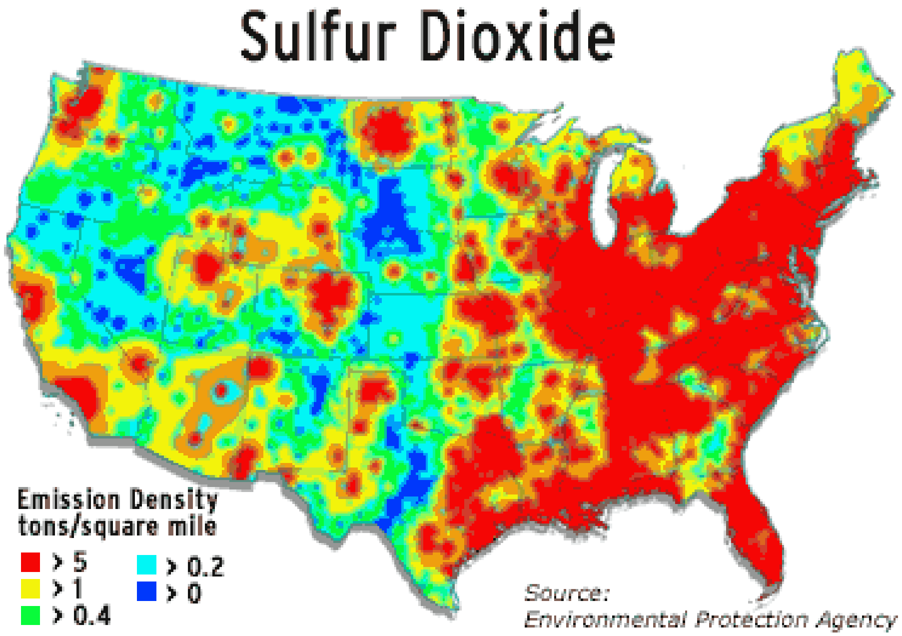
CREATING ENVIRONMENTAL MARKETS

Modeling Solutions to Environmental Problems

Creating Environmental Markets

- Conventional Solutions
- Market Solutions
  - Assign property rights
  - Pigouvian and emission taxes
  - Tradable permits or cap-and-trade
  - Deposit Refund System
- Summary



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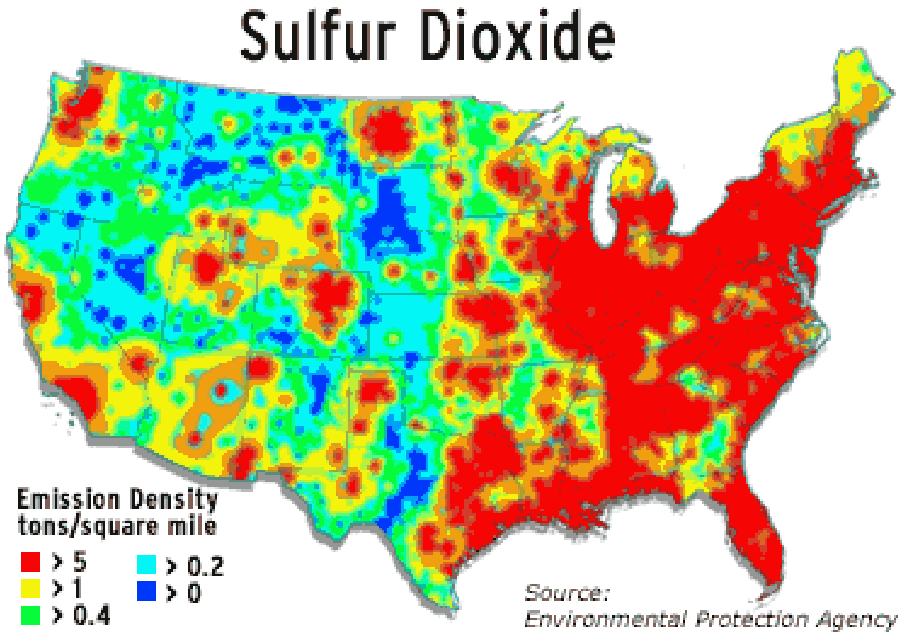


