International Climate Policy + Preliminary Final Exam Review

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Section 12
ECON 1661 / API-135: Spring 2022

April 22, 2022

Announcements

- Office hours today from 3:00-5:00pm EDT
- Problem set #5 due Wednesday, April 27 at 12:00pm EDT
- Final exam: Saturday, May 7 from 9:00am - 12:00pm EDT in Science Center D
- Review session for final exam: Friday, April 29 from 1:30-2:30pm EDT in Belfer 200
  - → Have posted three old final exams + solutions to the Canvas site
  - → Will announce additional office hours for the week leading up to the exam

Outline

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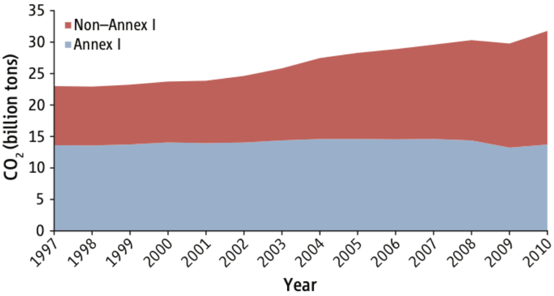
Early international climate policy: Rio to Kyoto

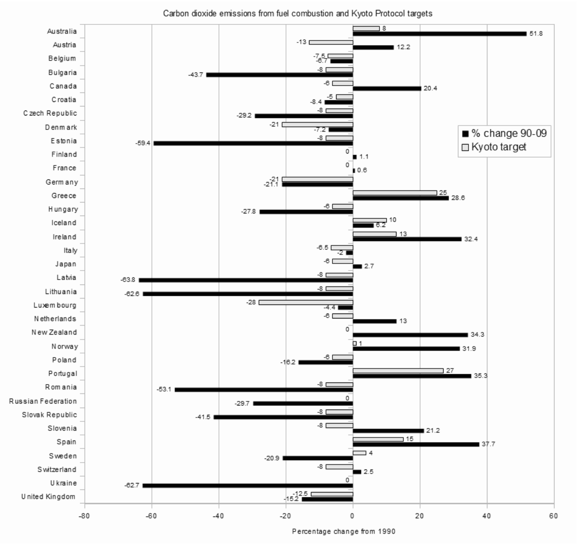


- 1992: United Nations Framework Convention on Climate Change (UNFCCC)
  - Article 3: **Common but differentiated responsibilities** → abatement burden on developed countries
- 1995: first Conference of the Parties (COP-1) in Berlin
  - Berlin Mandate: introduced Annex I/non-Annex I distinction
- 1997: Kyoto Protocol signed at COP-3
  - Fulfilled Berlin Mandate (COP-1)
  - Quantitative targets for Annex I countries

Kyoto Protocol

- **Centralized architecture**: countries established emissions abatement targets through centralized UNFCCC process
- Targets for first commitment period 2008-2012: averaged 5.2% $\downarrow$ relative to 1990 levels
  - Substantial heterogeneity: EU $\downarrow$ 8%, Australia $\uparrow$ 10% of 1990 levels
- Established flexible compliance mechanisms:
  - Emissions trading: Article 17 allows countries with excess emissions abatement to sell this to other countries
  - Clean Development Mechanism (CDM): Annex I countries can get credit for abatement projects in developing countries
  - Joint implementation: Annex I countries can get credit for abatement investments in other Annex I countries
- Stipulated that targets are *legally-binding*, but importantly any punishment is self-enforcing
  - Penalty for non-compliance: 30% penalty in second commitment period obligation

Kyoto's Impact



- General assessment: too little, too fast
  - Too little: trivial net global abatement over a narrow, 5-year window
  - Too fast: excessively ambitious for some, e.g., US target of ↓ 7% relative to 1990 would have actually meant ↓ 30% of BAU due to economic growth post-1990
- Not particularly cost-effective, especially due to exclusion of majority of countries, including key developing economies
- Ultimately, the centralized architecture and dichotomous distinction between Annex I and non-Annex I countries led to lack of key participation

