ECN 275/375 – Natural resource and environmental economics
12:15-15:15 March 7, 2023

All help aids allowed except assistance from others.
This test consists of 3 questions, for a total score of 100 points.
All questions are to be answered. You may answer in English or Norwegian.

In the case that you find a question unclear, or you are uncertain about what is meant, state the extra assumptions you need to be able to answer the question.

This test has been made to reduce the usefulness of ChatGPT. For thi tes using ChatGPT is not considered a violation of the independent work condition for tests/exams.

When I submit my answers on this test, I confirm that I have worked alone on my answers and not cooperated with others. I am aware that cooperation with others is to be considered an attempt or a contribution to cheat.
I am aware of the consequences of cheating (Ch. 39, Academic regulations for NMBU).

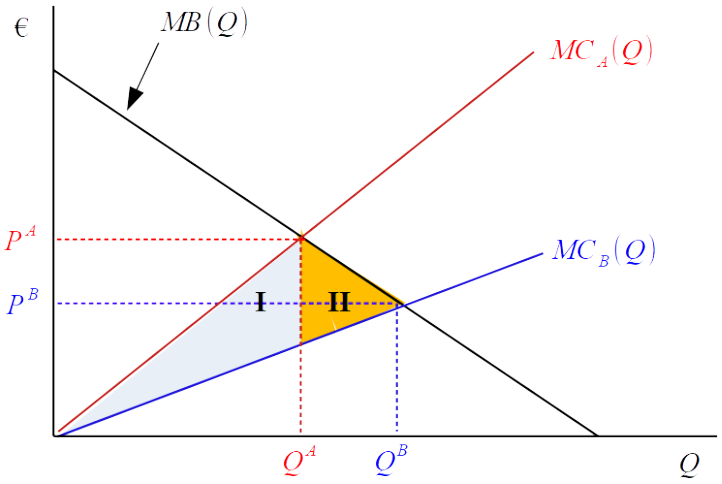
Your name: NN (+ ECN 275 or ECN 375)

Question 1 (30 points)

Supplying environmental goods and services under varying technologies when there is absence of environmental stock effects. Assume a standard marginal benefit function from increased production of the environmental good, Q.

(a) (i) Draw a graph that shows the optimal level to produce of an environmental good, Q, with the technology A. Label all axes and curves, and mark the optimal amount Q^A.
(ii) Explain verbally and mathematically the condition for the optimal allocation.
(10 points)

Answer: (i) The marginal cost function for the initial technology is given by $MC_A(Q)$ (blue lines and colored areas relates to question b). The marginal benefits from producing Q is given by $MB(Q)$.



(ii) The optimal level of Q^A makes the marginal cost of production equal to the marginal benefits evaluated at Q^A. Mathematically: $MC(Q^A) = MB(Q^A)$.

(b) A new production technology, B, is voluntarily* adopted by producers. (i) Draw a curve representing this new technology in the graph for (a), and explain the news curve's relation to the curve you drew in (a). (ii) Mark the optimal amount Q^B, and mark the welfare gains from adopting the new technology.

* Voluntary adoption in this case: Firms choose to adopt the new technology without the influence of additional governmental regulations or requirements.

Answer: (i) Absence of stock effects implies that the marginal benefit curve does not change over time. It therefore remains the same and is marked $MB(Q)$. A new technology that is adopted implies that its production costs are less for the original optimal production level and the new optimal production level. The marginal cost curve $MC_B(Q)$ meets this condition as it lies below the initial marginal cost curve.

(ii) The new optimal production level is given by Q^B on the figure. The welfare gains are given by the sum of the cost savings for producing Q^A (light blue area **I**), and increased net environmental benefits from further production to Q^B (orange area **II**).

(c) (i) Explain verbally how you would calculate the welfare gains in (b). (ii) Set up a mathematical expression that calculates the welfare gains shown in the graph you drew in (b). **(10 points)**

Answer: (i) For production up to Q^A the welfare gains are the difference in total costs between the two cost curves, i.e., the area marked **I**. For the production increase from Q^A to Q^B, the welfare gains are given by the triangle **II**, which is the increase in environmental benefits from the production increase less the extra costs of increasing the production.

