

Cap-and-Trade 101

Jennifer Morris

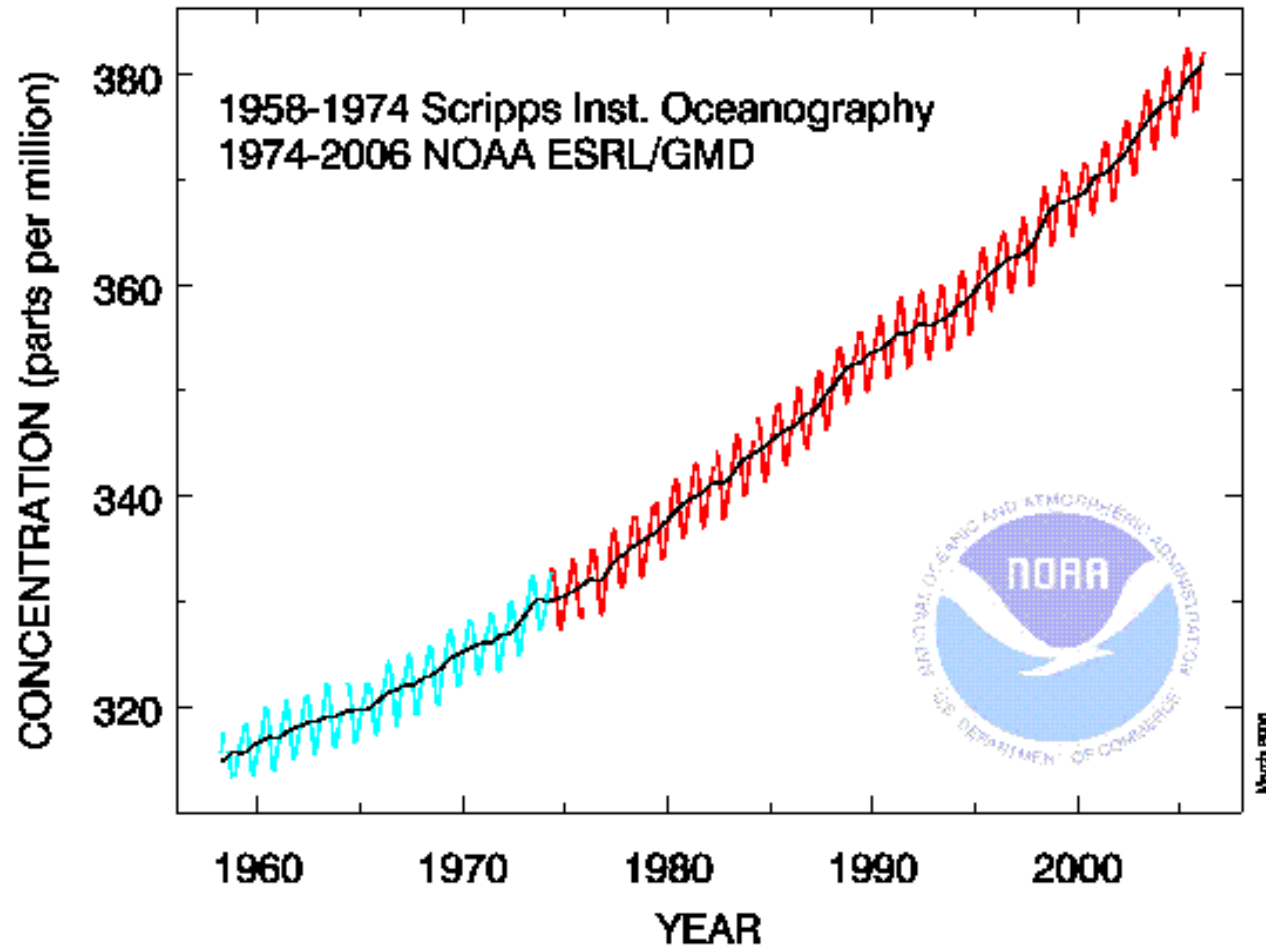
holak@mit.edu

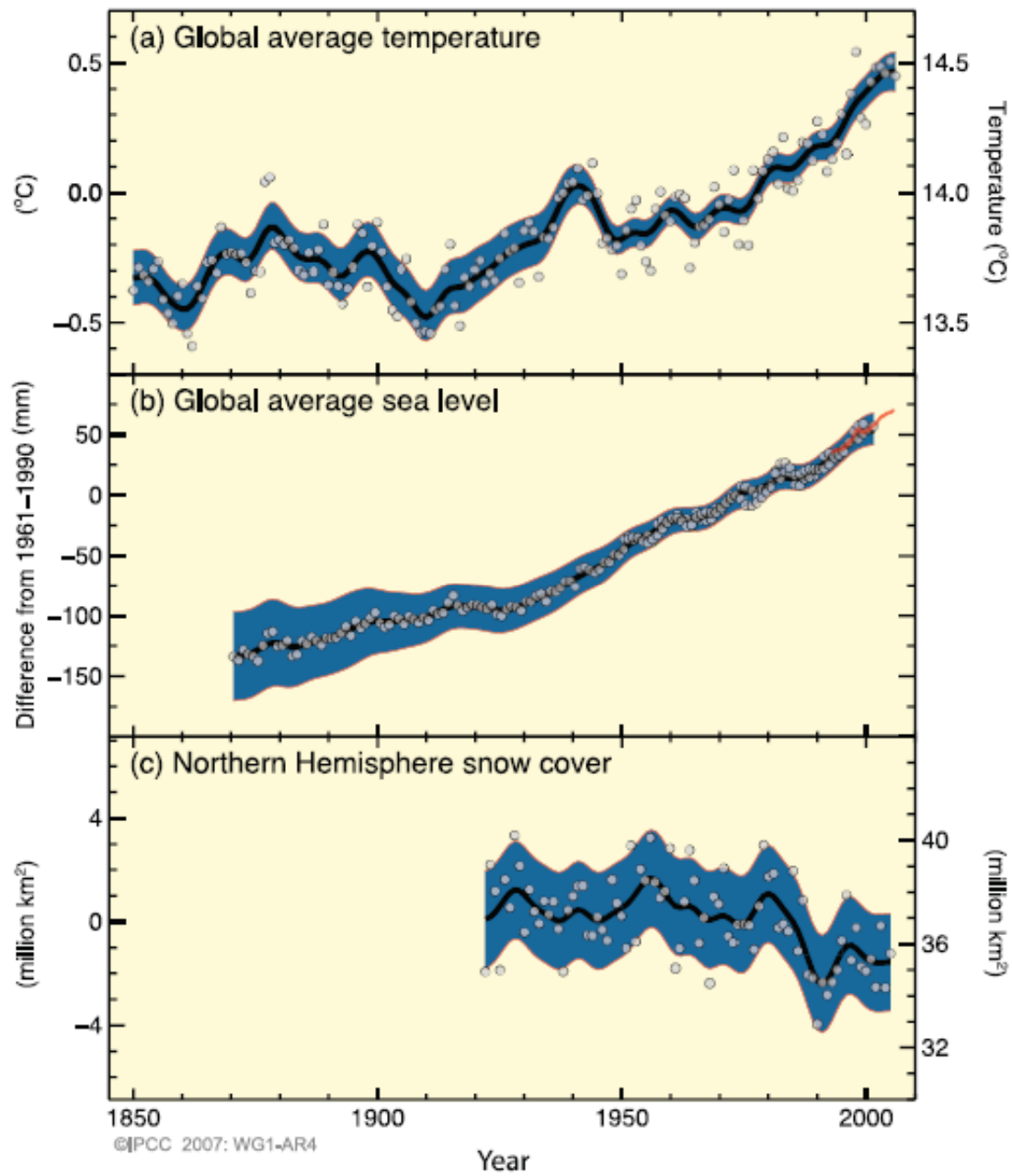
Presentation to MIT Energy Club October 2009



The Problem

Atmospheric CO₂ at Mauna Loa Observatory





- Will the market solve this problem?
- Or do we need to intervene with policy?

Market Assumptions

Market Conditions:

- (1) Perfect Information
 - (2) Perfect Competition
 - (3) Private Goods
 - (4) Private Decisions
- Rational behavior
 - No transaction costs

Market Failures:

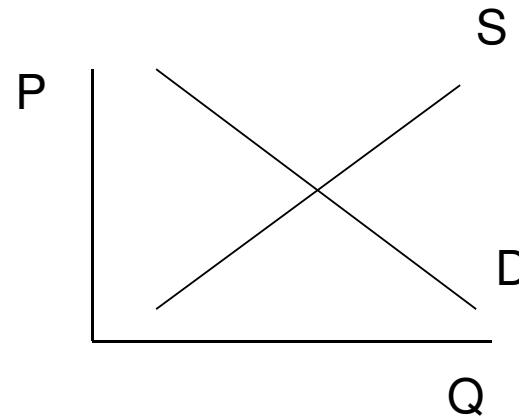
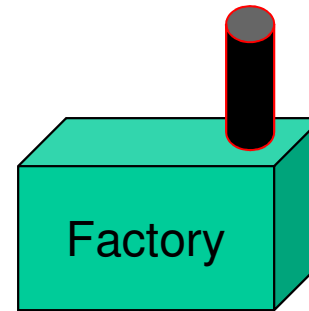
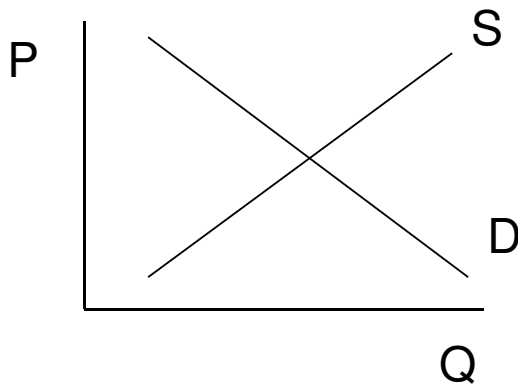
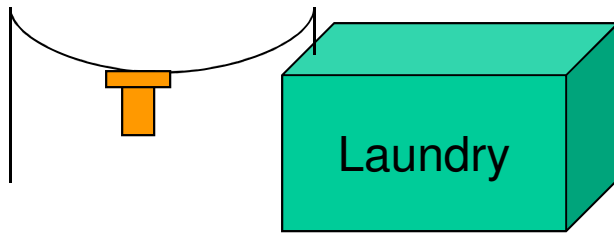
- (1) Information Asymmetry
 - (2) Monopoly, Monopsony, Oligopoly
 - (3) Public Goods
 - (4) Externalities
- Non-rational behavior
 - Transaction costs

