**Fisheries, User Rights, and Resource Rent**

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Abstract. Considering commercial *fisheries*, this paper suggests that property rights, or lack thereof, better be replaced by clearly defined *user rights*, widely held and well distributed. By assumption, their effective use is conditional, seasonal, and paid for - or valued - via direct deals or double auctions. Such auctions have efficiency properties akin to those of competitive equilibrium. Hence auctions may serve to restore or secure substantial parts of the *resource rent.* Residual parts will remain though, with fishermen who supply oligopolistic product markets. Thus, the model, developed below, marries a perfect market, in user rights, to a strategic game, in outputs. Broadly, Walrasian exchange of allowances connects to a Cournot oligopoly. This way, complaints about the fairness and legitimacy of outcomes can be reduced to complaints about the distribution, taxation or type of user rights.

*Key words*: Fisheries management, non-cooperative games, user rights, resource rent.

*JEL classification*: C62, C71, D33, D51, Q22.

## 1. Introduction

Consider a coastal nation that controls and determines the total quotas fishermen can catch, within its exclusive waters, during the year. Suppose those quotas be fairly split - up front, according to fixed rules - among numerous legitimate parties. More precisely, suppose many and qualified agents be allotted well defined quota shares.

The shares thus handed out are valuable, short-term allowances to catch specified amounts of various species. I shall call such allowances *user rights.* Those in focus here are *not* property rights, hence neither heritable nor transferable. Yet, suppose licensed fishermen can, for short or medium term, *rent* such rights on competitive markets.

I ask: *might rental arrangements restore and safeguard substantial parts of the resource rent*? Further, *can the distribution of realized rent come out fair and legitimate*?

I shall address these questions, albeit only qualitatively, in the optic of a simplified and stylized game. It unfolds within stable frames, and it features just two types of players: fishermen and holders of user rights.[1] Their interaction is strategic, à la Cournot in output markets, but non-strategic, à la Walras in markets for user rights.

[1] Some might act in both capacities.

Accordingly, the two most classical models of economics are intimately linked here.[2] Their juxtaposition, mediated by user rights, is the main novelty of this paper.

My motivation has two parts. A first relates to competitive exchanges. These are commonly praised for their efficiency properties but often starkly criticized for lack of fairness.[3] Much criticism rightly centers on skewed distributions of initial holdings (endowments) - not on the price-taking mechanism itself. To the extent that competitive markets valuate holdings, they are chiefly consequential or descriptive. No pioneering studies recommended competitive outcomes as normative. I presume that common sense and values - besides history and tradition - broadly indicate which distributions (of user rights) might pass as acceptable, fair and legitimate. On that premise, I take the distribution as given.[4]

Additional motivation, for this paper, stems from the fact that fisheries management offers attractive and common ground to manifold disciplines. Included are the behavioral and social sciences. Gintis [8] stresses that unless those sciences embrace game theory, they will remain compromised or handicapped. He also emphasizes that games evolve. Here though, for simplicity, the frames, institutions and rules stay fixed. Accordingly, no dynamic game - say, on choice of catch quantity or capacity [1], [14] - is played. For the national fisheries I have in mind, such play is precluded by regulation applied to exclusive maritime zones.[5]

Novelties come here by modelling how parts of resource rents might be identified, restored and shared via iterative learning of noncooperative play. The game at hand features rigid restrictions that couple the players to one another.

Arguments are organized as follows. Section 2 prepares the ground and sets the stage for games with coupling constraints. Fisheries provide many challenging instances. Section 3 formalizes an important one within the frames of Cournot and Walras. Broadly, the game unfolds on the basis of stable annual quotas.[6] Players may, however, need time to value user rights. Therefore, Section 4 outlines direct exchange of such items. Section 5 invokes exchange as chief vehicle to model repeated play - and shows how competitive valuations might emerge. Section 6 concludes.

