

The Study of Game Mechanism in Fishery Industry Chain

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Abstract Based on former research of some parts, this paper describes the content of fishery industry chain, studies the chain game players and explores the chain game mechanism in the fishery industry chain, considers that there are games between fish farmers and between fishermen and government in the marine fisheries and Competition games between fish farmers, Small-scale fish farmers and large-scale fishing enterprises, upstream and downstream fisheries enterprises or individuals in the freshwater fisheries.

Key words Fishery; Industry chain; Chain game mechanism; Game relations

1 Introduction

Like economics, game theory always stressed that the premise of individual rationality, which means pursuing the maximum utility under given constraints. Therefore, the assumption that the first game analysis is the individual rationality, which means when making decisions, assume that the game participant can fully take into account the possible interactions between the each other and make a rational choice accordingly these. In real life, each actor wants to select the optimal strategy, for having his own interests and goals, and facing with choice under various strategies. Therefore, the above assumptions of game Analysis are consistent with real life. In real life, there are consistent and inconsistent interests exist between individuals or companies. So, almost all interactive decision making between individuals or companies can be incorporated into the context of game theory. In this paper, we integrated Game Theory into fishery to analyze the game relations among various stakeholders in the fishery industry and it can contribute to the sustainable development of fishery industry.

2 The Connotation of Fishery Industry Chain

According to the domestic and foreign scholars' analysis about the connotation of industrial chain, this article will define the industry chain as: industry chain is companies in the same or different industries, which make the Products as objects, the input and output as link, the value adding as orientation, meeting user's goal as target, it is a dynamic and up-down related chain intermediate organization which base on the specific logical links and the layout of the space-time.

Based on the definition of Industrial chain, the modern fishery industry chain can be defined as: the modern fishery industry chain is Modern fishery related companies, which make the fishery related Products as objects, the input and output as link, the value adding as orientation, meeting user's goal as target, it is a dynamic and up-down related chain intermediate organization which base on the specific logical links and the layout of the space-time.

3 Chain Game Players in the Fishery Industry Chain

The development of fishery industry chain mainly relies on two players: the government and fishery-related enterprises or individuals. The basic premise of the harmonious development of fishery industry chain is the common goals and interests established by all parties and they can provide their own unique contribution for the cooperation. However, the government is non-profit organization and its ultimate goal is maximizing the whole society benefits, considering the macroeconomic aspects benefit the whole industry or not, its policies may affect interests of businesses or individuals in the chain, so, there are Game Relations between government and fishing enterprises and individuals; On the other hand, outstanding relationship of interests exists between the upstream and downstream business in the fishing industry, the upstream firm's output is the downstream firm's input, so the upstream and downstream businesses' game relationship exists; Due to fierce competition, there are game behaviors between fishing enterprises which are in the same area. Whatever the game is between government and enterprises or between individuals, it will affect the whole industry chain, and the game between two adjacent enterprises make a greater impact on the upstream and downstream businesses' interests, so this game is called the chain game.

4 The Game Mechanism in the Fishery Industry Chain

4.1 The game relations among the stakeholders of marine fisheries

(1) Game between the fish farmers

In the use of fisheries resources, there are game actions between the fish farmers. According to game theory and information economics theory we know that, if all the fishermen comply to the regulations and choose cooperation from the perspective of sustainable development, it is beneficial for all parties, but it is just easy when there is only one fisherman in a water, Once the fishermen in this water increase, the problem becomes complicated. Because after the increasing of fishermen, each of them started to diminish the sense of responsibility, it is reflected in that after the increasing of the number of the fishermen, the consequences of the individual behavior maybe negligible for the whole, but has a major impact on them. That is, on the one hand, when other people go fishing, he restrain himself on the base of sustainable use, then there is little benefits to the growth of the whole fishery resources, but he have to pay a considerable cost, in this case, the fishermen will choose illegal fishing; on the other hand, if he do the illegal fishing on the base of his own interests, then the overall damage is not significant, but he can be obvious and immediate benefits, then he choose the strategy of illegal fishing, that is, in general, when there is possibility of increasing the use of resources, he increase the use of resources but others do not, he benefit from it, if he and other fishermen all increase the use of resources, he will not lose, ultimately, all the fishermen increase the use of resources until the Nash equilibrium (that all parties are reluctant to change game strategy combination) level that everyone cannot increase the use of resources (further increasing will certainly cause damage).

Simply, when fisherman makes the Decentralized economic decision in the fierce market competition, as long as he can not find a sustainable way which can not increase the private cost, he would choose non-sustainable way according to personal (or family) interests. Suppose there are M fishermen in a water, they fish for a living, these fishermen are free to catch fish in this water, since the total natural production of fish for one year is limited, this water can only provide fishes for limited fishermen, if the number of the fishermen exceeded this limit, the output would reduce or having no harvest due to the lack of adequate resource. Suppose all the fishermen know the natural production of fish for one year in this water, this constitutes the fishing game among M fishermen. In this game, M fish farmers are game players, their own strategy space is the possible catch number of the fish $S_i (i=1, \dots, M)$; when each fish farmer's catch number is $S_1 \dots S_m$, then the total number is $S = \sum S_i$, now suppose $i=1$ and the Maximum natural production in this water is F, that is when the catch number is F, the water can naturally return to its original state, obviously $S=F$ is the best choice, in this way, the Fishery resources can be exploited fully; $S < F$, it means the fish have not been fully exploited; $S > F$, it means over-fishing, the destruction of natural fish production will cause the future production reduced; When S is much larger than F, it will lead to zero future fish stocks, then All the fishermen Bankruptcy. But in reality, fishermen usually only consider increasing their own catch number and raising their own income, so it is impossible to achieve $Q=F$, therefore, it generate $S > F$ until S is much larger than F, and leading to a serious decline in fish production in this sea area, or even extinction.

