Consequences of Recovering Enforcement Costs in Fisheries

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Fisken er et af de ældste kristne symboler, og udsmykker ofte moderne kirker.

Fisk hedder på græsk "ichthus". Hvis vi opløser ordet i fem dele, får vi "i", "ch", "th", "u" og "s", som kan udgøre forbogstaverne til en bekendelse til Jesus: "Iesous, Christos, Theou, Uios, Sotér", en sætning, som vi kan oversætte som følger: "Jesus Kristus (Messias), Guds Søn, Frelser". For en kristen person eller et kristent samfund bliver det således en kristen bekendelse at tegne eller male en fisk.

Endelig optræder der fisk i historierne om Jesus, der i ørkenen bespiser henholdsvis 4.000 og 5.000 mænd "foruden kvinder og børn". Det er de fem (eller syv) brød og "et par fisk", der mirakuløst mætter alle de spisende.

Og ligesom man i kristendommen tidligt forbandt disse brød med nadverens brød, gjorde man det samme med fiskene. Således kom både brød og fisk til at symbolisere Jesus selv. I kristendommen kom fisken således fra begyndelsen til at repræsentere både Jesus selv om "frelseren" og de kristne, der blev "frelst".

Tak til *Per Bilde, professor dr.theol. ved afdeling for religionsvidenskab på Aarhus Universitet*

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Outline

- Management expenditures and cost recovery
- Issues & purpose
- Bioeconomic models of cost recovery, policy & outcomes
- Results & Discussion
- Other issues & research directions

Management Expenditures

- Governments spend significant financial resources on fisheries management,
  - especially on enforcement, research, and management administration
- Sumaila, et al. (2016) estimate governments spend about USD 12.0 billion per year on management costs
  - Administration, research and enforcement

Cost Recovery

- Most fishery management programs are entirely financed by general taxpayers
- A few countries have implemented user charges to recover the costs of management
  - Australia
  - Canada
  - New Zealand

Recovery of fishery management costs

- Reasons & considerations
  - Raise revenue
  - Fairness
  - Economic efficiency
    - Improved cost-efficiency in provision of management services
    - Improved efficiency in mix of management services

Issues

- Getting the prices (cost recovery rates) ‘right’
  - Not straightforward in theory or practice
  - Eg. Canada, New Zealand difficulties
  - Ill designed programs can be detrimental
- Careful analysis of cost recovery design needed

Issues

- What are the advantages and disadvantages of different cost recovery methods?
  - User charges
  - Other financing methods (lump sum payments)
- What methods can best improve efficiency?
- How should charges be set & collected?

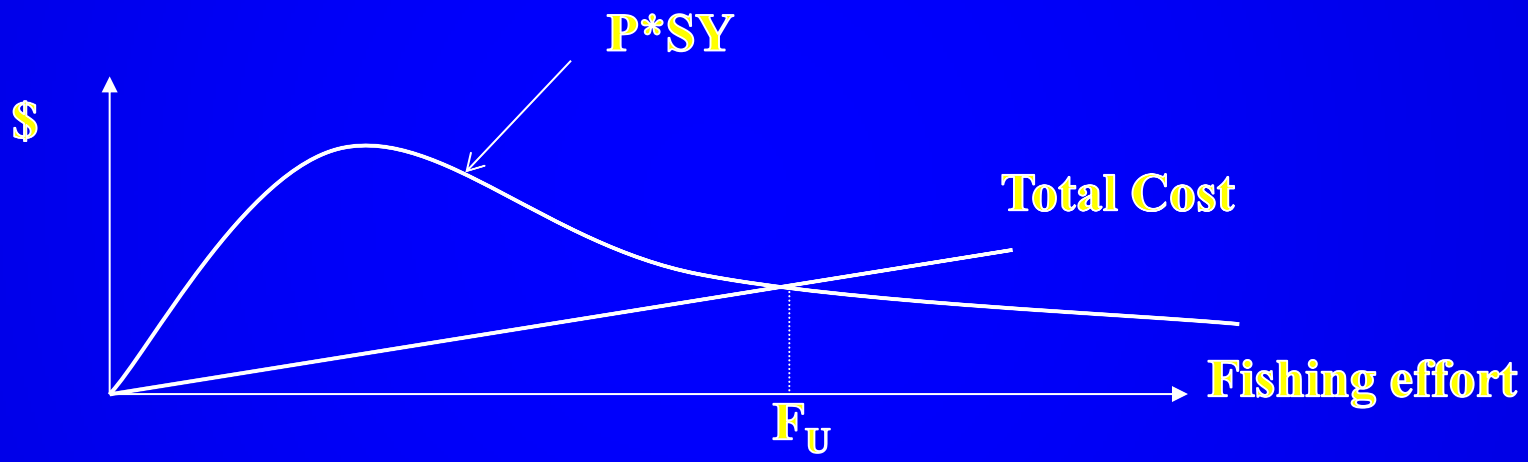
Purpose of this study

- To examine the consequences of applying a royalty to recover enforcement costs
  - By developing formal bioeconomic models to assess consequences for policy & outcomes
- To determine how a royalty r to recover costs affects
  - Policy
  - Biological and economic outcomes

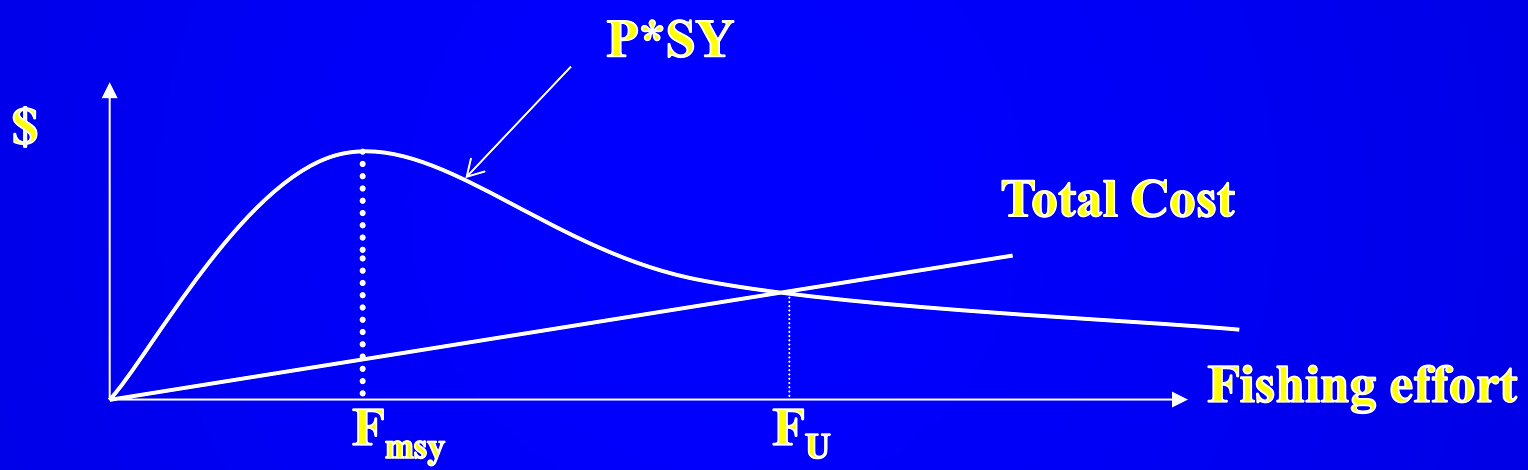
Bioeconomics
Part I

- Basic static bioeconomic model
  - Single species
  - Equilibrium
    - Fish stock
    - Fleet
    - Market
  - Fishery management authority
  - Fisheries enforcement agency

