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Does Self Management in Fisheries Enhance Profitability? Examination of Korea's Coastal Fisheries

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Does Self Management in Fisheries Enhance Profitability? Examination of Korea's Coastal Fisheries

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Abstract *Self management of natural resources has started to gain increasing attention as an alternative tool to command-and-control and market-based tools, but the fundamental question remains: is self management economically beneficial such that it should be promoted in the first place? This article uses a unique set of survey data from South Korea and applies an empirical strategy to provide some of the first quantitative evidence that self management is benefiting the fishermen. We find that positive benefits of fishery self management—an increase in fishery revenue and reduction in cost—are perceived by member fishermen, which is a good start considering the average number of years since the establishment of these self-management groups is only about seven. Empirical results of the magnitude of change in profit showed some consistent results, although the estimates were not as robust. These results suggest that the impact of fishery self management is still in progress. Thus, the government should maintain its current position to support self management as the country's fishery management policy.*

Key words Self management, club goods, matching methods, coastal fishery, South Korea.

JEL Classification Codes Q22, D71.

Introduction

Self management of natural resources has started to gain increasing attention as an alternative tool to command-and-control and market-based tools (*e.g.*, Cunningham and Bostock 2005; Wilson, Nielsen, and Dengbol 2003; Ostrom *et al.* 2002; Townsend, Shotton, and Uchida 2008). Self management, in which natural resource users decide on the rules, is said to have advantages over command-and-control in parts of the world where

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the government's capacity is weak in enforcement and monitoring, or where it lacks institutional capacity to implement a market-based tool, such as an individual transferable quota system. Self management of natural resources has been in existence for long time—decades if not centuries—in many parts of the world. However, the concept was rediscovered in the fisheries literature not so long ago (Jentoft 2003).

For self management of natural resources to be successful, however, the mere setting of rules by the natural resource users is not sufficient. Based on the theory of clubs, the group of natural resource users need to be "privileged" (Buchanan 1965); *e.g.*, managing the natural resource as a group needs to bring higher present value of benefits to its members than the status quo. This higher present value of benefits, therefore, is an incentive constraint of forming and maintaining a self-management group.

Despite the importance of this incentive constraint, existing literature has not empirically examined the impact of forming a self-management group on profitability. This is primarily due to the lack of adequate data. Large sample data on self management of common pool resources is rarely available. Even if such a dataset is available, it often is aggregated, cross-sectional and/or cross-country data, where the challenge to control for heterogeneity among countries, let alone unobservables, can be overwhelming (Agrawal 2001). For these reasons, many previous empirical studies are conducted on specific cases, often not focusing directly on the effect of self management but on how or if such a resource management regime can be maintained (Gaspart and Seki 2003; Platteau and Seki 2007; Schott *et al.* 2007). Thus, the critical question is left unanswered: is self management economically beneficial to resource users such that they have incentives to sustain the resource management regime?

To address this question, this article empirically investigates whether or not self management has improved economic outcomes in the context of fishery management. We examine the South Korean experience with coastal fisheries management. The advantages of studying Korean fishery self management are that a large number of groups have formed in recent years, and the specific rules adopted by the groups and fishery characteristics vary across groups. At the same time, however, all of the groups function under the same national fishery regulations and, to certain extent, share a common set of cultural and social characteristics. These advantages enable us to utilize wide variation in key fishery-related variables while controlling for other influential, but latent, disturbances.

The overall goal of this study is to quantify the effectiveness of self management and its institutional arrangements on profitability of the small-scale fishing households in Korea. The principal contribution of this study is to provide empirical evidence of the impact of self management on fishermen's profitability. To the best of our knowledge, this is the first study to quantitatively identify the economic impact of a self-regulatory approach of fish resources using data collected systematically at the individual resource user level, consisting of both members and non-members of self-management groups.

To meet this goal, we capitalize on a unique setting in South Korea which has an appealing institutional setting to study these questions. In 2001, South Korea instituted a policy to encourage voluntary self-management groups for fishery management. By 2007, more than 580 groups had formed. The groups have a rich variation in terms of targeted species and gear types. They also have introduced a variety of self-imposed rules; 25 rules were identified by the authors, ranging from effort coordination measures, fishing operation restrictions, and quality control activities. At the same time, there still exist numerous fishermen who are not members of any self-management groups.

To understand the economic impact of forming these self-management groups, we utilize a dataset from a survey that we designed and implemented to a total of 306 fishermen, including those who are members of self-management groups and those who are not. In identifying the effect of membership in a self-management group, we control for self selection by employing covariate matching method. Overall, we find strong evidence that membership in a self-management group has benefits on both revenue and cost compared to non-members, but there is weaker evidence on the actual extent of the increase in profitability.

Conceptual Framework: Theory of Clubs

Our conceptual framework is based on the theory of clubs (Buchanan 1965). A club is defined as a group of individuals deriving mutual benefits from sharing a class of public goods characterized by excludability and some rivalry in the form of congestion. The theory shows that such impure public goods, which lie between private goods (with complete rivalry and costless exclusion) and pure public goods (complete non-rivalry and infeasible exclusion), can be converted and provided as club goods. As such, a club is viewed as a private, non-governmental alternative provider of such impure public goods.

Fish resources, unless managed under an individual quota scheme, are common property resources and thus categorized as impure public goods. Unlike pure public goods, fish harvest is subject to rivalry—fish that were harvested by one fisherman cannot be harvested by someone else. If the fish resources have open access, they remain non-excludable. With limited access, however, such as through licensing or establishment of territorial user rights fisheries (TURF), fish resources can be made excludable to a varying degree. However, even with limited access and some excludability, fish resources can still be subject to overexploitation. For example, if the number of incumbent fishermen is too large—which is often the case—then non-excludability of the resources among the license holders or TURF members creates incentive structure similar to that of open access; *i.e.*, race to fish. Race to fish will lead to overexploitation of the resources, over-investment (capital stuffing), and rent dissipation.

One way to overcome overexploitation is to convert the fish resources to club goods. If successfully converted to a club good, members of the club would reap a stream of rents from the resources to which only the members have exclusive use rights. The size of the club membership and the level of the resource stock will determine the optimum such that the resource is used to sustain the rents over time. However, based on the theory of clubs, three conditions need to hold in order to transform the resources into club goods. First, fishing ground boundaries need to be defined in accordance to the ecology of the targeted fish so that only members have exclusive use rights to the fish. Second, group membership needs to be well-defined and controlled. Finally, and most importantly from the perspective of this study, the groups need to be “privileged”; that is, forming a group needs to bring higher present value of benefits to each member than nonmembers and the status quo. The first two conditions are related to excludability, while the third is related to profitability or an incentive compatibility constraint of forming and maintaining a club. These conditions are also interrelated; whether a club is privileged or not depends on how well the benefits are made exclusive to its members.