Clean Air/Climate as a Public Good

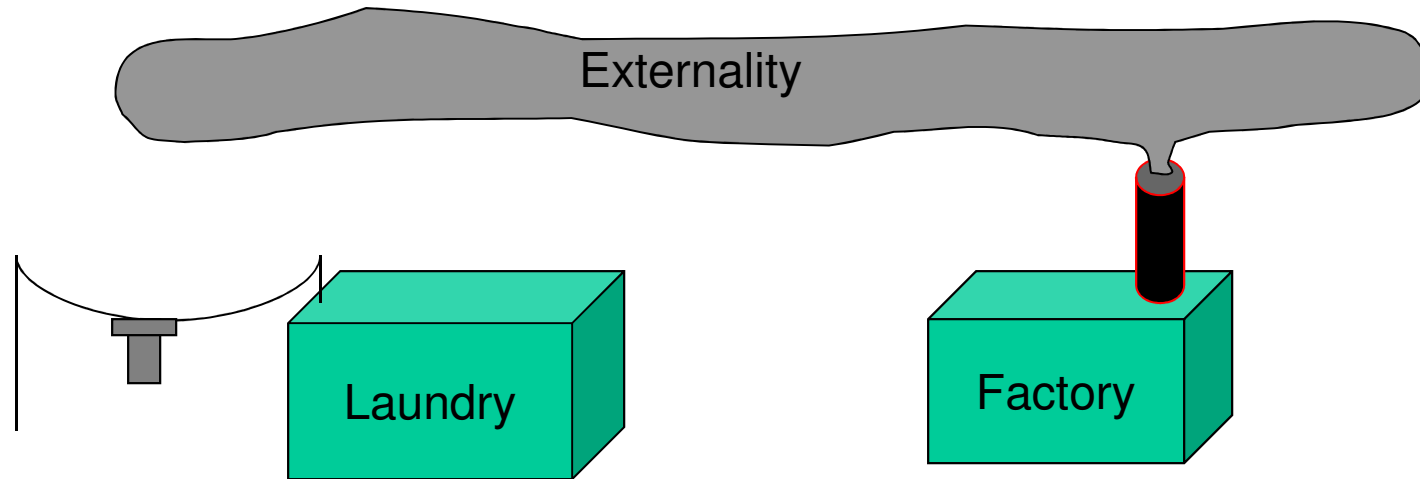
- Non-Rival: use by one does not prevent use by others
- Non-Excludable: can not prevent people from using
- Global Commons Problem
 - Concentrated costs
 - Diffuse benefits
 - Free riders
- Solutions
 - Privatize?
 - **Cooperation** → **Global Agreements like Kyoto**



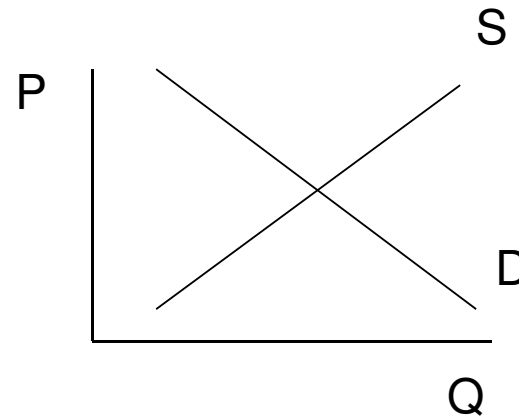
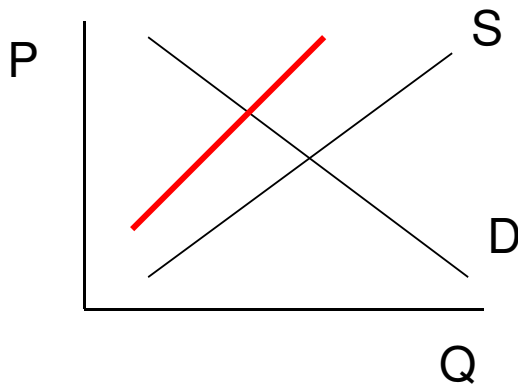
Externality



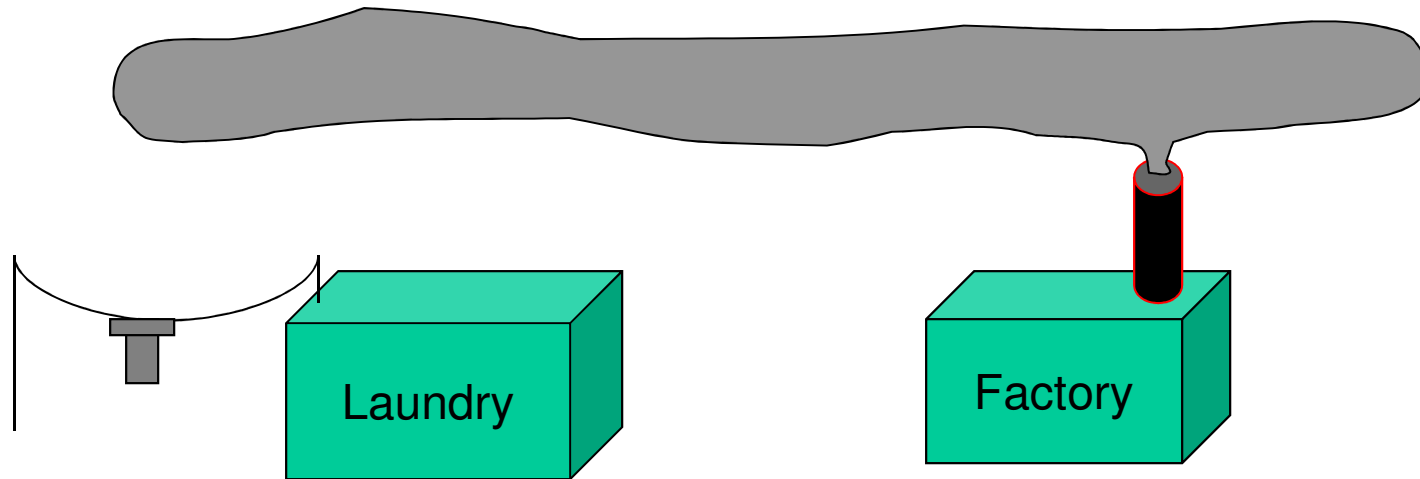
Externality 2



New S



Externality 3



What Are Possible Solutions?

If the laundry has a right to clean air?

If the factory has a right to emit?

If the rights are not clear?

Externalities in the Market

MPB = marginal private benefit

MPC = Marginal private cost

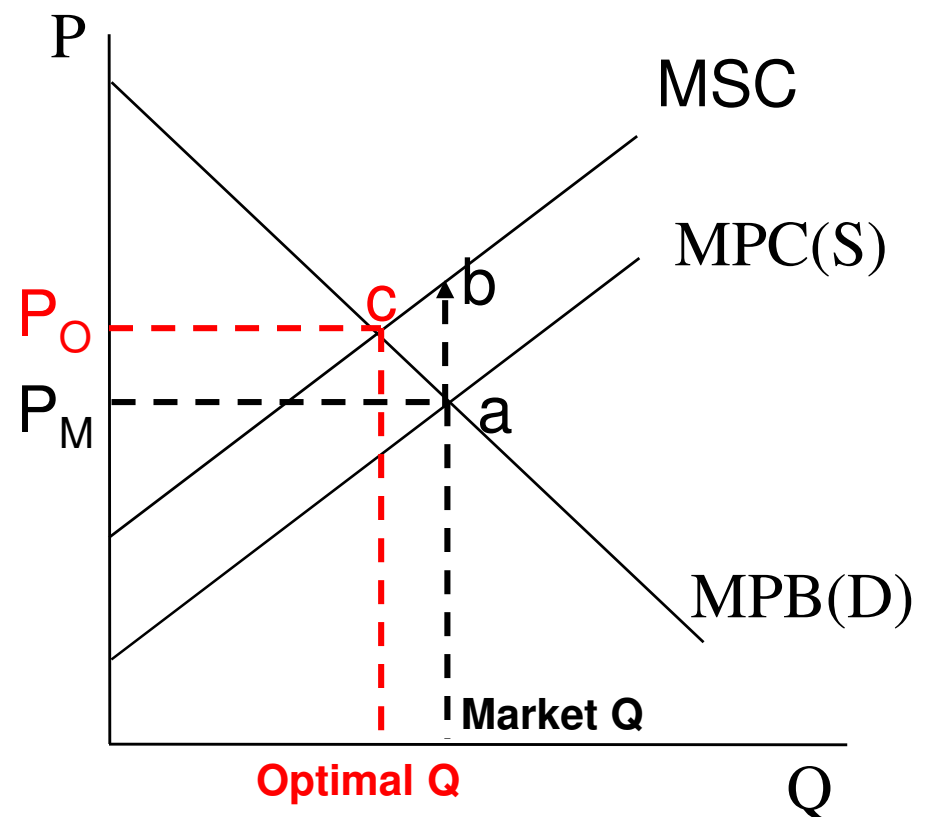
MSC = Marginal social cost
(e.g., health damage)

What market solution?

What is wrong?

What is social optimum?

How do we achieve social optimum?



Policy Tools

- Command and Control
- Carbon Tax
- Cap-and-Trade System

- R&D, Subsidies



Command-and-Control

- Mandate specific quantities, sources, compositions, etc. of emissions, or specific technologies, processes, etc.
- Examples:
 - CAFE Standards (fuel economy)
 - Renewable Portfolio Standards
 - Energy Efficiency Standards
 - Emission quotas/standards
 - Require scrubbers on coal plants
- Problem: shifts investment away from least-cost emission reduction options and toward specific technologies/reduction methods, which are not necessarily least-cost or even low-cost
 - Can result in technological lock-in of solutions that are not the best



Carbon Tax

- Pay set price for every ton of emissions produced

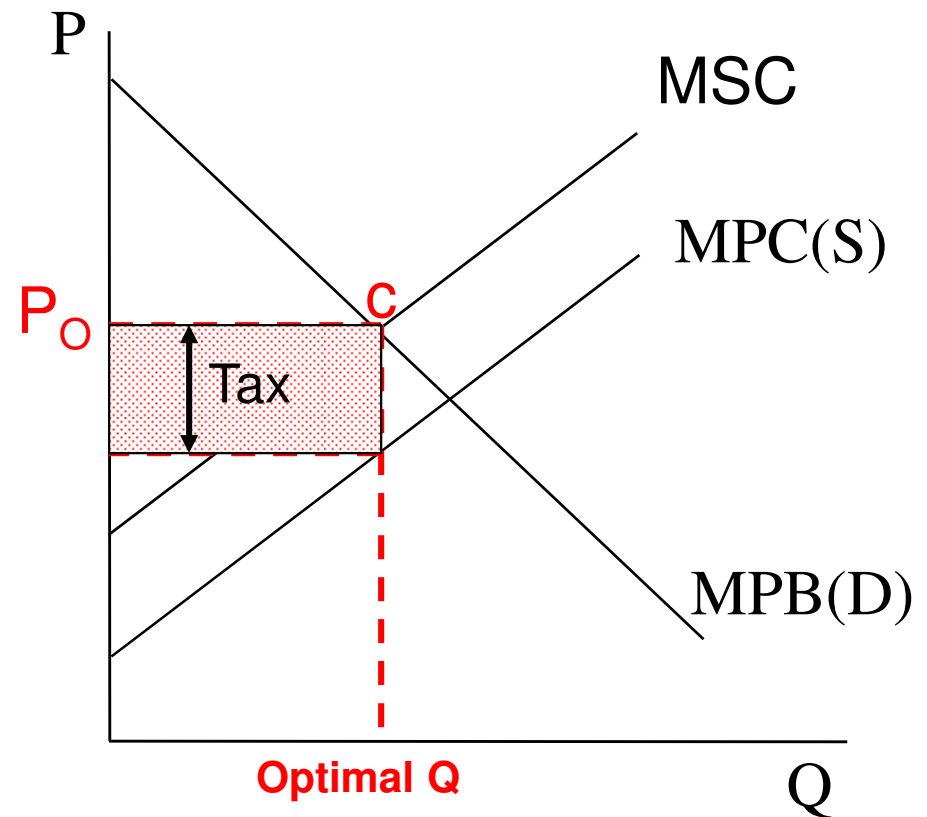
Known Price, Unknown Quantity



A Tax

What is the desired tax?

How much money does it collect?



