Sharing, Heterogeneity and Status Considerations: Incentive Theory and Empirical Evidences *

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Abstract

We study whether a linear income sharing rule (pooling system) can achieve Pareto efficiency in a problem of joint exploitation of fishery resources. When agents are selfish, the homogeneity of individual outputs in equilibrium is a necessary condition for the efficient pooling system. When agents exhibit a preference for status (i.e. for being among the well-performing members of the group), the pooling system can be efficient even without this condition. This is because, on the one hand, relative status considerations enlarge the tolerable range of heterogeneity and, on the other hand, it generates an incentive structure that may homogenise individual output performances.

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1. Introduction

This study is inspired by our empirical observations of three groups of Japanese fishermen who share income (see Platteau and Seki forthcoming, for more details). They practice income sharing not primarily for the purpose of insurance, but in order to make various profitable collective arrangements self-enforcing. Such collective arrangements include cooperation in searching for promising fishing spots, engaging in collective research and development of fishing techniques, regulating fishing effort and sharing expertise. Since individual effort contributions to each component of collective action are not separately verifiable, a complete contract of collective action cannot be written and thus any individual promise to cooperate cannot be enforced. An incomplete contract, such as a pooling system, emerges as one of the possible ways to overcome these problems.

One of the three sample groups has been sustaining full-pooling since the beginning of the 1960's and can extract several advantages of collective actions. Another group does not pool income and its members do not enjoy the peculiar benefit of collective actions. The third group had started full-pooling but reduced the extent of pooling after a 10 year trial. These differences between the three groups give rise to several interesting questions about the effectiveness of collective arrangements and their determinants. For one thing, does the pooling system contribute to improving production efficiency, and if so, how? On the other hand, why does only one group succeed to pool income to a large extent? These are the main questions we try to answer in this study.

We first examine the existence of a first-best pooling rule in a simple model with two fishermen who harvest the same type of fish in a commonly owned fishing ground. We then study the effect of relative status considerations on the pooling system when members are heterogeneous: how do such social considerations influence individual behaviour and how do they affect the sustainability of the first-best pooling system. A motivating factor of this inquiry is the frequent references made by fishermen to the importance of self-esteem and norm of social status arising from relative performance comparisons. Fishermen often explained the success (or failure) of pooling by the existence (or lack) of aspirations to seek self-esteem and by the attitude to try one's best to improve the relative standings in the group. Moreover, when they were asked about the expected emotional reactions of fishermen belonging to pooling system towards relatively higher and the lower performing members, as we will report later in Section 2, it became apparent that the pooling system generates a particular behavioural norm according to which members become keen to compare each other's performance and to perform better than the others. The oral testimonies of fishermen and their family members, and direct observations of their behaviour revealed that relative

status considerations engendered by the pooling arrangement actually circumvent incentive problems[1].

The pooling systems observed in our sample groups are reminiscent of a mixed profit sharing rule studied by Sen (1966). While Sen (1966) assumes identical preferences among agents and examines the effect of externally given levels of "social consciousness" on the Pareto efficient income distribution, we do not assume homogeneous agents but put forward a necessary condition for the existence of the first-best pooling system and study the effect of relative status considerations. We find that if there exists a pooling system whose Nash equilibrium levels of effort allocations are Pareto efficient, then individual output performances in the equilibrium must be identical. We show further that, provided members share some appropriate kind of relative status considerations, the pooling system becomes viable even when individual performances are heterogeneous. We also demonstrate that there is a mutually-enhancing relationship between the homogeneity of individual performances and the sustainability of the pooling system. Preferences for status will induce a two-sided incentive effect: less skilled members tend to work more diligently, while more better skilled ones produce modestly. As a consequence, the heterogeneity of performances is likely to be narrowed down, which enhances the possibility to sustain pooling system, and thus to avoid "community failure".

The two-sided incentive effects induced by the relative status considerations discussed in this study are closely related to peer monitoring as observed among borrowers of informal credit, workers at shop-floors, and members of producers' cooperatives. In the same way that peer monitoring helps control moral hazard problems arising from informational asymmetry between money lenders and borrowers, or between managers and workers (Arnott and Stiglitz 1991; Kandel and Lazear 1992), social status considerations circumvent incentive problems in team production. While the existing literature on peer monitoring has focused on how peer pressure operates in partnerships and profit sharing schemes, we want to analyse the effect of norms of relative status on the efficiency of profit-sharing and to examine how pooling gives rise to the appropriate kind of relative status considerations.

The implications from our theoretical analysis are subsequently tested against

[1]There are a growing number of empirical and theoretical studies that assert the importance of relative status considerations in economic analysis of institutions. To name a few, Frank (1985) investigates how competition for higher ranks influence the wage structure among workers. Jones (1984) and Bernheim (1994) examine conformity as a consequence of some agents' consideration of others' behaviour or perception. Aoki (1988) compares the relationship between institutional design and workers' behaviour in Japanese and American firms. For an overview of recent advancement in economic studies on social status, see special issues of European Economic Review, Vol. 42 (1998) and Journal of Public Economics, Vol. 70 (1998).

empirical data. First, means-testing on catches supports the homogeneity of output performances in groups where the pooling system is sustained. Secondly, we observe that this homogeneity of performances cannot be attributed to some homogeneity of capability. Individual mean catch performances are rather homogeneous in the groups with pooling arrangements, while the other group without pooling exhibits more heterogeneous catches. However, an approximated measure of capabilities of the fishing units shows that they are more dispersed in the groups with pooling than in the one without pooling arrangement. Hence, our empirical observations seem to support that, given relative status consideration, the two-sided incentive effects induced by the pooling system actually contribute to homogenising individual performances.

The paper is organised as follows. In section 2, we describe the collective institutional arrangements of the three sample groups on which our analytical framework is based. Transcription of fishermen's statements are presented in order to motivate our discussions on relative status considerations. In section 3, we present a baseline model of fishing in the commonly-owned fishing ground: the inefficiency of non-regulated exploitation of the commons is derived as expected. In section 4, we show a necessary condition for the efficient pooling system: individual performances in equilibrium must be homogeneous. We then examine the conditions under which the pooling system realises a Pareto efficient allocation. A discussion about relative status considerations is conducted in Section 5. Empirical verifications of the theoretical propositions are provided in Section 6 followed by some concluding remarks.

2. Empirical observations

2.1. Institutional characteristics of the sample groups

We have studied three groups of fishermen that operate in the coastal area along the Toyama Bay of Toyama prefecture, Japan, during the fishing season between April and August 1997. The fishermen of the three sample groups harvest the same species, the *shiroebi* (Japanese glass shrimp). Two of our sample groups, referred to as Groups A and B in this study, operate in the area called Shinminato. They use the same harbour facilities and belong to the same local fishery cooperative. In the Shinminato area, Group A used to be the only *shiroebi* fishing group several centuries ago. Since 1992, Group B has also been granted the right to fish *shiroebi* in Shinminato after six long years of negotiation with Group A under the auspices of the local fishery cooperative association. The way the two groups share shiroebi fishing rights combines a rotation scheme with independent operations by day. Between April and May, and again between September and October, only

Functional attributes	Group A	Group B	Group C
Pooling			
• Income pooling	Full pooling	No pooling (except two units)	Partial pooling
• Input cost pooling	Full pooling	No pooling	Partial pooling
Work coordination			
• Synchronization of fishing hours and number of hauls	Yes	Yes	Yes
• Collective net repair	Yes	Limited	Limited
• Exchange of current information	Systematic	Minimal	Minimal
Regulation			
• Control of access to fishing space	Well-developed	Imperfect	Imperfect
• Control of fishing effort	Effective control during exclusive fishing period (April-May, Sept.-Oct.)	No control	No control
Sharing of knowledge and expertise	Actively encouraged	Minimal	Minimal

Table 2.1: Functional characteristics of the three sample groups

Group A operates. On the other hand, between June and September, Groups A and B operate alternately on a daily basis. The third group, denoted Group C, operates in another area in Toyama Bay, known as Iwase. In Iwase, Group C is the only shiroebi fishing group belonging to the Iwase Fishery Cooperative Association. Throughout the seasons between April and October, they have the right to operate daily.