Standards in Environmental Policy

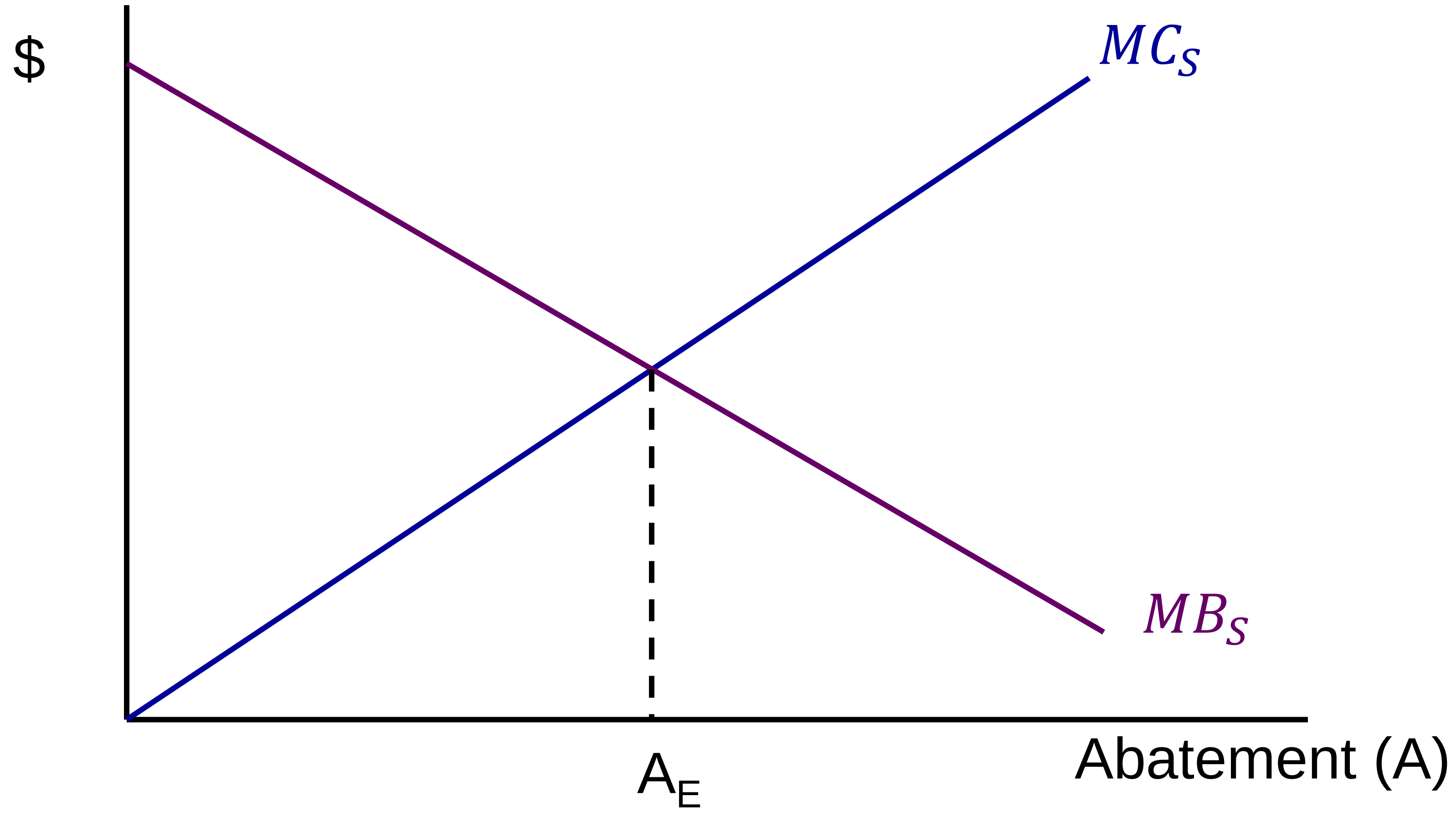
- Types of Environmental Standards
  - Ambient standard – a standard that designates the quality of the environment to be achieved, typically expressed as a maximum allowable pollutant concentration
  - Technology-based standard – a standard that designates the equipment or method to be used to achieve some abatement level
  - Performance-based standard – a standard that specifies a pollution limit to be achieved but does not stipulate the technology

Are Environmental Standards Precise?

- Two things to consider:
  - Are standards set to achieve allocative efficiency?
    - where MB_S of abatement equals MC_S of abatement

  - Given some environmental objective, is that objective being achieved in a manner that is cost-effective?

Modeling Allocative Efficient Abatement Levels



Allocative Efficiency Example

- Suppose the state of New Mexico is attempting to set a water quality standard, where water quality is measured as the percent of mercury abated (A), and the marginal social benefit (MB_S) and marginal social cost (MC_S) of abatement are estimated as follows:
- $MB_S = 40 - 0.1A$
- $MC_S = 36 + 0.25A$
- The state sets the standard at 20%. Is this standard efficient? Why or why not?

