Are Taxes Preferred over Strong User Rights for Fisheries? An Empirical Analysis.

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Plan.

- Plan for presentation:
  - 1. Introduction.
  - 2. Prior literature.
  - 3. A theoretical simulation model.
  - 4. Empirical estimation.
  - 5. Main results.
  - 6. An operational indicator.
  - 7. Generalization.
  - 8. Conclusion.

1. Introduction.

- Fisheries: A stock externality arise.

- Regulation is necessary.

- Commonly suggested regulatory mechanism: Strong user rights (defined as ITQs).

- However recent papers: Taxes can be preferred over strong user rights under various kinds of uncertainty.

- Pro-tax results: Theoretical arguments.

- No empirical investigation of the actual welfare gain of switching to taxes.

- This paper: How large is the actual gain of switching to tax regulation?

1. Introduction.

- Specifically we consider two research questions:
  - 1. Is there a welfare gain of switching to taxes and how large is this gain?
  - 2. Is there a reliable operational indicator that can be used to approximate the welfare gain switching to taxes?

  To answer these two questions we estimate biological and economic functions for the Danish cod fishery in Kattegat.

  Based on these functions the welfare gain switching to taxes is simulated.

2. Prior literature.

- Three theoretical contribution on tax versus strong user right for regulating for fisheries:

  - 1. Weitzman (2002). Use a stochastic stock-growth model to study pure biological uncertainty. Assume zero economics of scale in harvest. Taxes is always preferred over strong user rights.

  - 2. Hansen and Jensen (2015). Extend Weitzman (2002) to include non-zero economics of scale. Positive economics of scale: The welfare gain of taxes increase. Negative economics of scale: The choice between taxes and strong user rights depend on the relative size of the marginal stock cost and marginal harvest costs.

2. Prior literature.

- – 3. Hansen et al (2008). Investigate the implications of uncertainty about illegal landings (pure compliance uncertainty). Use the same model as Weitzman (2002). Taxes is always preferred over strong user rights.

- Conclusion from previous literature: Under various forms of uncertainty taxes may be preferred over strong user rights.

- However: How large is the welfare gain of switching to taxes for an actual fishery?

3. Theoretical simulation model.

- Our model is based on a feedback rule: A functional relation between the value of a control variable in a current period and previous periods values of a state variable.

- In the model: Biological uncertainty and compliance uncertainty is included.

- Fishermen make decisions in two possible situations:

  - Strong user rights: Maximize the profit less the expected penalty payments subject to a quota restriction.

  - Taxes: Maximize the profit less tax payment and the expected penalty payment.

3. Theoretical simulation model.

- Regulator faces biological and compliance uncertainty. Maximize expected welfare under a resource restriction.

- Resource restriction: Imply interdependence between the distinct time periods.

- Regulatory instrument (the tax or the quota) is the control variable.

- Fishermen´s reaction functions (the first-order conditions) is included.

- To find the value of the control variables (the regulatory instruments): Taylor approximations is used. G captures the number of time periods for which previous periods stock size is included. This is the feedback-rule.

3. Theoretical model.

- $G = 0$. Previous periods stock size is not included at all. A first-order Taylor approximation. Uniform taxes and strong user rights. This assumption is used in previous literature.

- $G = 1$. Last periods stock size is included. A second-order Taylor approximation.

- $G > 1$. More advanced rules. Higher-order Taylor approximations.

- Advantage of the feedback rule: Allow more advanced regulatory rules.

- Using a feedback-rule to compare regulatory instruments for fisheries: A novel contribution.

4. Empirical estimation.

- Specific functional forms and parameters is necessary for finding the welfare gain.

- For the Danish cod fishery in Kattegat three functions is considered:

  1. A logistic growth function have been estimated. The variances of the random variable in the estimation is a measure for the size of biological uncertainty.

  2. A cost function have been estimated. The degree of economics of scale in harvest is explicitly included.

  3. A penalty function have been calibrated. The variance of the calculated enforcement efficiency is a measure for the size of compliance uncertainty.

