E C O N O M I C S B U L L E T I N

A note on some determinants of property rights in U.S. marine fisheries

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Abstract

A simple probit model of property rights adoption is estimated for U.S. fisheries managed under the Magnuson Act. The results of the model are consistent with the literature on property rights and transaction costs: Namely, the adoption of private property rights to marine fisheries is shown to hinge on the value of variables which determine, on the one hand, the costs of monitoring and enforcing rights, and on the other hand, the benefits of more clearly defining such rights.

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1 Introduction

Received wisdom suggests that the economic value of a fishery is enhanced when exclusive property rights are defined and enforced to the resource. In the United States the legal authority to create such rights has existed since the passage of the Magnuson-Stevenson Fishery Management and Conservation Act of 1976.[1] Over the years property rights have been created to some – but not most – U.S. fisheries. If property rights are in fact critical to the economic viability of fisheries, why then, despite a legal framework designed to ease their creation, are most fisheries still lacking even rudimentary property rights?

This questions' breadth more easily elicits further questions rather than answers. A full accounting of the determinants of property rights in fisheries will be constructed from the answers to many narrower questions. In this note I investigate one such question: Are there important spatial and economic characteristics of fisheries managed under the Magnuson Act which affect the decision to establish property rights?

2 Literature Review

The general theory of property rights is well established (Barzel, 1989; Libecap, 1989). The creation of property rights is viewed as an economic decision because their design, monitoring, and enforcement consumes real resources. This view allows for a rational reconstruction of the choice process using marginal analysis (Anderson and Hill, 1974). Within the marginal framework one can not, *a priori*, demonstrate the universal adoption of property rights: The extent of property rights adoption will depend on the marginal costs and benefits. A core proposition of this literature holds that efforts to create property rights will, *ceteris paribus*, increase as either transaction costs fall and/or the value of resources increase. Empirical investigations lend support to this proposition (see Demsetz, 1967; Cheung, 1970; Field, 1989).

Several authors have incorporated these propositions into models of fishery management. Anderson and Lee (1986) show that positive transaction

[1] In 1996 Congress passed the Sustainable Fisheries Act that included a provision for a five–year moratorium on the implementation of individual transferable quotas. This provision was allowed to expire in 2002.

costs generate situations where fishery managers "failing" to fully enforce property rights may increase social welfare. Others have come to similar conclusions (Milliman, 1986; Sutinen and Andersen, 1985; Anderson, 1989).

3 Institutional Background

The Magnuson Act extended U.S. jurisdiction over marine resources from 12 to 200 nautical miles. The Act authorizes three agencies to manage fisheries in this 200–mile zone. Eight quasi–independent regional fishery management councils representing commercial, recreational, and consumer fishing interests develop fishery regulations that are presented to the Secretary of Commerce in the form of Fishery Management Plans (FMPs). In turn, the Secretary either approves or rejects each FMP. Much of this review process is delegated to the National Marine Fishery Service, a sub–agency in the Department of Commerce, that, along with the United States Coast Guard, enforces regulations contained in each FMP. (For a detailed analysis of this Act and the regulatory review process see Kincaid (1999)).

4 Construction of the Data Set

Drawing on data contained in these FMPs I developed a set of forty–five fisheries to serve as observations in my data set. My review of these plans revealed the existence of two basic categories of property rights: Limited–entry programs and Individual Transferable Quotas (ITQs). In the sample, entry is limited in twenty–one fisheries. Sixteen fisheries have permanent limited–entry programs, of which four have ITQ programs in place. ITQs assign a specific share of a fisheries' harvest (the 'quota') to individual fishermen who, in turn, may harvest this quota or transfer it to others. The remaining five fisheries have 5–year entry moratoriums.

Each program creates rents by limiting access to a resource that was heretofore (essentially) open to all takers. However, under limited–entry programs, these rents are unassigned and, in the absence of other regulations (e.g. restrictions on vessel size), remain at risk because of the strong incentive each fisherman has to capture as large a share of the harvest as possible. Thus, simple limited–entry programs run the risk of converting the problem of the fishery from one of too many fishermen chasing too few fish, to one

of a few fishermen with too much gear chasing too few fish. Because ITQ programs assign specific shares of the harvest to fishermen, these perverse incentives are dulled.

Notwithstanding these differences, each program confers some property interest and so, for this analysis, I treat their presence as an indication of property rights adoption. A binary variable, RIGHTS, summarizes this fact; where zero indicates no property rights and one indicates some form of property rights adoption. RIGHTS serves as the dependent variable in a probit model of the determinants of property rights.

The adoption of property rights hinges on a standard cost–benefit calculation, where property rights are adopted if the net benefit is positive. The variable REVENUE, a three–year weighted average of ex–vessel revenue (millions of 1995 dollars), proxies the benefits of adoption.