Post-Kyoto Paradigm Shift

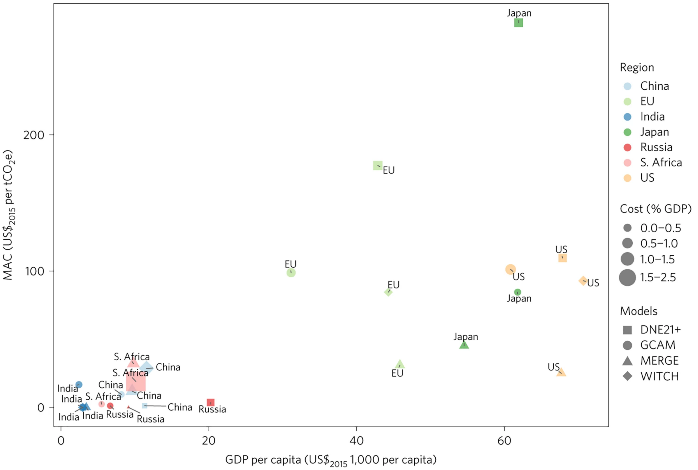
- COP-15/16: Copenhagen Accord (2009) and Cancun Agreement (2010)
  - → Blurred distinction between Annex I and non-Annex I countries
  - → Shifted norms of agreement: "consensus does not mean unanimity"

- COP-17: Durban Platform for Enhanced Action (2011) provided a mandate to adopt by 2015 a new framework to include *all countries*

The Paris Agreement (2015)

- **Hybrid architecture**:
  - Top-down: centralized oversight, guidance and coordination through UNFCCC processes
  - Bottom-up: "Nationally Determined Contributions" (NDCs) that are determined by national policies and goals
- Goal: limit warming to 2°C (1.5°C)
- NDCs → broad scope of participation
  - NDCs represented 187 countries, 96% of global CO_2 emissions (14% under Kyoto)
- Key components:
  - "Ratchet" mechanism: revision of NDCs every 5 years with expecation of increasing stringency (Article 4)
  - National monitoring, reporting, and verification, with same standards for developed/developing nations
  - Facilitates linkage (Article 6)
  - Global finance: commitment to $100 billion/year

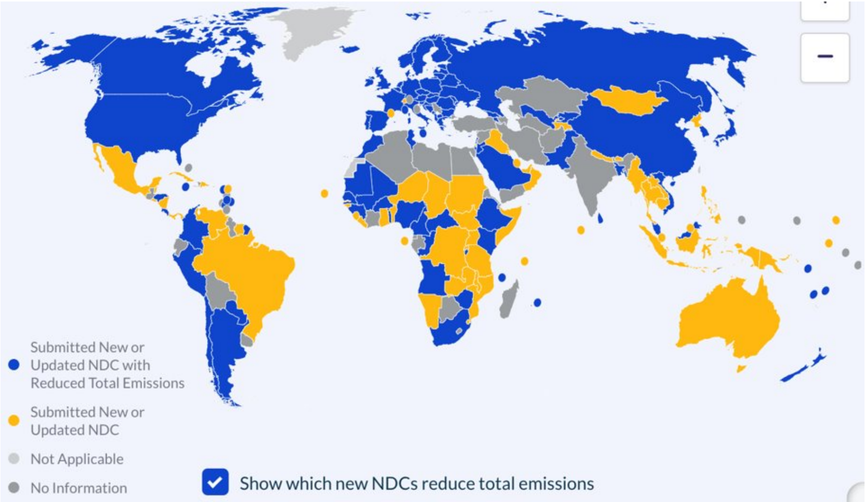
Assessing initial NDCs: Aldy et al. (2016)[1]



