# Week 2 Notes: Economic Efficiency

ENVS 30, Fall 2025 - Anna Pede

**Note: MB refers to Marginal Benefit and MC to Marginal Cost. We usually provide you with the MC and MB curves, but here I am showing how we can use a few data points to find them. Or in other words, how the table example we had in class is equivalent to the continuous case.*

Imagine that the marginal costs and marginal benefits of sulfur dioxide abatement can be described by the table below. The goal of this exercise is to find the economically efficient amount of sulfur dioxide abatement. Assume that the marginal cost and marginal benefit curves are linear. The marginal costs and benefits for each unit of abatement are the following:

| Abatement (unit) | Marginal Cost ($) | Marginal Benefit ($) |
|---|---|---|
| 1 | 2 | 18 |
| 2 | 4 | 16 |
| 3 | 6 | 14 |
| 4 | 8 | 12 |
| 5 | 10 | 10 |

Since the marginal cost and benefit curves for sulfur dioxide abatement are linear, we can use the numbers from the table above to find the equations that describe the MC and MB curves. Remember when thinking about the graph that we represent the units of abatement (quantity) in the horizontal axis and the cost $ (MC/MB) in the vertical axis.

Looking at the table, we observe that the **marginal cost of abatement is increasing** - that is, as the units abated increase, the cost of each additional (marginal) unit also increases. Using the same logic, we can see that the **marginal benefit of abatement is decreasing**.

That means that:

- Increasing marginal cost of abatement: positive relationship between quantity (units) and price → upward sloping curve (positive slope)
- Decreasing marginal benefit of abatement: negative relationship between quantity (units) and price → downward sloping curve (negative slope)

Which implies that the curves must have the following format since they are linear, where y = marginal cost/benefit and x = units of abatement:

Marginal Cost Curve:

$$Y = a + b * X \rightarrow \textit{Positive Slope} \tag{1}$$

Marginal Benefit Curve:

$$Y = c - d * X \rightarrow \textit{Negative Slope} \tag{2}$$

To find the curves that correspond to the MC/MB presented in the table, we just need to plug in values.

- **Finding the Marginal Cost curve:**

$$MC : Y = a + b * X \tag{3}$$

Plugin-in values (picking X=1 and X =4)

$$2 = a + b * 1 \tag{4}$$
$$8 = a + b * 4 \tag{5}$$

Therefore:

$$b = 2 - a \tag{6}$$
$$\tag{7}$$

Combining both equations:

$$8 = a + (2 - a) * 4 \tag{8}$$
$$a = 0 \tag{9}$$
$$b = 2 \tag{10}$$

Hence the Marginal Cost curve is:

$$Y = 2 * X \tag{11}$$

- **Finding the Marginal Benefit curve:**

$$MB : Y = c - d * X \tag{12}$$

Plugin-in values (picking X=1 and X =2)

$$18 = c - d * 1 \tag{13}$$
$$16 = c - d * 2 \tag{14}$$
$$\tag{15}$$

Therefore:

