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EFFICIENCY ADVANTAGES OF GRANDFATHERING IN RIGHTS-BASED FISHERIES MANAGEMENT

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Efficiency Advantages of Grandfathering in Rights-Based Fisheries Management

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Abstract
We show that grandfathering fishing rights to local users or recognizing first possessions is more dynamically efficient than auctions of such rights. It is often argued that auctions allocate rights to the highest-valued users and thereby maximize resource rents. We counter that rents are not fixed *in situ*, but rather depend additionally upon the innovation, investment, and collective actions of fishers, who discover and enhance stocks and convert them into valuable goods and services. Our analysis shows how grandfathering increases rents by raising expected rates of return for investment, lowering the cost of capital, and providing incentives for collective action.

Key Words
Fishing rights, property rights, allocating fishing rights, grandfathering fishing rights, auctions of fishing rights, fisheries rent

JEL classification: N 22, Q0, Q22, K11, D23

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I. Introduction

The recognition that weak property rights have been the major cause of the world-wide depletion in ocean fish stocks has led to the adoption of rights-based management (RBM) in fisheries (Neher et al. 1989, Shotton 2000, Beddington et al. 2007). Although the potential for RBM to improve fisheries is widely accepted, the mechanisms for allocating rights are controversial. By far the most common way of assigning rights has been to grant them on the basis of historical participation in the fishery (National Research Council 1999, Shotton 2000, Arnason 2002, FAO 2004). This practice is termed grandfathering or first possession (Epstein 1979, Rose 1985, Lueck 1995).

Some economists, however, favor auctions over grandfathering. They contend that auctions allocate rights to users who place the highest value on the rights; that they transfer resource rents to the state (which can then distribute them beneficially to the polity); and that efficiency in resource use is invariant to the rights distribution mechanism (see Grafton 1995, Morgan 1995, Bromley 2009).[1]

In this paper, we examine the efficacy of grandfathering relative to other rights allocation mechanisms. Our basic proposition is that grandfathering increases dynamic efficiency compared to the alternatives. We maintain that natural resource rents, far from being fixed, evolve over time and can either expand or contract. They are increased by productive investments in fish stocks and ocean habitat, by finding new fishing opportunities, by implementing improved production practices, by developing new products and marketing processes, and by producing public (or club) goods through local collective action. These advances do not happen automatically. They require the appropriate incentives in the form of expected returns on investments undertaken relative to the cost of capital.

Because natural resource rents constitute a significant part of the social wealth of many nations (World Bank 2006, 4), it follows that a major task of economic policy is to promote the expansion of such rents. Crucially, the act of fully or partially expropriating them generally will reduce the incentives for or the ability to undertake the necessary investments, or both. Although auctions may increase short-run

[1] Similar views have been expressed in other natural resource uses. For example, Parry et al. (1999) and Goulder et al. (2010) endorse auctioning allocations in a cap and trade program rather than grandfathering or free distribution because of the indirect advantages of using the funds to lower more distortive taxes.

government revenue and maximize the share of resource rents going to the state, the investments required to expand future rents are discouraged by such transfers. Long-term investments, by contrast, are encouraged by secure property rights that promote entrepreneurship and lower the cost of capital to firms that are in a position to exploit time- and place-specific information.[2]

To develop these arguments, we describe the movement toward RBM, discuss various allocation methods, elaborate on the role of rents for dynamic efficiency, develop formal arguments of the economic advantages of grandfathering relative to auctions, and provide empirical evidence supportive of our arguments. We conclude by speculating as to whether the advantages of grandfathering rights in fisheries holds for other resources and calling for increased research on the long-term effects of property rights distribution mechanisms.

II. Rights-Based Management

Fishery rents are vulnerable to dissipation under common-pool or open-access conditions through excessive short-term harvest, overinvestment in capital and labor, underinvestment in stocks, and distorted technical progress in the industry. These losses were first described by Jens Warming in 1911 (in Danish, translated by Andersen 1983) and Scott Gordon in 1954. As suggested by Anthony Scott (1955), the fundamental cause of this waste is the lack of private property rights. The absence of clear property rights (informal or formal, group or individual) leads to dissipation of resource rents and prevents bargaining solutions of the type outlined by Coase (1960). With declining catch-per-unit-of-effort and depletion of the fish stock, the opportunity for fisheries to provide a basis for long-term wealth creation is lost (World Bank & FAO 2009, xvii).

Prescriptive regulation to control entry and production has been costly and ineffective at halting the decline in fish stocks (see, for example, Johnson & Libecap 1982, Shotton 2000, Beddington et al. 2007), thus returning attention to rights-based management (see Neher et al. 1989, Shotton 2000, Hannesson 2004, Stavins 2007,

[2] Auctions transfer rents to the auctioneer, usually the state, in a similar way to Pigouvian taxes that extract resource rents (Pigou 1920, Baumol 1972). Although Pigouvian taxes are seldom used, relative tax rates across jurisdictions are important determinants of resource flows and investments. For a discussion of this, see Findlay (1978, 13) and Calomiris & Hubbard (1995). To the extent that auctions transfer rents, it is likely that they will have similar negative consequences for investment.