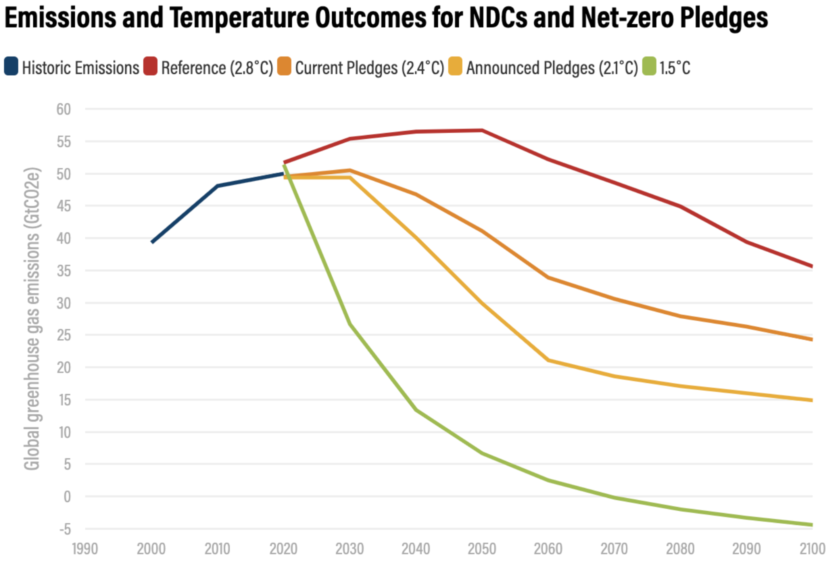
- Use 4 IAMs to estimate country-level costs of Paris Agreement pledges
- Find differentiated effort across countries based on comparable estimates of abatement costs
  - Wealthier countries pledge greater abatement with higher MAC
- Calculate cost-minimizing path to 2°C and find pledges insufficent

[1] Aldy, J.E. et al. "Economic tools to promote transparency and comparability in the Paris Agreement." *Nature Climate Change*, 6: 1000-1004.

First round of NDC updates



First round of NDC updates

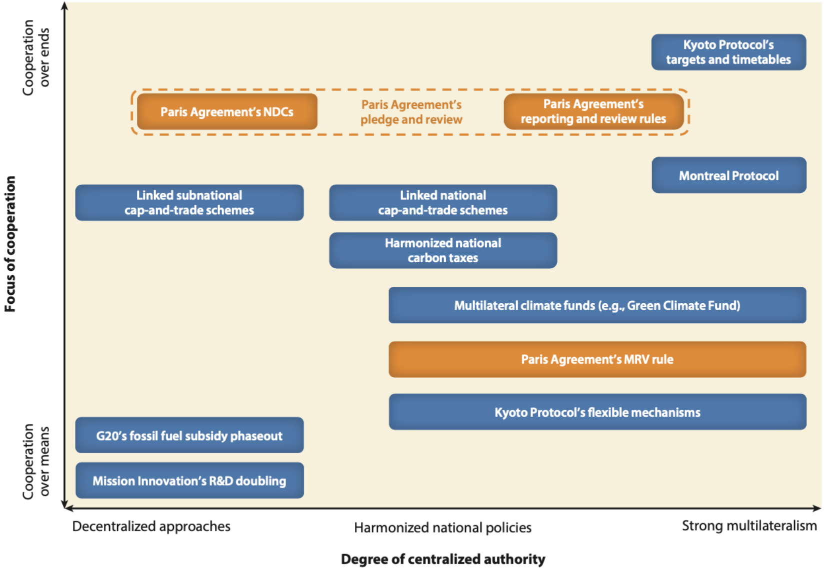


Outline

International climate policy architectures: Degree of centralization

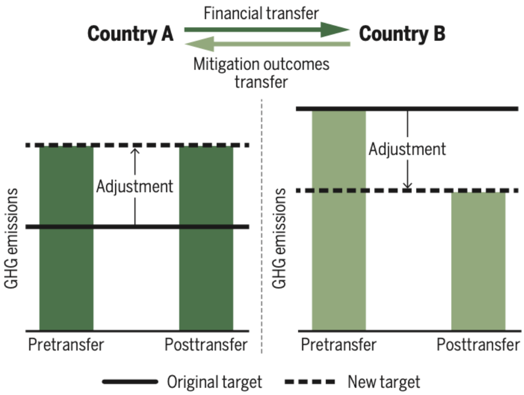
- **Strong multilateralism**: centralized, top-down, high-degree of coordination
  - Carbon tax administered by a single global organization
  - Kyoto Protocol's emissions targets
- **Harmonized national policies**: coordinated design of national policies
  - Harmonized rules of national ETS programs/carbon taxes
  - Pledge and review mechanism of the Paris Agreement
- **Decentralized**: bottom-up, varying degrees of coordination
  - Sub-national linkage or coordinated command-and-control policies
  - Paris Agreement's NDCs

Degree of centralization



Outline

Why link national climate policies?