The paper is intended for diverse readers. Included are fisheries managers, game theorists, mathematicians, political scientists, and resource economists. Proofs are relegated to companion papers [4], [5], [6].

**Notations and preliminaries.** All vector spaces mentioned in the sequel are real, finite-dimensional, endowed with customary dot product, associated norm, and stan-

[2] References include [3], [7], [10], [15].

[3] For interesting discussion and references see Chapter 6 on "Utopian capitalism" in Bowles [2].

[4] For instance, total quotas might be shared among coastal counties/communes based on "grandfather" records or proximity to fishing grounds. Rights can hardly remain exclusive, weakly taxed privileges for the permanent and few.

[5] Straddling stocks do not fit the frames of this paper.

[6] For manifold reasons, the quotas vary. So, superimposed on the stage game, played here, are capital or stock dynamics - as well as stochasticity. Extensions along these lines are not considered.

dard componentwise ordering.

A function $f$, from such a space $\mathbb{X}$ into $\mathbb{R} \cup \{-\infty\}$, has a *generalized gradient* $x^*$ *at* $x$, written $x^* \in \frac{\partial}{\partial x} f(x)$, if and only if $f(x)$ is finite *and*

$$f(\chi) - x^* \cdot \chi \leq f(x) - x^* \cdot x \text{ for all } \chi \in \mathbb{X}.$$

The reader may prefer to assume that $f$ be differentiable (in classical sense) at $x$. Then, provided $f$ also be concave, $\frac{\partial}{\partial x} f(x)$ reduces to the ordinary gradient.

At any member $x$ of any subset $X \subseteq \mathbb{X}$ there is an outward *normal cone*

$$N(X, x) := \{x^* \in \mathbb{X} : x^* \cdot (\chi - x) \leq 0 \text{ for all } \chi \in X\}.$$

That cone reduces to the singleton 0 if $x$ is interior to $X$. In the context of constrained optimization, such cones save tedious spelling out of Lagrange multipliers and attending complementarity conditions.

When a non-empty subset $X \subset \mathbb{X}$ is closed convex, the *projection* $\mathcal{P}_X[v]$ finds the *closest approximation* a vector $v \in \mathbb{X}$ has in $X$.

## 2. Noncooperative Games with Coupling Constraints

Fishermen and holders of user rights are tied together by the rigid restriction that individual quotas sum to fixed aggregates. Such coupling constraints are rare in received presentations of noncooperative game theory. Here they are essential. So, while preparing for subsequent arguments, this section briefly considers - in general terms - strategic interaction that works via objectives *and* constraints.

Accommodated throughout is a fixed, finite ensemble $I$ of economic agents. If member $i \in I$ chooses strategy $x_i$, codified as a vector in some space $\mathbb{X}_i$, he gets pecuniary payoff $\pi_i(x_i, x_{-i})$. As usual, $x_{-i} := (x_j)_{j \neq i}$ records the strategy profile chosen by $i'$s rivals.

Choice is subject to coupling constraints in that each strategy profile $x = (x_i)$ must belong to a non-empty, *non-rectangular* subset $X$ of the product space $\mathbb{X} := \Pi_{i \in I} \mathbb{X}_i$. In terms of $\pi(\hat{x}, x) := \sum_{i \in I} \pi_i(\hat{x}_i, x_{-i})$, such a profile $x$ is declared a *normalized Nash equilibrium* - *equilibrium* for short - iff

$$\pi(x, x) = \max \left\{ \sum_{i \in I} \pi_i(\hat{x}_i, x_{-i}) : \hat{x} \in X \right\}.$$

Henceforth suppose the constraint set $X$ be compact convex. Further, overall payoff $\pi(\hat{x}, x)$ is taken to be concave in $\hat{x}$ and jointly continuous in $(\hat{x}, x)$. *Then there exists an equilibrium* [5].

