Weitzman. 2002. Landing Fees vs Harvest Quotas with Uncertain Fish Stocks. JEEM 43, 325-338

ECON 260A

Juan Carlos Villaseñor

13/11/2018

By the same author:

- Weitzman. 1974. Prices vs quantities. RES. (3,683 GSC)

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- Weitzman. 2009. On Modeling and Interpreting the Economics of Catastrophic Climate Change. RES. (1,409 GSC)

This paper

Utility analysis and group behavior An empirical study M Weitzman Efficiency of Racetrack Betting Markets, 47-55	202	2008
Landing fees vs harvest quotas with uncertain fish stocks ML Weitzman Journal of environmental economics and management 43 (2), 325-338	201	2002
Bonuses and employment in Japan RB Freeman, ML Weitzman Journal of the Japanese and International Economies 1 (2), 168-194	192	1987

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- Uncertainty comes from stock-recruitment relationship.
- There is a lot of environmental variability.
- We are bad at measuring S and R.
- How bad is it?

It's bad

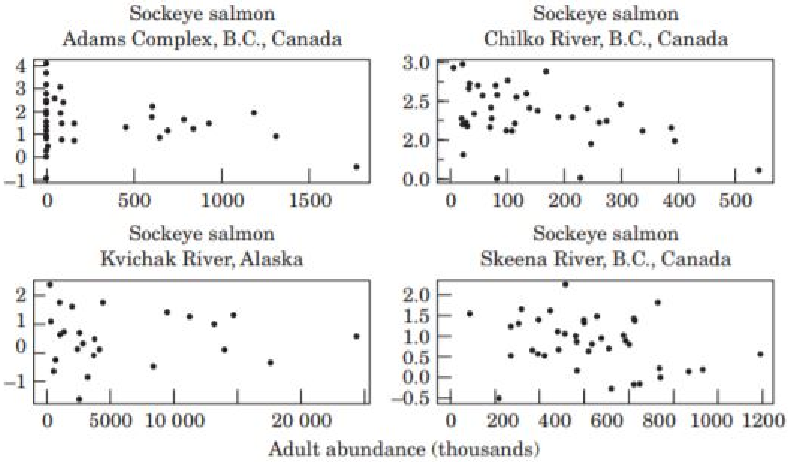

Figure 1: Myers, 2001

Models for SR

Ricker (1954)

$$R = aSe^{-bS}$$

Beverton-Holt (1957)

$$R = \frac{aS}{1 + bS}$$

Relationship varies through time

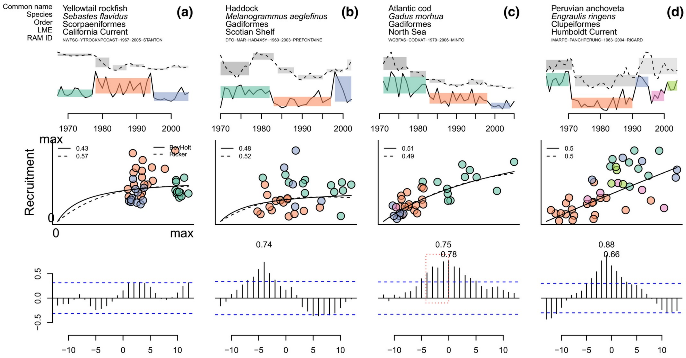

Figure 2: Szuwalski et al., 2015

The literature

Optimal constant escapement and stochasticity (Reed, 1979):

- $H^* = \max(X - S*, 0)$

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- Only numerical solution
- Build on value of SA

The paper

Setting

- Stock-recruitment uncertainty as a form of *environmental uncertainty*

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- Setting Q has the benefit of fixing the number of fish being caught

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- Setting Q has the benefit of fixing the number of fish being caught
- A fixed Q set without knowledge of X may put too much pressure on the stock
- Landing fees are better at controlling the *marginal* effort

The paper

Main finding

- Under stock-recruitment uncertainty, a harvest fee achieves the same outcome as if the manager was *myopically omniscient*.

What's different?

The paper

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What's different?

- Like Clark & Kirkwood, (1986) X is unknown
- Contrast landings fee and ITQ
- Analytical solution for both

The model

The bio

- $R_t = F(S_{t-1}|\varepsilon_t)$

The econ

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- $R_t = F(S_{t-1}|\varepsilon_t)$
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- Marginal profits are $\pi(x) = p - c(x)$
- Total profits are: $\int_{S_t}^{R_t} \pi(x)\, dx$

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- $S_t = R_t - H_t$
- Where ε is iid

The econ

- Marginal profits are $\pi(x) = p - c(x)$
- Total profits are: $\int_{S_t}^{R_t} \pi(x)\, dx$
- Where $\pi'(x) > 0$

The goal

The manager must maximize the expected (discounted) profits by inducing fishers to choose optimal H_t:

$$\mathbb{E}\left[\sum_{t=1}^{\infty} \alpha^{t-1} \int_{S_t}^{R_t} \pi(x)\, dx\right]$$

