Resource Economics: 10th week course

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Team project topics.

- Forecast of oil price: e.g., relationship between financial sector and oil markets, you may focus on the Hotelling rule
- Emission trading program: e.g., overview of EU-ETS and better ways to introduce and implement Korea version of ETS
- Fishery economics: e.g., current status of whale protection, how to control the whale catching?

Below topics are not yet covered in the class but will be studied until the end of May. If you don't like the topic selected above, you may choose either one of the below issues.

* Forest economics: possibility of forest CDM projects in Mongol and their economic benefits

* Optimal vaccine policy: why do we need stockpile policy for vaccine and how to achieve?

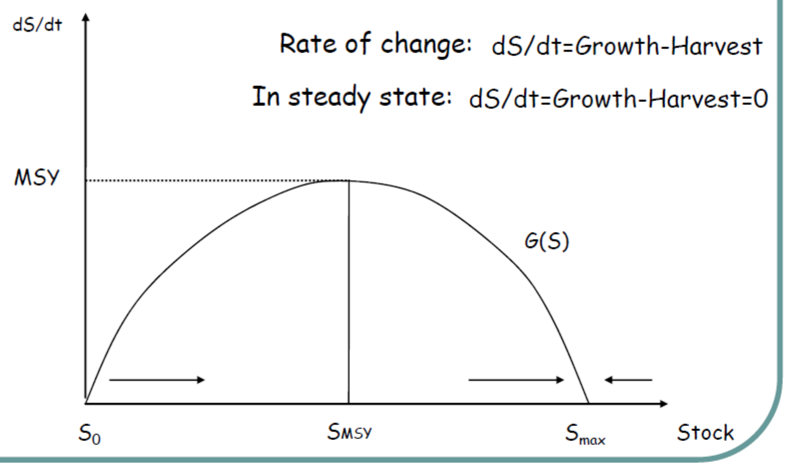
Team project evaluation

- Presentation will be made in the first week of June
  : 1. Jun (Tuesday), 3. Jun (Thursday)
- Deadline for your PPT submission is 31 May, no later than 24:00.
  * It's your responsibility to ask me to verify your email status in time.
- Ordering of presentation is noted in your card
- 10 mins for presentation and 5 mins for Q&A for each group
- Evaluation consists of
  : Contents (50%)
  : Presentation skill (25%)
  : Participation of Q&A (25%)
- Group head must report to me your group activities, e.g., the number of group appointments, person who missed
- Group head will get extra 20% of credits to the group score

What to do for this week

- Gordon-Schaefer model (Tietenberg 6th ed., Chapter 13)
  : graphical analysis
  : doing math ~
- Several concepts:
  sustainable yield, MSY, carrying capacity, minimum viable population, stability, compensatory, depensatory, equilibrium, open-access problem, effort cost, MR=MC rule for fishery

Steady state harvest and Maximum Sustainable Yield (MSY)



S_{MSY} = MSY population

How to achieve efficient sustainable yield?

- **Static efficiency**: the static efficient sustainable yield is the catch level which, if maintained properly, would reduce the largest annual net benefit while keeping sustainability

; mathematically simple maximization problem required

* catches, population, effort levels, net benefits must remain constant

- **Dynamic efficiency**: the dynamic efficient sustainable yield is the catch level which, if maintained properly, would reduce the largest ***discounted net benefits over time*** while keeping sustainability

; optimal control analysis is required.

* dynamic efficiency is not discussed in this class

Static efficient sustainable yield

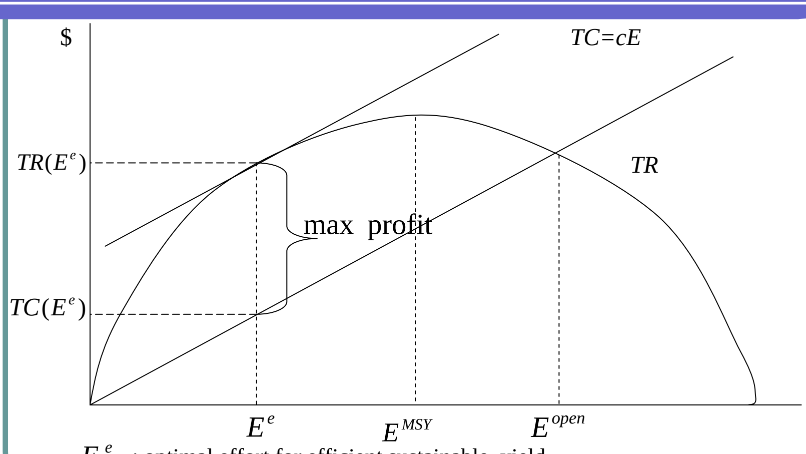
- Assumptions (*assumptions can be relaxed to improve model reality!)