$$d = c - 18 \tag{16}$$

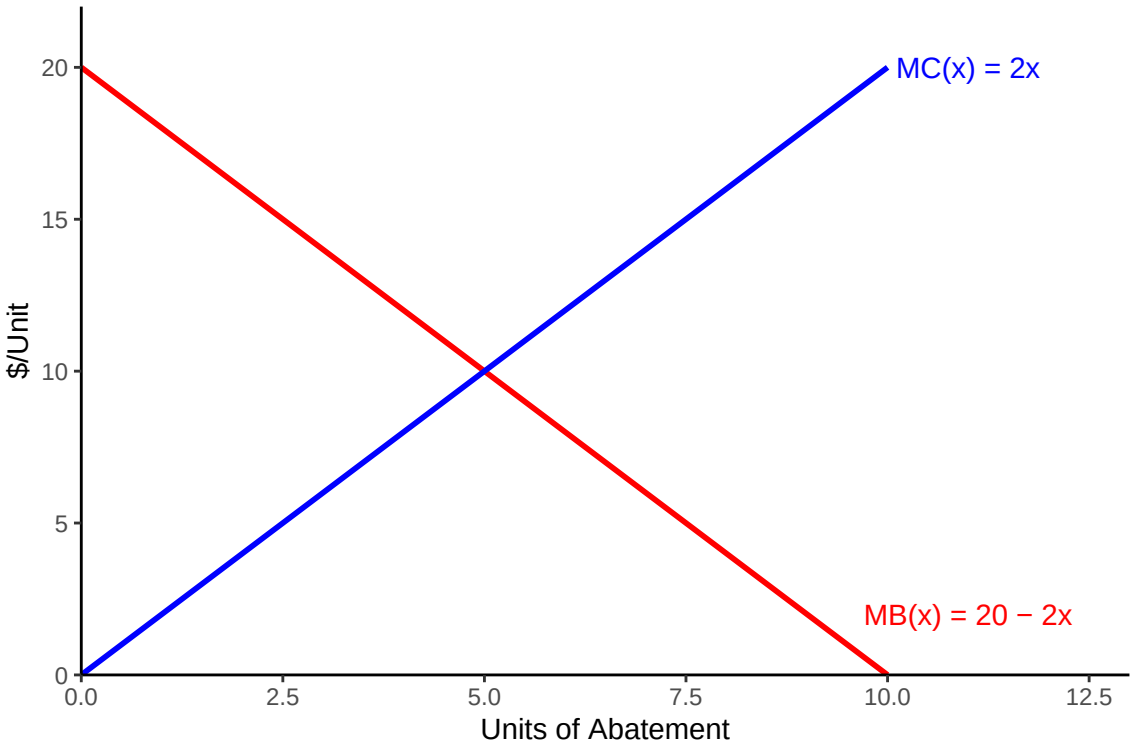
Combining both equations:

$$16 = c - (c - 18) * 2 \tag{17}$$
$$16 = c + 36 - 2c \tag{18}$$
$$c = 36 - 16 \tag{19}$$
$$c = 20 \tag{20}$$
$$d = 2 \tag{21}$$
$$\tag{22}$$

Hence, the Marginal Benefit curve is:

$$Y = 20 - 2 * X \tag{23}$$

Now that we have found the MC and MB curves, we can plot them:




Using the equimarginal principle - **MC = MB** - we can find the economic efficient amount of abatement $X^*$:

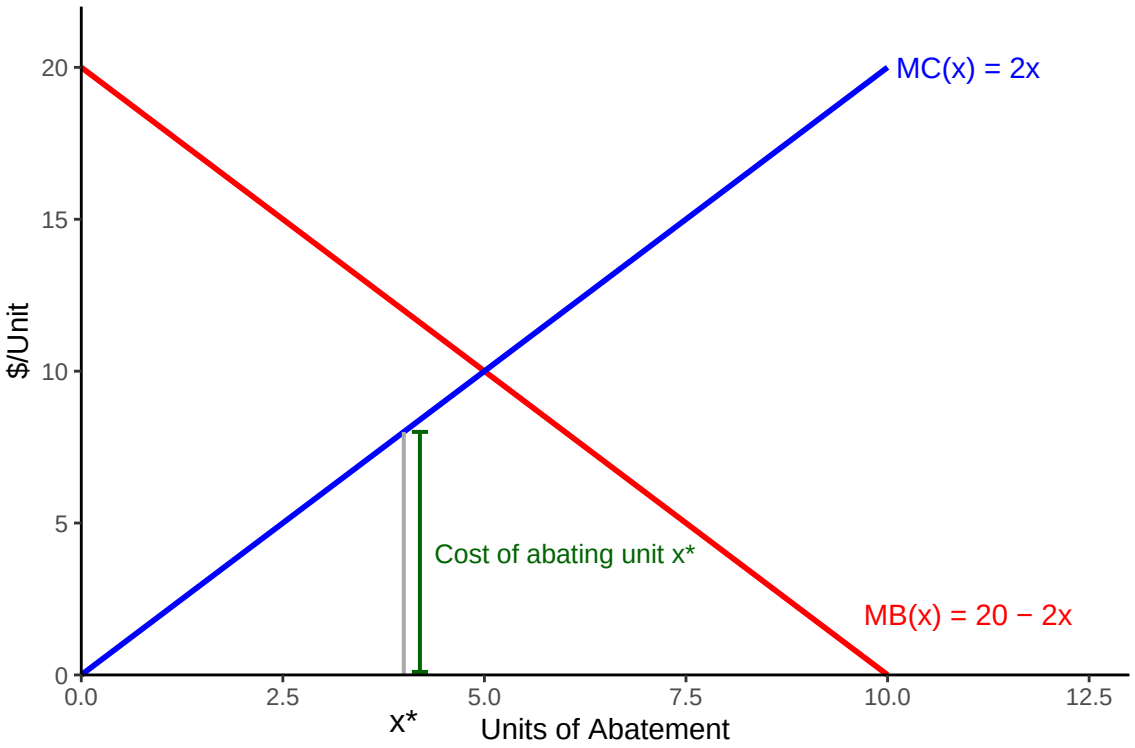
$$MC = MB \tag{24}$$
$$2 * X = 20 - 2 * X \tag{25}$$
$$X^* = 5 \tag{26}$$