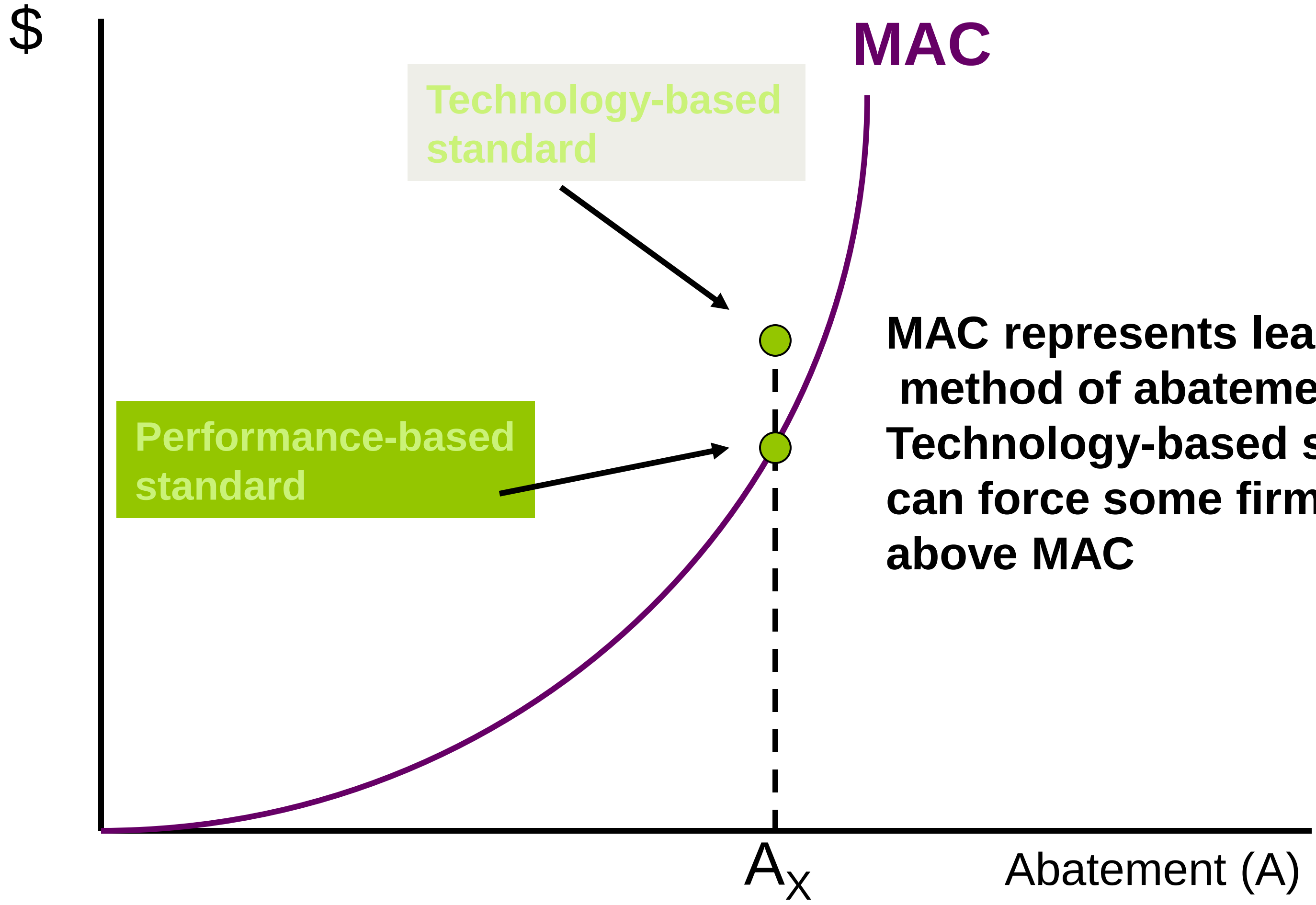
Command and Control Approach (CAC)

- Command-and-control: using standards or rules to *control* pollution

- Typically use
  - Technology-based standards
  - Uniform standards

- Results in cost-ineffectivness

Technology-based Standard: Modeling Cost-Ineffectiveness



MAC represents least-cost method of abatement
Technology-based standards can force some firms to operate above MAC

Model: Multiple Polluter Case

- Each firm responds as in a single polluter case
  - Abates as long as MAC < MT
  - Pays emission charge when MAC > MT
- **Polluter 1**: $TAC_1 = 1.25(A_1)^2$
  $MAC_1 = 2.5(A_1)$
    - where A_1 is pollution abated by Polluter 1
- **Polluter 2**: $TAC_2 = 0.3125(A_2)^2$
  $MAC_2 = 0.625(A_2)$
    - where A_2 is pollution abated by Polluter 2
- Find each firm's abatement level. Then, find each firm's total abatement costs (TAC) and tax payment at that level. Support with a graph.

Uniform Abatement: Modeling Cost-Ineffectiveness

- Assume that two farms, Farm 1 and Farm 2, release nitrogen into a local river that exceeds the emissions standard. To meet this standard, 30 units of nitrogen must be abated in total. The two farms face the following abatement costs:
- $MAC1 = 16 + 0.5A1$
- $MAC2 = 10 + 2.5A2$
  - Where costs are measured in thousands of dollars
- Prove a uniform standard will not meet the cost-effectiveness criterion.
- Determine how the abatement levels should be reallocated across the two firms to minimize costs.

Implications of CAC approach

- We saw that a uniform standard is not cost-effective.
- A cost-effective solution would require a firm-specific abatement standard.
  - Government would need to know the abatement cost conditions for every firm it was regulating = difficult
- Way around lack of info
  - Market approach can arrive at the same cost-effective solution without specific knowledge of polluters' costs.
  - Use market incentives and price mechanism in place of inflexible rules.

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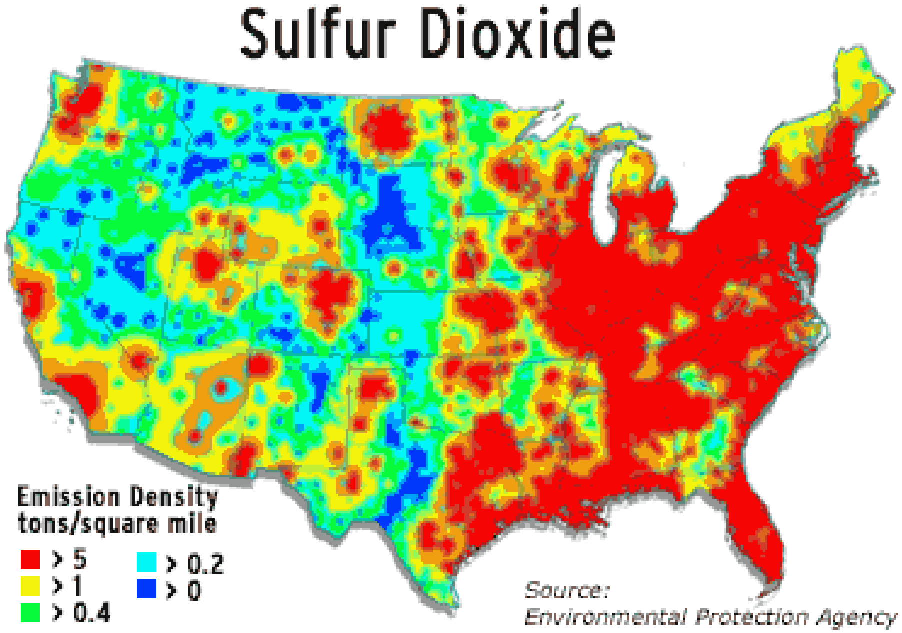