Beddington et al. 2007).[3] For fisheries, individual transferable quotas (ITQs) were first suggested by Francis Christy in 1973 as a means of incorporating property rights. Under this arrangement, the total allowable catch (TAC) is set by regulators and catch shares are assigned to fishers as a property right to the flow of harvest.[4] Other rights-based mechanisms include territorial user rights (TURFs), sole ownership, and community rights (Arnason 2007b).

By establishing property rights, RBM creates incentives and mechanisms for reducing the number of fishers and vessels, for increasing output-per-unit-of-effort, for improving access to capital markets, for trading rights to the most productive fishers, for encouraging investment in fish stocks and habitat, and for engaging in Coasean bargaining to reduce rent dissipation.[5] To be most effective, the rights must be permanent, secure, exclusive, and tradable (Scott 1989, Arnason 2007b).

Economists have documented many advantages of RBM in fisheries. Grafton et al. (2006) outline the process and impact of ITQs. Hannesson (2004) describes a general pattern of moving from uncontrolled entry to centralized governmental regulation (command and control) to the adoption of property rights of some type. Arnason (2000, 2002) summarizes international experiences with ITQs. Casey et al. (1995), Grafton et al. (2000), and Fox et al. (2003) demonstrate changes in harvest practices and product quality under adoption of ITQs in the British Columbia halibut fishery. Newell et al. (2005) and Arnason (2008) report rising quota prices in ITQ fisheries, implying the success of RBM. Finally, using a global database for over 11,000 fisheries from 1950 to 2003, Costello et al. (2008) find evidence that the use of catch shares generally halts and, in some cases, even reverses the declining trend in fish stocks.

[3] The literature on fishery regulation is very large and we cannot be inclusive. Some relevant papers are those by Crutchfield (1961), Brown (1974), Anderson (1985), Homans & Wilen (1997), and Wilen (2000).

[4] The literature on design and implementation of ITQs is also large. For a discussion, see Grafton (1996). Arnason (2009) notes that fishers holding ITQs could collectively set the annual TAC. Chu (2009) has a more moderate assessment of the impact of ITQs on the stock. See also the debate between Clark et al. (2010) and Grafton et al. (2010) on incentives to harvest and maintain the stock under ITQs.

[5] There were similar gains in the shift to emission permits from regulation in the SO2 emissions program in the United States. See Stavins (2007).

III. Mechanisms for Allocating Rights

Despite clear theoretical arguments and empirical evidence of how RBM can improve fisheries, the adoption of such systems has evolved slowly. In 2005, according to Arnason (2005), some form of ITQs were used by only 15 major fishing nations, accounting for perhaps 20 percent of global landings.[6] While this represents a great change from 25 years before when only two to three nations were using ITQs, most global fisheries are still harvested as open access or regulated common-pool resources. One of the main impediments to adoption of RBM systems is disagreement over how to allocate the rights. Here we briefly summarize the four rights allocation mechanisms.

A. Political allocation refers to the direct assignment of property rights by government officials. This mechanism has a clear potential for rent seeking (Kruger 1975, Buchanan et al. 1980).[7] It has rarely been used in fisheries perhaps because of the widespread respect for first possession, the specific information and human capital required for entry into the industry, and because RBM typically has been implemented when fish stocks have been dangerously depleted, reducing available rents and their value as political rewards (Hannesson 2004, 111; Libecap 2008).[8]

B. Uniform allocation distributes equal shares to all fishers. It is attractive because it appears equitable and because it avoids the transaction costs associated with designing auctions or with verifying claims based on past production for grandfathering. Moreover, if subsequent exchange of rights is allowed and the costs of trade are low, uniform allocation leads to an efficient solution via Coasean bargaining. The resource still migrates to high-valued users and rents remain in the fishery. Nonetheless, uniform allocation such as lottery distribution has not, to our knowledge, been used for fisheries RBM.

C. First possession or grandfathering assigns ownership to existing fishers based on historical catch, capital investment, or some combination of the two. First possession rules recognize current parties, who have experience in exploiting the

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[6] Among these nations are: New Zealand, Australia, Namibia, Morocco, Chile, Peru, USA, Canada, Greenland, Iceland, Norway, Denmark, Russia, Netherlands, Estonia, and South Africa. Costello et al. (2008) provide an estimate of smaller coverage of ITQs, at 2% of the world's fisheries. The economics literature on fishery RBM is large and we do not summarize its broad coverage here.

[7] Competition for resource rents in the presence of weak institutions results in rent dissipation and the so-called resource curse. See Sachs &Warner (2001) and Torvik (2002).

