Choke species, discards and quota prices in multispecies fisheries

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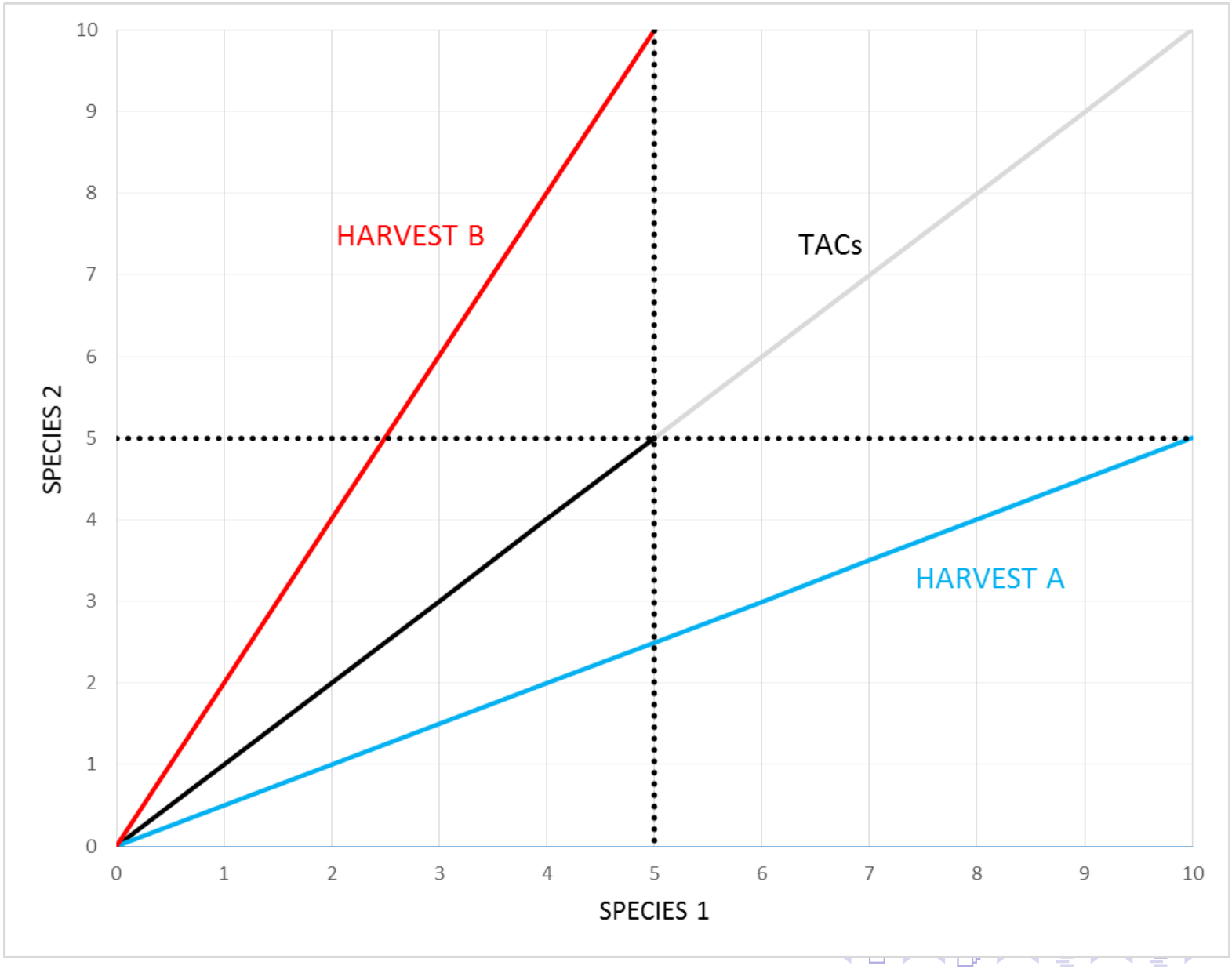
Introduction