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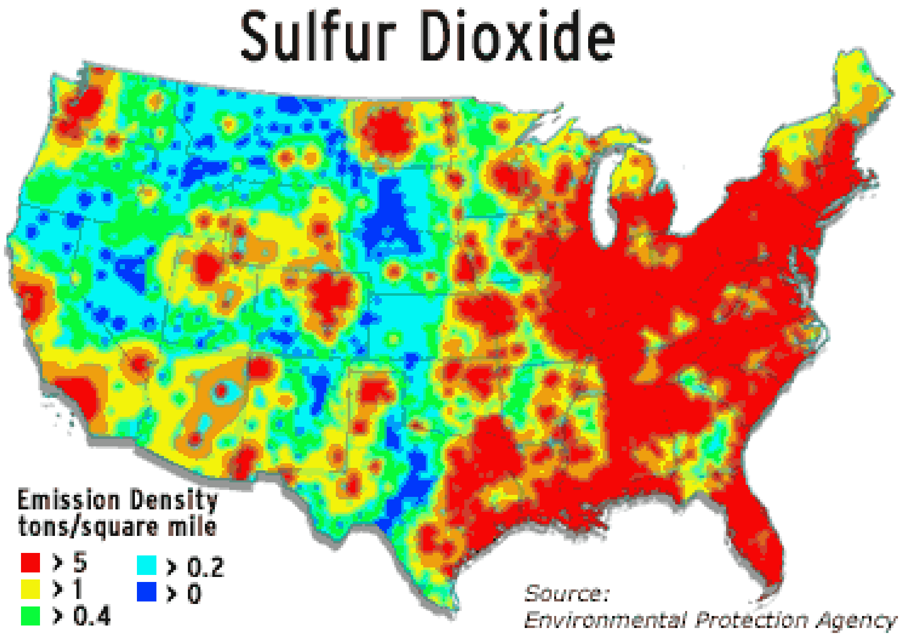

Assign Property Rights

- Introduced in 1960’s by Ronald Coase
  - Stated that two parties have an incentive to negotiate an efficient and mutually beneficial solution if property rights clearly defined
  - Requires removing institutional constraints in favor of property rights
  - Assumptions
    - Transaction costs low
    - Property rights can be enforced
- Key for efficiency is that property rights are assigned, not to whom they are assigned
  - Example of Ole and Riley

Property Rights Example

- A New Hampshire textile mill releases pollution into nearby wetlands, and the associated health and ecological damages are not considered in the private market. You are an EE working with the following information about the market
  - $MB_P = 800 - 0.5Q\ ; MEB = 0$
  - $MC_P = 20 + 0.3Q\quad ; MEC = 0.4Q$
- Suppose the textile mill owned the rights to the wetlands, and it is negotiating with a private environmental group that is willing to pay the mill to produce less output. For the 800th unit of output ,determine the range within which a payment would be acceptable to both parties.

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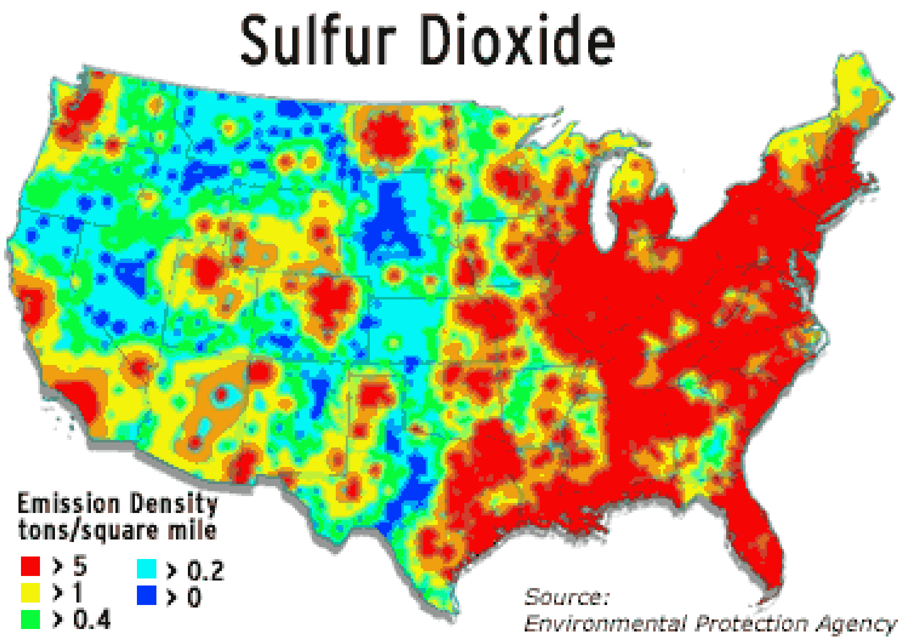