Four variables proxy transaction costs. VESSELS, the number of fishing vessels in a fishery, proxies exclusion costs (Cornes et al., 1986). PORTS, an ordinal variable ranging from 0 to 2, proxies land–based enforcement costs; where zero indicates a fishery with between 1 and 40 landing sites, one indicates 41 to 80, and two indicates 81 or more sites. EXTENT is an ordinal variable that proxies at–sea enforcement costs. EXTENT takes on the values 0, 1, and 2, and captures the geographical extent of a fisheries range. Zero denotes a fishery with a 'small' range, one a 'middling' range, and two a 'large' range.[2] Finally, PART is an ordinal variable keyed to the type of fishermen found in a fishery; a value of zero indicates a fishery with mostly full–time fishermen, one a mix of full and part–time fishermen, and two a fishery with mostly part–time fishermen. PART is motivated by the idea that fisheries prosecuted by full–time fishermen are likely to be less susceptible to 'hit–and–run' tactics, are likely to have more established norms of behavior, and other attributes which tend to make a given amount of monitoring resources more effective (see Anderson, 1989; Wilen, 1979).

[2]This index is based on a location of fishery. Fisheries found in a single management council's waters are set to 0, fisheries found in multiple council waters, but remaining within the EEZ are set to 1, and fisheries entering international waters are set to 2.

Table 1: Results of the Probit Estimation. The final two columns present the marginal effects (calculated at the mean values of the all of the independent variables) for each of the independent variables and their associated asymptotic standard errors.

Variable	Estimate	S.E	P–Value	ME	Asy. S.E.
(Intercept)	3.6221	1.1479	0.0016	—	—
REVENUE	0.0347	0.0153	0.0236	0.0137	0.0062
VESSEL	−0.0594	0.0310	0.0549	−0.0236	0.0124
EXTENT	−1.2379	0.6503	0.0570	−0.4907	0.2599
PORTS	−1.4432	0.5437	0.0079	−0.5721	0.2167
PART	−0.9823	0.4627	0.0338	−0.3894	0.1809

5 Empirical Model and Results

The following equation is estimated using probit methods,

$$\text{Prob}(\text{RIGHTS}=1) = \alpha_0 + \beta_1 * \text{REVENUE} + \beta_2 * \text{VESSELS} + \beta_3 * \text{EXTENT} + \beta_4 * \text{PORTS} + \beta_5 * \text{PART} \quad (1)$$

This specification allows for testing two hypotheses: Increases in REVENUE should increase the probability of property rights adoption and increases in transaction costs, as proxied by increases in VESSELS, PORTS, EXTENT or PART, should decrease the probability of adoption.

Table 1 summarizes the results of the probit estimation. Both coefficient estimates and marginal effects (calculated at the mean of the independent variables) are presented. Overall the specification performs well: 90% of fisheries not having property rights and 96% of those with property rights are correctly classified. Each of the marginal effects has the predicted sign: transaction costs proxies enter with negative signs, while REVENUE enters with a positive sign. All variables are statistically significant with p–values of 0.06 or less. A more important question turns on the empirical significance of the independent variables; that is to say, the magnitude of each variable's marginal effect.

Changes in the variables significantly affect the probability of adoption. A one million dollar increase in REVENUE will increase the probability of

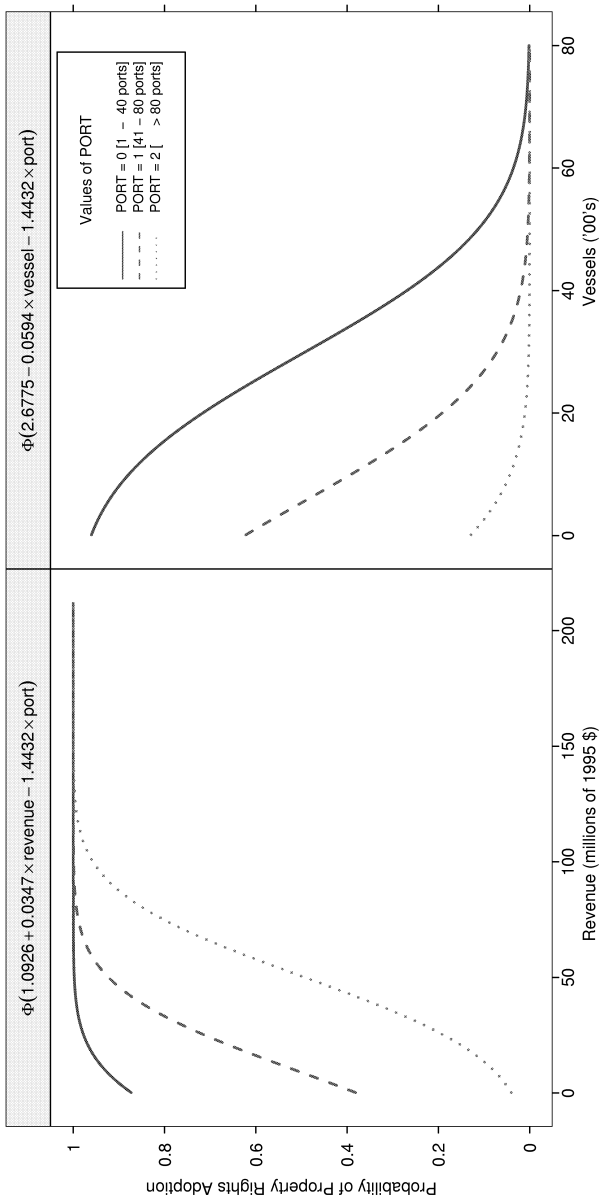

Figure 1: CDFs for each value of PORTS as a function of REVENUE (panel one) and VESSELS (panel two). Units of REVENUE are millions of 1995 dollars, and hundreds of VESSELS.