The excludability condition can be achieved in several ways. One example is the license system, where membership is defined by the possession of a license. Another example is forming a fishermen’s group, such as cooperatives in Alaska and sectors in the US Northeast groundfish fishery. In both examples, enforcement and monitoring of the violators will become key to providing exclusive use rights successfully.

The privileged condition is the most challenging to meet. There are several ways which clubs *can* bring higher profit to their members. Activities that could increase revenues or reduce costs often require some critical mass to be effective, or have a public good nature so that no single individual will voluntarily pursue them. An example is reducing harvest in order to rebuild the fish stock. This is effective only if done by most, if not all, harvesters, and no single fisherman will do it voluntarily. Maintaining fishing grounds, monitoring illegal fishing, sharing information on fishing spots and market prices, direct marketing, and quality control are other measures that self-management groups may adopt to meet the privileged condition. These measures would be more successful if fishermen coordinate as a group. Case studies from Japan and elsewhere demonstrate anecdotal evidence where combinations of these activities have brought higher profits to the cooperative (club) members (*e.g.*, Makino 2008; Uchida and Baba 2008; Uchida and Watanobe 2008).

A discussion on the feasibility of a self-management group—a club—and the type of targeted species in fisheries is in order. The conventional wisdom is that the less mobile the species, the better the chance of successful self management (*e.g*., Ostrom *et al.* 2002). Does this mean that migratory and pelagic species are ruled out? Anecdotal evidence shows that this is not necessarily the case; examples include: UK's Shetland Fish Producers Organization targeting white fish (*e.g*., haddock, cod, hake, and monkfish) (Anderson 2008), Cape Cod Commercial Hook Fishermen's Association and Rhode Island Fluke Conservation Cooperative in the US targeting groundfish (*e.g.*, Johnston and Sutinen 2009), and Hiyama Walleye Pollack Long Line Association in Japan targeting highly migratory pollack (Uchida and Watanobe 2008). There are two important points to note. First, it is not the fish per se that needs to be exclusive, rather it is the benefit—economic returns to be specific—from the fishery. This explains why many self-management groups engage in marketing activities such as quality control and developing a private brand. Second, excludability need not be spillover proof. As long as the group members receive higher net benefits than before formation of the group and compared to the current non-members, it is incentive compatible for members to maintain the group.

Lastly, with respect to the privileged condition, are low-valued species ruled out under this conceptual framework? Again, anecdotal evidence shows it is not necessarily so. One example is the clam fishery on the central Pacific coast of Japan, where the average annual revenue per fisherman is a mere 3 million yen (US$30,000). This is hardly enough to support a family, yet this self-management group is one of the often-cited successful groups. The reason is that revenue from this clam fishery is very stable and reliable compared to the *shirasu* (juvenile sardine) fishery, which was the group's main revenue source. It is the insurance-like benefit, not the revenue level, of this clam fishery that maintains its self-management group.[1] That said, such benefits and information are difficult to quantify or solicit through a survey. As such, in this study we attempt to identify quantitatively the impact of self management on fishermen's profitability.

Self Management of Fisheries in South Korea

South Korea provides a unique opportunity to study the impact of forming self-management groups on economic outcomes. As elsewhere, despite the government's effort to manage fisheries primarily through licensing and permit systems, Korea has still suffered from the problems of "race-to-fish" and stock depletion (Cheong 2004). Profitability of fisheries declined due to the vicious cycle of overcompetition, stock depletion, and capital stuffing. Illegal fishing persisted and aggravated the stock depletion problem despite costly monitoring and enforcement efforts. Fishing grounds suffered from conflicts among fishermen. Fishermen became prone to rely on government subsidy or other favorable policies. Rising international competition with cheaper imported seafood led to lower output prices. All of these conditions created a growing need for an alternative approach to the traditional command-and-control.

In response, the Ministry of Maritime Affairs and Fisheries initiated a policy in 2001 to encourage South Korean fishermen to form voluntary self-management groups and manage fisheries through self-regulated regimes (*jayul gwanry* fishery). These groups are typically established based on the fishing community organizations called *ochongye*. Under the new

[1] From an interview conducted on 2005/10/14 with Dr. Akira Nihira of the Ibaraki Prefectural Freshwater Fisheries Research Institute.

policy, fishermen can voluntarily form self-management committees, propose a set of self regulations to the government, and if approved, implement the rules. In response, the government gives stronger responsibility and authority to the groups to manage fishing grounds, stocks, and harvests. In addition to administrative and technical support to implement the self-management plans, the government also provides financial rewards to self-management groups with good performance records to incentivize more fishermen to form groups. In 2007 the government provided 11.8 billion KW (US$9.8 million) to 90 self-management groups (20% of the total number of self-management groups). These payments are made to the groups and not to the individual members; the regulations require that the money be reinvested in self-management activities. Typically the groups spend the money for restocking and business startup, such as direct-sale shops and restaurants.

Fisheries in South Korea can be categorized broadly into four types: *maul*, coastal, offshore, and aquaculture (Lee, Gates, and Lee 2006). A *maul* fishery is one that manages clams or other sedentary species in designated areas. Over 50% of the 579 self-management groups in 2007 were of this type (table 1). Coastal fisheries, which are the focus of this article, involve fishing vessels of less than eight gross tons operating in areas where fishermen fish and return to the departure port within a day. Eighteen percent of the self-management groups are associated with coastal fisheries, and another 16% are those engaged in both *maul* and coastal fisheries. Offshore fisheries involve fishing vessels greater than eight gross tons operating in areas where fishermen fish and return to the departure port within two or three days. Offshore fisheries typically target highly migratory species and often compete with foreign vessels. While a few self-management groups exist in offshore fisheries, because of these distinctive characteristics they are not included in our analysis. Lastly, 12% of the self-management groups are engaged in aquaculture.

As a result of government policy that promotes self management, the number of such groups and their members grew rapidly (table 1). Starting from 63 groups in 2001, by 2007 the total number of self-management groups had grown to 579. The number of participating fishermen has also steadily increased from 5,407 in 2001 to 10,765 in 2003 and 44,061 in 2007. Currently, the average number of member fishermen in each community is about 70 to 80. The government aims to establish 1,000 self-management groups by 2011 and in all of approximately 2,000 fishing communities after 2012. Despite the rapid expansion in the number of self-management groups, however, there is little evidence on the economic performance of this new approach to fisheries management.