It's convenient to refer to members of the sets

$$M_i(x) := \frac{\partial}{\partial x_i} \pi_i(x_i, x_{-i}) \quad \text{and} \quad M(x) := \frac{\partial}{\partial \hat{x}} \pi(\hat{x}, x) \,|_{\hat{x}=x} = \Pi_{i \in I} M_i(x) \tag{1}$$

as *margins*.[7] While troubled by lack of perfect foresight, agent $i$ ought be motivated by own margins. More precisely, his preference for adaptive behavior - and for better choice - indicates that his strategy ought be modified by non-zero margins, if any. Specifically, as a first proposal, suppose he contemplates to update his strategy $x_i$ as follows:

$$x_i^{+1} = x_i + sx_i^*, \quad \text{for some margin} \quad x_i^* \in M_i(x). \tag{2}$$

The parameter $s \geq 0$ is a *step-size* that reflects his responsiveness to payoff margins.

However, if all players do likewise, such updating could push them outside $X$. To preclude this, the profile of tentatively updated choices (2) must be bent by projection $\mathcal{P}_X$ onto $X$. Thus, $i'$s "first proposal" (2) motivates his part of the system

$$x^{+1} \in \mathcal{P}_X[x + sM(x)]. \tag{3}$$

But the said concern with feasibility brings up another serious query: *how could non-coordinated agents coordinate on the joint projection in* (3)?

A reader, mainly attracted to equilibrium *existence* and *properties*, might want to sidestep this query. The paper is though, much concerned with equilibrium *attainment* and *stability*. Accordingly, projection (3) is largely circumvented. In fact, subsequent arguments show that the players can do without any "logic of collective actions" [16]. Thereby they restore the predominantly noncooperative nature of their behavior.

## 3. Fishery Games à la Cournot-Walras

From here onwards, the player ensemble $I$ comprises licensed fishermen as well as qualified holders of user rights.

By assumption, an independent scientific body, concerned with bioeconomics and long-term management, determines (annual or seasonal) *aggregate* catch quotas from diverse fish stocks.[8] Taken together, those quotas are codified (and stacked) as a commonly observable vector $e_I$.

Also by assumption, clear and stable rules split that total take $e_I$ among legitimate stakeholders. Member $i \in I$ gets a definite share $e_i$. What many agents thus receive are only short-term, non-heritable *user rights*. I presume they are handed out and renewed - say, annually or periodically - for free.[9]

Suppose many small holders - namely those who neither have capacity nor competence to exercise their user rights themselves - put them up for rent, fully or partly, at various auction platforms [13]. Active fishermen bid for them at such venues.[10] What emerges thereby is a strategic game. The solution concept, defined next, blends

[7] By standing assumption, $M(x)$ *is non-empty and bounded at each point* $x \in X$.

[8] Other agencies ought control compliance and penalize violations.

[9] Alternatively, to tax use of common resources, a public body could sell short-term rights via first-price open bidding. Such an arrangement could fit a desire to distribute rent across all citizens. It appears, however, less efficient in fostering widespread appreciation of potential rent.

[10] Modern versions of such platforms are computerized and accessible via internet.

Cournot-Nash equilibrium with that of Walras.

**Formalization of the game**. The strategy $x_i = (y_i, z_i)$ of player $i \in I$ has two components. The first, $y_i$, which only applies if he is a fisherman, incorporates his activity plan, chosen without any concern for overall efficiency or cooperation. The second component, $z_i$ is construed as his user right - alias his allowance to catch specified amounts of various fish stocks.

As customary, individual choice is constrained: $x_i = (y_i, z_i)$ must belong to $X_i := Y_i \times Z_i$ where $Y_i$, $Z_i$ are non-empty compact convex subsets of vector spaces $\mathbb{Y}_i$, $\mathbb{Z}$ respectively. Both sets $Y_i$, $Z_i$ have non-empty interior. To avoid specific mention of inessential or evident details (for instance non-negativity of many decision variables) none of these sets are described any further.