Therefore, $X^* = 5$ is the amount of abatement which is economically efficient!

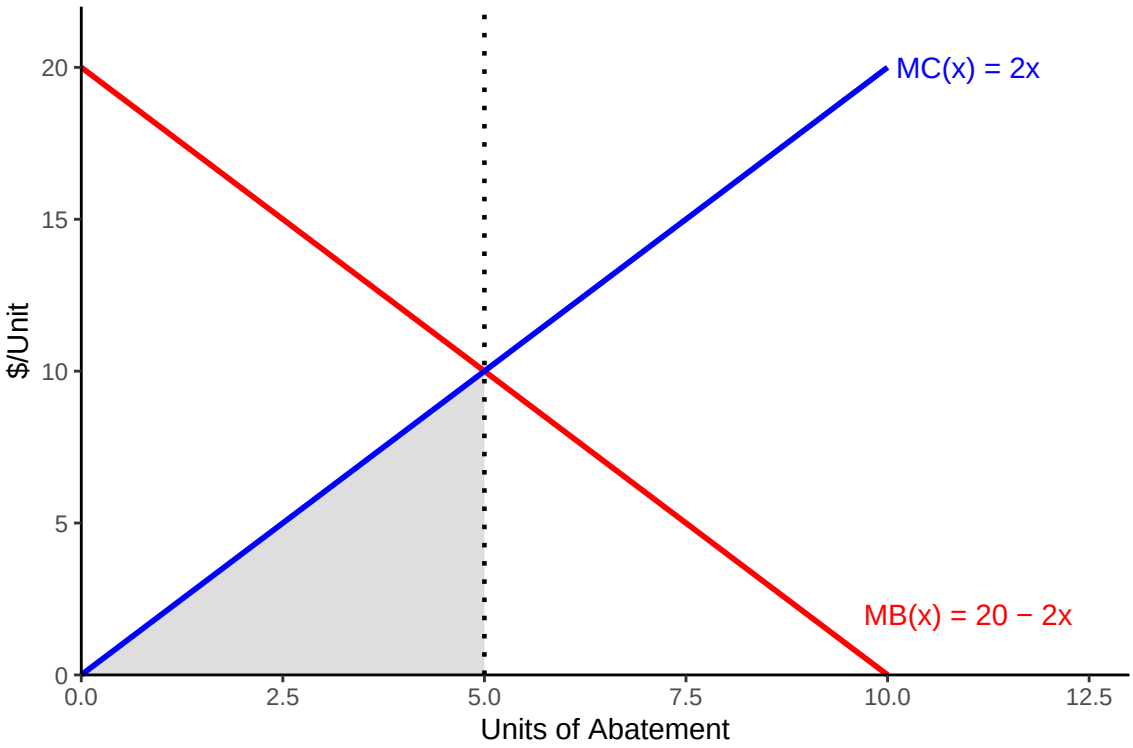
As discussed in class, the economic efficient quantity $X^*$ is the one which **maximizes the total net benefits**. We can represent this graphically. First, let's represent the total costs and total benefits in the same graph.