Data and Descriptive Characteristics

We use a dataset from surveys that we designed and implemented in 2008. The surveys were conducted among leaders of self-management groups and individual fishermen, which included both members and non-members of such groups. This dataset is believed to be the only existing dataset that includes individual fishermen of both members and non-members of self-management groups in South Korea. The descriptive statistics for the key variables discussed here are shown in tables 2 through 4.

The group leader survey employed a stratified sampling strategy designed to collect data on a sample of 33 group leaders engaged in coastal fisheries.[2] As of December 2007, there were 102 self-management groups engaged in coastal fisheries (Ministry of Maritime Affairs and Fisheries 2008). Of these, we were able to obtain a contact list of 92 groups. Among them, 30 self-management groups were established in or after 2006. Due to a concern that two years would be too short of a time period to detect the impact of group establishment, we excluded those groups from the sampling frame and focused

[2] The secretary general of the self-management group responded to the survey when he/she was most knowledgeable about the fishery's management.

Table 1
Growth of Self-management Groups in South Korea, 2001-2007

	2001	2002	2003	2004	2005	2006	2007
Maul fishery	32	35	61	92	159	233	294
Aquaculture	11	12	15	22	46	70	72
Coastal fishery	8	19	29	34	52	71	102
Combined fishery	12	13	17	26	43	62	94
Inland fishery	–	–	–	–	8	9	17
Total number of self-management groups	63	79	122	174	308	455	579
Total number of fishermen with membership	5,107	6,575	10,765	15,469	24,805	33,921	44,061
Average number of members per group	81	83	88	89	81	76	76

Source: Ministry of Maritime Affairs and Fisheries (2008).
Note: The numbers are cumulative.

on self-management groups that have been active for at least three years at the time of the survey. Of the remaining groups, we then focused our sampling frame on fisheries types for which we could find comparable fishermen who were engaged in the same fisheries in the same region but were not a member of any self-management group. As a result, we dropped 27 self-management groups in the net fishery and king crab fishery since there were few or no fishermen who were engaged in these fisheries but not a member of any self-management group. Of the remaining 35 groups, leaders of two groups refused to respond to the survey. We, therefore, received 33 valid responses from group leaders.

To enlist the fishermen from these 33 groups for individual surveys, ideally we would construct a sampling frame from a list of all fishermen in those groups and a list of all fishermen who are not members of those groups but are engaging in the same fisheries in the same fishing community (*ochongye*). Such lists, however, do not exist. As an alternative, we asked each leader to give us a list of fishermen from two categories: those who are members of the self-management group and non-members who are in the same fisheries in the same community. Of the 33 group leaders, 32 of them provided contact information for one or more fishermen. However, leaders of seven groups could not provide any non-member information, since most or all of the fishermen in their fishing communities were already members. In these cases, we selected fishing communities that were geographically the closest to each self-management group. Some groups included an equal number of both member and non-member fishermen; others included fishermen in only one of the categories. In our data, seven groups include only fishermen who are members of a self-management group. This sampling strategy and the resulting imbalance of member and non-member fishermen representing each group motivated our identification strategy.

In the end, we obtained individual data from 182 fishermen who were members of one of the 33 self-management groups in the survey (hereafter called “member fishermen”) and 124 fishermen who were not a member of any self-management group (hereafter called “non-member fishermen”) from 64 different fishing communities or fishery associations. The survey instruments were pretested and revised prior to full implementation. The survey was conducted by telephone by experienced and trained enumerators. The response rate was approximately 70%. A caveat of our data set is the potential recall bias in the information for the period before engaging in self-management groups. However, there is no individual-level data available from the period prior to the policy due to the government’s quick decision to implement the program. We designed the survey carefully and trained and monitored the enumerators to minimize recall bias and ensure that the best account of past amounts and activities was given by the respondents.

Characteristics of the Self-management Groups

Based on the group leader survey data, we find that self-management groups among coastal fisheries in South Korea adopt various ways to provide excludability and incentive compatibility to their members (table 2). The types of rules can be grouped into four categories: agreements on effort coordination, operational restrictions, revenue sharing, and quality control measures. Among the different types of agreements on effort coordination, several activities are adopted by a high percentage of the interviewed self-management groups: cleaning the fishing ground (94%), monitoring illegal fishing (70%), removing harmful species (70%), and information exchange (64%). More than half of the groups engaged in a joint search for hot spots and restocking of targeted fish. Eight groups also either assign or rotate fishing grounds. Self-management groups have adopted a number of operational restrictions as well. The most popular measures are size/age limits and seasonal closures, which are adopted by more than two-thirds of the groups. Nearly half of the groups control mesh size, the number of fishing gear, aggregate supply, duration of fishing operations, and designation of protected areas. Finally, some groups also have

Table 2
Number and Proportion of Self-management Groups in the Sample Adopting Specific Rules, 2007

	Number of Groups	Proportion of Total Groups Surveyed (%)
Agreements on Effort Coordination		
Cleaning fishing ground	31	94
Monitoring of illegal fishing	23	70
Removing harmful species	23	70
Information exchange	21	64
Joint search for hot spots	17	52
Restocking	17	52
Establishing artificial reefs	16	48
Assign/rotate fishing grounds	8	24
Agreements on Operational Restrictions		
Size/age limit	22	67
Seasonal closure	22	67
Mesh size	16	48
Number of fishing gear	16	48
Supply control	15	45
Operating hours limit	15	45
Operating days limit	15	45
Protected area	15	45
Total catch limit	14	42
Fishing gear type	11	33
Other restrictions on fishing gear	7	21
Gross tonnage	6	18
Number of fishing vessels	5	15
Revenue Sharing		
Revenue sharing among group members	1	3
Quality Control		
Joint marketing	15	45
Quality control of catch	8	24
Development of new products	5	15
Total number of groups	33	

Source: Authors' survey.

adopted quality control measures. Nearly half of the groups coordinate marketing of their fish (45%) and a quarter of them conduct quality control of their catch (24%). A few also jointly develop new products (15%). Only one self-management group in our sample adopted some sort of a revenue sharing rule among group members.

Interestingly, the 33 self-management groups in our sample adopt unique combinations of rules; *i.e.*, none of the groups have the same combination of rules. For this reason, we unfortunately cannot identify the impact of a specific rule or a combination of rules on the economic outcomes. Therefore, in the rest of the article, we will examine the impact of self-management groups as a whole on economic outcomes.