Besides individual restrictions, there is the *collective coupling constraint* that

$$\sum_{i \in I} z_i \leq \sum_{i \in I} e_i =: e_I,$$

$e_i \in Z_i$ being the *endowment* - alias *user right* - initially handed out to agent $i$. He decides, by way of market operations, to acquire or hold right $z_i$.

Upon choosing activity $y_i \in Y_i$, in face of the profile $y_{-i}$ chosen by rival fishermen, agent $i$ takes home *payoff* $\pi_i(y_i, y_{-i}, z_i)$. Where well defined, his payoff function $\pi_i$ is assumed jointly continuous in $(y_i, y_{-i}, z_i)$ and concave in own decision $(y_i, z_i)$.

With reference to the preceding section, posit $x_i = (y_i, z_i)$, $\mathbb{X}_i := \mathbb{Y}_i \times \mathbb{Z}$ and $\pi_i(x_i, x_{-i}) = \pi_i(y_i, y_{-i}, z_i)$ to have play occur in the "coupled" set

$$X := \left\{ x = (x_i) = (y_i, z_i)_{i \in I} : y_i \in Y_i,\ z_i \in Z_i \text{ and } \sum_{i \in I} z_i = e_I \right\}.$$

As announced, the solution concept is a mixed one, embodying features found in the equilibria of Cournot/Nash on one side and of Walras on the other. It features an endogenous competitive price vector which valuates user rights.

**Definition** (Cournot-Nash-Walras equilibrium). *A strategy profile* $(x_i) \in X$ *alongside a price vector* $p \in \mathbb{Z}$, *constitutes an* ***equilibrium*** *if no player* $i$ *regrets his choice* $x_i = (y_i, z_i)$. *That is,*

$$\pi_i(y_i, y_{-i}, z_i) - p \cdot z_i = \max \left\{ \pi_i(\hat{y}_i, y_{-i}, \hat{z}_i) - p \cdot \hat{z}_i : \hat{y}_i \in Y_i,\ \hat{z}_i \in Z_i \right\} \tag{4}$$

*for each* $i \in I$, *and all markets for user rights clear in that*

$$p \geq 0, \quad \sum_{i \in I} z_i \leq \sum_{i \in I} e_i, \quad \text{and} \quad p \cdot \sum_{i \in I} z_i = p \cdot \sum_{i \in I} e_i. \tag{5}$$

This solution concept is indeed of *Cournot-Nash* type because $(y_i)$ must qualify as a non-cooperative equilibrium profile provided $(z_i)$ already be given. Similarly, the same concept incorporates a *Walrasian* feature because, for given activity profile $(y_i)$, the allocation $(z_i)$ of user rights becomes a competitive equilibrium under price $p$.

A holder $i$ of just user right $e_i$ and no vessel - that is, one who cannot or will not fish - has $\pi_i \equiv 0$. He cashes in pure *user rent* $p \cdot e_i$. In contrast, besides any such rent, an active fisherman $i$ takes home additional profit

$$\max \{\pi_i(\hat{y}_i, y_{-i}, \hat{z}_i) - p \cdot \hat{z}_i : \hat{y}_i \in Y_i,\ \hat{z}_i \in Z_i\}.$$

The sum $\sum_{i \in I} p \cdot e_i = p \cdot e_I$ equals the aggregate realized resource rent. Fishermen might maintain additional rent via imperfect (Cournot type) competition in product markets. In short, rent doesn't totally dissipate; it's partly realized, widely distributed and - most likely, if not fully taxed - somewhat enjoyed.

**Remark** (*on property versus user rights*). I have not precluded that some quotas $e_i, i \in I$, derive from *long-term property rights.* To value these - and maybe tax them - it appears important that *short-term user rights* be traded on well functioning markets. Concerns with efficiency and fairness also speak for such markets. $\Diamond$

Equilibrium is best characterized in differential terms. For succinct statement, recall that $x_i = (y_i, z_i)$, $\pi_i(x_i, y_{-i}) = \pi_i(y_i, y_{-i}, z_i)$, and $X_i = Y_i \times Z_i$.