A static bioeconomic model



A static bioeconomic model



Enforcement & Compliance

- Each firm's effort above e_{msy} is illegal
  - MSY is management's target level of effort
- Penalty given by

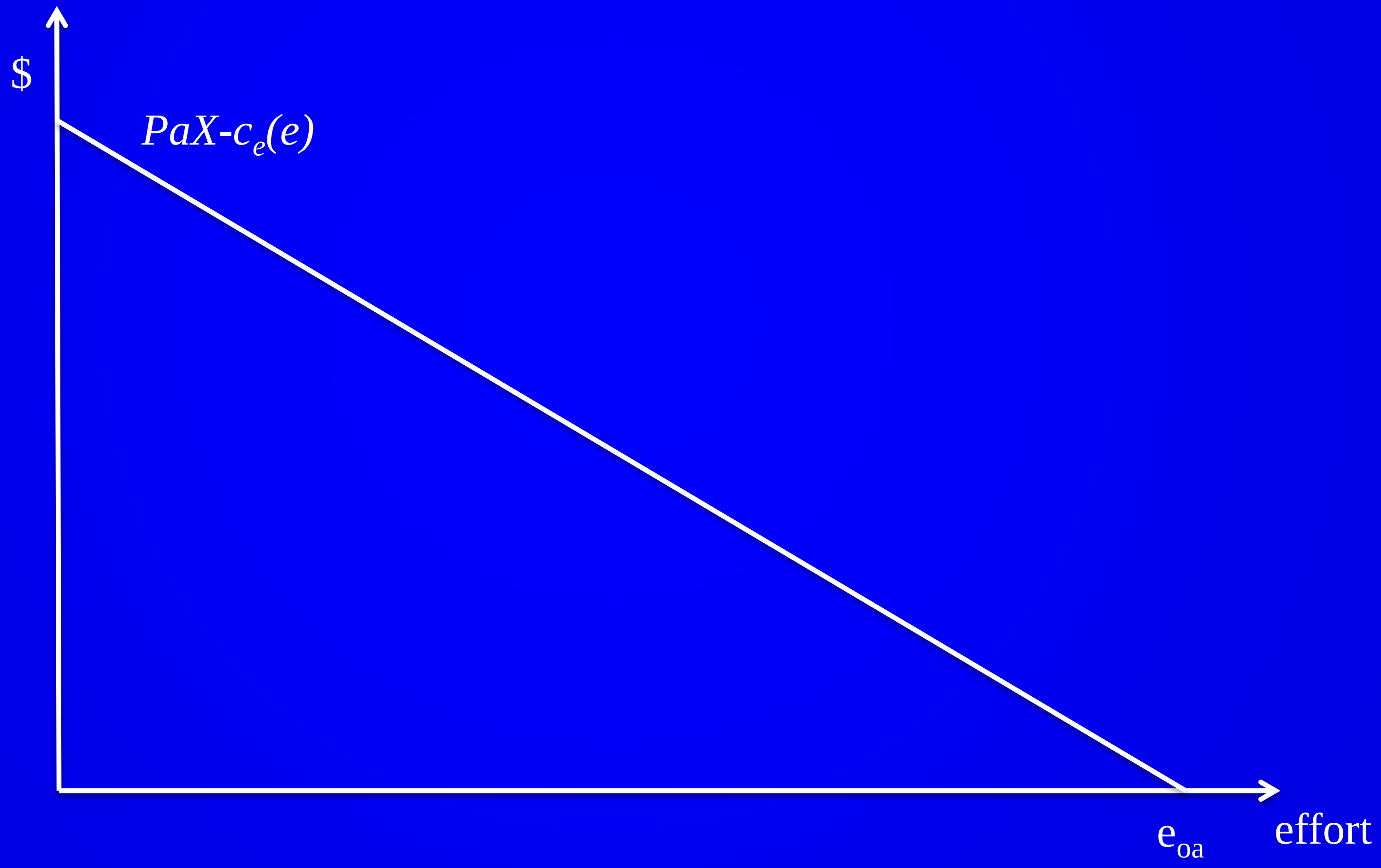
  $f = f(e\text{-}e_{msy})$, where $f_e > 0$ when $e > e_{msy}$

  $f = 0$ otherwise, and $f_{ee} \geq 0$
- Probability of detection & conviction given by

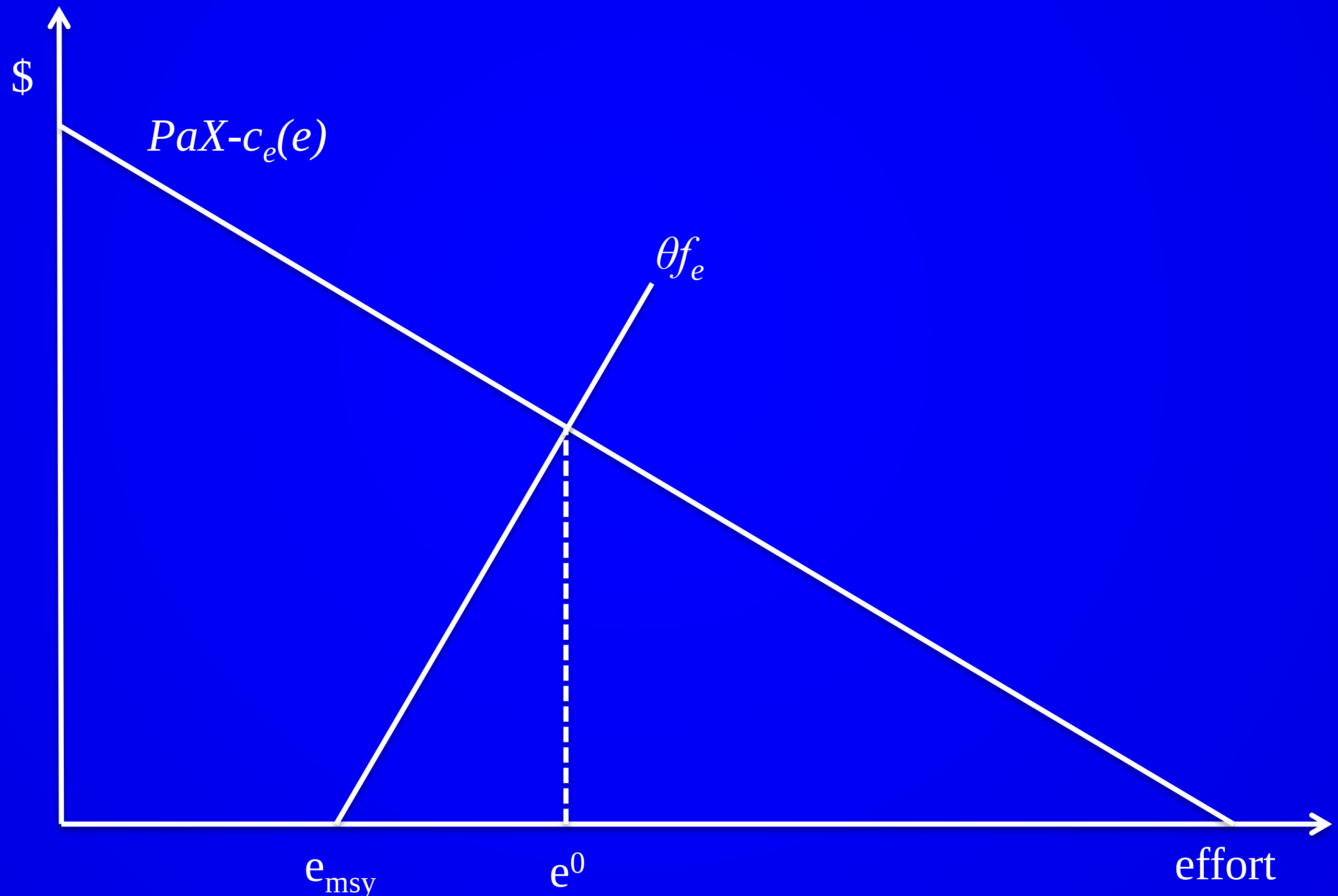
  $\theta = \theta(S)$, where $\theta_S > 0$, $\theta_{SS} \leq 0$, and

