Professional Career Program

Environmental Economic Theory No. 11

(8 January 2019)

Chapter 12. Incentive-based strategies: Transferable Discharge Permits

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Textbook: Barry .C. Field & Martha K. Fields (2009) ***Environmental Economics - an introduction***, McGraw-Hill, International Edition

PCP Environmental Economic Theory (Hosoda)
Homework 11
8 January 2019

- Theme: *"Should we stop using plastic bags and containers? State your own opinion, based upon environmental economics."*
- Language: English.
- Volume: A4 two pages. Single space. 12 points.
- Submission period: 9 a.m. 14 January 2019 - 9 a.m. 15 January 2019.
- Submission: Submit your paper in a pdf file. A file name must be "HW11.xxx.pdf" (xxx=your name). Send your file to hosoda@econ.keio.ac.jp.

The purpose of today's lecture

We study a transferable discharge (emission) permits approach, where, in order to bring about socially desirable circumstances, authorities issue a certain number of discharge permits, assigning initial discharge permits to each discharger. They can exchange permits according to their discharge plans. This scheme works through the decentralized market interactions of polluters.

The origin of the idea

- The idea of a transferable discharge (emission) permits approach goes back to the early 1960s, when J.H. Dales published a book entitled *Pollution, Property & Prices*.
- He proposed the idea in order to keep the water quality of a lake.
- Yet, the idea had been ignored by policy makers for such a long time, although economists noticed the usefulness and effectiveness of the policy tool.

How the idea spreads

- Gradually, the idea was elaborated by environmental economists in the 1970~1980s.
- The idea was realized as a policy in the United States.
- For example, a transferable discharge (emission) permits scheme was utilized to cut the amount of lead in gasoline.
- The scheme was considered very successful.

How the idea spreads

- The total amount of lead contained in gasoline decreased as expected by exchange of the permits. Furthermore, the abatement costs are much cheaper than in a CAC scheme, so that the trade of emission permits is cost effective.

Present circumstances

- A transferable discharge permit scheme has been introduced, in various forms, for cutting the amount of pollutants.
- A typical example is EU-ETS for cutting the amount of CO2 emission in EU countries.
- The scheme works very well sometimes but not so well in other situations.

General Principles

In a transferable discharge permit system, polluters are allocated a certain number of emission permits, each one of which entitles its owner to emit one unit of the waste material or pollutant specified in the plan. But the discharge permits are transferable; they may be bought and sold by anybody that is allowed to participate in the permit market, at whatever price is agreed upon by the participants.

Remarks

- There pro and con on transferable discharge permit .
- Some oppose the idea since such permit implies pollution right, which is unacceptable.
- Others fear that such permit may possibly be transformed into financial derivatives, which should be transacted by people who are not concerned with environmental problems at all.

Two Types of Permit Trading Plans

- One is credit trading programs (CRE) and the other cap-and-trade program (CAP).
- CRE programs work by allowing firms to sell the credits they create by reducing their emissions more than is required under existing regulations.
- Suppose firm A discharges e units of pollutants, and is required to reduce them to e^*. If it can reduce them to e^{**} ($< e^*$), then it can sell the credit which corresponds to ($e^* - e^{**}$).

Cap-and-Trade Program (CAP)

- The other program is cap-and-trade program (CAP), which has been adopted in quite a few countries.
- At a very abstract level, the two programs produce the same results.
- Yet, practically, the results are possibly different: institutional difference (how they are designed, carried out and so on) matters.

Cap-and-Trade Program (cont.)

- Cap-and-Trade Program is now getting more and more popular.
- Despite its own difficulty (allocation of initial permits and so on), it has been adopted for cutting the amount of CO2 emission in quite a few countries.
- It does not, however, work so well as expected so far. (EU-ETS)
- Yet, it is worth studying how it works.

Cap-and-Trade Program (cont.)

- Cap-and-Trade Program is getting well-known as a policy tool for reducing the amount of CO2 emission.
- However, the scheme is not limited to the policy for cutting the amount of CO2 emission.
- Remember it was used to reduce the amount of lead contained in gasoline in the United States.
- The scheme has got a wide range of applicability.

Cap-and-Trade Program (CAP). How it works.

- First step: The authority decides the aggregate quantity of emissions to be allowed.
- Second step: These permits are distributed among the sources responsible for the emissions.
- Third step: Dischargers exchange permits according to their production and emission plans.