The group leader survey revealed an interesting set of characteristics of the self-management groups engaged in coastal fisheries (table 3). The group size is around 71 fishermen, which is comparable to the national average (table 1, last row). On average, 52 vessels go out on an average fishing day, suggesting that some boats are operated by more than one member. Their vessel size is relatively small, an average of 7.4 tons. In 24 self-management groups in our sample, there are fishermen in the same community who are engaged in the same fisheries but are not members of the self-management group. In roughly one-third of the groups (10 groups), all members of the community engaged in the same fisheries as members of the self-management group. However, among the remaining two-thirds, the number of fishermen not participating in the self-management group is 213, on average, with a wide range of from 5 to 4,000. The average number of years since establishment is seven, suggesting that many of these groups were established at the time of the government policy in 2001 which introduced monetary incentives for fishermen to form self-management groups. Membership in a self-management group was voluntary for most fishermen in our sample (94%). This finding implies that we would need to control for self-selection bias in estimating the impact of group membership. Although most groups do not make membership mandatory, more than 60% of the groups require some sort of a membership fee. Of eight groups that gave a valid answer to the question regarding the level of membership fee, the average was 98 thousand KW (US$1=1,720 KW). Compared to the average total revenue of fishermen who are members of a self-management group (60 million KW), the membership fee can be considered modest.

Table 3
Descriptive Statistics of the Self-management Groups, 2007

	Sample Mean (standard deviation)
Number of fishermen in the self-management group	70.70 (61.69)
Number of fishermen in the ochongye who are in the same fisheries but not in the self-management group	212.66 (762.99)
Average age of fishermen	51.29 (6.08)
Total number of vessels on an average fishing day	52.09 (50.03)
Average tonnage of vessels in the self-management group	7.41 (11.79)
Number of years since establishment of the self-management group	6.68 (4.27)
Percent of groups in which the members have the autonomy of whether or not to join the group	93.75 (0.25)
Percent of groups that require a membership fee	60.61 (0.50)
Average membership fee (1,000 KW)*	97.50 (175.40)

Source: Authors' data. Notes: The total number of group leaders interviewed was 33. Valid responses for each question vary within a range of 29–33. * Does not include zero values. US$1 is approximately 1,160 Korean won (KW).

Profitability

Based on the descriptive statistics, the two types of fishermen are also statistically similar in terms of economic outcomes. The average total revenue in 2007 was approximately 65 million KW and the total cost was 35 million KW, with no statistically significant difference between the member and non-member fishermen (table 4, rows 1 and 2). We find that both types of fishermen, on average, experienced a decrease in revenue and an increase in cost since joining a self-management group or since 2002 in the case of non-members (table 4, rows 3 and 4).[3] Using the full sample, nearly 75% of the member fishermen said their total revenue decreased since joining a self-management group, whereas about 85% of the non-members said their total revenue decreased since 2002. On average, the direction of the change in revenue is negative for both groups, with more non-member fishermen experiencing a decline. Likewise, although both groups experienced an increase in total cost, more non-member fishermen experienced an increase in cost. The difference in means for the restricted sample, which is a subset of the full sample that responded to all questions pertaining to the economic outcomes, was statistically significant at the 20% level for the directional change in total revenue and 10% for the directional change in total cost. Otherwise, we find that there are no significant differences between fishermen in the restricted sample and those not in the restricted sample except for income; the restricted sample has a higher mean income category compared to the full sample.

Although the direction of change in revenues and costs over the years is informative when evaluating the effect of joining a self-management group, a caveat with these variables is that the baseline year is different among fishermen. For all non-member fishermen, the baseline year is 2002. For member fishermen, the reference year is one year prior to joining a self-management group, which differs depending to which of the 33 groups the fisherman belongs. Still, the reference year for 70% of the member fishermen in our sample is either 2001 or 2002, implying that the reference year for most fishermen in our sample is similar, but the issue of different base years still remains.

For a better comparison, we utilize the information on changes in total revenue and total cost in the reference year compared to 2007 and create new variables that indicate the annual growth rate in total profit, revenue, and cost (table 4, rows 5 through 7). We find that both types of fishermen experienced a high growth rate per year in profit, with an average of 33% per year for member fishermen and 38% for non-member fishermen. Not only did the revenue increased on average, but the total cost decreased. The average growth rate in total revenue was 2.0% for member fishermen and 2.4% for non-member fishermen, and the average growth rate in total cost was –7.5% for member fishermen and –6.1% for the non-member fishermen. At first look, these trends seem somewhat contradictory compared to the directional change in costs and revenues (rows 3 and 4). This result could stem from the possibility that the fishermen who responded to these questions may have experienced a larger increase in revenue and a larger decrease in costs than the full sample. In fact, the downside of these annual growth rate indicators is that only a subset of the respondents provided valid responses to the questions related to changes in revenues and costs in the baseline year. Given the advantages and disadvantages of these two sets of economic outcome indicators—directional change and annual growth rate—we utilize both of them in the subsequent analyses.

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[3] In our survey, we wanted to capture the change in revenue and cost before and after joining a self-management group. We requested 2007 revenue and cost data from all fishermen. However, given that fishermen joined self-management groups in different years, we asked each fisherman to consider one year prior to joining a self-management group and asked for the revenue and cost information for that year. For the non-member fishermen, we asked for revenue and cost information for 2007 and 2002.

Table 4
Descriptive Statistics of Fishermen's Performance, Fishing Activities, and Socioeconomic Characteristics Using Sampling Weights
Self-management vs. Non Self-management Fishermen, 2007

	Self-management Group			
	Members		Non-members	
	Full Sample (N=182) (1)	Restricted Sample[†] (N=63) (2)	Full Sample (N=136) (3)	Restricted Sample[†] (N=39) (4)
Average total fishery revenue in 2007 (million KW)	61.00 (11.51)	66.62 (14.32)	68.59 (10.26)	86.76 (13.87)
Average total fishery cost in 2007 (million KW)	30.14 (7.07)	35.96 (9.83)	40.84 (6.35)	52.27 (9.48)
Changes in revenue since 2002 or joining self-management group[a] (1=increased, 0=no change, –1= decrease)	–0.40 (0.17)	–0.20 (0.14)	–0.59 (0.10)	–0.47 (0.15)
Changes in costs since 2002 or joining self-management group[a] (1=increased, 0=no change, –1=decrease)	0.66 (0.10)	0.74 (0.09)	0.81 (0.06)	0.91 (0.05)
Average annual growth rate in profit since 2002 or joining self-management group (% change per year)	N.A.	33.11 (8.07)	N.A.	37.82 (11.29)
Average annual growth rate in revenue since 2002 or joining self-management group (% change per year)	N.A.	2.00 (1.22)	N.A.	2.38 (1.22)
Average annual growth rate in cost since 2002 or joining self-management group (% change per year)	N.A.	–7.51 (1.07)	N.A.	–6.08 (0.22)
Tonnage (tons)	5.23 (1.01)	5.04 (0.80)	4.43 (0.49)	5.17 (0.80)
Number of crew (persons)	2.39 (0.28)	2.14 (0.27)	2.82 (0.32)	2.75 (0.33)
Annual fishing days in 2007	198.65 (6.00)	200.98 (16.32)	198.81 (7.07)	199.17 (8.67)
Percentage of income from fishing	92.36[*] (2.72)	92.57 (2.78)	85.59 (3.00)	85.65 (3.08)
Years of fishing experience	27.16 (1.07)	24.68 (1.95)	25.87 (1.42)	28.54 (2.37)
Income category[b]	3.74 (0.25)	4.14 (0.32)	3.80 (0.24)	4.18 (0.32)
Education attainment[c]	2.10 (0.13)	2.08 (0.15)	2.02 (0.12)	1.82 (0.10)