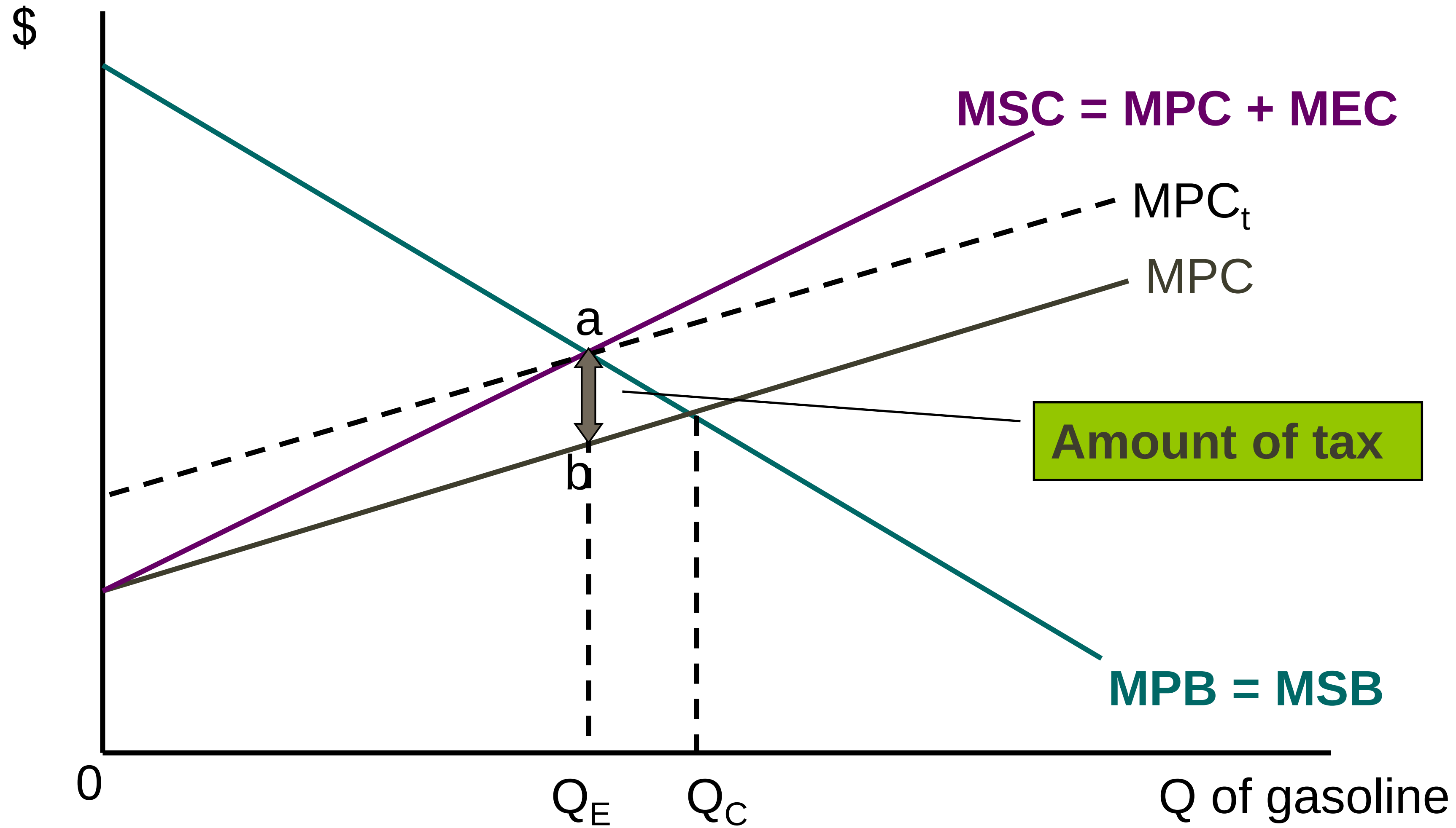
Set the Price of Social Damage

- Fee that varies with amount of pollutants released
  - Based on “Polluter-Pays Principle”
- Types of pollution charges
  - Pigouvian tax or Green tax
  - Effluent/emission fees

Pigouvian Tax or Green Tax

- Fee added to price of pollution-generating ***product***, which generates negative externality
- Impose product charge as per unit tax on product, e.g., gas tax
  - If the tax equals the marginal external cost (MEC) at Q_E, it is called a **Pigouvian tax**

Modeling a Pigouvian Tax



Chemical Manufacturing Example

- Suppose that a chemical manufacturing plant is releasing nitrogen oxides into the air, and these emissions are associated with health and ecological damages. Economists have estimated the following marginal costs and benefits for the chemical market, where *Q* is monthly output in thousands of pounds and *P* is price per pound.
  - $MB_P = 50 - 0.4Q\ ; MEB = 0$
  - $MC_P = 2 + 0.4Q \quad ; MEC = 0.2Q$
- Find the dollar value of Pigouvian tax that would achieve an efficient solution.

