Chapter 4

THE THEORY OF PUBLIC GOODS

Outline: Chapter 4 The Theory of Public Goods

1. The Characteristics of Public Goods
3. The Demand for a Pure Public Good
4. Efficient Output of a Pure Public Good
5. The Free-Rider Problem
6. Education: Externality, Public Good or Private Good
Public Goods

1. The Characteristics of Public Goods

- **Definition:** Public Goods are goods with benefits that cannot be withheld from those who do not pay and are shared by large groups of consumers.

- **Two Properties:**
  - Are *nonrival in consumption*, meaning that a given quantity of a public good can be enjoyed by more than one consumer without decreasing the amounts enjoyed by rival consumers.
    - Zero marginal cost of accommodating an additional consumer.
  - Are *nonexclusive*, meaning it is too costly to exclude those who refuse to pay from enjoying the benefits.

Pure Public and Pure Private Goods

1. The Characteristics of Public Goods

- **Pure public good** – nonrival in consumption for an entire population of consumers, nonexclusive
  - Results in widely consumed external benefits
  - Not divisible into units that can be apportioned

- **Pure private good** – provides benefits only to the person who acquires the good, not anyone else; is rival in consumption
  - Results in neither positive or negative externalities
Marginal Costs of Consuming a Pure Public Good

The diagram in A shows that the marginal cost of allowing an additional person to consume a given quantity of a pure public good falls to zero after it is made available to any one person.

The graph in B shows that the marginal cost of producing the good is always positive. In this case, the marginal cost of each extra unit of the good is $200.

Range of Benefits

• Some public goods, such as world peace, may provide collectively consumed benefits to every individual on earth.

• Some are collectively consumed within given nations, others locally consumed.

• Geographic range of shared benefits influences the desirability of having public goods supplied by various levels of government:
  - Federal, state, local
Congestible Public Goods

- Goods for which crowding or congestion reduces the benefits to existing consumers when more consumers are accommodated.

- Marginal cost of accommodating an additional consumer is not zero after the point of congestion is reached.

- E.g., a user of a congested road decreases the benefits to existing users by slowing traffic, increasing accident risk.

The marginal cost of allowing additional users to consume the congestible public good falls to zero after the good is made available to any one user, but then rises above zero after $N^*$ users are accommodated per hour.
Education as a Public Good

- Has characteristics of a public good in that it creates positive externalities.

- Price to families set at zero; funding by government tax revenues.

- The idea that some citizens would purchase less than the efficient amount of education for their children if it were provided in a competitive market is behind the principle of free and compulsory public education.

- However, has characteristics of a public good in that government cannot guarantee that all children receive an equal amount of education.

2. Suppose the services of a road are subject to congestion after 50,000 vehicles per hour enter the road. Assume that it is feasible to price road services on an hourly basis. Use a graph like that drawn in Figure 4.2 to show how the services of the road should be priced per hour when fewer than and more than 50,000 vehicles per hour are expected so as to achieve efficiency.

**ANSWER**

- At less than 50,000 vehicles per hour, no toll is required to achieve efficiency.

- When traffic rises above 50,000 vehicles per hour, the toll should be set at the marginal congestion cost.
Price-excludable Public Goods

- Goods with benefits that can be priced
  - Membership rights to private clubs
  - Schools, hospitals

- Can be individually consumed and are subject to exclusion, but their production and consumption is likely to generate externalities.

### Table 4.1: Alternative Means of Producing, Distributing, and Financing Goods and Services

<table>
<thead>
<tr>
<th>CHARACTERISTICS OF THE GOOD OR SERVICE</th>
<th>MEANS OF PRODUCTION</th>
<th>METHODS OF DISTRIBUTION</th>
<th>METHODS OF FINANCE</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Private Goods</td>
<td>1. Private firms; government</td>
<td>Markets; direct unit charge</td>
<td>Revenue from sales</td>
<td>Food; clothing; cars</td>
</tr>
<tr>
<td></td>
<td>2. Government; private firms under contract with government</td>
<td>No direct unit charge; eligibility to consume various amounts determined politically</td>
<td>Taxes</td>
<td>Government liquor stores; government tobacco monopoly</td>
</tr>
<tr>
<td>Price-Excludable Public Goods</td>
<td>1. Private firms; government</td>
<td>Markets; direct unit charge (may be subsidized)</td>
<td>Revenue from sales; taxes</td>
<td>Schools; hospitals; transportation</td>
</tr>
<tr>
<td></td>
<td>2. Government; private firms under contract with government</td>
<td>No direct unit charge; consumption available or required only at collectively chosen quantity and quality</td>
<td>Taxes</td>
<td>Government distribution of medical services and food to low-income citizens</td>
</tr>
<tr>
<td>Congestible Public Goods</td>
<td>1. Private firms; government</td>
<td>Fees for the right to use the facility sold in markets</td>
<td>Revenue from sales</td>
<td>Clubs; theaters; amusement parks sporting events</td>
</tr>
<tr>
<td>Pure Public Goods</td>
<td>1. Private firms; government</td>
<td>No direct unit charge; quantity dependent on amount collected</td>
<td>Fees; contributions</td>
<td>Private charity (green infrastructure), public television and radio</td>
</tr>
<tr>
<td></td>
<td>2. Government; private firms under contract with government</td>
<td>No direct unit charge; quality and quantity of service collectively chosen</td>
<td>Private charity (green infrastructure), public television and radio</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>National defense; environmental protection; disaster relief</td>
</tr>
</tbody>
</table>
Semipublic Goods