[8] Namibia and South Africa are examples of countries where political allocation of fishing rights has been used.

resource. As noted above, it is the most common allocation mechanism for fisheries (Shotton 2000, Hatcher et al. 2001, Arnason 2002, Libecap 2007).[9]

D. Auctions allocate rights to the highest bidder with the revenues going to the seller, generally the state.[10] Therefore, not surprisingly, they tend to be favored by governments (Milgrom 2004). Auctions are commonly used to grant use rights for previously unexploited resources for which the state may have clear ownership, such as timber concessions, oil and gas leases, and the division of the electro-magnetic spectrum. Auctions have also been adopted for allocating emissions permits under cap-and-trade policies for various types of air pollution control and proposed in new programs for greenhouse gas regulation.[11] In fisheries, they have rarely been used.[12]

IV. Resource Rents from RBM

Economic rents incorporate several distinguishable components. One is Ricardian or resource rent, generated by an asset that is naturally relatively fixed in supply, such as land (Ricardo 1821, 34−5, 44). This is the surplus value above costs and normal returns not necessary for production of the asset. Another is Schumpeterian rent, generated when the value of the asset is increased due to innovative activities (Schumpeter 1950). A third concept is inframarginal resource rent generated by individuals or firms characterized by greater skill, human capital, and/or risk tolerance in production using the asset. This rent is earned even in open-access settings where only the marginal actors earn zero rents (Johnson & Libecap 1982, Johnson 1995). Individuals with more skill and enterprise are more likely to invest and innovate and thereby generate additional Schumpeterian rent, an issue we

[9] Equity or fairness issues are major arguments raised against first possession as part of the privatization of fisheries (Bromley 2009, McCay 2010). McCay (2010) is concerned about consolidation in the industry under ITQs and the gradual decline of fishing communities. She advocates community rights or common property. The conditions under which common property regimes function effectively, however, are limited as outlined by Ostrom (1990, 90). Also, ironically, we argue that grandfathering is most likely to assist small, undiversified fishing firms and hence, reduce pressures for consolidation due to lack of access to funding.

[10] The literature on the efficiency advantages of auctions is large (Vickrey 1961, Bulow & Roberts 1989, Dasgupta & Maskin 2000, Milgrom 2004, Klemperer 2004).

[11] For a discussion of the arguments, see Goulder et al. (1997), Parry et al. (1999), Crampton & Kerr (2002), Goulder & Parry (2008, 160−61), and Goulder et al. (2010).

[12] We are only aware of four cases of auctions being used as a primary tool to allocate ITQ rights in fisheries—in certain fisheries in Russia and Estonia in the late 1990s (Vetemaa et al. 2002, Hønneland 2005), in a few small fisheries for squat lobster, yellow prawn, black hack, and orange roughy in southern Chile (Pena-Torres 1997), and in the Washington State Puget Sound geoduck fishery (Huppert 2005). In Russia and Estonia, the outcome of these auctions was found to be unsatisfactory and they were discontinued.

emphasize below. Finally, there is monopoly rent, generated when the asset's supply is artificially reduced in order to raise profits (Tullock 1967). Because monopoly rents are often short term and potentially competed away, they have been termed quasi rents (Klein et al.1978).

Some discussions of rent allocation mechanisms in fisheries appear to be restricted to a static framework and regard rents as a constant (Clark et al. 1989, Morgan 1995). With that perception, resource rents may be seen as a "fortuitous gift of nature" (Bromley 2009, 14) that "can either be taxed away by the government or left in the fishery to be capitalized into the value of the ITQ" without efficiency implications (Clark et al. 1989, 138). Morgan (1995) presents the case for auctions of fishing rights apparently along similar lines, and Bromley goes a step further to say that "the government **should** tax away that excess profit and return it to the owner [the government] of the fish" (Bromley 2009, 15, emphasis added).[13]

We take exception to the presumption that efficiency is invariant to the allocation of rights. Our main reason is that it ignores the dynamic process whereby rents are created. Even the resources that generate Ricardian rents must be discovered, and discovery requires effort. Moreover, rents can be augmented by entrepreneurship and innovation (see Schumpeter1950). Once entrepreneurship is introduced into the production process, Ricardian and Schumpeterian rents cannot be easily separated. They become a return to discovery and exploration, research and innovation, and other investments in the fishery, and not simply a "fortuitous gift of nature." Our contention, therefore, is that taxing away resource rents reduces the incentives for and raises the costs of activities that discover and create rents.

These negative effects are likely to be most important for more efficient, inframarginal fishers who apply their superior fishing, management skills, and knowledge to innovative actions that raise industry-wide rents. The prospect of obtaining and retaining these rents motivates producers to improve the productivity of the resource, to find lower-cost production methods, and to fund these activities.

Grandfathering rights thus increases the incentive for innovative discovery and investment by fishers and increases rents in three ways, all of which are less likely if rents are expropriated by government via lump sum taxes or auction. First, it

[13] Curiously, in these arguments, little attention is paid to how the rents collected by the government might be distributed. Volden & Wiseman (2007), for example, discuss the political obstacles in the legislative process to using government funds to provide public goods, rather than rewarding special interests in the legislative process. See also Grafton et al. (2009) for a response to Bromley.

generates higher private returns through generation of better information about the fishery, investments in human and physical capital, new marketing efforts, and investments to increase fish stocks.

