Regulation Policy and Economics of Regulation

Class No. 5 (file 5): Natural Monopoly

Objectives of Today's Class

(1) To recollect the discussion on monopoly
(2) To understand a concept of natural monopoly
(3) To understand the relationship between natural monopoly and a price regulation

Outline of Class No. 5

5-1 Economy of Scale
5-2 Natural Monopoly
5-3 Marginal Cost Pricing
5-4 Average Cost Pricing
5-5 Problems of Price Regulations
5-6 Price Cap
5-7 Price Regulations under Incomplete Information
5-8 Public Enterprise

Economy of Scale

(a) Merit of scale

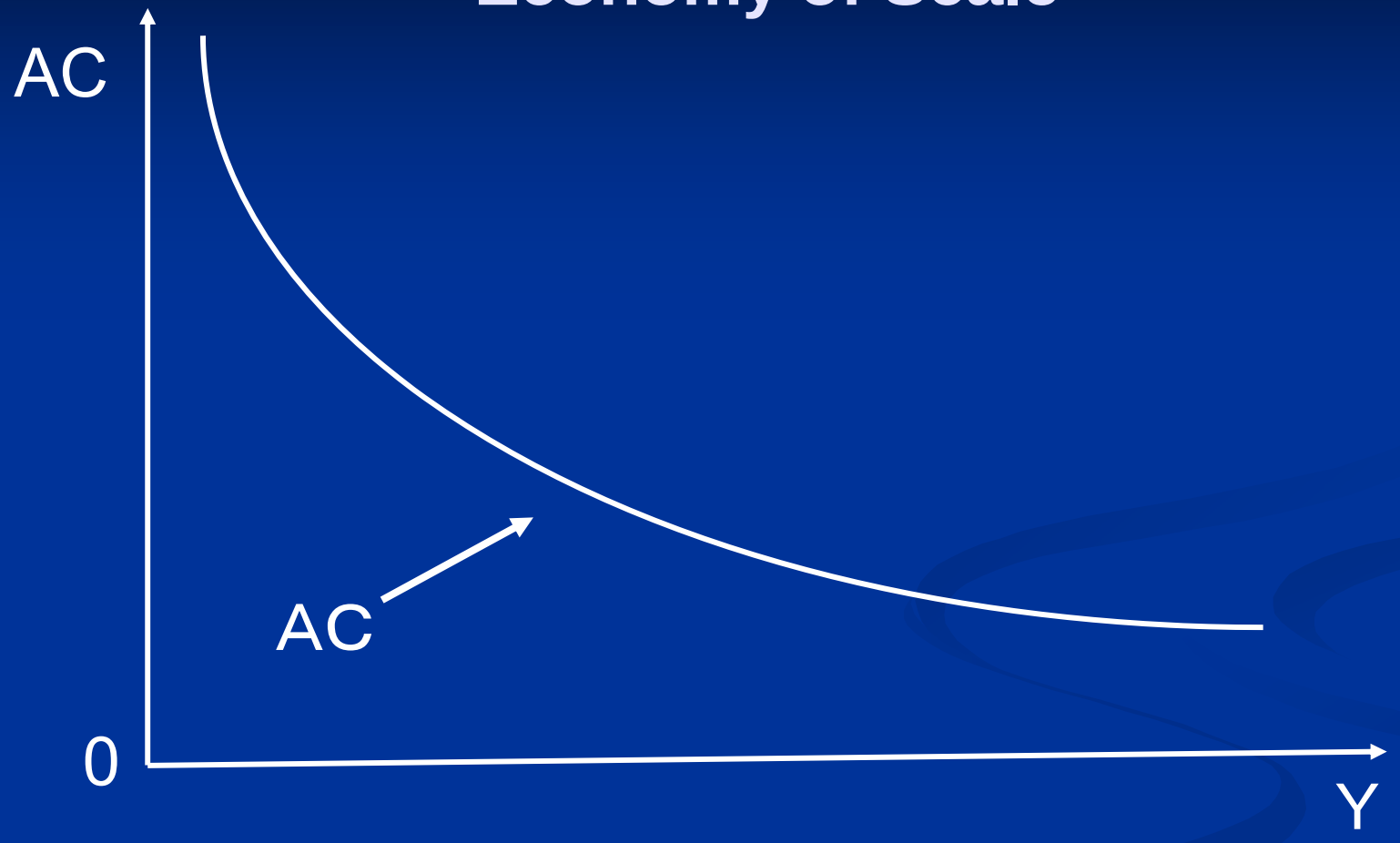
→ Average cost declines as production quantity increases.