The timing

The paper works with a model whose informational timing forces the regulatory instruments to be set when the size of the relevant resource stock is unknown

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- Regulators observe (estimate) escapement (S_{t-1}) at the end of $t-1$
- Between $t-1$ and t, managers assign best value (landings fee Φ or TAC Q)
- Fishers *observe* the realization of ε_t as $R_t = F(S_{t-1}|\varepsilon_t)$
- Fishers harvest H_t and leave S_t, so the manager now knows S_t for the next time period

Almost done

Fishers have a *response function* for each case

Quota

$$H_q = (Q; S|\varepsilon)$$

Landing fee

$$H_\varphi = (\Phi; S|\varepsilon)$$

The value functions

$$V_q(S) = \max_{Q \geq 0} \mathbb{E}_\varepsilon \left[\int_{F(S|\varepsilon) - H(Q;S|\varepsilon)}^{F(S|\varepsilon)} \pi(x)\, dx + \alpha V_q(F(S|\varepsilon) - H_q(Q; S|\varepsilon)) \right]$$

with solution

$\hat{Q}(S)$

$$V_\varphi(S) = \max_{\Phi \geq 0} \mathbb{E}_\varepsilon \left[\int_{F(S|\varepsilon) - H(\Phi;S|\varepsilon)}^{F(S|\varepsilon)} \pi(x)\, dx + \alpha V_q(F(S|\varepsilon) - H_\varphi(\Phi; S|\varepsilon)) \right]$$

with solution

$\hat{\Phi}(S)$

Last bit

$$V^*(S;\varepsilon) = \max_{Q \geq 0} \left[\int_{F(S|\varepsilon)-H(Q;S|\varepsilon)}^{F(S|\varepsilon)} \pi(x)\, dx + \alpha \tilde{\mathbb{E}} \left[V^*((F(S|\varepsilon) - Q); \tilde{\varepsilon}) \right] \right]$$

with solution

$Q^*(S;\varepsilon)$

Results

Managers set: $\hat{\Phi}(S)$

$$\underbrace{H_{\varphi}(\hat{\Phi}(S); S|\varepsilon)}_{\text{Harvest response with fee}} \quad = \quad \underbrace{Q^{*}(S; \varepsilon)}_{\text{Myopically omniscient TAC}}$$

Thoughts

- On both stochastic cases, the result relies on the fishers observing the realization of ε from $R_t = F(S_{t-1}|\varepsilon_t)$

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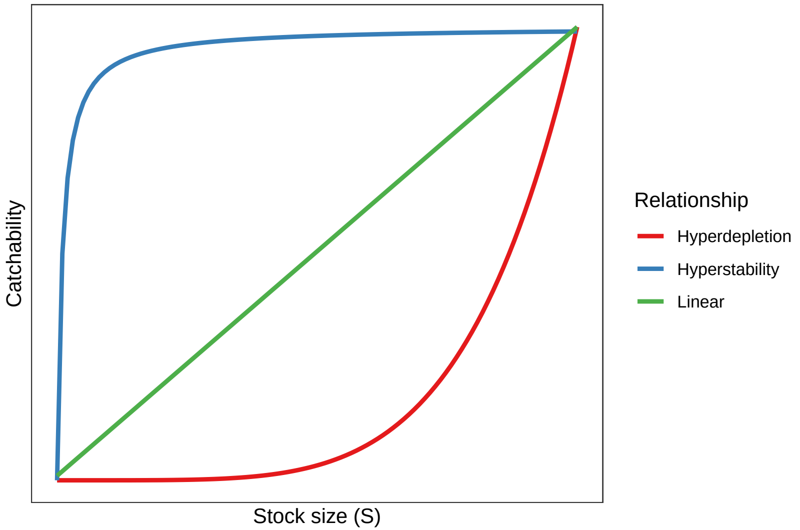
- On both stochastic cases, the result relies on the fishers observing the realization of ε from $R_t = F(S_{t-1}|\varepsilon_t)$
- Fishers need to know the shape of their marginal costs
- A flat marginal profit function of fish stocks favors quotas
- Weitzman calls for the characterization of fisheries that are better regulated by one method or the other (See Jensen & Vestergaard, (2003))

Applications

Figure 3: Fish spawning aggregations

Extensions


Catchability
Stock size (S)
Relationship
Hyperdepletion
Hyperstability
Linear

Further reading

W.J. Reed. 1979. Optimal Escapement Levels in Stochastic and Deterministic Harvesting Models. *JEEM* 6, 350-363

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D.G. Moloney and P.H Pearse. 1979. Quantitative Rights as an Instrument for Regulating Commerncial Fisheries. *Journal of Fisheries Research Board Canada*. 36: 859-86

F. Jensen and N. Vestergaard. 2003. Prices versus Quantities in Fisheries Model. *Land Economics*, Vol. 79, No. 3 (Aug., 2003), pp. 415-425

C. Costello, S.D. Gaines, J. Lynham. 2008. Can catch shares prevent fisheries collapse? *Science*, 321 (5896), 1678-1681