Second, secure property rights to fishery rents reduce the cost of internal capital finance. Rent retention not only rewards past investment decisions, it signals the opportunity for similar benefits from future wealth-increasing actions. Risky new investments by entrepreneurial actors are difficult to finance in impersonal capital markets and therefore often must be funded internally by retained earnings or other informal sources. Evans & Jovanovic (1989) examine the role of liquidity constraints on entrepreneurial behavior and conclude that capital markets provide too little capital to entrepreneurs because of asymmetric information, moral hazard, and adverse selection problems. This means entrepreneurs must finance themselves and bear the risk of failure.[14]

Like retained earnings in other enterprises, retained fishery rents provide a source of self-financing. All firms rely on internal financing, but risky new activities in particular, depend upon such sources (Myers & Majluf 1984).[15] The expropriation of retained earnings by any means increases firm-specific risk because of reduced funds and the greater likelihood of negative earnings outcomes. This increased risk raises the cost of external financial capital. This impact is felt more by small undiversified firms which are very common in fisheries, than by large diversified companies.

The third dynamic effect of grandfathering rights is that it encourages fishers to undertake collective action.[16] Johnson (1995, 337) notes that a quota system "provides incentives for the industry to act collectively to lower costs and to engage in activities such as product development and fishery management that have the potential to increase quota value." Pooling information on resource availability increases collective rents by reducing search costs. Cooperation to invest in technology dependent on economies of scale is more likely if the returns on such

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[14] Evans & Jovanovic develop a static model of entrepreneurial investment and test it against National Longitudinal Survey of young men over the period 1966−1981. They estimate the probability of entering into self-employment as a function of assets and other variables. They find strong support for liquidity constraints on new startups.

[15] There appears to be a "pecking order" theory of corporate finance that says that corporations first use retained earnings, then debt (senior claims on the firm have lower asymmetric information costs), and then equity when debt capacity is exhausted (Myers & Majluf 1984).

[16] Deacon et al. (2008, 2010) document such collective action in the Alaska salmon fishery. See also Arnason (2009).

investments cannot be competed away by unrestricted entry or expropriated by taxation. Again quoting Johnson (1995, 337) "because the identities of the participants are known, organizational costs are lower than in an open access setting." Creating collective rents requires undertaking coordination costs for which there is only a return once rights are established. Obviously, these group investments are risky with highly uncertain returns so that standard capital markets are less likely to provide funding. Extracting resource rents not only reduces incentives for coordinated investment, but reduces the ability of participants to support such actions.

The negative effects on all three types of rent creation are greater if there are repeated actions by government to extract the rents through new taxation or repeated auctions as new rents are generated. As fishers anticipate this, their incentives and funding abilities are reduced, and the rent-generating process is curtailed.

V. A Formal Model of Rent Retention

In this section, we formalize some of the arguments for grandfathering described above. Due to limitations of space, we restrict the analysis to the impact of rent expropriation on the financial costs of investments. We compare grandfathering to a once-and-for-all auction because it creates the least distortion (Arnason 2007a). The analysis proceeds in three step steps. First, we establish that auctions reduce the wealth of the successful bidders. Second, we argue that reduced wealth will lead to higher costs of financial capital to the company. Third, we show that higher capital costs will lead to less investment in research and development and, therefore, lower resource rents in the future.

Consider a company with resource use rights. Let the maximum present value of the profits function of this company at resource level $x(0)$ and efficiency level $\phi(0)$ be $V(x(0),\phi(0))$. Thus, before the auction, the wealth of this company is $V(x(0),\phi(0))$ plus any other net assets the company may own, say w. We represent initial wealth by:

$$W(0)= V(x(0),\phi(0))+w.$$

Let the auction price be A. Then, following the auction, the wealth of the

company is:

$W(1)=W(0)-A.$

Note that if the auction is truly competitive, $A \approx V(x(0),\phi(0))$ so $W(1) \approx w$.

Now, let us assume that perfect capital markets are accessible to this company. In these markets, the company will be faced with financial capital prices. The prices at which it can borrow depend, among other things, on the default risk associated with the company perceived by potential lenders (Merton 1974). Clearly, *ceteris paribus*, this risk is a declining function of the company's wealth—higher wealth implies greater ability to pay if things go wrong and, besides, offers a wider scope of marketable collateral. Thus, other things being equal, the wealthier the company, the lower is its cost of capital.