**Proposition 3.1** (on agent's best choice) *Optimality condition* (4) *holds if and only if*

$$\frac{\partial}{\partial x_i}\pi_i(x_i, y_{-i}) - (0, p) \in N(X_i, x_i). \quad \Box \tag{6}$$

**Remark** (*on differentiable data*). For simplicity and interpretation, one could suppose $\pi_i(\cdot, y_{-i})$ continuously differentiable at $x_i$, and take this point as interior to $X_i$. Then, (6) is satisfied if

$$\frac{\partial}{\partial y_i}\pi_i(y_i, y_{-i}, z_i) = 0 \text{ and } \frac{\partial}{\partial z_i}\pi_i(y_i, y_{-i}, z_i) = p.$$

In general though, boundary choice, or lack of smoothness, shouldn't be ignored, For example, consider a payoff function

$$\pi_i(y_i, y_{-i}, z_i) := \max \{c_i(y_{-i}) \cdot y_i : y_i \geq 0 \text{ and } A_i(y_{-i})y_i \leq z_i\},$$

which emerges - as optimal value - from an underlying linear program. Then, extreme solutions aren't exceptional; they rather become the rule. And the value isn't always differentiable or finite. $\Diamond$

Can *the agents themselves solve system* (4), (5)? The subsequent two sections take up this question. Together, they provide constructive and positive answers.

## 4. Bilateral Exchange of User Rights

Consider two holders $i, j$ of user rights $z_i \in Z_i$ and $z_j \in Z_j$ respectively. If these agents exchange parts of such rights, then, with no loss of generality, their updated holdings take the form

$$z_i^{+1} := z_i + sd \in Z_i \quad \text{and} \quad z_j^{+1} := z_j - sd \in Z_j \tag{7}$$

where $s \geq 0$ is a *step* taken along some bounded direction $d \in \mathbb{Z}$. The first inclusion in (7) implies that $d$ belongs to agent $i$'s *cone of feasible directions*:

$$D_i(z_i) := \{r(\hat{z}_i - z_i) : r \geq 0 \text{ and } \hat{z}_i \in Z_i\}.$$

Likewise, the second inclusion in (7) tells that $-d \in D_j(z_j)$. Hence, for the feasibility of exchange, it's necessary that

$$d \in D_{ij}(z_i, z_j) := D_i(z_i) \cap -D_j(z_j).$$

Which directions in $D_{ij}(z_i, z_j)$ are desirable? To address that question, call any vector

$$p_i = z_i^* - n_i \text{ with } z_i^* \in \frac{\partial}{\partial z_i}\pi_i(y_i, y_{-i}, z_i) \text{ and } n_i \in N(Z_i, z_i) \tag{8}$$

a *personal price* applied, by agent $i$, to valuate user rights at $(y_i, y_{-i}, z_i)$. Since $(y_i, y_{-i})$ is fixed here, temporarily let $\Pi_i(z_i) := \pi_i(y_i, y_{-i}, z_i)$ and, in view of (8), posit

$$p_i \in P_i(z_i) := \frac{\partial}{\partial z_i}\Pi_i(z_i) - N(Z_i, z_i). \tag{9}$$

**Proposition 4.1** (on bilateral exchange [4]). *When agents $i, j$ hold respective user rights $z_i \in Z_i$ and $z_j \in Z_j$, they* ***cannot*** *make a proper exchange in case the cone of feasible directions is degenerate, meaning $D_{ij}(z_i, z_j) = \{0\}$. They* ***ought not*** *make any exchange if $p_i = p_j$ for some prices $p_i \in P_i(z_i)$, $p_j \in P_j(z_j)$. The reason is that* (7) *and* (9) *then yield $\Pi_i(z_i^{+1}) + \Pi_j(z_j^{+1}) \leq \Pi_i(z_i) + \Pi_j(z_j)$.* □

