Public bad: A market for reducing a "pollutant"

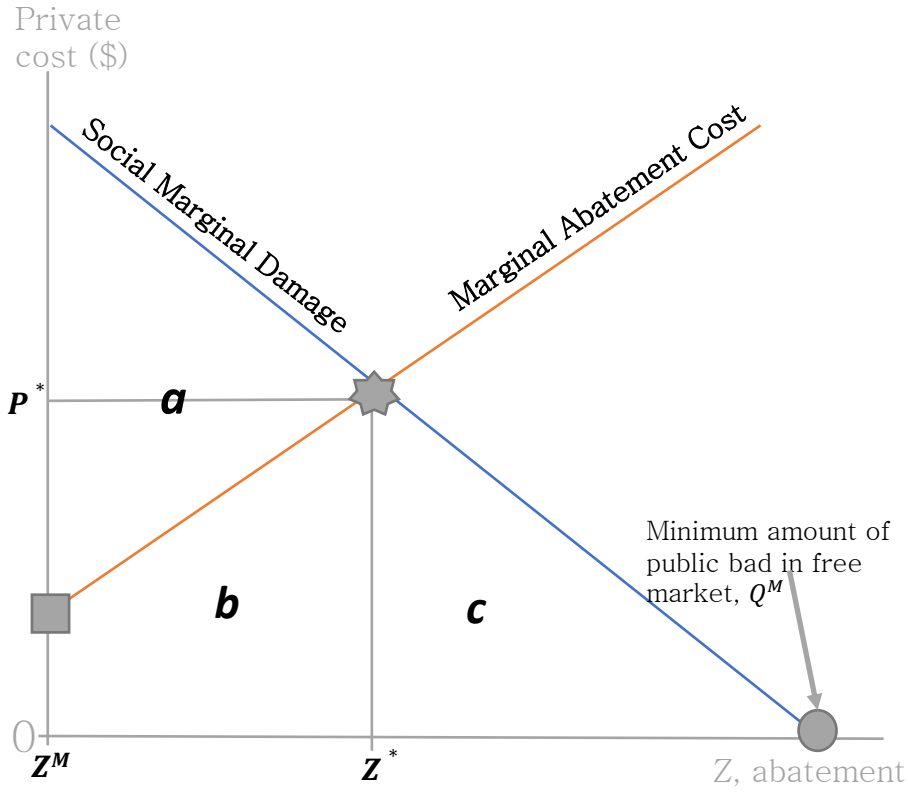
Definition – A public bad is non-excludable, non-rival and negatively affects public welfare.
Source: https://www.britannica.com/topic/public-bad

Intuition – A public bad harms many people at the same time. Yet, as the amount of the bad is reduced, the harm is usually lower and lower. On the other hand, reducing these harms is expensive and typically more expensive for each additional bit: do the cheapest reductions first, and then more costly ones! Society must balance the harms with the expenses of reduction. The best outcome is where reduction of the next bit causes exactly the same harm as the cost to reduce it.

Mathematical / Technical

- Social Marginal Damage (SMD) is the value of damage per unit of reducing the public bad; tends to be downward sloping because for each unit the public bad decreases, the damage inflicted on society is less.
- Marginal Abatement Cost (MAC) is the cost per unit of removing the public bad; upward sloping because entities choose lowest cost actions first and then proceed with more expensive ones.
- The free market outcome occurs without public intervention that forces entities to abate. The entity produces as much of the bad as they want, and therefore, abatement is zero: $Z^M = 0$.
- The intersection point between the MAC and the SMD is the socially optimal amount of abatement. Find Z^* such that
$$MAC(Z^*) = SMD(Z^*)$$
- P^* is the socially optimal cost of abatement, find the value of $MAC(Z^*)$ or $SMD(Z^*)$.
- Deadweight Loss: value lost from an inefficient economic outcome. The deadweight loss is represented as the area below SMD and above the MAC, and when less abatement than optimal occurs ($Z < Z^*$). For linear functions, deadweight loss is the area of the triangle, and is
$$\frac{1}{2}\left[(SMD(0) - MAC(0)) * (Z^*)\right]$$
- Deadweight loss is 0 at the social optimal.
- Total social cost is the total cost of damages from the public bad (area under SMD) less the total abatement cost of reducing the public bad (area under MAC). The total social costs are minimized at the social optimal.
- If the social marginal damage curve (SMD) is entirely above the marginal abatement cost curve (MAC), the optimal outcome is banning the public bad.
- As a mirror concept, the flip of abatement is "emissions," Q, the amount of pollution from the bad. Free-market emissions, Q^M are equal or greater than where marginal damages go to 0, find $SMD(Z) = 0$. Current emissions are $Q_0 - Z$.

Graphical – Market for a Public Bad



The horizontal axis is the level of abatement of the public bad. The vertical axis represents the private costs public bad. The area ***a*** deadweight loss with the free market outcome, Z^M; ***b*** represents the total abatement costs to get to the optimal, Z^*; and ***c*** represents the remaining total cost of damages.

Real-world aspects – **Pollution** produces negative externalities such as bad air quality. It harms the health of animals and humans. The abatement costs are actions that reduce pollution produced. **Covid19** and other infectious diseases are public bads. They spread contagiously, disrupting our routines and create physical harm to our personal lives as well as economic harm to us and surrounding communities. Increased deaths and unemployment rates are some harmful outcomes of Covid19. The abatement costs of the current policy are social distancing and business closures. **Discrimination** is a bad that we face everyday. People suffer socially from it. The presence of the public bad results in less professional opportunities. Abatement costs are education programs and resources to educate the public about the harmful effects of discrimination.
Source: Gruber, J. (2016) *Public Finance & Public Policy*

Practice questions

1. Assume a pollution producing firm has a marginal abatement cost given by $P = 4.5Z$. The social marginal damage function is given by $P = 100 - 0.5Z$. What is minimum free market emissions? What is the efficient level of abatement for this firm? What is the deadweight loss? Explain why zero pollution not socially optimal.
2. Describe intuitively how Covid19 satisfies the definition of a public bad. Social distancing is government's policy on public intervention. What are the abatement costs of social intervention? Should we fine the people who are not abiding by the policies implemented and how much?
3. Suppose discrimination persists in the office, with social marginal damages of $P = 100 - 0.1Z$. To abate discrimination, the firm creates education programs with marginal costs of $P = 0.5Z + 18$. What is the total cost of eliminating the damages of discrimination? What is the "socially" optimal amount of discrimination and the total cost to achieve this? Explain why these total costs are different and thus why discrimination unfortunately still persists after the education programs.

Numerical solutions: **1.** $Z^* = 20$, DWL = \$81,000 ; **3.** total costs = \$147,500, $Z^* = 136.7$, actual abatement costs = \$5,900.