Let the profit function (on a cash-flow basis) of the company at a point of time, *t*, be:

$$\pi(t) = \phi(t) \cdot \Pi(q(t), x(t)) - C(i(t), W(t)) .$$

The function $\Pi(q(t), x(t))$ is the company's base profit function with $q(t)$ denoting harvest and $x(t)$ biomass. This function is the typical profit function in fisheries economic analysis (Clark & Munro 1975, Anderson 1986). The technical coefficient, $\phi(t)$, standard in dynamic production analysis, represents productivity due inter alia to R&D (research and development) (Solow 1957). This coefficient shifts the profit function over time just as a neutral technical progress would shift the production function. Non-neutral technical impacts on the profit function are, of course, possible but add nothing material to this analysis. Note that the technical coefficient in the current context is a wider concept than in standard production theory. It represents anything that shifts the profit function, including marketing development, management improvements, organization changes, and so on.

The function $C(i(t), W(t))$ represents the cost of R&D with $i(t)$ denoting investment in R&D and $W(t)$ the company's wealth. In accordance with the discussion above, we assume that both the cost and the marginal cost of R&D falls with the company's wealth, i.e., C_W, $C_{iW}<0$.

Note that this profit function contains two state variables, $x(t)$ and $\phi(t)$ and two control (decision) variables $q(t)$ and $i(t)$ determining the evolution of the state variables over time. In order to simplify the presentation we will, in what follows, restrict our attention to the technical coefficient and its evolution in discrete time.

In discrete time, let the change in the technical coefficient be:

(1) $$\phi(t+1) = \phi(t) + F(i(t)),$$

where the function $F(i(t))$ determines how investments in R&D modify the technical coefficient. Presumably, this function is increasing in investments, and we assume that this increase is diminishing with the level of investments, i.e., that the function is concave.

Write the maximum value function (present value of profits) at time zero as:

$$V(x(0),\phi(0)) = \pi(0) + \delta \cdot \pi(1) + \delta^2 \cdot V(x(2),\phi(2)),$$

where $\delta = \frac{1}{1+r}$ is the company's discount factor.

Consider initial time t=0. At this time, the firm is faced with deciding on investment in R&D and harvest. To focus on the investment decision, assume the path of harvests $\{q\}$ is somehow exogenous, e.g., due to a harvest quota system. Thus, the path of base profits, $\{\Pi(q(t),x(t))\}$, is given too. At time t=0, the optimal choice of investment in R&D is given by:

(2) $$C_{i(0)}(i(0),W(0)) = \delta \cdot F_{i(0)}(i(0)) \cdot \Pi(q(1),x(1)) + \delta^2 \cdot V_{\phi(2)}(x(2),\phi(2)) \cdot \frac{\partial \phi(2)}{\partial i(0)}.$$

By repeated substitutions into (2), we find:

(3) $$C_{i(0)}(i(0),W(0)) = F_{i(0)}(i(0)) \cdot \sum_{t=1}^{\infty} \delta^t \cdot \Pi(q(t),x(t)).$$

For equilibrium base profits (i.e., equilibrium harvest and biomass), $\overline{\pi}$, condition (3) reduces to

(4) $$C_{i(0)}(i(0),W(0)) = F_{i(0)}(i(0)) \cdot \frac{\overline{\pi}}{r}.$$

Differentiating (3) or (4) with respect to initial wealth shows that investment in R&D increases as initial wealth increases. More precisely, from (3) we find:

(5) $$\frac{\partial i(0)}{\partial W(0)} = \frac{-C_{iw}}{C_{ii}(i(0),W(0)) - F_{ii}(i(0)) \cdot \sum_{t=1}^{\infty} \delta^t \cdot \Pi(q(t),x(t))}$$

And from (4)

(6) $$\frac{\partial i(0)}{\partial W(0)} = \frac{-C_{iw}}{C_{ii}(i(0),W(0)) - F_{ii}(i(0)) \cdot \bar{\pi}/r}$$

On the assumptions made (C_{ii}, $C_{iw}>0$ and $F_{ii}<0$), both derivatives are unequivocally positive. It immediately follows that reduced company wealth leads to less investments in R&D, and therefore less future rents in the fishery than would otherwise have been the case.

The wealth effect on investments in R&D defined by (5) and (6) operates via the cost of financial capital, i.e., the interest rate demanded by providers of finance who require a higher risk premium from less wealthy companies and vice versa. In addition to this direct effect, it will generally be the case that changes in the interest rate on external finance will affect the company's weighted cost of capital in the same direction and therefore also the discount factor used by the company to calculate the present value of profits (Ross et al. 2008). This further reinforces the above results.

These arguments establish that extraction of rents, by auctions or other means, will reduce company wealth, increase the cost of capital, and generally reduce investment in R&D.

In addition to the effect of reduced wealth at time zero delineated in expressions (5) and (6), the reduced wealth in period one and in future periods will have a similar effect. Thus, there will be an accumulative impact on investments in R&D over time stemming from the initial extraction of rents from the industry.

Note that the marginal impact of wealth on the marginal cost of investments measured by the derivative C_{iw} in expressions (5) and (6) is likely smaller for a large diversified company than for a small specialized fishing company. Thus, by the usual laws of economic competition, auctions of fishing rights will, ceteris paribus, favor the former type of companies and encourage concentration in the industry—an outcome feared by other researchers (McCay 2010).

