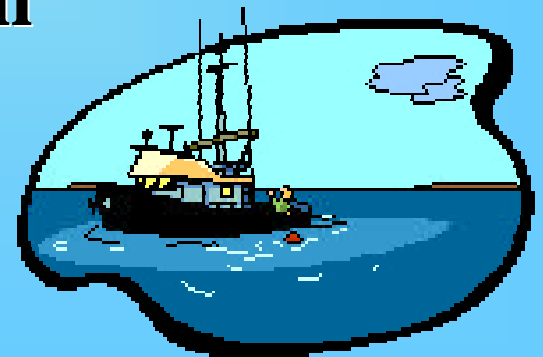


# A Model of Fishing Conflicts in Foreign Fisheries

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# A Brief History of Fisheries Exploitation

- Until the later half of this century most marine fisheries were accessible to DWFNs
- The Extended Fisheries Jurisdiction created 200 mile Exclusive Economic Zones (1982)
- Many of the world fisheries are now under the control of developing nations
- Some developing nations permit DWFNs to exploit their fisheries for a fishing fee

**Example: Parties to the Nauru Agreement charge a 5% fishing fee (Campbell, 96)**

# Exploitation of Foreign Fisheries

- Without regulation dynamic externalities will lead firms to over-fish the stock (Levhari & Mirman, 80)
- Coastal nations may choose domestic exploitation, foreign exploitation, both or neither by splitting a Total Allowable Catch between fleets (Charles, 86)
- Coastal nations benefit from using a dual-tax system, but can not simultaneously maximize their revenue and net return from fishery (Clarke and Munro, 87 & 91)
- With domestic exploitation, coastal nations will use taxes to induce a common equilibrium (Raissi, 01)

# Contributions to Literature

- Base model generalizes the interaction to  $n$  fishing firms (to see how changes in  $n$  affect behavior)
- Extension of model allows the fishery owner to select the number of firms that exploit the fishery
- Objective 1: Characterize the fishing fee and whether it is socially optimal (use non-cooperative game theory to find the subgame perfect equilibrium)
- Objective 2: Determine the number of firms that the fishery owner admits to the fishery and whether the arrangement is socially optimal

# A Model with Exogenous Firms

(1)  $\frac{dx}{dt} = g x \left( 1 - \frac{x}{K} \right) - \sum_{i=1}^n h_i$  (Logistic Growth Function)

(2)  $h_i = q x e_i$  (CPUE Production Function)

(3)  $\bar{x}(e) = K \left[ 1 - \frac{1}{g} \sum_{i=1}^n q e_i \right]$  (Steady Stock)

Size of Stock  
Intrinsic Growth Rate  
Carrying Capacity  
Catchability Coeff.

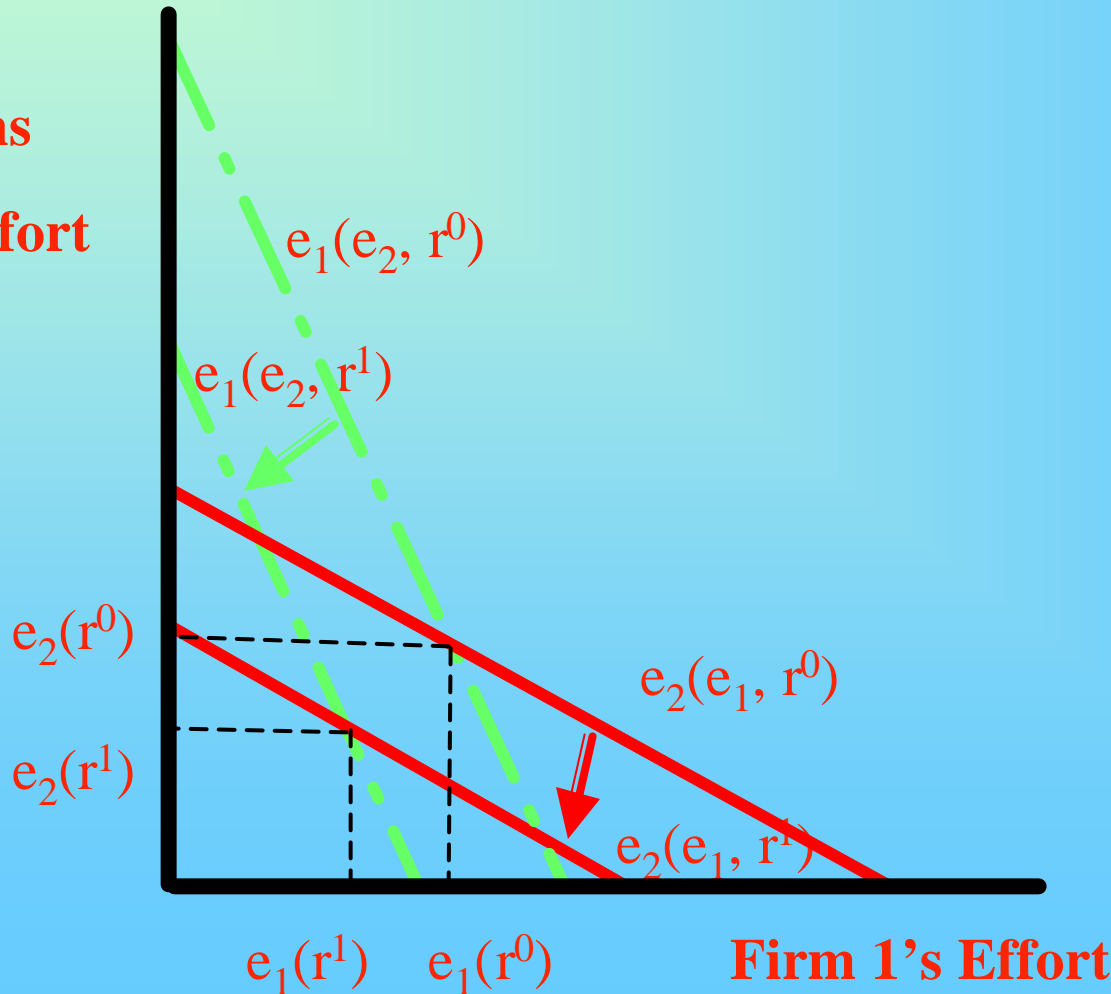
(4)  $Max_{e_i} \Pi_i = (1-r)\bar{p} \times q x(e) e_i - c e_i$  (Steady-state Profit)

