Effect of Grandfathering Quotas on Instituting Regulatory Change: Lessons from Fisheries Economics

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A Tale of Two Regulatory Efforts

- Fisheries:
  - Individual Tradable Quotas (ITQs) have been *successfully* instituted in many important fisheries (Pacific halibut, Iceland, New Zealand)
- Pollution Regulation:
  - Tradeable Emission Permits (TEPs) have mostly been a *failure* (SO_2, Kyoto)

Why the difference?

- How quotas are allocated: the role of Grandfathering
- Heterogeneity of producers

Grandfathering

Grandfathering Definition

- "A legal term used to describe a situation in which an old rule continues to apply to some existing situations, while a new rule will apply to all future situations."
- ITQs and TEP: *Grandfathering quotas/permits implies permits are allocated for free to existing producers*

Grandfathering & the "Double Dividend" Hypothesis

The "Double Dividend" Argument for Taxing/Auctioning Quotas

- First dividend: Fixes the environmental problem
- Second dividend: Reduce cost of other inefficient taxes
  - Quota prices are economic rents: No efficiency cost of taxing rents!
  - Taxes elsewhere (income, sales, etc.) are distortionary
- Tax or auction permits; do not grandfather permits

Table: Grandfathering Costs for Kyoto & SO_2

Program	Method	Annual Cost (Billion $)	Annual Benefits (Billion $)	Net Benefits (Billion $)	Grandfathering Costs (Billion $)
Kyoto	Grandfathering	55	45	-10	20-45
	Auction/Taxes	10-35	45	10-35	
50% ↓ in SO_2	Grandfathering	1.7	10	8.3	0.5
	Auction/Taxes	1.2	10	8.8	

Source: Burtraw et al. (1998 CEP), Goulder et al. (1997 Rand), Parry et al. (1999 JEEM), Parry (2002 RFF)

Double-Dividend Potential in Fisheries

Pacific Halibut in 2010:

- 40 million pounds harvested
- Quota rental price $3-4/pound, sales price $35-40/pound
- Grandfathering costs $120-160 million/year or $1.2-1.6 billion in present value

Outline of talk

- Model In-Season Regulated Open Access Equilibrium
  - Total Allowable Catch Constraint: $Q = TNh$
  - TAC enforced by season closure, $T = Q/Nh$
  - Each fisher chooses harvest rate h to maximize profits
  - Free Entry with heterogeneous fishers: $\pi(N) \geq 0$.
- Model In-Season ITQ Equilibrium
  - Total Allowable Catch Constraint: $Q = TNh$
  - Tradable quotas with market price m
  - Share s of quotas allocated by grandfathering, $1 - s$ by auction
  - Each fisher chooses h & T to maximize profits
  - Free Entry/Exiting with heterogeneous fishers: $\pi(N) \geq 0$.
- Analyze the Effect of the Grandfathering Share, s
  - Efficiency Effects within fishery
  - Efficiency Effects overall: "double-dividend"
  - Political Economy: Wicksellian unanimity; median voter
- Effect of Grandfathering on Tradeable Emissions Permit Markets
- Conclusions

Model Assumptions

In-season fishery model: Clark (1980 CJFAS), Boyce (2004 JEEM)

- TAC Constraint:

$$Q = T \sum_{n=1}^{N} h_n$$

- Season Length Constraint (in years)

$$T \leq \bar{T} \equiv 1$$

- Participation Constraint

$$\pi(n) = T[ph_n - c(h_n)] - w(n) \geq 0, \qquad n = 1, \ldots, N$$

  - $c(h)$: increasing & convex in harvest rate, h: $c'(h) > c(h)/h$
  - $w(N)$: non-decreasing in number of fishers, N

Feasible N-h Combinations

Assume that each fisher chooses the same h and that the TAC constraint binds:

$$T = Q/Nh$$

Then,

- Season Length Constraint:

$$T = \frac{Q}{Nh} \leq \bar{T} \qquad \text{implies} \qquad N \geq \frac{Q}{\bar{T}h}$$

  (an asymptotic hyperbola)

- Participation Constraint:

$$\frac{Q}{Nh}[ph - c(h)] \geq w(N) \qquad \text{implies} \qquad w(N)N \leq Q\left[p - \frac{c(h)}{h}\right]$$