Assessing the Model

- In theory, achieves an efficient outcome
- Double dividend
- In practice, difficult to identify the value of MEC at Q_E
- Allows only for an output reduction to reduce pollution

Emission (Effluent) Charge

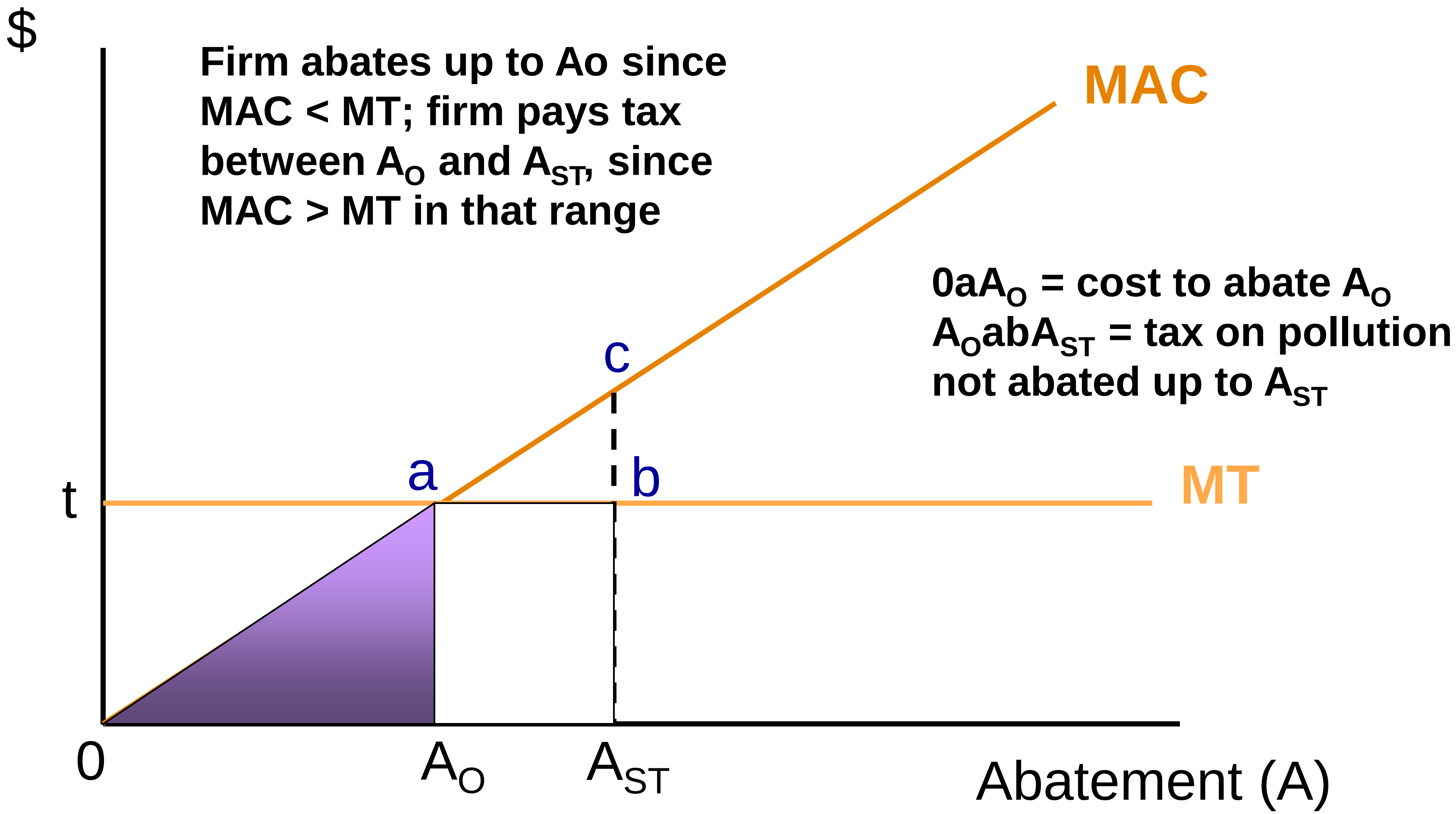
- A fee imposed directly on the discharge of ***pollution***
  - Assigns a price to pollution
- Typically implemented through a tax

Model: Single Polluter Case

- Government sets an abatement standard at A_{ST}
- Policy options to polluter are:
  - Abate up to A_{ST} and incur those costs OR
  - Pay a constant per unit tax, t, on any abatement less than A_{ST}
    - **Total Tax = $t(A_{ST} - A_O)$**
      - where A_O is actual abatement level
    - **Marginal Tax (MT) = t**
      - Because t is constant, t = MT
- Firm will choose the least-cost option: the marginal tax (MT) or the marginal abatement cost (MAC)