(5)  $e_i(\hat{e}_j) = \frac{1}{2} \left[ \frac{[(1-r)\bar{p} - c]g}{(1-r)\bar{p}} - (n-1)\hat{p} \right]$  (Reaction Function)

Firm's Share  
MC of Effort

# Interaction Between Firms

**Firms**  
**2's Effort**



# Bionomic Equilibrium

$$(6) \quad e_i(r) = \frac{g}{(n+1)q} \left( 1 - \frac{c}{(1-r)b} \right) \quad (\text{Equilibrium Effort})$$

$$(7) \quad r_{\text{MAX}} = (1 - c/b). \quad b = pqK \quad (\text{marginal benefit of effort})$$

If  $r \geq r_{\text{MAX}}$  then there will be no exploitation

- The total equilibrium effort,  $E(r)$ , decreases in  $r$
- The bionomic equilibrium stock increases in  $r$
- Total bionomic harvest,  $H(r)$ , is concave in  $r$

$$(8) \quad H(r) = Kg \left( \frac{n}{(n+1)} \right) \left( 1 - \frac{c}{(1-r)b} \right) \left[ 1 - \left( \frac{n}{(n+1)} \right) \left( 1 - \frac{c}{(1-r)b} \right) \right]$$

# Results of Base Model

Owner's Objective: (9)  $\text{MAX}_r \text{rpH}(\mathbf{r})$

Proposition 1: There exist at least one fishing fee,  $r^*$ , that maximizes the owner's revenue function.