  ($p = c(h)/h$ implies $N = 0$, and $h = 0$ implies $w(N)N \leq Q[p - AC(0)]$)

The Feasible Region

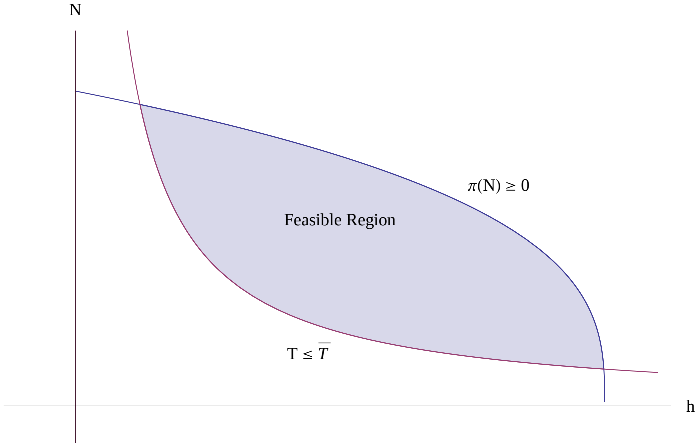

Figure: The Feasible Region is bounded by Participation Constraint & Season Length Constraint

Regulated Open Access Equilibrium

- Regulated Open Access Equilibrium

$$\begin{aligned} \text{Harvest Choice:} \quad & p = c'(h_{OA}), \qquad n = 1, \ldots, N_{OA} \\ \text{Free entry:} \quad & T_{OA}[ph_{OA} - c(h_{OA})] - w(N_{OA}) = 0 \\ \text{TAC Constraint:} \quad & T_{OA} = Q/N_{OA}h_{OA}. \end{aligned}$$

- Rents under regulated open access:

$$\begin{aligned} R_{OA} &= \text{Rents to Fishery} + \text{Inframarginal Rents} \\ &= \quad 0 \quad + \quad \int_0^{N_{OA}} [w(N_{OA}) - w(n)] \, \mathrm{d}n \end{aligned}$$

The Open Access Equilibrium

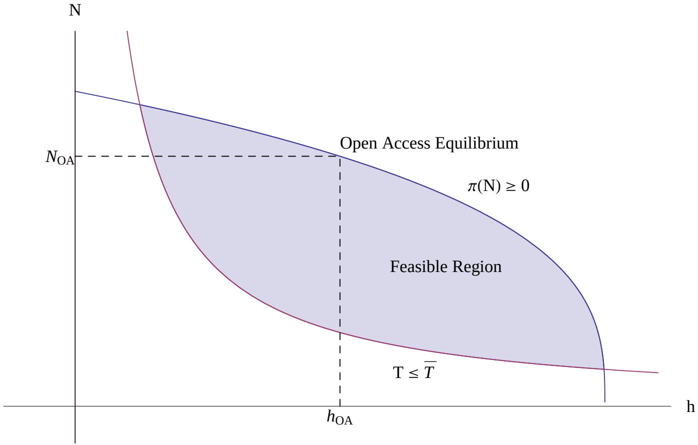

Figure: The Open Access Equilibrium occurs on the $\pi(N_{OA}) = 0$ locus and has with $T_{OA} < \bar{T}$

Inframarginal Rents under Regulated Open Access

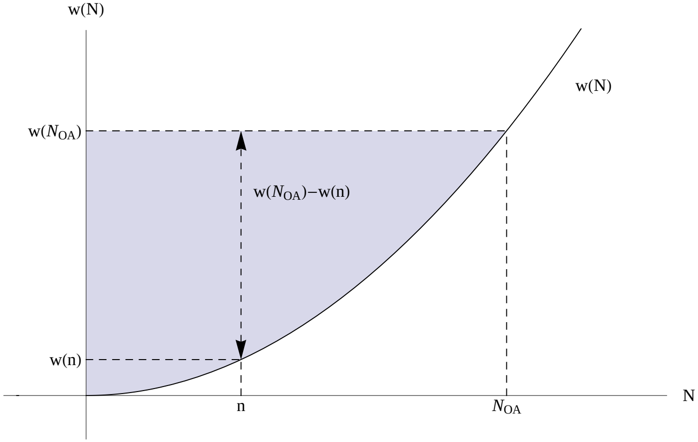

Figure: Inframarginal Rents under Regulated Open Access

ITQs and Grandfathering

- Grandfathering: share $s \in [0,1]$ of Q is grandfathered:

$$\text{Per Fisher Quota Allocation:} \qquad z(s) = \frac{sQ}{N_{OA}}$$

- Profit to a fisher facing quota price m and given quota allocation $z(s)$:

$$\pi(n) = \begin{cases} T\left\{[p-m]h_n - c(h_n)\right\} - w(n) + mz(s) & \text{if active} \\ mz(s) & \text{if inactive} \end{cases}$$

- Quota price clears quota market

$$\underbrace{N_{OA}z(s)}_{\text{Grandfathered}} + \underbrace{(1-s)Q}_{\text{Auctioned}} = T\sum_{n=1}^{N} h_n$$

Effect of s on the ITQ Equilibrium

Individual Transferrable Quota Equilibrium

$$\begin{aligned}
\text{Harvest:} \quad & p - m_{ITQ} = c'(h_{ITQ}) \\
\text{Season Length:} \quad & \frac{d\pi}{dT} = \{[p - m_{ITQ}]h_{ITQ} - c(h_{ITQ})\} > 0 \implies T_{ITQ} = \bar{T} \\
\text{Free Entry:} \quad & \bar{T}\{[p - m_{ITQ}]h_{ITQ} - c(h_{ITQ})\} - w(N_{ITQ}) + m_{ITQ}z(s) = m_{ITQ}z(s) \\
\text{Quota Market:} \quad & Q = N_{ITQ}T_{ITQ}h_{ITQ}
\end{aligned}$$

Proposition

The ITQ equilibrium, $\{N_{ITQ}, T_{ITQ}, h_{ITQ}, m_{ITQ}\}$, is independent of the Grandfathering share, s.

- $z(s)$ only appears in the entry equation:

$$\bar{T}\{[p - m_{ITQ}]h_{ITQ} - c(h_{ITQ})\} - w(N_{ITQ}) + \underbrace{m_{ITQ}z(s) = m_{ITQ}z(s)}_{mz(s)\text{ cancels out}}$$

ITQ & Open Access Equilibria

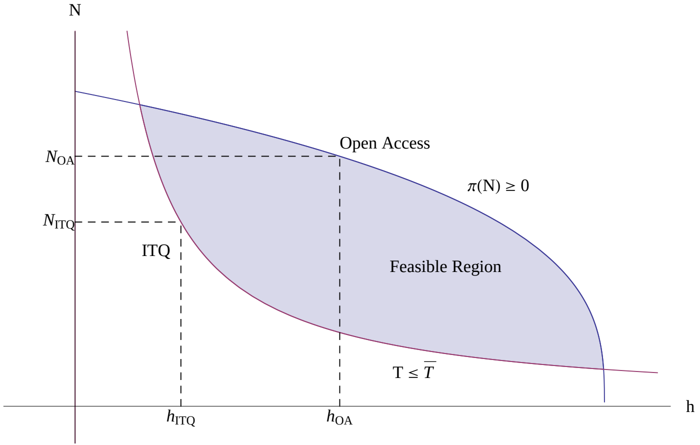

Figure: The Open Access and ITQ Equilibria Compared: Overcapitalization & Race for Fish under Open Access is Eliminated with ITQs

Inframarginal Rents under ITQs & Open Access

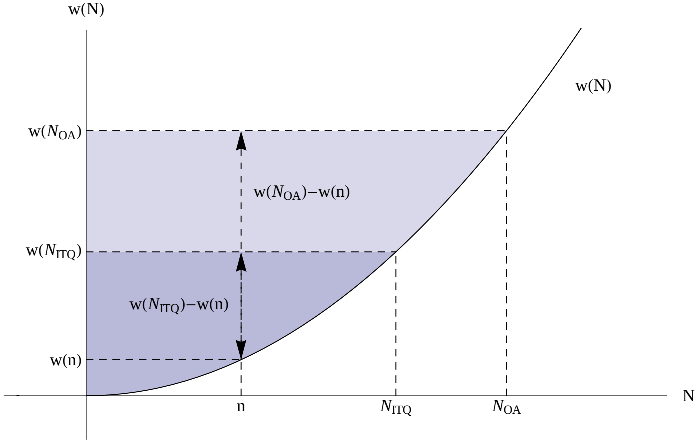

Figure: Inframarginal Rents under Open Access and under ITQs

Effect of s on Social Welfare

Social Welfare:

$$
\begin{aligned}
SW_{ITQ}(s) &= \text{Rents to Fishery} + \text{Inframarginal Rents} \\
&\qquad\qquad + \text{Reduction in Taxes Elsewhere} \\
&= m_{ITQ}Q + \int_0^{N_{ITQ}} [w(N_{ITQ}) - w(n)]\,\mathrm{d}n \\
&\qquad\qquad + (1-s)m_{ITQ}Q(\psi - 1)
\end{aligned}
$$

- where $\psi - 1 > 0$ is the dead-weight-loss per dollar of taxes elsewhere

Proposition

("Double-Dividend") The social welfare maximizing grandfathering quota share is $s^* = 0$.

- Intuition: (*i*) The quota share does not affect the ITQ equilibrium, and (*ii*) society gains more than a dollar of welfare for each dollar of taxes reduced elsewhere.

Effect of s on Active Fishers

- Change in surplus to active (under ITQs) fisher n:

$$\begin{aligned}\Delta\pi(n) &= \{\text{Rents under ITQs}\} - \{\text{Rents under Open Access}\}\\ &= \{w(N_{ITQ}) - w(n) + m_{ITQ}z(s)\} - \{w(N_{OA}) - w(n)\}\\ &= w(N_{ITQ}) - w(N_{OA}) + m_{ITQ}z(s), \qquad n \in [1, N_{ITQ}]\end{aligned}$$

- $\Delta\pi(n)$ is independent of n
- $\Delta\pi(n)$ is greater than zero if, and only if,

$$s \geq \bar{s} \equiv \frac{N_{OA}[w(N_{OA}) - w(N_{ITQ})]}{Q m_{ITQ}}$$

This uses $z(s) = sQ/N_{OA}$

Effect of s on Inactive Fishers

- Change in surplus to inactive (under ITQs) fisher n:

$$\begin{aligned}\Delta\pi(n) &= \text{Rents under ITQs} - \text{Rents under Open Access} \\ &= m_{ITQ}z(s) - w(N_{OA}) + w(n), \qquad n \in (N_{ITQ}, N_{OA}]\end{aligned}$$

- $\Delta\pi(n)$ depends on n
- $\Delta\pi(n)$ is greater than zero if, and only if,

$$s \geq \tilde{s}(n) \equiv \frac{N_{OA}[w(N_{OA}) - w(n)]}{Qm_{ITQ}}$$

- $\bar{s} > \tilde{s}(n)$ since $w(n) > w(N_{ITQ})$ for inactive fishers:

$$\bar{s} \equiv \frac{N_{OA}[w(N_{OA}) - w(N_{ITQ})]}{Qm_{ITQ}} > \frac{N_{OA}[w(N_{OA}) - w(n)]}{Qm_{ITQ}} \equiv \tilde{s}(n)$$
$$w(n) > w(N_{ITQ})$$

The choice of s under Wicksellian (1896) Unanimity Rule

Active Fishers

$$\bar{s} \equiv \frac{N_{OA}[w(N_{OA}) - w(N_{ITQ})]}{Qm_{ITQ}}, \qquad n \in [1, N_{ITQ}]$$

Inactive Fishers

$$\tilde{s}(n) \equiv \frac{N_{OA}[w(N_{OA}) - w(n)]}{Qm_{ITQ}}, \qquad n \in (N_{ITQ}, N_{OA}]$$

Proposition

When $w'(N) > 0$ (heterogenous fishers), only for $s^{**} \geq \bar{s} > \tilde{s} \geq 0$ are no fishers made worse off by adopting ITQs.

