

Cost sharing and catch sharing¹

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Abstract:

The model developed in this paper attempts to provide an explanation of the fact that Icelandic vessel owners and Icelandic skippers do not share costs of operation of a vessel. In the model a skipper is contracted to take a fishing vessel to the fishing ground. The skipper is remunerated with a share of the catch, subject to an agreed minimum. Skippers and vessel owners are modelled as if risk neutral. Skippers develop a fishing strategy which is more costly, the higher the value of the potential catch associated with that strategy. Costs that accrue are partly pecuniary (and shareable) and partly skipper-specific (and non-shareable). The conclusions of the paper demonstrate that given the assumptions of our model, a vessel owner should prefer a remuneration contract with a positive revenue share and zero cost share.

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1 Introduction

Icelandic vessel owners and Icelandic skippers do not share the costs of operating of a vessel. This is in spite of the fact that they share the revenues from its operation, and the fact that skippers and vessel owners operating in neighboring regions of the North Atlantic do share costs, at least to some extent. Hence, it may seem at first glance that the Icelandic vessel owners offer an inefficient remuneration contract for their crews.

The model developed in this paper attempts to provide a partial explanation of the phenomena of zero cost share in Icelandic fisheries. In the model a skipper is contracted to take a vessel to the fishing ground and remunerated with a share of the catch, subject to an exogenous base (minimum) wage. Skippers and vessel owners are modelled as if risk neutral. Skippers develop a fishing strategy, which is more costly, the higher the value of potential catch associated with that strategy. Costs that accrue are partly pecuniary (and shareable) and partly skipper-specific (and non-shareable). The conclusions of the paper demonstrate that a vessel owner should in fact choose a remuneration contract with a positive revenue share and zero cost share. The structure of the model and the organization of the proof is inspired by the model presented in Basu (1992).

The model presented in this paper differs in certain respects from Basu's model. Basu analyses an absentee landowner's choice of remuneration contract with a tenant. In Basu's model costs are (implicitly) assumed to be unrelated to strategies² chosen by tenants. In the present model costs are influenced by a skipper's choice of strategy. Furthermore, Basu argues that institutions offering possibilities for cost sharing are hard to establish in the agricultural setting, as landowners cannot observe if seed or fertilizers are resold once bought and brought to the farm. This problem does not exist on a fishing vessel, as indicated by the very existence of cost sharing in some fisheries.

The paper is organized as follows: In the first section a brief overview is given of cost sharing in the fisheries as it is practiced. In the next section the existing literature on cost

²In Basu's terminology strategies are "projects".

sharing in fisheries is surveyed. Thirdly, the basic production relationship for fishing utilized in the paper is introduced. Skipper strategies are defined and discussed and interactions between skippers and owners are accounted for. The last section of the paper outlines its conclusions.

2 International evidence on cost sharing in fisheries

The International Labour Office (ILO) published in 1952 a survey on systems of fishermen's remuneration based on data available for 1947-1949. When reviewing the evidence, Zoetewij (1957) concludes that "... fishermen's earnings depend (in most cases) wholly or largely on the value of the catch ...". Zoetewij refers to this as an extreme form of profit and loss sharing.

Zoetewij points out that in some cases the income of fishermen is determined by the size of the catch, but more often by its value. The distribution of operating costs varied widely in the late forties, according to Zoetewij. Sometimes the cost of fuel, ice, water, food, lost gear and selling of catch are distributed in the same manner as income. Sometimes vessel-owners and crew have agreed on rules which differ from the income distribution rule. Sometimes vessel-owners foot the bill for these items entirely, sometimes the bill is the crew's responsibility.

A comprehensive survey of the form of remuneration in fisheries, similar to that of the ILO survey mentioned above, has not been conducted at a more recent date. But there is no indication that the importance of sharing has diminished through the years. Unfortunately, it is also impossible to judge if the form of sharing has changed since the late forties.

In a personal communication, James E Kirkley of Virginia Institute of Marine Science, has indicated that the lay or share systems of the Northwest Atlantic fisheries in the US vary considerably. Costs are shared, and vessel-owner income guaranteed to some extent in the

offshore fishery, while costs are not shared and crew income guaranteed in the menhaden fishery.³

Crew remuneration on Norwegian vessels is regulated by collective bargaining. According to Bergland (1995) a distinction should be made between the Norwegian inshore and offshore fleet. The inshore fleet consists of smaller vessels than the offshore fleet, which includes the entire trawler fleet and big long-line and gill-net vessels. The vessels of the

³One system is the so-called 60/40 split used in the offshore fisheries from Maine as far south as North Carolina. Kirkley explains that according to this system owners receive 40% of the gross dockside value of catch and are responsible for capital investment loans and interest, most dockside repairs, basic hull insurance, accounting fees and certain legal fees. The crew receives 60% of the catch value and are responsible for costs for fuel, food, ice, crew insurance, and other supplies related to the individual trip. Crew members are responsible for their personal supplies and pay for landing costs. The crew also pays fixed fees out of their share (for example, \$300 for electronics). Skipper's bonus, engineer's fee etc. are paid from the crew's share. One variant of this system is the 60/40 split with owner guarantee share. In that case the owner is guaranteed at least \$10,000 per trip. A 50/50 net split also exists, Kirkley reports. Under that rule the crew receive 50% of gross receipts net of fuel and skipper's bonus. Skipper and crew are responsible for electronics, ice, insurance, engineer's and mate's fees, and miscellaneous supplies. The owner remains responsible for all fixed costs and mortgage. As for the inshore/offshore corporate menhaden fishery, Kirkley reports that there is a lay system plus a minimum guaranteed level of earnings. Each crew member is guaranteed \$750 per 5-day week. If net proceeds exceed this level per individual the crew receives 1% of the gross while the skipper receives 3% of the gross. In the strictly inshore fishery (hard crab) a similar rule is in use. For other fisheries, Kirkley reports, the crew are paid a share of the total catch, while the captain receives a bonus which is usually 3-7% of the total landed value of catch.

inshore fleet are as a rule owned partly or wholly by the skipper. Some of the crew members may also be partial owners. Sharing of proceeds net of operating costs is the general rule in the inshore fishery.⁴ The skipper or captain on a trawler (or other type of vessel) participating in the off shore fishery is not, as a rule, an owner or partial owner of the vessel he operates. Remuneration consists of a share of operational profits and a fixed wage component. According to Bergland, *op. cit.*, remuneration by fixed wage has not been in use in the Norwegian fishing fleet since the end of World War II.