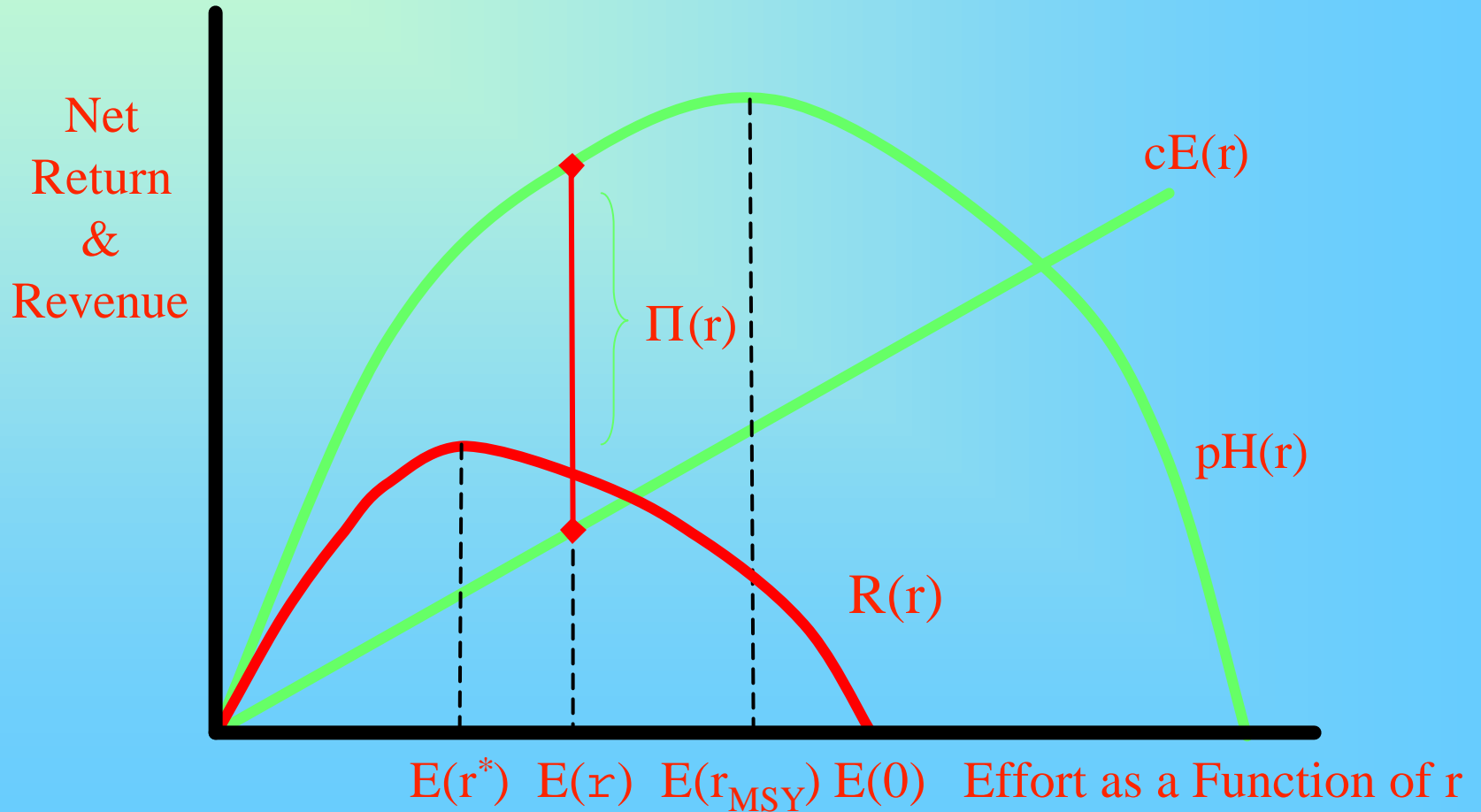
$$0 < r^* < r_{\text{MAX}}$$

The socially optimal fee maximizes the net return from the fishery: (10)  $\Pi(\mathbf{r}) = \text{pH}(\mathbf{r}) - \text{cE}(\mathbf{r})$

Proposition 2: If the concavity condition holds (and in most other cases), then  $r^*$  is higher than the socially optimal fee.

Firms exert less effort than is socially optimal.