Table 2.1 summarises the functional characteristics of the three groups. The first thing to note in this table is that Group A, composed of seven fishing units, has the most complete pooling system. Since the beginning of the 1960's, they have been maintaining equal sharing of both income and operating expenses[2]. Five fishing units of Group B had adopted a pooling arrangement but abandoned it after a one year trial[3]. Group C had started full-pooling arrangement at the same time as Group A, in the beginning of the 1960s. Since the early 1970s, Group C has shifted to partial pooling: they equally shared only a part of the income obtained from the shrimp sold at prices above the lowest price set by negotiation between fishermen and traders[4]. Consequently, the proportion of income currently shared among Group C members amounts to only about 10% of the total gross income.

In addition to income and input cost pooling, there are three major aspects of the collective functioning of the groups. They include functions of work coordi-

[2] As for investment costs, only expenditure related to nets are pooled.

[3] In Group B, unlike Group A, both investment and operating costs were individually borne by Group B's owners.

[4] In Iwase, shiroebi prices are directly negotiated within a range of four possible levels among which the minimum price is predominant. See Platteau and Seki (1998, pp.9-10) for more details.

nation, effort regulation and sharing of expertise. Finally, the work coordination includes cooperative searching of stock, coordination of access to fishing spots, collective searching for lost nets and repairing of net damages. There are substantial economies of scale to be yielded from these work coordinations. Secondly, the collective regulation of fishing effort prevents individual fishermen from unprofitable overproduction. Lastly, sharing of expertise enables them to take advantage of collective R & D on innovative fishing techniques as well as to insure against technological changes that make existing skills and expertise suddenly obsolete.

It is worth emphasising that the pooling arrangement that we have observed does not primarily aim at providing insurance. As a matter of fact, fishermen do not consider the pooling mechanism as an objective in itself, since it can actually be instrumental to make collective action self-enforcing (for more detailed discussion on this point, see Platteau and Seki forthcoming). More correctly, the pooling system is necessitated to circumvent the incentive problems inherent in the organisation of collective actions.

2.2. Importance of local status considerations

According to standard economic theory, there will be serious problems of effort embezzlement if income were to be shared equally. This is the so called '$\frac{1}{n}$ problem': in a group composed of n members, an individual is entitled to claim only $\frac{1}{n}$ th of the marginal profit of his effort, while he is responsible to cover the full cost of his own effort. Consequently, collective goods will be under-produced. Our empirical observations turn out to show otherwise. As we will show later, the pooling arrangement, when it is sustained, generates no serious incentive problems. A plausible explanation is that it is accompanied by a particular social norm in which members become keen to compare each other's performance and to perform better than the others. Apparently, such norms of relative status considerations seem to produce interesting incentive effects: the less-skilled fishermen are induced to work harder while the better-skilled ones tend to exert relatively less effort.

Fishermen's statements made by members of Group A protray vividly of the absence of serious incentive problems. Those people emphasise tirelessly their high regard of relative performance comparison and their motivation to keep abreast of the others. Between the lines of their statements, we detect an implicit but distinct code of conduct: less experienced fishermen are expected to work harder (i.e. make use of their given capabilities scrupulously while trying to improve them), while more skilled fishermen work modestly (i.e. do not make full use of their capabilities but to share part of them with others by teaching and helping less capable ones). Here are a few quotations from the transcripts of interviews

in Group A [5]:

> - There is a peer pressure to be above the average. The fact we share income makes me work more thoroughly (seriously and cautiously).
>
> - It is out of the question to become lazy by sharing income (with a puzzled facial expression in response to our reference to 'shirking' behariour).
>
> - Do I become lazy because we pool landings? No way! Because we pool, I always feel pressure to have a good catch and to be above the average.
>
> - Though we cooperate, we shall have a spirit of competition. Since everyone wants to be the best, I shall work harder to be competitive. Pooling cannot be sustained if one has a frame of mind to take things easy while others work hard.
>
> - Able persons shall behave modestly and share their ability with others.

On the contrary, the members of Groups B and C predominantly expressed antagonistic feelings about inter-personal comparisons and relative status considerations. For instance:

> - (We decided to abandon the pooling system because) without pooling, we could not indulge ourselves 'in the lukewarm water (a Japanese expression referring to an easy-going attitudes with lack of willingness to learn and excel)'. Pooling spoils our eagerness to strive.
>
> - Under the pooling arrangement, we loose the competitive spirit. As a result, we may make less effort to have better landings.
>
> - I find it unjust to subsidise the others (with lower catches).
>
> - We are too preoccupied to compare each others' landings to the extent that we find it too nerve-breaking.
>
> - We tend to compare each other's landings and criticise discreetly those with consistently lower landings. This is sickening.
>
> - When I have a little catch, I will feel strained. When I damage my net repeatedly, I will again be criticised. If my crews are not good at mending

[5] One of us conducted interviews using the method of oral history. After some period of immersion and confidence building in the communities, interviews were made intermittently on various casual occasions, e.g. on the landing sites while waiting for the boats' arrival with traders and their family members, during net mending, on the boats, at their homes or local bars frequented by them. Respondents included fishermen, their wives and family members. Interviews were recorded, translated and transcribed, whenever appropriate. These recorded oral statements turn out to be valuable in our analysis because they reveal emotional contents of responses and allow us to analyse carefully their statements by paying attention to subtle indications of sentiments in verbal and non verbal expressions. For advantages and disadvantages of oral history technique, see for instance, Slim and Thompson (1993).

nets or slow in working, we will hear back-biting voices. Without pooling, it is a matter for myself thus I can be free from this kind of pressure.

As a matter of fact, members of Group B had suffered from double sided frustrations, as one of them explained: "on the one hand, those with higher catches found it unjust to share their catch with the less performing fishermen, on the other hand, the lower performers felt unreasonable to be made feel ashamed".

In order to gain further insights regarding the relative status considerations of the fishermen, we asked each skipper about his prediction concerning how a fisherman feels towards his colleagues with either inferior or superior catch performances, and how this fisherman reacts to them. Table 2.2 reports the responses. Except for one skipper in Group C, all skippers responded spontaneously to this inquiry, which supports the significance of the relative status considerations in their mind. It is interesting to note that fishermen's feelings towards the inferior and the superior are asymmetric: a number of fishermen expressed remorseful feelings to be inferior that appear to be more intense than the pride experienced when they perform better than others. Furthermore, their responses about the reactions towards superior and inferior catches suggest that the better performing fisherman would be more willing to help the inferior fisnermen, while the poorly performing ones are driven to work harder. This particularity of relative status considerations is further examined in Section 6.

Why has Group A been so successful in maintaining full-pooling over 35 years and what are the difficulties encountered by the members of Group B? Why Group C scaled down the extent of pooling after a decade of full-pooling? And what are the roles played by local status considerations in sustaining effective pooling institutions? To these questions we now turn.

3. The basic model

Before we go into the analysis of the pooling system, it will be helpful first to sketch baseline cases, i.e., Pareto efficient and Nash equilibrium allocations.

3.1. Economic environment

We consider a fishing group composed of two fishermen, $i, j \in \{1, 2\}$, who are exploiting the same fishery resources in the same fishing ground.