  S represents enforcement services, e.g. surveillance

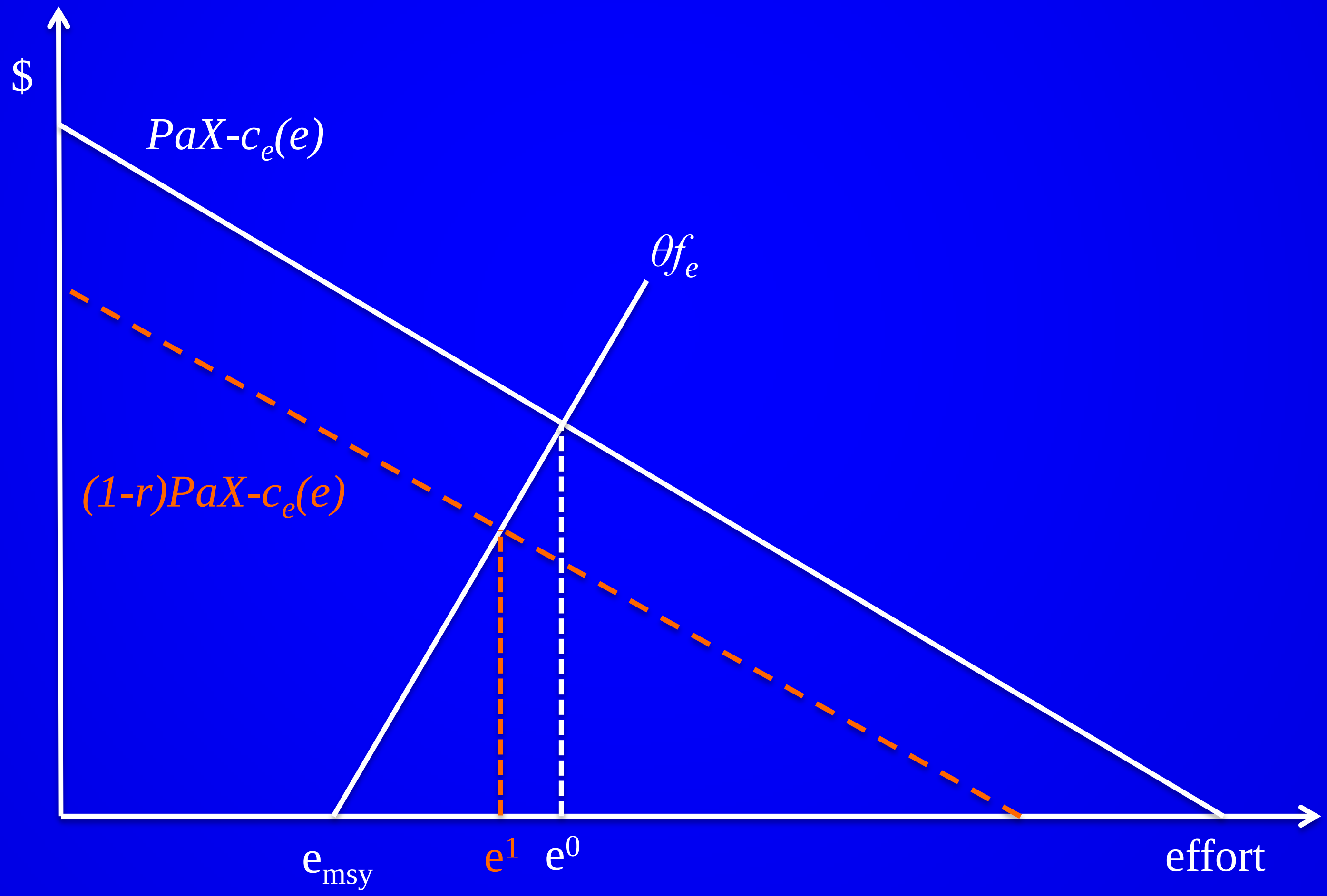
Firm's effort – open access



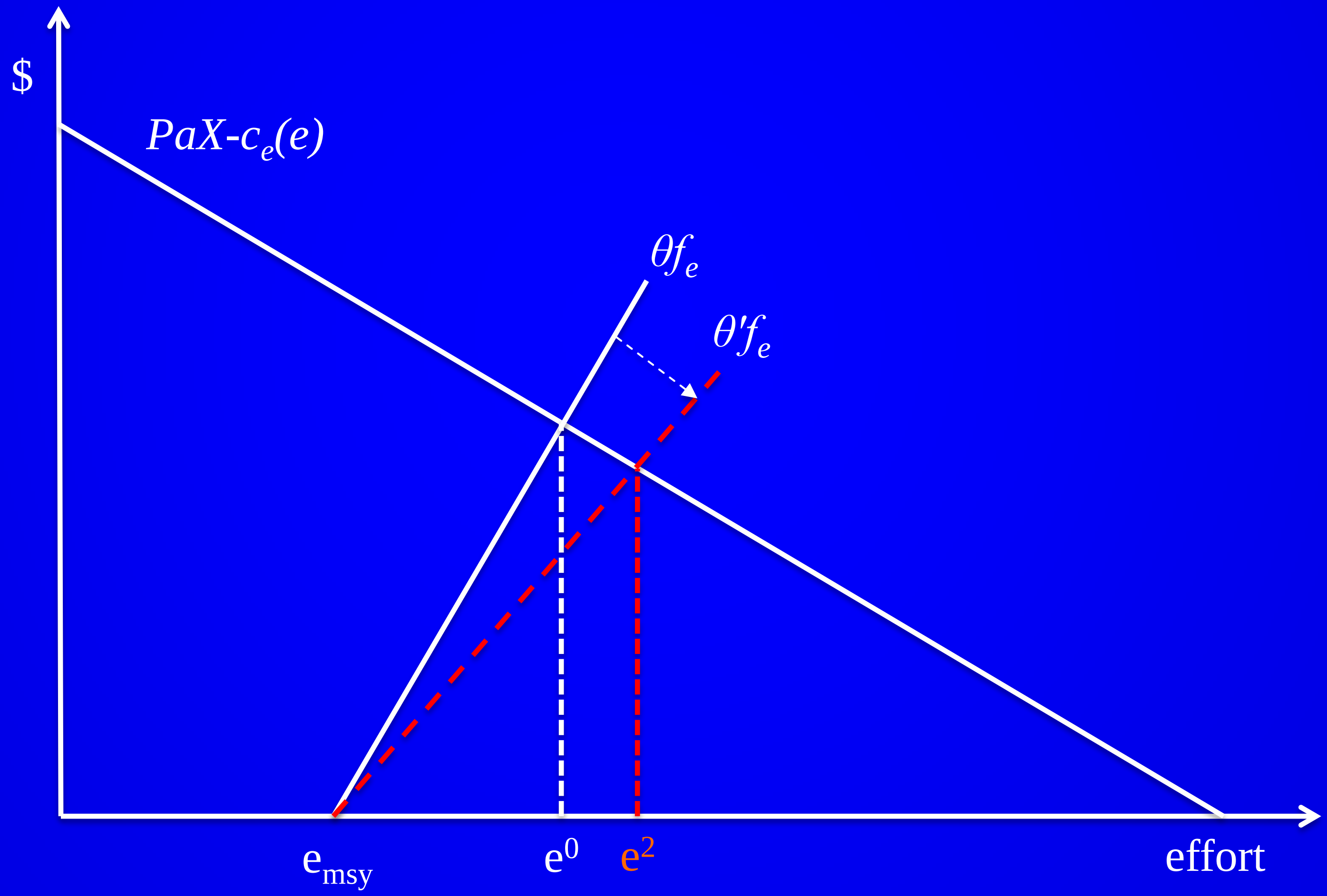
Firm's effort
costly, imperfect enforcement



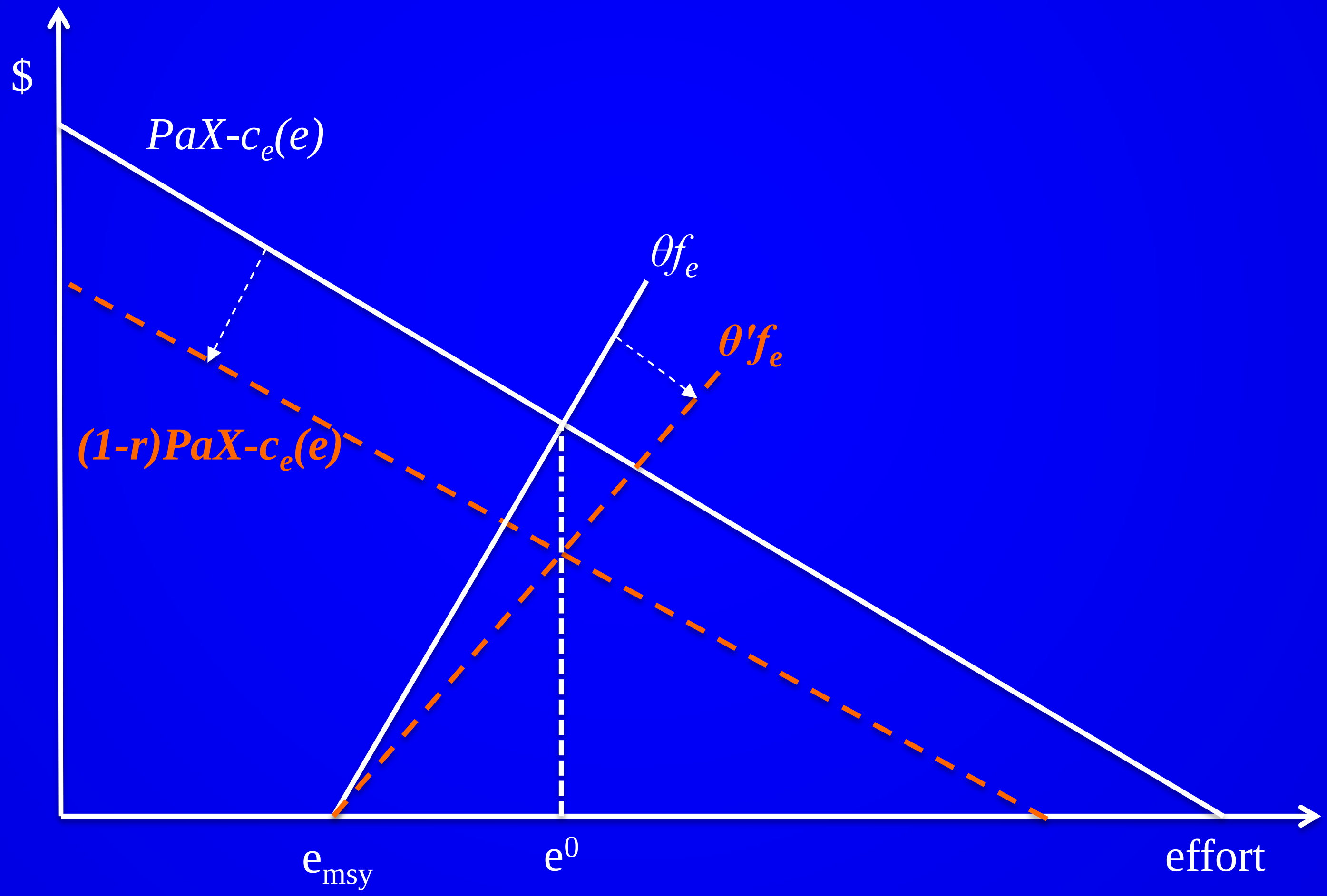
Firm's effort - with royalty, r>0



Firm's effort
Lower enforcement



Firm's effort with royalty, less enforcement



Enforcement & Compliance

- Aggregating each firm's effort rate across all firms results in the aggregate effort function