# A Schaefer Representation



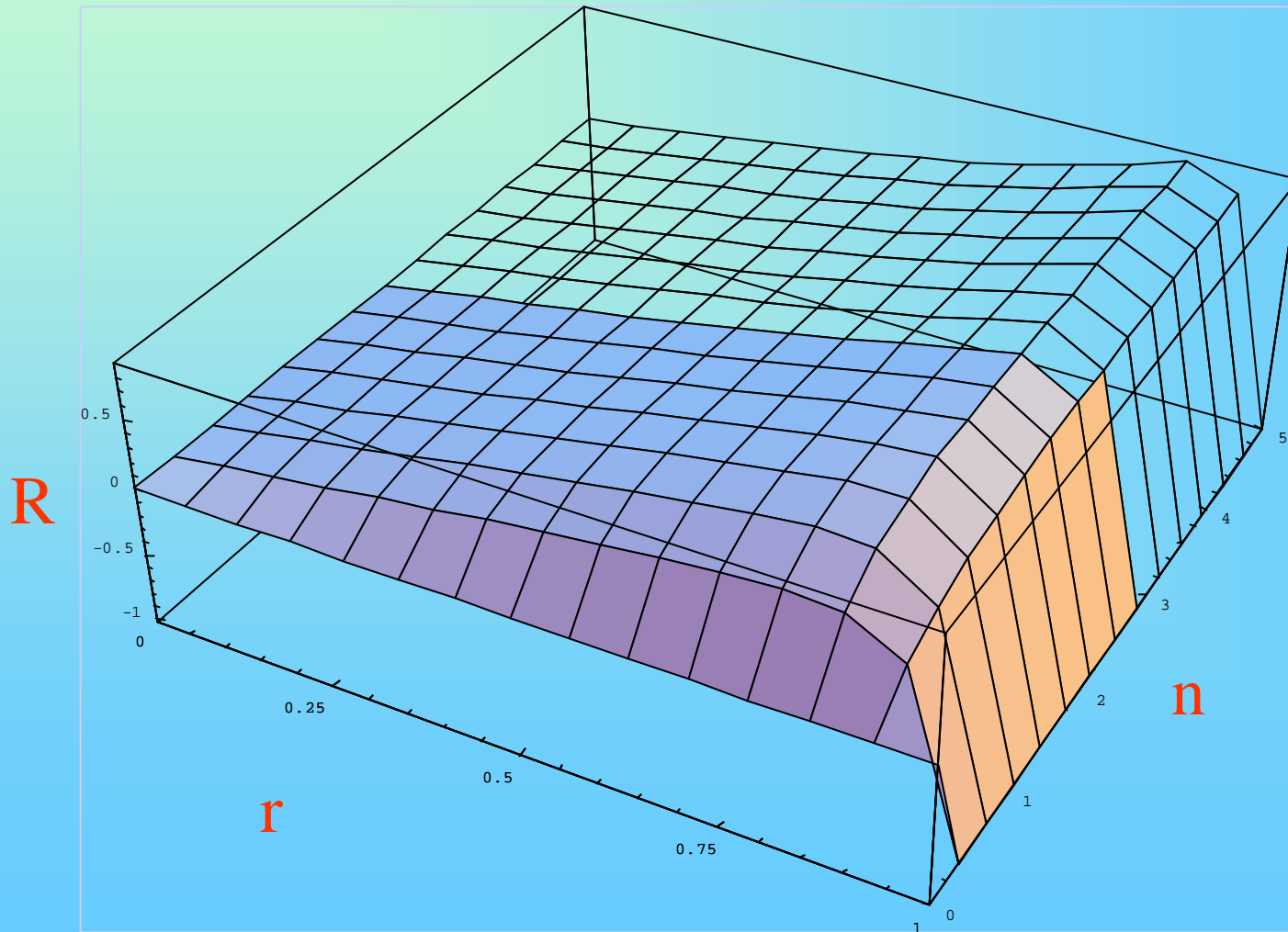
# A Model with Endogenous Firms

- The Extended Fisheries Jurisdiction allows the fishery owner to choose the number of firms

## The Effects of an Increase in the Number of Firms

- Each of the firm's effort and profit will fall
- Total effort will increase reducing the stock's size
- Total bionomic harvest will increase if  $b/c < 2$ .  
(If  $b/c < 2$  then the owner will set  $n = \infty$ )
- Owner's Objective: (11)  $\text{Max}_{n, r} = rpH(r, n)$

# The Owner's Revenue Function



# Results of Extension

- The owner does not restrict access to the fishery  
The only feasible interior solution yields less revenue than free access for all values of the parameters

- The owner will set  $r_{OA} = (b - c)/(b + c)$

$r_{OA}$  Solves for the owner's revenue under open access

$$(12) \quad R(\infty, r) = rp \times Kg \left( 1 - \frac{c}{(1-r)b} \right) \left( \frac{c}{(1-r)b} \right)$$

- The open access solution maximizes net return

$E(\infty, r_{OA})$  is socially optimal

# Welfare Implications

## When the Number of Firms is Exogenous

- The coastal nation charges a fee that is too high
- If the number of firms is sufficiently small then nationalizing the fishery may reduce welfare

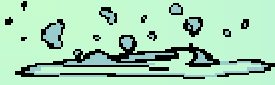
## When the Number of Firms is Endogenous

- Owner does not restrict entry to the fishery
- The owner maximizes its revenue and net return
- Firms do not earn any profit

# Why Owners Restrict Access

- To protect domestic fishing firms
- Out of environmental concerns (worries about spillover and production externalities)
- Out of political considerations (support one DWFN in exchange for aid or technology)
- Because monitoring cost increases as the number of firms increases
- Because they must charge a low fishing fee
- Owner may be able to extract the rent from the fishery using a two-tier tariff

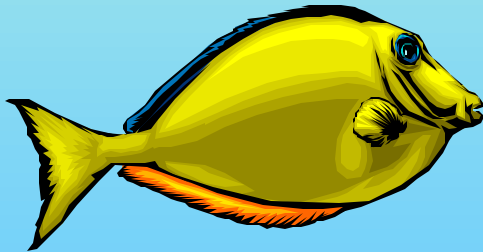
# The End



**Questions?**



**Comments!**



**Suggestions?**