(b) Subadditivity of cost function

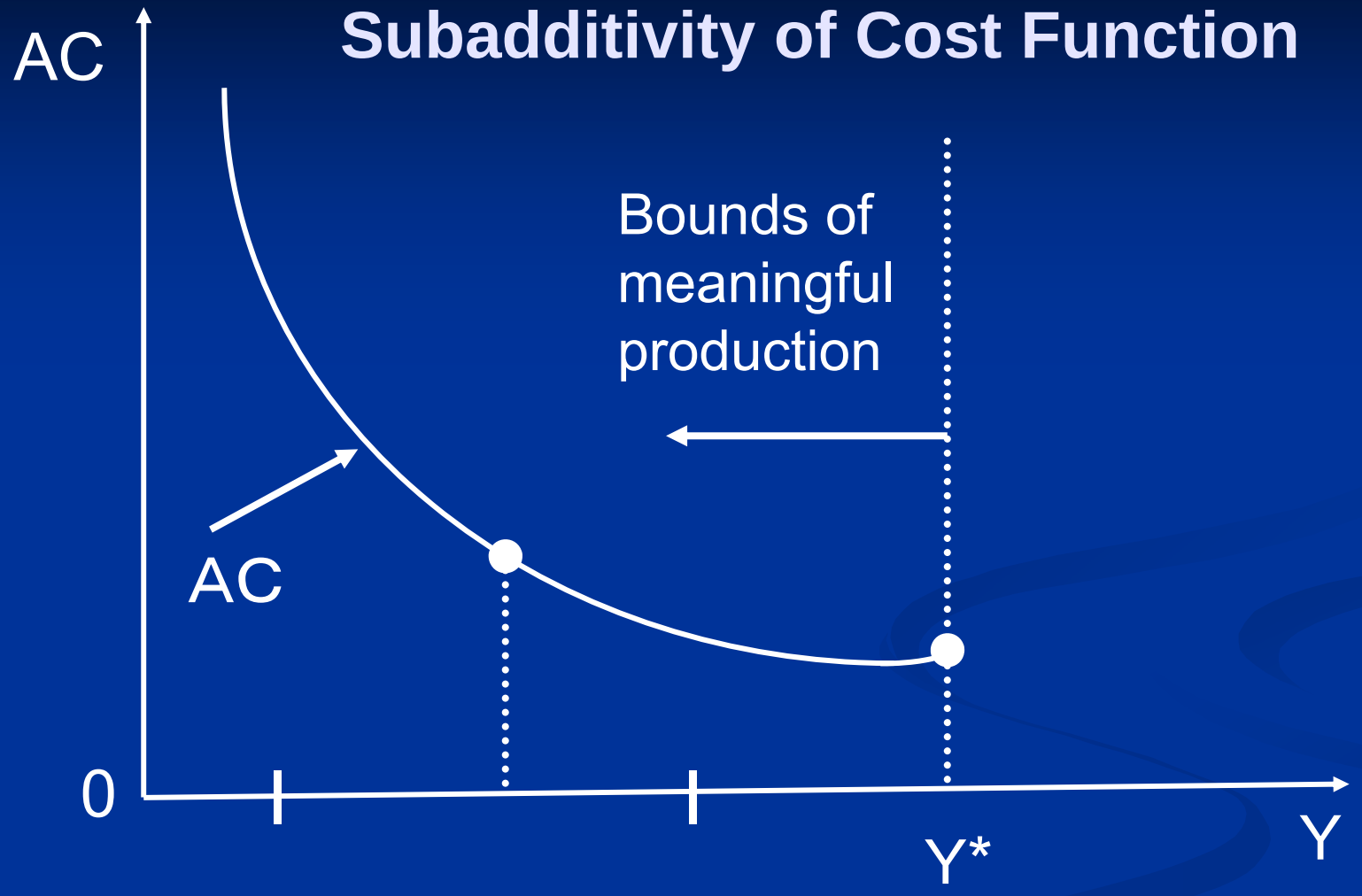
→ Production by a single firm costs less compared to one by plural firms (dividing up the same quantity).

If (a), it's (b). (The reverse is not true.)