$$F = F(S,r,X)$$

- Using the population equilibrium function

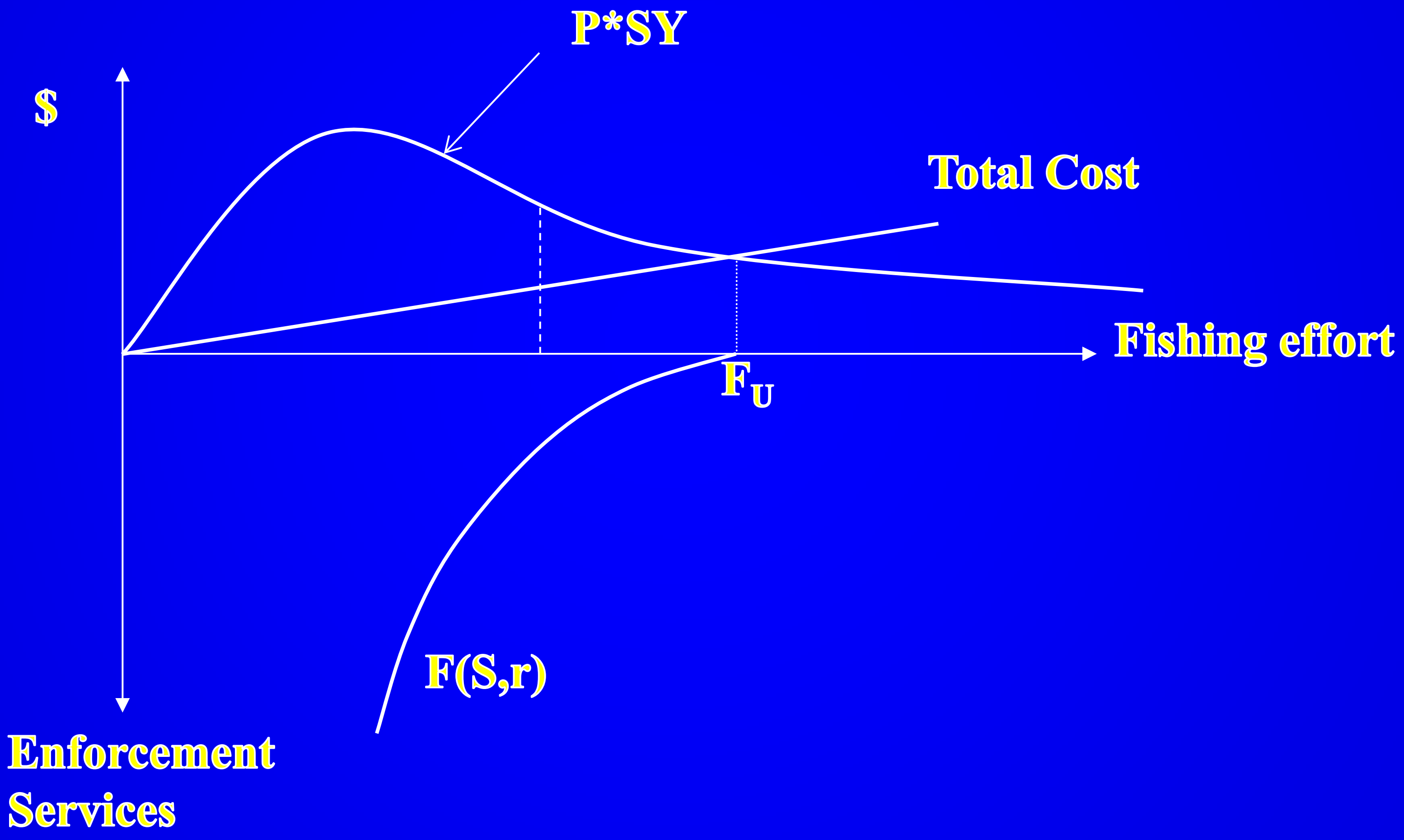
$$X = X(F)$$

- The aggregate effort function becomes

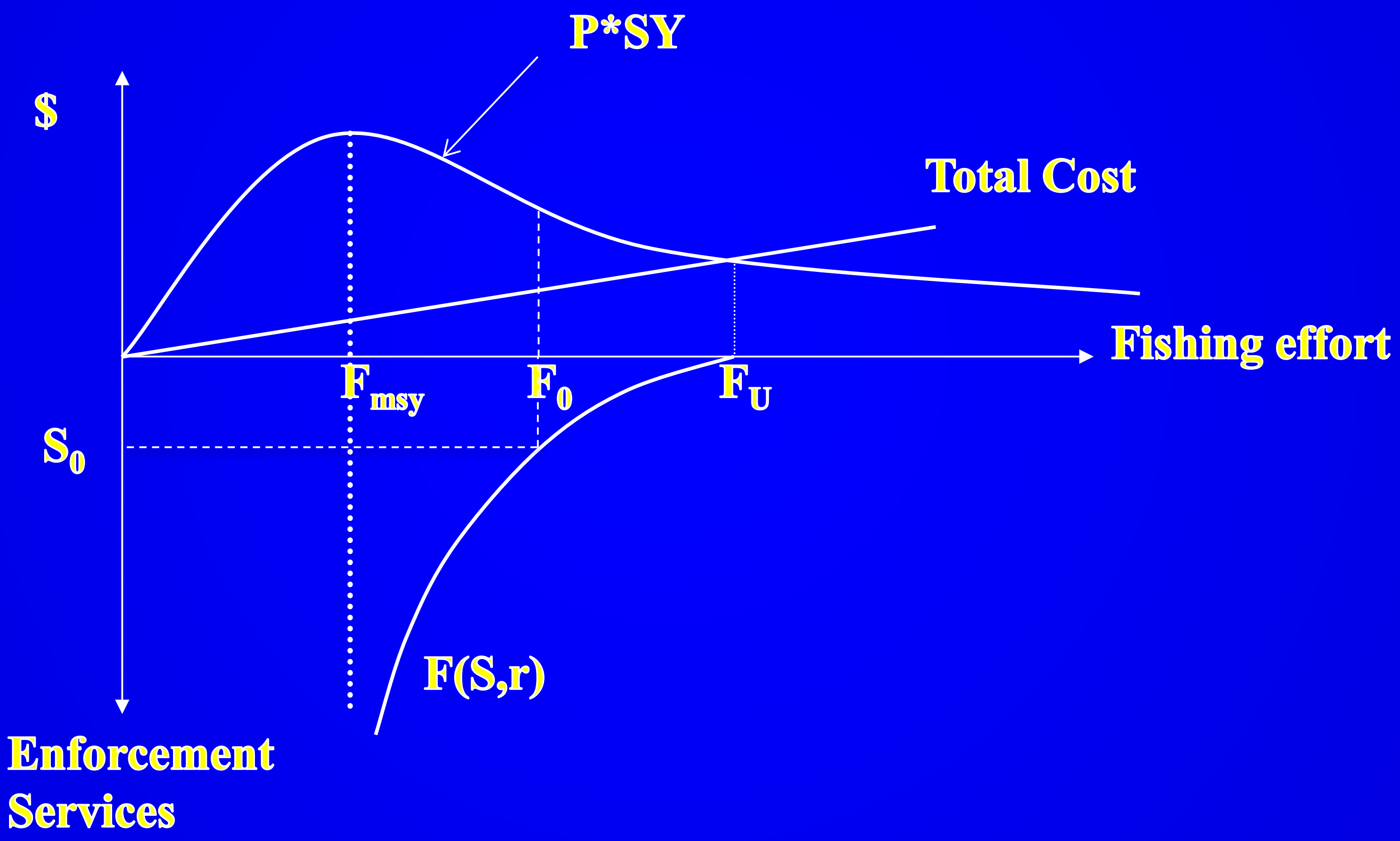
$$F = F(S,r)$$

Which is the relationship between aggregate effort, F, and enforcement services, S, and the royalty rate, r