Remuneration of fishing vessel crews in Iceland is, and has for decades been, regulated by collective bargaining. The standard remuneration contract on the Icelandic fishing fleet consists of a revenue share and guaranteed minimum wage. The share varies considerably depending upon the fishery and size/type of vessel. The share size depends on the number of crew members on a given vessel. Lastly, the share depends on the world market price of fuel. If fuel prices are high the share is reduced according to a formula contained in the collective bargaining contract.⁵ Conversely, if fuel prices are low the crew's share is increased. Dockside prices were regulated by a semi-governmental price board, but that system has been practically replaced with the advent of fish auction markets. When fishing vessels are owned by the same interests as freezing plants which purchase their catch, the wage settlement contains instructions as to how price disputes should be handled. Historically forms of remuneration other than revenue sharing have been used including a flat wage (supplemented

⁴Cost categories that are shareable are listed in the agreement between the Vessel Owners' Union and the Fishermen' Union, see Bergland and Moe (1988).

⁵The formula is up for renegotiation every time the contract is renewed and has been changed several times.

by a “premium” in the case of good catch)⁶ and revenue and cost sharing (on some of the vessels participating in herring fisheries in the 1950s and 1960s). Hence, revenue sharing supplemented with a guaranteed minimum wage is the present form of crew-remuneration in Icelandic fisheries.⁷

Azabou, Bouzaiane and Nugent (1989) report that in Tunisia sharing is “...universally on a ‘share of the net’ basis.” According to Azabou et.al. a list of approved deductions from the gross value of sales was codified by the Algerian Ministry of Agriculture in 1987. Before that such a list was standard practice. The list includes cost of fuel, lubricants, ice, repairs of tools, nets and ropes as well as selling costs, fixed wage costs of land-based workers, cost of food for the crew, social security contributions and part of the cost of repair of the motor on smaller vessels.

⁶ In 1996 only one trawler used this form of remuneration.

⁷Until 1986 the guaranteed minimum wage was paid by a special fund financed by a levy on exported fish products. Hence, the cost of minimum wage insurance was internal to the industry but external to each decision-making unit. A multitude of funds similar to the minimum-wage-guarantee-fund were in use, financing everything from basic hull insurance to the fuel bill. In 1986 an all-encompassing reform was implemented, eliminating all such funds and restructuring the share ratio as to leave the crew income at the same level as before the reform. In other words, the intention was that vessel owners should accrue funds in their own companies to meet the obligations that the collectively financed funds had previously covered. One should also bear in mind that the rate of exchange of the Icelandic currency (the krona) was steered so as to secure a given level of profits in the fishing sector. The declared motive of the reform was to reduce unnecessary transactions (shuffling the same money back and forth is not only unnecessary but also costly) and to make the system simpler and easier to comprehend.

Platteau and Nugent (1991) study sharing in fisheries in lesser-developed countries. They report a study by Amarasinghe (1988) who finds that crew on a new type of 3.5 ton vessels used in south Sri Lanka share costs of crew allowances, fuel and market commissions but not repair expenditure. On the other hand, repair expenditure is shared on the less sophisticated inshore fishing vessels that use bible nets and also on traditional craft that participate in deep-sea fishing. This exclusion of repair costs from the categories of costs that are shared is also found in developed countries, according to Platteau and Nugent. They refer to White (1977) who finds that repair costs were shared on simple fishing craft used in the shrimp fishery in the Gulf of Mexico but not on modern vessels.

Davidse et.al. (1993) account in general terms the rules of remuneration used in four EC countries. The remuneration systems all have different names in the various countries, but in all the countries some variation of the operational-profit-sharing system is in use. In England and Scotland costs that were defined as non-trip related have been redefined in recent years in order to increase the profitability in the fishery.

Pure revenue sharing exists in Scotland and England, where it is in use on big vessels. Pure revenue sharing also exists in a part of the Dutch fleet and for the small vessels in Denmark.

Table 1: Rules of remuneration of fishing vessel crews, a partial review				
Source	Area/Vessel type	Accruing to, or paid by crews		
		Crew income, revenue share or fixed wage	Cost share, trip-related	Cost share, non-trip-related
J.E. Kirkley, pers. comm. 1996	Maine/NC USA	Revenue share, 60%	Crew pays all trip related costs	Non-trip related costs not shared
J.E.Kirkley	Menhaden fishery USA	Mixed rule: \$750 + Max[0 ; 0.01*NetProceeds]	Costs are not shared	Non-trip related costs not shared

Source	Area/Vessel type	Accruing to, or paid by crews		
		Crew income, revenue share or fixed wage	Cost share, trip-related	Cost share, non-trip-related
Bergland (1995)	Inshore fleet, Norway	Revenue share that depends on fishery and vessel type	Same as revenue share covering most operation cost categories	Non-trip related costs not shared
Bergland (1995)	Offshore fleet, Norway	Fixed wage plus revenue share	Same as revenue on few cost categories	Non-trip related costs not shared
Hansdóttir, Author's own inquiry (1996)	Iceland	Revenue share varies, guaranteed minimum income	Costs are not shared	Non-trip related costs not shared
Azabou, et.al. (1989)	Tunisia	Variable revenue share	Same as revenue share	Non-trip related costs not shared
Amarasinghe (1988)	Sri Lanka, traditional fleet	Variable revenue share	Same as revenue share	Repair costs, same as revenue share
Amarasinghe	Sri Lanka, "new" fleet	Variable revenue share	Same as revenue share	Non-trip related costs not shared
White (1977)	USA, shrimp, Gulf of Mexico, simple crafts	Variable revenue share	Same as revenue share	Repair costs, same as revenue share
White	USA, shrimp, Gulf of Mexico, "modern" craft	Variable revenue share	Same as revenue share	Non-trip related costs not shared
Davidse et.al. (1993), Vestergaard, personal communication	Denmark, industrial fishery	Revenue share, 30%–50%	Same as revenue share, 30%–50%	Non-trip related costs not shared
Davidse et.al. Vestergaard, personal communication	Denmark, Smaller vessels	Revenue share equal to 50% and a base wage	Costs are not shared	Non-trip related costs not shared