Cap-and-Trade

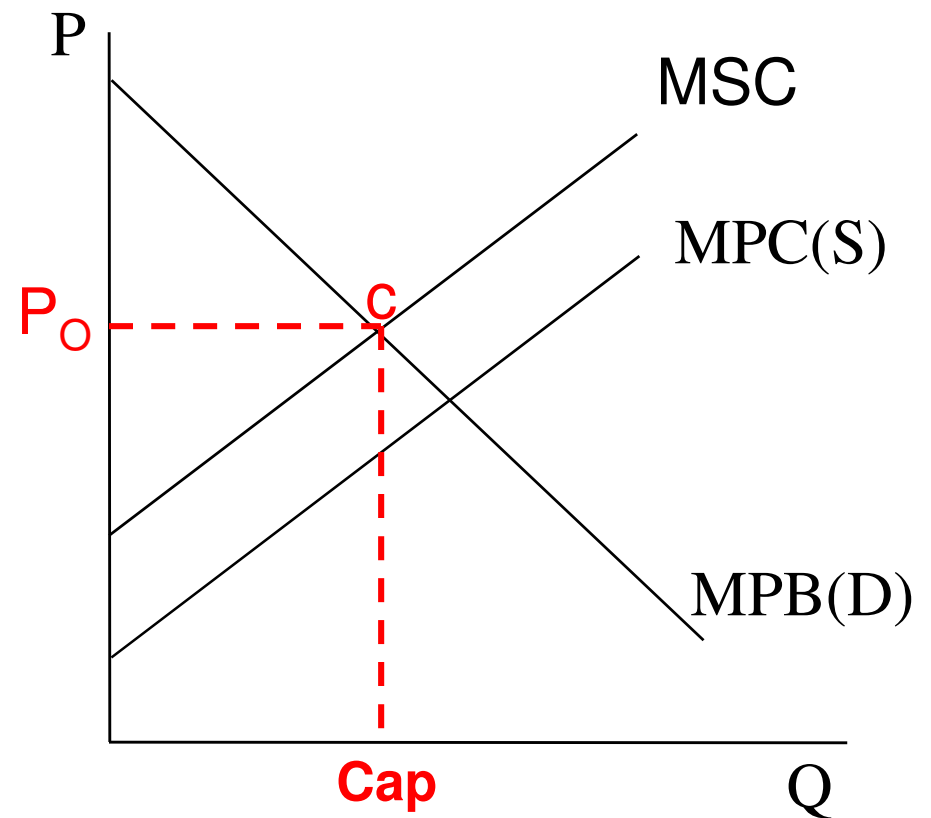
- Cap or limit on total quantity of emissions
- Submit permit for every ton of emissions produced
- Total number of permits in existence = cap
- Covered entities can trade permits
- Trading creates market for permits → market price for permits (carbon price)

Known Quantity, Unknown Price



A Cap-&-Trade System

Where to set the cap on allowances to produce?

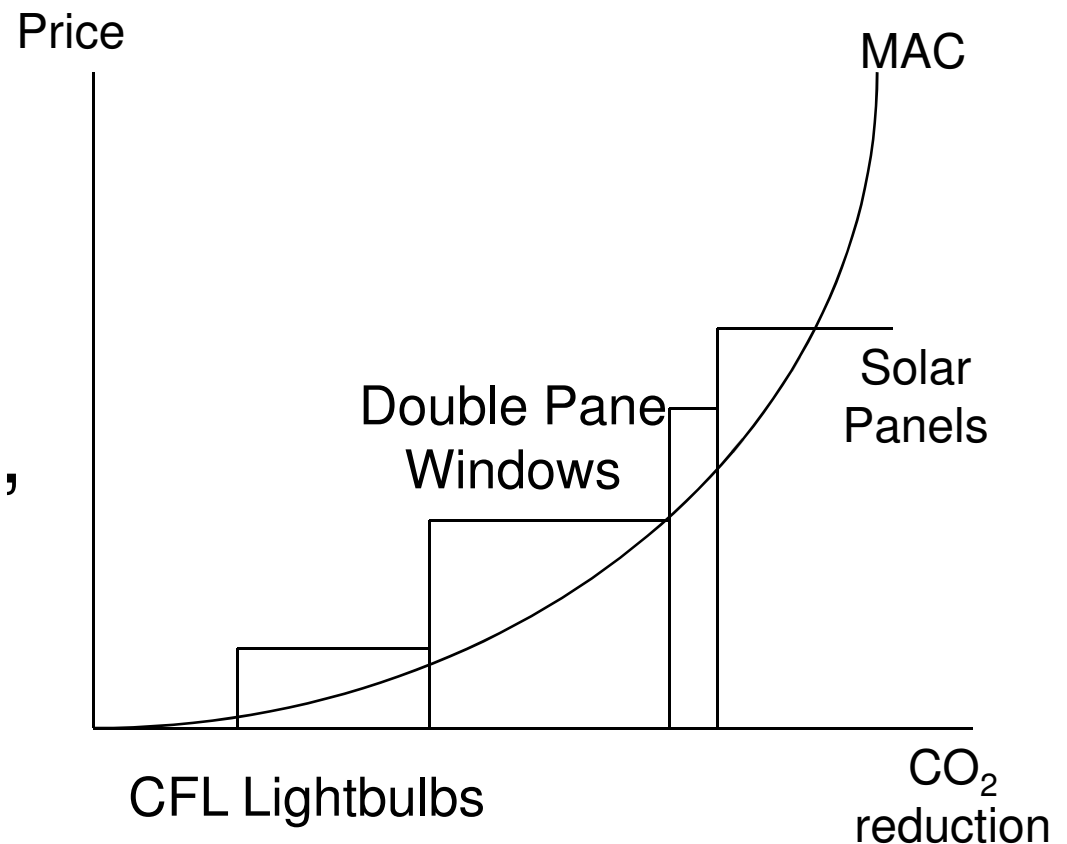


How does cap-and-trade work?

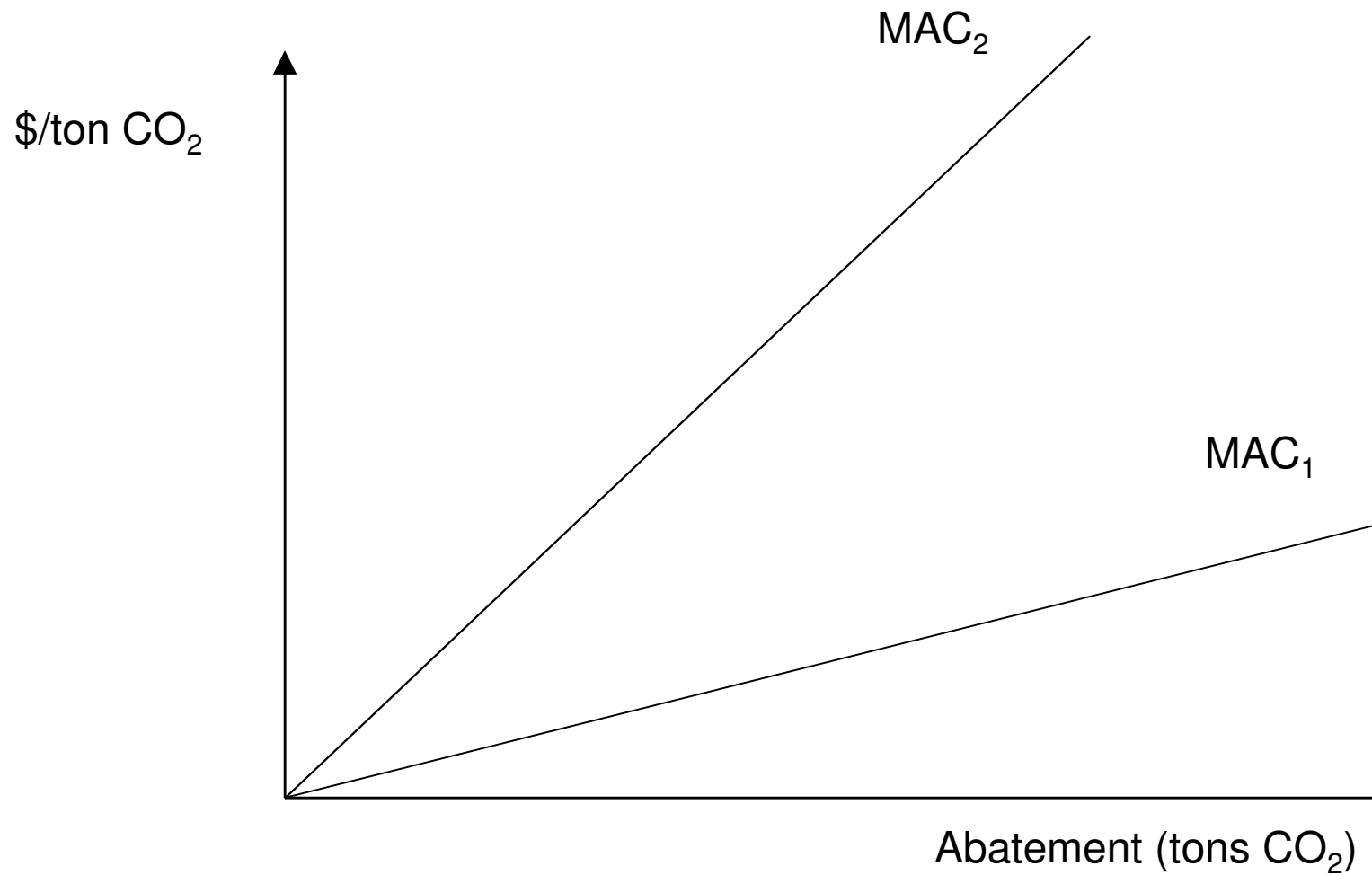


Side Note: Marginal Abatement Cost

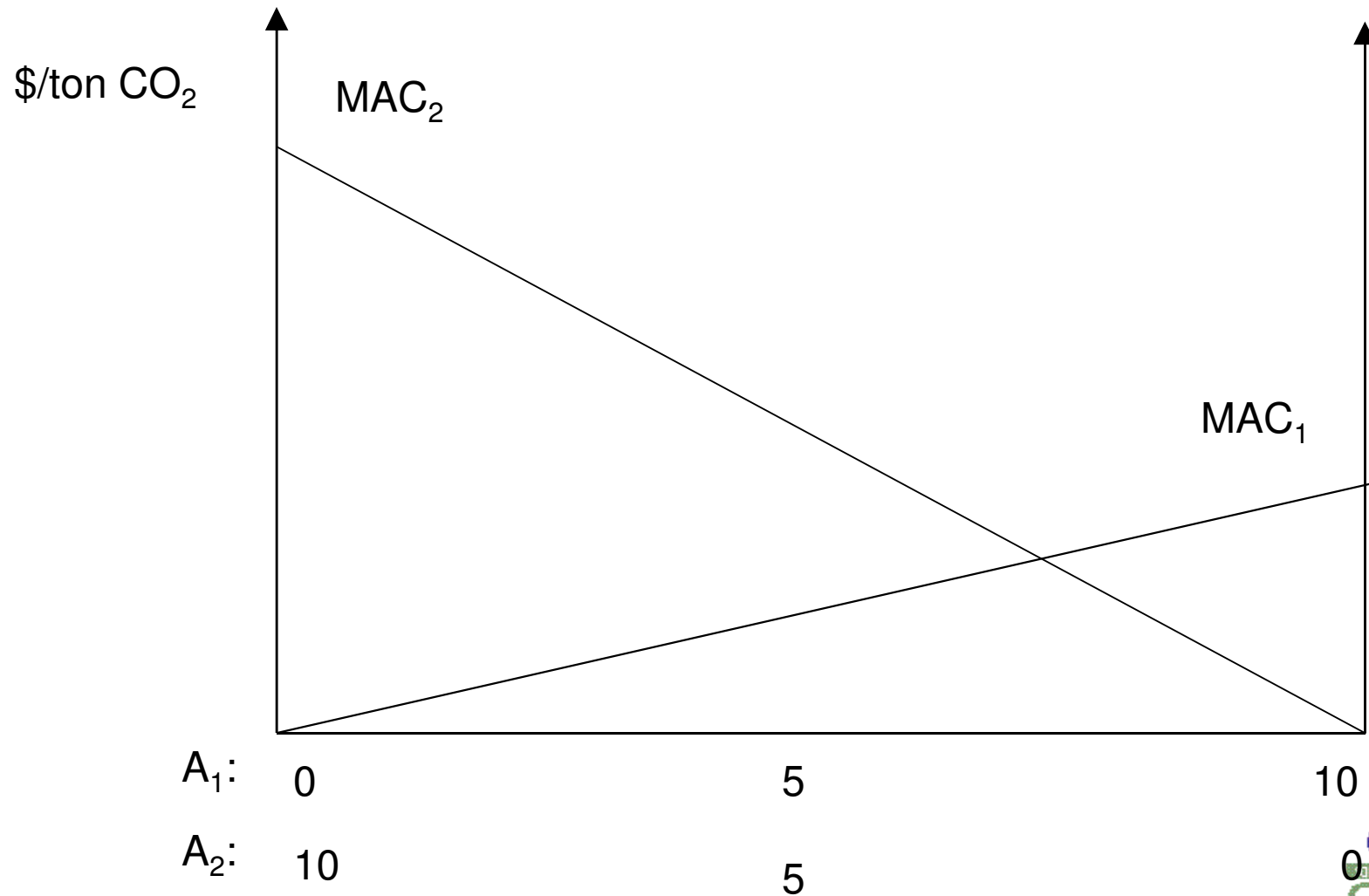
- “MAC curve”
- Include all options for reduction, ordered by price, with quantity available at that price