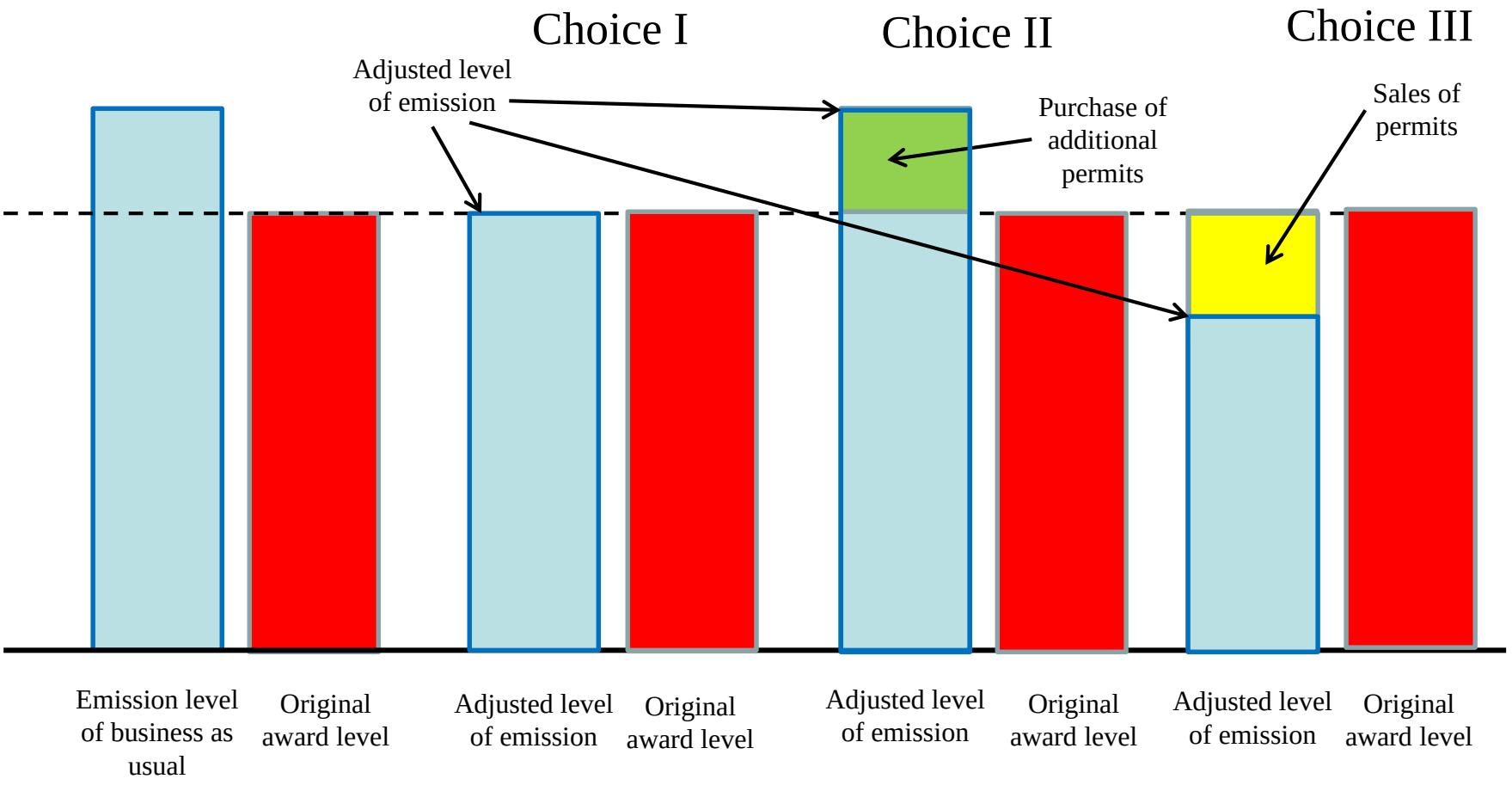
Merits of transferable discharge permit

- One of the merits of transferable discharge permit is that actors have flexibility for responding to the requirement for reduction of the total amount of pollutants.

Three Choices

- First choice: to reduce emissions to the level covered by the number of permits initially allocated.
- Second choice: to buy additional permits and emit at levels higher than the original award level.
- Third choice: to reduce emissions below the original award level and to sell the permits one does not need (i.e., credit).

Three Choices: explanation by means of a figure

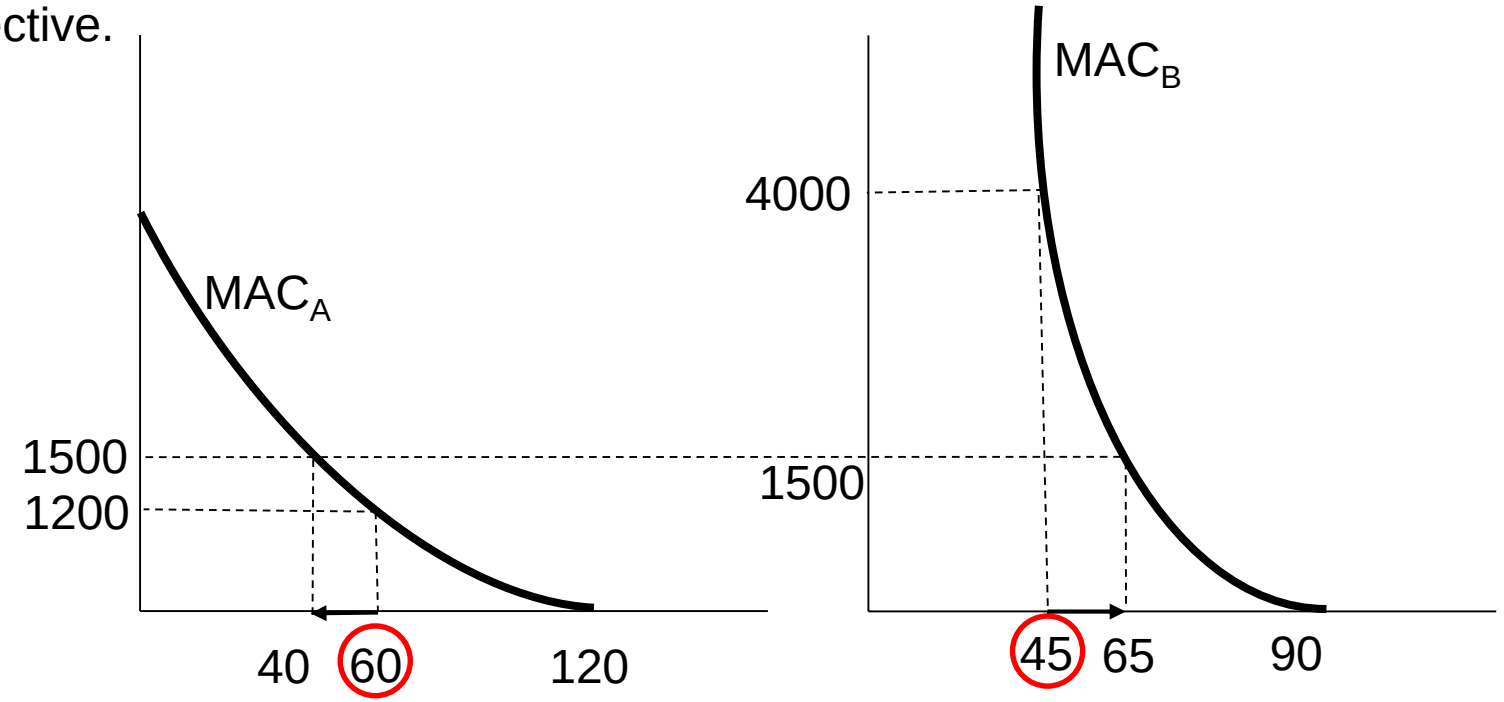


Purchase or sale?

- Why do some dischargers sell permits, while others buy?
- Because there are differences among dischargers' marginal abatement costs and the initial allocation of permits.
- Basically, dischargers who can reduce the amount of emission easily may possibly sell permits, while those who cannot reduce it easily may possibly buy permits.