Economy of Scale



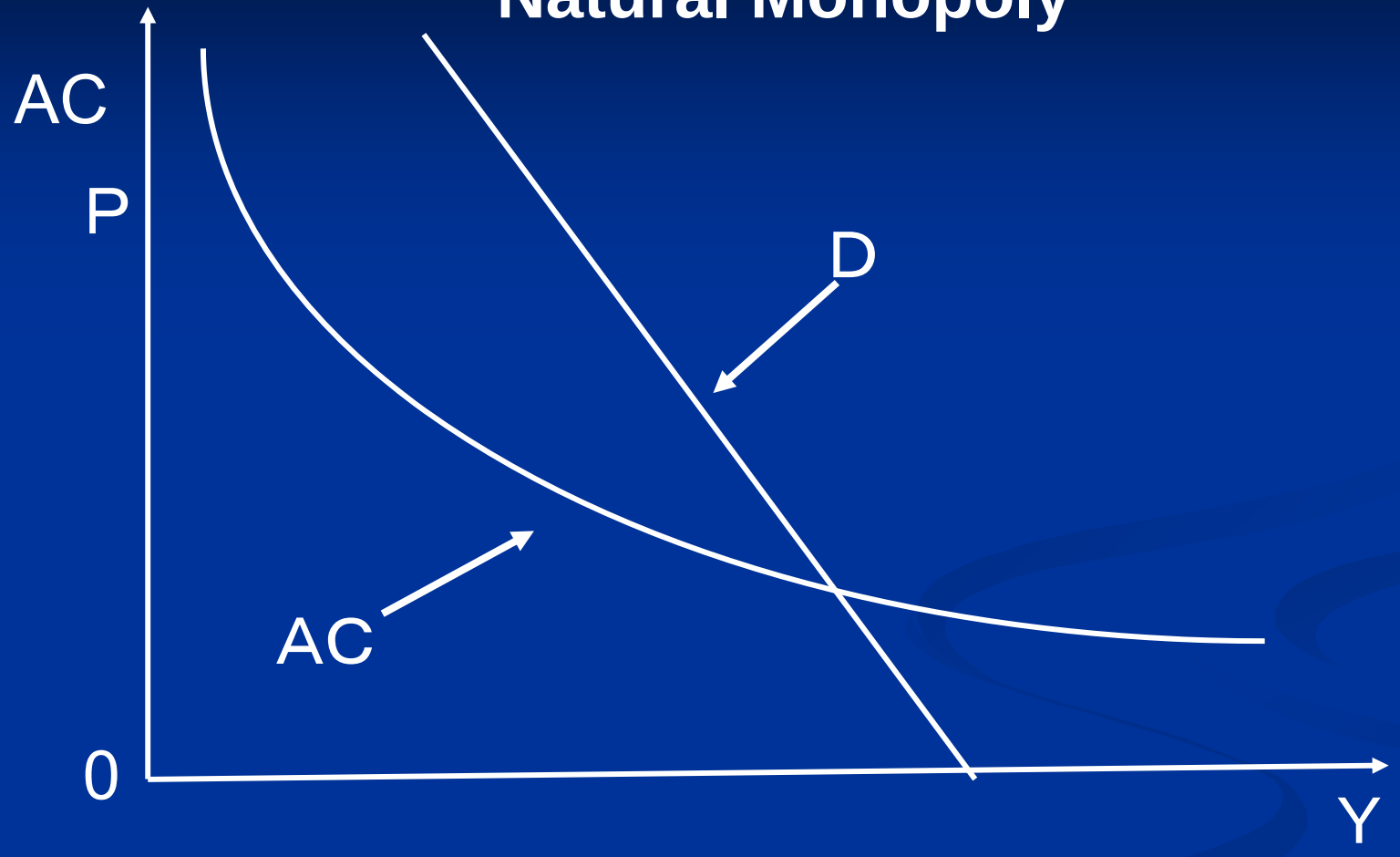
Subadditivity of Cost Function



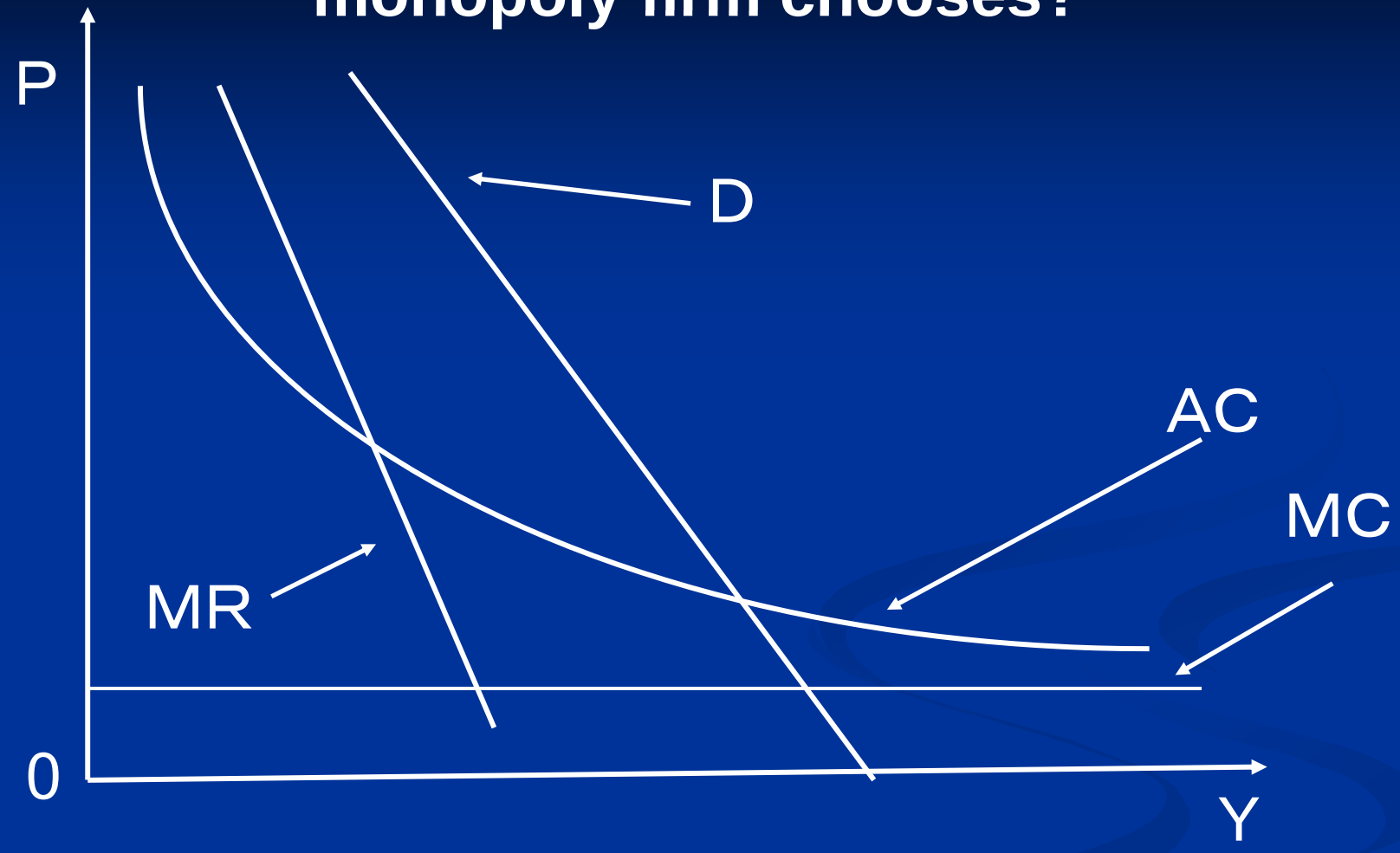
Economy of Scale: Examples

- Industries requiring huge setup costs
  （E.g.） the steel industry, LNG receiving facilities
- Industries requiring huge R&D costs
  (E.g.) pharmaceutical, semiconductor, large aircraft
- Industries requiring network facilities
  （E.g.）telecommunications, electric power, city gas
- Markets where network externalities work strongly
  （E.g.）OS, computer game
- Niche markets of a small market size

