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On the appropriate rate of discount

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Introduction

- Rate of discount prominent role in fisheries economics (Theory and applications)
  - Early proponents: Scott 1956, Zellner ´62, Plourde ´70
- Generally assumed:
  - The appropriate rate of discount is the social rate of discount
  - Constant over time.

Social rate of discount tends to be low

⇒ Suggested "optimal" policies are quite conservative (& less conservative policies criticized)

Is this necessarily appropriate?

The role of the rate of discount

Optimal equilibrium (standard condition):

$$G_x + \frac{\Pi_x}{\Pi_q} = r$$

Optimal dynamic path (key equation):

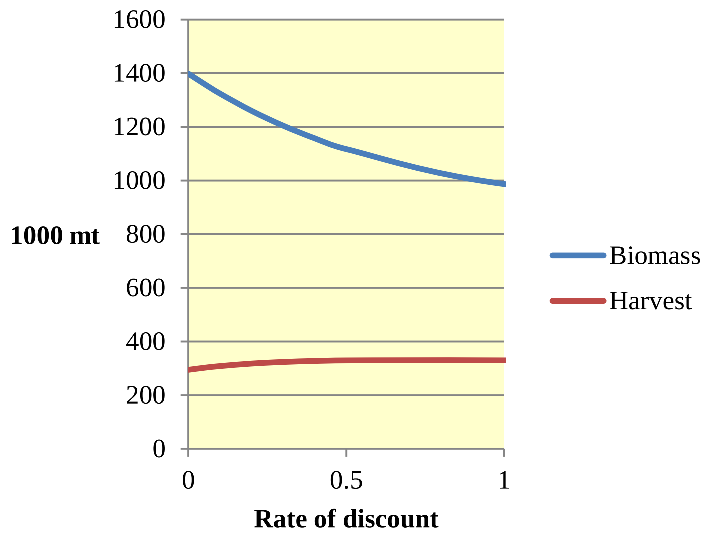
$$G_x + \frac{\Pi_x}{\Pi_q} + \frac{\dot{\Pi}_q}{\Pi_q} = r$$

Complicated

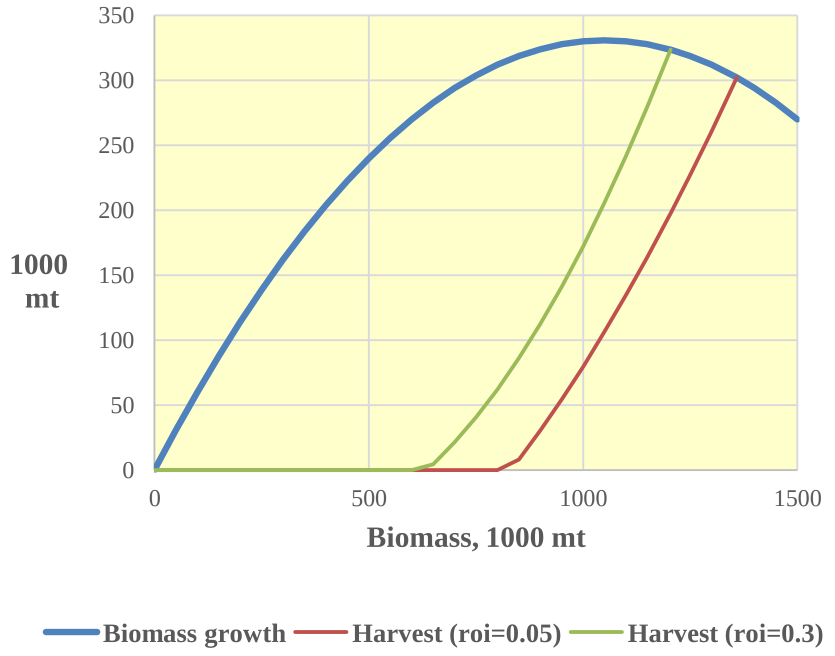
Numerical example

(Simple model based on Icelandic cod)

Equilibrium



Dynamic paths



A two sector economic growth model

Industry 1: $Y(k), \quad \dot{k} = i$

Industry 2: $\Pi(q,x), \quad \dot{x} = G(x) - q$

Social welfare: $W(c)$

Consumption: $c = Y(k) + \Pi(q,x) - i$

Social problem: $$\underset{i,q}{Max} \int_0^{\infty} W(Y(k) - i + \Pi(q,x)) \cdot e^{-r \cdot t} dt$$

$$\text{s.t. } \dot{k} = i, \quad \dot{x} = G(x) - q$$

Social rate of discount!