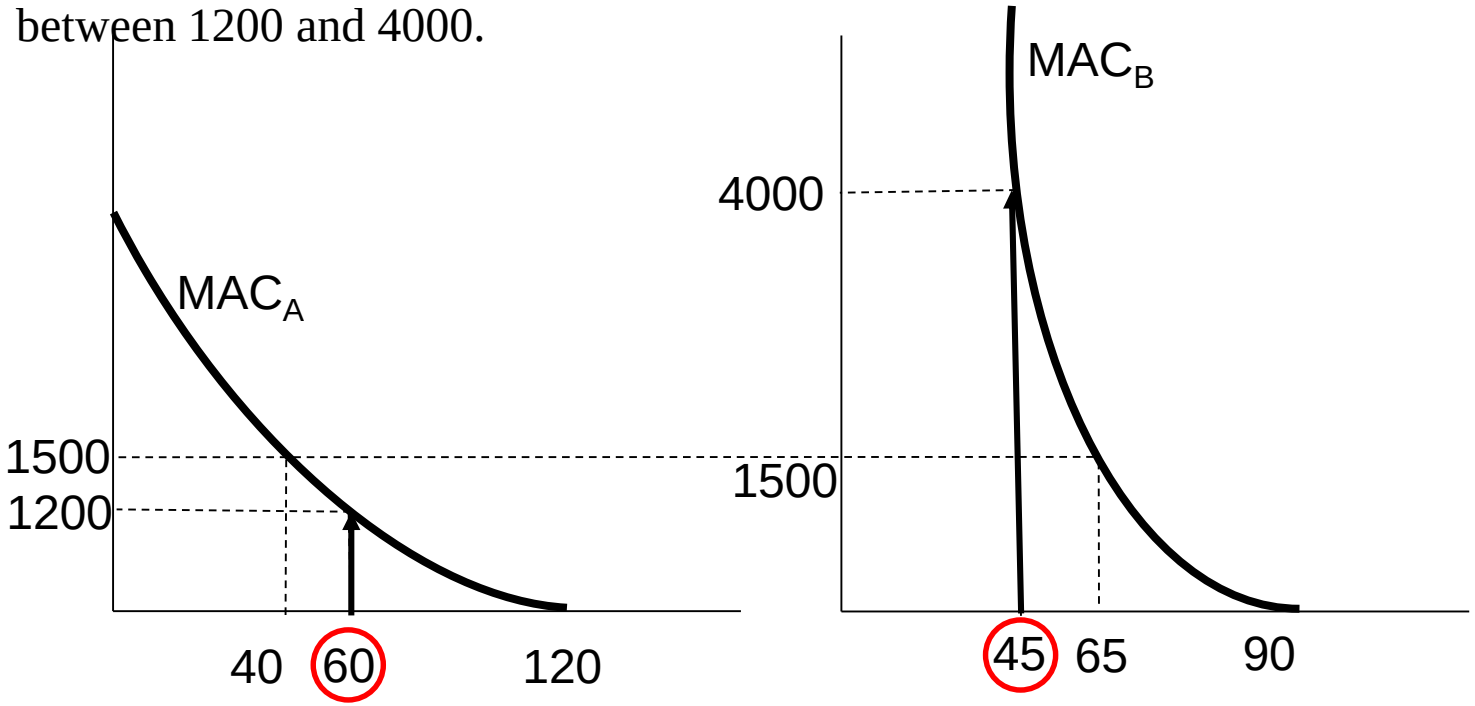
Gain from Trade: Equi-Marginal Principle Again!

The total emissions of the business as usual is 210 (= 120 + 90). Suppose the authority intends to reduce the emissions to 105, and the initial allocation of the permits to firm A and B is (60, 45). Firm A has an incentive to sell the permits by 20 units, reducing emissions to 40. On the other hand, firm B has an incentive to buy the permits by 20 units, increasing the emissions to 65. Finally, *equi-marginal principle holds*. Both firms gain by this trade. The scheme is cost effective.



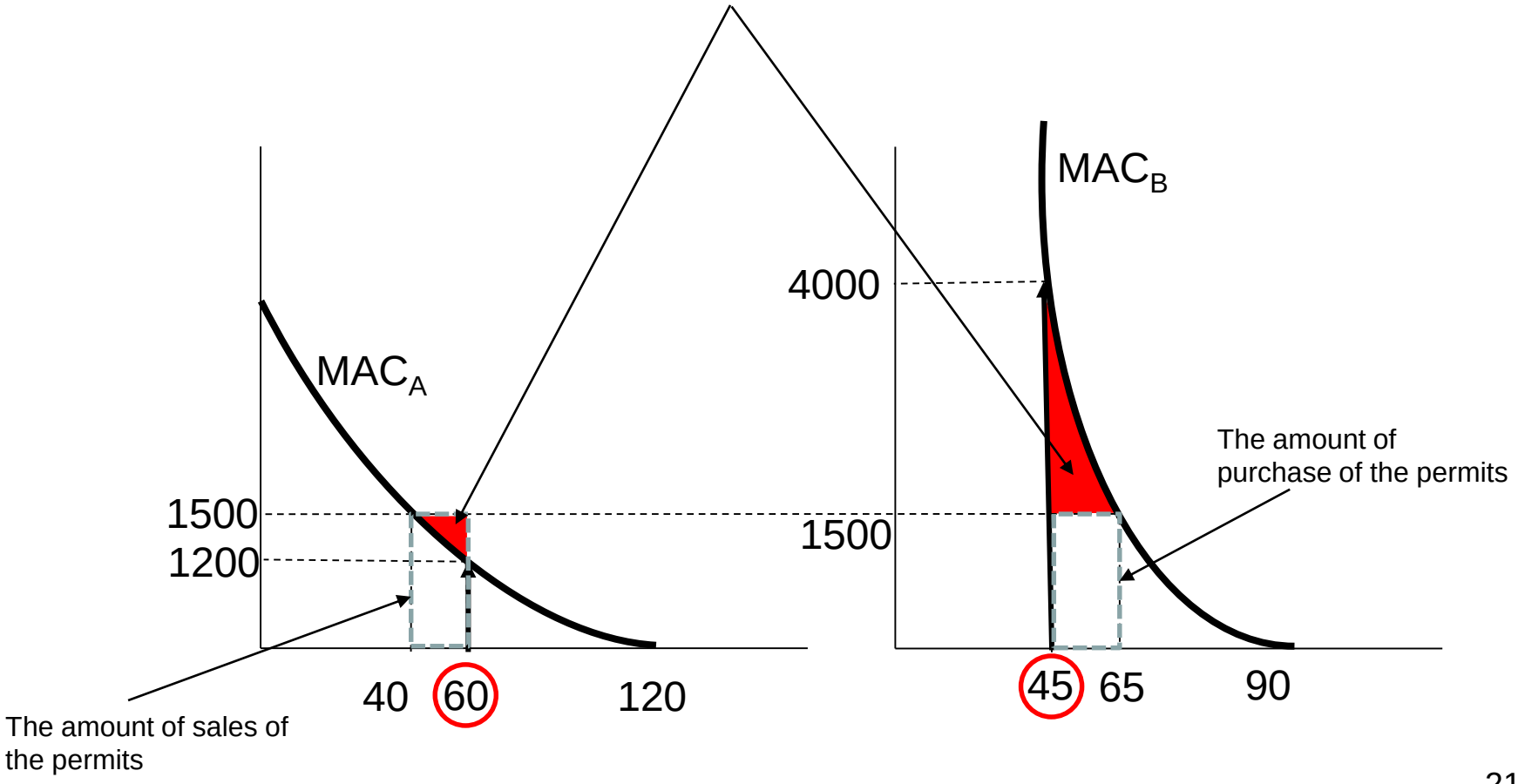
Why does such a trade occur?