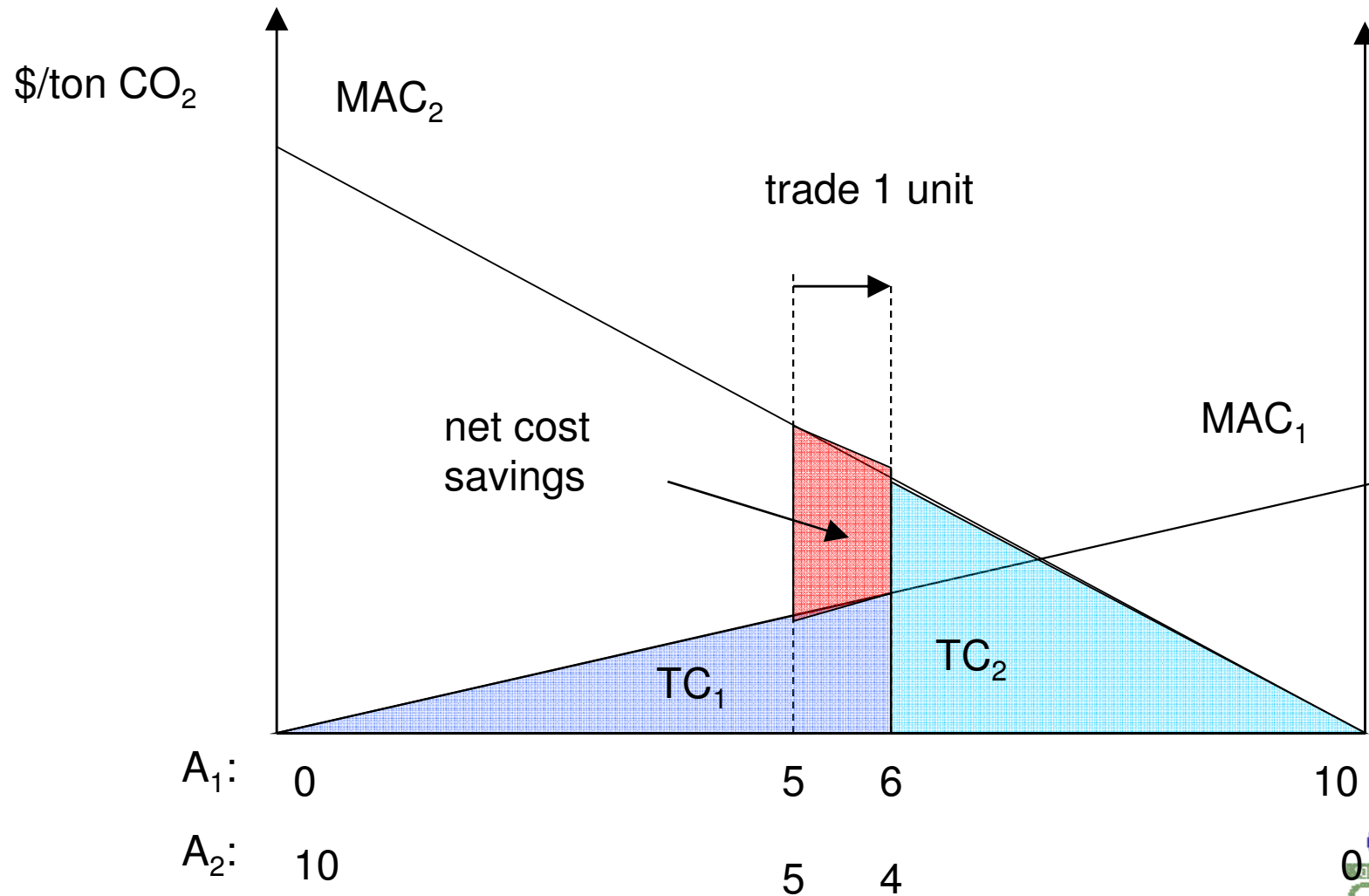
Trading Example with 2 Sources



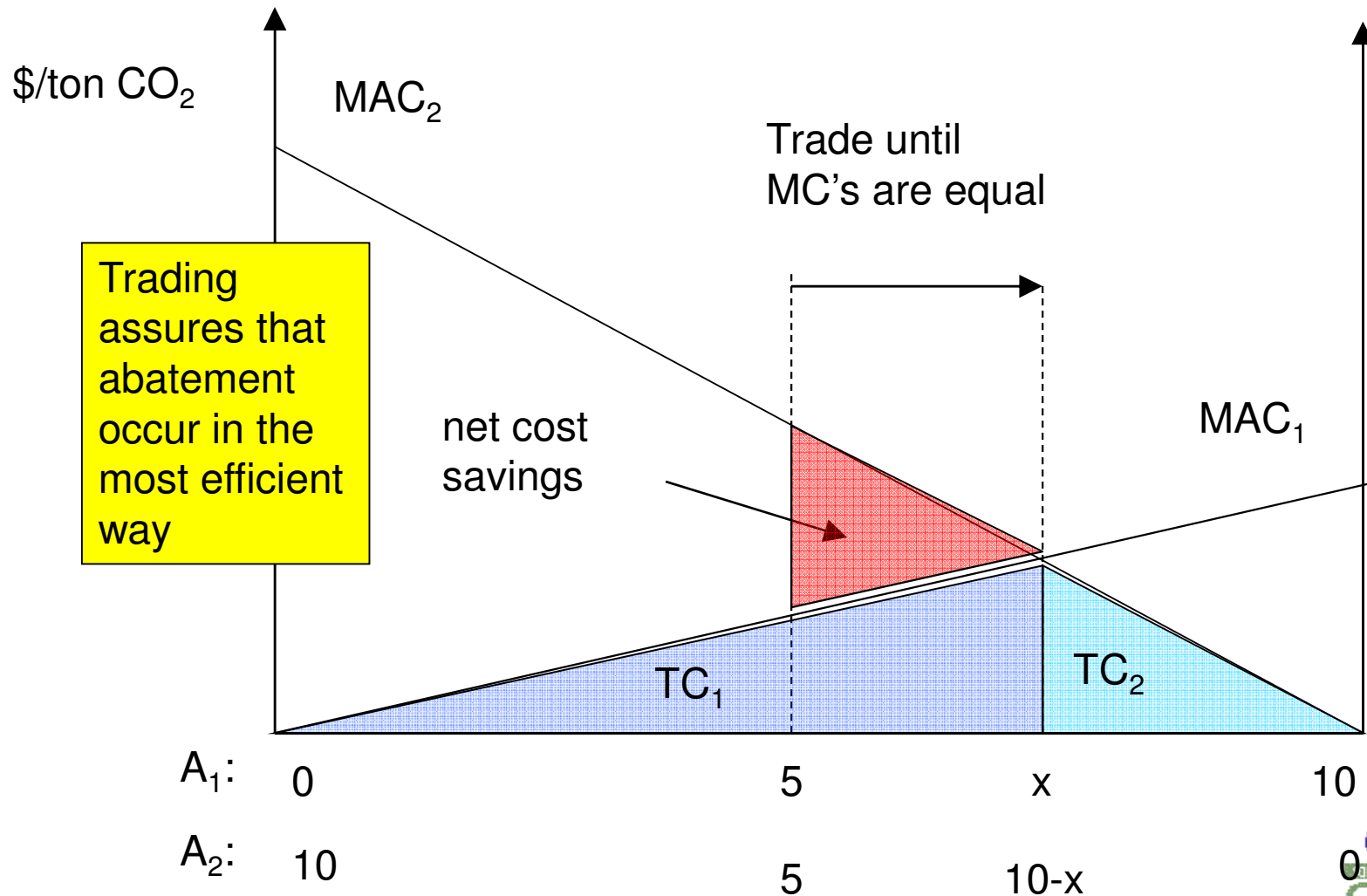
Re-Order the MAC Curves



Begin Trading



Trading Solution



Cap & Trade vs. Tax: Important Issues

- Revenue
- Allocation
- Efficiency
- Price Volatility
 - Cost containment mechanisms
- Political Feasibility
- Emissions



Carbon Tax vs. Cap & Trade: Revenue

- Revenue generated from cap & trade only if permits auctioned
- Carbon Tax and Cap-and Trade with huge revenue potential:
 - \$80 billion annually with a constant \$15 per ton CO₂ price
 - 80% cap-and-trade ~\$300-500 billion annually
 - 3-10% of Non-CO2 federal tax revenue
 - Rebates of \$1,000-\$5,000 per family of 4 per year
 - Order of magnitude larger than Acid Rain Program
- Free permits are a hidden transfer



Carbon Tax vs. Cap & Trade: Allocation

- Permits are valuable assets
 - Big political fight
- Current focus on allocation has perverse distributional results
 - Any distributional emphasis should be on compensating affected parties, not regulated sectors