- What determines quota (lease) prices in multispecies fisheries?
- Jointness in production (harvest) - individual quota prices not separable?
- Not straightforward - mWTP may depend on (expected) costs associated with disposal (discarding, over-quota landings)
- Quota prices then depend on *behaviour*
- Quota demand/supply imbalances - excess demand and the problem of "choke" species
- Only limited possibilities for increased targeting/selectivity
- Context: EU TAC allocation system and the landing obligation for demersal fisheries 2016-19
- Quote: skippers "will pay anything [for choke species quotas] in order to keep fishing"

Harvest patterns and TACs (quotas)



Multispecies harvest model

- Representative firm harvest (catch) model
- Assume compliance with quotas on landing
- Fixed proportions technology with zero harvesting costs

$$\max_{h,q,d} \quad \sum_i p_i \left[\beta_i h - d_i\right] - \sum_i r_i q_i - \omega \sum_i d_i,$$

$$\text{s.t.} \quad h \leq \bar{h}; \quad q_i \geq \beta_i h - d_i, \quad d_i \leq \beta_i h, \quad i = 1, 2, ..., N.$$

where

- β_i is the proportion of the ith quota stock in the harvest h
- ω is an expected (here unit) penalty for discarding $d_i > 0$
- quota q_i has a rental price r_i

Multispecies harvest model

- The profit-maximising conditions are

$$\sum_i [p_i - r_i]\,\beta_i = \lambda \geq 0$$

for $h^* \leq \bar{h}$ and

$$p_i + \omega = r_i, \quad i = 1, 2, ..., N$$

for discarding $d_i^* > 0$

- We then expect quota prices to satisfy

$$r_i \in [0, p_i + \omega]$$

- Thus

$$r_i = 0 \leq p_i + \frac{1}{\beta_i}\left[\sum_{j \neq i} [p_j - r_j]\,\beta_j\right] \leq p_i + \omega$$

Two species example: zero discard cost

- Consider two quota species: Sp1 and Sp2
- Assume Sp1 quota binds first: quota price bid up to the marginal opportunity cost of discarding

$$r_1 = p_1$$

- Sp2 quota limits total harvest (at h^* marginal profit goes to zero)

$$p_2\beta_2 = r_2\beta_2 \quad \Rightarrow \quad r_2 = p_2$$

- Or, Sp2 quota not binding at $\bar{h}$ ($r_2 = 0$)

$$p_2\beta_2 = \lambda > 0$$

Two species example: positive discard cost

- Sp1 quota binds first: quota price bid up to the marginal opportunity cost of discarding

$$r_1 = p_1 + \omega$$

- Sp2 quota limits total harvest (at h^* marginal profit goes to zero)

$$r_2 = p_2 - \frac{1}{\beta_2}\omega\beta_1$$

- Or, Sp2 quota not binding at $\bar{h}$ ($r_2 = 0$)

$$p_2\beta_2 - \omega\beta_1 = \lambda > 0$$

Two species: species 1 chokes harvest (no discards)

- Assume harvest restricted (choked) by Sp1 quota
- No discards: arbitrarily high ω, or "psychic cost"?
- Sp1 quota binds first and limits harvest: Sp2 quota is slack at h^* (excess supply) and $r_2 = 0$
- Sp1 quota priced at marginal value of harvest

$$r_1 = p_1 + \frac{1}{\beta_1} p_2 \beta_2$$

- Here the 2nd term on RHS can be interpreted as the shadow price of discarding

Note: non-linear discard penalties

- What if marginal (expected) discard costs are increasing?
- Let $\omega = \omega\left(\sum_i d_i\right)$, with $\omega'(.) > 0, \omega''(.) > 0$
- The discard condition becomes