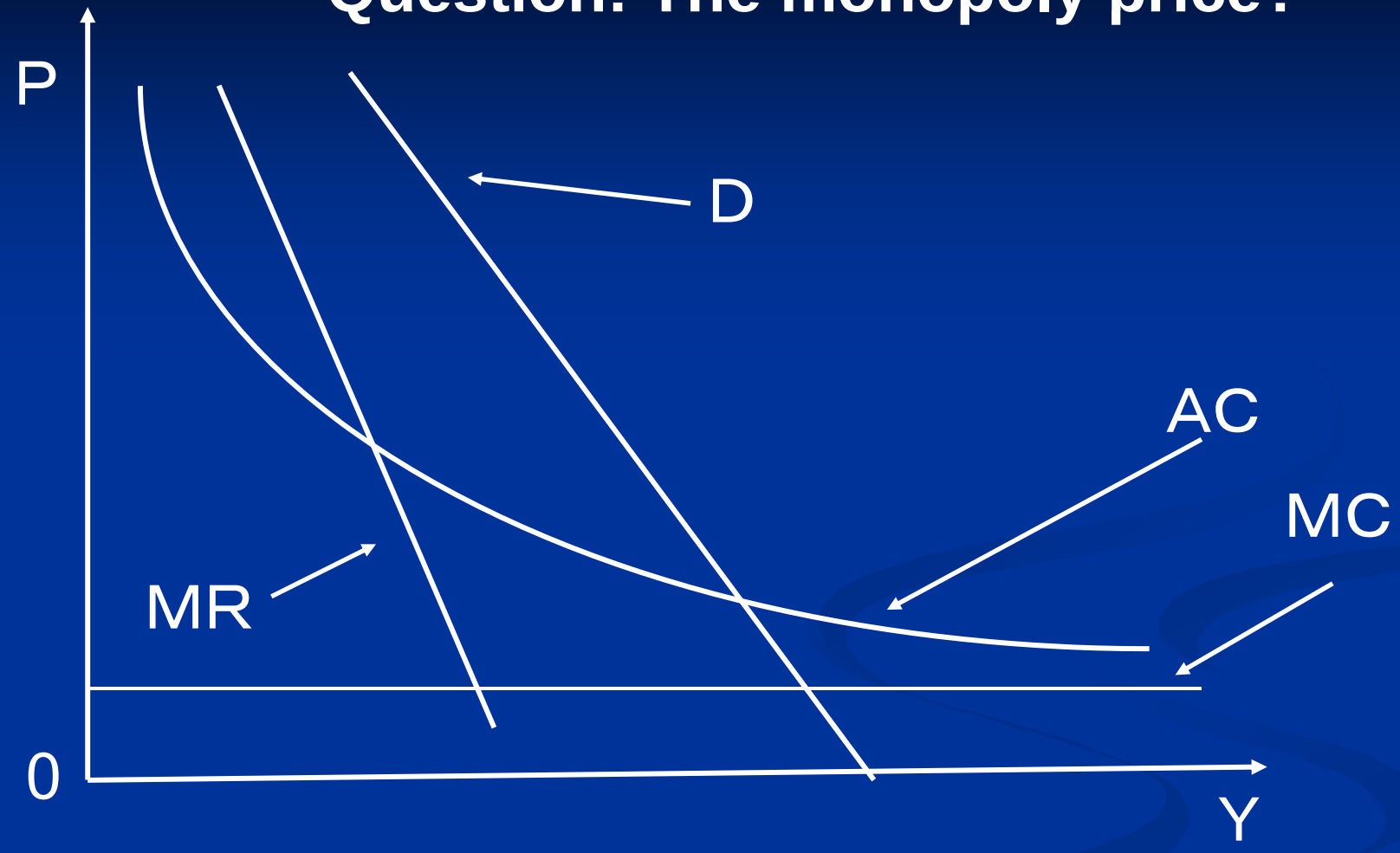
Natural Monopoly



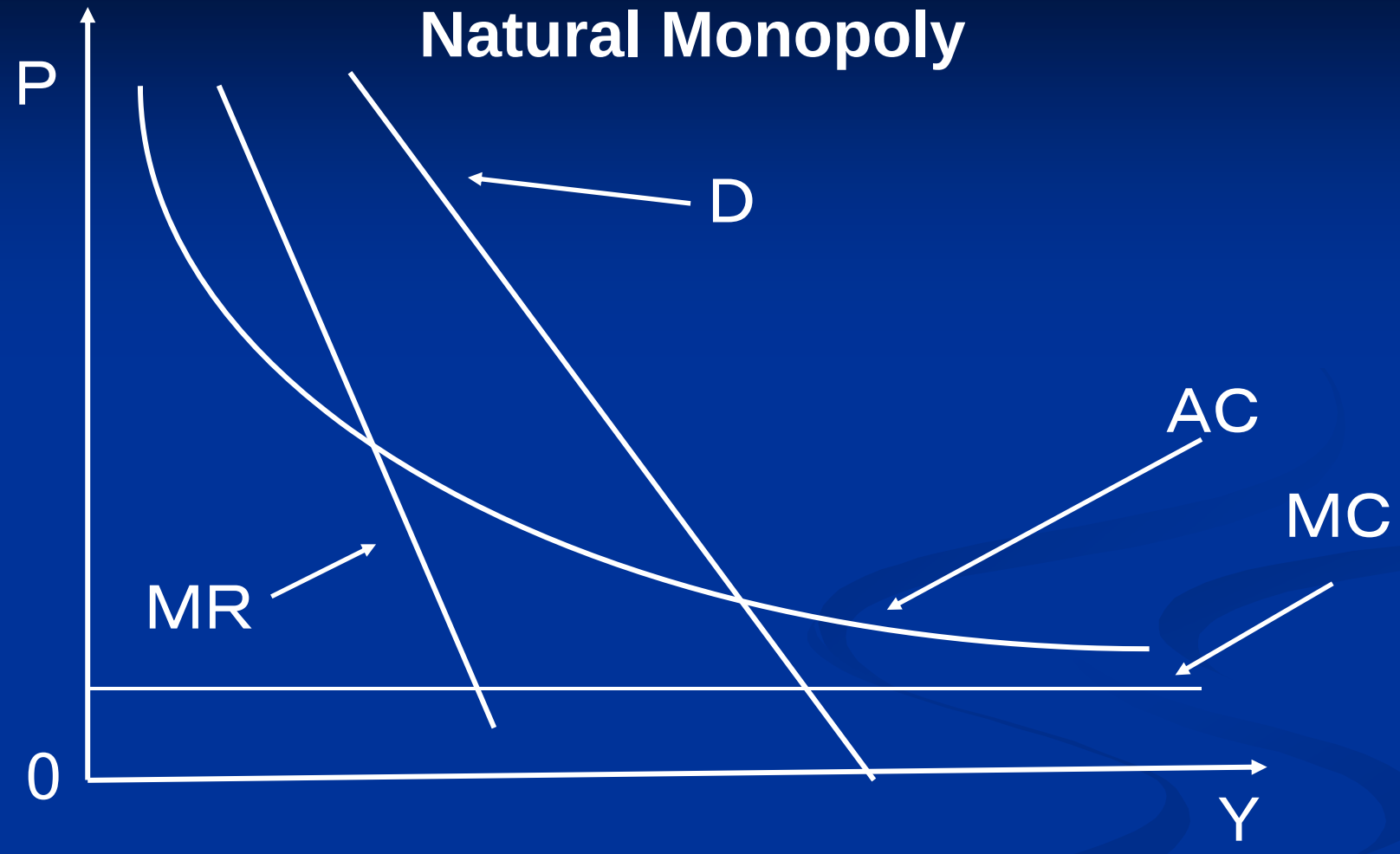
Question: Which is the production quantity a monopoly firm chooses?



Question: The monopoly price?