Preference of fisherman i is defined by a utility function U_i over income, y_i, and efficiency unit of work effort, x_i. The utility function is continuous in the both arguments, strictly decreasing in x_i and strictly increasing in y_i.

$$U_i(x_i, y_i), U_{ix} < 0, U_{iy} > 0,$$

	How superior fishermen feel about and/or react towards inferior fishermen*	How inferior fishermen feel about and/or react towards superior fishermen*
Group A:		
A1	"shall accept the fact and not be grumpy about it" "shall advise better (fishing) spots and teaching (techniques)."	"must be feeling ashamed of lack of skill"
A2	"cannot do much about it (differences of catches), so is indifferent about it" "advise better spots"	"cannot do much about it (differences of catches), so shall not mind it as long as he is doing his best"
A3	"feels annoyed and frustrated by the fact that the inferior is not up to the standard and that he (the superior) is taken advantage of." "expresses his dissatisfaction by means of giving warnings"	"feels so much pressure to catch more that he contemplates seriously about the way he fishes"
A4	"closes his eyes (tries not to recognise the difference)"	"does not feel guilty nor ashamed, but he feels bad about loosing his place (i.e. recognition in the group) in spite of doing his best."
A5	"feels sorry about his bad luck, (because it is the randomness of the marine condition that is responsible for his poor catch" "advises better spots"	"feels ashamed of his apparent lack of skills."
A6	"will have nothing to say (because those young and inexperienced members will improve their performance in future)". "feels sorry for his bad luck" "shall behave modestly"	"feels marginalised and less influential in the group"
A7	"is not too attentive about such performance gaps" "teach technique"	"feels ashamed of his lack of skills"
Group B		
B1	"feels frustrated about being taken advantage of his superior catch" "Wait and see whether such asymmetric situation continues or they are random events"	"feels ashamed of his lack of skills"
B2	"he shall not find it problematic as long as the inferior members do their best" "But he feels disappointed by the poor performance of his colleague." "Wait and see whether such asymmetric situation continues or they are random events" "expresses dissatisfactions to the poor performer"	"feels ashamed of inferior performance" "shall immediately examines his net and corrects defections (that may be a primary source of bad catches"
B3	he feels disappointed by the poor performance of "his colleague." "advises better spots and teaches better techniques"	"becomes more serious about fishing and work more scrupulously"
B4	"feels pity for poor ability" "makes insulting comments"	"feels less influential in the group"
B5	"Wait and see whether such asymmetric situation continues or they are random events" "feels sorry for his lack of skills"	"feels guilty for free-riding on those with superior catches." "feel humiliated by back biting comments"
Group C		
C1	"feels pity for his poor ability" "teach better techniques"	"tries to learn from the more experienced members"
C2	"feels pity for his poor ability"	"feels ashamed of lack of skills"
C3	- n.a.	- n.a.
C4	"advises better spots and teaches techniques" "if the situation persists more than one to two years, he shall reassess the situation"	"feels ashamed of lack of skills" "makes an effort to improve skills"
C5	"close his eyes (try not to recognise the difference)" "Wait and see whether such asymmetric situation continues or they are random events"	- (no comments)
C6	"feels sorry for his lack of skills" "advises better spots"	"does not mind about it because we share the fates as we share the sea"

* Superior and inferior fishermen refer to those with relatively higher and lower catch performances.

Table 2.2: Fishermen's feelings and reactions towards inter-personal comparison of output performances

U_{ix} and U_{iy} are the first derivatives of i's utility function with respect to effort level and income, respectively. We assume throughout the paper that leisure is a normal good.

The commonly owned production technology is denoted by a production function $F(x_1 + x_2)$ that is a continuous and strictly increasing concave function in the aggregate effort levels, $x_1 + x_2$.

$$F(x_1 + x_2), \quad F' > 0, F'' < 0$$

Furthermore, we denote $f_i(x_i, x_j)$ as individual i's output function, that is, an output share of i in the total production F. So the Tragedy of the Commons is captured by the following assumption.

Assumption 1: The Tragedy of the Commons

$$\begin{aligned} f_{i1} &> 0, \quad f_{i11} < 0 \\ f_{i2} &< 0, \quad f_{i22} < 0 \\ f_{i12} &= f_{i21} < 0 \end{aligned}$$

We also assume that the externality will not reach a prohibitive level, to the extent that the marginal externality inflicted on the other fisherman would be greater than the private marginal product of one's effort.

Assumption 2: Non prohibitive externality

$$\forall x_1, x_2 : f_{i1} \geq -f_{i2}$$

It must be noted that in our model we abstract ourselves away from production uncertainties. This is to allow us to focus on the efficiency of polling system independently of its insurance values, which simplifies the exposition.

3.2. Pareto efficient allocations

Let us suppose that there is a Management body of the group that decides and administers the production plan and allocates the work effort between the two fishermen. The objective of the Management body is to realise a Pareto efficient allocation of effort and income, that is, to solve the following problem:

$$\underset{x_i, x_j, y_i, y_j}{Max} U_i(x_i, y_i)$$

$$\begin{aligned} s.t. \quad U_j(x_j, y_j) &\geq \bar{U}_j \text{ and} \\ y_i &= f_i + T, \; y_j = f_j - T \end{aligned}$$

where $\bar{U}_j$ is a reservation utility level for fisherman j and T is a lump-sum transfer that Management administers.

Taking a Lagrangian,

$$L = U_i\left(x_i, f_i + T\right) + \mu\left[U_j\left(x_j, f_j - T\right) - \bar{U}_j\right]$$

The first-order conditions at an interior solution yield:

$$\frac{\partial L}{\partial x_i} = 0 \Rightarrow U_{ix} + U_{iy} f_{i1} + \mu U_{jy} f_{j2} = 0 \tag{3.1}$$

$$\frac{\partial L}{\partial x_j} = 0 \Rightarrow U_{iy} f_{i2} + \mu\left(U_{jx} + U_{jy} f_{j1}\right) = 0 \tag{3.2}$$

$$\frac{\partial L}{\partial \mu} = 0 \Rightarrow U_j\left(x_j, f_j - T\right) - \bar{U}_j = 0 \tag{3.3}$$

$$\frac{\partial L}{\partial T} = 0 \Rightarrow U_{iy} - \mu U_{jy} = 0 \tag{3.4}$$

From (3.1) and (3.4),

$$-\frac{U_{ix}}{U_{iy}} = f_{i1} + f_{j2}.$$

The marginal rate of substitution between effort and consumption equals the social marginal product of effort that is a sum of the marginal product of i's own effort (f_{i1}) and the marginal externality inflicted on j (f_{j2}). Similarly, from (3.2) and (3.4),

$$-\frac{U_{jx}}{U_{jy}} = f_{j1} + f_{i2}.$$

Since the two fishermen operate in the same fishing ground, they face identical social marginal product of effort (F'). It follows that if the allocation is Pareto optimal, then the marginal rates of substitutions are identical for both fishermen, and they are equivalent to the social marginal product of effort. Therefore, **necessary conditions for Pareto optimality** are

$$-\frac{U_{ix}}{U_{iy}} = -\frac{U_{jx}}{U_{jy}} \tag{3.5}$$

$$-\frac{U_{ix}}{U_{iy}} = f_{i1} + f_{j2} = F'. \tag{3.6}$$

3.3. Inefficiency of unregulated fishing

We now consider the situation in which fishing rights are commonly owned but there is no Management body that decides and enforces a Pareto efficient allocation. In this *laissez faire* set-up, each fisherman harvests as much fish as he pleases. Let us continue to suppose that there are two members in the fishing group. Assuming that the fishermen have perfect information concerning the production technology and the preferences of the others, each fisherman chooses his own effort level so as to maximise his own utility, taking the other's effort level as given. That is

$$\underset{x_i}{Max}\ U_i\left(x_i, y_i\right)$$

$$s.t. \quad y_i = f_i\left(x_i, \bar{x}_j\right)$$

From the first-order condition:

$$\frac{dU_i}{dx_i} = U_{ix} + U_{iy} f_{i1} = 0.$$

Hence,

$$-\frac{U_{ix}}{U_{iy}} = f_{i1} > F'. \tag{3.7}$$

By symmetry, each fisherman exerts fishing effort to the extent at which the marginal rate of substitution is now equated with the private marginal product of an efficiency unit of effort. Comparing (3.7) with (3.6), we notice the standard result of the Tragedy of the Commons: unregulated fishing results in over-exertion of fishing effort. Since no individual will take into account the negative externality inflicted on the other, the aggregate effort level overshoots the social optimal level. In the following sections, we assume that the *laissez faire* distribution of fish is proportional to labour expended among the fishermen:

Assumption 3: Individual production as average sharing

$$f_i = \frac{x_i}{x_1 + x_2} F\left(x_1 + x_2\right). \tag{3.8}$$

In this case, (3.7) is rewritten as:

$$-\frac{U_{ix}}{U_{iy}} = \frac{x_j}{x_1 + x_2}\frac{F}{x_1 + x_2} + \frac{x_i}{x_1 + x_2} F' > F'.$$

4. The pooling system

4.1. Necessary condition for the first-best pooling system

Let us now consider a pooling system in which a fraction of income is shared equally among the fishermen in the group. For a start, assume that Management is perfectly informed of the preferences of fishermen and of technological characteristics. Our objective in this section is to identify conditions under which the pooling system provides an effective solution to the common's tragedy that is to attain Pareto optimal allocations of effort and income in Nash equilibrium.