- Exist in a continuum ranging from pure private goods to pure public goods.

- Goods are categorized according to the degree of rivalry in consumption and the degree of excludability.

A pure public good corresponds to point B, where there is no rivalry for benefits and excludability from benefits is impossible. A pure private good corresponds to point A on the graph.

A nonrival good, such as TV transmissions, for which exclusion is possible, corresponds to a point like C. A congestible public good for which it is possible to charge for use, such as a limited access highway, corresponds to a point like H.
Demand for a Pure Private Good

- The demand for a private good is obtained by adding the quantities demanded by each consumer at each possible price.
- The efficient output is six units per week, which corresponds to point $E$.
- At a price of $3 per loaf, $MB_A = MB_B = MB_C = MC$.

Demand for a Pure Public Good

- All consumers must consume the same quantity of the good, as pure public goods cannot be divided into individual units (nonrival and nonexclusion).
- Therefore, on the demand curve, the variables on the vertical axes are the maximum amounts that people would pay per unit of the pure public good as a function of the amount of the good actually available.
The demand curve for a pure public good is obtained by summing the individual marginal benefits at each quantity.

The marginal social benefit of any given amount of a pure public good is the sum of the individual marginal benefits received by all consumers.

Efficient quantity per time period corresponds to the point at which output is increased; sum of marginal benefits to consumers equals marginal social cost of the good.

Efficiency conditions are:

\[ \text{MSB} = \sum MB = \text{MSC} \]
4. Efficient Output of a Pure Public Good

THE THEORY OF PUBLIC GOODS

### TABLE 4.2
Hypothetical Marginal Benefits of Security Protection for a Community of Three People

<table>
<thead>
<tr>
<th>NUMBER OF SECURITY GUARDS PER WEEK</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$MB_A$</td>
<td>$300$</td>
<td>$250$</td>
<td>$200$</td>
<td>$150$</td>
</tr>
<tr>
<td>$MB_B$</td>
<td>$250$</td>
<td>$200$</td>
<td>$150$</td>
<td>$100$</td>
</tr>
<tr>
<td>$MB_C$</td>
<td>$200$</td>
<td>$150$</td>
<td>$100$</td>
<td>$50$</td>
</tr>
<tr>
<td>$\sum MB_i$</td>
<td>$750$</td>
<td>$600$</td>
<td>$450$</td>
<td>$300$</td>
</tr>
</tbody>
</table>

- The efficient output occurs at point $E$, which corresponds to three security guards per week.
- At that point, $\sum MB_i = MSC$. The Lindahl equilibrium is also at point $E$.
- At that point, voluntary contributions of the three people would cover the cost of the public good.
- Each person would demand three security guards per week at a price per unit equal to the marginal benefit received from three guards per week.
7. The following table shows how the marginal benefit enjoyed by John, Mary, Loren, and all other consumers of outdoor rock concerts varies with the number made available by a city government per summer.

### Marginal Benefit of Number of Rock Concerts per Consumer (in Dollars)

<table>
<thead>
<tr>
<th>CONSUMERS</th>
<th>NUMBER OF CONCERTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>John</td>
<td>150</td>
</tr>
<tr>
<td>Mary</td>
<td>125</td>
</tr>
<tr>
<td>Loren</td>
<td>100</td>
</tr>
<tr>
<td>All Others</td>
<td>600</td>
</tr>
</tbody>
</table>

a. Derive the demand curve for rock concerts assuming that it is a pure public good.

### ANSWER

<table>
<thead>
<tr>
<th>CONSUMERS</th>
<th>NUMBER OF CONCERTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>∑MRS</td>
<td>975</td>
</tr>
</tbody>
</table>

The demand curve shows how the sum of the marginal benefits of all consumers varies with the number of concerts.

b. If the marginal cost of producing rock concerts is $1,000 no matter how many are produced, then what is the efficient number of concerts to have each summer? What would be the efficient number of concerts to produce if the marginal cost of production were $425 instead of $1,000?