The upshot is that $i$ and $j$ ought exchange user rights only when their valuations of such items differ - that is, when $P_i(z_i)$ (9) does *not* intersect $P_j(z_j)$. On such an occasion, it appears reasonable that a transfer, to $i$ from $j$, be aligned with the price difference

$$d = p_i - p_j \text{ where } p_i \in P_i(z_i) \text{ and } p_j \in P_j(z_j). \tag{10}$$

To appreciate this suggestion, suppose, just here, that $\Pi_i$ be differentiable at $z_i \in intZ_i$ - and similarly for agent $j$. Then,

$$d = \Pi_i'(z_i) - \Pi_j'(z_j).$$

That is, user rights are reallocated towards the party who actually prices them higher. To argue analytically for format (10), note that the joint payoff $\Pi_i + \Pi_j$ has *steepest slope*

$$\mathfrak{S}_{ij}(z_i, z_j) := \max\left\{\Pi_i'(z_i; d) + \Pi_j'(z_j; -d) : d \in D_{ij}(z_i, z_j) \ \& \ \|d\| \leq 1\right\}, \tag{11}$$

$\Pi_i'(z_i; d)$ denoting the standard directional derivative. Let $\mathcal{P}_{ij}$ be the orthogonal projection (in the space $\mathbb{Z}$ of user rights) onto the closure $T_{ij}(z_i, z_j)$ of the cone $D_{ij}(z_i, z_j)$.

**Proposition 4.2** (on steepest payoff slope and minimal deviation of margins [4]). *The steepest slope* (11) *equals*

$$\begin{aligned} \mathfrak{S}_{ij}(z_i, z_j) &= \min\left\{\left\|\mathcal{P}_{ij}\left[z_i^* - z_j^*\right]\right\| : z_i^* \in \partial\Pi_i(z_i),\ z_j^* \in \partial\Pi_j(z_j)\right\} \\ &= \min\left\{\|p_i - p_j\| : p_i \in P_i(z_i),\ p_j \in P_j(z_j)\right\}. \ \square \end{aligned}$$

**Remark** (*on value added*). Admittedly, it's neither fully convincing nor quite practical that agents $i, j$ always secure their steepest payoff slope. More realistically, they could contend with achieving a fraction $\varphi_{ij}$ of the said slope. Accordingly, say they make a *real transfer* if (7) holds with

$$\text{valued added} \quad := \Pi_i(z_i^{+1}) + \Pi_j(z_j^{+1}) - \Pi_i(z_i) - \Pi_j(z_j) \geq \varphi_{ij} s \mathfrak{S}_{ij}(z_i, z_j) > 0. \quad (12)$$

**Proposition 4.3** (on real transfers [4]). *Whenever* $(z_i, z_j) \in Z_i \times Z_j$ *and* $\mathfrak{S}_{ij}(z_i, z_j) > 0$, *agents* $i, j$ *may indeed make a real transfer. Then, the two inequalities*

$$\Pi_i(z_i^{+1}) + \mu_i > \Pi_i(z_i) \quad \text{and} \quad \Pi_j(z_j^{+1}) + \mu_j > \Pi_j(z_j)$$

*are solvable with monetary side-payments* $\mu_i$, $\mu_j$ *that sum to zero.* $\square$

Who gets how much of value added (12) is a matter of bargaining [17], not modelled here.

## 5. Repeated Play and Convergence to Equilibrium

This section explores one avenue that could lead agents towards equilibrium.