Compare MAC_A with MAC_B at 60 and 45units respectively. The former is much smaller than the latter. This means that Plant A gains profits if it sells emission permits at the price higher than 1200, while B gains profits if it buys emission permits at the price lower than 4000. Demand for and supply of the permits match at the price somewhere between 1200 and 4000.



How are gains are allocated?

Plant A gains profits and plant B reduces costs by the exchange of the permits



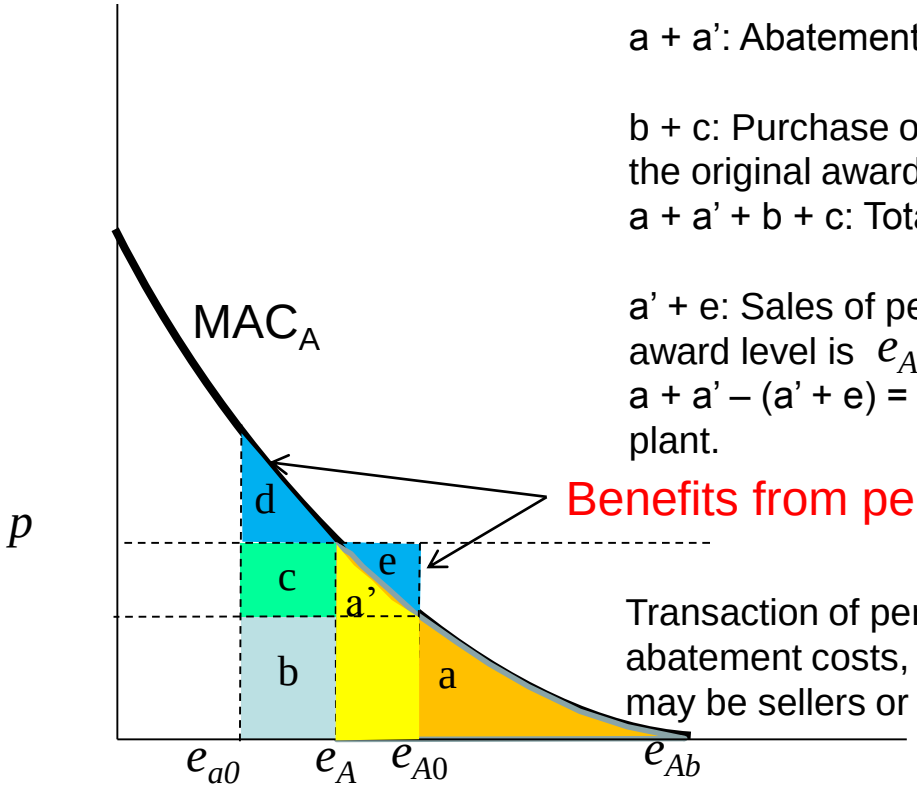
Remarks

- The essential point: Insofar as marginal abatement costs are unequal between these sources, they can both become better off by trading permits at some price between those marginal abatement costs.
- In markets with many sources participating, trading would be a continuous phenomenon because of the built-in incentive for polluters to look for better ways of reducing emissions and because of natural changes in a growing economy.

Profit Maximization: Mathematics

- Suppose that there is a market of the discharge permits and that the market price is p.
- Then, the reduction costs of pollutants of the i-*th* firm is expressed as $\mathrm{AC}_i(e_{ib} - e_i) - p(e_{i0} - e_i)$ where e_{ib} is the business-as-usual emissions, and e_{i0} is the initially allocated permits for the i-th firm.
- Then, profit maximization leads to $\mathrm{MAC}_i(e_{ib} - e_i) = p$ for each i. (Equi-marginal principle.)

Profit Maximization: Figure



If the market price of the permits is *p*, the firm chooses the emission level at e_A.

a + a': Abatement costs

b + c: Purchase of emission permits. when the original award level is e_{a0} .
a + a' + b + c: Total costs for this plant.

a' + e: Sales of permits when the original award level is e_{A0}.
a + a' – (a' + e) = a – e: Total costs of this plant.