Table 1: Rules of remuneration of fishing vessel crews, a partial review				
Source	Area/Vessel type	Accruing to, or paid by crews		
		Crew income, revenue share or fixed wage	Cost share, trip-related	Cost share, non-trip-related
Davidse et.al., Guillotreau, Daures, personal communication	France, artisanal and semi industrial vessels	Revenue share 45%–55%	Same as revenue share, 45%–55%	Non-trip related costs not shared
Guillotreau, Daures, personal communication	French, industrial vessels	Revenue share and guaranteed minimum income	Costs are not shared	Non-trip related costs not shared
Davidse et.al.	Dutch Cutter Fisheries (85% of the Dutch fleet)	Revenue share 40%–45%	Cost share 40%–45%	Non-trip related costs not shared
Davidse et.al.	Dutch fisheries covered by collective bargaining	Minimum wage plus revenue share	Costs are not shared	Non-trip related costs not shared
Davidse et.al.	England, not large vessels	Revenue share	Same as revenue share	In principle 0%, but gaining ground
Davidse et.al.	Scotland, not large vessels	Revenue share equal to 50%	Same as revenue share	In principle 0%, but gaining ground on small vessels
Davidse et.al.	England and Scotland, large vessels	Variable revenue share	Costs are not shared	Non-trip related costs not shared

The study of the practical arrangement of remuneration in fisheries as described thus far can be summarized in the following way: 1. Sharing is almost the universal form of remuneration. 2. Where remuneration is not governed by collective bargaining a variety of contract forms exists. Where remuneration is governed by collective bargaining rules are more similar in form from fishery to fishery. 3. Sometimes costs are shared and sometimes not. It seems that costs are not shared in fisheries where fishers are secured a guaranteed minimum income. 4. The most common form of cost sharing is that of sharing trip-related costs. Repair

costs are more likely to be shared on simpler, lesser sophisticated vessels. Definition of shareable costs may be influenced by the profitability of the particular fishery in question.

Explanations of the universality of sharing are offered in Zoeteveij (1956), Sutinen (1979), Anderson (1982), Bergland (1995) and Matthiasson (1996). These papers stress that the share system offers incentives for the crew to work hard by linking effort and (expected) income and yet save the crew from the risk exposure involved in full-fledged owner-operation.⁸ The last paper points out that the production environment in fishing, where there are direct links between effort and production, is a factor that favours sharing as remuneration rather than other forms of remuneration.

Collective bargaining offers economies of scale in contracting in cases where contracts must cover a multitude of vessel sizes, species caught, number of crews, types of gear. Hence, the fact that contracts are more uniform under collective bargaining than under decentralized bargaining is quite understandable.

Why should some fishermen share costs while others do not? One obvious reason why fishermen should share costs is to give the fishermen incentives to economize on the use of fuel and other variable costs. That argument obviously does not apply to all possible cases.

As to the fourth fact, Platteau and Nugent (1991) point out that cost sharing acts as a dis-incentive to fishermen to misuse the vessel or other equipment. This discouraging of the mismanagement of assets comes in addition to the discouragement inherent in the fact that improper use may reduce effective fishing time. Platteau and Nugent explain the lower frequency of maintenance cost sharing on sophisticated vessels by pointing out that the probability of damage to vessel and/or nets depends to large extent on human skill, foresight and coordination on labour-intensive vessels, but to a lesser extent on the modern, sophisticated vessels. They also mention that measurability of inputs and the possibility of

⁸ Zoeteweij (op.cit.) points out that the share system alleviates the risk that an absentee owner is exposed to.

asset-use over-reporting are important factors in determining whether costs are shared.

3 Theoretical considerations concerning cost sharing in the literature

Share cropping in agriculture has been widely studied [for a survey of some relevant literature see Singh (1989)]. Sharing in fisheries has not been object of the same interest. Noteworthy exceptions are Sutinen (1979), Anderson (1982) and Bergland (1994). The literature has mainly concentrated on the choice between sharing and other remuneration arrangements. Sharing of expenditure as part of the share cropping arrangement has been studied even less than sharing of revenue in fisheries. Exceptions are Heady (1947), Adams and Rask (1968) and Braverman and Stiglitz (1986), all of which study the matter in context of agriculture. In their models the income from and costs of an agricultural project are shared between a land owner and a tenant. Bergland (1994) concentrates on sharing in the context of fisheries. In his model the income from and costs of a fishing project are shared between a vessel owner and his crew (or skipper). Heady and Adams and Rask argue that inputs are most efficiently used if the cost share and the revenue share are equal.⁹ Braverman and Stiglitz and Bergland show that such an assumption only holds if agents are risk neutral and if the (relative) size of the share parameters does not influence the willingness of the tenant (or the skipper) to supply effort. The relative sizes of the two share parameters depends on features of

⁹Adams and Rask note that a transition from a share contract where tenants pay for inputs to, in their view the more economical, cost-sharing contract would enhance output and increase the net income of tenants. They argue that the case is less clear-cut from the point of view of landlords. Landlords will not only participate in paying for the extra inputs used due to the more efficient payment system, they will also pay for the inputs that the tenant was using under the previous, less efficient, payment scheme. Hence, it would be possible that landlords might lose more than they gained from applying the more incentive correct payment system. Adams and Rask do not consider the possibility of adjusting the revenue share parameter along with the cost share parameter in order to keep the landowner's income unchanged.

the farmers production and utility functions. Other investigators have reasoned differently: “Since the tenant chooses the project it is natural ... that the tenant incurs the cost of its implementation. In any case since the project choice cannot be monitored by the landlord, if he paid for it, the tenant would take the money and choose the project which is most advantageous from the tenant’s point of view.” (Basu [1992], p. 208). The same line of reasoning can be extended to many other principal-agent relationships: a carpenter mending the roof of a house usually supplies his tools, they are not provided by the house-owner. The divorce lawyer usually uses his own computers and telephones and does not require his to-be-divorced client(s) to supply them. One obvious reason for this state of matters is the cost of surveillance required to ensure that agents do not use principal supplied assets to their own benefit. It seems likely that for landlords to monitor whether fertilizers were used on shared land or on plots that the tenants harvests privately would be far too costly. In the case of the carpenter and the divorce lawyer it is obviously more cost-effective for tools to be supplied by the agent than by the principal. Hence, both the theoretical literature and the practical examples supplied above suggest that cost of inputs in principal-agent relationships is either shared or paid by the agent. The agent accrues the full cost of the inputs if he can supply inputs much more efficiently than could the principal. And the principal’s cost of monitoring the agent use of inputs can be prohibitive. Consequently, in order to understand the rational for the absence of costs sharing in some fisheries it is necessary to investigate the nature of the production relationship in fisheries.