VI. Empirical Evidence

To test our arguments, we require comparable fisheries with different rights allocation mechanisms. We do not have such data, but there is supportive empirical evidence from several fisheries and from other industries consistent with the hypotheses that follow from our model. Below we provide evidence showing that: 1) fisheries are characterized by small, specialized companies; 2) grandfathering facilitates the continuing existence of smaller, specialized firms that are more able to take advantage of time- and place-specific information and avoid principal-agent problems than are larger companies; 3) grandfathering encourages investment in resource discovery and innovation in extraction; and 4) taxing rents discourages self-financing and reduces expansion, especially in newer industries.

A. Rents Finance and Reward Small, Undiversified Fishing Firms

We argue that rents increase with investments specific to fisheries but that there are asymmetric information problems that raise the cost of obtaining capital in formal markets. Hence we would expect fisheries to be dominated by small, undiversified firms, and this is confirmed by FAO for several fisheries. According to FAO (2007), in 2004, the total number of fishing vessels was approximately 4 million. This means that the average annual catch was just over 20 metric tons, the landed value of which was unlikely to be in excess of US$20,000 on average.[17]

Table 1 shows that the number and average size of decked fishing vessels in a few fishing countries is dominated by relatively small vessels with low engine power. The only exception is Iceland where the average vessels size is almost 200 gross tons (GT). However, the Iceland data, like those for the other countries, ignore a large number (at least 500) of undecked vessels (under 10 GT) which also participate in the fishery on an occasional basis. For the rest of the world, especially developing nations, the average size of vessels is even smaller.[18]

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[17] According to the World Bank & FAO (2009, 9), the average landed price of fish in 2004 was US$ 918 per metric ton.

[18] The data in the Table do not provide direct information about the size of companies—they could conceivably operate a number of vessels. However, it is our belief that the great majority of the world's

Table 1 Characteristics of fishing fleets in selected countries					
	China	South Korea	EU-15	Iceland	Norway
Number of decked vessels	509,717	87,207	85,480	939	8,184
Mean tonnage (GT)	14	8	22	199	48
Mean engine power (kw)	30	192	81	493	162

Source: FAO 2004

The Icelandic decked fishing vessels have been operating under an ITQ system since the 1980s, but have not been subject to auctions of ITQ rights or other significant form of rent expropriation.[19] According to Icelandic Fisheries Directorate data, permanent quota share holdings of all companies in this fishery at the beginning of the 2009−10 fishing season were held by 571 companies and were assigned to less than 700 vessels. Hence, the great majority of companies operated only one vessel. The average size of each company in terms of quota share was less than 0.2 percent. This corresponds to approximately US$1 million in annual turnover. Only three companies held more than 5 percent of the total quota.

The size distribution of Icelandic companies is further described in Table 2. These data show that the Icelandic fishing industry is dominated by small or very small fishing companies.

fishing companies (or concerns) hold only one vessel. Unfortunately, data on fishing companies are not routinely collected by the FAO.

[19] A special fishing fee has been imposed to pay for the cost of management.

Table 2 Size distribution of Icelandic fishing companies	
Share of allocated quota	Number of companies
Less than 0.005%	198
0.005-0.01%	102
0.01-0.02%	67
0.02-0.05%	64
0.05-0.10%	42
0.1-0.15%	20
0.15-0.25%	24
0.25-0.5%	23
0.5-1%	11
1-2.5%	8
2.5-5%	9
5-10%	2
More than 10%	1
Total	571

Source: Icelandic Fisheries Directorate

The California urchin and wetfish fisheries also are characterized by small, undiversified operations. The urchin fishery is very gear- and knowledge-specific. With a mean length of 29 feet and a mean haul capacity of 6,410 pounds, vessels on the North Coast of California make day trips and support specialized dive equipment for the collection of urchins (Scholz et al. 2010). These vessels are too small to support line or net towing, and the human capital associated with urchin diving is not easily transferable to other fisheries. Scholz et al. (2010) also found that the fishermen obtained 100 percent of their income from fishing and 88 percent of that from the urchin fishery.

Similarly, the wetfish fishery uses specific equipment and knowledge that is not readily applied elsewhere. Wetfishing is defined by the practice of offloading the catch directly from vessel holds that are specifically designed to maintain the catch in water or ‘wet’ (California Wetfish Producers Association, n.d.). It includes northern anchovy, jack mackerel, pacific mackerel, pacific sardine, market squid, various tunas (bluefin, skipjack and yellowfin) and pacific bonito (Hackett 2002). Equipment and knowledge are relatively malleable within this list and fishermen do fish multiple species (Pomeroy et al. 2002). The data in Table 3 reveal the relatively small size of vessels in the industry.

Table 3 Characteristics of respondents' vessels in the California wetfish fleet

	MEAN	RANGE
Length (ft)	60.1	19-86
Net Tons	55.4[a]	18-107[a]
Horsepower	357.2	165-750
Market Value of Vessel (US$)	605,469[b]	125,000-1,800,000[b]

Note: N=45, [a] N=44, [b] N=30

Source: Pomeroy et al. (2002).