Carbon Tax vs. Cap & Trade: Efficiency

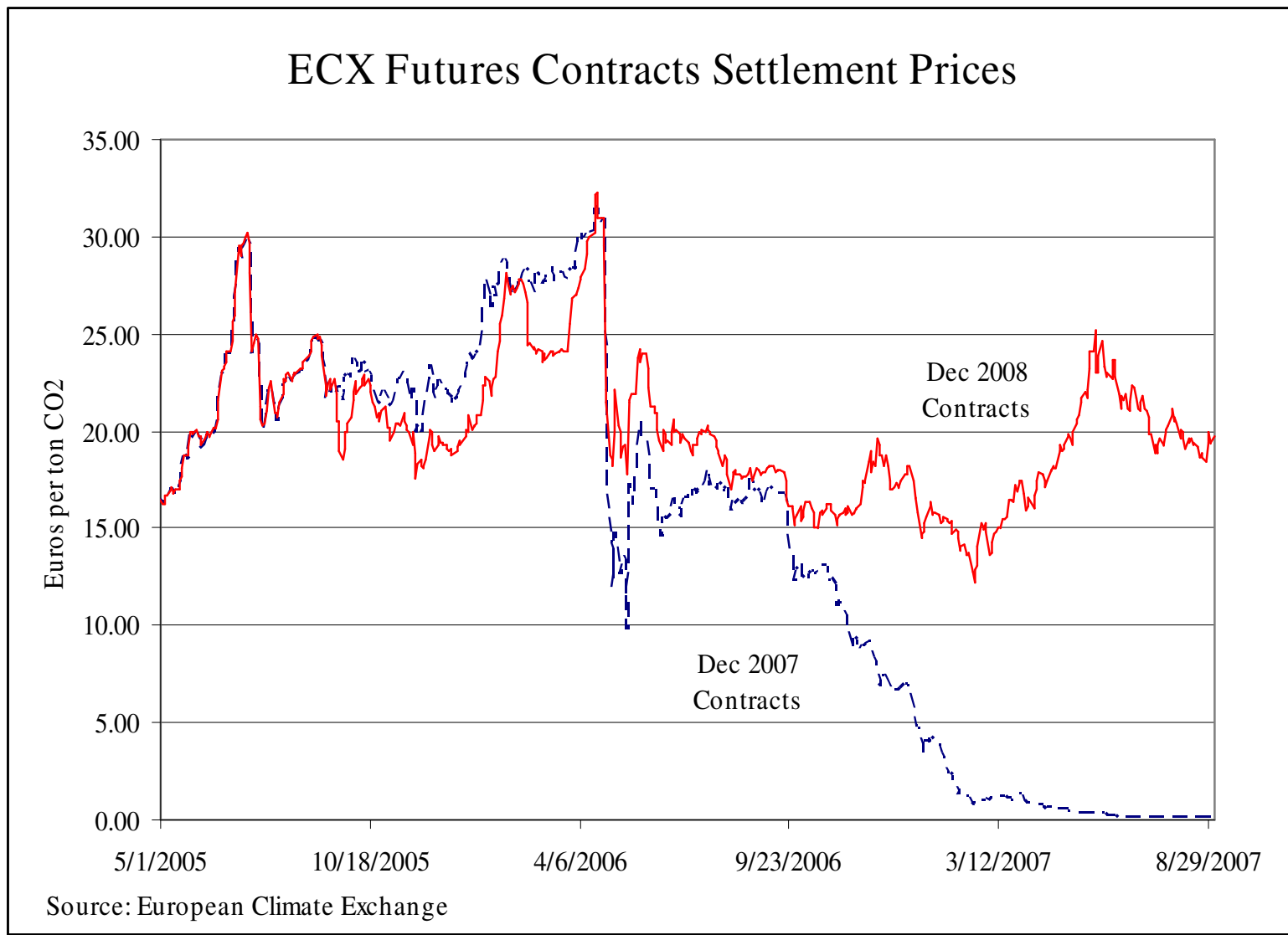
- Pure cap & trade fixes quantity but not price
- Pure tax fixes price but not quantity
- Economic modeling consistently shows that a tax is more efficient way to achieve given GHG reductions under abatement cost uncertainty



Carbon Tax vs. Cap & Trade: Price Volatility

- Permit prices can be volatile
 - EU-ETS, Acid Rain Program
- Makes planning by firms difficult
- Cost Containment mechanisms important

EU Prices

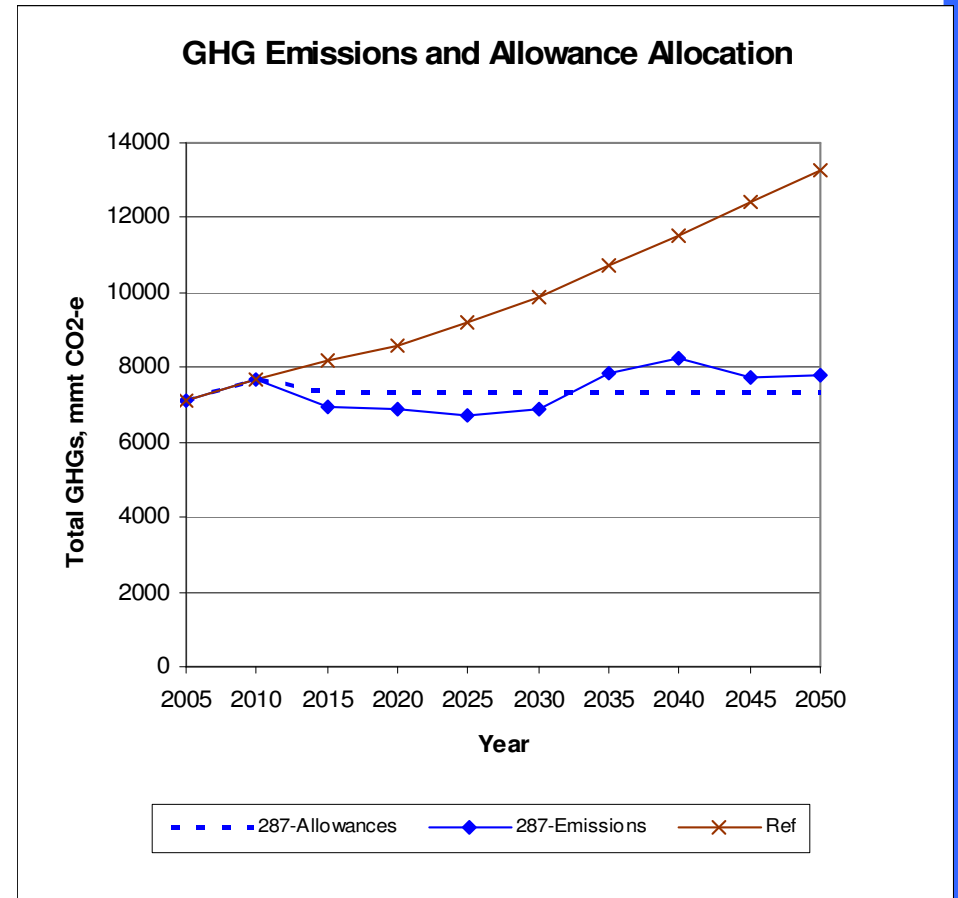


Aside: Cost Containment Mechanisms

- Banking

Aside: Banking

- Future emission reductions are more expensive
 - Policies get more stringent over time
 - Abate easy emissions first
- Banking: tendency to reduce more early on while cheaper, bank extra permits to use in future when reductions are more expensive



Aside: Cost Containment Mechanisms

- Banking
- Safety Valve

Aside: Safety Valve

- If market price for permits reaches certain price, safety valve is triggered and covered entities can purchase as many permits from the government as they would like at the safety valve price
- Once safety valve is triggered, effectively becomes a carbon tax

Aside: Cost Containment Mechanisms

- Banking
- Safety Valve
- Borrowing (from future)
- Intensity Target (emissions per \$ GDP)
- Credits and Offsets (sequestration, international projects, non-covered entities)

Carbon Tax vs. Cap & Trade: Political Feasibility

- Cap-and-trade with advantage at this time
 - Doesn't contain word "tax" (politically appealing)
 - Control over quantity of emissions → climate impacts
 - Trading allows flexibility
 - Success in SO₂ Market
 - Can learn from EU-ETS
- But opposition to tax may decrease
 - growing concern over climate change
 - Market crash: permits for cap-and-trade could be traded on Wall Street → do people trust that anymore?



Carbon Tax vs. Cap & Trade: Emissions

- Cap-and-trade thought to be more certain of emissions reduction, but cap can be loosened if price too high
 - Congress is ultimate safety valve
- Tax can be tightened if underachieving reduction targets

Important Policy Design Issues

- Coverage
 - Sectors
 - Gases (CO₂ vs. all GHGs)
- Target stringency & path
- Point of regulation (upstream vs. downstream)
 - Upstream (coal mine and refinery gate) vs. downstream (firms and gas stations)
- Cost containment
- Allocation Method
- Revenue use
- International linkage
 - Trade in allowances
 - Trade protection

Waxman-Markey

H.R.2454



Waxman-Markey

- **Title I:** Clean Energy (Renewable Electricity Standard)
- **Title II:** Energy Efficiency and Standards
- **Title III:** Cap-and-Trade System
- **Title IV:** Transition to Clean Economy and Competitiveness Issues



Title I

- Combined efficiency and renewable electricity standard
 - Begins at 6% in 2012, gradually rises to 20% in 2020
 - 75% must be met by renewable energy
- Advanced Technology Support
 - CCS: bonus allowances, demonstration & deployment program
 - Clean Vehicles: electric vehicle infrastructure, fuel standards, advanced vehicle manufacturing aid, and loan programs
 - State Energy and Environment Development (SEED) Accounts for energy efficiency and renewable energy deployment
 - Clean Energy Investment Fund
 - Smart grid advancement and transmission planning and siting



Title II

- Energy efficiency standards for buildings, lighting, and appliances
- Emission standards for heavy-duty vehicles and off-road vehicles (ex. construction equipment, trains, large ships)
- Measures to increase efficiency of water
- Promote energy savings by the federal government and other public institutions



Title III

- Cap-and-Trade System

- Coverage

- Covers all GHGs (HFCs with separate cap)
 - Covers electricity generation, large stationary sources*, producers and importers of fossil-based liquid fuels (petroleum refineries), natural gas distributors, F-gas producers, and other specified sources

- *Large = results in 25,000 or more tons of CO₂-e per year

- Ultimately covers 84.5% of total U.S. GHG emissions

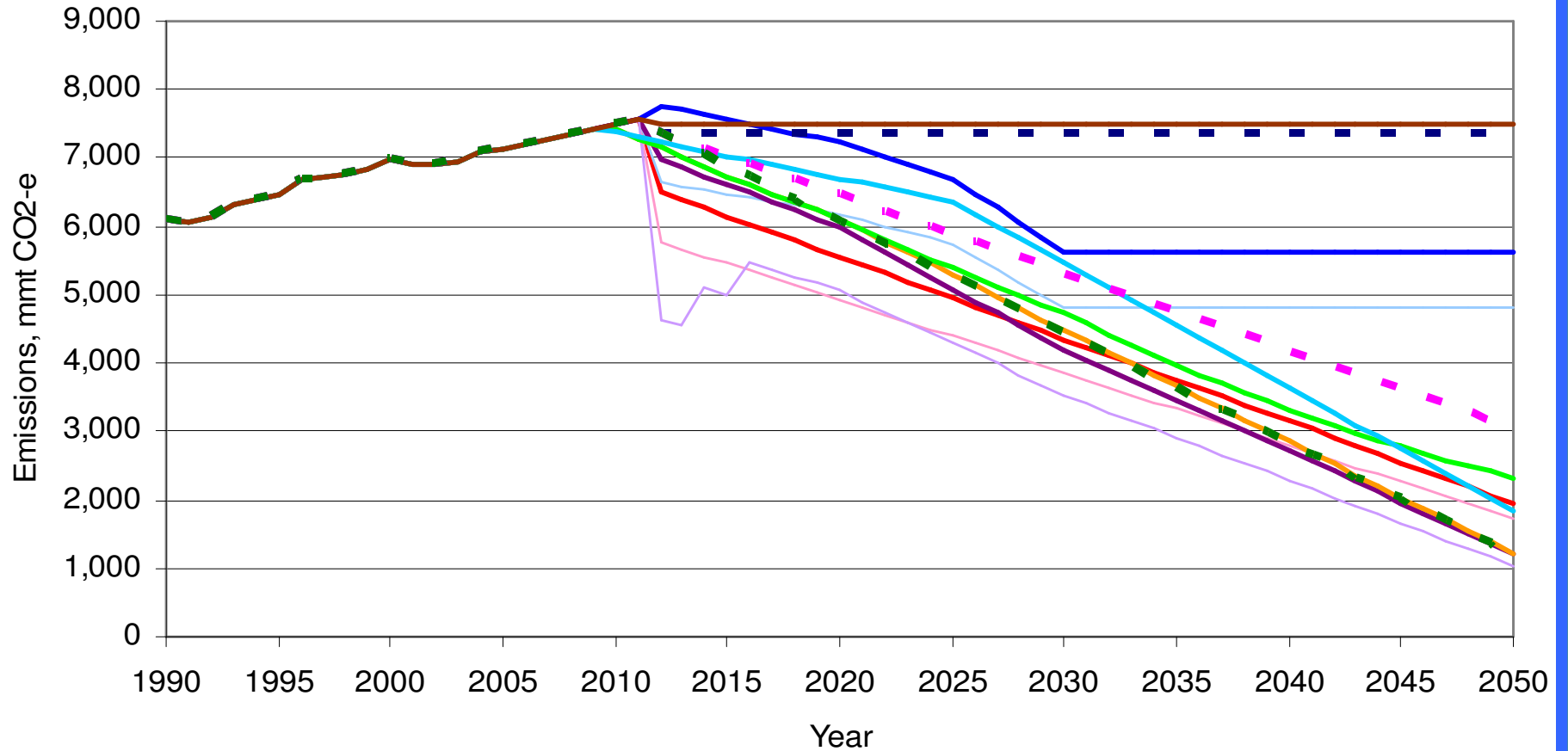
- Point of Regulation

- Upstream/downstream mix

- Target

- Reduce covered sector emissions to 3% below 2005 levels in 2012, 17% in 2020, 42% in 2030, and 83% in 2050
 - Reduce total national emissions to 3% below 2005 levels in 2012, 20% in 2020, 42% in 2030, and 83% in 2050