Necessary conditions

(1) $$Y_k + \frac{\dot{W}_c}{W_c} = r$$ (The Ramsey (1928) equation)

(2) $$G_x + \frac{\Pi_x}{\Pi_q} + \frac{\dot{\Pi}_q}{\Pi_q} + \frac{\dot{W}_c}{W_c} = r$$ (Extended fisheries rule)

Implication

$$G_x + \frac{\Pi_x}{\Pi_q} + \frac{\dot{\Pi}_q}{\Pi_q} = Y_k \quad !!$$

$\therefore$ Appropriate discount rate in the fishery is the marginal product of capital in the other sector(s) **!!**

(….and vice versa)

So, the appropriate discount rate is:

- Not the social rate of discount but (the highest) marginal product of capital in other sectors, $Y_k = \gamma$
- Time variant (⇒ non-autonomous problem), $\gamma(t)$

Appropriate formulation of the fisheries problem:

$$\underset{q}{Max} \int_0^\infty \Pi(q,x) \cdot e^{-\gamma(t)\cdot t} dt, \quad \text{s.t.} \quad \dot{x} = G(x) - q$$

The optimal dynamic rule then is:

$$G_x + \frac{\Pi_x}{\Pi_q} + \frac{\dot{\Pi}_q}{\Pi_q} = \gamma + \dot{\gamma} \cdot t = \gamma \cdot (1 + E(\gamma, t))$$

Implications

The appropriate rate of discount varies over

- The business cycle (with Y_k)
- The course of economic development

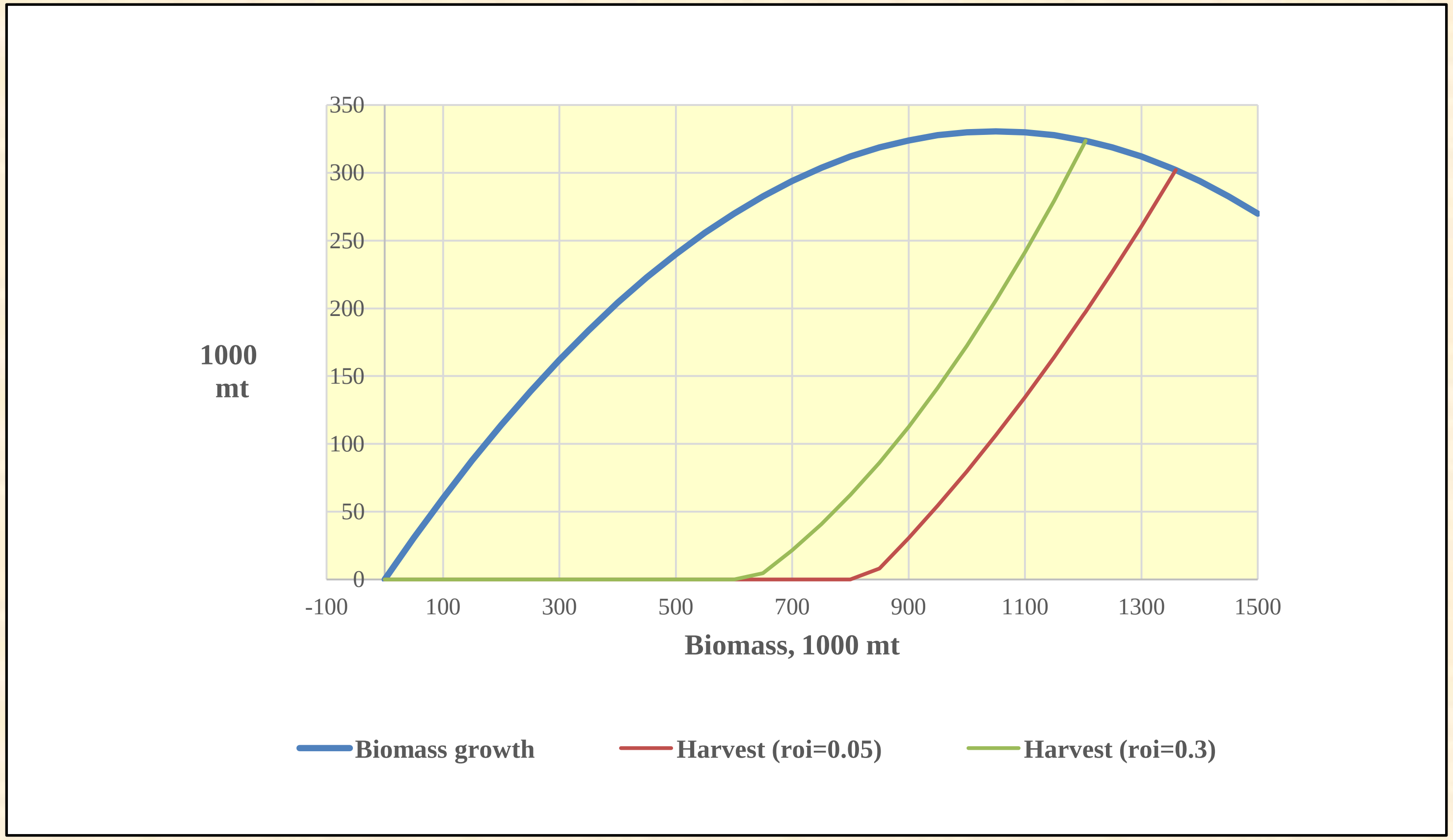
⇒ Target biomass and optimal paths vary accordingly