Let t represent a fraction of output to be pooled and shared equally. The sharing rule underlined in the pooling arrangement between the two fishermen is defined as:

$$\begin{aligned} y_i &= (1-t) f_i + \frac{t}{2}(f_i + f_j) \\ &= \left(1 - \frac{t}{2}\right) f_i + \frac{t}{2} f_j. \end{aligned}$$

Individual income now becomes a sum of one's own earnings that was retained, and an equal share of the pooled income. The fisherman i's utility maximisation problem is now:

$$\begin{aligned} & \underset{x_i}{Max}\, U_i(x_i, y_i) \\ \text{s.t.} \qquad y_i &= \left(1 - \frac{t}{2}\right) f_i + \frac{t}{2} f_j. \end{aligned}$$

The symmetric first-order conditions are:

$$\frac{dU_i}{dx_i} = 0 \Rightarrow U_{ix} + U_{iy}\left[\left(1 - \frac{t}{2}\right) f_{i1} + \frac{t}{2} f_{j2}\right] = 0$$

From this we find the marginal rate of substitution between effort and income as:

$$-\frac{U_{ix}}{U_{iy}} = \left(1 - \frac{t}{2}\right) f_{i1} + \frac{t}{2} f_{j2} \tag{4.1}$$

Using Assumption 3: (individual production as average sharing) as in (3.8), (4.1) can be rewritten explicitly as:

$$-\frac{U_{ix}}{U_{iy}} = (1-t)\frac{x_j}{x_1 + x_2}\frac{F}{x_1 + x_2} + \frac{x_i + \frac{t}{2}(x_j - x_i)}{x_1 + x_2} F' \tag{4.2}$$

We are now ready to state the following proposition concerning necessary condition for an existence of the first-best pooling system.

Proposition 4.1. *When there exists a sharing rate t^* that attains Pareto efficient allocations, it satisfies the following property: all fishermen choose homogeneous output levels at the Nash equilibrium.*

Proof:

In order for allocations generated by a pooling system to be Pareto optimal, they must satisfy conditions for Pareto optimality, (3.5) and (3.6), in Nash equilibrium. Thus

$$(3.5) \Leftrightarrow \frac{x_j - x_i}{x_1 + x_2}(1-t)\left(\frac{F}{x_1+x_2} - F'\right) = 0 \tag{4.3}$$

and,

$$(3.6) \Leftrightarrow -\frac{U_{ix}}{U_{iy}} = (1-t)\frac{x_j}{x_1+x_2}\frac{F}{x_1+x_2} + \frac{x_i + \frac{t}{2}(x_j - x_i)}{x_1+x_2}F' = F'. \tag{4.4}$$

First, we show that the optimal sharing rate t^*exists which takes a value between zero and one. It is easy to observe in (4.4) that when $t = 0$, the marginal rate of substitution between leisure and income (MRS_{ixy}) is greater than the social marginal product, F'. On the other hand, if $t = 1$, MRS_{ixy} is smaller than the marginal product. Given that the individual effort level, x_i, is continuous in the sharing rate t, there must be at least one value of t between zero and one that satisfy (4.4) by the theorem of intermediate values.

Second, we identify the condition for which t^* engenders Pareto optimality. Now, (4.3) is satisfied either if effort levels are homogeneous, i.e., $x_i = x_j$, or in the case of full-pooling, i.e., $t = 1$. However, we have already seen from (4.4) that the latter case is excluded, thus homogeneous equilibrium outputs are required. Hence, it follows that if there exists an optimal sharing rate t^* that induces the Pareto efficient outcome, then it is necessary for both fishermen to produce identical quantities at any equilibrium.

Finally, let us show the sufficient condition for the uniqueness of the optimal sharing rate t^*. Using (4.4), we obtain the following implicit function that defines the Pareto optimal sharing rate t^*

$$t^* = 1 - \frac{\frac{1}{2}F'}{\frac{x_j}{x_1+x_2}\frac{F}{x_1+x_2} - \frac{1}{2}\frac{x_j - x_i}{x_1+x_2}F'}.$$

Since equilibrium effort levels shall be identical for the two fishermen,

$$t^* = 1 - \frac{F'}{\frac{F}{x_1+x_2}} \tag{4.5}$$

Notice that the social marginal product of effort F' increases as the total effort level decreases. Since leisure is a normal good, the higher sharing rate t implies a lower equilibrium effort level and therefore a lower income. From this and (4.4), it follows that $MRS_{xy} - F'$ decreases monotonically. There exists a unique t^* that satisfies (4.5) if and only if the MRS_{xy} declines as both the equilibrium effort and the income get smaller. For instance, the preference profiles with indifference curves on income and effort plane that become flatter in the south west quadrant of any point and steeper in the north east quadrant of any point (e.g., quasi-linear preferences) satisfy this condition.

It is interesting to note that the second term on the RHS of (4.5) is the elasticity of output with respect to an efficiency unit of effort: the percent change in output relative to the percent change in aggregate effort level. It is intuitive to observe that, for given utility functions of fishermen, the less elastic the production function is with respect to total effort contribution, (that implies a stronger diminishing trend of marginal product), the higher the sharing rate must be in order to internalise the damaging marginal effects of externality.

Indeed, the above result (4.5) is reminiscent of Sen's (1966) study on mixed profit sharing rule in which he assumes that group members have identical utility functions. We, on the contrary, allow individual utility functions to vary and examine the necessary condition for such Pareto optimal sharing rate to exist. We find that individual utility functions need not be identical but they must be locally compatible with efficient egalitarian allocations. In this case, there is a first-best pooling system.

5. Effect of relative status considerations

In this section, we consider that fishermen care about self-esteem arising from norms of relative status considerations of the following type: the higher performing members gain a positive utility from social esteem, while the lower performing members receive some disutility from being ashamed of occupying the lower status (see Section 2). Our motivation to integrate such social status considerations are grounded on the empirical facts that the fishermen in our sample groups exhibit significant concerns about relative status considerations in relation to the heterogeneity of the catches among the group members. This provides us with the insight that the pooling system can be sustained even among heterogeneous members if they are somehow concerned about relative status.

We now integrate into the model human emotions such as self-esteem and pride or shame generated by human interactions. Such an approach was pioneered by Becker (1974) who considered the "social payoff" as the sum of a person's utility from his own income and the satisfaction value deriving from interacting with

others. In this section, we study how some considerations of social status affect the sustainability of an efficient pooling system. For this purpose, let us redefine the fishermen's utility function by integrating relative status considerations denoted as z_i :

$$U_i \equiv U_i\left(x_i, y_i, z_i\right), \ z_i \equiv z_i\left(f_i - f_j\right)$$

where x_i and y_i remain individual effort contribution and income as before. The relative status considerations, z_i, depends on performance differences between the two fishermen, i.e., $f_i - f_j$. We assume that social esteem increases as performance differences enlarge (i.e., z_i is an increasing function of performance difference), and there is no relative status effect when performances are identical:

$$z_i' > 0, \ z_i\left(0\right) = 0.$$

Note that by introducing relative status considerations, z_i, fishermen are no longer indifferent to others' performances. A positive (negative) difference in performances signifies a higher (lower) status that generates positive (negative) feelings arising from self-esteem (feeling ashamed)[6]. Social esteem can be interpreted as tournaments, i.e., reward structures based on rank order (Green and Stokey 1983)[7]. By allowing for the uncertainty of rank ordering (say, if individual productivity is subject to some idiosyncratic shock), the expected reward from probable rankings can be construed as a payoff from social status. Relative status considerations in our model are different from the standard tournament in the sense that the former are endogenous to the members' effort choice, while in the latter the expected gains from the tournament are predetermined.