5. Main result.

- We obtain that the is negative and significant economics of scale for the Danish cod fishery in Kattegat.

- Despite this: Taxes is always preferred over strong user rights. Thus, the marginal stock costs dominates the marginal harvest costs.

- Some results of the simulations of the model is shown below.

5. Main results.

	Welfare gain of taxes compared to strong user rights (%)
Pure biological uncertainty	
G = 0	2.77
Pure compliance uncertainty	
G = 0	0.15
Combined uncertainty	
G=0	2.83
G=1	1.62
G=2	1.62
G=3	1.61

5. Main results.

- For G = 0:
    - a. Pure biological uncertainty. Weitzman (2002) and Hansen and Jensen (2015). The welfare gain of switching to taxes is low.
    - b. Pure compliance uncertainty. Hansen et al (2008). The welfare gain of switching to taxes is very low.
    - c. Combined uncertainty. The welfare gain of switching to taxes is low.

    For G > 0:

    More advanced regulatory rules decrease the welfare gain of switching to taxes.

5. Main results.

- Sensitivity analysis: Varying all parameter values with +/- 50% separately. Correspond to a comparative static analysis.

- Results:
    - 1. Varying parameters in the cost function and the measure for compliance uncertainty has almost no effect on the welfare gain of switching to taxes.
    - 2. Varying parameters in the natural growth function may influence the welfare gain. However, only when the carrying capacity is decreased with 50% the welfare gain of switching to taxes become so high that the choice of regulatory instrument matters (a level on 12.35%).

    Conclusion: The choice between tax and strong user rights is not empirical important for the Danish cod fishery in Kattegat.

6. An operational indicator.

- Problem with the analysis above:

  - The information requirements is huge.

  Therefore: Can we develop a simple, operational indicator that can be used to approximate the welfare gain of switching to taxes when the regulator known that negative economics of scale exist?

  Above: The main variation in the welfare gain of switching to taxes arise when varying the parameters in the logistic growth function.

 Therefore: The indicator must be based on this function.

6. An operational indicator.

- Under negative economics of scale we suggest using:

  (the size of biological uncertainty)/(stock size at MSY).

  Whether this indicator can be used is investigated by using two methods:

  1. Correlation coefficients for the results of the sensitivity analysis mentioned above. The correlation coefficients between the indicator and the welfare gain of switching to taxes is large.

  2. An upper and lower bound for the welfare gain of switching to taxes is identified. Additional simulations have been conducted and the results is shown below.