(ii) Mathematically when I denote welfare gains as ΔW:

$$\Delta W = \int_0^{Q^A} \left(MC_A(Q) - MC_B(Q)\right) dQ + \int_{Q^A}^{Q^B} \left(MB(Q) - MC_B(Q)\right) dQ$$

Question 2 (30 points)

Uniform price procurement auctions opens for truthful revelation of producers' costs of supplying environmental goods like biodiversity or conservation habitat. Such auctions and how they are applied still need to be carefully designed to get *truthful revelation*. There are also some concerns related to uniform price auctions leading to the possible excessive rents to bidders in uniform price auctions. The European Union has even gone further, requiring that in association with payments for environmental contracts, there should be no (extra) rents.

(a) For procurement auctions: (i) Define truthful revelation. (ii) Define the N^{th} bid, and explain how the price is determined in *N-price* uniform price auctions and (*N*+1)-*price* uniform price auctions. **(5 points)**

Answer: (i) Truthful revelation (bidding) implies that the bid given by an agent equals the agent's opportunity cost, i.e., $b_i = c_i$.

(ii) The N^{th} bid is the last bid given a contract, i.e., the last winning bid.

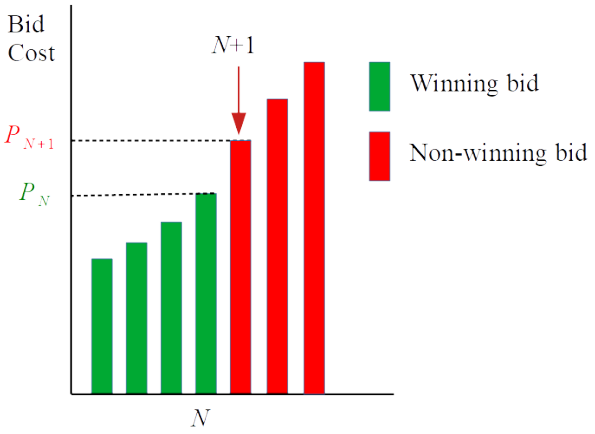
N-price uniform price auction: Last winning bid sets the price.

(*N*+1)-*price* uniform price auctions: First non-winning sets the price.

Question 2-b on the next page

(b) (i) Draw a graph showing that producer rents decline when using the *N-price* rule over the (*N*+1)*-price* rule in a uniform price procurement auction. Explain briefly why you have drawn your graph the way you have. (ii) Explain what the rents to winning bidders are for the two price rules. (iii) Explain verbally why the incentives for truthful bidding are less disputed for an (*N*+1)*-price rule* than for an *N-price rule* auction. **(15 points)**

Answer: (i) Bids are sorted from the lowest to the highest bid on the horizontal axis. For demonstration purposes the graph only contains seven bidders, and four contracts are to be awarded ($N=4$). The height of each bar shows the truthful bid, $b_i=c_i$ for bidder *i*.



The graph is drawn to highlight the issues needed to answer the ensuing questions.

(ii) Rents to winning bidders are the differences between their bid $b_i=c_i$ and:

N-price rule: Rents $\pi_i=P_N-b_i$. (*N*+1)*-price* rule: Rents $\pi_i=P_{N+1}-b_i$.

(iii) The (*N*+1)*-price* rule is less disputed in procurement auctions on its truth-telling properties than the *N-price rule* as it completely separates the price paid to winners, P_{N+1}, from their bid. For the *N-price rule* the last winner of a contract is paid equal to the bid, i.e., P_N-b_N. This implies that attempts to manipulate the auction price cannot be ruled out for an agent who perceives he/she could be the N^{th} bidder.

(c) Why is the EU's "no extra rent rule" problematic for the truthful revelation properties of policies to supply environmental goods or services? **(10 points)**

Answer: The "no extra rent rule" basically rules out using uniform price auctions as a mechanism for allocating contracts for supplying environmental goods and services due to the information rents inherent in uniform price auctions.