(2) Fishermen and government

In the management of marine fisheries resources, the government develop and implement policies, and regulate the behavior of fishermen or fishing enterprises, the fisherman as a managed object whose behavior is always under the constraints to achieve utility maximization, so, fishermen and the government are both the parties of the game. In this game, the government is the first mover, it is according to their information to develop policies first, the goal is to protect fishery resources, that is to maximize the overall interests, and then the fishermen move, they make their decision on the base of the principle that to maximize their own interests, that is the local interests maximization, then come to the contradiction between fishermen's and government's decision-making goals. We can understand it as a "dynamic game of two people", our country have developed many policies to protect fisheries resources, such as fishing permit system, fishing-prohibiting period policy, fishing quota system and so on, then take the fishing-prohibiting period policy as example to analyze the game between law enforcement agencies and fishermen, as shown in figure 1.

During the closed seasons, if the fishermen comply with the contract and don't do the illegal fishing, the government needs not spending money on law enforcement at sea, the two sides have no expenses(0,0); if fishermen fishing default, then if the government does not control, that is (R-C,0), and fishermen benefit $R-C > 0$, R is revenue, C is the cost of fishing; If the government does the inspection and it has to pay the cost f, at this time if the fishermen comply with the contract, don't do the illegal

fishing, then (0,-f); if fishermen were checked when they fishing (R-C-M,-d), M is the cost to pay after being arrested, such as penalty, etc. When the $R-C-M < 0$, comparing the sub-game under the condition of be track down at the final stage, fish farmers' best decision is no illegal fishing, that is (0,-f);reverse forward to the second stage, there is a dilemma of greater profit from no supervision and greater profit from fishing. Therefore, only implement the measures of checking the fishermen's illegal fishing activities which have to pay the cost -f can let fishermen Comply with government's fisheries legislation and earnestly implement the closed fishing seasons system. When the $R-C-M > 0$, the fish farmers are profitable, and will be trying to steal the fish. Therefore, the government must strengthen the supervision of illegal fishing and confiscate their illegal earnings and impose severe punishment, in order to effectively prohibit the breach of fishing, so as to promote sustainable development of fisheries.

		Fishermen	
		Fishing	No fishing
government	Supervision	-f, R-C-M	-f, 0
	No Supervision	0, R-C	0, 0

Figure 1 Game Analysis Between Fishermen and Government in the Fishery Industry

4.2 Game relations between freshwater fisheries stakeholders

Most of the development of freshwater fisheries is retail's decentralized management, they contracted their own ponds for breeding nursery, aquaculture, fishing and then to the market sales. Large-scale freshwater fisheries enterprise also contract large freshwater lake waters for the production and sale of fishery product. There is competition game between the fishermen retail, but basically there is few fishermen retail to compete for a fish pond. To large freshwater lake fisheries, of course there is illegal fishing phenomenon come from the fishermen retail who live near by, in this case, the game between the fishermen and this freshwater fisheries Contractor is similar to the game between fishermen and the government in marine fisheries, so I will not go into details here.

(1) Competition game between fish farmers

Fishery at this stage has quite a lot of retail business; these retail competitions in the same geographical area are very intense, because the species of fish are same in the same geographical area. Due to their small scale retail, they can't make a greater impact on the whole fisheries market, so if they want to achieve dominance in the game, they must seek fish species which are difficult to breed and the other retails can not breed, but in this case this retail's operating costs will be greatly improved and many retail investors are not afford, therefore, the market which is constituted by these retails is just as a fully competitive market environment, can only rely on the market to adjust prices, the retails can only passively accept.

(2) Competition game between Small-scale fish farmers and large-scale fishing enterprises

In order to gain advantage in the competition, large-scale fishing enterprises need innovation to make a big difference between their own products and small-scale fish farmers' products. This is because the small-scale fisheries retails have a lower cost, and they culture similar products year after year, then their experience is rich, and it is difficult to have highly competitive edge over these species. Therefore, large-scale fishing enterprises generally will choose the higher value fishery species such as shrimps and crabs, turtles, salmon, etc., because these aquatic Products need higher breeding techniques and better breeding environment, it is difficult for economy retail-based fishermen to a large number of breeding success, they can not afford. Meanwhile, some large companies started to engage in fishery production areas of aquatic products processing, so that they can gain competitive advantage.

(3) Game between upstream and downstream fisheries enterprises or individuals

At this stage, most of our fisheries belong to retail business are still in the relatively low level of

industrial chain, so the cooperation and competition between upstream and downstream enterprises and the bargaining power are also mainly depend on the size and status of the two sides in the overall market. Which side has a larger size, and then they will have stronger bargaining power and take advantage of the game. Such as the game between the fishing enterprise and its downstream Aquatic products processing enterprises, if fishery production enterprises can offer a lot of fresh Aquatic Products, then they will have greater options to choose in many aquatic products processing enterprises; Conversely, if a aquatic products processing enterprise has relatively large-scale, then it has a comparative advantage on choosing the upstream producers.

5 Conclusion

This paper describes the content of fishery industry chain, studies the chain game players and explores the chain game mechanism in the fishery industry chain, considers that there are games between fish farmers and between fishermen and government in the marine fisheries and Competition games between fish farmers, Small-scale fish farmers and large-scale fishing enterprises, upstream and downstream fisheries enterprises or individuals in freshwater fisheries. The deficiency of this article is that it does not give some relevant case studies about the game relations in the fishery industry chain.

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