6. An operational indicator.
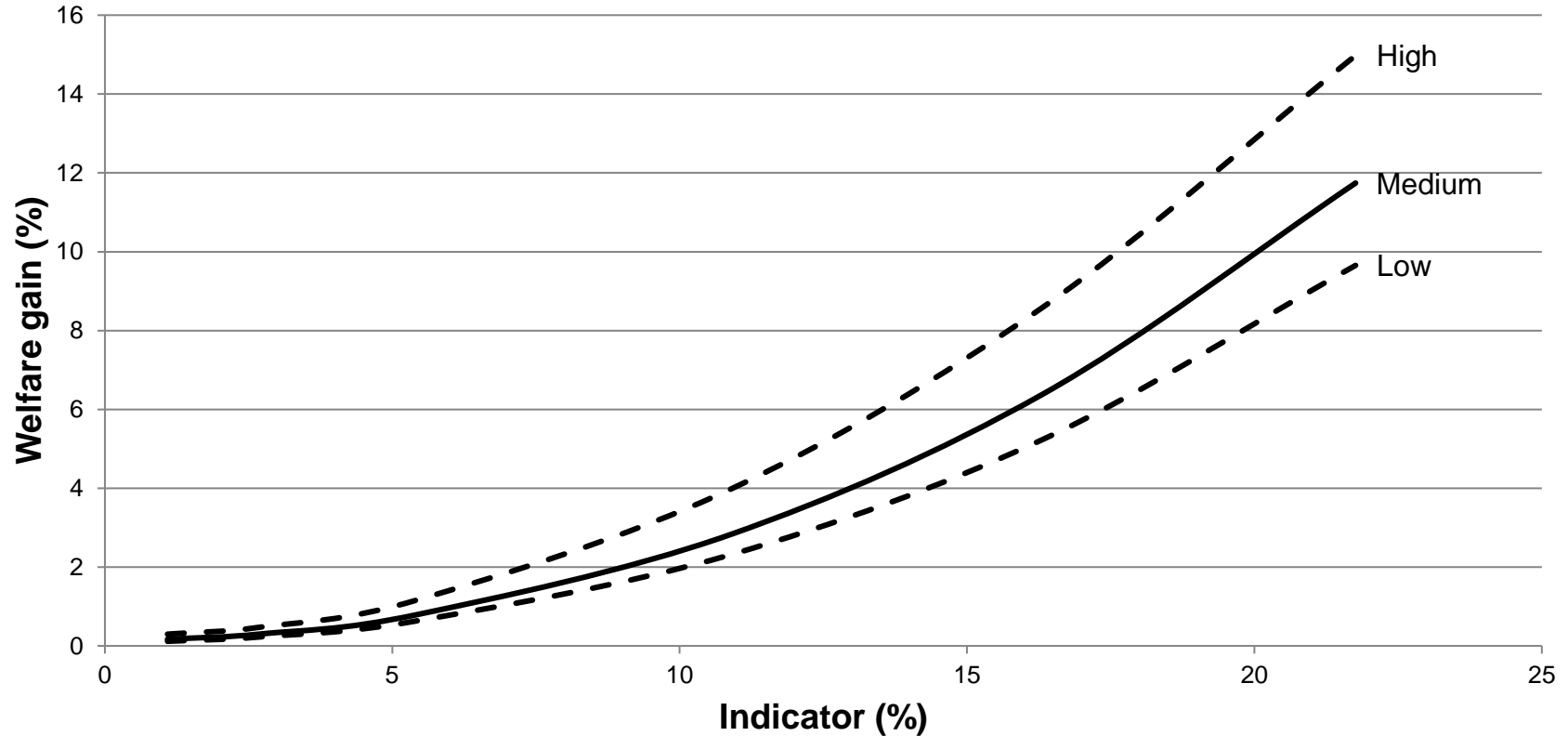
6. An operational indicator.

- Conclusion: The indicator is a good approximation of the welfare gain of switching to taxes under negative economics of scale.

- Advantage of indicator: When a regulator knows that negative economics of scale exist only a logistic growth function shall be estimated.

- Thus, the information requirements is reduced considerably.

7. Generalization.

- Can the indicator be used to generalize the result about the low welfare gain of switching to taxes to other fisheries where there are negative economics scale?

- Have reviewed existing literature estimating logistic growth functions.

- Most of the papers have not estimated the degree of economics of scale. However, we assume that the fisheries is characterized by negative economics of scale.

- Many papers: Do not report the size of biological uncertainty.

- Therefore: Only 10 studies have been included. Shown in Figure below.