Corollary

When $w'(N) = 0$ (homogeneous fishers), any $s^{**} \geq 0$ ensures that all fishers are made no worse off by adopting ITQs.

The choice of s under Downsian (1948) Median Voter Rule

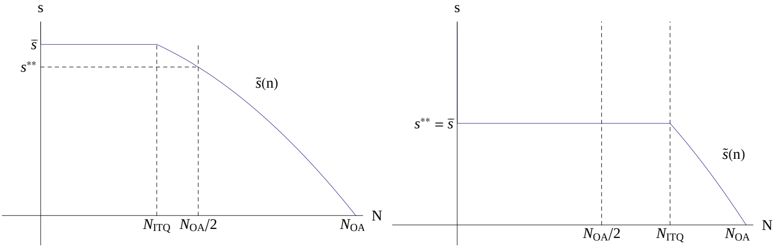

Figure: Median Voter is $N_{OA}/2$. If $N_{ITQ} < N_{OA}/2$, $s^{**} < \bar{s}$; else $s^{**} = \bar{s}$.

E.g., BC Halibut fishery: 436 boats in 1991 (when ITQs instituted), 140 boats now

Tradeable Emissions Permits and Grandfathering

- Laissez-Faire: No limit on pollution emissions
  - Firm profits ($P'(Q) < 0$):

$$\pi(n) = P(Q)q_n - c(q_n) - w(n), \qquad n \in [1, N_0]$$

  - Pollution

$$E_n = \beta q_n \qquad \text{and} \qquad E = \beta Q$$

- Tradeable Emissions Permit Regulation: $E \leq \bar{E}$
  - Grandfathering: share s of Q is grandfathered:

$$\text{Per Producer Quota Allocation:} \qquad z(s) = \frac{s\bar{E}}{N_0}$$

  - Producer profits, given quota price m and allocation $z(s)$:

$$\pi(n) = \begin{cases} [P(Q) - m]q_n - c(q_n) - w(n) + mz(s) & \text{if active} \\ mz(s) & \text{if inactive} \end{cases}$$

  - Quota price m clears quota market:

$$\bar{E} = \beta \sum_{n=1}^{N} q_n$$

Tradeable Emissions Permit Market

- Laissez-Faire Market Equilibrium

$$\begin{aligned} \text{Production:} \quad & P(N_0 q_0) - c'(q_0) = 0 \\ \text{Entry:} \quad & P(N_0 q_0) q_0 - c(q_0) = w(N_0) \\ \text{Pollution:} \quad & \beta N_0 q_0 = E_0 \end{aligned}$$

- Tradeable Emissions Permit Market Equilibrium

$$\begin{aligned} \text{Production:} \quad & P(N_1 q_1) - c'(q_1) - m_1 = 0 \\ \text{Entry:} \quad & P(N_1 q_1) q_1 - c(q_1) - m_1 q_1 = w(N_1) \\ \text{Pollution:} \quad & \beta N_1 q_1 = \bar{E} < E_0 \end{aligned}$$

- Production / Firm and the Number of Firms

$$c'(q)q - c(q) = w(N) \qquad\qquad E = \beta N q$$

Tradeable Emissions Permits Equilibrium

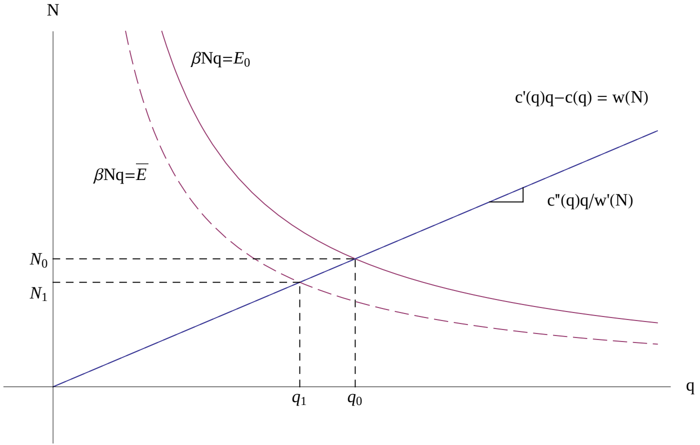

Figure: Effect of Reducing Emissions on Number of Firms, *N*, and Output per Firm, *q*.