Benefits from permits scheme

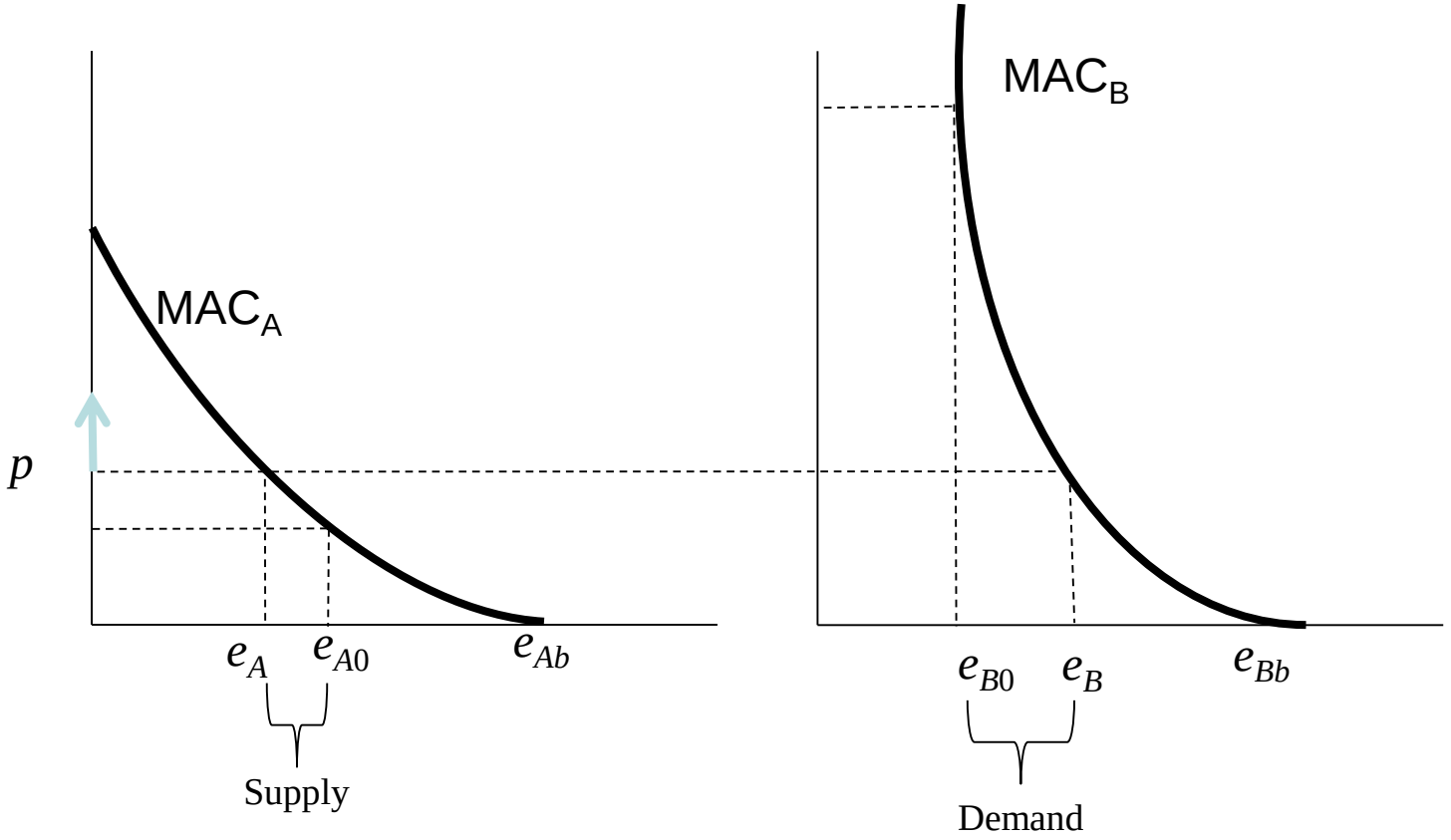
Transaction of permits decreases the abatement costs, whether dischargers may be sellers or buyers of permits.

Supply-demand adjustment

- How are supply of and demand for permits adjusted?
- Does market mechanism work for the adjustment?
- The answer is absolutely “yes”.

Price adjustment

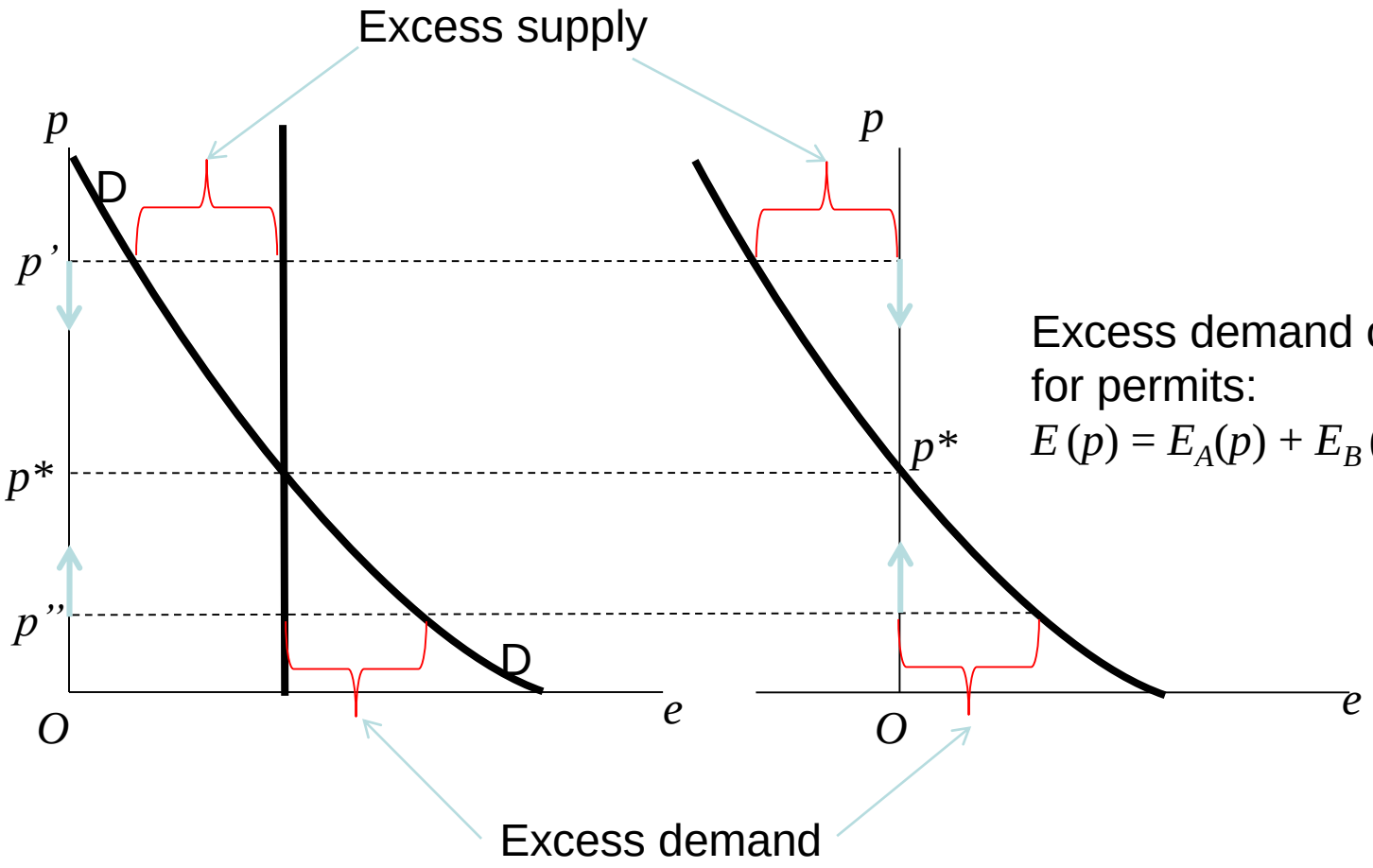
$e_B - e_{B0} > e_A - e_{A0}$. Then, the demand is larger than the supply, so that the price of emission permit increases. If the inequality is opposite, the price decreases.