Table 2: Marginal Effect of PORTS as a function of REVENUE (columns 2 and 3) and VESSELS (columns 5 and 6). The values of REVENUE and VESSEL were generated by sorting the 45 observations and taking the means of three groups of 15 observations each. ME_{01} is the marginal effect of PORTS as it shifts from 0 to 1, and ME_{12} is the marginal effect of PORTS shifts from 1 to 2.

REVENUE	ME_{01}	ME_{12}	VESSELS	ME_{01}	ME_{12}
2.11	−0.49	−0.35	1.51	−0.12	−0.49
10.80	−0.42	−0.43	5.03	−0.17	−0.52
74.33	−0.01	−0.20	24.10	−0.47	−0.37

property rights adoption by 1.4%. An increase of 100 VESSELS decreases the probability of adoption by 2.3%. As EXTENT shifts from a lower category to higher category the probability of adoption decreases by 49%, a similar shift in PORTS decreases the probability of adoption by 21%, and likewise a shift in PART decreases probability of adoption by 39%.

Because the marginal effects are non–linear functions of the data, a more complete assessment of their magnitudes requires one to calculate their values over a range of the other variable's values (see Greene, 2002, for details.) For example, the impact of PORTS may be quite different in fisheries with high levels of REVENUE or VESSELS compared to those with low levels.

To consider this question I use the coefficient estimates from the probit model to calculate the cumulative distribution function (CDF) for each value of PORTS as a function of various values of REVENUE, holding the other variables at their means. I repeat these calculations using VESSELS instead of REVENUE. This exercise results in six distinct CDFs that are displayed in figure 1. Figure 1 is an example of a trellis graph (Cleveland, 1993; Ihaka and Gentleman, 1996), where the left panel contains the estimated CDFs for REVENUE and the right panel those for VESSELS. Each of the panel labels presents information on the actual value of the respective CDF's. PORTS has a significant affect on the probability of property rights adoption, but the magnitude of its effect depends substantially on REVENUE and likewise on VESSELS. Table 2 summarizes the marginal effect of PORTS for three different values of REVENUE and VESSELS.

At low levels of REVENUE, changes in PORTS has a relatively large impact

on the probability of property rights being adopted, however the impact of PORTS diminishes substantially for high levels of revenue. The exception is ME_{12}, where even at high levels of revenue, there is a substantial impact on property rights adoption.

The interplay between changes in the number of vessels and the number of ports is a bit more complicated. ME_{01} is relatively small for fisheries with small numbers of vessels, however, as the number of vessels increases, the magnitude of the marginal effect increases substantially. ME_{12} is relatively large for all values of vessels, suggesting that fisheries with more than 80 ports present particularly difficult obstacles to property rights adoption. When one considers that 42% of the fisheries in my sample have more than 80 landing sites, the impact of PORTS, and by extension, transaction costs, is likely to be an important factor affecting the probability of property rights adoption.

6 Conclusion

The passage of the Magnuson Act was heralded as a historic shift away from traditional and inefficient regulatory management of fishery resources to a system of management that would, on the one hand, enhance fishermen's income by creating property rights to fishery resources, and on the other, preserve fishery stocks though the stewardship that resource ownership affords. The fact that, 27 years after the Act's passage, only a small number of fisheries have some form of property rights defined has lead to disappointment in many quarters, and a search for answers to why traditional management practices seem so entrenched.

The pattern of property rights adoption in U.S. marine fisheries can be largely explained by the variation in variables that describe important spatial and economic characteristics of those fisheries: Increases in the value of a fishery increases the probability of adoption, and increases in transaction costs reduce the probability of adoption. The effects of these variables are consistent with the broader literature on property rights and transaction costs, and suggest a partial explanation to the question of why so few fisheries are currently managed using exclusive property rights: Given the benefits that they would confer, the costs of defining, monitoring and enforcing those rights may be too high.

This should not, however, be viewed as a Panglossian statement that fisheries are managed in the best of all possible worlds. The net benefits of

property rights are a function not just of the characteristics of the fishery, but also of the institutional structure of fishery management and the technology of monitoring and enforcing property rights. Changes in either could lead to the further adoption of property rights.

The fact that my sample is one of convenience justifies a cautious appraisal of my findings. Nonetheless, these findings indicate that efforts to more closely measure transaction costs and correlate these costs with the incidence of property rights will be fruitful. This note is drawn from an ongoing project designed to model the adoption or non-adoption of five different forms of regulation in marine fisheries. The results of such research should provide useful information to policy makers as they reassess the history of fishery management since the passage of the Magnuson Act and seek to better the economic standing of both fishermen and the resources that sustain them.

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