4 The fishing trip production relationship and skipper strategies

Doll (1988) reviews the literature on economic modelling of fishing vessels. He claims that trip production functions have not been considered in detail in the literature (p. 106). According to Doll, the fisherman is usually assumed to know the abundance of fish at given locations with certainty. Hence, it is assumed that if a trip is made, catch can be calculated with certainty.

Dupont (1993) develops a model to explain a vessel owners choice of location of port of operation for a whole season. In her model vessel owners choose port of operation on the basis of expected profits and expected variability of profits. Decisions regarding individual trips are not a concern in Duponts model.

Palsson (1982) and Durrenberger and Palsson (1986) have studied behaviour of the skippers of Sandgerði, Iceland during the 1981 fishing season. They find that skipper choice of fishing spot is not random: “Most boats visit few locations and only a few locations are visited by many boats.” [See Durrenberger and Palsson (1986), p. 221]. Palsson (1982) studies the behaviour of skippers after a period of no fishing activity, either due to non-fishing intervals prescribed by the Ministry of Fishery or to foul weather. He finds that during the first day after the fishery is reopened vessels are scattered around. The next day the vessels flock to places where high per vessel catches were experienced the day before. Moreover, catch per vessel during the day is common knowledge at the end of the day.¹⁰ The fishing grounds that a given vessel utilized during the day are not announced in the same manner, hence a skipper puts considerable effort into surveillance of the movements of his fellow skippers.¹¹

If all vessels flock to the same fishing place, that place will be overcrowded, with subsequent “chaos of lines”, lost gear and reduced catches. There are reports of fishers using either informal or formal institutions to resolve such problems. Acherson (1981, p. 281)

¹⁰A list of catch per vessel is typically posted in a conspicuous location by the Harbour Office. The Harbour Office registers all catches landed.

¹¹Professor Páll Jensson at the University of Iceland Engineering Faculty has put some effort into developing models of skipper decisions on trawlers. In communication with the author he reported that the trawler skippers in most cases do not conceal their whereabouts in the same manner as do skippers on gill-net or long-line vessels. Jensson also told the author that trawler skippers tend to flock to a location where fish congregated at any given time.

reports that sometimes fishing rights are allocated to the vessel that reaches the fishing ground first, sometimes the fishing is organized in such a way that crews take turns in utilizing a given (rich) fishing spot.¹² There are even cases where governments control rights to fish a given spot.¹³

Schlager (1994) examines 30 in-depth field studies of coastal fisheries around the world. She finds that sometimes fishing grounds are reserved for special equipment. In other cases fishers are required to harvest a given fishing spot in a given order or during given time slots, “so that all fishers have equal opportunities of harvesting from the most productive spot over the course of the year”. One of the most ingenious arrangements she finds is in Alanya, Turkey, where more than 15 fishermen compete for 15 productive spots. The fishers have developed a lottery and a rotation system to assign the best spots.

If a fishing ground is considered to be good it will attract many skippers. Hence, skippers will not be able to utilize the fishing ground at their discretion. The expected catch per vessel on a trip to an attractive fishing ground is hence determined by the formal and informal

¹²Páll Benediktsson, reporter for the Icelandic State Broadcasting Network visited trawlers of many nationalities fishing red ocean perch [*Sebastes marinus*] on the Reykjanes Ridge in early spring 1996, observed that the trawlers took turns fishing as fish congregated in a very narrow space [personal communication and Benediktsson (1996)].

¹³Palsson (1987) reports that rules governing “rowing time” were set as early as 1901 in the Icelandic fishing settlement in the Westmann Islands (off the south coast of Iceland, close to the spawning grounds of the Icelandic cod). The Icelandic Parliament, Althingi, passed a law that regulated rowing time in the fishing villages of the Suðurnes peninsula (including Sandgerði) in 1946. The ruling stated at what hour vessels from given harbours were allowed to start a fishing trip, and thus giving all vessels “equal” opportunity to occupy the good fishing places.

rules that govern fishing-ground access. As alluded to above, formal rules tend to stress equality of access to the resource.¹⁴ Hence, if there are many vessels competing for relatively few good fishing places one could anticipate that the expected catch per vessel per season would be equalized (after making allowance for size differences, gear differences, weather variability, etc.).

During a fishing season a skipper will make several trips to the fishing grounds. Each skipper will have to develop a strategy as to how to visit the various fishing spots within reach.¹⁵ A skipper on a gill-net vessel may drop his nets all in one place and keep to that location throughout the season. Or he may drop nets in different locations. He may develop a rule for relocation of his nets based on movements of the fish and reports of the success of other fishers.

¹⁴Rules are also in some cases used to eliminate unproductive competition as in the case of the “rowing time” regulation in Iceland. Such unproductive competition can be costly or result in unstable outcomes or both. In the case of the rowing time, there is obviously no solution to a game where every skipper tries to start a trip earlier than his fellow skippers.

¹⁵Thorlindsson (1994) describes what he terms “skipper science”. He identifies at least three strategies (or tactics as he calls it). The first strategy is to assume that the fish behaves in the same way as last year. A second strategy is to look at the behaviour of the fish some years back and search for a pattern that suits to the present situation. A third strategy is the strategy of the catch-king skipper. The catch king skipper does not assume that patterns are the same from season to season. He considers differences as well as similarities, using his throughout knowledge of the previous seasons, using his own theory of how the fish behaves and connects that to readings of environmental indicators and adapts the theory to the novelty of the present situation.

If we let F represent the catch of a skipper who drops his gear at random (follows a “passive” strategy¹⁶), the size of F will be determined by the average quantity of fish and average catchability of that fish for the given area. Hence, F can be assumed to be constant. If we assume that skippers have access to a continuum of “active” strategies, successful “active” strategy, M , will yield $M-F$ tons of catch in excess of what a random drop of gear would produce. If the strategy is unsuccessful it will be as productive as the passive strategy, yielding F tons of catch.¹⁷ Hence, expected catch from strategy M is given as:

$$E=p(M)[M-F] + F$$

or

¹⁶I have named the random strategy “passive” to reflect that it involves passive use of information. But it need not be passive in terms of sailing and putting out fishing gear. In his study of the behaviour of the Sandgerði skippers, Gisli Palsson observed that: “... the skipper ... who fished in more locations than any other skipper failed. He was hired to skipper a boat owned by a processing plant and was fired at midseason because he had not lived up to the plant owner’s expectations. He may have panicked at his early lack of success.” [Durrenberger and Palsson (1986), p. 223]. This skipper may have started out with a strategy that failed and fallen back on a random strategy using lot of time and energy to go from place to place.