- Linkage: emission reductions in one jurisdiction counted toward abatement commitments of another
- Benefits of linkage:
  - Reduces costs of achieving a given abatement level
  - Improves cost-effectiveness by allowing reductions in lower-cost jurisdictions
  - Drives participants towards a common cost of carbon
- Linkage of market-based policies can improve functioning
- Key example: California and Quebec

Concerns with linkage

- Distributional equity
  - *Could* yield increased correlated pollutants in certain jurisdictions, exacerbating EJ concerns
  - But this will depend on the distribution of marginal abatement costs across space

- Decreased policy autonomy
  - Hard linkage: emission reductions in one jurisdiction formally recognized in another for compliance purposes (e.g., link between California and Quebec cap-and-trade programs)
    - → Design choices of another jurisdiction directly impact performance of your program
  - Soft linkage: harmonization of carbon prices across jurisdictions, but emission reductions in one jurisdiction do not count for compliance in another

Linkage of heterogeneous policies

- Linkage is straightforward when policies are similar
  - E.g., a California emissions permit = a Quebec emissions permit
  - E.g., (hypothetically) Washington State sets its carbon tax at the level of the British Columbia tax
- Sources of policy heterogeneity
  - Type of policy instrument (e.g., tax, cap-and-trade, technology standard)
  - Level of government (e.g., regional, national, sub-national)
  - Nature of policy target (e.g., emissions intensity, change relative to BAU, change relative to base year)
  - Other details (e.g., sectors covered)

Linkage under Paris: Article 6.2

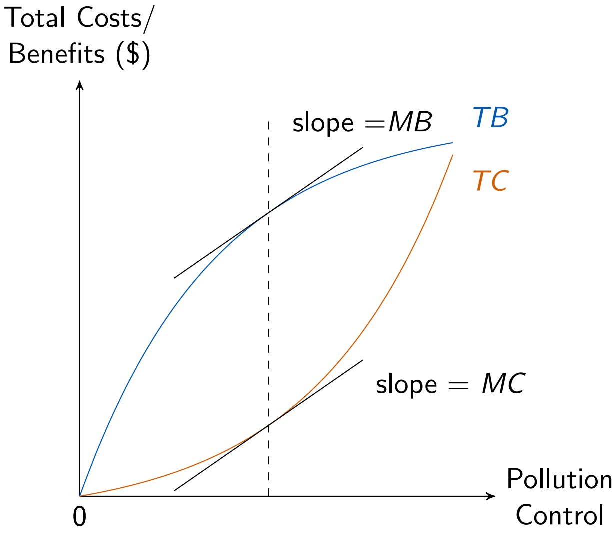
- Under Article 6.2, parties can use **international transferred mitigation outcomes (ITMOs)** to comply with emissions targets in NDCs
  - No specific guidance in Paris Agreement on how to accomplish this
  - Concerns: double counting, additionality

- ITMOs are designed to be a unit of accounting for corresponding adjustments, not a medium of exchange for government-government purchase and sale like under Article 17 of Kyoto

- Difficulties of implementing Article 6.2 surround accounting with heterogeneity in policy design/NDC objectives