Marginal productivity of capital differs across nations

- High in developing countries => aggressive fishing is optimal
- Low in advanced countries => more conservative fishing is optimal

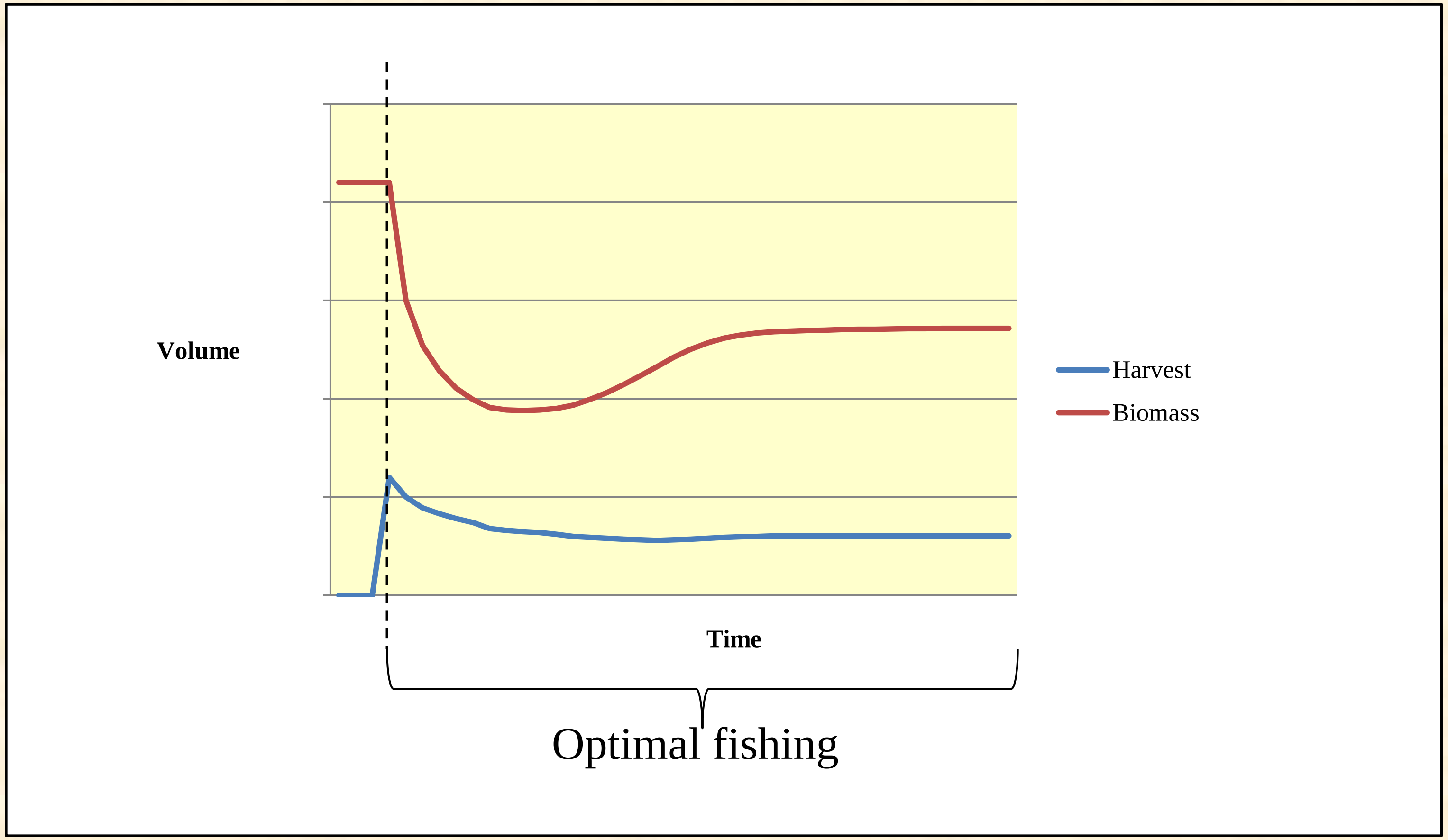
Optimal fishing

High Y_k developng country vs. low Y_k developed country



Evolution of optimal biomass & harvests over the course of economic development (Ath)

Economic development: As capital accumulates $Y_k \rightarrow r$ (social rate of discount)



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