The fishermen's utility maximisation problem now becomes:

$$\underset{x_i}{Max}\ U_i\left(x_i, y_i, z_i\right)$$

[6]As a matter of fact, the relative status considerations and social esteem deriving from it are somewhat dependent on the pooling system itself, namely the higher the sharing rate, the more people become keen on the social status. This endogeneity of norm of social esteem in institutional design has not been explicitly captured in this framework. Nevertheless, our construction reflects straightforwardly how social esteem is conceived and perceived by the fishermen.

[7]Lazear and Rosen (1981) and Green and Stokey (1983) compared tournaments with individual contract. Lazear and Rosen showed that a tournament does as well as a piece rate in acheiving the first best allocation of effort when agents are risk neutral and there is no common shocks. On the contrary, advantages of tournaments depend on a trade-off between an increase in the randomness in any agent's compensation by making his reward depend on the idiosyncratic shock of his peers, and reduction of randomness by filtering out the common noises (Green and Stokey 1983). Modeling status considerations as tournaments will enable us to further integrate the issues related to uncertainties into the analysis.

$$\text{s.t.} \qquad y_i = f_i + \frac{t}{2}\left(f_j - f_i\right).$$

Taking the total differentiation of the objective function and dividing it by dx_i, we get the marginal rate of substitution between leisure and income as:

$$\frac{dU_i}{dx_i} = U_{ix} + U_{iy}\left[\left(1 - \frac{t}{2}\right) f_{i1} + \frac{t}{2} f_{j2}\right] + U_{iz} z_i' \left(f_{i1} - f_{j2}\right) = 0$$

$\Rightarrow$

$$-\frac{U_{ix}}{U_{iy}} = \left(1 - \frac{t}{2}\right) f_{i1} + \frac{t}{2} f_{j2} - \frac{U_{iz}}{U_{iy}} z_i' \left(f_{j2} - f_{i1}\right). \tag{5.1}$$

Using (3.8) from Assumption 3 (Individual production as average sharing),

$$\begin{aligned} -\frac{U_{ix}}{U_{iy}} \;=\; & (1-t)\frac{x_j}{x_1 + x_2}\frac{F}{x_1 + x_2} + \frac{x_i + \frac{t}{2}\left(x_j - x_i\right)}{x_1 + x_2} F' \\ & + \frac{U_{iz}}{U_{iy}} z_i' \left(\frac{2x_j}{x_1 + x_2}\frac{F}{x_1 + x_2} - \frac{x_j - x_i}{x_1 + x_2} F'\right). \end{aligned} \tag{5.2}$$

The first thing to note is that the expressions of the first two terms in (5.1) and (5.2) are identical to the expression of the MRS at an Nash equilibrium in the absence of relative status considerations, (4.1) and (4.2). The larger the sharing rate t, the smaller the marginal rates of substitution becomes between income and effort for both fishermen, i.e. reducing the individual incentive to work at the margin. As we have discussed in the previous section, when $x_i \neq x_j$, the sums of the two terms of the two fishermen are never identical.

Secondly, the third terms in (5.1) and (5.2) reflect the marginal effect of relative status considerations that is different for the two fishermen with heterogeneous input contributions. Indeed, when relative status considerations offset the differences in the sum of the first two terms in (5.1) and (5.2) between the two fishermen, the Pareto efficient allocation of effort and income can be attained at the Nash equilibrium of the pooling system. For instance when $x_i < x_j$ and $0 < t < 1$, it is easy to see that the sum of the first two terms is greater for i than for j, i.e. the slope of MRS_{xy} of fisherman i without status considerations is steeper than that of j. The introduction of the status considerations in the third term provides a possibility of equalising the MRS_{xy} between fishermen and of satisfying Pareto efficiency. Considerations of relative status may transform appropriately the indifference curves on income and effort space so that the MRS_{xy} of the two fishermen are equalised in spite of heterogeneous effort contributions.

But what kinds of relative status considerations is deemed to be appropriate? To answer this, we let $\hat{t}_i \equiv \frac{t}{2} - \frac{U_{iz}}{U_{iy}} z_i'$ and rewrite (5.1) as:

$$-\frac{U_{ix}}{U_{iy}} = f_{i1} + \hat{t}_i \left(f_{j2} - f_{i1}\right) \tag{5.3}$$

In fact, $\hat{t}_i$ can be interpreted as a personalised shadow value of a given sharing rate t. We are interested in finding out appropriate types of relative status considerations, under which such shadow values of sharing rate can equalise the MRS_{xy} of the two agents. This is equivalent to identifying conditions under which a sharing rate (t^*) exists, such that its shadow values ($\hat{t}_i$) operate as personalised sharing rates that achieve a Pareto efficient allocation among fishermen with heterogeneous equilibrium outputs.

As the first step, we identify the shadow values of the sharing rates, $\hat{t}_i$ that satisfy the following Pareto optimality conditions:

$$-\frac{U_{ix}}{U_{iy}} = -\frac{U_{jx}}{U_{jy}} \tag{5.4}$$

$$-\frac{U_{ix}}{U_{iy}} = F' = f_{i1} + f_{j2} \tag{5.5}$$

$$-\frac{U_{iz}}{U_{iy}} = -\frac{U_{jz}}{U_{jy}}. \tag{5.6}$$

Using (5.1), (5.5) can be rewritten as:

$$f_{i1} + \hat{t}_i \left(f_{j2} - f_{i1}\right) = f_{i1} + f_{j2}.$$

Then, we obtain the following implicit function that defines the optimal shadow sharing rate $\hat{t}_i$:

$$\begin{aligned} \hat{t}_i &= \frac{\frac{x_j}{x_1+x_2}\left(\frac{F}{x_1+x_2} - F'\right)}{\frac{2x_j}{x_1+x_2}\frac{F}{x_1+x_2} - \frac{x_j - x_i}{x_1+x_2}F'} \\ &= \frac{1}{1 - \frac{f_{i1}}{f_{j2}}} \end{aligned} \tag{5.7}$$

The RHS of (5.7) is always positive and smaller than one. Since individual output functions f_i and f_j are continuous in x_i and also in $\hat{t}_i$, there exists at least one value of $\hat{t}_i$ that satisfies this identity.

Next, (5.4) can be rewritten as:

$$\hat{t}_i + \frac{U_{iz}}{U_{iy}} z_i' = \hat{t}_j + \frac{U_{jz}}{U_{jy}} z_j' \tag{5.8}$$

From the optimal allocation of income and esteem expressed in (5.6):

$$\frac{U_{iz}}{U_{iy}} = \frac{U_{jz}}{U_{jy}} = \frac{U_z}{U_y}$$

Rearranging (5.8),

$$\frac{1}{1 - \frac{f_{i1}}{f_{j2}}} - \frac{1}{1 - \frac{f_{j1}}{f_{i2}}} = \frac{U_z}{U_y} \left(z_j' - z_i' \right)$$

Thus,

$$\frac{f_{i1} f_{i2} - f_{j1} f_{j2}}{\left(f_{j2} - f_{i1} \right) \left(f_{i2} - f_{j1} \right)} = \frac{U_z}{U_y} \left(z_j' - z_i' \right) \tag{5.9}$$

(5.9) is a necessary condition for status considerations that enable the pooling system to attain Pareto efficiency. In order to gain some intuitive interpretation of this condition, we pay attention to the fact that the denominator of the LHS of (5.9) is always positive due to Assumption 2 (non prohibitive externality). Thus the sign of the numerator of the LHS must coincide with the sign of the RHS. That is:

$$sign \left\{ f_{i1} f_{i2} - f_{j1} f_{j2} \right\} = sign \left\{ z_j' - z_i' \right\}. \tag{5.10}$$

Hence, $f_{i1} f_{i2} - f_{j1} f_{j2} \geq 0 \Leftrightarrow z_j' \geq z_i'$,
or

$$f_{i1} f_{i2} - f_{j1} f_{j2} \geq 0 \Leftrightarrow \frac{f_{i1}}{f_{j2}} \geq \frac{f_{j1}}{f_{i2}} \Leftrightarrow \frac{f_{i1}}{|f_{j2}|} \leq \frac{f_{j1}}{|f_{i2}|} \Leftrightarrow x_i \geq x_j.$$