Table 4 (continued)
Descriptive Statistics of Fishermen's Performance, Fishing Activities, and Socioeconomic Characteristics Using Sampling Weights
Self-management vs. Non Self-management Fishermen, 2007

	Self-management Group			
	Members		Non-members	
	Full Sample (N=182) (1)	Restricted Sample† (N=63) (2)	Full Sample (N=136) (3)	Restricted Sample† (N=39) (4)
Age	53.70 (0.81)	53.33 (0.92)	54.95 (0.93)	55.54 (1.79)
Household size	2.97 (0.14)	3.11 (0.33)	2.68 (0.15)	2.74 (0.21)
Number of children (<18 years old)	0.48 (0.15)	0.67 (0.23)	0.67 (0.13)	0.68 (0.23)
Number of household members older than 65	0.37 (0.06)	0.36 (0.17)	0.26 (0.05)	0.31 (0.10)

Source: Authors' survey.

Notes: Linearized standard error in parentheses. * The difference in means is significant at the 10% level based on a one-tailed t-test. All other mean comparisons were statistically insignificant. The means are weighted using inverse probability. The number of sampled fishermen in a self-management group is 182; those not in a self-management group is 124. The number of valid responses differs depending on the variable. For the self-management group members, revenues and costs are from the managed fisheries only, but not necessarily for a single species. "Household" is the typical unit of business in coastal fisheries, and thus the revenue and costs are those at the household level. For non-members, the revenues and costs are from the fisheries that generated the largest revenue for non-members. † The means are calculated only among respondents who answered both revenue and cost and changes thereof over the years (63 self-management fishermen and 39 non self-management fishermen.) [a] Although insignificant at the 10% level, the absolute value of t-statistics testing the difference between the two groups (restricted sample) in the means for change in total revenue was 1.31 (P-value=0.20) and for total cost was 1.66 (P-value=0.103). [b] The income categories are (in million KW): 1 <10 ; 2=10 to <20; 3=20 to <30; 4=30 to <40; 5=40 to <50; 6=50 to <60; 7=60 to <70; 8=70 to <80; 9=80 to <100; and 10=>100. [c] Education categories are 1 = middle school graduate; 2 = some high school; 3 = high school graduate; 4 = professional college graduate; 5 = some college; and 6 = college graduate.

Descriptive Statistics: Members vs. Non-members

The individual-level fisherman survey revealed that members and non-members of a self-management group share a number of similar characteristics (table 4). There is no statistically significant difference in the key fishing characteristics, including average tonnage of vessels, number of crew members, and effort measured by total fishing days in 2007 (rows 8 to 10). The fishermen in our sample operate vessels of 4 to 5 tons. These vessels are slightly smaller than the group average derived from the group leader survey. Moreover, the member and non-member fishermen also share similar socioeconomic characteristics, including years of fishing experience, income level, education attainment, age, household size, number of children, and number of household members over 54 years old. The only characteristic that was significantly different at the 10% level was percentage of income from fishing, with member fishermen, on average, having a share of more than 90% of income from fishing, compared to 86% for non-member fishermen. These common characteristics suggest that the two types of fishermen are comparable, which is an appropriate condition for identifying the impact of self-management groups on economic outcomes.

To further understand the factors associated with membership in a self-management group, we compare results from two logit models (table 5). The dependent variable is a binary indicator of if the respondent is a member of a self-management group or not. Note that these logit models are for descriptive purposes rather than to identify causal effects. Model 1 includes variables related to socioeconomic characteristics of the fishermen, fisheries characteristics, and regional fixed effects. Model 2 includes perception questions regarding the current status of their fisheries.

Overall, there are two key findings. On one hand, many of the coefficients are insignificant, suggesting that the fishermen from the two groups are somewhat similar. This supports comparability of these fishermen. On the other hand, there are several variables that are associated with membership, which suggests that the two types of fishermen differ in some aspects and that they need to be controlled for when examining the effects of self management on economic outcomes. Based on Model 2, we find that fishermen that have lower incomes are younger, have more years of fishing experience, and are more likely to be members of a self-management group. Moreover, fishermen using trap nets are more likely to be a member compared to "other" gears (the dropped category). Fishermen who target shellfish are less likely to be members compared to those who target finfish. Some perceptions also are associated with group membership. Individuals who think there is capital stuffing and oversupply (and resulting price decrease) are more likely to be members. In our subsequent analyses, which identify the effect of self-management groups on economic outcomes, we control for all of these variables, except the perception questions.[4]

Empirical Strategy

In an ideal world, we can identify the impact of self-management groups on economic outcomes using the following model:

$$y_i = \beta_0 + \beta_1 selfmgt_i + \varepsilon_i, \tag{1}$$

where y_i is an economic outcome for an individual fisherman i; $selfmgt_i$ is a dummy variable indicating 1 if the individual fisherman is a member of a self-management group and 0 otherwise; and ε_i is the error term. The coefficient of interest is β_1.

Selection Bias

There are three key problems in identifying β_1.The first key issue is self-selection bias. Since individual fishermen were not randomized into a self-management group, there could be systematic differences between those who did and those who did not become members of a self-management group that lead to differences in profitability. Although the descriptive statistics shown in the previous section indicated that member and non-member fishermen are similar in most aspects, the results from the logit models showed

[4] We exclude the perception questions from the matching models since they ask about the current conditions of their fishery.

