative and the monopsony buyer.

Simulation results for the Nash bargaining game are presented in Table 4 above. Production quantities, consumer surplus and total welfare are equal to the competitive equilibrium. The producer surplus declines by half to 16 million NIS (first period) while the marketing sector benefits compared to the competitive outcome. Producers bargaining collectively receive a lower surplus compared to the case of a monopsony marketing firm buying from unorganized producers. This phenomenon can be explained by the elastic long-run supply functions used for obtaining the simulation results.

Simulation results for short-run inelastic supply

In the short run, supply of pond fish is very inelastic. Decisions about production quantities have to be taken a long time before marketing.[8] In addition, the possibilities for storing live fish in ponds are limited by the requirements of the production cycle and feed costs. It is reasonable to assume that for quarterly data short-term supply of pond fish is completely inelastic. Inelastic supply increases the potential of an imperfectly competitive marketing sector to exploit oligopsonistic market power.

We simulate the impact of a single buyer and inelastic supply on equilibrium results for two cases: (a) unorganized growers, and (b) growers organized as marketing cooperative. In a competitive market, growers will receive the selling price net of marketing costs (p^n) which is determined by the derived demand function according to the quantity produced in period *t*. If growers are not organized a monopsonistic buyer will pay just a minimum price ($w^{\min}$) which in the case of fish farmers is the price paid by the fish processing industry. This price will generally be lower than the competitive price. In this case, cooperation of growers can substantially improve the price they receive. The solution of the Nash bargaining game in the short run is obtained by maximizing

8 It takes about one and a half years to grow the main pond fish produced in Israel.

$$\max_{w}\left(wQ - w^{\min}Q\right)\left(p^{n}Q - wQ\right). \qquad (4)$$

We obtain the first order condition

$$w = \frac{p^{n} + w^{\min}}{2}\ , \qquad (5)$$

indicating that a grower cooperative can obtain a price between the competitive price and the price paid by the monopsonistic single buyer without bargaining. According to the model of Nash, this price does not depend on the quantity produced.

Table 5 presents the simulation results for the short-run equilibrium, based on data for period 2001-2004. We compare the monopsony outcome of a single buyer and the cooperative bargaining solution to the competitive equilibrium, for short-term supply quantities equal to the long-run competitive equilibrium and for quantities 10% and 20% lower than the long-run competitive equilibrium. We assumed that the minimum price $w^{\min}$ is 7 NIS/kg for all three fish species. This price is lower than production costs, but somewhat higher than prices paid by the processing industry (about 5 NIS/kg). It is located at the lower range of prices actually paid in recent years after the termination of cooperative marketing and takes into account longer-term considerations of a monopsonistic buyer. Grower profits in Table 5 are calculated with costs based on long-run supply functions.

The simulation results demonstrate the potential of an imperfect marketing sector to depress grower prices if there is no possibility to adjust production quantities in the short run. The magnitude of grower losses calculated provides an upper bond – for an imperfectly competitive marketing sector with several buyers losses are expected to be smaller. Our analysis also simplifies by assuming that the available surplus is split equally between the trader and growers. In reality, the division of the surplus depends on the relative bargaining strength of the trade sector and the grower organization. The results reveal the benefits of cooperation – losses are either much smaller or growers manage to obtain profits despite imperfect competition in marketing. In the case of completely inelastic supply imperfect competition does not affect the consumer surplus and total welfare. However, the distribution of benefits is affected, with profits transferred from growers to marketing firms. This is expected to lead to a decline in production quantities in the longer run – with negative effects for producers, consumers and total welfare.

Table 5: Simulation results for period 2001-2004 – short-run inelastic supply
(yearly average)

Simulation results	Price (NIS/kg)	Revenue growers (1000 NIS)	Profit growers (1000 NIS)*
Perfect competition			
Quantity = competitive equilib.	11.25	175,644	26,474
Quantity -10%	12.86	180,674	48,754
Quantity -20%	14.46	180,683	65,495
Trade monopsony			
Quantity = competitve equilib.	7.00	109,314	-39,856
Quantity -10%	7.00	98,382	-33,538
Quantity -20%	7.00	87,451	-27,738
Nash bargaining equilibrium			
Quantity = competitve equilib.	9.12	142,479	-6,691
Quantity -10%	9.93	139,528	7,608
Quantity -20%	10.73	134,067	18,878
Base data	Quantity (mt)	Cost (1000 NIS)*	
Quantity = competitve equilib.	15,616	149,169	
Quantity -10%	14,055	131,920	
Quantity -20%	12,493	115,189	

* Cost: based on long-run supply function.

Summary and Conclusions

Israeli fish farmers were organized for decades in a marketing cooperative responsible for marketing most of the aquaculture production. Despite joint marketing and little competition from imports, simulation results indicate that the Fish Growers Organization did not behave like a cartel and marketed quantities which were much closer to the competitive equilibrium than to an outcome expected for a producer cartel. On the other hand, simulation results reveal that imperfect competition in the marketing sector may cause a significant decline in producer surplus, especially if production is characterized by inelastic supply. In the longer run, also consumer surplus and total welfare are expected to decline. In the case of imperfect competition, cooperative marketing of producers can increase producer surplus and total welfare.

Cooperation of growers is also important for promotion of consumption, the development of new products and quality assurance systems. Estimation results indicate that demand for fresh pond fish in Israel is declining over time. Negative publicity in the wake of a food scare also depressed demand, at least temporarily. Grower cooperation is necessary to develop the demand for fresh pond fish and new, convenient and high-quality fish products, to the benefit of all growers and consumers.

Cooperative marketing of aquaculture producers was enabled by the antitrust exemption for the agricultural sector. Despite far-reaching cooperation encompassing most fish farmers, the Fish Growers Organization exploited just a small share of its potential monopoly market power. On the other hand, we demonstrated significant potential benefits from cooperation if the marketing sector is imperfectly competitive. This is common for many agricultural products because markets are regional, limiting the number of buyers, and products are perishable, decreasing the bargaining power of farmers. The Israeli aquaculture sector provides an example for the importance of a limited antitrust exemption for the agricultural sector which enables growers to employ restrictive arrangements for cooperative marketing. At the same time, it shows that authorities should have the possibility to intervene if the exemption is exploited to the detriment of consumers and total welfare.

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