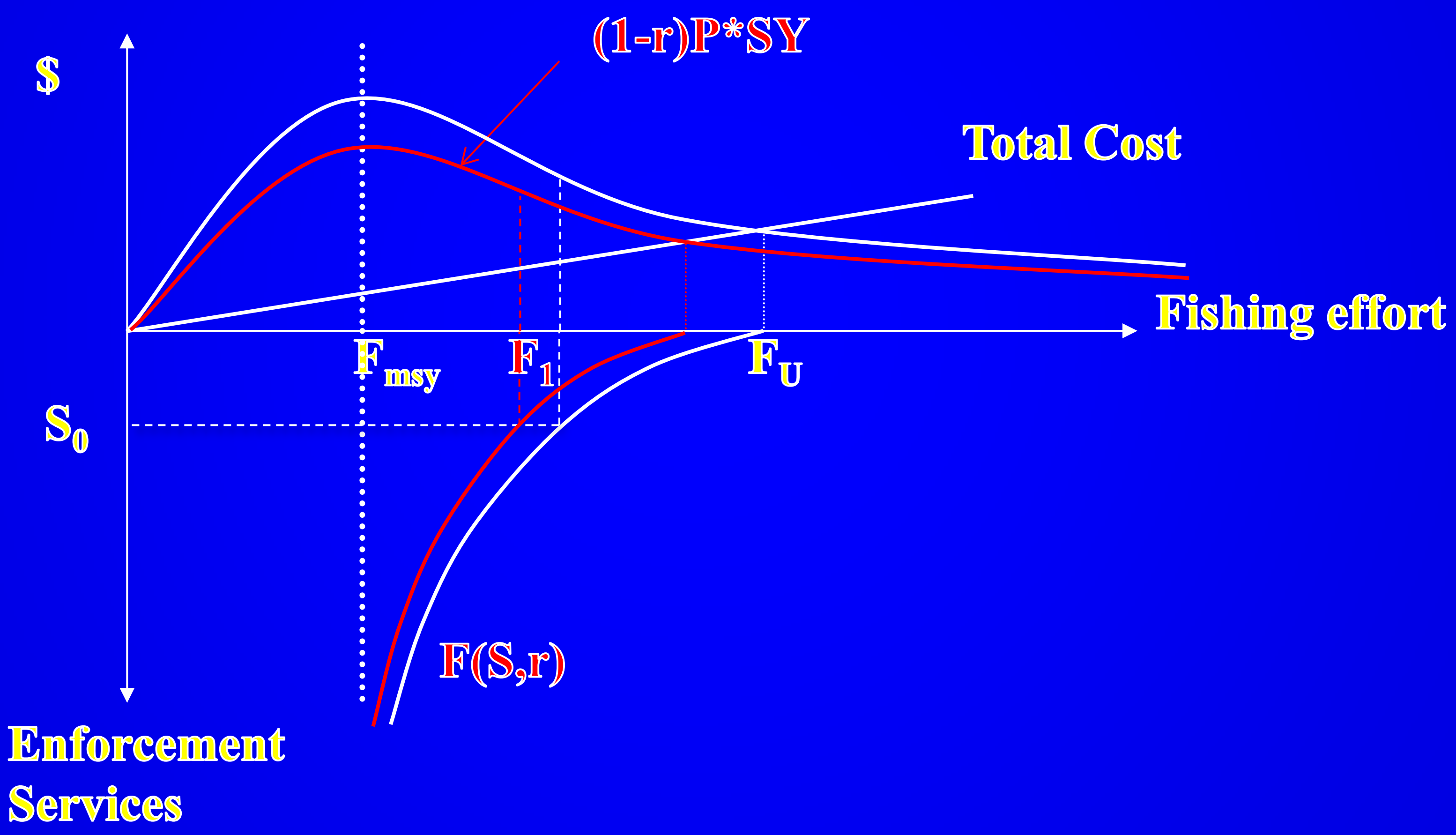
Bioeconomic outcomes, no royalty, *r = 0*



Bioeconomic outcomes, no royalty, *r = 0*



Bioeconomic consequences of a royalty, r > 0



Results & Discussion I

- A royalty to recover enforcement costs
  - Reduces the incentive to produce & violate
  - Can lower the cost & amount of enforcement for a given level of production
  - Has a conservation payoff
    - A result not heretofore understood
    - In addition to other efficiency payoffs

Results & Discussion II

- Our results are further evidence that

  'Who pays and how they pay'

  - Influences policies and performance of a fishery
  - Specifically, producers paying via a royalty appears to be one of the best methods to recover costs of management

Limitations

- Limitations of our analysis
  - Other management costs need to be considered
    - Research, observers, administrative, etc.
  - Only licensed, authorized producers are considered

Other Issues

- Pros & cons of different types of user charges?
  - User fees
  - Regulatory fees
  - Beneficiary-based taxes
  - Liability-based taxes
- How should user charges be set?
- How best to collect user charges?

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Other Issues

- User group management
  - Authority to manage fisheries devolved to cooperative, producer organizations, etc
    - How should user groups pay for management costs?
  - What's the appropriate analytical model?
    - A club à la Buchanan?
      - Andersen and Sutinen (2004)

Bioeconomics
Part II

- Dynamic optimal bioeconomic model
  - In terms of output, *Q*, not effort
  - Extension of the Sutinen and Andersen (1985) paper: The Economics of Fisheries Law Enforcement, *Land Economics*
  - Costly, imperfect enforcement

Enforcement Costs

- Enforcement costs are denoted by $E(\theta)$

  Where $E_\theta > 0$ and $E_{\theta\theta} > 0$

- Using the inverse form of the aggregate output function, $\theta = Q^{-1}(Q,r,X)$

$$E(\theta) = E(Q,r,X)$$

  Where $E_Q < 0$, $E_r < 0$, $E_X > 0$

Optimal Policy

- The management authority is assumed to maximize net social benefits subject to
  - The stock constraint, and
  - A cost recovery constraint
    - All enforcement costs are recovered via a royalty

Optimal Policy

In earlier work (Sutinen and Andersen 1985) we derived optimal policies by maximizing the discounted sum of net social benefits over time,

$$\int_0^{\infty}\left[\int_0^{Q} p(s)ds - C(Q,X) - E(r,Q,X)\right]e^{-\rho t}dt$$