Outline

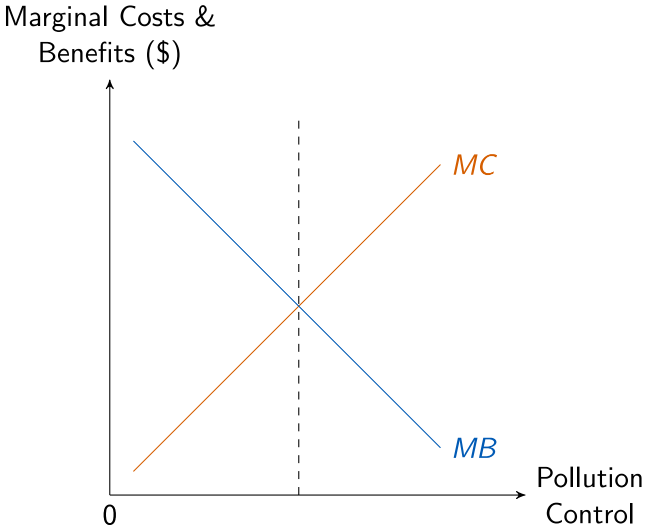
Review: Economic efficiency



- To an economist, efficiency means maximizing net benefits

- Equimarginal rule: efficient level of abatement occurs where MB=MC

Review: Economic efficiency



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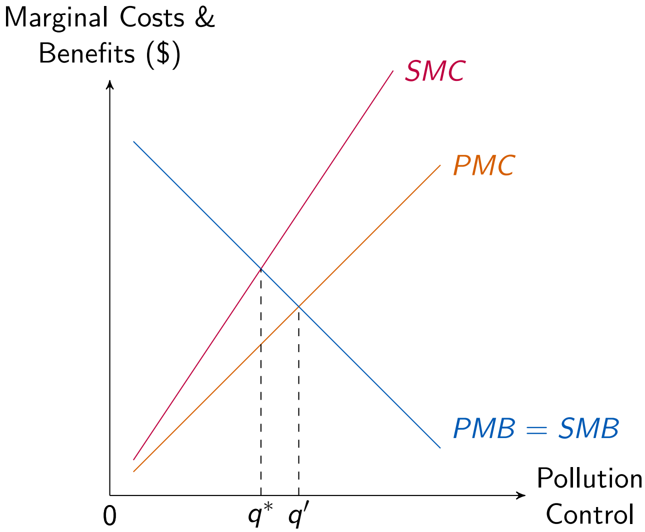
Review: Externalities



- Externalities occur when private and social marginal costs (or benefits) are not equal
- In these cases, intervention in the market is needed to reach the efficient outcome
  - Exception (Coase): under certain conditions, bilateral negotiation can result in the efficient outcome w/o intervention

Example problem: Economics of externalities

A factory produces steel with the following supply function: $Q_s(P) = 10P$*, where* P *is the price of steel. Consumer demand for steel is defined by* $Q_D(P) = 1000 - 10P$*. What is the competitive market equilibrium quantity,* Q'*, and price,* P'*? Show this equilibrium on a graph.*

- The competitive market equilibrium will equate the quantity supplied with the quantity demand, i.e., $Q_S = Q_D$. Using this, we can solve for P':

$$Q_S(P) = Q_D(P)$$
$$10P = 100 - 10P$$
$$20P = 1000$$
$$P' = 50$$

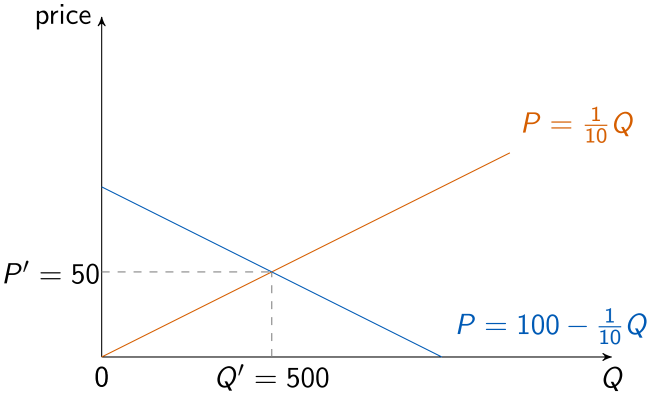
- Since we solved for P', to find Q', all we need to do is plug in $P' = 50$ into either the supply or demand function:

$$Q' = Q_S(50) = 10 \times (50) = 500$$

Example problem: Economics of externalities

A factory produces steel with the following supply function: $Q_s(P) = 10P$, where P is the price of steel. Consumer demand for steel is defined by $Q_D(P) = 1000 - 10P$. What is the competitive market equilibrium quantity, Q', and price, P'? Show this equilibrium on a graph.