¹⁷Thorlindsson (1994, p. 331) reports: “In herring fishing, for example, success depends upon being where the herring surface. Frequently a number of boats are close to a shoal of herring, but only one of them will catch it. Late-comers stand very little change of catching anything.” Hence, in the case of the herring fishery, F is almost zero.

$$E=p(M)M + [1-p(M)]F \quad (4.1)$$

Here $p(M)$ is the probability that strategy M is successful. It will be assumed that costs associated with a strategy will increase as M increases.¹⁸

Strategy M consists of successive trips to one or more fishing spots. Each skipper will have to choose among many possible strategies. Each skipper knows that his fellow competitors will have to choose between numerous strategies too. Catch resulting from any one fishing strategy depends on the availability and catchability of fish in the fishing spots included in the strategy as well as the strategies' pursued by all the other skippers. Skippers do not reveal their strategies for each other.¹⁹ Hence, a skipper can safely assume that his choice of strategy will not influence other skippers choice of strategy. The question is now, what will be the expected catch associated with each strategy? That will depend on the strategies chosen by the other skippers. Hence, we can think of the skippers as if they were playing a coordination game. Suppose there are many vessels and two fishing strategies. Should a skipper follow strategy a or strategy b ? A skipper knows that if all other skippers follow strategy a he is best off following strategy b and vice versa. He knows that all other skippers are as knowledgeable as he is. Hence, he is not likely to be able to gain knowledge of the choices of the others by introspection. Consequently, he must assume that the other skippers choose strategies randomly. But if the skipper believes that all other skippers mix their strategies he is

¹⁸One reason might be that waiting time at sea is longer. Another reason could be that more locations would be visited during a given trip.

¹⁹Skippers do not even reveal their strategies to their own crew-members. And the crew-members may have hard time figuring out the strategy of the skipper: "...One of Binni's [*Binni was a famous catch king*] former crewmen remarked in an interview with the author that only after having worked on his boat for several seasons did he begin to detect a pattern in the skipper's fishing tactics", Palsson (1991, p. 118), italics added by the author of this paper.

best off by also mixing his strategies.²⁰ On the condition that all skippers have the same information, and that they are all equally able and that they all expect others choice of strategy to be unaffected by their own choice, expected catch will be equalized between strategies.²¹ To see this, consider the opposite, that catch is not equalized across strategies. Assume, for the sake of argument that strategy z is better than any other strategy. Then, a skipper would be able to increase expected catch of his vessel by choosing the strategy with higher probability than other strategies. But, if this enhanced the well-being of one skipper, a similar move

²⁰Skippers may use different methods to randomize their choice. Some claim to follow signs given in dreams, or some strange message, "...a whisper", see Pálsson (1991, p. 118).

²¹Assume that there are only two fishing spots available. Strategies will involve a visit to each spot with a given probability. Denote average catch in spot a as A_a and average catch in spot b as A_b . Assume that average catch in each spot is given as $A_i = X_i/n_i$ where X_i is a measure of catchable fish in spot i at a given period of time, while n_i is the number of vessels visiting that spot during that period. Assume further that total number of vessels is N . Then a skipper that believes that other skippers mix strategies would do best by visiting spot a by the probability:

$$p = \frac{n_a^2 X_b}{n_a^2 X_b + n_b^2 X_a} = \frac{n_a^2 X_b}{n_a^2 X_b + (N - n_a)^2 X_a} \quad (*)$$

If all skippers mix strategies $n_a = pN$. Together with (*) that would yield that average catch

per vessel in either location would be equal to $\frac{X_a + X_b}{N}$.

would enhance the well-being of other skippers. Hence, strategy z would be followed more often than other strategies. Furthermore, fishing spots that strategy z prescribed visited would attract more vessels than “equally rich” fishing spots only prescribed by other strategies. But, by earlier assumptions, when a fishing spot is overcrowded, catch in that fishing spot declines. Hence, expected catch accruing to vessels of skippers following strategy z would eventually decline. The decline of expected catch associated with strategy z , would not come to halt until expected catch associated with strategy z was equal to expected catch from any other strategy. Consequently, it may be concluded that equilibrium in choice of strategies involves equalization of catch across strategies.

It should however, be kept in mind that although expected catch is fixed across strategies, the probability for the success of strategies differs. Thus, high M is associated with concentration of trips to a series of fishing spots where a lucky skipper might get a very good catch. But of course the rich fishing spots will attract many vessels, making access more difficult than if less attractive fishing spots were visited. Hence, the first derivative of the $p(M)$ function, denoted as $p'(M)$, is negative.

5 Skipper and vessel owner interactions

Let us suppose that a vessel owner has decided to remunerate his skipper by shares. He has yet to decide the size of the cost- and revenue-share parameters. The vessel owner knows that his choice of share parameters will influence the skipper’s choice of strategy.

The pecuniary-shareable-costs of following a strategy are represented by the cost function, $C(M)$. Gear-, fuel- and ice-expenses are examples of such costs. Further skipper-specific, non-shareable-costs, are represented by the function $S(M)$. The (implicit) cost of skipper time spent on information gathering and digestion is an example of skipper-specific costs. Both types of costs are independent of whether the strategy is a “failure” or a

“success”.²² It will be assumed that $C'(M) > 0$, $S'(M) > 0$ and that $C''(M) > 0$, $S''(M) > 0$. If the vessel stays in harbour (so that no project is carried out) then $C(0) = S(0) = 0$.

The skipper is remunerated by a share in the revenue less a (different) share of the costs. Let us assume that the vessel owner is restricted by a minimum wage rule. Such a rule might, for example, be the result of collective bargaining between organizations of employers and employees. Hence, if skipper income generated by the share system fails to meet the minimum B the vessel owner must, according to the general rule just mentioned, pay the minimum wage and ignore the provisions of the share agreement.

Now, as skipper strategies can be either successes or a failures three possibilities must be considered: i) Catch can be high enough in both states to avoid the use of the minimum wage rule. Then the skipper receives a share of the revenue and contributes a share of costs in both states. ii) Catch can be so low in both states that the use of the minimum wage is required. iii) The successful state is good enough to trigger the use of the share rule, while the failure state triggers the payment of the flat wage. Situation i) resembles the set-up that is usually analyzed in the share-cropping literature. Income is totally governed by the share agreement.²³ Situation ii) resembles the situation of fixed wage and the skipper faces the so-called moral hazard dilemma. Both situations have been widely analyzed. The following section will focus on case iii). Here, if catch is good, the skipper will earn

²² A skipper on a gill-net vessel, for instance, must visit all his nets regularly. A long-line vessel skipper must have his gear towed up and rebaited regularly, regardless of the quantity of the catch, as bait is either “stolen” (by non-commercial species) or loses its attractiveness in time. Furthermore, the cost of trawling does not depend to any considerable extent on the volume of catch in the trawl.