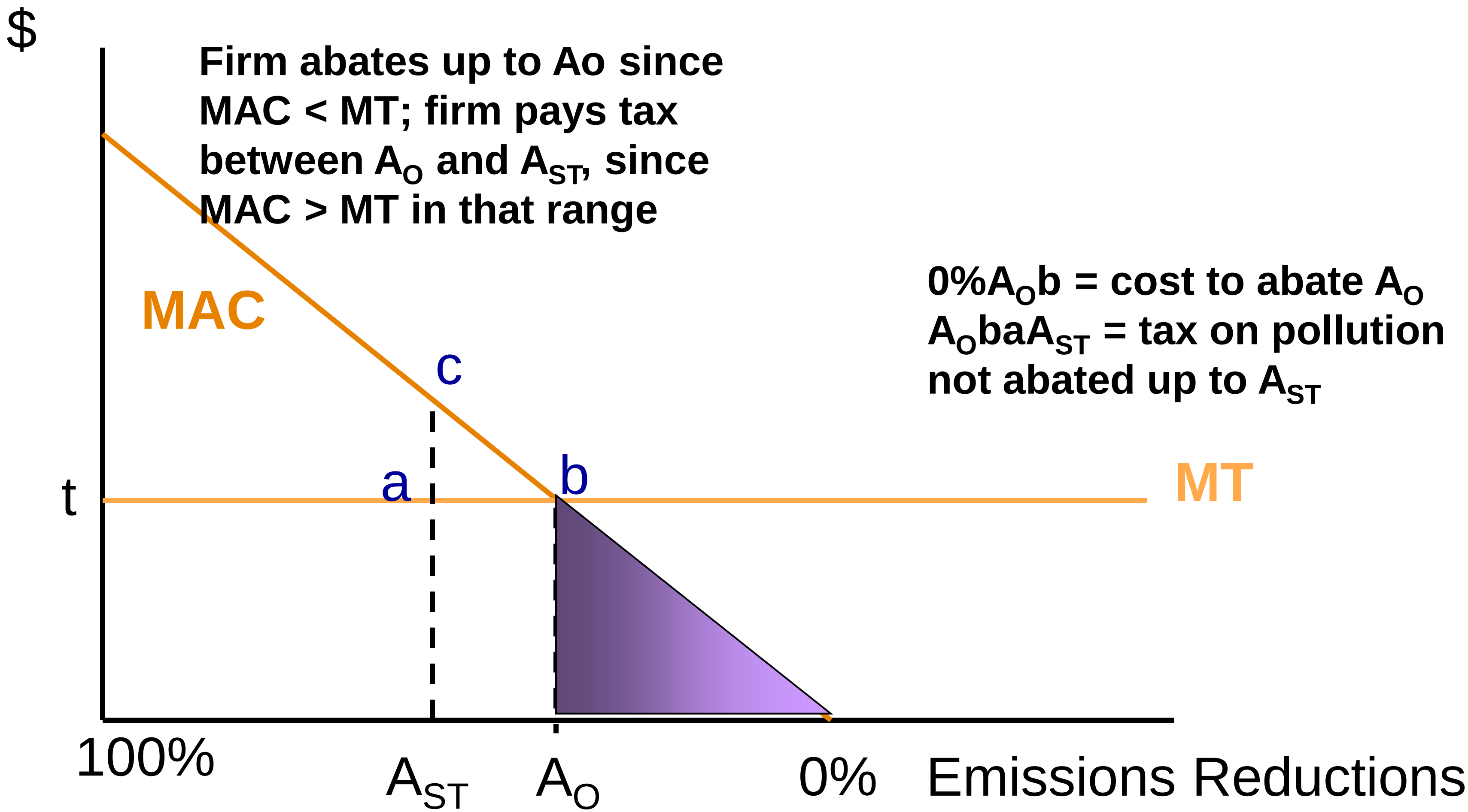
Modeling Emission Charge

Single Polluter



Modeling Emission Charge

Single Polluter



Model: Multiple Polluter Case

- Assumptions
  - 2 polluting sources in some region
  - Each generates 10 units of pollution
  - Government sets emissions limit for region as 10 units, which implies $A_{ST} = 10$
  - Policy: To achieve A_{ST}, government imposes an emission charge as a unit tax (t) of $5

Model: Multiple Polluter Case

- Each firm responds as in a single polluter case
  - Abates as long as MAC < MT
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- **Polluter 1**: $TAC_1 = 1.25(A_1)^2$
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- **Polluter 2**: $TAC_2 = 0.3125(A_2)^2$
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- Find each firm's abatement level. Then, find each firm's total abatement costs (TAC) and tax payment at that level. Support with a graph.

Solution

- **Polluter 1:**
  - Abates up to the point where $MAC_1 = MT$,
    - Set $2.5(A_1) = \$5$, or $\mathbf{A_1 = 2}$
  - Incurs $TAC_1 = 1.25(2)^2 = \$5$
  - Incurs Total Tax = 5(10 - 2) = **$40**
- **Polluter 2:**
  - Abates up to point where $MAC_2 = MT$
    - Set $0.625(A_2) = \$5$, or $\mathbf{A_2 = 8}$
  - Incurs $TAC_2 = 0.3125(8)^2 =$ **$20**
  - Incurs Total Tax = 5(10 - 8) = **$10**

Compare Result to CAC

- Under CAC approach, each polluting source would reduce emissions by 5 units.
- Determine each polluters marginal abatement cost and the total abatement cost.