- Remember we graph *inverse* supply and demand curves
- Inverse supply: $Q_S(P) = 10P \rightarrow P = \frac{1}{10}Q$
- Inverse demand: $Q_D(P) = 1000 - 10P \rightarrow P = 100 - \frac{1}{10}Q$



Example problem: Economics of externalities

Unfortunately, steel production causes pollution. The marginal damages from producing Q units of steel are given by $MD = 2Q$. What is the efficient quantity, Q^*, and price, P^*? Show the efficient equilibrium graphically.

- Net benefits *to society* are maximized when $SMC = MB$.
- How do we find SMC? Vertically add marginal damages to the private marginal cost curve.
  - Why? Because this describes the cost to society from an additional unit of steel produced, which is the cost of producing that unit and the external cost of the associated pollution
  - What is the private marginal cost curve? The inverse supply curve!
- So the social marginal cost curve is:

$$SMC = PMC + MD = \frac{1}{10}Q + 2Q = \frac{21}{10}Q$$

Example problem: Economics of externalities

Unfortunately, steel production causes pollution. The marginal damages from producing Q units of steel are given by $MD = 2Q$. What is the efficient quantity, Q^*, and price, P^*? Show the efficient equilibrium graphically.

- We can now solve for the efficient equilibrium by setting $SMC = MB$

$$SMC = MB$$
$$\frac{21}{10}Q = 100 - \frac{1}{10}Q$$
$$21Q = 1000 - Q$$
$$22Q = 1000$$
$$Q^* = 45.5$$

- Plugging $Q^* = 45.5$ into SMC, we can get P^*:

$$P^* = SMC(45.5) = \frac{21}{10} \times (45.5) = 95.5$$

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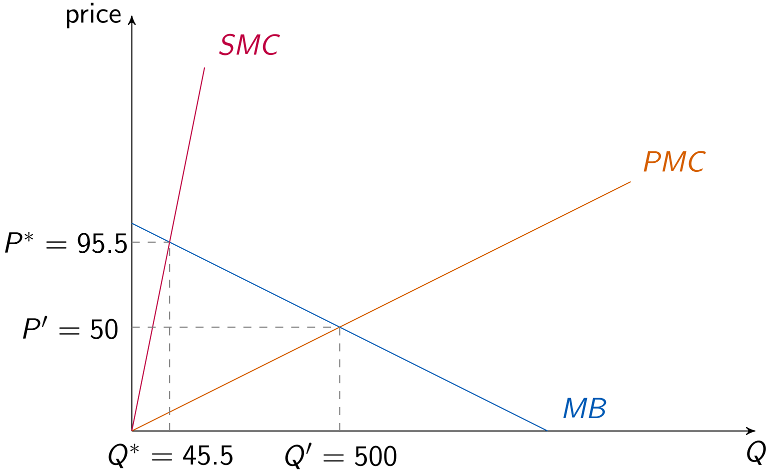

Example problem: Internalizing externalities

There are now two steel factories that produce emissions. They can abate emissions at the following marginal costs:

$$MC_1 = 5q_1 \qquad MC_2 = 2q_2$$

The benefits of pollution abatement are given by $MB = 10 - \frac{4}{7}Q$, where $Q = q_1 + q_2$. What is the efficient level of overall abatement?