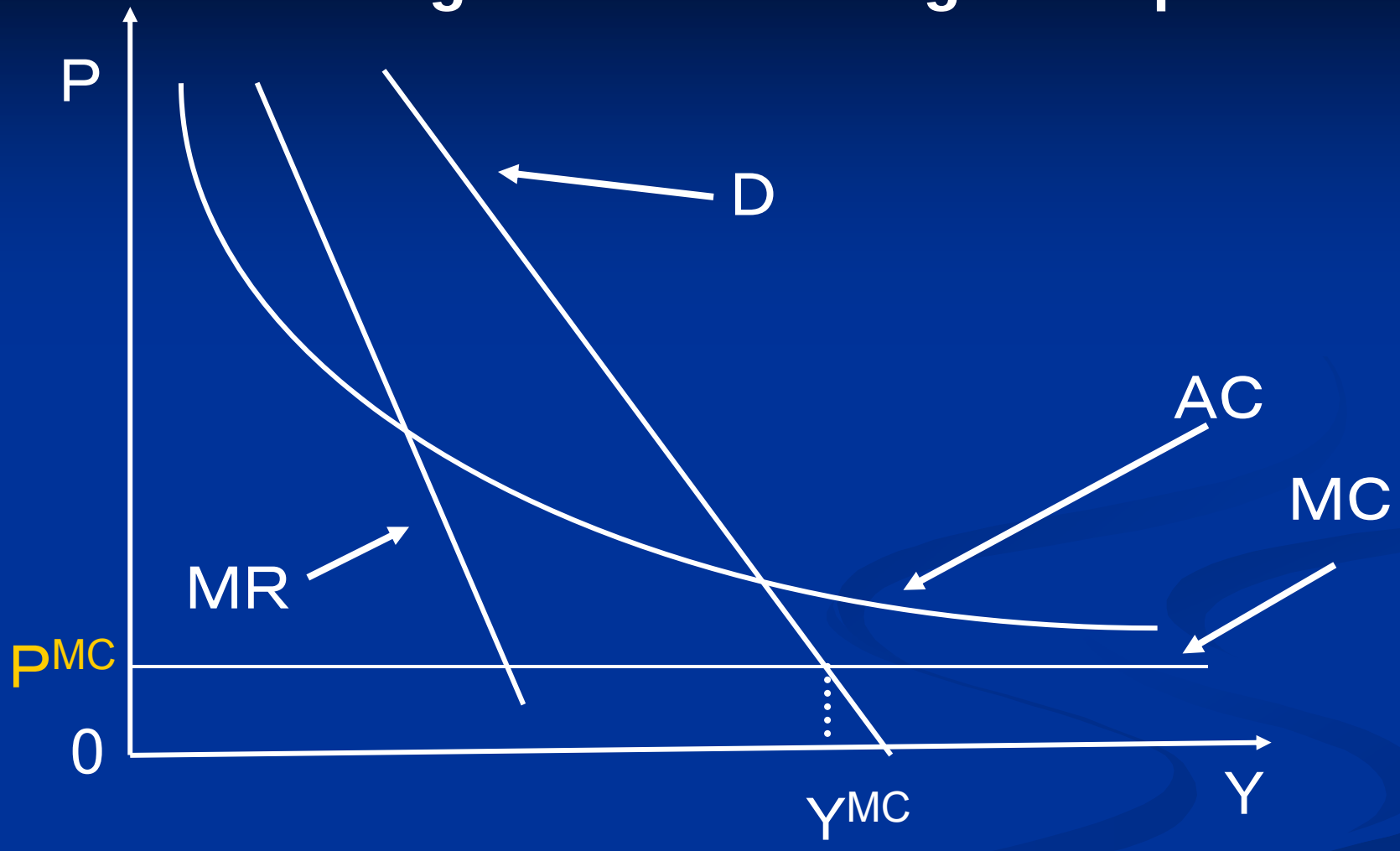


Natural Monopoly



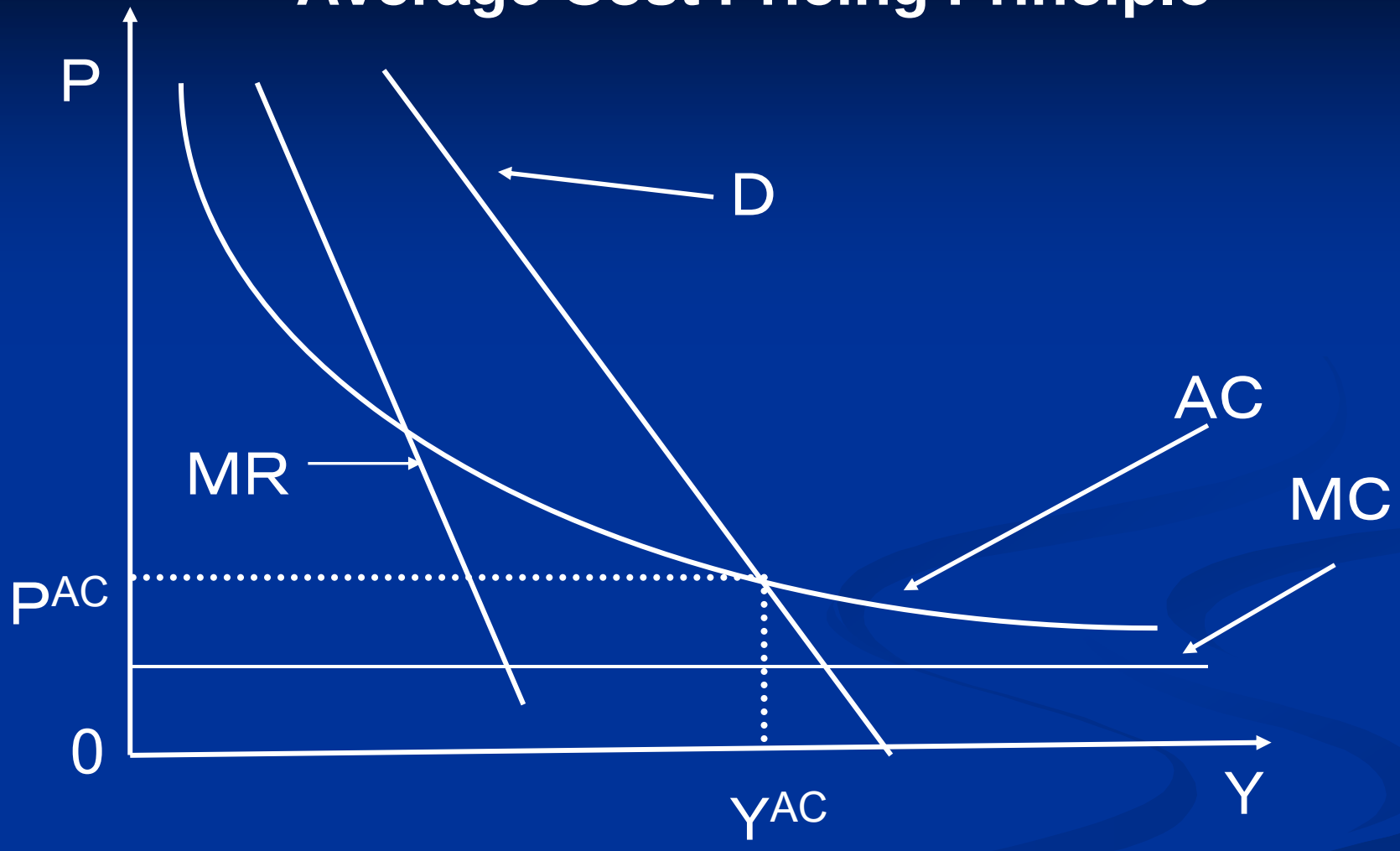
Question: Deadweight loss of welfare?