- **Graphical representation of Total Costs and Total Benefits:**

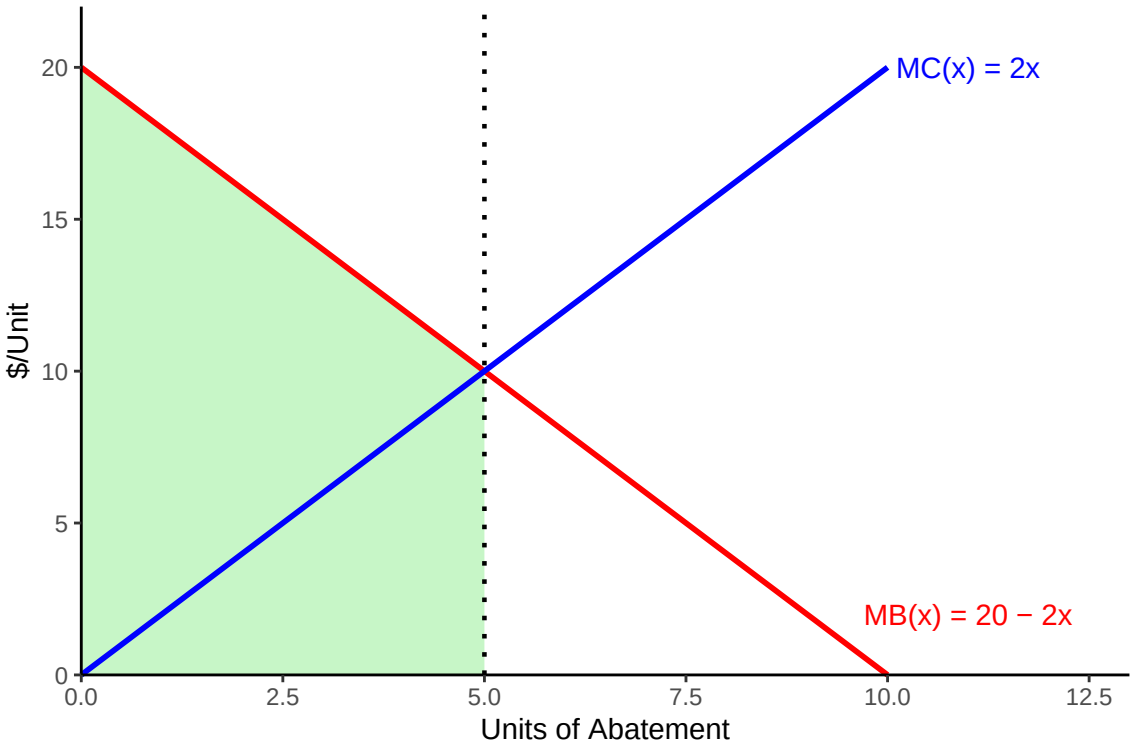
There is a relationship between the Marginal Cost and Marginal Benefit curves with the associated Total Cost and Benefit. Note that for a given quantity $x^*$, the vertical gray segment under the MC curve (highlighted in the figure bellow) represents the cost of abating that unit.




Hence, if we combine all 'segments' (individual costs) for each unit of abatement, we will get the **total cost**. That is, the total cost is just the combination of all individual marginal costs (segments). The combination of all 'segments' is the shaded area below - if you are comfortable with calculus, that is the integral of the MC curve. Therefore, for the economically efficient quantity $X^* = 5$, the **total cost** of abatement is given by the following shaded gray area:




We can use the same logic to understand how the marginal benefit curve and the total benefit are linked. For the economically efficient quantity, $X^* = 5$ the **total benefit** of abatement is given by the green shaded area:

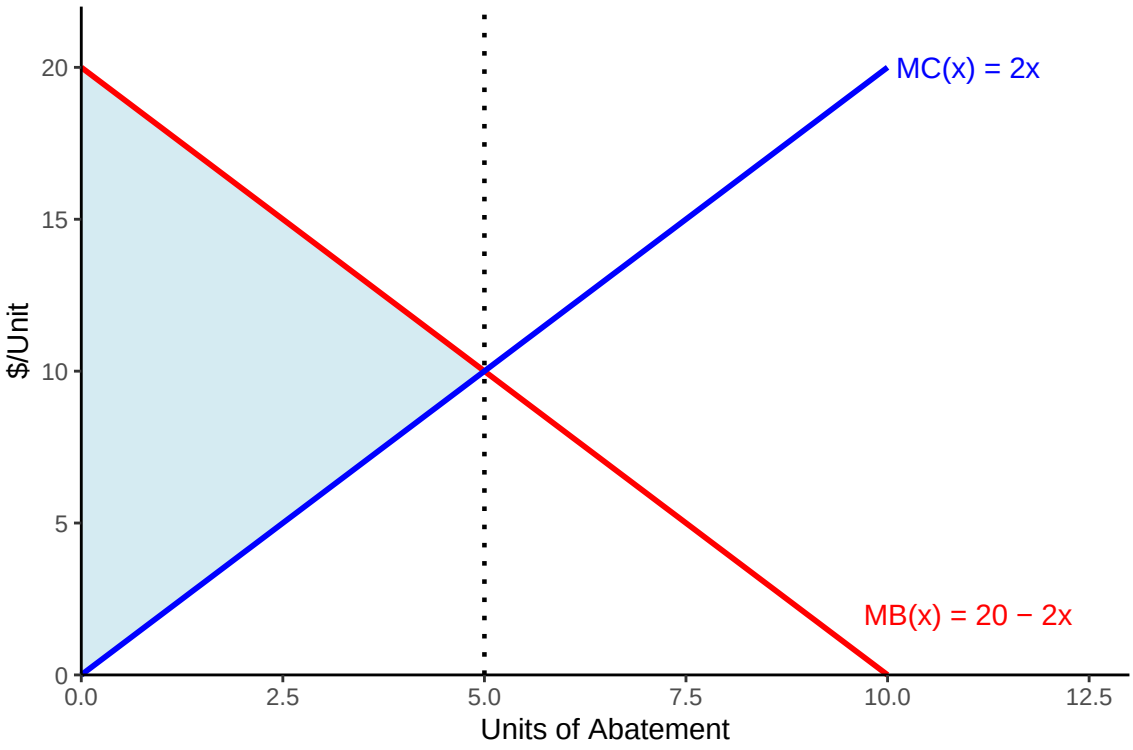



- **Graphical representation of Total Net Benefits:**

Now that we know that the total benefit and total cost for the economically efficient abatement $X^* = 5$ are equivalent to the area under the MB and MC curves, we can represent the total net benefit in the same graph. Just remember that:

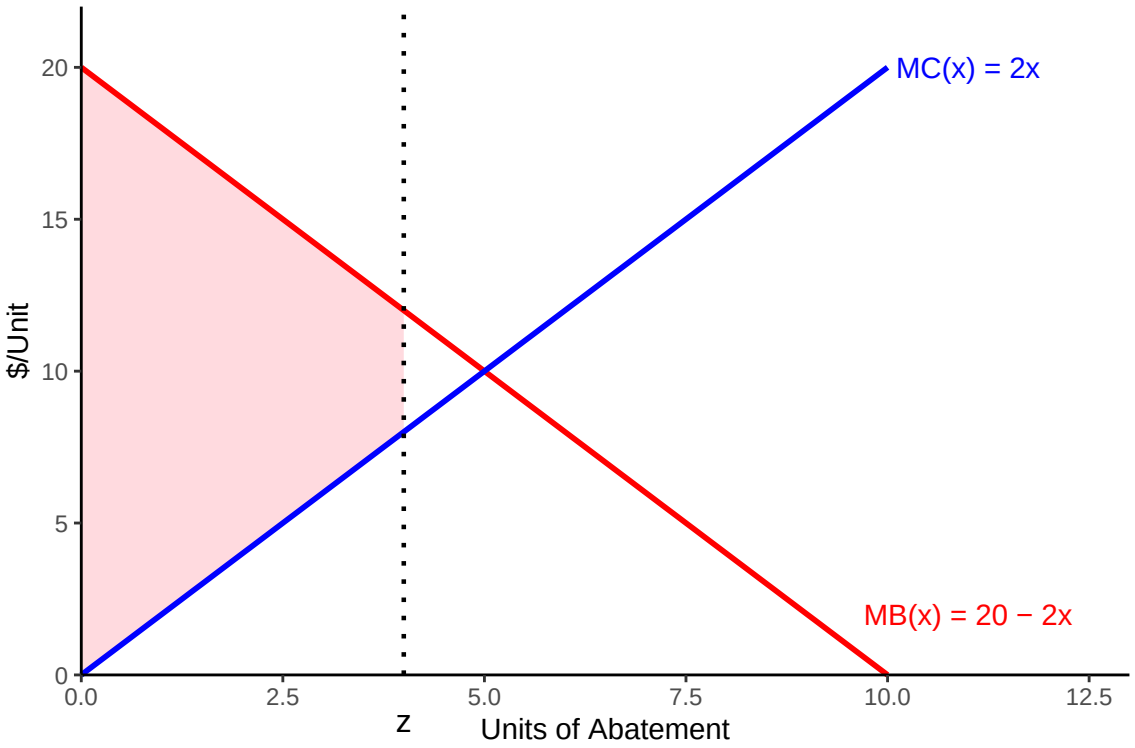
**Total Net Benefit = Total Benefit - Total Cost**