Table 5
Factors of Membership in a Self-management Group Based on Logit Model

	Dependent Variable: 1=Member of a Self-management Group; 0=Otherwise	
	Model 1	Model 2
Income category[§]	–0.025 (1.26)	–0.053** (2.10)
Education attainment[§]	0.016 (0.50)	0.025 (0.73)
Age	–0.012** (2.16)	–0.018** (2.29)
Proportion of income from fishery	0.005** (2.02)	0.003 (0.95)
Total fishing days in 2007	–0.000 (0.19)	–0.000 (0.09)
Years of experience in fishing	0.007* (1.73)	0.009** (2.08)
Tonnage in 2007	0.027 (1.31)	0.034 (1.51)
Number of crew in 2007	–0.027 (1.02)	–0.033 (1.19)
Gear Type Variables[†]		
Gill net	0.104 (0.57)	0.064 (0.31)
Trap net	0.361*** (3.60)	0.366*** (3.83)
Composite fishery	0.230 (1.36)	0.224 (1.12)
Species Variables[†]		
Crustacean	–0.222 (1.36)	–0.227 (1.35)
Shellfish	–0.550*** (3.06)	–0.468** (1.87)
Other	0.216 (1.63)	0.171 (1.27)
Region Variables[†]		
Southeast region	0.007 (0.04)	–0.126 (0.59)
North region	0.0047 (0.25)	–0.080 (0.44)
Resource stock is low due to overharvesting		–0.052 (1.05)
Overall fishing effort is declining		0.051 (1.04)
There is overinvestment in vessels and gears		0.104** (2.01)

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	(0.19)	(0.09)
Years of experience in fishing	0.007*	0.009**

that some socioeconomic characteristics (lower income, younger, and more fishing experience) and fishery characteristics (using trap net and targeting species other than shellfish) are positively associated with membership. These factors could affect economic outcomes. For example, those with more fishing experience might have higher revenue and lower costs; this could lead to a positive selection bias. Fishermen using trap nets may have lower productivity and hence lower revenue, leading to a negative selection bias. Although the combined effect of selection bias is an empirical question, it is unlikely to be zero. Hence, applying ordinary least squares to equation (1) is unlikely to yield an unbiased treatment effect.

To deal with self-selection bias, we utilize the covariate matching method. This method is used to examine the impact of a treatment (in our context, membership in a self-management group) on an outcome (in our case, profit, revenue, and cost) when selection takes place on observable characteristics (Rosenbaum and Rubin 1983). Measuring the effect of group membership on economic outcome without bias using the matching method assumes that the outcome in the base state (economic outcome if the fisherman is not a member of a group) is independent of the treatment (being a member of a group), conditional on observed covariates. In other words, for fishermen within subgroups defined by the covariates, being a member of a self-management group is unrelated to what the economic outcome would be if the fisherman were not a member. This is the so-called Conditional Independence Assumption. If this assumption holds, we can say that given the observable covariates, the economic outcome of the non-member fishermen is what the economic outcome of the member fishermen would have been had they not been a member.

Matching works by finding a non-member fisherman who is very similar to a member fisherman by conditioning on covariate variables nonparametrically (Black and Smith 2004). Moreover, with matching methods, we can impose "common support," which excludes member fishermen for whom we cannot reliably find a similar non-member fisherman.

We follow the recent literature and match using covariate matching and its variants.[5] Covariate matching matches directly on covariates. In our analysis, we choose to match the two nearest neighbors with the same (similar) covariates (Z_i). The member and non-member fishermen are matched on income, educational attainment, age, proportion of income from fishing, annual fishing days, tonnage, size of crew, region, gear type, and target

[5] Using the Monte Carlo simulation, Zhao (2004) showed that with small sample size (500 or less), covariate matching is preferred over propensity score matching.

species. In particular, we do exact matching on region, gear type, and target species, since we believe the fishermen would be quite different if these characteristics were not similar. Within this group, we can then directly estimate $E(y_{1i}|selfmgt_i=1, Z_i)$ and $E(y_{0i}|selfmgt_i=0, Z_i)$, where the second term replaces the hypothetical counterfactual, $E(y_{0i}|selfmgt_i=1)$. This approach means that once we have a matched sample, we compare the economic outcome of the member fishermen with the economic outcome of the non-member fishermen.

We report the estimated coefficients that use the post-matching bias correction factor developed by Abadie and Imbens (2006). This correction factor is needed to correct for the conditional bias in finite samples when there are three or more continuous variables. Based on recent work that demonstrates that bootstrapping standard errors are invalid with non-smooth nearest neighbor estimators, we use Abadie and Imbens's variance formula for nearest-neighbor estimators that are heteroskedasticity consistent. With covariate matching, we report the results using two weighting matrices. One approach uses the inverse variance weighting scheme; the other uses the Mahalanobis metric weighting scheme.

To further control for unobserved covariates that may affect membership or the economic outcomes, we take advantage of the recall data for the baseline year and first difference the variables in equation (1). We, therefore, examine five different variables as economic outcomes (Δy_i): directional change in total revenue and total cost and annual growth rate in profit, total revenue, and total cost. First differencing the membership status will result in a dummy variable for $selfmgt_i$ because, by definition, the baseline year is the one in which self management was established. This differencing procedure yields the so-called difference-in-difference matching, which controls for time-invariant unobserved variables that change in parallel between the member and non-member fishermen in addition to all the advantages of the matching method.

Unequal Sampling Probability

Due to the way the member and non-member fishermen were sampled, each fisherman has a different probability of being selected into our sample. The number of fishermen in each self-management group differs; therefore, the probability of a member fisherman being selected is inversely proportional to the size of the group. Moreover, the community size from which a non-member fisherman was sampled also differs. To take into account this unequal sampling probability, we weight the samples based on the inverse of the probability using the total number of fishermen in the self-management group or the fishing community to which the fisherman belongs. The size of the self-management group was determined by data from the group leader survey. The 2007 data for size of the fishing community from which the non-member fishermen were sampled came from unpublished data through the Ministry of Maritime Affairs and Fisheries (2008). We show both the weighted and unweighted estimates.

Two Measures of Self-management Effect

We are interested in two types of effects of self management on profitability: the average treatment on the treated (ATT) and the average treatment effect (ATE). ATT measures the effect of a self-management group on the profitability of the member fishermen. In other words, it quantifies how much better off the self-management members are than they would have been if they had not become a member. ATT can be expressed as $E[y_{1i}-y_{0i}|selfmgt_i=1]$. In contrast, the ATE, which is expressed as $E[y_{1i}-y_{0i}]$, measures the effect of self-management group on the entire sample; *i.e.*, unconditional on membership status.

In summary, we have five economic outcomes of interest: directional changes in total revenue and total cost and the average growth rate in profit, total revenue, and total cost. For each of these outcomes, we show the estimates that use inverse distance and Mahalanobis metrics for matching. In addition, we show both ATT and ATE for all outcomes and weighted and unweighted estimates. In total, we show estimates from 40 matching models.