Subject to the stock constraint

$$\dot{X} = h(X) - Q$$

Optimal Policy

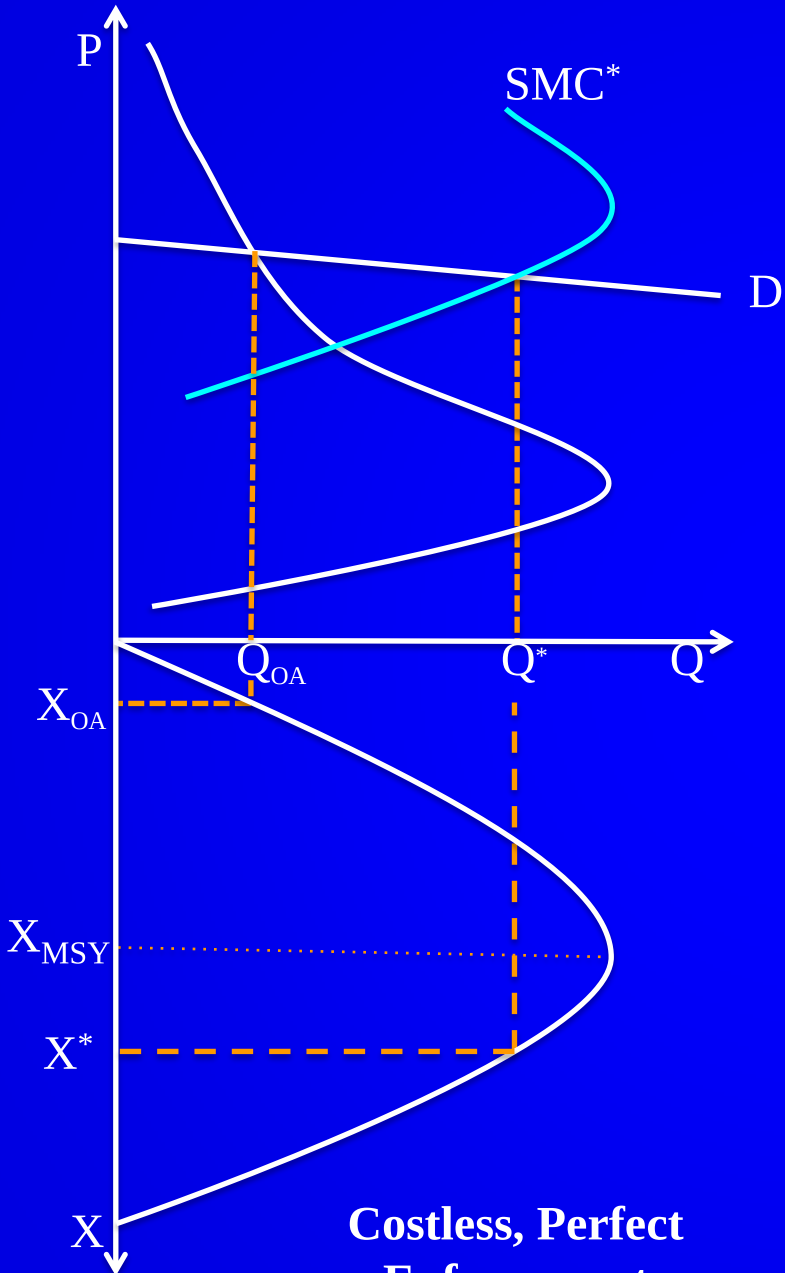
without cost recovery, *r=0*

The optimal stock size when enforcement costs are not recovered (*r=0*) is determined by

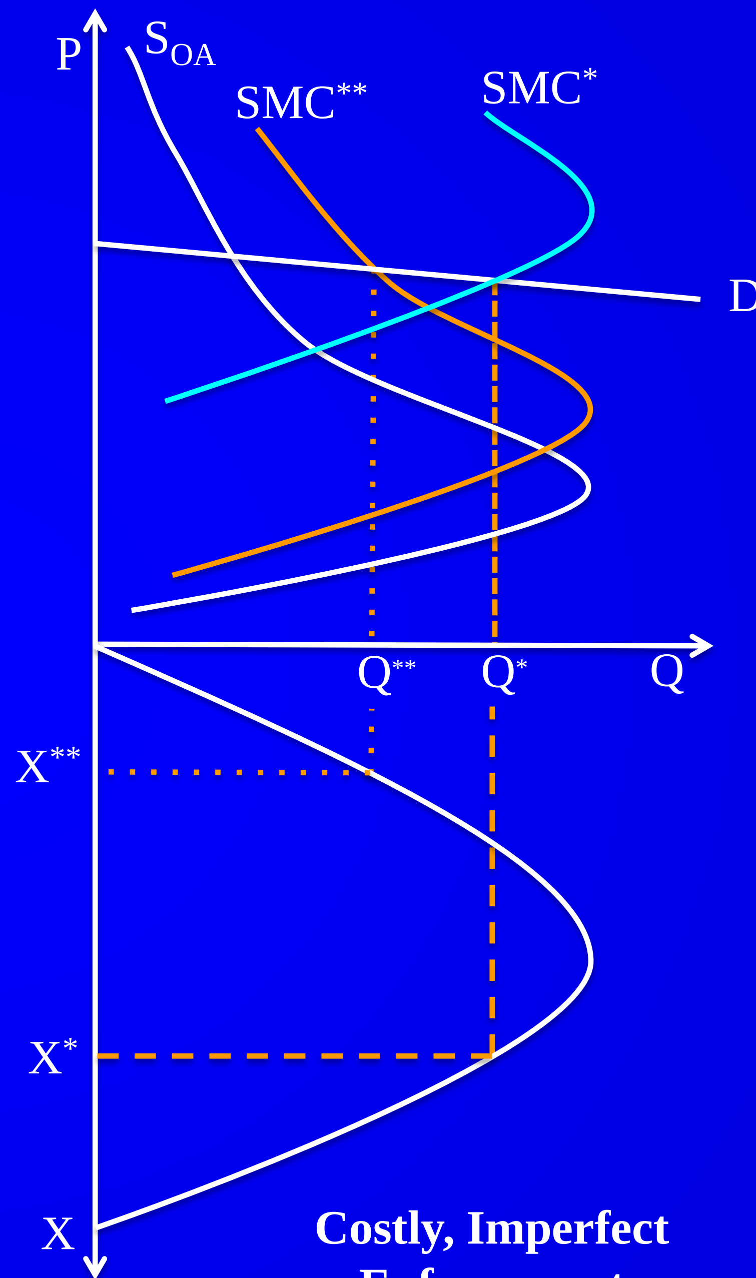
$$[\rho - h_x] = \frac{-(C_x + E_x)}{\{p - (C_Q + E_Q)\}}$$

which results in a SMC** that lies below the costless, perfect enforcement SMC* and a lower optimal stock size.

This result is illustrated in the following two graphs.