### ANSWER

<table>
<thead>
<tr>
<th>CONSUMERS</th>
<th>NUMBER OF CONCERTS</th>
<th>∑MRS</th>
<th>MC=1000</th>
<th>MC=425</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

At a marginal cost of $1,000, it is efficient not to hold any outdoor rock concerts at all.

At a marginal cost of $425, the efficient number of concerts per summer is three.
6. The following table shows how the marginal benefit of a service varies for four consumers:

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>ALICE</th>
<th>BEN</th>
<th>CAROLYN</th>
<th>DON</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000</td>
<td>800</td>
<td>600</td>
<td>400</td>
</tr>
<tr>
<td>2</td>
<td>800</td>
<td>600</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>600</td>
<td>400</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>400</td>
<td>200</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

a. Suppose the service is a pure private good and is sold in a competitive market with the only buyers being the four people whose marginal benefits are shown in the table. If the market price of the product is $400, what is the quantity demanded?

**ANSWER** a) 10

b. Suppose the service is a pure public good with the only consumers being the four people whose marginal benefits are shown in the table. What is the marginal social benefit of two units of the service?

**ANSWER** b. $2,000

c. If the marginal social cost of the good is $2,000, what is the efficient output assuming that it is a pure private good?

**ANSWER** c. zero

d. If the marginal social cost of the good is $2,000, what is the efficient output assuming it is a pure public good?

**ANSWER** d. 2

5. National defense is a pure public good. Yet members of the public disagree about the appropriate size of the Defense Department. Use a diagram similar to Figure 4.6 to find the appropriate amount of total spending for national defense. (For this example, assume that there only are three members of the public.)

Peter the Peacenik thinks that all national defense is unimportant. Add Peter’s demand curve (MBp) to Figure 4.6. Has the optimal amount of national defense changed? Explain.

**ANSWER**

1. Draw three downward sloping demand curves and a cumulative demand curve with a horizontal supply curve similar to Figure 4.6.

2. Peter’s demand curve is a horizontal line at zero (he views defense as unimportant and consequently has no demand because there is no benefit).

   Peter’s demand curve will not affect the cumulative demand curve and consequently will not change the existing optimal amount of national defense.
Voluntary Contributions and Cost Sharing

• By sharing costs, members of a community can pool their resources to enjoy public goods that they could not afford if they had to purchase them on their own in a market.

• In small communities, pure public goods could be made available in efficient amounts, financed by voluntary contributions.

• In larger communities, financing by voluntary contributions may not be feasible, because the sum of the marginal benefits of the good would likely fall short of the marginal cost.

The Lindahl Equilibrium

• Named for Swedish economist Erik Lindahl.

• States that the voluntary contribution per unit of the public good of each member of the community equals his or her marginal benefit of the public good at the efficient level of output.

• Equilibrium contributions per unit of the public good sometimes called *Lindahl prices*.

• Lindahl equilibrium could be achieved by assigning each participant a Lindahl price per unit of the public good.
The Lindahl Equilibrium

Equilibrium under voluntary cooperation meets the following conditions:

1. Amount contributed per unit of public good by each person must be adjusted so that each individual desires the identical amount of the public good.

2. Sum of amounts contributed by each member of the community per unit must equal the marginal social cost of producing the public good.

3. All individuals must agree voluntarily, with no coercion, on the cost-sharing arrangement and the quantity of the good.

3. Suppose the marginal cost of producing rock concerts is only $250 per concert no matter how many are produced. Use the data from the previous question to calculate the efficient number of concerts. If a Lindahl scheme is used to finance the concerts, what prices of admission should be charged to John, Loren, and Mary?

Marginal Benefit of Number of Rock Concerts per Consumer (in Dollars)

<table>
<thead>
<tr>
<th>CONSUMERS</th>
<th>NUMBER OF CONCERTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>John</td>
<td>150 125 100 75</td>
</tr>
<tr>
<td>Mary</td>
<td>125 100 75 50</td>
</tr>
<tr>
<td>Loren</td>
<td>100 75 50 25</td>
</tr>
<tr>
<td>All Others</td>
<td>600 400 200 100</td>
</tr>
</tbody>
</table>

**Demand for Public Good**

<table>
<thead>
<tr>
<th>CONSUMERS</th>
<th>NUMBER OF CONCERTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>John</td>
<td>150 125 100 75</td>
</tr>
<tr>
<td>Mary</td>
<td>125 100 75 50</td>
</tr>
<tr>
<td>Loren</td>
<td>100 75 50 25</td>
</tr>
<tr>
<td>All Others</td>
<td>600 400 200 100</td>
</tr>
</tbody>
</table>

**ANSWER**

3. The efficient number of concerts would be four; John would be charged $75, and Mary would be charged $50, while Loren would pay $25 for each concert.
4. Suppose the marginal cost of pure public good increases as more is purchased by a community. Prove that the Lindahl equilibrium will result in a budget surplus at the efficient annual output of the pure public good.