- The efficient level of abatement occurs where $MC_{total} = MB$
  - → At the efficient abatement level, $MC_1 = MC_2 = MC_{total}$
- First we need to find the aggregate marginal cost curve. We do so by horizontally summing the two firms' marginal cost functions
  - Aggregate cost curve asks: for a given marginal cost across all firms, what is the total abatement?
    - → Or: how can you achieve a given level of total abatement with MC equal across firms?
  - Horizontally sum individual MC curves to get aggregate: do so by inverting individual MC curves and using the fact that we want MC equal across firms

Example problem: Internalizing externalities

There are now two steel factories that produce emissions. They can abate emissions at the following marginal costs:

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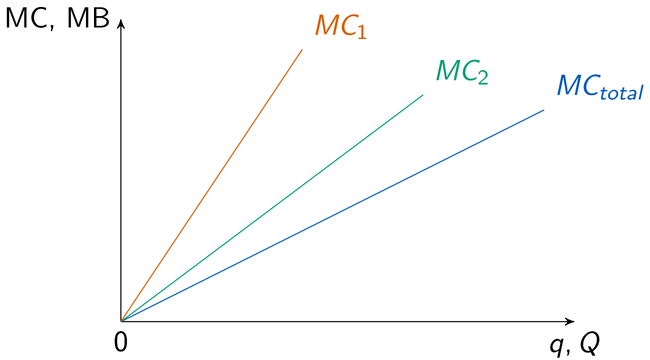
The benefits of pollution abatement are given by $MB = 10 - \frac{4}{7}Q$*, where* $Q = q_1 + q_2$*. What is the efficient level of overall abatement?*



- Summing the two inverse MC curves, we find that

$$\begin{aligned} Q = q_1 + q_2 &= \frac{MC_1}{5} + \frac{MC_2}{2} \\ &= \frac{MC_{total}}{5} + \frac{MC_{total}}{2} \\ &= \frac{7MC_{total}}{10} \end{aligned}$$

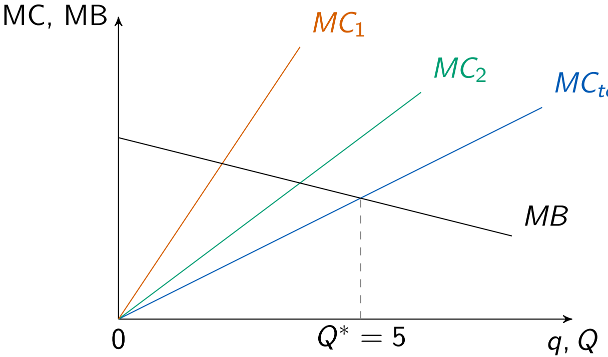
$$\implies MC_{total} = \frac{10}{7}Q$$

Example problem: Internalizing externalities

There are now two steel factories that produce emissions. They can abate emissions at the following marginal costs:

$$MC_1 = 5q_1 \qquad\qquad MC_2 = 2q_2$$

The benefits of pollution abatement are given by $MB = 10 - \frac{4}{7}Q$, *where* $Q = q_1 + q_2$. *What is the efficient level of overall abatement?*



- Can now solve for Q^* by setting $MC_{total} = MB$:

$$\frac{10}{7}Q = 10 - \frac{4}{7}Q$$

$$Q^* = 5$$

Example problem: Internalizing externalities

What is the allocation of abatement between the firms at the efficient level of overall abatement? What is the marginal cost of abatement?

- At the efficient level of abatement, $MC_1 = MC_2 = MC_{total}$ and $q_1 + q_2 = 5$
- Setting $MC_1 = MC_2$:

$$5q_1 = 2q_2$$
$$q_1 = \frac{2}{5}q_2$$

- Plugging this into the second equation from our system:

$$\frac{2}{5}q_2 + q_2 = 5$$
$$q_2^* = \frac{25}{7}, q_1^* = \frac{10}{7}$$

- And the marginal cost for both firms is therefore

$$5\left(\frac{10}{7}\right) = \frac{50}{7} = 2\left(\frac{25}{7}\right)$$

Concluding thoughts

- Long history of international climate negotiations

- Helpful way to think about different approaches to international climate agreements in practice: level of centralization

- Pay attention to the discussion of leakage next week $\rightarrow$ very relevant, important topic!

- Section next week: final exam review
  $\rightarrow$ Will discuss exam logistics, suggest study tips, and provide an outline of important concepts