Externalities: Problems and Solutions

5.1 Externality Theory

5.2 Private-Sector Solutions to Negative Externalities

5.3 Public-Sector Remedies for Externalities

5.4 Distinctions between Price and Quantity Approaches to Addressing Externalities

5.5 Conclusion
externality  Externalities arise whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so.

market failure  A problem that causes the market economy to deliver an outcome that does not maximize efficiency.
Examples of Externalities

• Negative Externalities
  – Pollution
  – Cell phones in a movie theater
  – Congestion on the internet
  – Drinking and driving
  – Student cheating that changes the grade curve
  – The “Club” anti-theft device for automobiles

• Positive Externalities
  – Research & development
  – Vaccinations
  – A neighbor’s nice landscape
  – Students asking good questions in class
  – The “LoJack” anti-theft device for automobiles

• Not Considered Externalities
  – Land prices rising in urban area
  – Known as “pecuniary” externalities
In December 1997, representatives from over 170 nations met in Kyoto, Japan, to attempt one of the most ambitious international negotiations ever: an international pact to limit the emissions of carbon dioxide worldwide because of global warming. The nations faced a daunting task.

The cost of reducing the use of fossil fuels, particularly in the major industrialized nations, is enormous.

Replacing these fossil fuels with alternatives would significantly raise the costs of living in developed countries.

**The United Nations Climate Change Conference, Durban 2011**

The outcomes included a decision by Parties to adopt a universal legal agreement on climate change as soon as possible, and no later than 2015.

http://unfccc.int/2860.php
**FIGURE 5-1**

**Global average temperature (degrees F)**

**Average Global Temperature, 1880 to 2008** – There was a steady upward trend in global temperatures throughout the twentieth century.

Source: Figure adapted from NASA’s Goddard Institute for Space Studies, “Global Annual Mean Surface Air Temperature Change,” located at http://data.giss.nasa.gov/gistemp/graphics/FigA2.lrg.gif
Externality Theory

Economics of Negative Production Externalities

negative production externality
When a firm’s production reduces the well-being of others who are not compensated by the firm.
**Externality Theory**

**Economics of Negative Production Externalities**

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**FIGURE 5-2**

Market Failure Due to Negative Production Externalities in the Steel Market: A negative production externality of $100 per unit of steel produced (marginal damage, MD) leads to a social marginal cost that is above the private marginal cost, and a social optimum quantity ($Q_2$) that is lower than the competitive market equilibrium quantity ($Q_1$). There is overproduction of $Q_1 - Q_2$, with an associated deadweight loss of area BCA.
5.1 Externality Theory

Economics of Negative Production Externalities

**private marginal cost (PMC)** The direct cost to producers of producing an additional unit of a good.

**social marginal cost (SMC)** The private marginal cost to producers plus any costs associated with the production of the good that are imposed on others.
5.1 Externality Theory

Economics of Negative Production Externalities

private marginal benefit (PMB) The direct benefit to consumers of consuming an additional unit of a good by the consumer.

social marginal benefit (SMB) The private marginal benefit to consumers plus any costs associated with the consumption of the good that are imposed on others.
Externality Theory

Negative Consumption Externalities

**negative consumption externality** When an individual’s consumption reduces the well-being of others who are not compensated by the individual.
5.1 Externality Theory

Negative Consumption Externalities

**FIGURE 5-3**

**Market Failure Due to Negative Consumption Externalities in the Cigarette Market** • A negative consumption externality of 40¢ per pack of cigarettes consumed leads to a social marginal benefit that is below the private marginal benefit, and a social optimum quantity ($Q_2$) that is lower than the competitive market equilibrium quantity ($Q_1$). There is overconsumption $Q_1 - Q_2$, with an associated deadweight loss of area $ACB$. 
5.1 \hspace{1cm} \textbf{APPLICATION}

The Externality of SUVs

- The typical driver in 2008 was in a car that weighed about 4,117 pounds. The major culprits in this evolution of car size are sport utility vehicles (SUVs) with an average weight size of 4,742 pounds.