Therefore, graphically, the total net benefit is equivalent to the area under the marginal benefit curve minus the area under the marginal cost curve - green area minus the gray area - shaded in blue below:




- **Two ways of understanding Economic Efficiency**

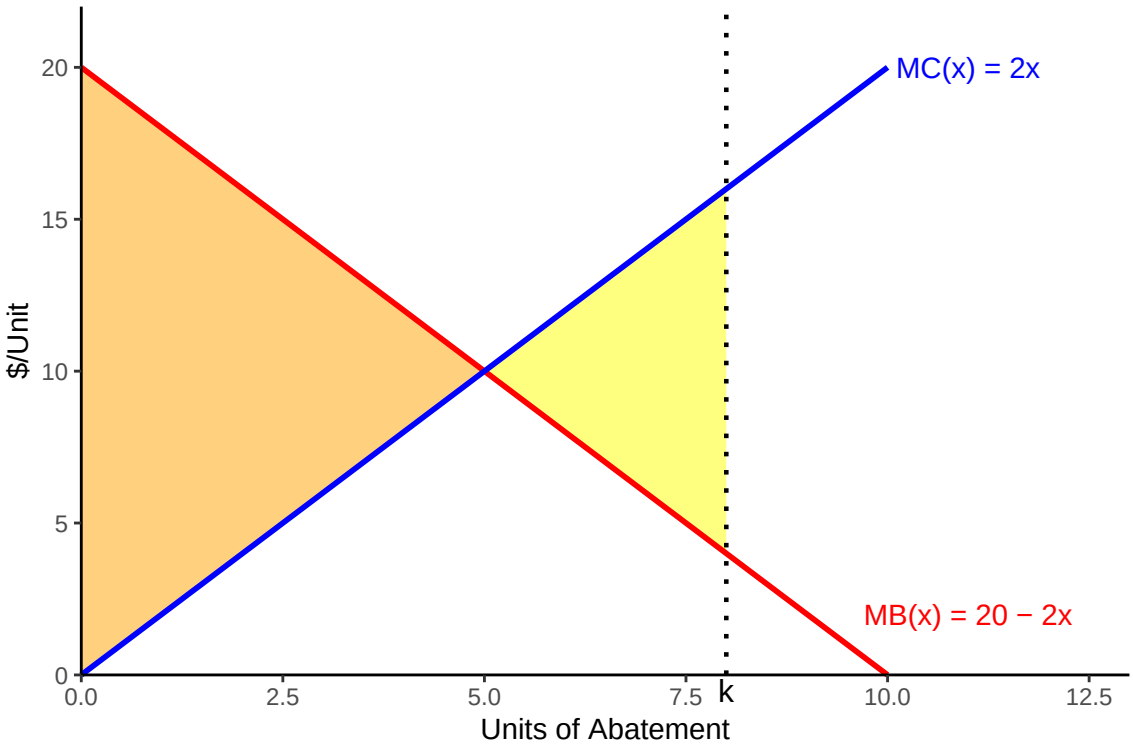
Note that at $X^* = 5$ we have that $MC = MD$ and the total net benefit is equal to the area shaded in blue above. Note that if we pick an abatement level $z$, where $z < 5$, we would get the total net benefit shaded in pink below:




Note that the area in pink - equivalent to the total net benefits of pursuing z level of abatement - is smaller than the blue area, achieved when $MB = MC = X^* = 5$.

Now, suppose.we pick an abatement level $k$, where $k > 5$.

We would get the total net benefit shaded in orange below **minus** the area in yellow. The area in yellow represents the units where their marginal cost is greater than the marginal benefit - in other words, adding any units of abatement beyond $X^* = 5$ brings more additional cost than benefit.




Therefore, if we choose less or more abatement than the economic efficient ammount $X^* = 5$ we will end up with a smaller total net benefit. Therefore, **the point where $MC = MB$ is the one that maximizes the total net benefits**.