$$p_i + \omega' = r_i, \quad i = 1, 2, ..., N$$

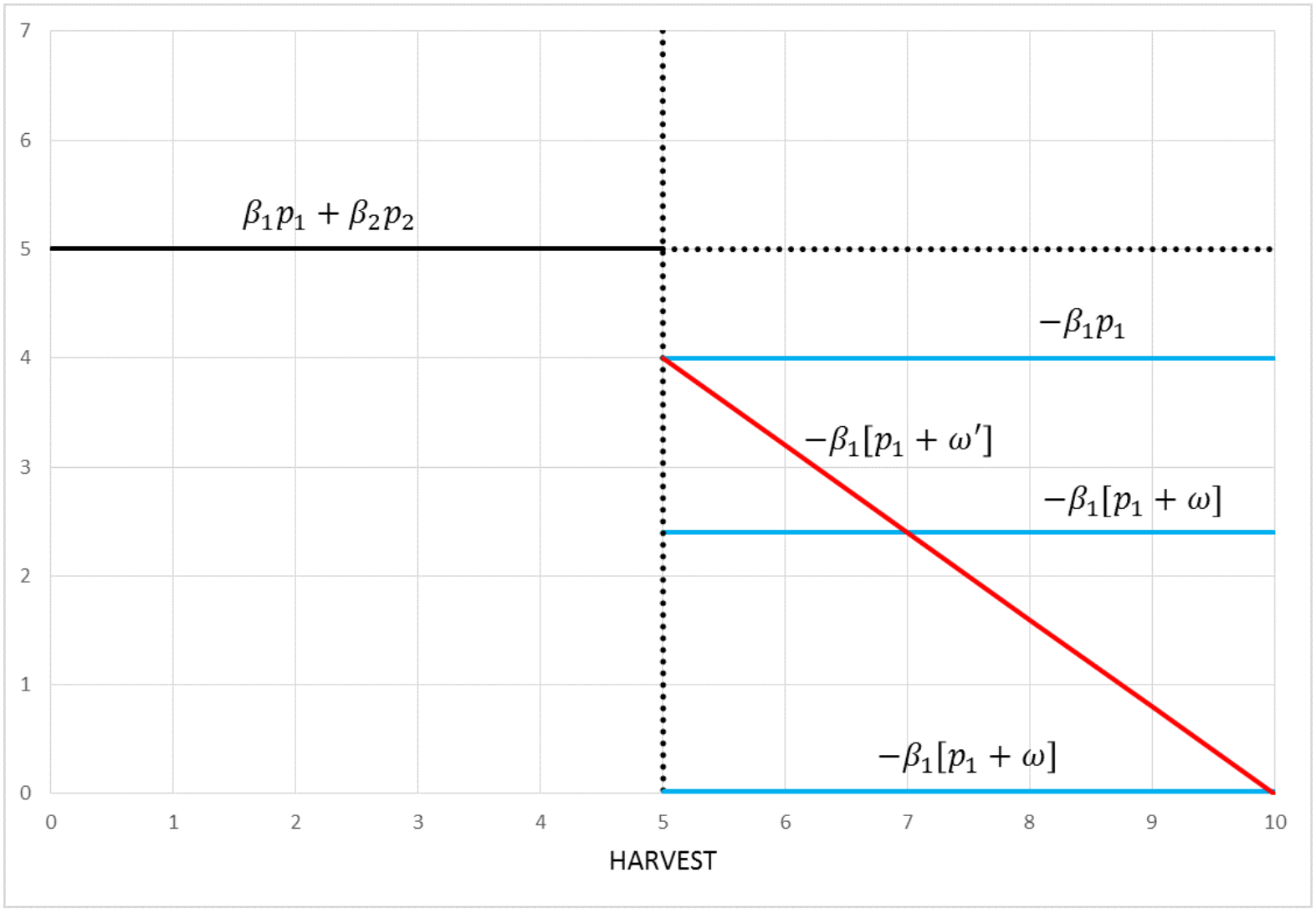
- Quota prices then satisfy

$$r_i = 0 \leq p_i + \frac{1}{\beta_i}\left[\sum_{j \neq i}\left[p_j - r_j\right]\beta_j\right] = p_i + \omega'$$

- Example: choke species quota price now *increasing* in discards, with

$$r_1 = p_1 + \frac{1}{\beta_1} p_2 \beta_2 = p_1 + \omega'$$

Marginal value of harvest and marginal discard penalty (2 spp)



Conclusions

- How much are fishermen willing to pay for choke species quota?
- If they behave rationally, the price ceiling is set by the opportunity cost of discarding - the ex-vessel price plus the expected marginal penalty (if any)
- Or the marginal value of the harvest, if this is smaller
- These are equalised in the non-linear case
- Choking the fishery implies no discarding and choke species quota bid up to the marginal value of the harvest
- Analysis can be extended to include the expected cost of landing over-quota fish
- What information do we then get from quota (lease) prices?