Demand for and Supply of Permits

- From $\mathrm{MAC}_i\,(e_{ib} - e_i) = p$, the emission corresponding to profit maximization is determined. Let us denote it as $e_{id}(p)$.
- Then, the excess demand function for the permits of is expressed as $E_i\,(p) = e_{id}\,(p) - e_{i0}$.
- If $E_i\,(p)$ is positive, this firm supplies permits in the market. If $E_i\,(p)$ is negative, it demands permits.
- Supply-demand equalization means $\sum E_i\,(p^*) = 0$.
- p^* is the equilibrium price of the permits.

Demand for and Supply of Permits: Figure



Initial allocation of permits

- Initial allocation of permits does not affect the equilibrium price of the permits under certain conditions.
- Yet, it matters very much for firms, since it affects distribution of income.
- There is no agreed formula to distribute discharge permits among dischargers.
- Neither equal distribution nor distribution proportional to business-as-usual emission can satisfy dischargers.
- There should be a big argument when it comes to the discussion on initial allocation of permits.

Why doesn't initial allocation of permits affect the equilibrium price of the permits?

- Notice that the following holds for $i = A, B$:
- $E_i(p) = e_{id}(p) - e_{ib}$
- Thus, $E(p) = E_A(p) + E_B(p) = \{e_{Ad}(p) + e_{Bd}(p)\} - \{e_{A0} + e_{B0}\} = \{e_{Ad}(p) + e_{Bd}(p)\} - \bar{e}$ holds.
- The equilibrium condition is $\{e_{Ad}(p) + e_{Bd}(p)\} = \bar{e}$
- This implies that initial allocation of permits does not affect the equilibrium price of the permits.

Initial allocation of permits changes income distribution

- If a discharger is given a large amount of permits as initial allocation, he or she gains profits, selling permits.
- Otherwise, he or she has to pay for buying permits.
- Thus, income distribution is affected by initial allocation of permits.

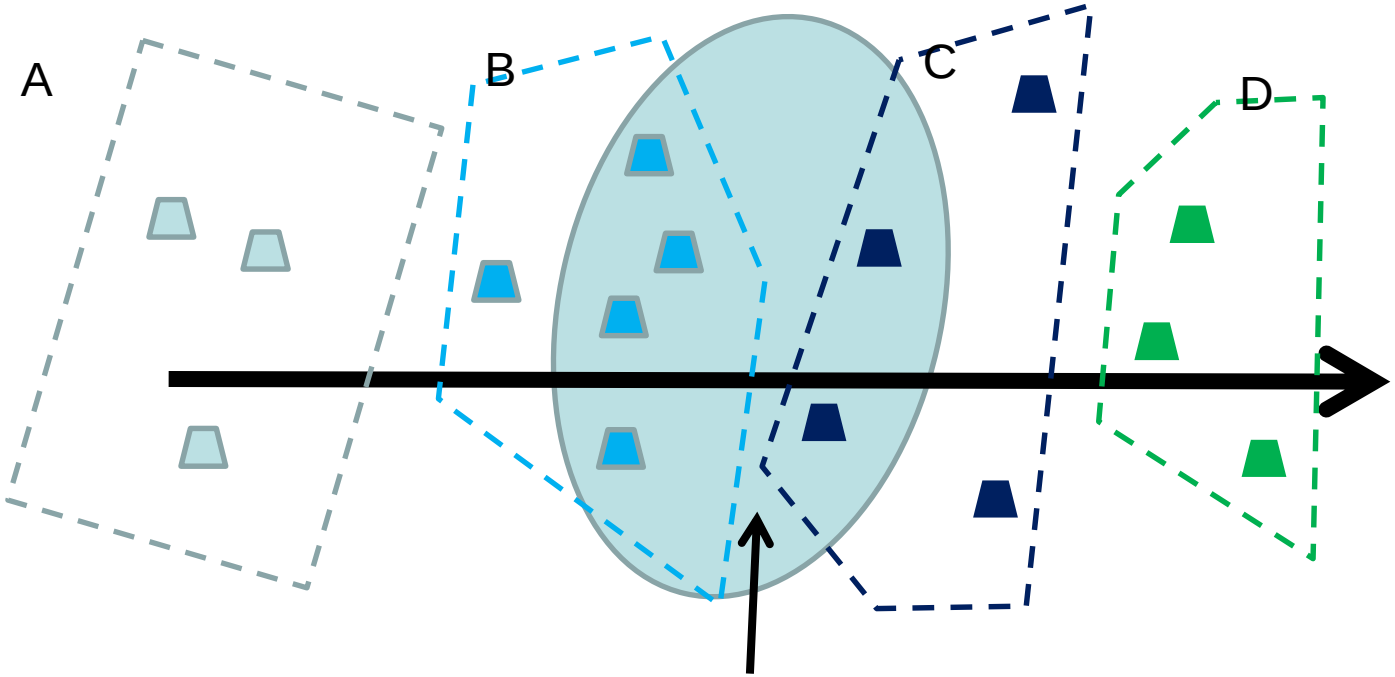
Trading rules

- Trading rules must be established so that transaction of permits can be smooth.
- For example, it should be established who can participate in the market.
- Can NGOs or grass-root organizations participate in the transaction of permits?
- Who is responsible for checking formally that transaction of permits is completed?
- How should the authorities respond to a situation in which a discharger emits more pollutants than the permits allow?

How can the number of the total permits be reduced?

- If the efficient number of permits should be reduced over time, what should be done?
- Public organization can reduce the total number of permits, buying them in a market.
- The same thing could be done, say, by environmental organization, NPOs and so on.
- Another idea is to make permits valid during a certain period.

Non-uniform emissions



If emissions from sources in one area give different damages to different areas, it may be recommended to adjust the trading rules to take into account the impacts of individual sources. In each zone, permits are exchanged among sources in the one-to-one unit base between emissions and permits. Yet, if a source in zone B buys permits from one in zone A, the former has to buy, say, two units of permits for one unit of emission.

CAPs and problems of competition

- CAP programs work through a trading process in which buyers and sellers interact to transfer permits.
- Markets work best when there is substantial competition among buyers and sellers.
- From the standpoint of fostering competition, one should set trading zones as widely as possible, to include large numbers of potential buyers and sellers.
- This may, however, work against environmental protection.
- For environmental reasons, it may well be desirable to have trading areas restricted, whereas for economic reasons one may want to have trading areas defined broadly.