Tradeable Emissions Permits Equilibrium

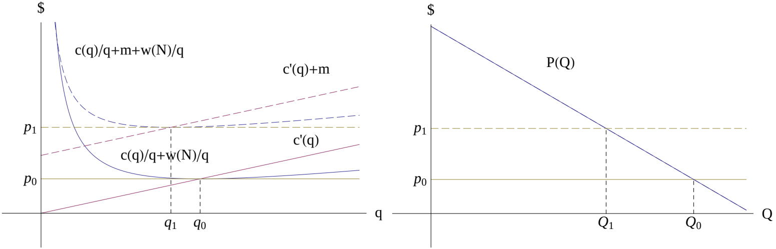

Figure: Tradeable Emissions Permit Market Effects

Grandfathering with Tradeable Emissions Permits

- $z(s)$ appears only in the entry equation:

$$P(N_1 q_1)q_1 - c(q_1) - m_1 q_1 - w(N_1) + \underbrace{m_1 z(s) = m_1 z(s)}_{m_1 z(s) \text{ terms cancel}}$$

Proposition

The TEP equilibrium, $\{N_1, q_1, m_1\}$, is independent of the Grandfathering share, s.

- Social Welfare equals:

$$\begin{aligned} SW_1(s) &= \text{Rents to Quota} + \text{Inframarginal Rents} \\ &\qquad + \text{Reduction in Taxes Elsewhere} \\ &= m_1 \bar{E} + \int_0^{N_1} [w(N_1) - w(n)]\, \mathrm{d}n + (1-s) m_1 \bar{E}(\psi - 1) \end{aligned}$$

Proposition

("Double-Dividend") The social welfare maximizing grandfathering quota share is $s^* = 0$.

Effect of Heterogeneity on Grandfathering

- Change in surplus to producer n (relative to Laissez-Faire):

$$\begin{aligned}\Delta\pi(n) &= \{\text{Rents under TEP}\} - \{\text{Rents under Laissez-Faire}\} \\ &= w(N_1) - w(N_0) + m_1 z(s), \qquad n \in [1, N_1] \\ &= w(n) - w(N_0) + m_1 z(s), \qquad n \in (N_1, N_0]\end{aligned}$$

- Therefore, $\Delta\pi(n)$ is greater than zero if, and only if,

$$s \geq \bar{s} \equiv \frac{N_0[w(N_0) - w(N_1)]}{\bar{E} m_1} > \frac{N_0[w(N_0) - w(n)]}{\bar{E} m_1} \equiv \tilde{s}(n)$$

Proposition

When $w'(N) > 0$ (heterogenous producers), only for $s^{**} \geq \bar{s}$ are no producers made worse off by emissions regulation through TEP.

Corollary

When $w'(N) = 0$ (homogeneous producers), any $s^{**} \geq 0$ ensures that all producers are made no worse off by emissions regulation through TEP.

Conclusions from the Political Economy

- The "double-dividend" hypothesis implicitly assumes homogenous firms
  - With homogeneous firms, auctions/taxes always yield higher social surplus than does grandfathering
  - Opposition from industry has derailed most tradeable emissions programs: heterogeneity implies $s^{**} > s^* = 0$!
- Most fisheries ITQ programs have been designed to protect the interests of those in the industry
  - s has been close to 100%
  - Deviations have been small: Community Development Quotas are only 2 million out of 40 million tons (5%)
- Three Lessons Environmental Economists could learn from Fisheries Economists
  - Recognize that heterogeneity is important: $s^{**} > 0$
  - Focus on fixing the primary problem – avoid trying to do everything at once! (ITQ Rents independent of s)
  - If you mess with people's livelihoods, expect them to fight you!

Caveats

This a very simple model...

- Fishery / Pollution models
  - Heterogeneity did not affect h_i or q_i
  - Only one fishery, no bycatch, discarding, etc.
  - Ignored stranded capital, irreversible investment
- Political economy model
  - Wicksell's unanimity rule is a very strong condition
  - Median voter model may allow s^{**} to be lower
  - No processors, no input suppliers, no consumers

Thank You!
and
Happy Birthday, Dr. Clark!