The evidence in Tables 1, 2, and 3 and other anecdotal evidence showing that many fisheries are dominated by small, undiversified companies is consistent with our hypothesis that such companies generate greater dynamic resource rents. Because fisheries are characterized by pervasive asymmetric information and principal-agent problems, small specialized companies are better at internalizing the value of location-specific fishery information, at monitoring on-board processing and quality control, and at adjusting to marketing.[20] If auctions of fishing rights tilt the balance toward large diversified companies, it follows that fishery rents associated with RBM will be reduced.

[20] One indication of the asymmetric information and principal-agent problems in fisheries is the almost universal practice of remunerating fishing vessel crews with share in the value of the landed catch. A similar argument is made by Allen & Lueck (2002) regarding the pervasiveness of small family farms in the United States despite apparent economies of scale in agriculture.

B. Rents Encourage Investment, Innovation, and Collaboration in Fisheries Management

An example from the New Zealand abalone fishery illustrates investments that are rent-creating under grandfathered ITQs (Anderson & Libecap 2010). Until RBM was implemented in 1986, abalone divers needed only a non-transferable license to harvest in what was otherwise an open-access resource. Under these conditions, they harvested as much as possible and had no incentive to invest in the stock, which was declining due to open access.[21] RBM, however, provided divers with a tradable share in the TAC established by fishery authorities. As a result, quota values rose an order of magnitude in just five years from approximately NZ$33,000 per metric ton in 1988 to NZ$320,000 per metric ton in 1993.

Some of this increase resulted directly from reduced access, but additional returns were due to value-enhancing investments by individual fishers. To achieve these gains, the diving business had to be redefined. Specialized dive boats with support crews for harvesting abalone were introduced. Research into other abalone fisheries, market trends, and processing operations was conducted, and abalone aquaculture was started with the development of an "aqua barrel," a molded polyethylene barrel in which abalone could be planted, grown, and harvested.

For instance, Sea-Right Investments Limited obtained permits for developing a five-hectare marine farm site for abalone pearl culture in Akaroa Harbour, New Zealand, in 1994. The CEO, Roget Beattie described the importance of RBM for the success of his business: "Property rights changed the company from a hunter/gatherer at the ends of the earth to a business launching into the top end of the fine jewelry market in sophisticated world capitals" (Sea-Right Investments Limited, e-mail communication, December 2, 1999).

Another example of investment encouraged by the prospect of retaining rents is drawn from Alaska. Deacon et al. (2008, 2010) describe the effects of a cooperative that operated between 2002 and 2004 in the Chignik sockeye salmon fishery. The fishery had suffered from overexploitation, even though access was limited by regulation of season, licensing, and equipment. In 2002, however, the Alaska Board

[21] There was an indirect limit imposed on the abalone harvest because abalone processors faced a cap on what they would buy due to export quotas. These export quotas were neither property rights nor transferable, however, and so they did nothing to encourage divers to stop the fishery's decline or help the fishery grow.

of Fisheries approved a self-selected cooperative involving between 77 and 87 of the 100 permits in the fishery. Because members of the cooperative shared in the rents created by the cooperative, they had an incentive to undertake the costs of collective action. These cooperative efforts included a) reducing the portion of permits actively fished to between 25−28 percent as compared to 92−100 percent for nonmembers, thus reducing pressure on the fishery; b) coordinating the location of harvest with a focus on lower-cost areas and positioning barriers or "fences" to channel fish so that they could be more effectively caught in nets; c) increasing the fishing season by 48 percent; d) improving fish quality; and e) increasing the quota value and the associated rents by at least 25 percent (Deacon et al. 2010, 20−32).

C. Rents Encourage Franchisee Investment

As we have noted above, all firms rely on internal financing, but risky new activities are particularly dependent upon in-house financing because of asymmetric information and the problem of volatile expected earnings. If franchisers tried to extract all of the Schumpeterian rents from franchisees, not only would they reduce the incentive for innovation, they would increase the cost of capital for innovation. Kaufmann & Lafontaine (1994) report that McDonald's and other franchisers do not extract all (ex ante) rents via their royalties and franchise fees.

Queues for McDonald's franchises suggest that the company is not pricing the franchises so as to capture all of the rents. Instead, the firm leaves some rents available for the initial franchisees as an incentive mechanism for good operations, development of the franchise location, and investment in the overall franchise reputation that also benefits the parent firm. Additionally, McDonald's seeks undiversified, small operators focused on the potential rents from a new franchise. The resulting asymmetric information, however, increases downstream liquidity constraints and raise borrowing costs. Accordingly, franchisees must rely on cash flow resulting from franchise rents.

This practice applies especially for new franchises because they face greater uncertainty and more time- and place-specific information. For subsequent franchise sales, McDonald's retains the right of first refusal, but also allows the franchisee to extract as much of the rents as possible in the sale. By that time, there may be less information asymmetry about the franchise, making capital markets a more likely source of capital.