Assessing the Model (pros)

- Abatement standard is met
- Generates $40 in tax revenues from high-cost abater and $10 from low-cost abater
- Low-cost abaters do most of cleaning up
- Cost-effective solution is obtained
  - MACs are equal at $5 tax rate
  - Combined TAC of $25 is lower than $39.06 under command-and-control with a uniform standard

Assessing the Model (cons)

- Tax authority will not know where MACs are equal
  - Will have to adjust rate until objective achieved
- Monitoring costs potentially higher
- Firms might evade tax by illegally disposing pollutants
- Distributional implications
  - Consumers may pay higher prices due to tax
  - Job losses may result from polluter paying new taxes and/or changing technology to abate

Pollution Charges in Practice

- Internationally, the pollution charge is the most commonly used market-based instrument
  - Australia, France, Germany, and Japan use **fees or taxes** to control noise pollution generated by aircraft
  - Canada, France, Mexico, and Poland are among the nations using **effluent charges** to protect water resources.
  - Others levy charges on products such as batteries, tires, lubricant oil, packaging, paint, paint containers, and gasoline

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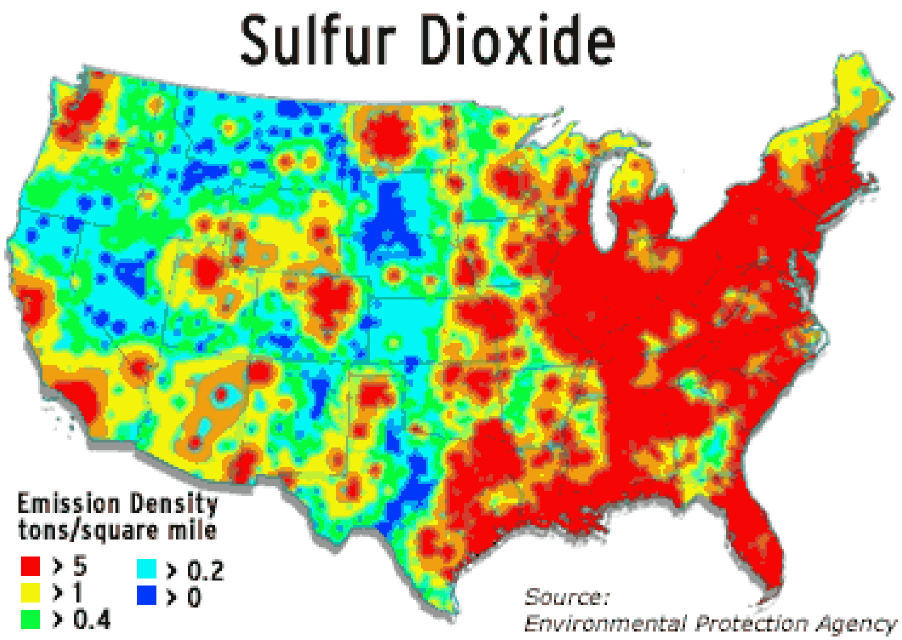

Pollution Permit Trading Systems

- A pollution permit trading system establishes a market for rights to pollute by issuing tradeable pollution credits or allowances
  - **Credits** are issued for emitting *below* a standard
  - **Allowances** indicate how much can be released
- Two components of the system are
  1. Fixed number of permits is issued based on an "acceptable" level of pollution set by government
  2. The permits are marketable
- Bargaining gives rise to a market for pollution rights

How Permit Trading Works

- There is an incentive to trade as long as polluters face different *MAC* levels
- Suppose a firm has 50 permits but normally emits 75 units of SO_2. What must it do?
  - Answer
    - Abate 25 units of emissions ***OR***
    - Buy 25 permits from another producer
- Which option will the firm choose?
  - Answer
    - Whichever option is cheaper

Example: Return to the Multiple Polluter Case

- Assumptions
  - 2 polluting sources in some region
  - Each generates 10 units of pollution
  - Government sets emissions limit for region as 10 units.
  - Assume the government allocates 5 permits to each polluter.

Example continued

- If the permit system did not allow for trading, then each firm would be forced to abate by 5 units each.
  - TAC here equals $39.06
- As long as MAC are different, there is an incentive to trade.
- End result: each polluter faces $MAC = \$5$. Polluter 2 abates 8 units; Polluter 1 abates 2 units. $TAC = \$25$

Result

- Low-cost abaters will clean up pollution and sell excess permits to other firms
  - They will ***sell*** at any P ***higher*** than their MAC
- High-cost abaters will buy permits rather than abate
  - They will ***buy*** at any P ***lower*** than their MAC
- Trading will continue until the incentive to do so no longer exists, at which point, the cost-effective solution is obtained, i.e., the MACs across firms are equal
- Notice: Identical to Pigouvian efficient outcome
  - Differences

Assessing the Model

- Trading establishes the price of a right to pollute without government trying to "search" for a price
- No tax revenues are generated
- Trading system is flexible
  - Note that an emissions standard can be adjusted by changing the number of permits issued

Pollution Trading Systems in Practice

- Most of the evolution of trading is occurring in U.S.
  - An important example is the allowance-based trading program to control sulfur dioxide emissions under the Clean Air Act Amendments of 1990
  - More innovation has occurred at state and local levels
    - Ozone Transport Commission in the Northeast
    - California Regional Clean Air Incentives Market (RECLAIM)
- Key international example
  - Trading of greenhouse gas allowances are part of the Kyoto Protocol, an international accord aimed at global warming
    - Includes the European Union Greenhouse Gas Emission Trading System (EU ETS), launched in 2005

Deposit-Refund System

- For information about deposit-refund systems, click the link below

- Deposit-Refund Systems in Practice and Theory
  - Resources for the Future (RFF), November 2011.