²³ This case can be analyzed in the present model by observing the requirement that $0 < p(M) < 1$.

$\alpha M - \beta C(M) - S(M)$, if catch is bad he will earn $B - S(M)$. In this case α and β are the respective revenue and cost shares facing the skipper. B is the income transferred from the vessel owner to the skipper in case of a failure.

Expected income of a skipper can be written as:

$$Z_s(\alpha, \beta, M) = \{1 - p(M)\} B + p(M) \{\alpha M - \beta C(M)\} - S(M) \quad (5.1)$$

The skipper will choose M , so as to ensure that (5.1) is maximized. The skipper's choice of fishing strategy will hinge on the values of the share parameters. Thus,

$$M(\alpha, \beta) = \underset{M}{\text{Argmax}} Z_s(\alpha, \beta, M) \quad (5.2)$$

Now, we can use (4.1), the definition of expected catch associated with any given strategy and the assumption that catch in case of failure, F , is constant and the result that expected catch associated with any possible strategy is E , to write:

$$p(M) = \frac{E - F}{M - F} \quad (5.3)$$

Thus, the higher M is the lower is the probability that M is a success, as suggested above.

The first-order condition associated with (5.2) [using (5.1) and (5.3)] is given as:

$$(E - F)[B - \alpha F - (M - F)\beta C'(M) + \beta C(M)] - (M - F)^2 S'(M) = 0 \quad (5.4)$$

To interpret (5.4), add and subtract $\alpha M(E - F)$, and divide through with $(M - F)^2$, and observe

that $\frac{Mp}{MM} = -\frac{E - F}{(M - F)^2}$. Then, (5.4) can be written as:

$$p\alpha + \frac{MP}{MM} [\alpha M - \beta C(M) - B] = SN(M) + p\beta CN(M) \quad (5.5)$$

The left hand side of (5.5) represents expected increase in income accruing to the skipper due to increase in M by one unit. This gain is influenced by the expected increase in output and the effect that changed strategy has on the probability that the chosen strategy is successful. The cost is influenced by increase in skipper non-shareable costs and expected increase in the burden of shared costs.

Note that (5.4) can not be fulfilled unless:

$$B > \alpha F - \beta C(M) \quad (5.6)$$

This requirement implies that the income guarantee must really enhance skipper income in case of failure.

Fulfillment of the second-order condition associated with (5.2) requires that:

$$\Delta = (E - F)\beta CO(M) + 2SN(M) + (M - F)SO(M) > 0 \quad (5.7)$$

The requirement (5.7) is fulfilled due to the assumptions regarding the first and second derivatives of the cost functions and the fact that $M > E > F$ (with at least one of the inequalities effective at each time) while β is non-negative. Hence, given the restriction listed in (5.6) the existence of a strategy, M , that solves the problem of the skipper is ensured.

Compartive static results

Differentiating (5.4) with respect to B yields:

$$\frac{MM}{MB} = \frac{-(E - F)}{-(M - F)\Delta} = \frac{(E - F)}{(M - F)\Delta} > 0 \quad (5.8)$$

Hence, skippers will react to increase in the guaranteed base wage by choosing a higher yielding, more demanding and more risky strategy. Increasing B reduces the loss incurred in case of failure. The (marginal) gain involved in aiming at a somewhat higher M will be bigger than the (marginal) cost of doing so. More specifically, the effect of increasing B can be traced to two effects that I will term the income effect and the probability effect. The income effect [which, in the above expression is represented by the term $-(E-F)$] comes around as increase in B increases skipper income and enables him to “buy” more inputs to support a higher M . The probability effect [which, in the above expression may be represented by the term $-1/\{(M-F)\}$] comes around as increase in M increases the probability that the (now a bit better) “bad” state is realized. Both effects are negative, but as a change in probability is involved they interact in a multiplicative manner, yielding a positive relationship between M and B .

Furthermore, we find that:

$$\frac{MM}{M\alpha} = M_{\alpha}(\alpha, \beta) = - \frac{(E-F)F}{(M-F)\Delta} < 0 \quad (5.9)$$

Hence, a increase in the revenue share parameter induces the skipper to engage in strategies that yield lower catch than before. Increasing the revenue share increases the loss that the skipper experiences in case of a failed strategy. The marginal cost of the chosen strategy must be lowered. The only way to do that is by aiming at a lower M . Again there are two effects at work. Consider first the income effect, represented by the term $(E-F)F$. An increase in the revenue share reduces the gain that the skipper gets from the base wage guarantee. Hence, as the base wage is worth less he reduces the amount of inputs that he buys. Secondly, consider the probability effect, represented as before by the “multiplier” $-1/\{(M-F)\}$. If the revenue share term is increased, then the base wage becomes lesser worth so the skipper will try harder to avoid the “bad” state. He can reduce the probability that the “bad” state is to be realized by reducing M . The probability effect is negative and

multiplicative. The income effect is positive. The overall effect is therefore a negative relationship between the revenue share and the yield of the chosen strategy in the “good” state.

Lastly, we find that:

$$\frac{MM}{M\beta} = M_{\beta}(\alpha, \beta) = \frac{(E-F)(M-F)\frac{C(M)}{M} \left[-\frac{M}{M-F} + \frac{CN(M)M}{C(M)} \right]}{-\Delta(M-F)} \quad (5.10)$$

The sign of M_{β} will depend on the size of elasticity of shareable costs with respect to choice of strategy and the ratio of catch in the “good” state relative of catch in the “bad” size in the following way:

$$M_{\beta}(\alpha, \beta) \neq 0 \text{ iff } \frac{CN(M)M}{C(M)} \geq \frac{M}{M-F} \quad (5.11)$$

Now, we know that the cost elasticity is bigger than one. Hence, $C'(M)M/C(M) > 1$. Consequently, M_{β} must be negative for small F 's or when M is large relatively to F .

