6. WELFARE ECONOMICS AND COST-BENEFIT ANALYSIS

Environmental welfare economics

The foundation for welfare economics has been laid by Marshall, Pigou and Pareto. According to their theory the contribution of a certain good to social welfare is determined by deducting social costs from gross social benefits. The result can be called net social benefits. Gross social benefits can be measured by the consumers' willingness to pay. Figure 6.1 shows the demand curve d and supply curve s. In equilibrium the amount of $q^*$ is supplied at equilibrium price $p^*$. Total willingness to pay is represented by areas A + B + C. The willingness to pay can be divided into total variable costs (area C), producer surplus (area B) and consumer surplus (area A). Branch turnover is represented by areas B + C. If producer surplus exceeds the fixed costs, there is a profit. If it is less, the branch makes a loss. In a situation of perfect competition, at equilibrium, the producer surplus equals fixed costs, hence no profits will be made. In that situation the contribution to social welfare equals the consumer surplus (area A).

![Figure 6.1: Willingness to pay, consumer surplus, producer surplus.](image)


W. J. M. Heijman, *The Economic Metabolism*
The collective demand function represents gross marginal social benefits, \( b_{gm} \), of a good. Indeed, this function shows how society values one extra unit. The supply function equals marginal private costs, \( c_{pm} \), of a good. These are the private costs of producing one extra unit. Private costs are costs that have already been valued in money. Those costs that are not valued in money are called externalities. Marginal externalities, \( e_m \), plus marginal private costs, \( c_{pm} \), together are called marginal social costs, \( c_m \). Gross marginal social benefits, \( b_{gm} \), which equal the price of the good, minus marginal social costs, \( c_m \), are called net marginal social benefits, \( b_{nm} \). In order to maximize social welfare, \( b_{nm} \) of a good should be 0, in other words, \( b_{gm} \) must equal \( c_m \). In order to reach this, externalities should be internalized in the money costs of a good. This can be obtained by applying a fee, generally referred to as 'Pigovian tax'. To recapitulate:

\[
b_{gm} = c_m, \quad \text{so:}
\]
\[
b_{nm} = b_{gm} - c_m = 0, \quad \text{or, because } c_m = c_{pm} + e_m,
\]
\[
b_{gm} = c_{pm} + e_m.
\]

The theory above can be demonstrated by an example. Suppose a good with quantity, \( q \), is characterized by the following collective demand function, \( b_{gm} \), and cost structure, \( c_{pm} \), and \( e_m \):

\[
b_{gm} = -0.4q + 16,
\]
\[
c_{pm} = 0.3q + 2,
\]
\[
e_m = 0.2q.
\]

From the equations above, \( b_{nm} \) can be derived:

\[
b_{nm} = b_{gm} - c_{pm} - e_m = -0.9q + 14.
\]

In order to reach a situation of maximum social welfare, \( b_{nm} \) should be zero, so:

\[
14 - 0.9q = 0, \quad \text{so: } q = 15.56,
\]
\[
p = b_{gm} = -0.4 \times 15.56 + 16 = 9.78.
\]

Assume that the situation of maximum welfare is to be reached by introducing a fee. In that case, fee, \( f \), should equal the marginal externality in the optimum, so:

\[
f = 0.2 \times 15.56 = 3.11.
\]