CAPs Programs and Enforcement

- The administrative agency has to keep track of the following two things: (1) the number of permits in the possessions of each source (2) the quantity of emissions from each source.
- Permits buyers are supposed to have strong incentive to have their purchases revealed to the agency.
- Notice that purchases imply sellers who are the counterparts of the transaction!
- A system of self-reporting may be sufficient to provide reliable information on which sources have the permits.
- Yet, to monitor cumulative emissions from sources may be a tough work.

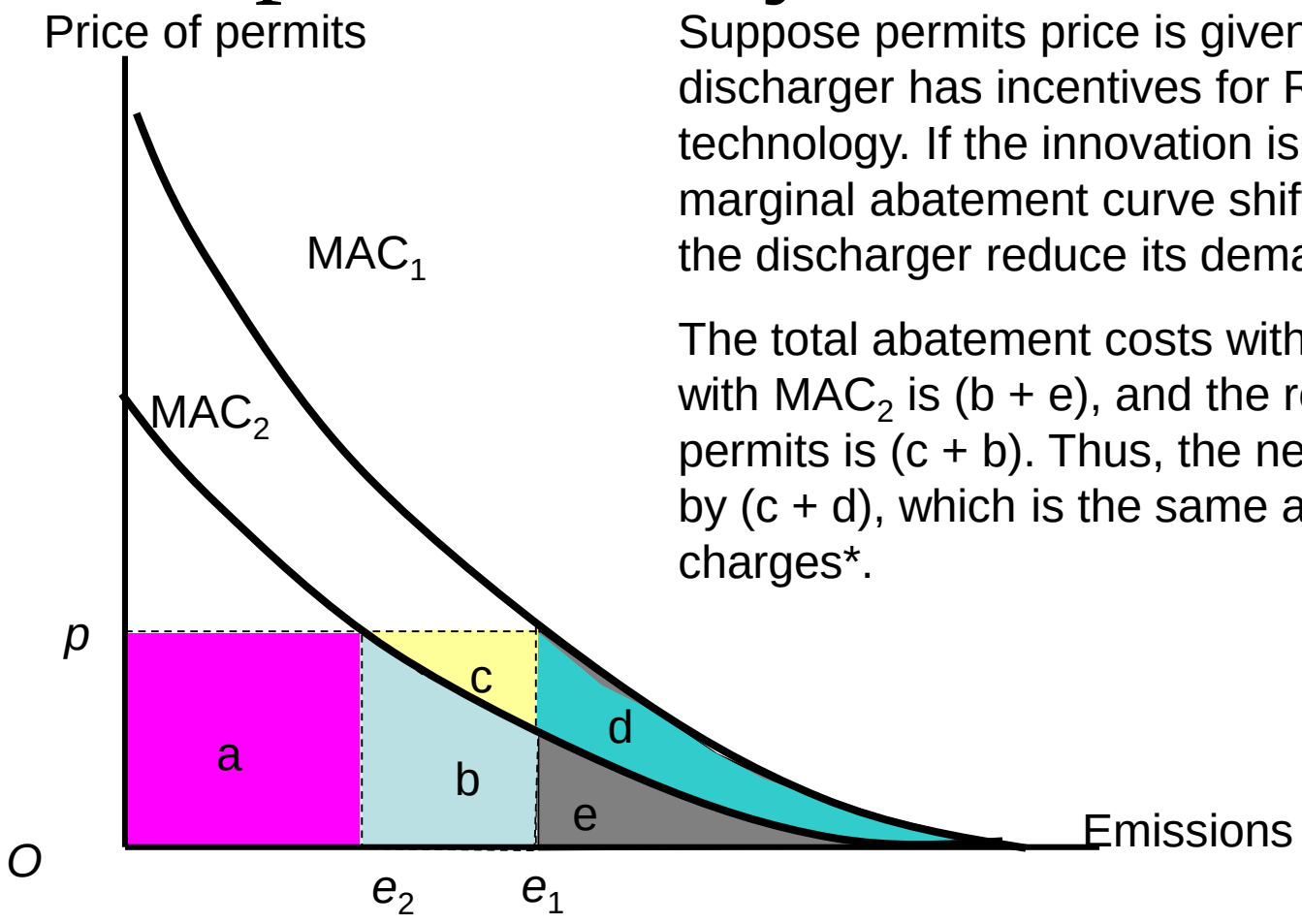
Voluntary Trading

- CAP programs may be established on a voluntary basis.
- Merits of voluntary agreement: this contains some incentive for sources to monitor each other, at least informally.
- Voluntary markets of this type have helped to fuel the growing markets for offsets.
- A good example is a scheme of *carbon* offsets.

CAPs and the incentive for R&D

- What effects do CAP programs have on the incentive for R&D?
- In this respect, we can say that they are identical to emission charges as far as theory is concerned.
- There is an important assumption for the above to hold: the price of emission permits is the same even if there is a shift of a MAC curve.
- This assumption is legitimate if the shift happens just for one firm. If such shift happens for all the sources, it is not legitimate any more.

Explanation by Means of a Figure



Suppose permits price is given at *p*. Then, the discharger has incentives for R&D for new abatement technology. If the innovation is successful and the marginal abatement curve shifts down as in the figure, the discharger reduce its demand for permits to e_2.

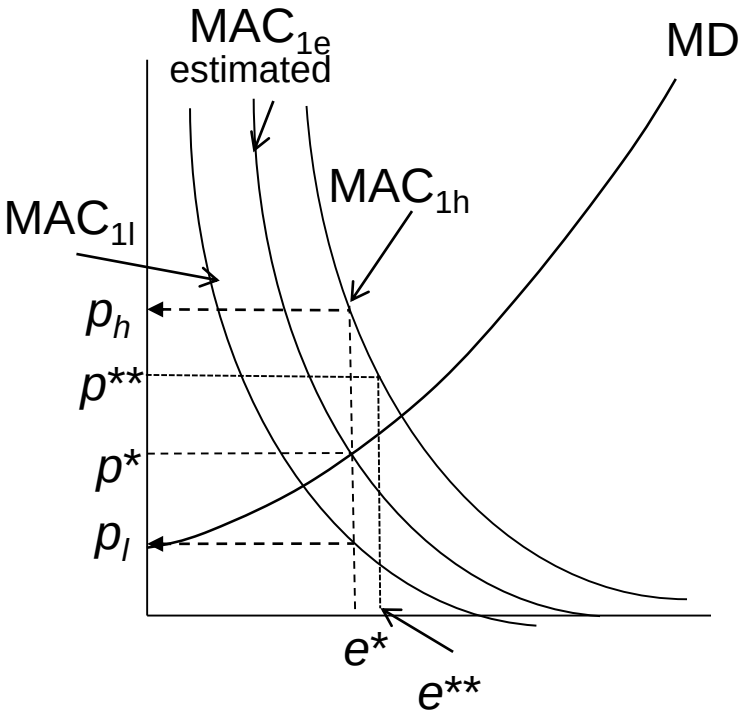
The total abatement costs with MAC_1 is (d + e), those with MAC_2 is (b + e), and the receipts from sale of permits is (c + b). Thus, the net benefits is expressed by (c + d), which is the same as in the case of emission charges*.