Furthermore, the bigger is M the more likely is it that skippers will react to a increase in the share parameter by reducing M . An one-sided increase in the costshare reduces the loss that skipper would experience in case of a failed strategy. Was this the only effect at work the skipper would pursue a strategy involving a higher M . But increasing the cost share will also increase the cost of using inputs, so the unit cost of M so to speak, is now higher. Again, was this the only effect at work the skipper would pursue a strategy involving lower M . Equation (5.11) reveals that the second effect is stronger when the cost elasticity is bigger than the ratio of M to $(M-F)$.

The problem of a vessel owner

For a given set of share parameters and the skipper's choice of fishing spot the expected net income of a vessel owner is given as:

$$Z_{BO}(\alpha, \beta, M) = \{1 - p(M)\} \{F - B - C(M)\} + p(M) \{(1 - \alpha)M - (1 - \beta)C(M)\} \quad (5.12)$$

The problem of the vessel owner is:

$$\underset{\alpha, \beta}{\text{Max}} Z_{BO}(\alpha, \beta, M) \text{ s.t. } i) M = M(\alpha, \beta) \text{ and } ii) Z_S \geq Z_S^*$$

The first constraint is to take into account that the skipper's choice of fishing spot is influenced by the choice of share parameters, while the second constraint takes into account that the skipper must be guaranteed an expected income from fishing that is no less than the expected income in alternative employment if he is to be induced to engage in the fishing enterprise.

If we let (α^*, β^*) be the solution to the vessel owner's problem, and denote other equilibrium values with a star, we are ready to establish the following proposition:

Proposition 1: *As long as $S(M) > 0$ and $B > 0$, and as long as (5.6) holds, the vessel owner maximizes his profits by paying all costs himself ($\beta = 0$) rather than sharing costs with the skipper.*

Proof:²⁴ The proof proceeds as follows: an optimally designed contract is offered. Then it is assumed that the cost share according to that contract

²⁴The proof is inspired by Basu (1992).

is positive. Could the vessel owner improve that contract by reducing the cost share to zero? If the answer is yes, then the assumptions of a positive cost share parameter must be modified.

Suppose (α, β) is an equilibrium contract. Assume that $0 < \alpha < 1$ and $0 < \beta < 1$. In such case:

$$\begin{aligned} \alpha N &= \alpha - \beta \frac{C(M)}{M} \\ \beta N &= 0 \end{aligned} \quad (5.13)$$

Here $M = \underset{M}{\text{Argmax}} Z_s(\alpha, \beta, M)$.

Now, if the skipper is to accept the changed contract it must satisfy the skipper's participation constraint. Hence, we must investigate if:

$$Z_s(\alpha N, \beta N, M N) \geq Z_s \quad (5.14)$$

Where $M N = \underset{M}{\text{Argmax}} Z_s(\alpha N, \beta N, M)$

From the definition of M' we know that the skipper can not improve his position by choosing a different project, hence:

$$Z_s(\alpha N, \beta N, M N) \geq Z_s(\alpha N, \beta N, M)$$

In particular, we have that:

$$Z_S(\alpha N, \beta N, MN) - Z_S(\alpha N, \beta N, M)$$

Hence by use of the definition of Z_S :

$$\begin{aligned} Z_S(\alpha N, \beta N, MN) - Z_S(\alpha N, \beta N, M) \\ &= p(M) \left(\alpha - \beta \frac{C}{M} \right) M + \{1 - p(M)\} B - S(M) \\ &= Z_S(\alpha, \beta, M) - Z_S \end{aligned}$$

which establishes (5.14). Hence, the changed contract does not violate the skipper's participation constraint.

If the changed contract is to be superior to the original contract from the vessel owner's point of view the following must be true:

$$Z_{BO}(\alpha N, \beta N, MN) - Z_{BO}(\alpha, \beta, M) \quad (5.15)$$

To find out the effect of changing the contract we have to establish how the skipper reacts to changes in the revenue and cost share parameters. First we totally differentiate $M = M(\alpha, \beta)$ [cf. (5.2)] with respect to α , β and M taking into account that a change in the revenue share will trigger a change in the cost share:

$$(M - F) (-1) \Delta \frac{MM}{M\alpha} + (M - F) (-1) \Delta \frac{MM}{M\beta} + \frac{M\beta}{M\alpha}$$

$$+ (E - F) \left[-F - \{M - F\} C N(M) \frac{M\beta}{M\alpha} + C(M) \frac{M\beta}{M\alpha} \right] = 0$$

Here Δ is given by (5.7). The changed contract stipulated in (5.13)

implies that $d\alpha = \frac{C}{M} d\beta$. Inserted in the above expression and

simplified this yields:

$$\frac{dM}{d\alpha} \Big|_{d\alpha = \frac{C}{M} d\beta} = \frac{(E - F)}{\Delta} \left\{ 1 - \frac{C N(M)}{C(M)} M \right\} < 0 \quad (5.16)$$

The sign of the derivative in (5.16) follows from our assumptions that

$C'(0) > 0$, $C''(0) > 0$ and $C(0) = 0$ which implies that $\frac{C N(M)}{C(M)M} > 1$.

Hence, as $\beta N = 0$ which implies $\alpha N < \alpha$, then [by (5.13) and (5.16)]:

$$M^* < M' \quad (5.17)$$

If we assume that the changed contract improves vessel-owner profit so that (5.15) is true, then:

$$\begin{aligned} & p N (1 - \alpha N) M N + (1 - p N) (F - B) - C(M N) \\ & > p \left\{ (1 - \alpha) M - (1 - \beta) C(M) \right\} \\ & + (1 - p) \left\{ F - B - C(M) \right\} \end{aligned} \quad (5.18)$$

Inserting elements of (5.13) in (5.18) and simplifying yields:

$$(1 - \alpha N) (p \mathbb{N} M \mathbb{N} - p M) > (F - B) (p \mathbb{N} - p) - [C(M) - C(M \mathbb{N})] \quad (5.19)$$

Utilizing (5.3) we can write:

$$p \mathbb{N} M \mathbb{N} - p M = \frac{(E - F) F (M - M \mathbb{N})}{(M \mathbb{N} - F) (M - F)}$$

and:

$$p \mathbb{N} - p = \frac{(E - F) (M - M \mathbb{N})}{(M - F) (M \mathbb{N} - F)}$$

Inserting in (5.19) and simplifying yields:

$$\begin{aligned} & \frac{(E - F) F (M - M \mathbb{N})}{(M - F) (M \mathbb{N} - F)} (1 - \alpha N) \\ & > (F - B) \frac{(M - M \mathbb{N})}{(M - F) (M \mathbb{N} - F)} - [C(M) - C(M \mathbb{N})] \end{aligned} \quad (5.20)$$