So (5.10) holds if and only if:

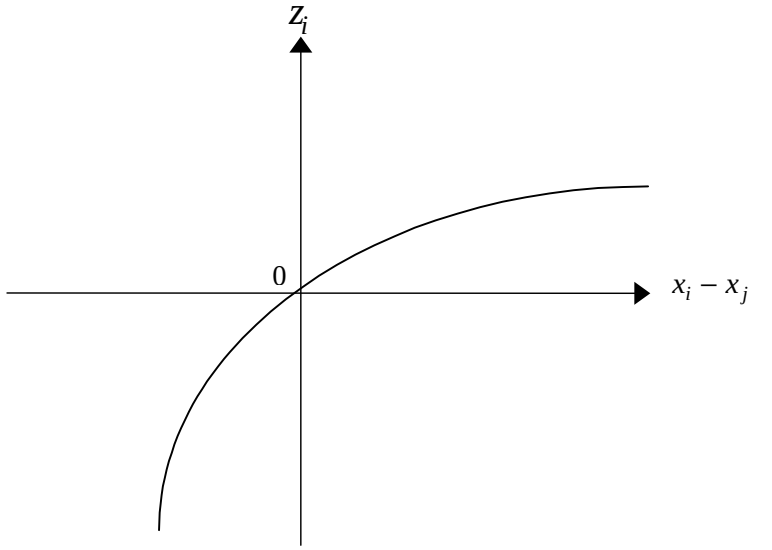
$$x_i \geq x_j \Leftrightarrow z_j' \geq z_i'. \tag{5.11}$$

Figure 5.1 depicts the possible forms of relative status z_i implied by (5.11) with respect to performance differentials. It shows an asymmetry in relative status considerations: the marginal status effect is stronger for the less than for the better performing person. Therefore, shapes of the appropriate status function z_i are either:

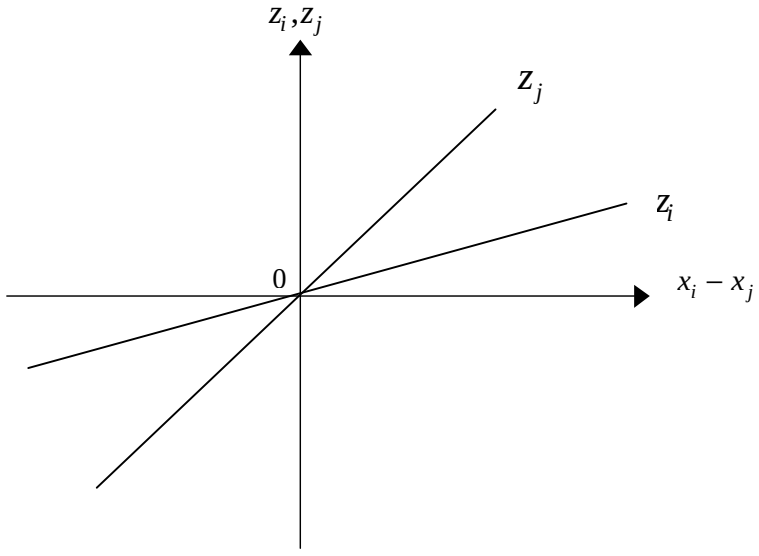
form (i) concave and identical for both agents, or

form (ii) flatter for the superior performer, and steeper for the inferior performer.

From the above, we are now ready to state the following proposition:



Form (i)



Form (ii)

Figure 5.1: Two possible forms of relative status considerations conducive to establishing efficient pooling system

Proposition 5.1. *When there exists an efficient pooling system among members with heterogeneous performances, it is necessary that members pay attention to relative status considerations so that less performing members experience greater marginal status effects than better performing ones.*

From the above proposition, we can make further remarks concerning the effects of heterogeneity of performances on the possibility of efficient pooling systems and on individual incentives through relative status considerations.

Let $\beta_i = \frac{x_i - x_j}{x_1 + x_2}$ (level of relative performance), we rewrite (5.7) as:

$$\hat{t}_i = \frac{\frac{1}{2}(1-\beta_i)\left(\frac{F}{x_1+x_2} - F'\right)}{(1-\beta_i)\frac{F}{x_1+x_2} + \beta_i F'} = \frac{1}{2}\left[1 - \frac{F'}{(1-\beta_i)\frac{F}{x_1+x_2} + \beta_i F'}\right] \tag{5.12}$$

Thus, the optimal sharing rate can be implicitly described as:

$$\begin{aligned} t^* &= 2\left(\hat{t}_i + \frac{U_z}{U_y} z_i'\right) \\ &= \left[1 - \frac{F'}{(1-\beta_i)\frac{F}{x_1+x_2} + \beta_i F'}\right] + 2\frac{U_z}{U_y} z_i' \end{aligned} \tag{5.13}$$

Remark 1. *The level of heterogeneity is bounded if the sharing rate has to be smaller than 1. The upper bound is larger, the stronger the relative status considerations.*

In this case, the sharing rate cannot be greater than one:

$$t = 2\left(\hat{t}_i + \frac{U_z}{U_y} z_i^{'}\right) \leq 1.$$

Manipulating this inequality, we obtain:

$$\hat{t}_i = \frac{1}{2}\left[1 - \frac{F'}{(1-\beta_i)\frac{F}{x_1+x_2} + \beta_i F'}\right] \leq \frac{1}{2} - \frac{U_z}{U_y} z_i^{'}. \tag{5.14}$$

We can deduce from the inequality (5.14) a relationship between heterogeneity of performances and the relative status considerations. The LHS of (5.14) becomes larger the greater the level of heterogeneity, $\beta_i = \frac{x_i - x_j}{x_1 + x_2}$. The RHS becomes larger, as fishermen are made more sensitive to their status (i.e., through a larger marginal rate of substitution -$\frac{U_z}{U_y}$, or a greater marginal status consideration $z_i^{'}$). From this, it is easy to observe that the relative status considerations enlarge a permissible level of output heterogeneity among group members to sustain efficient pooling system.

Remark 2. *There are two-sided incentive effects induced by the pooling system in the presence of relative status considerations. This means that as a consequence of a necessary property of the status function derived in (5.11), the lower performing member's MRS_{xy} is affected more drastically than that of the higher performing members. As a result, locally, the former is more inclined to work hard than his colleague.*

Algebraically, the shadow value of the optimal sharing rate under the pooling system is larger for the better performing one than for the less performing one due to the shape of relative status considerations implied by the proposition above:

$$\hat{t}_i = \frac{t}{2} - \frac{U_z}{U_y} z_i^{'} > \frac{t}{2} - \frac{U_z}{U_y} z_j^{'} = \hat{t}_j, \quad \text{if } x_i > x_j$$

Intuitively, this implies that the incentive of a more capable person is a more curtailed than that of the less capable one compared to the *laissez faire* case without a pooling arrangement thereby creating two-sided incentive effects: a less capable person is driven to feel stronger pressure to contribute more additional labour input compared to the more capable one due to the relative status considerations[8].

Finally, it should be noticed that multiple pure Nash equilibria could arise under optimal pooling: individual effort choices will depend on their assessment of the effort level of the other members. The operation of relative status considerations may help agents choose the higher equilibrium effort given the expected gains from the tournament for social status. In order to verify this point, we would need to use a multi-period model with a probability distribution of relative status.

6. Empirical illustrations and conclusions

In this section, we try to test, as far as possible, our theoretical propositions about heterogeneity and social status norms by examining empirical data obtained from the three sample groups in Toyama prefecture.

The data set that we use in this section is composed of two types of information; production performance and an indicator of capability. Catch per unit of haul[9] is used to measure production performance. The indicators of experiences of

[8] Such a two-sided incentive effect is compatible with phenomena observed among groups of workers, known as the 'Hawthorn Puzzle'. Jones (1984) explained workers' behaviour to meet the group's standard as induced by conformism, i.e., a two sided peer pressure using a specific utility function with a piece rate wage scheme. By contrast, we show homogeneous performance among individuals with a more general utility function and with a pooling system.