- The consumption of large cars such as SUVs produces three types of negative externalities:
  - Environmental Externalities:
    - The contribution of driving to global warming is directly proportional to the amount of fossil fuel a vehicle requires to travel a mile. SUV drivers use more gas to go to work or run their errands, increasing fossil fuel emissions.
  - Wear and Tear on Roads:
    - Each year, federal, state, and local governments spend $33.1 billion repairing our roadways. Damage to roadways comes from many sources, but a major culprit is the passenger vehicle, and the damage it does to the roads is proportional to vehicle weight.
  - Safety Externalities:
    - One major appeal of SUVs is that they provide a feeling of security because they are so much larger than other cars on the road. Offsetting this feeling of security is the added insecurity imposed on other cars on the road.
5.1 Externality Theory

Positive Externalities

**positive production externality**  When a firm’s production increases the well-being of others but the firm is not compensated by those others.
5.1 Externality Theory

Positive Externalities

**FIGURE 5-4**

Market Failure Due to Positive Production Externality in the Oil Exploration Market • Expenditures on oil exploration by any company have a positive externality because they offer more profitable opportunities for other companies. This leads to a social marginal cost that is below the private marginal cost, and a social optimum quantity \((Q_2)\) that is greater than the competitive market equilibrium quantity \((Q_1)\). There is underproduction of \(Q_2 - Q_1\), with an associated deadweight loss of area ABC.
5.1 Externality Theory

Positive Externalities

**positive consumption externality** When an individual’s consumption increases the well-being of others but the individual is not compensated by those others.

Quick Hint: One aspect of the graphical analysis of externalities is knowing which curve to shift, and in which direction. There are four possibilities:

- Negative production externality: \( SMC \) curve lies above \( PMC \) curve
- Positive production externality: \( SMC \) curve lies below \( PMC \) curve
- Negative consumption externality: \( SMB \) curve lies below \( PMB \) curve
- Positive consumption externality: \( SMB \) curve lies above \( PMB \) curve

The key is to assess which category a particular example fits into. First, you must assess whether the externality is associated with producing a good or with consuming a good. Then, you must assess whether the externality is positive or negative.
5.2 Private-Sector Solutions to Negative Externalities

The Solution

**internalizing the externality** When either private negotiations or government action lead the price to the party to fully reflect the external costs or benefits of that party’s actions.
Private-Sector Solutions to Negative Externalities

The Solution

A Coasian Solution to Negative Production Externalities in the Steel Market • If the fishermen charge the steel plant $100 per unit of steel produced, this increases the plant’s private marginal cost curve from \( \text{PMC}_1 \) to \( \text{PMC}_2 \), which coincides with the \( \text{SMC} \) curve. The quantity produced falls from \( Q_1 \) to \( Q_2 \), the socially optimal level of production. The charge internalizes the externality and removes the inefficiency of the negative externality.
5.2

Private-Sector Solutions to Negative Externalities

The Solution

Coase Theorem (Part I)  When there are well-defined property rights and costless bargaining, then negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity.

Coase Theorem (Part II)  The efficient solution to an externality does not depend on which party is assigned the property rights, as long as someone is assigned those rights.
Private-Sector Solutions to Negative Externalities

The Problems with Coasian Solutions

In practice, the Coase theorem is unlikely to solve many of the types of externalities that cause market failures.

The Assignment Problem

Because of assignment problems, Coasian solutions are likely to be more effective for small, localized externalities than for larger, more global externalities.

The Holdout Problem

**holdout problem** Shared ownership of property rights gives each owner power over all the others.

As with the assignment problem, the holdout problem would be amplified with a huge externality.
5.2  
Private-Sector Solutions to Negative Externalities

The Problems with Coasian Solutions

The Free Rider Problem

**free rider problem**  When an investment has a personal cost but a common benefit, individuals will underinvest.

Transaction Costs and Negotiating Problems

The Coasian approach ignores the fundamental problem that it is hard to negotiate when there are large numbers of individuals on one or both sides of the negotiation.