1) price of fish is constant and does not depend on the amount sold and the size of fish stock
2) the marginal cost of a unit of fishing effort is constant
3) the amount of fish caught per unit effort is proportional to the size of fish population
4) age-specific property is not considered

- Notations

1) fish price: $p(t)=p$ for all t
2) harvest function: $H=qES$ when q: catchability coefficient, E is effort level for fishing
3) total cost = cE

Efficient sustainable yield



E^e : optimal effort for efficient sustainable yield

E^{MSY} : effort level which ensures MSY

E^{open} : open-access equilibrium

Derivation of optimal effort level and effort under open-access resource

To sustain sustainability, the amount of catching fishes must be equal to the growth rate → $qES=rS(1-S/K)$ → arrange this to get $S=K(1-qE/r)$ (1)

Insert (1) into the harvest function, we have $H(E)=qEK-q^2E^2\frac{K}{r}$ (2)

1) How to find out E^{MSY} ? Try with maximizing H using (2) ➔ $E^{MSY}=\frac{r}{2q}$

2) How to find out E^{e} ? Try with profit function $\pi(E)=pH(E)-cE$ and maximize this with respect to E ➔

$$E^{e}=\frac{r}{2q}\left(1-\frac{c}{pqK}\right)$$

3) How to find out E^{open} ? Try with $\pi(E)=pH(E)-cE$ and let it be 0.

➔ $E^{open}=\frac{r}{q}\left(1-\frac{c}{pqK}\right)$

Open-access problem

- In ocean fishery without exclusive property rights for fishing for anybody else, there are over-fishing efforts at which there are no more profits for competing fishers.

- Over-efforts are caused by

  ; over-capitalization ➔ we need policies to adjust over-capitalization

  ; overtime labor ➔ we need policies to reduce labor or fishing hours

- Over-efforts cause

  ; over-fishing beyond efficient level ➔ we need policies quota-like policies

Working Paper No. 30/02

Economic evaluation of the fisheries policies in Denmark, Iceland and Norway: Some performance indicators

by

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Iceland, Norway and Denmark are all major fishing nations harvesting a number of fish species. We have chosen to concentrate on cod fishing as this is the single most important fishery, from an economic point of view, in all three countries. The three cod stocks in question are biologically distinct. The period for comparing their cod harvesting policies is 1964-2000. The three nations conduct their cod fisheries in quite different contexts. First, there is a difference in national control over the respective fisheries. Prior to 1976 all three fisheries were characterized by open access. Since the extension of her fisheries jurisdiction to 200 miles in 1976, Iceland has been in virtual sole control of her cod fishery. Norway, on the other hand, shares her cod stock, the Arctic cod, with Russia and must therefore decide on a harvesting policy jointly with Russia. Denmark is only one of several, mainly European Union, countries pursuing the North Sea cod fishery. Since the early 1980s the European Union has set the overall total allowable catch (TAC) for this fishery of which Denmark merely receives a share. Thus, compared to Iceland and Norway, Denmark probably has least control over her cod harvesting policy. In view of these differences in autonomy between the respective cod harvesting policies. Second, since the mid-1980s, the fisheries management systems employed in the three countries have been quite different. Stated very briefly, Iceland has since 1984 operated a more or less complete ITQ-system in her cod fishery. (Arnason, 1993). Norway has for about the same period managed her cod fishery by means of quasi-permanent individual quotas (Anon., 1996d). In Denmark, however, the fishery has for the past two decades essentially been managed on the basis of a license limitation program supplemented with very short-term (down to two months) non-permanent, non-transferable vessel quotas (Vestergaard, 1998). Thus, it is clear that the quality of the harvesting rights held by individual companies in these three cod fisheries has differed greatly in recent years.

Basic model

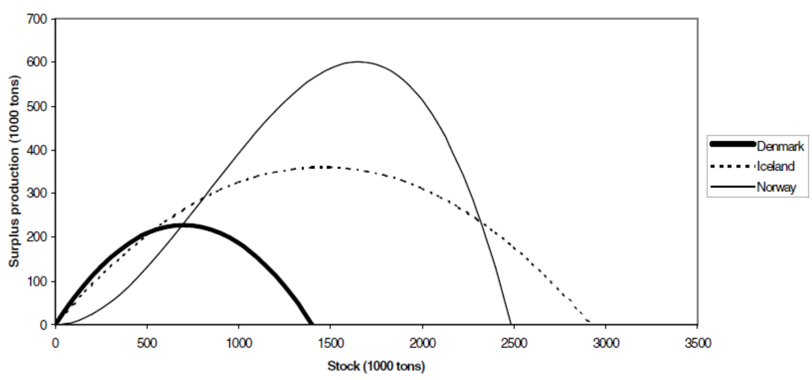
(1) $$\int_0^\infty e^{-\delta t}\Pi(h,x)dt$$

$$\text{subject to } \dot{x} = f(h,x),\ x(0) = x_0,\ \lim_{t\to\infty} x(t) = x^* > 0$$

Table 1. Statistical properties of the biological growth functions. K is 1000 tons.