Results

Directional Change in Total Revenue and Cost

The covariate matching estimates for the effect of self management on directional changes in revenue and cost suggest that being members of a self-management group benefits both the revenue and cost sides of fishing activities (table 6). The ATT estimates for total revenue suggest that when we compare member and non-member fishermen who are similar or exactly the same in the covariates, membership in a self-management group is likely to lead to an increase in revenue (columns 1 and 2). Moreover, the ATT estimates for total cost are negative and statistically significant, suggesting that membership in a self-management group is also likely to lead to a decrease in cost (columns 3 and 4). These results are generally consistent regardless of the metrics used for matching (inverse distance vs. Mahalanobis), weighted or unweighted using sampling weights.

The ATE estimates show that the benefits arising from forming or becoming a member of self-management groups may also extend to non-member fishermen, but more so for revenue than cost. The ATE estimates for the directional change in total revenue are positive and significant, and the magnitudes are similar to ATT (columns 5 and 6). This result suggests that, on average, the matched non-member fishermen could benefit as much as the member fishermen in terms of higher revenue had they also become a member. The ATE estimates for directional change in total cost give a mixed result. The weighted estimates are negative and significant, suggesting that self-management membership will lower the cost for an average fisherman. However, the unweighted estimates are insignificant, suggesting that the unconditional effect of self management is zero. Again, these results are consistent across the two metrics, inverse distance and Mahalanobis metric. We believe that weighted estimates are more accurate given our sampling strategy; thus, it is more likely that the cost of fishing will decrease as a result of becoming a member of a self-management group.

Average Growth Rate in Profit, Total Revenue, and Cost

When we examine the degree of change in profit, total revenue, and total cost, we find results that are consistent with the effect on directional change, although the estimates are not as statistically robust (table 7). The ATT estimates for the average growth rate in profit are positive, ranging from 16 to 23% (top table, columns 1 and 2). While the magnitude of the effect of self management on member fishermen is large, the estimates are significant only at 10–20% significance level. When we break this down into revenue and cost, the ATT estimates for the average growth rate in total revenue ranged from 4 to 5%, and the estimates were statistically significant at the 1% level for the weighted estimates (columns 3 and 4). On the other hand, the estimates for the average growth rate in total cost are insignificant (weighted) or only weakly significant (unweighted) (columns 5 and 6).

The ATE estimates show that the self management had no unconditional effect on overall growth in profit or revenue, but the estimates on total cost show that self management had small unconditional effects in reducing costs (lower table, columns 1 to 6). The estimates range from –1.5 to –1.9% annual reductions in costs, and the results are consistent across the two metrics for matching and weighted and unweighted.

Table 6
Estimated Effect of Self Management on the Direction of Change in Total Revenue and Total Cost from Covariate Matching Models

	Average Treatment Effect on the Treated (ATT)				Average Treatment Effect (ATE)			
Dependent Variable	Change in Total Revenue (1=positive, 0=no change, –1=negative)		Change in Total Cost (1=positive, 0=no change, –1=negative)		Change in Total Revenue (1=positive, 0=no change, –1=negative)		Change in Total Cost (1=positive, 0=no change, –1=negative)	
	Weighted (1)	Unweighted (2)	Weighted (3)	Unweighted (4)	Weighted (5)	Unweighted (6)	Weighted (7)	Unweighted (8)
Inverse distance	0.354** (2.03)	0.288** (2.23)	–0.226*** (–3.13)	0.120 (1.21)	0.311** (2.72)	0.284*** (2.68)	–0.116** (–1.97)	0.071 (0.80)
Mahalanobis	0.216 (1.14)	0.282** (2.20)	–0.196*** (2.75)	–0.165* (1.69)	0.227* (1.85)	0.291*** (2.81)	–0.094* (1.86)	–0.095 (1.06)

Notes: N = 262. Absolute value of z-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. All estimates use bias-corrected matching estimator. Standard errors are heteroskedasticity consistent. Each treated sample is matched against two control samples using nearest neighbor matching based on the covariates income, education, age, proportion of income from fishing, effort, tonnage, and the number of crew. The treated and control samples are exact matched based on primary target species, gear type, and region. Estimates in columns labeled "weighted" are weighted using sampling weights; *i.e.*, the inverse of the probability that the observation is included due to sampling.

Table 7
Estimated Effect of Self-management on Changes in Average Growth per Year in Profit, Total Revenue, and Total Cost from Covariate Matching Models

	Average Treatment Effect on the Treated (ATT)					
Dependent Variable	% Change per Year in Profit		% Change per Year in Total Revenue		% Change per Year in Total Cost	
	Weighted (1)	Unweighted (2)	Weighted (3)	Unweighted (4)	Weighted (5)	Unweighted (6)
Inverse distance	16.901 (1.51)	22.976* (1.72)	5.369*** (3.10)	4.317 (1.60)	–0.015 (0.02)	–1.071 (1.41)
Mahalanobis	15.835 (1.46)	17.688 (1.38)	5.010*** (2.97)	4.038 (1.55)	–0.071 (0.02)	–1.059 (1.39)
	Average Treatment Effect (ATE)					
Dependent variable	% Change per Year in Profit		% Change per Year in Total Revenue		% Change per Year in Total Cost	
	Weighted (1)	Unweighted (2)	Weighted (3)	Unweighted (4)	Weighted (5)	Unweighted (6)
Inverse distance	–1.592 (0.19)	14.937 (1.24)	–0.506 (0.24)	2.670 (0.99)	–1.454* (1.91)	–1.866** (2.32)
Mahalanobis	–1.072 (0.13)	14.716 (1.31)	1.562 (0.90)	3.142 (1.22)	–1.498** (1.96)	–1.818** (2.23)

Notes: N=103. Absolute value of z-statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. All estimates use bias-corrected matching estimator. Standard errors are heteroskedasticity consistent. Each treated sample is matched against two control samples using nearest neighbor matching based on the covariates income, education, age, proportion of income from fishing, effort, tonnage, and the number of crew. The treated and control samples are exact matched based on primary target species, gear type, and region. Estimates in columns labeled "weighted" are weighted using sampling weights; *i.e.*, the inverse of the probability that the observation is included due to sampling.

Conclusion

Based on theory of clubs, a critical incentive compatibility criterion for self-management groups of natural resources to sustain in the long run depends on whether or not managing the resource as a group results in economic gains for its members. This paper uses a unique set of data from South Korea and an empirical strategy to provide one of the first quantitative evidences that self management is benefiting fishermen. Overall, we find that membership in a self-management group benefits the member fishermen on both the revenue and cost sides of fishery activities. Although statistical evidence of the actual levels of change is not as robust, we find consistent, strong evidence that at least self management of fisheries is leading to increased revenue and decreased cost. These findings are encouraging indications that support the privileged condition for self-management groups to function as clubs.