Allowance Allocation: Congressional Bills and Core Cases



- Lieberman-Warner 2007 National
- Bingaman-Specter 2007 National
- Waxman-Markey 2009 National
- Sanders-Boxer 2007
- Feinstein August 2006
- 287 bmt
- 167 bmt
- Lieberman-Warner (Covered sectors only)
- Bingaman-Specter (Covered sectors only)
- Waxman-Markey (Covered sectors only)
- Kerry-Snowe 2007
- Udall-Petri 2006
- 203 bmt

Title III

– Cost Containment

- Unlimited banking
- Borrowing: unlimited from 1 year ahead without penalty, 15% from 2-5 years ahead with interest
- Strategic Allowance Reserve Auction: small percentage of allowances (1-3%) to be auctioned each year to contain price volatility
- Offsets: 2 billion tons each year- 1 billion domestic and 1 billion international
 - More international offsets allowed if domestic supply is insufficient
 - 1.25 international offsets for 1 ton of emissions compliance

Title III

- Allowance Allocation
 - Initially approximately 20% auctioned, by 2030 and beyond about 70% auctioned
 - Allowances or auctioned proceeds go to:
 - **Electricity, natural gas, and home oil and propane heating consumers**
 - **Low-income households**
 - **Energy intensive, trade-vulnerable industries and domestic refiners**
 - CCS technologies
 - Advanced vehicle technologies
 - Energy R&D
 - State Energy and Environmental Development (SEED) Accounts for renewable energy and energy efficiency programs
 - Worker adjustment
 - Domestic and international adaptation
 - Technology deployment
 - Deficit reduction
 - **Climate Change Consumer Refund Account for lump-sum rebates to households**

“How good is your DC office?”



Distribution of Allowances American Clean Energy and Security Act of 2009 (H.R. 2454 - Waxman-Markey as Passed by U.S. House of Representatives)

Available Allowances
(tC₂e)

5,000,000,000

5,000,000,000

4,000,000,000

3,000,000,000

2,000,000,000

1,000,000,000

0

2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050

Year

- Supplemental Agriculture and Renewable Energy (Sec. 782(j))
- Compensation for Early Actors (Sec. 782(i))
- Climate Change Consumer Dividend (Sec. 782(q))
- Deficit Reduction (Sec. 782(q))
- International Clean Technology Deployment (Sec. 782(c))
- International Adaptation (Sec. 782(n))
- State Domestic Wildlife and Natural Resource Adaptation (Sec. 782(m)(1))
- Domestic Wildlife and Natural Resource Adaptation (Sec. 782(m)(2))
- Climate Change Health Promotion and Protection (Sec. 782(l)(2))
- Domestic Adaptation (Sec. 782(l)(1))
- Energy Efficiency and Renewable Energy Worker Training (Sec. 782(k)(2))
- Worker Assistance and Job Training (Sec. 782(k))
- Small Business Refiners (Sec. 782(j)(2))
- Domestic Fuel Production (Sec. 782(j)(1))
- Advanced Automobile Technology (Sec. 782(i))
- Advanced Research Project Agency-Energy (Sec. 782(h)(2))
- Energy Innovation Hubs (Sec. 782(h)(1))
- States for Building Retrofits (Sec. 782(g)(3))
- Energy Efficiency in Building Codes (Sec. 782(g)(2))
- Renewable Energy and Energy Efficiency (Sec. 782(g)(1))
- Carbon Capture and Sequestration (Sec. 782(f))
- Energy-Intensive, Trade-Vulnerable Industries (Sec. 782(e))
- Low Income Consumers (Sec. 782(d))
- Home Heating Oil and Propane Consumers (Sec. 782(c))
- Natural Gas Consumers (Sec. 782(b))
- Merchant Coal Generators and Long-term Power Contracts [reflects 14.3% of electricity allocation]
- Electricity Consumers (Sec. 782(a)(1))
- States for Cogeneration at Industrial Plants (Sec. 782(a)(3))
- Prevention of Tropical Deforestation (Sec. 781)
- Allowances Placed in Strategic Reserve (Sec. 726)

Title IV

- Energy-intensive, trade-exposed industries that make products like iron, steel, cement, and paper will receive allowances to cover their increased costs
 - At first 15% of 2014 allowances set aside for program, percentage decreases over time and is phased out between 2025 and 2035
- Green Jobs and worker transition
- Consumer Assistance
- Deployment of clean technologies
- Adaptation to climate change



Key Design Features

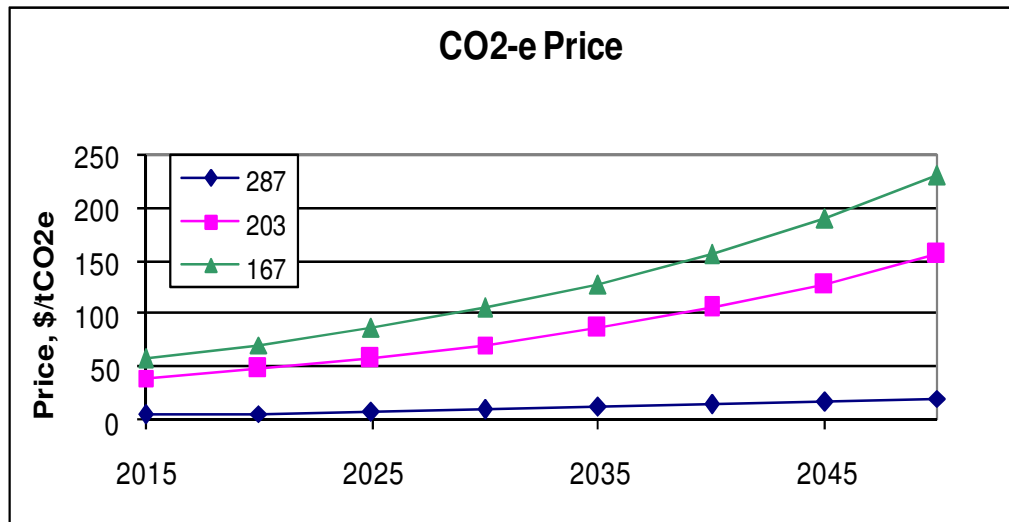
- Coverage: all GHGs, 84.5% of economy
- Targets: 83% below 2005 by 2050
- Point of Regulation: upstream/downstream
- Cost Containment: banking and borrowing, strategic reserve auction, offsets
- Allowance Allocation: 80% free, gradually moving toward 30%
- Use of Revenue: many uses, majority to reduce consumer impact
- Technologies: RPS, subsidies



Cost Of Climate Policy

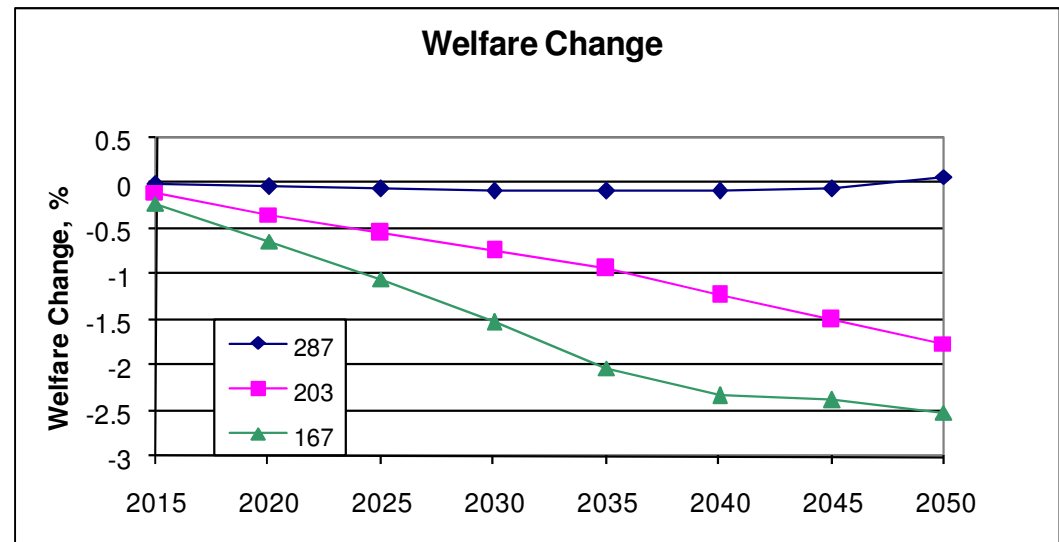


CO2-e Price and Welfare Change



- **287 bmt** = hold emissions at 2008 levels
- **203 bmt** = reduce emissions by 50% below 1990 level by 2050
- **167 bmt** = reduce emissions by 80% below 1990 levels by 2050

Cost per household of 203 (50%) case: ~\$600



Factors Affecting Cost of Policy

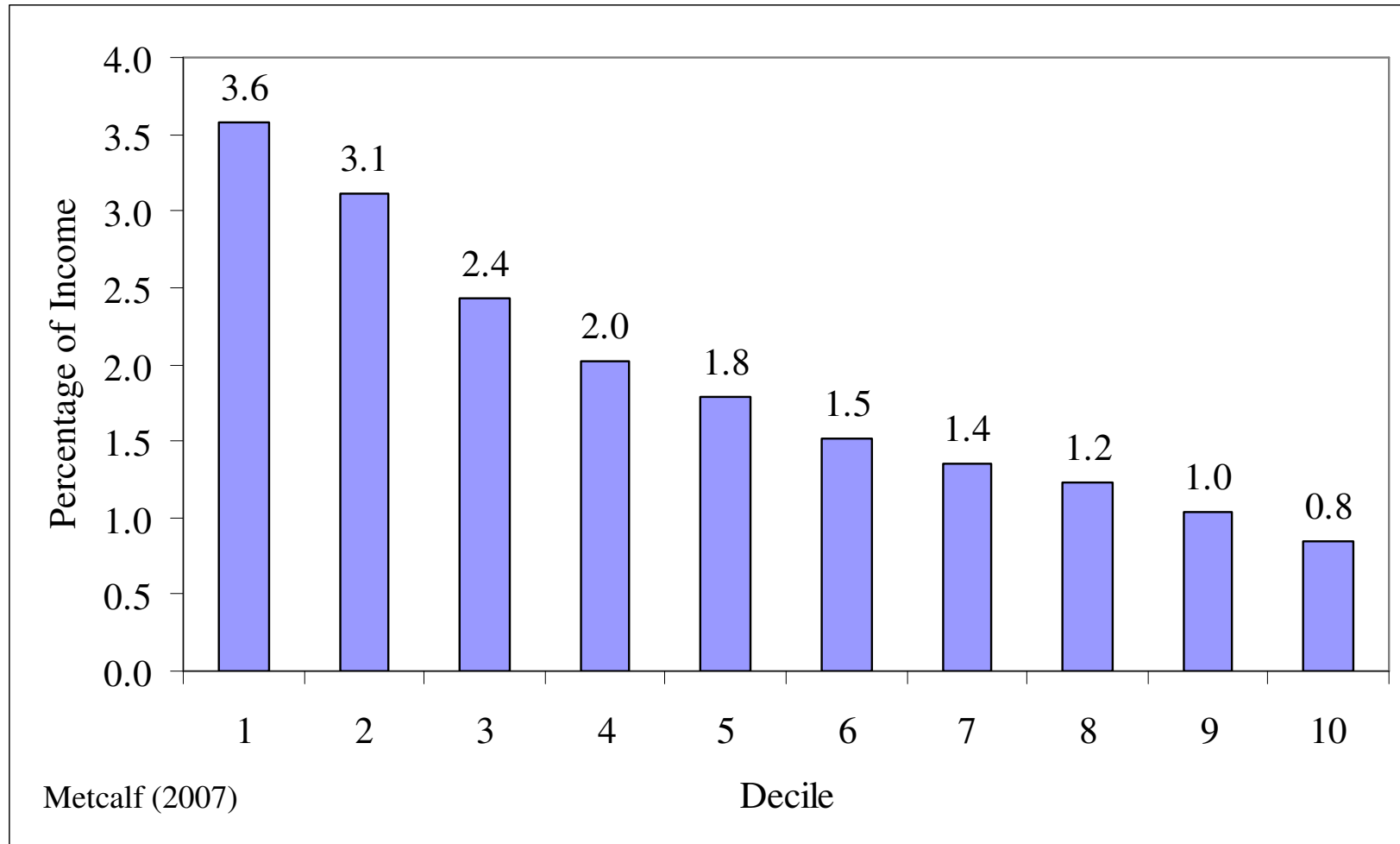
- Target stringency & path
- Coverage
- Cost and availability of low-emitting technologies
- Economic conditions
- Cost containment mechanisms
- Additional C&C regulations
- Climate policies abroad



