

Comment on “Landing Fees versus Harvest Quotas with Uncertain Fish Stocks.”

William K. Jaeger
 Department of Economics
 Williams College, Williamstown, MA 01267

In “Landing fees vs. harvest quotas with uncertain fish stocks”, Martin Weitzman maintains that the conventional view among both fisheries economists and fisheries managers is that “prices” are inferior to “quantities” as instruments for regulating the fishing industry. Weitzman takes the opposite position, appealing to two well-established ideas in economics: 1) his own seminal insight on “prices vs. quantities” (Weitzman 1974), and 2) the “powerful general theme in economics that a ‘price signal’ can compress into a simple reduced form all relevant information for inducing correct decentralized decisions.” His paper is an attempt to capture and formalize his intuition on the subject using a standard dynamic fishery model with a stochastic stock-recruitment relation which introduces uncertainty, and evaluating the performance of both landing fees and harvest quotas in comparison to a hypothetical “perfect-information” optimal solution.

The basic model is a well-known type which gives rise to a “bang-bang” optimal escapement target, S^* . Weitzman rigorously solves the optimizing fishery manager’s dynamic programming problem for each management regime, and shows that the result for a constant landing fee (corresponding to S^*) is identical to the “perfect-information” solution, but that both are superior to the harvest quota.

This result is undoubtedly correct for the models being appraised. The basis for this finding is less clear, however, since the assumptions which have given rise to this result are not explicitly identified. Indeed, on closer examination, the source of these striking results appears to be unrelated to “prices vs. quantities” in the classic sense. Furthermore, the theme in economics that a ‘price signal’ can compress information and induce correct decentralized decisions appears to be unrelated since there are no differentiated decentralized decisions to be made in the model.

To clarify what exactly is, and is not, going on in this model, a simple diagram can be used to represent the essential elements of the optimal harvest decision of the model for each harvest period. In Figure 1 the fish stock, x , is represented on the horizontal axis so that harvesting represents a movement from right to left, drawing down the stock from its initial level or recruitment, R_t , to the ending level or escapement, S_t . Marginal profits, $\pi(x)$, are

represented in the figure so that total profits equal the integral of $\pi(x)$ from R_t and S_t .

Given the assumptions of the model, the optimal escapement is fixed at S_t^* where the marginal profit of catching an additional fish in the current period is just equal to its user cost, the present value of the expected future marginal profits represented as $\frac{\partial V}{\partial S}$.

Weitzman’s analysis appears to implicitly assume that S^* and $\pi(S^*)$ are known, or at least that any errors in estimating S^* are independent of the management regime, and inconsequential to the result. There is also no information or assumption made regarding the relative slope of the two curves in Figure 1, the marginal benefit and marginal cost curves intersecting at S^* . This being the case, we can conclude that the conclusion that landing fees are superior to harvest quotas is not an example of the well-established analysis of “prices vs. quantities” because that analysis hinges fundamentally on a) uncertainty about the exact location of the intersection of the marginal benefit and marginal cost curves, and b) their relative slope.

Similarly, the advantage of a price instrument over a quantity instrument cannot be the source of the current finding, because no decentralized information is assumed to exist in the model. The results obtained will hold whether we assume the fishery contains one fisherman or numerous identical fishermen. The potential coordinating advantages of a price signal over a quantity rule are not present in the model.

On closer examination, the critical assumption driving Weitzman’s result appears to be the asymmetry in the timing of decisions, and consequently the information available for use under each of the two management regimes. Referring to Figure 1 we can characterize the landing fee system as follows. For any given (and uncertain) R_t , fishermen will begin to fish so long as $\pi(x) > \pi(S^*)$. Because R_t is the only relevant source of uncertainty, the fisherman need only discover whether the marginal profit, $\pi(x)$, exceeds the landing fee at the outset. If so, fishing will continue and $\pi(x)$ will be observed by the fisherman and will decline as harvesting continues. When $\pi(x) = \pi(S^*)$ they will stop fishing. Hence, the decision about the total harvest is made precisely on the last day of the fishing season, when all information about the stock is revealed via the marginal

profit function. The landing fee can be seen as a trigger mechanism which says, when you observe that $\pi(x) \leq \pi(S^*)$, stop fishing.

By contrast, for the harvest quota system, the fishery managers are required to decide a level of total harvest, $H_t = R_t - S^*$, prior to the start of the season, "before anyone can observe what will be the realization of the state of the environment..." Thus, any 'in-season' information that reveals where the fishers are actually operating on the marginal profit curve, and hence what the actual stock is, is disallowed for management purposes. Since the only uncertainty which is explicitly modeled and has bearing on the result is uncertainty about the recruitment, R_t , selection of H_t will be imprecise and inefficient (since $H_t = R_t - S^*$ and R_t is uncertain), whereas this source of uncertainty will not affect the landing fee (since S^* and therefore $\pi(S^*)$ is assumed to be known or estimated). (This will not be exactly true, however, since if $\pi(x) < \pi(S^*)$ at the outset, fisherman will incur costs to discover that the optimal harvest is zero, at which point they will have exceeded the optimal harvested and incurred extra costs relative to the "perfect information" solution.)

The key differences between these two management systems, in terms of their assumptions and outcomes, can be illustrated using the analogy of managing a Broadway play in one of two possible ways: either 1) deciding, prior to opening night, what the run of the play will be, or 2) deciding only to open the play and have the run go until ticket revenues drop below a given level. The second approach uses information that is only revealed gradually as the activity is undertaken; the other makes a "best guess" at a time when less information is available on which to base the decision. Obviously, deciding to end a play's run on its last day by monitoring declining revenues will be superior to guessing in advance what that day will be. Likewise, in-season information on marginal profits or catch-per-unit effort will afford more accurate harvest decisions than trying to guess the value of $R_t - S^*$ in advance.