Marginal Cost Pricing Principle



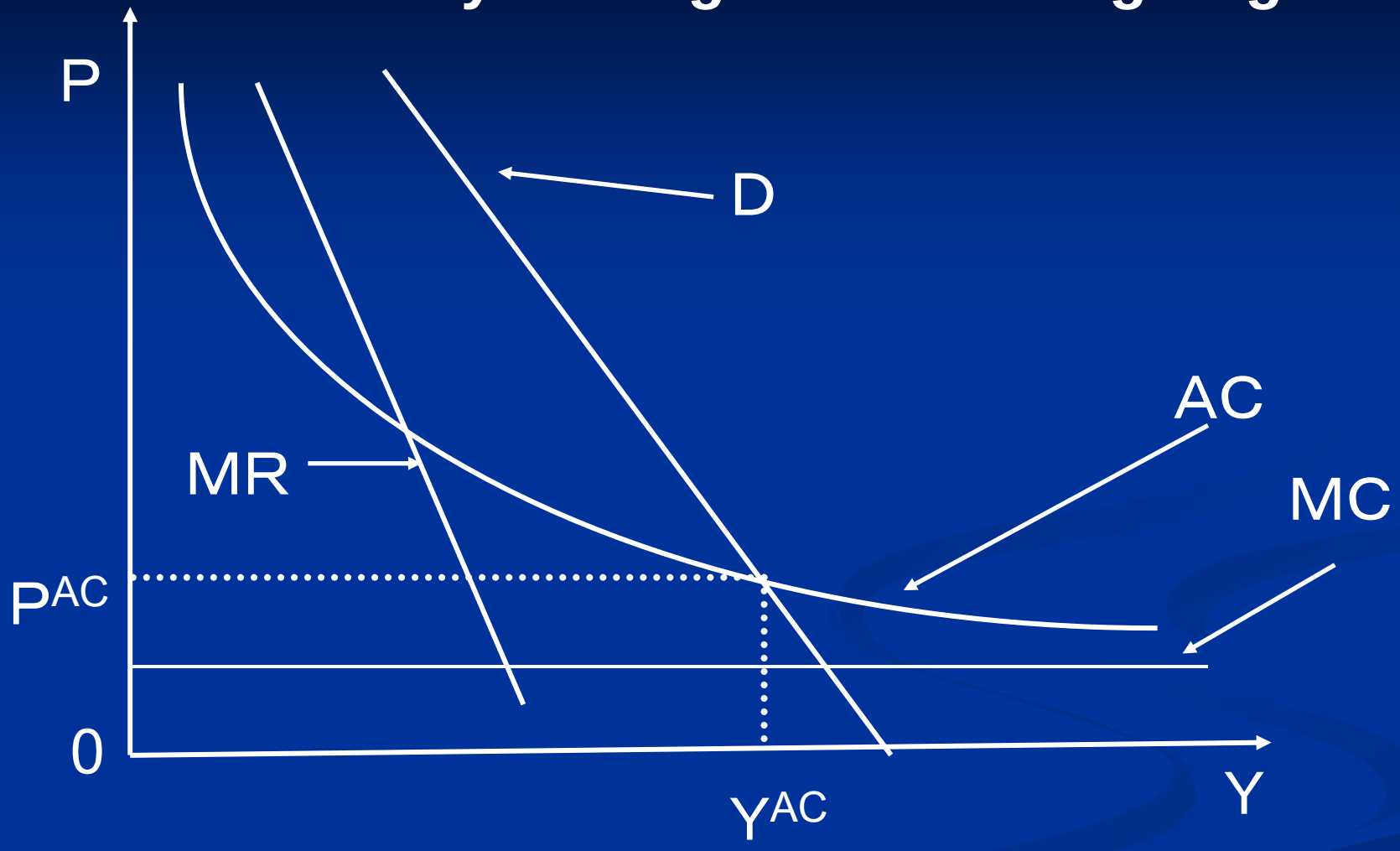
Question: Firm's deficit?

Average Cost Pricing Principle



Question: Deadweight loss of welfare?

Loss of Welfare by Average Cost Pricing Regulation



Question: Which average cost pricing yields bigger deadweight loss of welfare, the regulated or non-regulated?

Problems with Price Regulation

Problem with a regulation based on the principle of marginal cost pricing

- Deficit being incurred ← Required to be covered with subsidy
- Difficult to grasp accounting marginal costs sometimes

Problem with a regulation based on the principle of average cost pricing

- Welfare loss being incurred

Problem common with both regulations

- No inducement for cost reduction
- Real costs being unclear sometimes

→ It's unclear if accounting costs are truly necessary ones.

Price Cap

To set up the upper-limit price, and change it as per a certain rule: P=f(x)-g(t)

g(t) to signify the time factor; e.g., a rule to reduce 1% every year (the part to take technological innovation and such into account)

f(x) being the part to incorporate various economic factors

（Examples of those factors）price increase rate, factor price (e.g., petroleum price: adjustments of fuel costs/raw material costs）, interest rate, quality of supply products

～ Factors unrelated to one's own effort on cutting costs

→ Not to impair inducements to cut costs

Similar system: the fuel cost/raw material cost adjustment system（Class No. 7, 8）

Problems with Price Cap

(1) Welfare loss being incurred: Prices not to come down with the reduction in costs → the disparity of marginal costs and prices

(2) It's difficult to obtain a commitment not to reduce the upper limit price even if costs go down.