[9] One haul refers to a complete manoeuvering of a single net that consists of series of operations: preperation of net on board, spreading them in the water, drifting, lifting them from the

skippers and crew members, physical fishing power and congruence between the skippers and crew members are used to measure the capability of fishing units. The data on catch per unit of haul of Groups A and B were collected through direct observations during 43 fishing days between June and August 1997, while the same data of Group C for 63 fishing days between April and August 1997 were extracted from the records kept by the local Fishery Cooperative Association.

We have drawn the following empirically testable hypothesis on the basis of the field observations and of the theoretical predictions made in the previous sections.

1) An efficient pooling system exists only if the members have identical levels of output performance at an equilibrium, or if the pooling system is accompanied by concerns about relative status arising from interpersonal comparison of output performances.

2) For the efficient pooling system to be viable, however, the heterogeneity of output performances shall be within a tolerable range.

3) There emerges a two-sided incentive effect once the pooling system is adopted. Group members with higher capability tend to work modestly, while those with poorer capability tend to work harder. As a result, the heterogeneity among individual output performances is likely to be reduced.

6.1. Empirical observations

We now attempt to test empirically the validity of these claims as well as to explain the observed differences in the pooling arrangements among the three sample groups. Let us first look at the intra-group heterogeneity of production performances in the three sample groups. Table 6.1 reports catch performances and the analysis of variance of boats belonging to Groups A, B and C, respectively. Comparing mean catches per haul between Groups A and B fishermen, we observe that Group A members are, on average, more performing than the fishermen belonging to Group B. The mean catch of Group C members is much higher than those of Groups A and B, which is due to the fact that they operate in different geographical environments characterised by higher stock abundance. Since the members of Group C operate in the environment with a different production technology, it is not meaningful to compare directly the average performance of Group C against those of the other groups.

What is interesting to examine is the analysis of variance[10]. The tables show

water, and removing catch from the net. On a given fishing day, each boat will make four to five hauls and each haul takes about 1.5 to 2 hours. After each haul, boats return to the harbour in order to land and to hand over the catch to buyers.

[10]We abstract ourselves away from the fact that the two fishing units in Group B are pooling income and repairing costs (only labour costs). This is reasonable given the fact that the pooling units interact strategically with the other fishing units so that the efficiency gain from

(a) Group A

```
                Summary of quantity
       boat |        Mean   Std. Dev.       Freq.
------------+------------------------------------
         11 |   78.157895   44.316552          57
         12 |   70.775862   51.176695          58
         13 |   72.454545   41.576266          55
         14 |   79.067797   54.986163          59
         15 |         63    44.548766          55
         16 |   70.103448   48.647565          58
         17 |   62.807018   38.417555          57
------------+------------------------------------
      Total |    70.97995   46.672166         399

                          Analysis of Variance
    Source              SS         df       MS             F     Prob > F
------------------------------------------------------------------------------
Between groups      14272.5528       6   2378.75879       1.09     0.3655
 Within groups      852687.287     392   2175.22267
------------------------------------------------------------------------------
    Total           866959.84      398   2178.29105

Bartlett's test for equal variances:  chi2(6) =  10.2472  Prob>chi2 = 0.115
```

(b) Group B

```
           |         Summary of quantity
       boat |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   92.162162   48.824808          37
          2 |   64.162162   59.347149          37
          3 |   77.914286   51.429776          35
          4 |   47.230769   36.796354          39
          5 |    48.72973   30.065344          37
------------+------------------------------------
      Total |   65.708108   48.996131         185

                          Analysis of Variance
    Source              SS         df       MS             F     Prob > F
------------------------------------------------------------------------------
Between groups      55177.2206       4   13794.3051       6.42     0.0001
 Within groups      386537.017     180   2147.42787
------------------------------------------------------------------------------
    Total           441714.238     184   2400.62086

Bartlett's test for equal variances:  chi2(4) =  19.7982  Prob>chi2 = 0.001
```

(c) Group C

```
           |      Summary of (sum) quantity
       boat |        Mean   Std. Dev.       Freq.
------------+------------------------------------
          1 |   246.76768   200.24301          99
          2 |   266.89216   213.45887         102
          3 |   266.50943    225.3611         106
          4 |      255.39   296.69795         100
          5 |    253.9619   230.21165         105
          6 |   223.29412   182.01505         102
------------+------------------------------------
      Total |   252.25407   226.93871         614

                          Analysis of Variance
    Source              SS         df       MS             F     Prob > F
------------------------------------------------------------------------------
Between groups       133211.59       5    26642.318       0.52     0.7648
 Within groups      31437010.8     608   51705.6098
------------------------------------------------------------------------------
    Total           31570222.4     613   51501.1784
```

Table 6.1: Analysis of variance for individual catch performances

that the mean catch performance of boats are homogeneous among those belonging to Groups A and C: the homogeneity of mean catch performances is supported by high p-values. The same statistic is significantly low in Group B: the homogeneity of performances among Group B members is rejected. Therefore, Groups A and C with full- and partial-pooling satisfy the necessary condition for an efficient pooling system, i.e., homogeneity of performance, while Group B does not.

Care must be taken, however, in interpreting the homogeneity of performances. For one thing, homogeneous performances may be a consequence of self-selection, namely, that groups are originally formed by members with homogeneous capabilities. For another thing, homogeneity of performance may be endogenously generated by the two-sided incentive effect of relative status considerations embodied in the pooling system. Precise tests should be conducted with data when Group B members were pooling, or when Groups A and C had not been pooling. Regrettably, available data only allows us to use their current heterogeneity in catch performances, which frustrates the direct test of the significance of the two-sided incentive effects. But we are able to find a way round by indirectly verifying the endogenous effects of pooling system on the homogeneity of catch performances through checking the heterogeneity of capability among group members, since catch performances reflect efficiency units of effort that depend on nominal efforts (i.e. hauls or numbers of hours) and the intensity of a unit of nominal effort.

The intensity of effort depends firstly on the capability of the fishing unit, that is composed of various factors including the skill of skippers, the competence of crew members, the physical fishing capacities and the congruence of attitude between skippers and the crew members[11]. Secondly, the effort intensity also depends on the extent to which fishing unit makes use of such capability. It is important to bear in mind that capabilities are exogenous to fishing units in the short-run, while skippers and crew members are free to choose to what extent they make use of their capabilities. From this, it follows that if the members with homogeneous output performance have actually homogeneous capabilities, the homogeneity of their catch performances are most likely a consequence of self-selection. On the other hand, if homogeneous performances are observed alongside some heterogeneity of their capabilities, we may infer that the observed homogeneity is mainly due to the two-sided incentive effect of pooling among status-regarding agents.

We identify several characteristics that enter the capability of a fishing unit:

this pooling is limited.

[11]These components of capability are constant in the short-run, but can vary over the long-run: fishermen may acquire new skills through learning by doing and/or improve capabilities through sharing knowledge and experties among them.

(a) Skippers' skills measured in years served as a boat captain

	Group A	Group B	Group C
Group mean	26.9	22.4	17.2
Coefficient of variation*	0.4026	0.1456	1.1647
Proportional distance**	0.002	0.312	0.002

* Coefficient of variation is mean of variance

** Proportional distance is proportion of the lowest figure in the highest.

(b) Crew members' experiences measured in years of fishing

	Group A	Group B	Group C
Group mean	22.2	15.2	17.7
Coefficient of variation*	0.1426	0.0501	0.0727
Proportional distance**	0.337	0.582	0.412

(c)Fishing powers measured in terms of GRT (Gross Registered Tons)

	Group A	Group B	Group C
Group mean	6.86	9.85	8.21
Coefficient of variation*	0.0426	0.0072	0.0285
Proportional distance**	0.577	0.791	0.667

(d)Levels of congruence between skippers and crew members measured in the numbers of crews in kin relationship with skippers

	Group A	Group B	Group C
Group mean	0.43	1.4	2.0
Coefficient of variation*	1.2659	0.0857	0.1

Table 6.2: Heterogeneity of capacities of the fishing units' belonging to the three sample groups

(a) number of years of experiences of skippers (as being a captain of fishing boat), (b) average years spent in fishing by crew members, (c) fishing power measured in GRT (Gross Register Tons), and (d) number of crew members who have kin relationship with the skipper. These are proxies for skills of skippers, ability of crew members, physical fishing capacity, and congruence between skippers and crews members, respectively. Table 6.2 reports group means and two measures of heterogeneity, namely coefficients of variation, and proportional distances.