The contrasting results in Weitzman's model are indeed striking, but close inspection reveals that they are due to differences in their use of in-season information rather than other inherent differences between prices and

quantities. The question naturally arises, however, whether fishery managers using a harvest quotas also use in-season information to make adjustments as information is revealed by the act of harvesting. The answer is clearly yes, and there are numerous examples where test fisheries, multiple openings, and in-season adjustments are made, such as with pacific salmon, Alaska king crab, herring, and squid in the U.S. and Canada. Icelandic fishery managers also make in-season adjustments in harvest quotas on the basis of information revealed in catch data (Ragnar Arnason, personal communication, July 10, 2000). Where recruitment is highly variable, and where the option value of in-season information is high, we would expect to find fishery managers making use of such information, and a casual look at the evidence appears to support that. By contrast, where fish populations are more stable and hence easier to predict (as with slow growing groundfish), preseason setting of harvest levels is common. In the context of the current analysis, these observed differences in the way that fisheries are actually managed make a great deal of sense.

In sum, Weitzman's analysis highlights important differences between a fishery management system that makes use of in-season information and one that does not. In a world of stock-recruitment uncertainty, estimating the relationship between marginal profit and user cost to arrive at an optimal escapement target is a centralized calculation. Once that calculation is made, fishery managers may implement the target with a landing fee or a harvest quota, but either way, in-season information can improve the precision with which the target is achieved. Of course, periodic revisions of a harvest quota in-season may involve somewhat greater administration costs to managers. But if both the escapement target and the recruitment are uncertain, then fishery managers are likely to continually monitor marginal profits to evaluate and revise the existing target. In that case, the advantages of landing fees over harvest quotas on the basis of access to timely in-season information may be slight, and other considerations such as the political acceptability of landing fees, or the political difficulties of raising landing fees once established, may overshadow these considerations.

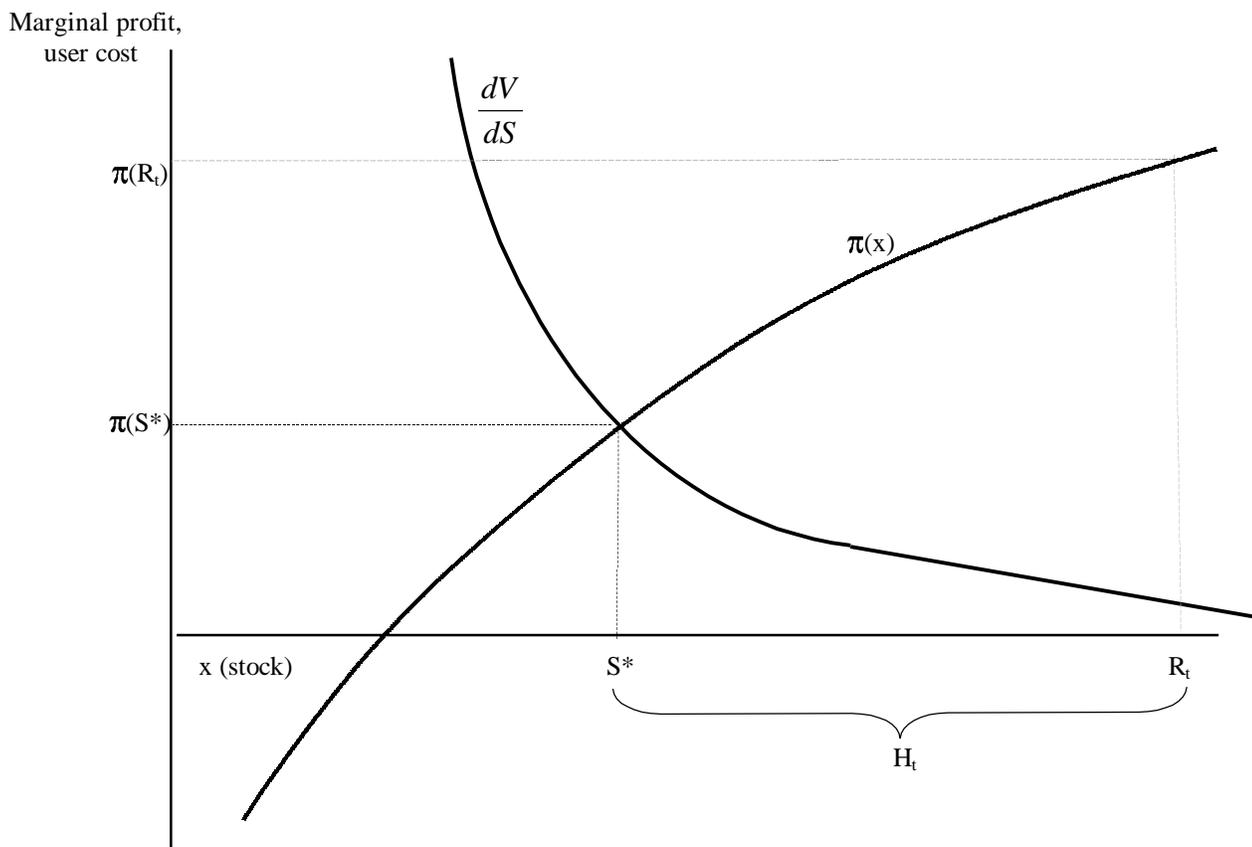


Figure 1. Optimal escapement in a discrete-time fishery.

Reference

Weitzman, Martin L., "Prices vs. Quantities," *Review of Economics Studies*, 41, 477-91, 1974.