For motivation, return to agent $i$'s first proposal (2). When he sees "state" $(y_i, y_{-i}, z_i)$, any of his margins

$$x_i^* = (y_i^*, z_i^*) \in \frac{\partial \pi_i(y_i, y_{-i}, z_i)}{\partial(y_i, z_i)} \quad (13)$$

has a first component $y_i^*$ in activity - and a second $z_i^*$ in user right. His adjustment of own activity requires no coordination; it's a matter of discretion. Accordingly, in the spirit of (2), suppose his *update of own activity* $y_i$ takes the form

$$y_i^{+1} = \mathcal{P}_{Y_i}[y_i + csy_i^*], \quad (14)$$

where $c > 0$ is some constant, $s \geq 0$ is the actual step-size, and $y_i^*$ was already chosen in (13).

*Updates of user rights* were described in the preceding section. By assumption, only two agents - say, $i$ and $j$ - change these at any stage. Their novel holdings comply with (7) and (10).

**Repeated play** is now modelled as a discrete-time process - in the nature of an algorithm:

• *Start* at choices $(y_i, z_i) \in Y_i \times Z_i$ such that $\sum_{i \in I} z_i = \sum_{i \in I} e_i$ For example, let $z_i = e_i$.
• *Update activities* of everybody by the rule (14).
• *Randomly select two agents* $i, j$ with uniform probabilities. *Update their holdings* of user rights by (7) and (10).
• *Return* to *Update activities.*
• *Continue* until convergence. $\Diamond$

**Remark** (*on two time scales*). As formalized, repeated play invokes two different "clocks." One regulates activity updates; it ticks for *every* agent at each stage. The other clock, which regulates the updating of user rights, ticks for just two agents at any stage. The scaling factor $c$ in (14) brings the two adjustment processes to run with comparable velocities. $\Diamond$

For convergence equilibrium $\bar{x}$ is supposed *asymptotically stable* [5] - hence unique - in that

$$\bar{x} \neq x \in X \Longrightarrow \max \{m \cdot (x - \bar{x}) : m \in M(x)\} < 0. \qquad (15)$$

**Theorem 5.1** (on convergence of non-coordinated play). *Suppose repeated play among* $n := \#I$ *parties, as modelled above, proceeds at discrete stages* $k = 0, 1, ...$ *with step-sizes* $s_k \geq 0$, *chosen, on line, by the agents themselves, such that*

$$\sum_{k=0}^{\infty} s_k = +\infty \quad \text{and} \quad \sum_{k=0}^{\infty} s_k^2 < +\infty. \qquad (16)$$

*Then, under asymptotic stability* (15) *and* $c = 4/(n-1)$, *the generated sequence* $k \mapsto x^k$ *converges to the unique equilibrium.* $\Box$

**Corollary 5.2** (on common pricing of user rights). *Besides the hypotheses in Theorem 5.1 suppose equilibrium is such that some agent* $i$ *has* $z_i \in intZ_i$ *and* $\pi_i(y_i, y_{-i}, \cdot)$ *differentiable at* $z_i$. *Then there is a unique equilibrium price in the market for user rights.*

## 6. CONCLUDING REMARKS

Fisheries management brings up at least *three* blocks of coupled concerns [18]:
*First*, to "get institutions right", which roles ought be given to - and best played by - community, market or state?
*Second*, can efficiency balance or comply well with fairness and legitimacy?
*Third,* in metaphorical terms - regarding *"the logic of collective action"* [16], *"the*

*prisoner's¨dilemma*" [17] or *"the tragedy of the commons*" [11], [12] - may prudent management block utterly dismal outcomes?

Broadly, while taking middle ground, I have indicated that:
* rules better divide competencies among community, market and state;
* user rights - fairly and thinly distributed among legitimate parties - better replace ever-lasting property rights;
* the received metaphors better not remain chief issues. Indeed, *collective action* is rare among parties who have more of opposed than of common interest. Strategic *dilemmas* are attenuated by shifting them towards weakly coupled output markets. And finally, proper resource management precludes *tragedies of the commons*.

In short, upon replacing nobody's property rights with somebody's user right, a rental market for such items might - via fair sharing - enhance efficiency and meet with common acceptance.

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