→ One makes a big profit. → It becomes clear that one's costs are low. → The inducement for one to revise its price occurs ex post facto.

⇒ As a practical matter, a long-term commitment is difficult to come by. In many cases, the practice is to fix the rule for a term of X years (some 3-5 years in a large number of instances), and to have another look after X years.

～To result in shrinking inducements to cut costs

Example 1

No cost with no production. For production, the setup cost being 100, and another 20 as the cost per a single unit of production: the demand function being P=100-Y

A monopoly firm engages in production in this market; the government establishes the pricing and subsidy S. (If S is negative, it means imposition of taxes.)

The firm does not produce unless its profit should be nonnegative.

Aggregate surplus ＝CS（consumer surplus）＋PS（producer surplus）－ S

The government settles on the pricing and subsidy so as to maximize the aggregate surplus.

Question: What are the price the government sets and the necessary subsidy？

Excess Burden of Tax

- Expenditure for tax collection
- Excess burden of tax accompanying tax collection

（E.g.）an excess burden of 10%

A subsidy of 10 billion yen to the business enterprise sector ⇒ the cost at 1 billion yen

Example 2

No cost with no production. For production, the setup cost being 100, and another 20 as the cost per a single unit of production: the demand function being P=100-Y

A monopoly firm engages in production in this market; the government establishes the pricing and subsidy S. (If S is negative, it means imposition of taxes.)

The firm does not produce unless its profit should be nonnegative.

Aggregate surplus ＝CS（consumer surplus）＋PS（producer surplus）－ (1+λ)S ：λ being a positive constant

The government settles on the pricing and subsidy so as to maximize the aggregate surplus.

Question: What are the price the government sets and the necessary subsidy？

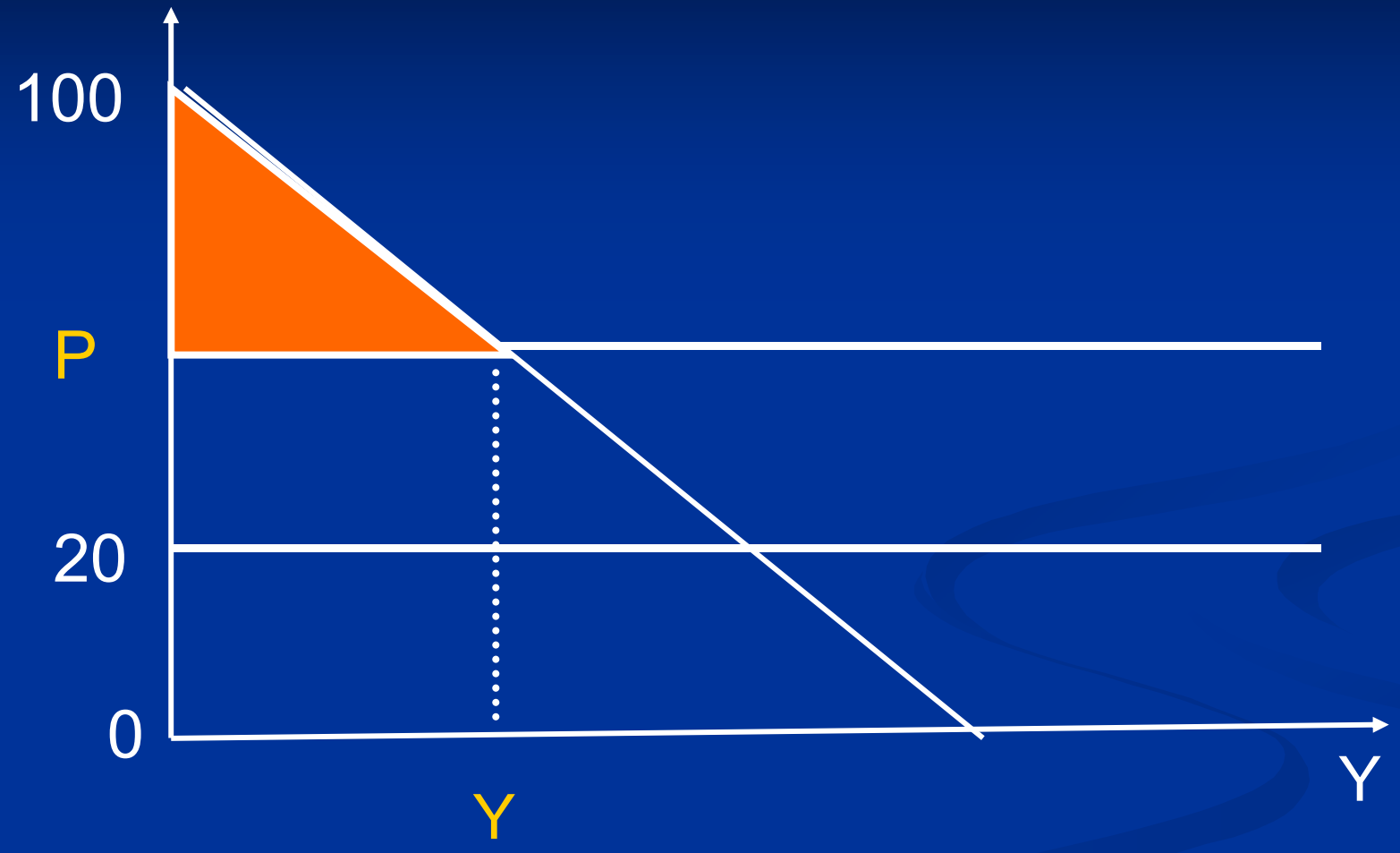
Example 2

Question: What are the price the government sets and the necessary subsidy？

To set S to attain PS=0

$W=CS-(1+\lambda)S$

Consumer Surplus



例２

To set S to attain PS=0

W=CS － (1+λ)S

Question: What is CS?（Express as P’s function.)