Costless, Perfect Enforcement



Costly, Imperfect Enforcement

Optimal Policy with cost recovery, r>0

Optimal policies are found by maximizing the discounted sum of net social benefits over time,

$$\int_0^\infty \left[\int_0^Q p(s)ds - C(Q,X) - E(r,Q,X)\right] e^{-\rho t} dt$$

Subject to the stock constraint

$$\dot{X} = h(X) - Q$$

and cost recovery constraint

$$rpQ = E(r,Q,X)$$

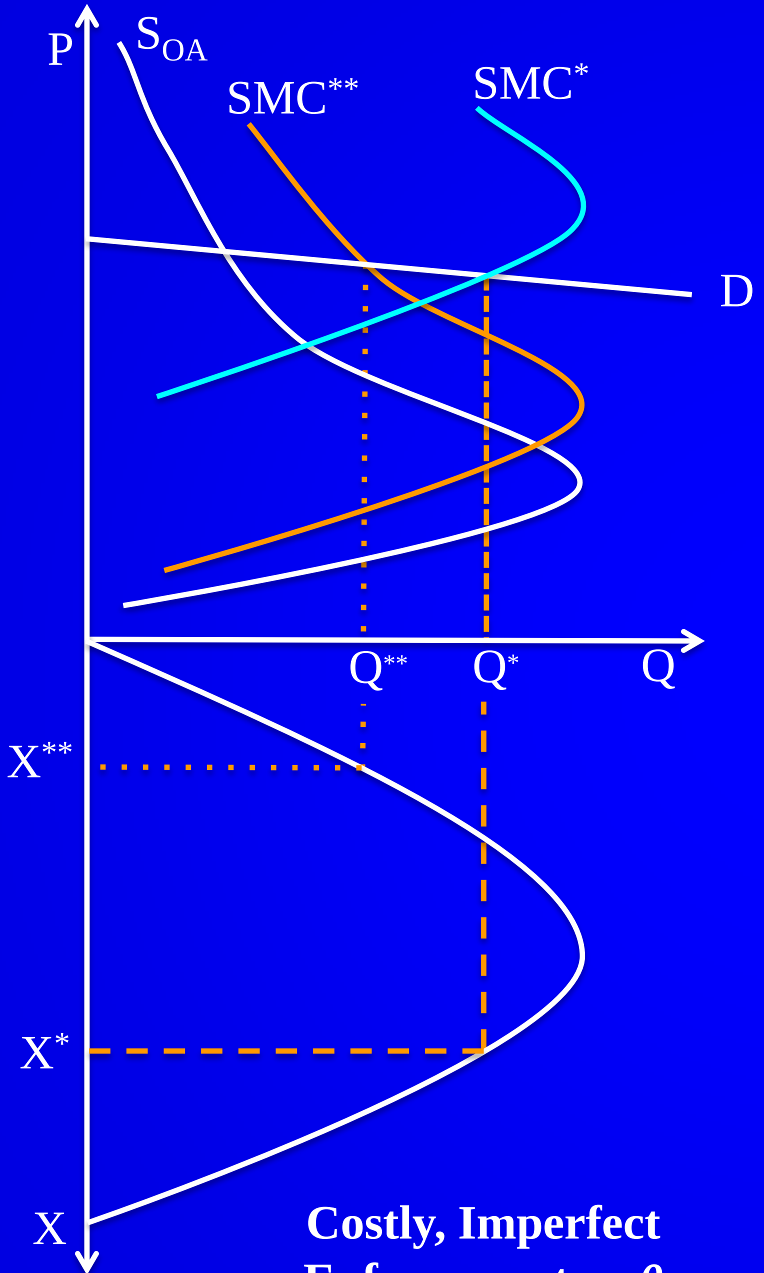
Optimal Policy
with cost recovery, *r>0*

When enforcement costs are recovered with a royalty (*r>0*), the optimal stock size is determined by a far more complex condition:

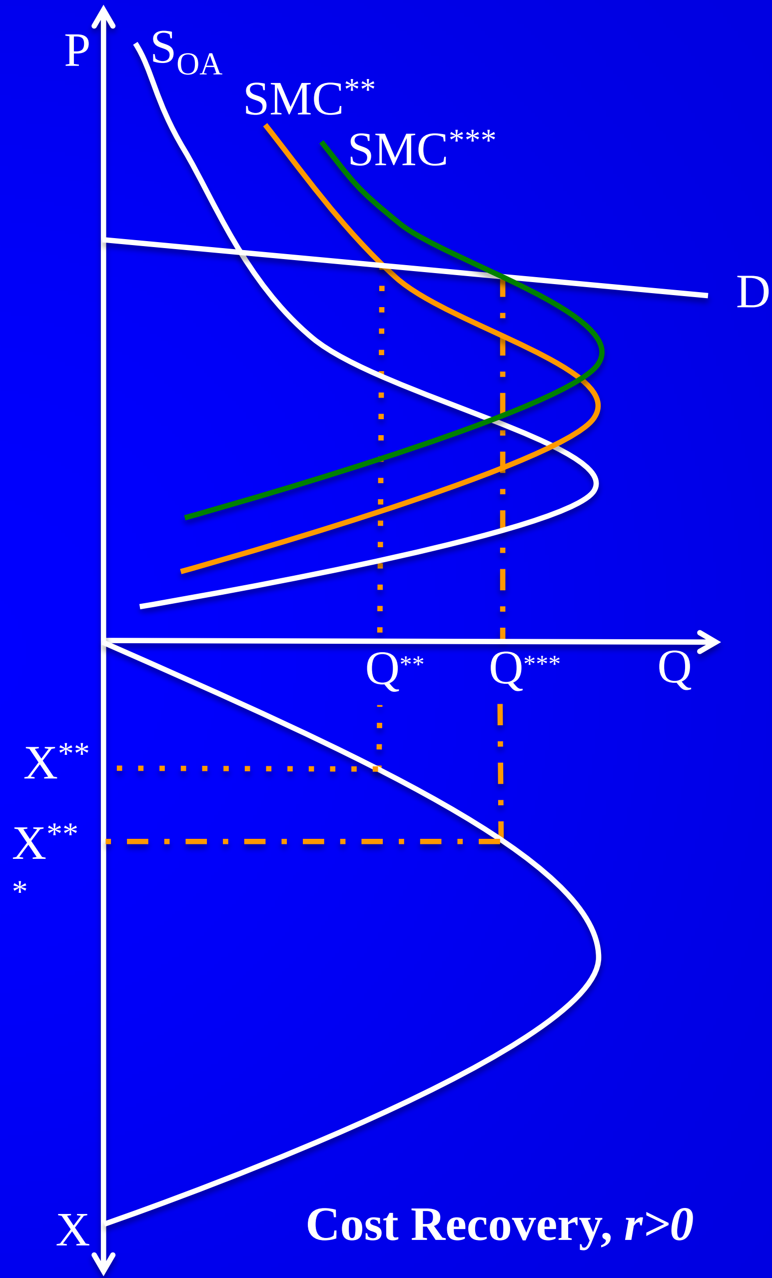
$$[\rho - h_x] = \frac{\{(E_r E_x)/[\,pq - E_r]\} - (C_x + E_x)}{\{p - C_Q - E_Q + E_r\left[rp - E_Q\right]/[pq - E_r]\}}$$

This shifts the SMC up towards the costless enforcement SMC* resulting in an optimal stock that is larger than when enforcement costs are not recovered with a royalty.

This is illustrated in the following graph.



Costly, Imperfect Enforcement, *r=0*



Cost Recovery, *r>0*

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