D. Rents Encourage Discovery and Innovation in U.S. Hard Rock Mining

The U.S. hard rock mining industry in the 19th and early 20th centuries was notoriously risky and initially dominated by small, undiversified exploration and mining firms. Clay & Wright (2010) build on David & Wright (1997) and argue that the U.S. minerals industry was able to develop rapidly because entry into exploration and patenting of mining claims was low cost. Procedures under the Mining Act of 1862 allowed mining companies to retain rents and thereby encouraged exploration, adaptation, and innovation in hard rock mining.

Early efforts to tax mining, beginning in California in 1850 and later with the federal mining law in 1866, were dropped not only at the insistence of the industry, but also because of the arguments of local governments seeking to promote economic development. The federal mining laws of 1866, 1870 and 1872 which still govern today, essentially established free mining discovery and development. [22]

The United States was more thoroughly prospected than other countries such as Mexico, where property rights were less secure and rents were extracted, at least in part, by the state or politicians. Moreover, investment in risky new exploration and extraction techniques in the United States resulted in repeated expansion of economic mineral stocks, even as initial ore grades declined, generating substantial additional economic rents. Further, the innovative, entrepreneurial nature of the U.S. mining industry encouraged the creation of and interaction with mining colleges throughout the country and the development of new mining technologies that added dynamically to the knowledge base. As a result, the United States became the world leader in mining technology and methods for extracting low-quality ores.

E. Taxing Rents Discourages Self-Finance and Economic Growth

In 1983, Ben Bernanke argued that one reason the Great Depression was so long and deep in the United States was the high cost of external financing and the associated negative impact on investment. Calomiris & Hubbard (1995) use manufacturing firm-level data to test Bernanke's claim by examining the effects of the Undistributed Profits Tax of 1936−37 that reduced the availability of in-house funding. Between 1934 and 1939, 98 percent of investment funds of nonfinancial

[22] It is the case that the Mining Law of 1872 is criticized today for the failure to require payments to cover externalities occasioned by mining. These are legitimate payments and not wholesale rent transfers that we caution against here.

companies were supplied internally (Calomiris & Hubbard 1995, 445). The tax, however, changed payout strategies, reducing retained earnings at the firm level and the funds available for innovation.

Taking advantage of differential impacts of the tax and costs of external funds across the firms within their sample, Calomiris & Hubbard find that the tax reduced investment in positive net present value projects. Further, many of the most vulnerable firms with high surtax margins were concentrated in growing industries. The negative effects of the tax were apparent enough that the legislation was repealed as an impediment to the growth of young, dynamic companies—just the kinds that were necessary for expansion and recovery from the Depression.

VII. Conclusion

The adoption of RBM in many fisheries has demonstrated how this approach can mitigate losses from open access. Despite the economic gains from RBM, the mechanism for allocating rights — usually to existing fishers — has been controversial. A major reason is distribution, that the increased value of the rights is for the most part captured by the initial recipients.

Most economists who argue against allocating fishing rights to existing fisheries through grandfathering, implicitly or explicitly assume that another allocation mechanism will have no negative efficiency consequences. This assumption seems to be based on the notion that fisheries rents (and rents from other similar resources) are naturally provided and independent of human action. Therefore, on equity grounds, rents should not accrue to existing parties, who by assumption have done little to earn them. Moreover, these rents can be captured via auctions or lump sum taxes for distribution by governments for public purposes—perhaps to reduce distortive income taxes—with no significant adverse effects.

We contend that these conclusions neglect dynamic investment outcomes that can create and expand rents through discovery, technological advances, coordination, innovation and other investments. Moreover, our theory suggests that firms, especially smaller, undiversified companies, rely upon internal funding to take advantage of information asymmetries and to reduce principal-agent costs. Grandfathering rights increases rents relative to auctions and other mechanisms for extracting rents from RBM in three ways: 1) it retains industry-generated rents within firms, thus providing rewards for rent-enhancing investments; 2) it increases the ability to self-finance besides lowering the cost of external financial capital associated with asymmetric information and principal-agent problems; and 3) it encourages collective action among rights holders that lowers information costs and reduces rent dissipation.

Taking away resource rents, particularly through auctions, which are designed to fully extract them from the fishery, inevitably raises the cost of capital and reduces discovery and innovation. Empirical evidence from some fisheries and other industries supports our argument that rent retention promotes discovery, innovation, collaboration, and self-finance.

We have formulated out arguments mainly in terms of the fishery. However, the same basic arguments appear to apply in other natural resource use. In all cases RBM would improve the economic efficiency of resource use, compared to the alternative, and the secure retention of the resulting rents by the rights-holders would encourage them to discover ways to take further steps for increasing the economic efficiency of the utilization.

More research is needed to test for and measure the importance of rent retention for dynamic efficiency. Until that research is forthcoming, economists do not, in our opinion, have a reasonable basis for suggesting that the efficiency of RBM is invariant to the rights allocation and rent distribution mechanism.

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