First, we notice by comparing the mean values of characteristics among the groups that Group A is composed of fishing units with more able skippers and crew members on average than the other groups (from tables (a) and (b)), while the reverse is true in terms of physical fishing power and of the level of congruence (from tables (c) and (d)). Secondly, Group A (with homogeneous catch performances) exhibit a wider heterogeneity in terms of capabilities than Group B (with heterogeneous catch performances). A similar reverse relationship between relatively homogeneous catch performances and relatively heterogeneous abilities of skippers and crew members holds true between Groups A and C.

We are now ready to find a consistent explanation about different pooling arrangements observed among the sample groups with due reference to effects of relative status considerations. Let us recall, as we have described earlier in

	Group A	Group B	Group C
No bad feelings/ wait and see	5	3	3
Teach better techinique and give advices	4	1	3
Feel sorry and pity	1	2	3
Feel frustrated and express dissatisfaction	1	4	1

Table 6.3: Reactions of skippers with superior performances towards inferior skippers (frequency of responses)

Section 2, only Group A has succeeded in making full-pooling of income and input cost a sustainable venture lasting for more than 30 years. Consequently, Group A has been able to take the most advantage of collective actions. Group B had attempted full-pooling but it had been short-lived lasting for only one year. Finally, after about ten years of existence, Group C has drastically amended the pooling system with the result that only 10% of the total value of landings remains subject to equal sharing among members.

It may be inferred from the above simple comparison that homogeneous catch performances among Group A members is not due to homogeneity in their capabilities. We therefore conjecture that it is mainly due to the two-sided incentive effects endogenously generated by the pooling system: fishing units with lower capability exert more conscientiously their effort while those with higher capability apply modestly their potential capabilities in their fishing activities.

As we see in Table 6.3 that summarises the responses reported in Table 2.2, only one skippers of Group A state that a skipper with superior output will have remorseful feelings toward the inferior. Moreover, a majority of skippers predict that the superior helps the inferior to improve the latter's performances[12]. With regards to feelings and behaviour of those with inferior performances, in Table 6.4, all but one skipper of Group A respond that the inferior feels ashamed or guilty, pressured to work harder, and suffers from loss of self-esteem. Such asymmetric behavioural responses toward relative status considerations seem to support our conjecture of the two-sided incentive effects predicted in the model: the less capable person is driven by status considerations to feel stronger pressure to produce more, compared to the more capable one. As a result, the output performances among members of Group A are likely to be homogenised.

In comparison with Group A, Group B is composed of fishermen of lower capabilities on average (Table 6.2). Our theoretical model predicts a relatively

[12]We actually witnessed that the more experienced and skilled fishermen spare some time and efforts to help the less experienced ones by identifying fishing space suitable for their skills, providing advice by monitoring the movement of fishing net during fishing operations, and by helping in mounting and repairing the nets.

	Group A	Group B	Group C
Feel ashamed or guilty	3	3	2
Humiliated by loss of recognition	2	1	0
Pressured to work hard	1	2	2
No reaction	1	0	1

Table 6.4: Reactions of skippers with inferior performances towards superior skippers (freauency of responses)

low sharing rate[13] and less tolerance about heterogeneity of performances (see equation (4.5)). Consequently, unlike in Group A, two-sided frustrations, instead of two-sided incentive effects, are likely to prevail: the higher skilled fishermen find it unjust to share income, while the poor skilled ones find it too humiliating to perform poorly. Responses of Group B skippers support this prediction: all but one indicate strong remorseful feelings of the inferior crews and spiteful reactions of the superiors (Table 6.3, see also oral statements in Section 2). Such frustrated sentiments will have discouraged rather than encouraged helping and learning effects among Group B members. As a result, performance gaps will have not been narrowed down, they were possibly even enlarged over some time span, which makes it even more difficult to sustain pooling system.

As for Group C, its members currently possess relatively modest capabilities with moderate heterogeneity (Table 6.2). These observations suggest itself that partial pooling system is optimal and that a modest level of relative status considerations shall prevail. As a matter of fact, the production performances of Group C members are identical (Table 6.1), which testifies that the heterogeneity was kept well within the tolerable range. As expected, the partial pooling arrangement has been sustained in Group C[14].

[13] In fact, Group B attempted full-pooling which was abandoned after the first year of trial. The oral statements of Group B fishermen (some of which are reported in Chapter II) reveal that inter-personal comparison of catch performances generated by full-pooling were overly strong. This implies that optimal sharing rate was to be less than one.

[14] We need to introduce some dynamic learning effects into account in order to fully explain the reason why Group C members had reduced sharing rate after a decade of full-pooling. According to interview results and participant observations, Group C members have not shared actively their skills and expertise. Actually, Group C fishermen call 'spying' or 'stealing' (instead of 'learning') the ability to turn knowledge or experiences of other persons to one's own advantage. Thus, it is not surprising that there were no positive references made by them to the learning effect derived from pooling, in spite of the fact that there has been a tendency for the capabilities of Group C members to become equalised through spying/learning. From the above, we can conclude that full-pooling was no-longer sustainable in Group C as a result of modest but sufficient inter-temporal reduction of output heterogeneity.

6.2. Concluding remarks

In this paper, we study the possibility of a linear income sharing rule for the efficient exploitation of commonly owned resources. We show that the first-best pooling scheme is viable only if it results in homogeneous outputs among the members. On the basis of insights gained through empirical observations, we further explored the effect of relative status considerations on the sustainability of an efficient pooling system in a model of the Tragedy of the Commons. We find that the relative status considerations of a particular type will relax the homogeneity condition. Moreover, such social status considerations generate the two-sided incentive effects favourable for sustaining pooling system which, on the one hand, homogenise performance differences and, on the other hand, enhance tolerance regarding heterogeneity. A wider range of equilibrium output profiles become compatible with an efficient pooling system if individual behaviours exhibit the following pattern: the more capable agents exert modest levels of effort while the less-capable agents work harder. This pattern is expected when relative status considerations enter individual preferences, i.e. when people care about relative differences between their output performances and those of the others.

Our theoretical predictions fit well with the empirical evidences that we find among the three sample groups of Japanese fishermen. Homogeneous catches cannot be rejected when pooling is sustained, quite independently of the homogeneity of the capabilities. On the contrary, significant differences among individual catches are observed in the group which abandoned income-pooling. Our theoretical propositions also square nicely with qualitative data. Oral statements of fishermen actually revealed that sentiments towards relative status played an important role in the sustainability of income-pooling. The model establishes a link between preferences for a high social status and tolerance vis-à-vis heterogeneity in individual outputs, in a strategic framework ruled by an efficient pooling system.

The most general point of this paper is to give an alternative explanation of the fact that workers' cooperative are uncommon (Hansmann, 1996; Kremer, 1997; Frohlich et.al., 1997; and Bonin, et. al., 1993, for a through review of literature) and that egalitarianism tends to cause inefficiency when members are heterogeneous (Farell and Scotchmer, 1988; Ray and Ueda, 1996). Our theoretical approach can rationalise the possibility of efficient self-governance of the commons and of efficient workers' cooperatives in situations where heterogeneity in capability is compensated by some heterogeneity in preferences, remarkably when the latter is the reflection of a moral norm or of a sentiment of social-esteem. Furthermore, egalitarian institutions, such as a pooling system, may engender a sentiment of social esteem and preferences for higher status that eventually enhance efficiency. This is because relative status considerations activated by the

sharing institution can give a rise to two effects favorable for the sustainability of an efficient sharing institution: on the one hand, output performances will become more homogeneous thanks to the two-sided incentive effect, on the other hand tolerance to heterogeneity is strengthened owning to social esteem. One should notice, however, that we do not suggest any causal relationship between the allocation of consumption goods and morality, but we rather show the mutually reinforcing relationship between sharing institution and social norms in which comparisons of individual performances and self-esteem play a significant role.

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