A Note on Equity



Burden of Carbon Pricing



Metcalf (2007)

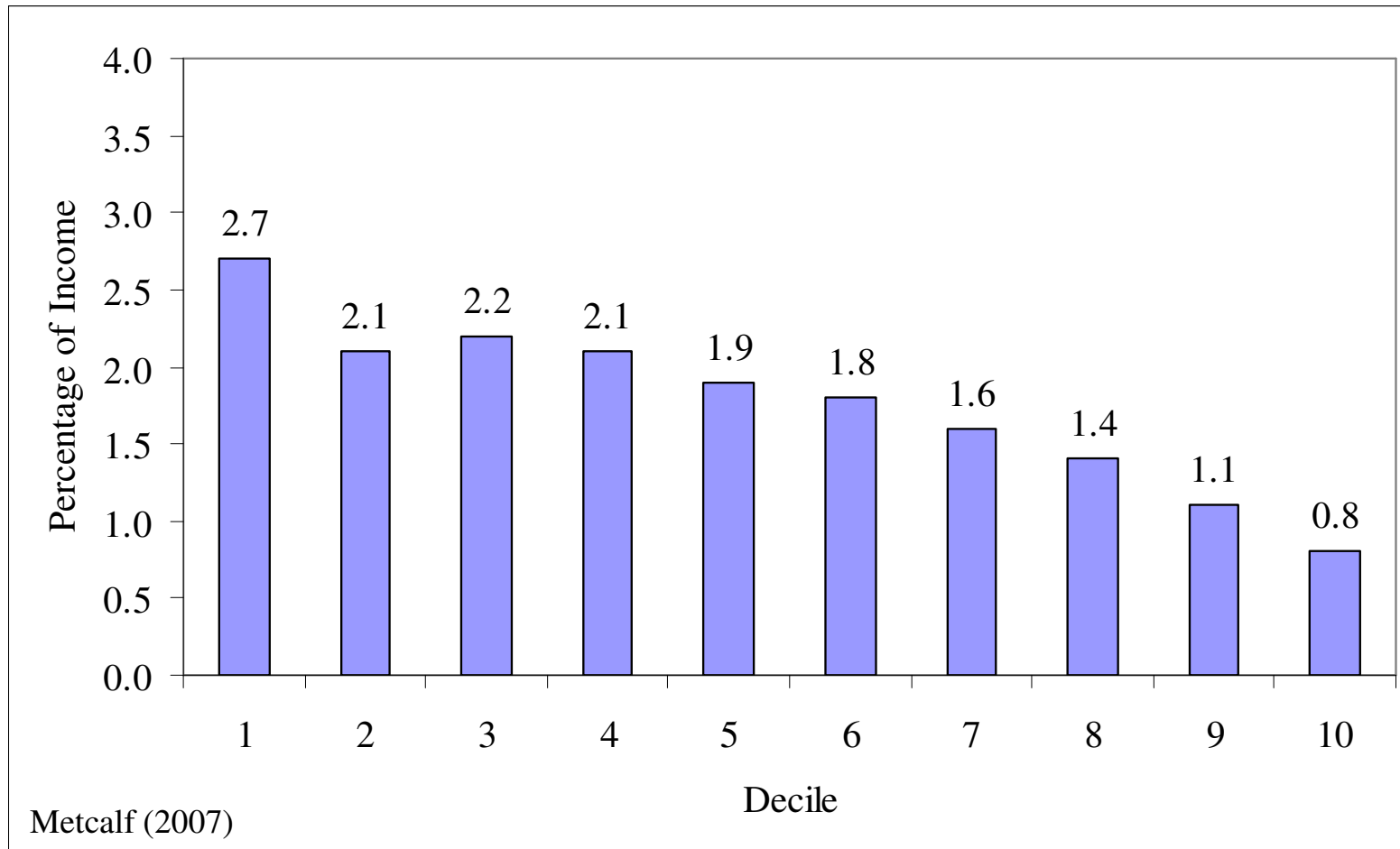
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80% Reduction Policy Revenue

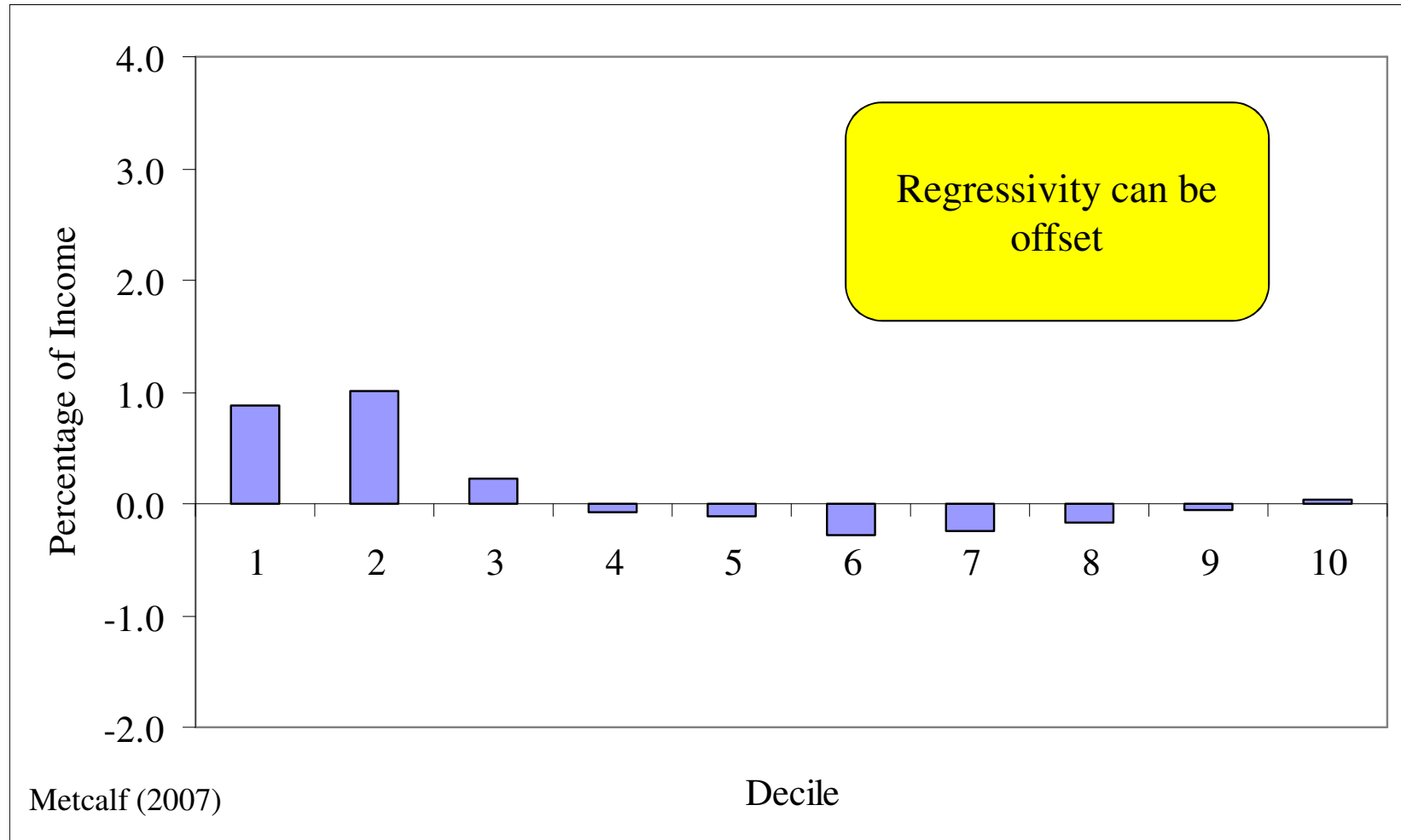
- Full auctioning
- ~\$300-\$400 billion annually
- Rebates of ~\$2,500-\$5,000 per family of 4 per year
- ~5-20% of non-CO2 federal tax revenue