	Function	Parameters	t-statistics	Other statistics[6]
Denmark (n = 36)	$rx\left(1-\frac{x}{K}\right)$	r=0.652155 K=1,402	4.87 6.03	R^2 =0.11 F=4.31 DW=2.30
Iceland (n = 45)	$rx\left(1-\frac{x}{K}\right)$	r=0.4946 K=2,919	8.53 3.83	R^2 = 0.25 F=14.67 DW = 1.52
Norway (n = 22)	$rx^2\left(1-\frac{x}{K}\right)$	r = 6.57E-4 K = 2,485	11.65 23.73	R^2 = 0.51 F = 23.16 DW = 1.67

Figure 1. The biological growth function for Denmark, Iceland and Norway



Economic model

The generic net revenue function employed in the empirical model is:

$$\pi(h, x) = p(h, x)h - C(x, h).$$

Denmark

Using data from Anon (1991) and Anon (1996b) a inverse demand function for cod landing of the form $p(h) = a - bh$ was estimated. Adjusted for autocorrelation it turned out that th slope coefficient was statistically insignificant. We therefore proceed on the assumption of constant price of cod landings of DKr 10.4. The estimation results are summarized in Table 2 A likely reason for this result is that Danish cod landings are quite small relative to the tota supply in the North Sea market area, and consequently the price is not very sensitive t variations in Danish landings.

Because we only have data for two years in Anon (1996a), we have calibrated variable cost function (see Howitt 1995 for an example). We have calibrated on the whol North Sea stock but have used the Danish part of the catches in The North Sea. Th calibration gives the following result:

$$C(h, x) = 29.618\ h^2/x$$

The Danish net revenue function thus reads:

$$\pi(h, x) = 10.4h - 29.618\ h^2/x,$$

when h and x are measured in metric tons.

Figure 2. Denmark: Stock relative to optimal steady state

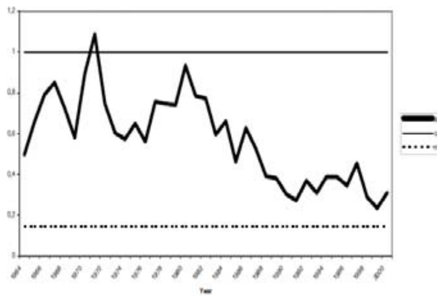


Figure 3. Iceland: Stock relative to optimal steady state

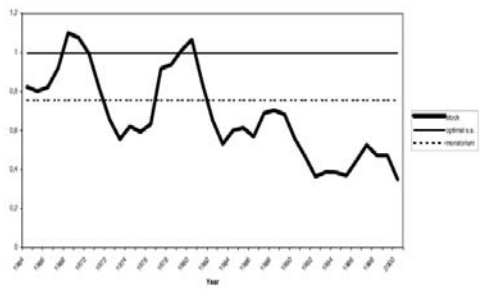


Figure 4. Norway: Stock relative to optimal steady state

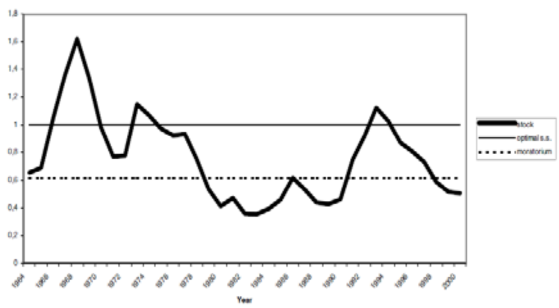


Figure 6. Iceland: Growth function and actual and optimal harvest against stock

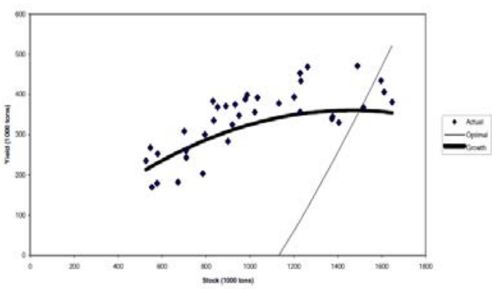


Figure 5. Denmark: Growth function and actual and optimal harvest against stock

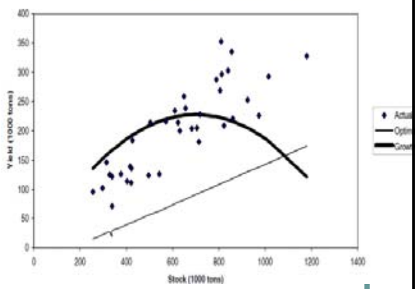
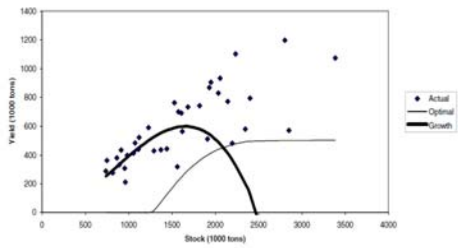


Figure 7. Norway: Growth function and actual and optimal harvest against stock



Conclusion

As illustrated in Figures 2-4, the cod stock biomass for these three countries is far below the economically optimal level (i.e. unity in the diagrams) for most of the period. Moreover, all three cod stocks exhibit a clear downward trend relative to the optimal level over time. Thus, the model confirms the general view that the North-Atlantic and North Sea cod stocks are overexploited, and the overexploitation is getting worse. There is no sign of any change in this trend after TAC-regulations were introduced in the late seventies.