**ANSWER**

- The sum of the marginal benefits must equal the marginal cost in the Lindahl equilibrium.
- When MC is increasing, MC > AC for any given quantity supplied. At the efficient level of output, the sum of the contributions will be greater than AC.
- Because contributions per unit exceed cost per unit, the total revenue collected will exceed the cost of making the good available, which is AC(Q).
- Thus, there is a budget surplus.

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**USA -Defense Expenditure as a Share of GDP, 1962-2005**

![Graph showing defense expenditure as a share of GDP from 1962 to 2005.](image-url)
The Free-Rider Problem

- A free rider is a person who seeks to enjoy the benefits of a public good without contributing anything to the cost of financing the amount made available.

- This strategy almost guarantees that the equilibrium amount of a pure public good will be less than the efficient amount.

- Problems become more acute in large groups, where a free rider reasons that their contribution is less likely to be needed or missed.

Public Goods are goods with benefits that cannot be withheld from those who do not pay and are shared by large groups of consumers.
Voluntary Contribution

Voluntary Contribution to Finance the Marginal Social Cost of Operation Desert Shield and Desert Storm (Billions of Dollars)

<table>
<thead>
<tr>
<th>NATION</th>
<th>CONTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi Arabia</td>
<td>$17</td>
</tr>
<tr>
<td>Kuwait</td>
<td>16</td>
</tr>
<tr>
<td>Japan</td>
<td>11</td>
</tr>
<tr>
<td>Germany</td>
<td>7</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>4</td>
</tr>
<tr>
<td>Total Pledged</td>
<td>54</td>
</tr>
<tr>
<td>U.S. Share</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
</tr>
</tbody>
</table>

Source: Office of Management and Budget and Congressional Budget Office.

Compulsory Finance

- The free-rider problem is partially remedied by compulsory finance
  - Taxation
  - Payment for schooling, roads, postal services

- One may decide how to vote by comparing tax share per unit of a public good with the marginal benefit at the proposed output
Policy Perspective – Congestion pricing

- Singapore – electronic tools that vary according to the time of day
- San Diego – single drivers can use high-occupation-vehicle lanes for a price that depends on how congested the highway is at the moment
- London – levy a fee of 5 pounds during peak hours

1. Only 10% of viewers of public television make contributions to public television stations. Yet the Congress approves budgets that subsidize public television. Why would the typical voter/taxpayer contribute nothing to public television, yet simultaneously want more tax money given to public television? Also explain this voter’s overall strategy.

**ANSWER**

1. The voluntary funding of public television is an example of a free-rider problem where those who do not fund a public good receive the benefit of the public good.

2. By voting for taxpayer contributions to public television, the cost is distributed among all potential beneficiaries in the form of tax and alleviates the free-rider problem (i.e. no one member of the tax-paying community can avoid not funding public television).

- In Thailand, Thai PBS is sponsored by sin taxes (0.5% of the excise tax revenues on sin products).

**Public Goods** are goods with benefits that cannot be withheld from those who do not pay and are shared by large groups of consumers.
Education

Positive Externalities?
Private Good?
Public Good?

Positive Externality

- College education
  - Positive externality versus Increased productivity
  - In US, an additional year of education contributes to an increase in annual earnings between 5-11 percent
  - No Education vs College graduate
    - return differential = 89%
Return to Education

- Aemkulwat (2014)
  - Return to male private employees = 9.4%
  - Return to private employees = 7.4%


- As long as the earnings of college graduates reflect their higher productivity; there is no externality
Positive Externality vs. Private Good

- Investment or Consumption
- Human Capital Theory
  - similar to investment in machinery (capital)
  - More education, higher income
- Education is a private good? Rival and exclusion
Social vs Private Returns

- Canton (2007)
- Short run private return = 7.5%
- LR social return = 11-15%
  - Social returns due to college and secondary education are more than those from returns due to lower than high-school education.

Is Education a Public Good?

- The Conventional Wisdom
  - Social mobility, political stability (democracy).
  - Primary and secondary education – Literate and well-informed populace.
Recap: Chapter 4 The Theory of Public Goods

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- Education: Public Good or Private Good