* Notice that the cost increase is expressed as (b + e – {d + e} – {c + b}) = - (c + d), so that net benefit is (c + d).

CAP and Uncertainty

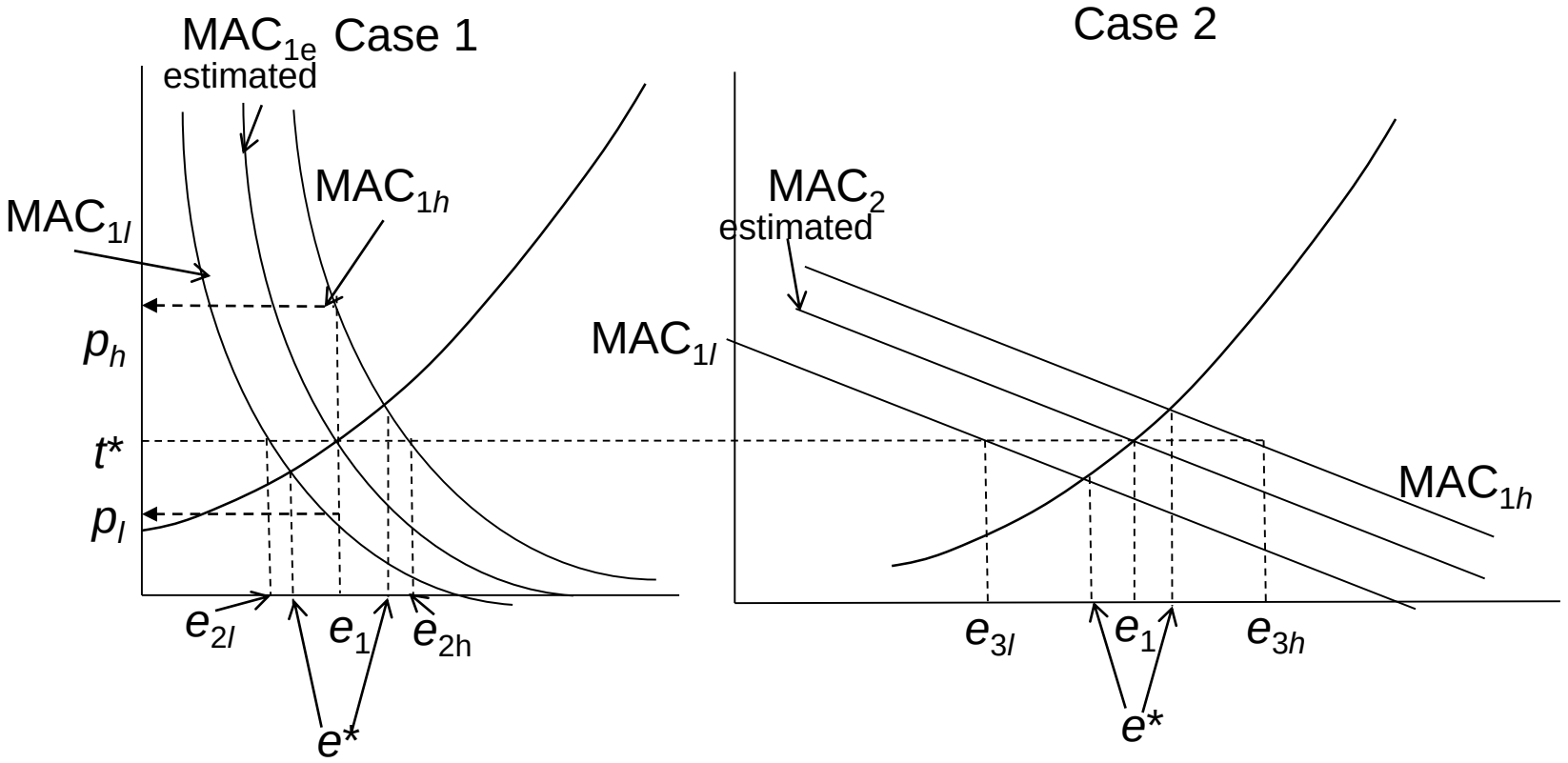
- CAP can be regarded as a quantity- based system.
- It starts with the setting of a quantity limit on total emissions, which then produces a certain price for emission permits.
- In the case of emission charges, one cannot be certain about how much of a reduction of emissions one could obtain from a given emission charge, when uncertainty prevails on information of MAC.
- In the case of emission permit-trading, one cannot be certain about how much one should pay for purchase of one unit of emission permits, when uncertainty prevails on information of MAC.
- Then, a *safety valve* may be required.

CAP and Uncertainty



Suppose the estimated MAC is MAC_{1e} although the true MAC is MAC_{1h}. Since the total emission permits are issued based upon the estimated MAC and MD, the number of the total emission permits is e^*. But, if e^* is issued, the actual price of permits is p_h, instead of p^*, which may be unacceptably high. Then, a safety-valve price p^{**} may be implemented by the authority. If so, the number of the total emission permits may be expanded to e^{**}.

Comparison of CAP and emission charge scheme under uncertainty



Suppose the estimated MAC is MAC_{1e}, but the true one is MAC_{1h}. The emission charge scheme realizes e_{2h}, and CAP realizes e_1 on the other. The divergence from the target e^* is smaller in the emission charge scheme. That is, $e_{2h} - e^* < e_1 - e^*$, and $e_{2l} - e^* < e_1 - e^*$.

In this case, the divergence from the target e^* is smaller in the CAP. That is, $e_{3h} - e^* > e_1 - e^*$, and $e_{3l} - e^* > e_1 - e^*$.

What does this comparison imply?

- If there is uncertainty, CAP and emission charge scheme produce different results.
- If MAC changes elastically with respect to an emission rate *e*, an emission charge scheme is more recommendable.
- If MAC changes less elastically with respect to an emission rate *e*, a CAP scheme is more recommendable.