This problem is amplified for an externality such as global warming, where the potentially divergent interests of billions of parties on one side must be somehow aggregated for a negotiation.
The Problems with Coasian Solutions

**Bottom Line**

Ronald Coase’s insight that externalities can sometimes be internalized was a brilliant one.

It provides the competitive market model with a defense against the onslaught of market failures.

It is also an excellent reason to suspect that the market may be able to internalize some small-scale, localized externalities.

It won’t help with large-scale, global externalities.
The Environmental Protection Agency (EPA) was formed in 1970 to provide public-sector solutions to the problems of externalities in the environment.

Public policy makers employ three types of remedies to resolve the problems associated with negative externalities.
Public-Sector Remedies for Externalities

Corrective Taxation

**FIGURE 5-6**

Taxation as a Solution to Negative Production Externalities in the Steel Market • A tax of $100 per unit (equal to the marginal damage of pollution) increases the firm’s private marginal cost curve from $PMC_1$ to $PMC_2$, which coincides with the $SMC$ curve. The quantity produced falls from $Q_1$ to $Q_2$, the socially optimal level of production. Just as with the Coasian payment, this tax internalizes the externality and removes the inefficiency of the negative externality.
Public Responses to Externalities - Taxes

\[ 
MSC = MPC + MD \\
(MPC + cd) 
\]

Pigouvian tax revenues

$ \begin{align*}
Q & \quad \text{per year} \\
0 & \quad \text{Q per year} \\
\end{align*} \]
Externality Example Problem

The private marginal benefit associated with a product’s consumption is $PMB = 360 - 4Q$

and the private marginal cost associated with its production is $PMC = 6Q$.

The marginal external damage associated with this good’s production is $MD = 2Q$.

To correct the externality, the government decides to impose a tax of $T$ per unit sold.

What tax $T$ should it set to achieve the social optimum?
Public-Sector Remedies for Externalities

Subsidies

**subsidy**  Government payment to an individual or firm that lowers the cost of consumption or production, respectively.
Public-Sector Remedies for Externalities

Subsidies

**Figure 5-7**

Subsidies as a Solution to Positive Production Externalities in the Market for Oil Exploration: A subsidy that is equal to the marginal benefit from oil exploration reduces the oil producer’s marginal cost curve from $PMC_1$ to $PMC_2$, which coincides with the SMC curve. The quantity produced rises from $Q_1$ to $Q_2$, the socially optimal level of production.
Public-Sector Remedies for Externalities

Regulation

In an ideal world, Pigouvian taxation and regulation would be identical. Because regulation appears much more straightforward, however, it has been the traditional choice for addressing environmental externalities in the United States and around the world.

In practice, there are complications that may make taxes a more effective means of addressing externalities.
5.4 Distinctions between Price and Quantity Approaches to Addressing Externalities

Basic Model

**FIGURE 5-8**

- **Pollution reduction (S)** (firm’s cost, society’s benefit)
- **S = PMC = SMC**
- **MD = SMB**
- **D = PMB**

**The Market for Pollution Reduction**
The marginal cost of pollution reduction (PMC = SMC) is a rising function, while the marginal benefit of pollution reduction (SMB) is (by assumption) a flat marginal damage curve. Moving from left to right, the amount of pollution reduction increases, while the amount of pollution falls. The optimal level of pollution reduction is \( R^* \), the point at which these curves intersect. Since the pollution is the complement of reduction, the optimal amount of pollution is \( P^* \).
5.4 Distinctions between Price and Quantity Approaches to Addressing Externalities

Price Regulation (Taxes) vs. Quantity Regulation in This Model

The optimal tax, as before, is equal to the marginal damage done by pollution. Plants will “walk up” their marginal cost curves, reducing pollution up to a reduction of $R^*$ at point $B$. The government simply mandates that the plant reduce pollution by an amount $R^*$, to get to the optimal pollution level $P^*$. For the more general case of a falling $MD$, the government needs to know the shapes of both $MC$ and $MD$ curves in order to set either the optimal tax or the optimal regulation.
Distinctions between Price and Quantity Approaches to Addressing Externalities

