Public good: free-rider problem

Definition – When individuals can consume a public good without paying, the incentive to free ride leads to the good being under-provided, or sometimes not provided at all.

Source: https://tinyurl.com/rt7rqtd

Intuition – In society, there are many valuable public goods, such air quality and military protection. Yet, our individual willingness to pay for these goods is often low — no person will individually pay the cost of improving the world's air quality — while the collective benefit of providing them is massive. People are unrestricted in using the goods. And so, if they can have others pay for these public goods and use the goods anyway, they will: they will free ride. Of course, this means nobody pays for them, which illustrates why government intervention is needed.

Mathematical / Technical –

Free-Rider Game: Suppose there is an n-person society where you get 1 unit of happiness for a 1-unit reduction in litter, and two units of happiness for saving the time that it takes to clean up 1 unit of litter. These choices can be modeled as:

- Y = binary variable, you pick up litter or not
- Z = number of other people picking up litter
- X = binary variable, you do something else
- W = number of others doing something else

$$Ind.Utility = (Y+Z)*1 + (X)*2 + (W)*0$$

⇒ nobody picks up litter, because individuals maximize own well being. Thus,

$$Each\ Ind.Utility = (0)*1 + (1)*2 + (n-1)*0 = 2$$

But if *all* people pick up litter:

$$Each\ Ind.Utility = (n)*1 + (0)*2 + (0)*0 = n$$

The problem is people let others provide, while not contributing themselves (free riding):

$$Your\ Ind.Utility = (n-1)*1 + (1)*2 + (0)*0 = n+1$$

⇒ While this appears to maximize utility, we rarely reach this level of utility since everyone only chooses for themselves.

Showing free-ridership with reaction functions: Two individuals value private good X & public good Y.

Total provision of public good $Y = Y_1 + Y_2$

$$U_i = 2\log(X_i) + \log(Y_1+Y_2)$$

Subject to budget $X_i + Y_i = 100$

First order conditions:

$$Y_1 = (100 - 2Y_2)/3 \text{ and } Y_2 = (100-2Y_1)/3$$

Nash Equilibrium ⇒ $Y_1 + Y_2 = (200 - 2(Y_1+Y_2))/3$

$$Y = \left(\frac{200}{5}\right) = 40 \Rightarrow Y_1 = Y_2 = 20$$

Social Optimal ⇒ $MRS^i_{YX} = \frac{\frac{1}{Y_1+Y_2}}{\frac{2}{X_i}} = X_i/2Y$

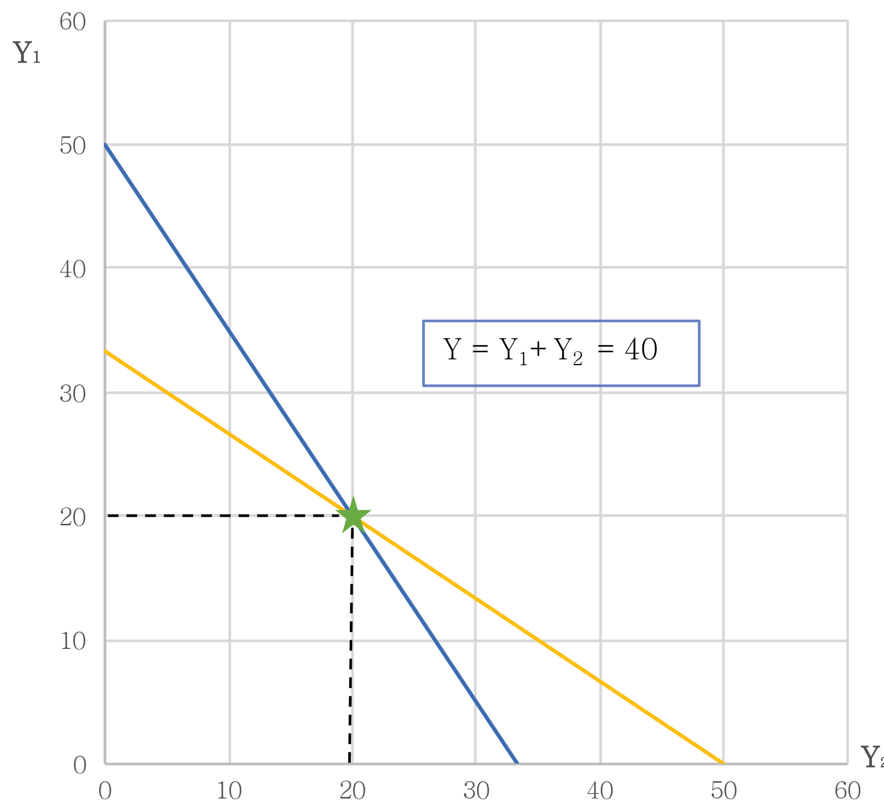
$$\Sigma MRS^i = \frac{X_1+X_2}{2Y} = \frac{(200-Y)}{2Y}$$

$$\Sigma MRS^i = \frac{1}{1} \Rightarrow 200 - Y = 2Y \Rightarrow Y = \frac{200}{3} = 66.66$$

$$66.6 > 40$$

⇒ The public good is underprovided.

Graphical – Nash Equilibrium



Under the Nash Equilibrium seen above, the total amount of public goods provided by society is below the socially optimal level, due to the free-rider problem.

Real-world aspects – The free-rider problem is extremely prevalent. A modern example is with news/newspapers. Newspapers are funded in large part by print or online subscribers. These subscriptions allow the papers to employ journalists, who tweet the news they report on in real-time. Anyone with internet access can view these tweets, and as a result, people that don't pay for a newspaper subscription are free-riding and still receive the news, which is being funded by someone else's subscription, not your own.

Source: https://tinyurl.com/yd4krwq6

Practice questions -

1. Explain two ways in which governments try to mitigate the effects of the free-rider problem.
2. Say two individuals can buy hot dogs (X) or fireworks (Y) on the 4th of July, with budget $X_i + Y_i = 200$. One's total utility = $U_i = 3\log(X_i) + \log(Y_1 + Y_2)$.
   A. How many fireworks would be bought ***in total*** under the Nash Equilibrium?
   B. How many total fireworks would be the socially optimal outcome?
   C. Why are the answers to A. and B. different values?
3. Say you get 1 unit of utility when someone else decides not to drive to work because they are reducing pollution. When you drive to work you get 10 units of utility, because it saves you time. Say there are 100 people at your workplace.
   A. How much utility do you receive if everyone drives? If only you drive? If nobody drives?
   B. What will people be motivated to choose?
   C. What is socially optimal?

Numerical solutions: **2A.** 80, **2B.** 100, **3A.** 10, 110, 100.