Multiplying with $\frac{(M - F) (M \mathbb{N} - F)}{(E - F) (M - M \mathbb{N})}$ yields:

$$(1 - \alpha N) F > (F - B) - \frac{(M - F) (M \mathbb{N} - F)}{(M - M \mathbb{N}) (E - F)} [C(M) - C(M \mathbb{N})] \quad (5.21)$$

Further simplification yields:

$$B - \alpha NF > - \frac{(M - F)(MN - F)}{(M - MN)(E - F)} [C(M) - C(MN)] \quad (5.22)$$

In (5.6) we ruled out all contracts excepts those that fulfilled the requirement that $B > \alpha F - \beta C(M)$. This must therefore also hold for the apostrophe marked contract. Hence, $B > \alpha NF$. The expression

$$\frac{(M - F)(MN - F)}{(M - MN)(E - F)} [C(M) - C(MN)] \text{ is positive as } M^* < M' \text{ and}$$

$C(M^*) < C(M')$. Hence (5.22) is true as the entity on the left hand side of the inequality sign is positive and the entity on the right hand side is negative. But (5.22) is deduced from (5.15) so (5.15) must also be true. But (5.15) stated that the apostrophe marked contract is better than the star marked contract. Hence we can conclude that the starred contract can be replaced by another contract (the apostrophe marked contract) which will yield results as good or better to the vessel owner as the starred contract did. Hence, (5.22) contradicts the initial assumption that the star marked contract was as good or better than any other contract that could be designed. QED

The comparative statics results reported above showed that a reduction in the revenue share would induce the skipper to choose a more risky strategy, a higher M . The comparative statics results also showed that skipper reaction to a reduction in the cost share parameter would be ambiguous. Proposition 1 shows that a simultaneous change in the two parameters that is

designed so as to leave pecuniary skipper income unchanged will induce the skipper, unambiguously, to choose a more risky and more demanding strategy.

The results above hinges crucially on two aspects of the situation. Firstly, the existence of a guaranteed base wage, B , that is sufficiently high so that (5.6) is fulfilled. In light of proposition 1, this requirement implies that the base wage must be higher than the skipper revenue share if the chosen strategy fails.

The second aspect that is crucial for the our result is the existence of strategy-dependent skipper-specific costs. The existence of strategy-dependent skipper-specific costs introduces a wedge between the interests of the skipper and the vessel owner. The vessel owner would presumably want the skipper to pursue more daring strategies than what the skipper finds optimal. Our comparative static results show that the existence of a guaranteed base wage induces the skipper to engage in higher “good” state yield strategies than he would do in the absence of such a guarantee. But Proposition 1 shows that the vessel owner is better off if he uses the instruments at hand to induce the skipper to engage in still more daring strategies. That he can do by simultaneously lowering both share parameters.

6 Conclusion

The fundamental question that we started with was: Why do Icelandic vessel owners pay all costs of operation of their vessels when vessel owners in many other countries share such costs with their crews?

According to the model presented in this paper, the base wage and the zero cost share are both likely to coexist in fisheries where strategy-dependent skipper-specific costs are important. It is not so that the one causes the other, but rather so that both are caused by the specific situation of skipper-specific costs. Now, skipper specific costs are by definition non-sharable. In most cases they are also non-observable. Hence, the covariance of skipper specific costs and zero cost sharing will not lend it self testable. But the model predicts a positive covariation of skipper-specific costs, a guaranteed base wage and zero cost sharing.

The covariation of a guaranteed base wage and zero cost sharing seems to fit well with facts. In fisheries where a base wage is guaranteed the general rule is that costs are not shared. This is the case in the Icelandic fisheries, in the menhaden fishery in the US, and in parts of the Danish, Dutch and English fisheries. The same tendency of reduced cost sharing in the presence of a guaranteed base wage can also be traced in the Norwegian fisheries. More data gathering is necessary, however, to establish how and to what extent costs are strategy-dependent in those fisheries.

The guaranteed base wage, B , is modelled as if exogenously given. Base wage guarantees are either negotiated between organizations of employers and employees or stipulated by an act of law. The spirit of the model presented is that introduction of a guaranteed base wage need not be very harmful to vessel owners and beneficial to skippers. The introduction of a positive base wage would induce a skipper faced with strategy-dependent skipper-specific costs to engage in more daring strategies and hence induce him to spend some more of his own resources than he would otherwise have been willing to do. Vessel owners in fisheries where skipper specific costs are, or could be important, that offer a base wage and a zero cost share might do better than vessel owners that offer other forms of remuneration.

Note that, according to the model, vessel owners go as far as possible in order to induce skippers to take more risky strategy. Or in other words, the vessel owners behave as if they were risk-loving, while skippers behave as if risk averse, even though both agents are modelled as risk neutral. This is contrary to the findings of Basu (1992). The sharecroppers in his model and the skipper in the present model are in similar position. The same is true for landowners in his model and vessel owners in the present model. Sharecroppers in Basu's model behave as if risk lovers while the landowners behave as if risk-averse, but both are modelled as if risk neutral. The reason for different conclusions has to do with different assumptions regarding institutions and the production environment. Basu's sharecroppers pay all costs implied by the strategy chosen, and he assumes that agricultural costs are not strategy-dependent. In the fishery context I find it natural to take a different approach and assume that costs are strategy-dependent. Dupont (1993) finds that some Canadian salmonskippers/vessel

owners seem to be risk lovers while others seem to be risk averse with respect to choice of location for their operations in a given season. In the light of the present model and the model of Basu, such conclusion should not come as a surprise. It is possible that her findings reflect differences in institutional arrangements and/or differences with respect to the production process.

The sparse evidence presented in Table 1 indicates that cost sharing is more widespread in traditional fisheries than in technologically more advanced fisheries. This would be consistent with the present model if skippers' choices of strategies in the traditional case had little influence on revenue and costs, while having significant consequences in the advanced fisheries.

Costs may be shared in fisheries where the assumptions for proposition 1 are not fulfilled. Hence we are likely to find cost sharing in fisheries where choice of fishing strategy does not affect costs, and where skipper-specific costs are insignificant, or where choice of strategy does not affect vessel-owner income and/or skipper income in a significant manner.

The basic lesson from the exercise presented in this paper is that it need not be totally uneconomical when principals pay all costs incurred by an agent. Given certain institutional and productive arrangements the costs saved by the principal by using a cost-sharing rule might be less than income gained by not using that rule.

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