Multiple Plants with Different Reduction Costs

**FIGURE 5-9**

Pollution Reduction with Multiple Firms • Plant A has a lower marginal cost of pollution reduction at each level of reduction than does plant B. The optimal level of reduction for the market is the point at which the sum of marginal costs equals marginal damage (at point Z, with a reduction of 200 units). An equal reduction of 100 units for each plant is inefficient since the marginal cost to plant B ($MC_B$) is so much higher than the marginal cost to plant A ($MC_A$). The optimal division of this reduction is where each plant's marginal cost is equal to the social marginal benefit (which is equal to marginal damage). This occurs when plant A reduces by 150 units and plant B reduces by 50 units, at a marginal cost to each of $100.
5.4 Distinctions between Price and Quantity Approaches to Addressing Externalities

Multiple Plants with Different Reduction Costs

Policy Option 1: Quantity Regulation

The efficient solution is one where, for each plant, the marginal cost of reducing pollution is set equal to the social marginal benefit of that reduction; that is, where each plant’s marginal cost curve intersects with the marginal benefit curve.

Policy Option 2: Price Regulation through a Corrective Tax

Pigouvian taxes cause efficient production by raising the cost of the input by the size of its external damage, thereby raising private marginal costs to social marginal costs.

Policy Option 3: Quantity Regulation with Tradable Permits

Trading allows the market to incorporate differences in the cost of pollution reduction across firms.
5.4 Distinctions between Price and Quantity Approaches to Addressing Externalities

Multiple Plants with Different Reduction Costs

- FIGURE 5-9

**Pollution Reduction with Multiple Firms** - Plant A has a lower marginal cost of pollution reduction at each level of reduction than does plant B. The optimal level of reduction for the market is the point at which the sum of marginal costs equals marginal damage (at point Z, with a reduction of 200 units). An equal reduction of 100 units for each plant is inefficient since the marginal cost to plant B ($MC_B$) is so much higher than the marginal cost to plant A ($MC_A$). The optimal division of this reduction is where each plant's marginal cost is equal to the social marginal benefit (which is equal to marginal damage). This occurs when plant A reduces by 150 units and plant B reduces by 50 units, at a marginal cost to each of $100.
Distinctions between Price and Quantity Approaches to Addressing Externalities

Uncertainty about Costs of Reduction

**FIGURE 5-10a**

Market for Pollution Reduction with Uncertain Costs • In the case of global warming (panel (a)), the marginal damage is fairly constant over large ranges of emissions (and thus emission reductions). If costs are uncertain, then taxation at level \( t = C_2 \) leads to a much lower deadweight loss (DBE) than does regulation of \( R_1 \) (ABC).
5.4

Distinctions between Price and Quantity Approaches to Addressing Externalities

Uncertainty about Costs of Reduction

- FIGURE 5-10b

Market for Pollution Reduction with Uncertain Costs: In the case of nuclear leakage (panel (b)), the marginal damage is very steep. If costs are uncertain, then taxation leads to a much larger deadweight loss (DBE) than does regulation (ABC).
Distinctions between Price and Quantity Approaches to Addressing Externalities

**Uncertainty about Costs of Reduction**

**Implications for Effect of Price and Quantity Interventions**

The uncertainty over costs has important implications for the type of intervention that reduces pollution most efficiently.

**Implications for Instrument Choice**

The central intuition here is that the instrument choice depends on whether the government wants to get the amount of pollution reduction right or whether it wants to minimize costs.
Conclusion

Externalities are the classic answer to the “when” question of public finance: when one party’s actions affect another party, and the first party doesn’t fully compensate (or get compensated by) the other for this effect, then the market has failed and government intervention is potentially justified.

This naturally leads to the “how” question of public finance. There are two classes of tools in the government’s arsenal for dealing with externalities: price-based measures (taxes and subsidies) and quantity-based measures (regulation).

Which of these methods will lead to the most efficient regulatory outcome depends on factors such as the heterogeneity of the firms being regulated, the flexibility embedded in quantity regulation, and the uncertainty over the costs of externality reduction.