7. Generalization.
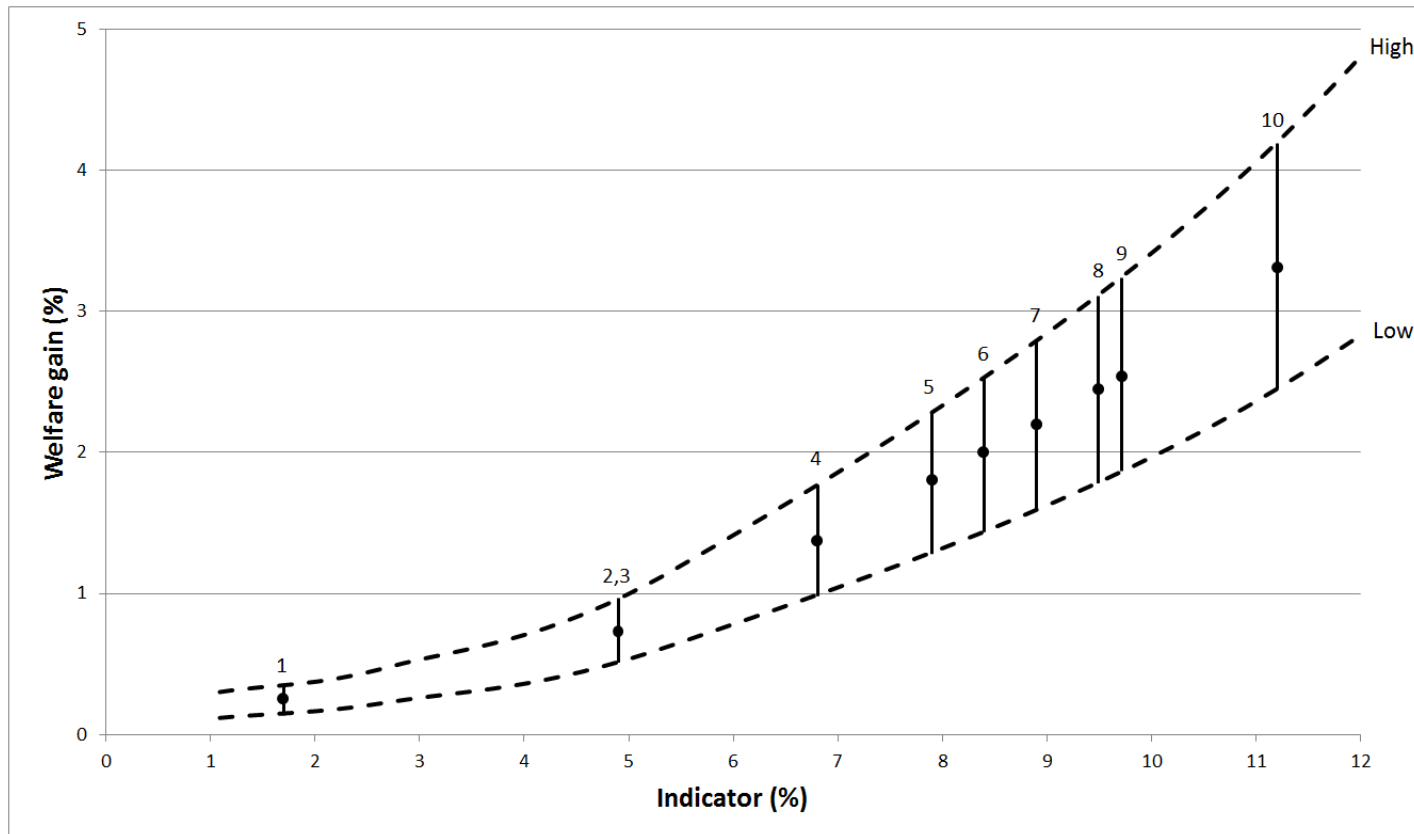
7. Generalization.

- Figure: In all papers we have reviewed that estimate a logistic growth function, the welfare gain of switching to taxes is small.

8. Conclusion.

- Three main conclusions:

    - 1. The welfare gain of switching to taxes for the Danish cod fishery in Kattegat is very small.

    - 2. Under negative economics of scale the parameters in the logistic growth function can be used to approximate the welfare gain of switching to taxes.

    - 3. Under negative economics of scale the result under 1 generalize to other fisheries.

    Tempting to conclude: Theoretical analyses of tax versus strong user rights under biological uncertainty and compliance uncertainty is simply vast of time.

    However, to draw this conclusion we must also analyze the size of the welfare gain of switching to taxes under positive economics of scale.