

**MARKET REGULATION - EXERCISE**

Consider the competitive market for fertilizer, assumed to be a homogenous good. "Producers" make fertilizer and sell it to "users". Their aggregate demand is given by:  $Q_D = 25 - p/2$ . The producers' aggregate supply is given by  $Q_S = p/4 - 2$  (which corresponds to a total cost of production  $TC = 8q + 2q^2$ ).

1. Calculate the market equilibrium, i.e., the market price  $P_M$  and the quantity traded  $Q_M$ .
2. Represent this graphically. Warning: The supply curve does not start from (0,0).



3. Calculate the marginal willingness to pay (mWTP) function, i.e., the inverse of the demand function, and the marginal willingness to accept (mWTA) function, i.e., the inverse of the supply function.

4. For the market equilibrium, calculate the surpluses of the users and the producers, as well as the UP surplus, defined as the sum of these surpluses. Check your result for the UP surplus by recalculating it as total WTP minus total WTA (i.e., total cost).

Production causes external costs (environmental degradation, for example) as a function of the quantity produced:  $EC = 2q + q^2$ .

5. Calculate the marginal external cost function (= the external cost of an additional unit of production) and the social mWTA function. Add it to the graph above.
6. Calculate the socially optimal level of production  $Q^*$ . Compare it with the market equilibrium and explain the differences.
7. Calculate the price  $P_H^*$  at which the users would want to buy the quantity  $Q^*$  of fertilizer, and the price  $P_L^*$  at which the producers would want to sell the quantity  $Q^*$  of fertilizer.
8. Calculate the UP surplus for the social optimum  $Q^*$ , under the assumption that the users with the highest WTP get  $Q^*$  and that the producers with the lowest WTA (i.e., costs) produce it. To do this, calculate total WTP and total private WTA for  $Q^*$ .
9. Calculate the total external costs for  $Q_M$  and  $Q^*$  and recompute total surpluses corrected for external costs. What do your results show?

You are going to compare different possible interventions by the regulator:

10. The authority issues free production quotas to the sellers who produced  $Q_M$ , for a total amount equal to  $Q^*$ . The trade of these quotas is organised, to make sure that it is the producers with the lowest production costs who produce  $Q^*$ . What will be the price of fertilizer? Calculate the users' and producers' surpluses (all producers', whether they actually produce or not), the UP surplus and the social surplus corrected for external costs.
11. The authority introduces a unit tax on production, sufficient to move the market equilibrium to  $Q^*$ . Calculate the rate of this tax and the new WTA and supply function for the producers when they have to pay this tax per unit of sales. Show that the new market equilibrium is the social optimum.
12. Compute the tax revenue. Calculate the distribution of this burden between users and producers. Compare the tax revenue with the external cost for  $Q^*$  and explain the difference.

13. Calculate the users' and producers' surpluses, UP surplus and total surplus, where the latter includes tax revenue and external cost, following the introduction of this tax.
14. Instead of taxing the production of fertilizer, the authority decides to offer a subsidy to producers who reduce their production of fertilizer, proportional to the production reduction relative to  $Q_M$ . Calculate the rate of the subsidy sufficient to move the market equilibrium to  $Q^*$  and show that if sellers get this subsidy per unit that they do not sell compared to  $Q_M$ , the new market equilibrium is the social optimum.
15. Compute the total amount of subsidy that will result, the user and producer surpluses, UP surplus and total surplus, where the latter includes subsidy cost and external cost.
16. Compare the outcomes of the equilibria you calculated: initial market equilibrium, equilibrium with a cap on production with free transferable production quotas, equilibrium with the incentive tax, equilibrium with incentive subsidy. Compare them in terms of surpluses and comment. Begin by filling your answers to the earlier questions into the table below.

Equilibrium	Users' surplus	Producers' surplus	UP surplus	Transfer to 'social'	External cost	Social surplus
$Q_M$						
Cap						
Tax						
Subsidy						