However, these results do not necessarily paint a rosy picture of self management for South Korea's fisheries. Our finding merely supports the argument that member fishermen are not worse off. The finding that estimates of the impact on directional change were more robust than the extent of the change, suggests that the process might still be in progress in South Korea, and a longer timeframe may be necessary to observe a solid trend of increasing profit. Given that the average age of self-management groups is only about seven years, such an outcome is within one's expectation, but it also means that much more self-management effort is needed. Nonetheless, the majority of member fishermen perceive the change to be in the right direction, which suggests that members may have the incentive to maintain the group status for the time being.

The results obtained in this study provide some policy implications for fishery self management in South Korea and beyond. First, the results show that, on average, self management of fisheries brings positive benefits not only to current members but potentially to all non-members. As such, this finding could support the argument for South Korea's government to continue its policy to promote and support the establishment and operation of self-management groups. This seems particularly important at this juncture where the positive trend is felt by many member fishermen, but tangible and measureable impacts are yet to arrive. Thus, it would be a great loss of opportunity if the government were to discontinue this endeavor.

Secondly, one statistic that stood out compared to other countries' self-management experience is the high share of South Korean self management dealing with finfish (figure 1). Both the theory and typical case studies, including those in Japan, point out that immobile species, such as shellfish and crustaceans, are more suited for self management than mobile species (*e.g.*, Ostrom *et al.* 2002).The ability to swim around makes the species potentially difficult to co-manage, since they can easily straddle across the border of self-management groups. This implies that a self-management organization that administers an area large enough to cover the movement of such species becomes necessary for effective management.

The challenge, of course, is that larger self-management groups are often difficult to establish, let alone sustain. Common wisdom is that the smaller the group size, the more likely its endurance (Olson 1965; Ostrom *et al.* 2002). In fact, South Korean self-management groups have fewer members (average of 71) than non-self management groups. There will be a higher degree of heterogeneity, which could impede reaching any sensible consensus on self-imposed rules and other cooperative arrangements. Political forces will be much stronger, which could completely change the group's direction (as seen in some U.S. coastal fishery management; *e.g.*, Gaines 2008; Murphy 2008).

In sum, there are advantages and disadvantages to enlarging the self-management group: cover the entire migration path of managed finfish species but with the possibility of increasing transaction costs among the members. A possible remedy is the coalition of self-management groups, as seen in Japan (Uchida and Makino 2008). By utilizing the pre-existing organizational hierarchy, it may be possible to keep transaction costs low.

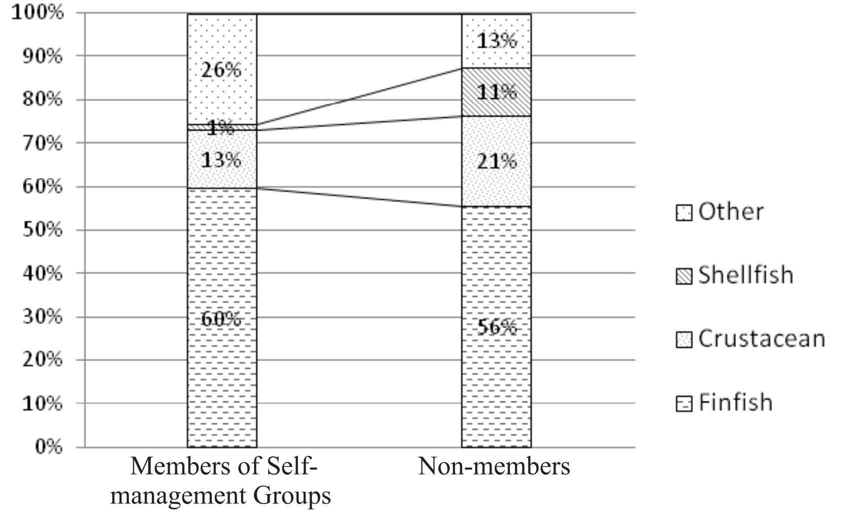

Figure 1. Proportion of the Primary Target Species Type, Members of Self-management Groups vs. Non-members, 2007

Source: Authors' data.

Thirdly, the extent and the types of self-management activities currently adopted by self-management groups indicate that there is still significant room for further utilizing advantages of self management. For example, the most popular self-management activities in our sample were cleaning fishing grounds, monitoring for poachers, removing pests, and information exchange. Although all of these are important fishery management activities, their impacts on enhancing total revenue or reducing costs are passive at best. One of the key strengths of self management—and collective management in general—is the ability to engage in activities that are ineffective if done individually but potentially very effective if done as a group. Such an example is joint marketing and quality control.

In Japan, for example, more and more fishing cooperatives are starting their own retail shops and internet sales.[6] The concept is to cut the middleman and present their products as the freshest available to a consumer. Since Japanese consumers are very selective about the freshness of fish, this method is fairly low-tech and yet quite effective to differentiate their product from others. Similarly, South Korea's self-management groups may take advantage of these strategies to differentiate their products and increase sales.

Finally, in the survey sample there was only one case where the respondent mentioned revenue sharing. Unfortunately, we do not know the details of how this is actually done, but it could be something very similar to what several studies have found in Japan (Gaspart and Seki 2003; Platteau and Seki 2001; Seki 2000; Uchida and Baba 2008; Uchida and Watanobe 2008). A pooling arrangement, as it is often termed, is recently garnering attention from the theoretical front as well, with results generally being positive about its effect on successful self management. The key driving force for this outcome is the fact that a pooling arrangement aligns individual incentive (profit maximization) to that of a group as a whole (maximize total profit).

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[6] Personal communication with Dr. Osamu Baba of Tokyo University of Marine Science and Technology and fishery cooperative association members.

It will be difficult to convince fishermen to accept this regime. Even in Japan where more than 20% of self-management groups have adopted a pooling arrangement, fishermen will typically resist its implementation initially. But some of those fishermen are now doing fairly well, at least when one considers the environment in which they operate (Uchida and Baba 2008; Uchida and Watanobe 2008).

The risk of a pooling arrangement is of course the prospect of free-riding. The lesson from the Japanese experience, as is consistent with the Folk Theorem in game theory, is that as a result of a pooling arrangement the members must be better off than without it. In a repeated infinite game, any incentive compatible strategy can be supported as Nash equilibrium. Thus, if it is the fishermen's interest to maintain the pooling arrangement and self-management group for the current period, then they will do so for all subsequent periods. Thus, we are back to our previous point, that self-management groups should put more effort in direct profit enhancement (revenue increasing and/or cost reduction) activities.

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