Rebate Distribution



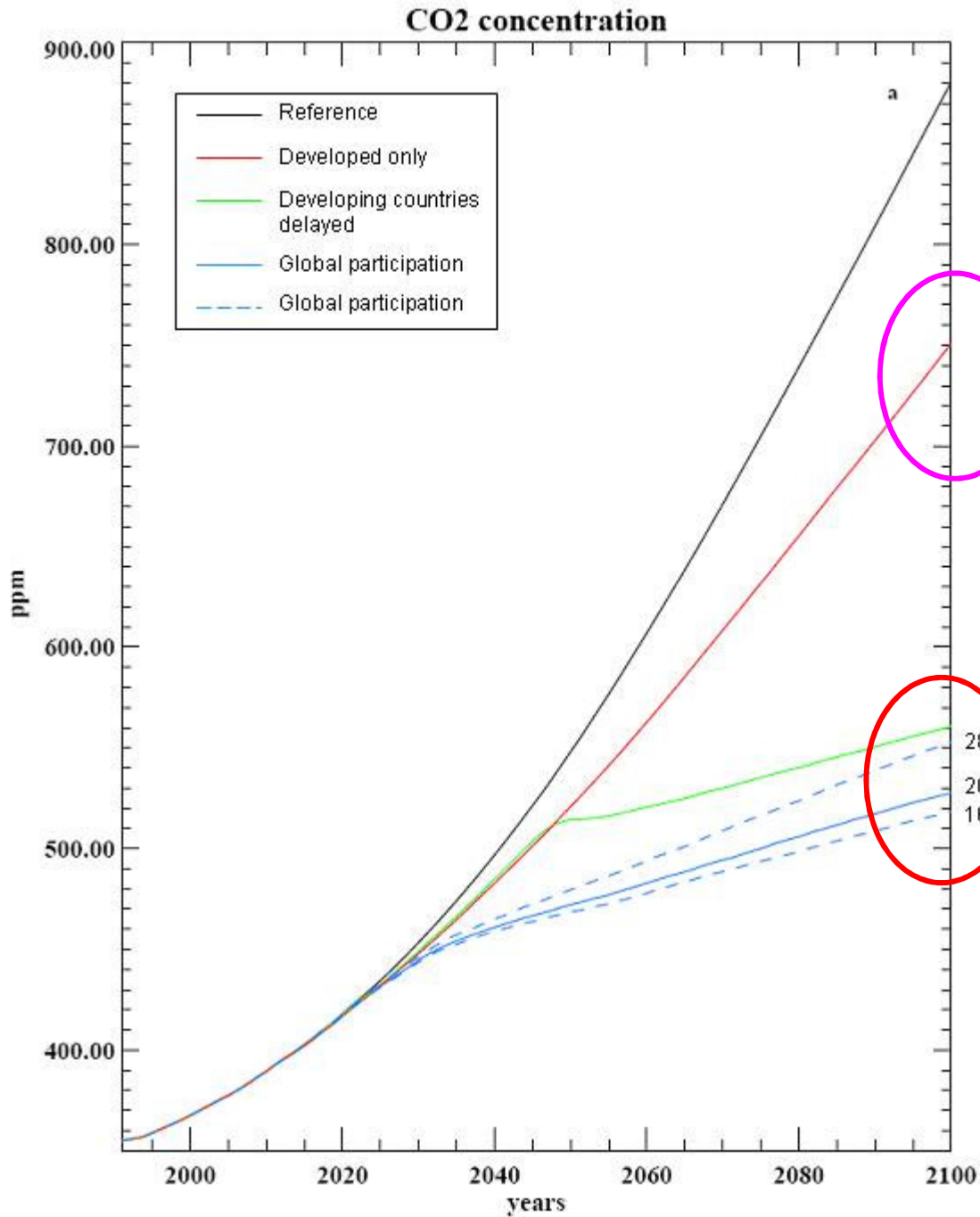
Net Burden



A Note on Meeting Global Climate Objectives

- US policy can not guarantee that a global atmospheric concentration stabilization or temperature target will be met
- Depends on what other countries do
 - Global commons problem





BUT if developing countries NEVER join we are in BIG trouble

We can afford to wait 50 years for developing countries to join... can still come close to 550 stabilization.



Temperature Increase 2000 to 2100 from 3 Leading Climate Models

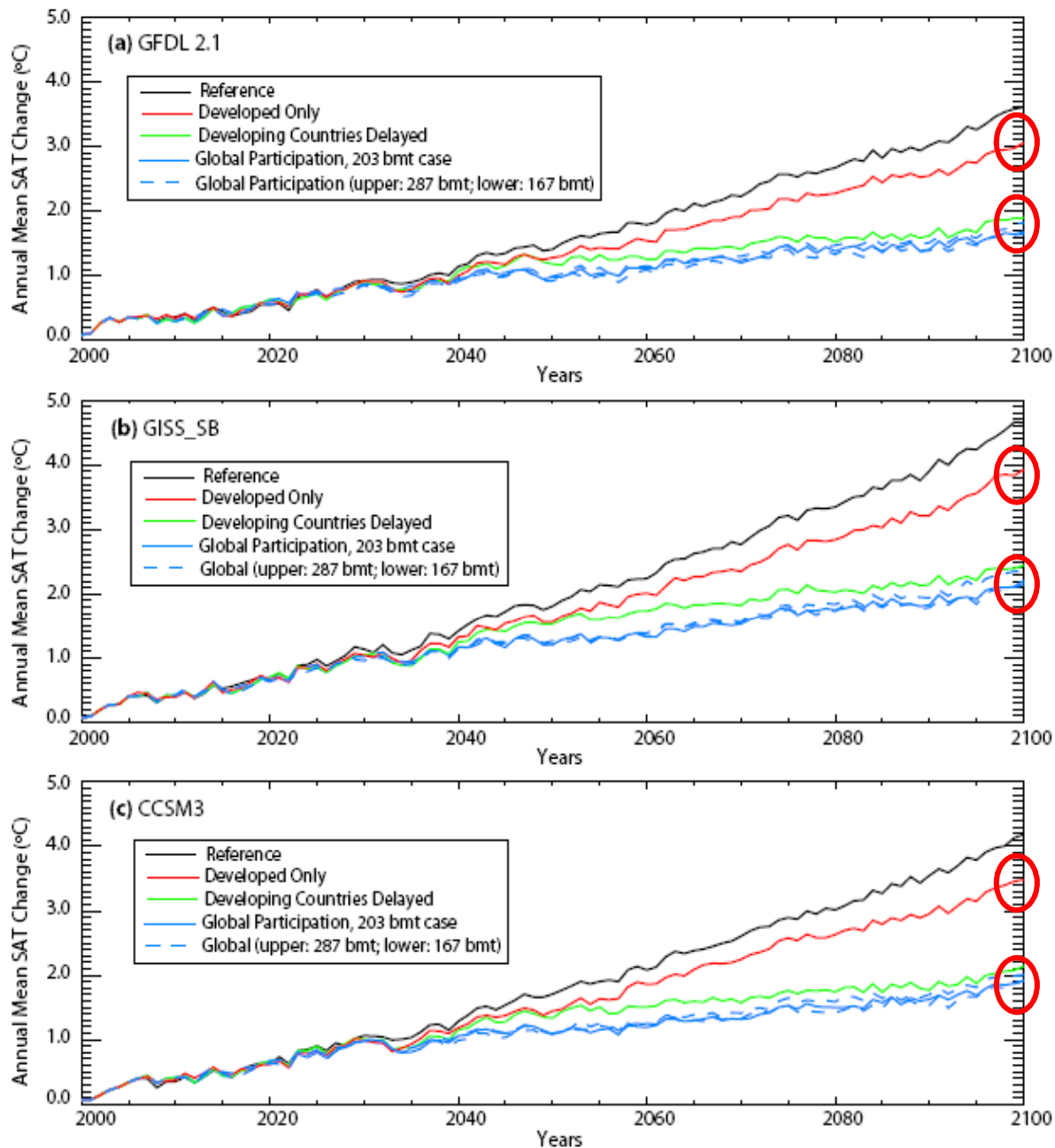


Figure 17. Global mean surface air temperature increase, 2000 to 2100.

Again, we can afford to wait 50 years for developing countries to join

BUT if developing countries NEVER join we are in trouble



Concluding Points

- Policy is needed to correct market failures
- Carbon pricing policy (a cap-and-trade or emissions tax) more efficient than command-and-control regulations
 - Provides flexibility to choose least-cost options
 - Does not attempt to pick winning technologies
 - Do not need to know future costs of technologies
- Differences between tax and cap & trade can be overstated
 - Both can yield target level of abatement and would have similar economic consequences
 - Both can be adjusted over time

Concluding Points

- Cost containment mechanisms (especially banking) are very important in cap-and-trade
- Allowance allocations and revenue use are key to political debate
- Potential revenue from allowance sales or a CO₂-e tax is huge, and can be used to offset regressivity of policy
- Global success depends on what other countries are doing → How stringent must US policy be to get the rest of the world to do something?

Questions?

Jen Morris: holak@mit.edu



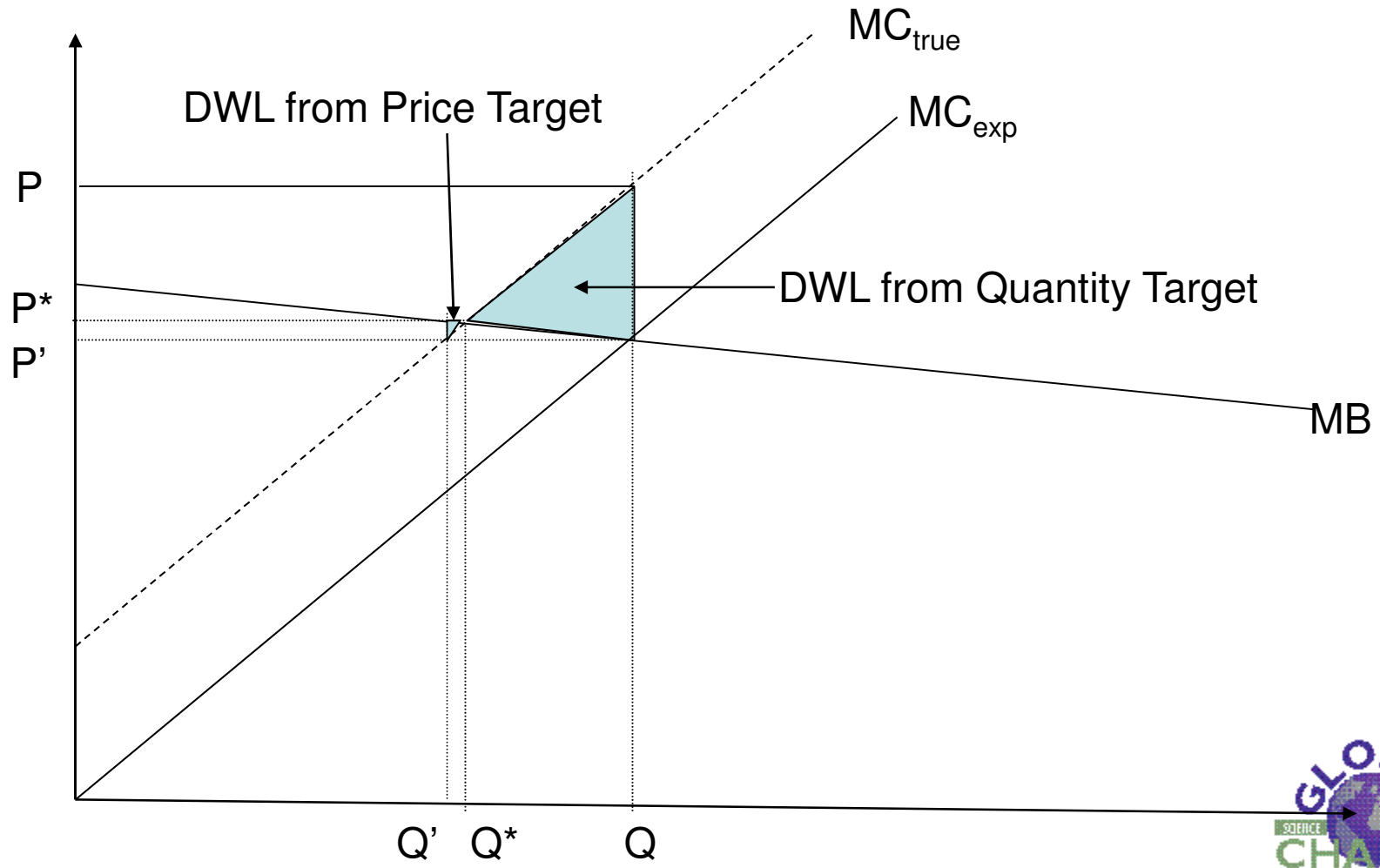
- **Cap-and Trade Papers:**

- Paltsev, S., J. Reilly, H. Jacoby, A. Gurgel, G. Metcalf, A. Sokolov and J. Holak, 2007: Assessment of U.S. Cap-and-Trade Proposals, MIT Joint Program on the Science and Policy of Global Change Report 146, April (http://globalchange.mit.edu/pubs/abstract.php?publication_id=718). Condensed version in *Climate Policy*, 8(4): 395–420.
- Paltsev, S., J. Reilly, H. Jacoby and J. Morris, 2009: The Cost of Climate Policy in the United States. MIT Joint Program on the Science and Policy of Global Change, Report 173, April (http://globalchange.mit.edu/files/document/MITJPSPGC_Rpt173.pdf).

- **Carbon Tax Paper:**

- Metcalf, G.E., S. Paltsev, J. M. Reilly, H.D. Jacoby and J. Holak, 2008: Analysis of U.S. Greenhouse Gas Tax Proposals, MIT Joint Program on the Science and Policy of Global Change Report 160, April (http://globalchange.mit.edu/pubs/abstract.php?publication_id=870).

Weitzman Result: Price Instrument Preferred Under Uncertainty (with flat MB)



[Slide from Mort Webster]