If (discriminatory price) auctions were to be used to allocate such contracts, the incentives for truthful bidding are reduced, which means that bids received could be strategically manipulated (potential providers who are reasonably certain there are low cost providers) could hand in a bid $b_i>c_i$, implying hidden information rents. That could reduce the legitimacy of payment schemes for providing environmental goods and services.

Only the two above points are required for full score on this sub-question. Please note:

- The EU policy in this matter is also inconsistent with their own policies of paying fixed rates subsidies, *S*, because providers where $c_i<S$ would by definition receive rents equal to $\pi=S-c_i$.
- Finally, the EU-rule breaks with any market logic as we know that in ordinary markets with costs of entering the market as producers earn rents when individual marginal production costs are increasing . Draw a simple graph to see this point. Note that if entry to a market is costless, most rents would disappear as costless entry drives down prices to $AVC_i(q_i^*)=MC_i(q_i^*)$, i.e., to the minimum cost solutions you are (or should be?) familiar with from your intermediate micro economics classes.

Question 3 (40 points)

Increasing the share of electric vehicles (EVs) is an important part of Norwegian policies to reduce domestic climate gas emissions. Many economists are highly critical of this EV policy, arguing that one of the faults of these regulations is that the subsidies and other benefits to EV owners are excessive. Non-governmental organizations (NGOs) like Bellona and Zero argue that subsidies and other benefits are necessary compliments to carbon emission taxes or tradable carbon emission permits to achieve sufficiently large reductions in carbon emissions.

Comment on the validity and weaknesses of the following two views:

(a) The mainstream economic position is that for negative externalities like carbon emissions, environmental regulations should primarily focus on pricing, i.e., taxing, the externality. **(10 points)**

Answer main points:

- Subsidizing the reduction of "bads" increases the risk of entry → extent of negative externality grows.
- Taxes provides revenues for the government which enable the reduction of other taxes with undersirable distortionnary effects. Example: Lower labor taxes increase the value of work → people work less → GDP/capita is lower.
- Subsidies reduces government funds available for promoting other welfare enhancing activities like education, culture, and infrastructure. On the latter: Some of the "subsidies" to Norwegian EV owners could have been spent on improving public transportation which would lower GHG emissions and produce other benefits (like less particulate matter and costly road accidents). In brief: The *opportunity value* or *marginal cost of public funds* arguments.

(b) The NGO's position that targeted supports to reward consumers for adopting environmentally more friendly technologies are needed to reach the targets for reduced carbon emissions. **(10 points)**

Answer main points:

- Using EVs as an example: EV-subsidies increase the demand for EVs → EV research and development (R&D) become more profitable → more EV R&D.
- A more direct and less costly approach to society would be to directly part-fund EV R&D.

EVs have less emissions over the lifetime of the vehicle compared to fossil fuel powered vehicles (FVs) of similar size provided that the distance driven is sufficiently large. The "lifetime profile" of emissions of EVs and FVs differ, with a high share of EV emissions occurring during the construction phase, while for FVs a large share of emissions occurs from using the vehicle.

(c) (i) How does this difference in lifetime emission profiles matter from an economic efficiency perspective? (ii) How could you make the efficiency properties of the lifetime emission profiles (life cycle analysis) more comparable to ordinary economic effectiveness analyses? Please justify your answers. **(10 points)**

Answer main points:

- (i) Early emissions cause more damage than late emissions even from a natural science perspective, in particular for stock pollutants → early damages should be given more weight.
- (ii) Discounting one way of providing such weights.

On a wider climate policy scale, there are trade-offs between the expected cost savings from technological progress over time, and the expected gains of early reductions in climate gas emissions.

(d) How do the above trade-offs influence the extent (strictness) of climate policy over time? Please justify your answer. **(10 points)**

Answer main points:

- Static analyses falls short. We need to compare the discounted cost savings over time with the discounted benefits from early adoption of emissions reducing measures.
- As the concentration of GHG in the atmosphere increases and we see natural emissions increase (like thawing of the thundra leading to methane emissions), the marginal damages of emissions are like to increase. There could be threshold issues with unknown severity and arrival time, that increases advantages of shifting abatement measures forward in time.