## EXTERNALITIES

## Problem \#1

A beekeeper owns an apiary [i.e. a shed containing a number of beehives] located in the neighborhood of an orchard. The marginal cost of its operation equals $\mathrm{MC}(q)=10+2 q$, where $q$ is the number of beehives. Each beehive brings him honey that he can sell in the market for the price of 20 PLN. The owner of the orchard obtains significant benefits from the apiary located nearby. One beehive pollinates ca. 1 acre of his apple orchard. The profits resulting from this for the owner of the orchard are "free". The number of beehives is, however, insufficient for the pollination of the entire apple orchard. For this reason its owner supplements the pollination process artificially and this costs him 10 PLN per acre.
a) How many beehives will the beekeeper be willing to maintain?
b) How may beehives maintained by the beekeeper would be efficient from the social point of view?

## Problem \#2

A student of chemistry varnishes tin containers in his apartment during the summer. Purchasing unvarnished containers costs him 200 cents per unit. The marginal cost of varnishing is $\mathrm{MC}(q)=150-10 q$ $+q^{2}$ cents, where $q$ stands for the amount of containers. The unpleasant odor of the varnish bothers the student's neighbors. For avoiding this trouble they would altogether pay $5 q^{2}$ cents. The student sells varnished containers in a competitive market for souvenirs at a price of 450 cents per unit. Find the socially efficient amount of containers that should be varnished by the student.

## Problem \#3

A German company producing luxurious deodorants operates in a purely competitive industry. The marginal production cost of deodorants is described by the formula $\mathrm{MC}(q)=0.4 q$, where $q$ stands for the amount of packages. The market price of a package is 20 euro. The local government is, however, aware that the production process of this company pollutes the natural environment. According to its estimations, the social marginal cost of producing deodorants is $\operatorname{SMC}(q)=0.5 q$.
a) Find the optimal output level (number of deodorants produced) from the point of view of the firm.
b) Find the optimal output level from the social point of view.
c) How much must a tax imposed by the government amount to so as to provide for the socially efficient output amount?

## Problem \#4

There are two factories in a little village. One of them produces shoes according to the cost function $C(x)=$ $x^{2}+10$, where $x$ denotes the number of pairs. However, side products of this production process are polluting the nearby river. The second factory, producing fruit juice, bears additional costs connected with the necessity to purify the water from the river. The cost function for this factory is $C(y)=y^{2}+x$, where $y$ is the number of juice containers. Both factories are selling their products in a purely competitive market. The price of a pair of shoes is 20000 , while for a container of juice it is 40000 . Find the output of both factories in the case when authorities do not interfere. Determine the efficient rate of the Pigouvian tax imposed on products of the first factory.

## Problem \#1

The analysis of a market with an externality shows that equilibrium can emerge in a point which is not Pareto-optimal. Does this contradict the First Theorem of Welfare Economics?

## Problem \#2

The private and social marginal costs functions are given by the following formulas: $\operatorname{MPC}(q)=2 q$, $\operatorname{MSC}(q)=1+3 q$, where $q$ stands for output quantity. The private and social marginal benefits functions are: $\operatorname{MPB}(q)=\operatorname{MSB}(q)=61-2 q$. Find the Pigouvian tax rate $(P T(q))$ eliminating inefficiency in this market.

## Problem \#3

A milk dairy is located in the neighborhood of the airport. The total revenue of the airport is $T R_{A}(A)=48 A$, while the total cost is $T C_{A}(A)=A^{2}$, where $A$ is the daily amount of landing airplanes. The total revenue of the dairy is $T R_{D}(C)=60 C$, while the total cost is $T C_{D}(C)=C^{2}+C^{*} A$, where $C$ is the amount of cows (in hundreds). Notice that the nearby localization of the airport causes negative externalities for the dairy.
a) How many cows would the dairy have and how many airplanes would be landing daily, if both enterprises maximized profits in absence of any legal restrictions concerning negative effects of the airport's activity on its surroundings? Find the total profits of both enterprises in this case. Assume there is no possibility of an agreement between the airport and the dairy concerning the number of landing airplanes.
b) Find the Pigouvian tax rate aiming at a correction of the erroneous market allocation described in point a). How many cows would then be kept by the dairy and how many airplanes would be landing? Find the total profits of both enterprises for this case (calculate the tax as $T(A)=\left(M S C\left(A_{\text {corr }}\right)-M C\left(A_{\text {corr }}\right)\right)(A$ $\left.-A_{\text {corr }}\right)$, where $A_{\text {corr }}$ is the daily number of landing airplanes following the correction of the erroneous allocation).
c) Assume that there exists a law that demands that the airport fully compensates the dairy's loss of profits caused by the negative externalities of the airport's activity. How many cows would then be kept by the dairy and how many airplanes would be landing? (the remaining conditions are as in point a)). Find the total profits of both enterprises.
d) (additional) Assume that both enterprises are able to agree on the number of landing airplanes. Find the compensation amount that the dairy should offer the airport in order to maximize its profits (provide the relevant calculations). How many cows would then be kept by the dairy and how many airplanes would be landing? Find the total profits of both enterprises.

## Problem \#4

True or false? An explicit delineation of property rights usually eliminates the problem of externalities.

## Problem \#5

True or false? The distributional consequences of the delineation of property rights are eliminated when preferences are quasilinear.

## Problem \#6

Suppose that the government wants to control the use of the commons, what methods exist for achieving the efficient level of use?