Example 2

To set S to attain PS=0

W=CS － (1+λ)S

Question: What is (1+λ)S?（Express as P's function.）

Example 2

To set S to attain PS=0

$W=CS - (1+\lambda)S$

Question: What is $(1+\lambda)S$?（Express as P's function.）

Answer: $(1+\lambda)(100-(P-20)(100-P))$

Example 2

Question: What is the price the government sets?

To set S to attain PS=0

$W=CS - (1+\lambda)S$

Example 3

No cost with no production. For production, the setup cost being 100, and another 20 as the cost per a single unit of production: the demand function being P=100-Y

A monopoly firm engages in production in this market; the government establishes the pricing and subsidy S. (If S is negative, it means imposition of taxes.)

The firm does not produce unless its profit should be nonnegative.

Aggregate surplus ＝CS（consumer surplus）＋PS（producer surplus）－ (1+λ)S ：λ being a positive constant

The government settles on the pricing and subsidy so as to maximize the aggregate surplus.

Question: What is the price the government sets?

Real Costs being Unclear

It’s unclear whether the firm’s cost structure is high or low.

Setting up the regulation price low by making a rush judgment that a firm’s cost is low would cause the firm really with a high cost structure to make an exit.

⇒ To have the firm declare its own cost

∼ Requirment for inducements to declare correct costs

Self-selection

Example 4

No cost with no production. For production, the setup cost being 100, and another 20 or 10 as the cost per a single unit of production. The government does not know whether the firm's production cost is 20 or 10: the demand function being P=100-Y.

A monopoly firm engages in production in this market; the government establishes the pricing and subsidy S. (If S is negative, it means imposition of taxes.)

The firm does not produce unless its profit should be nonnegative.

Aggregate surplus ＝CS（consumer surplus）＋PS（producer surplus）－ S

The government settles on the pricing and subsidy so as to maximize the aggregate surplus.

Question: What is the price the government sets? And the subsidy？

Example 4

Question: What is the price the government sets? And the subsidy？

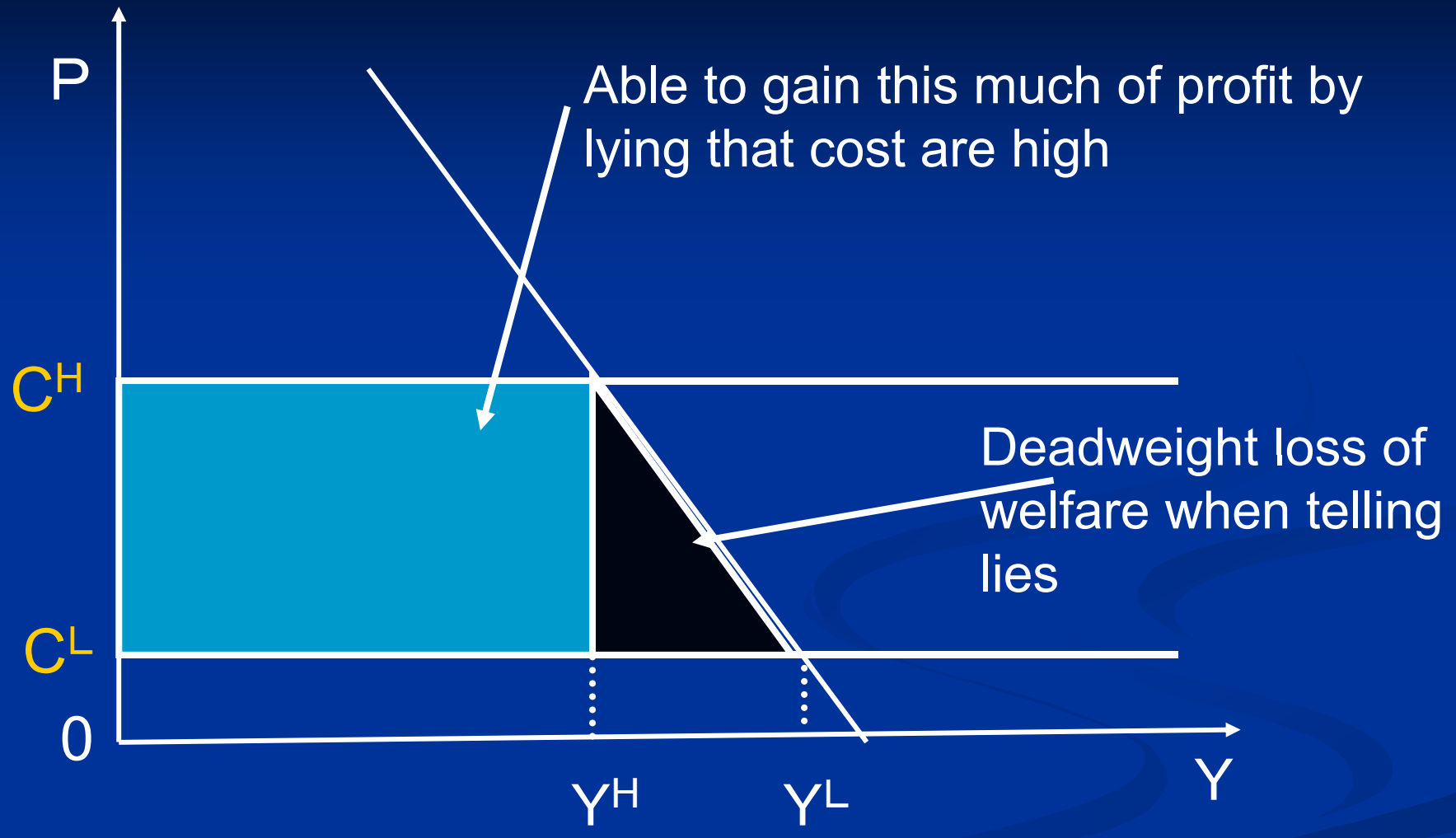
Answers: to present the two schedules of

P＝20 Subsidy＝100

P＝10 Subsidy ＝180

Choose the former if the firm's cost is 20, an the latter if it is 10.

Imperfect information (No Excess Burden of Tax)



Example 5

No cost with no production. For production, the setup cost being 100, and another 20 or 10 as the cost per a single unit of production. The government does not know whether the firm's production cost is 20 or 10; the probability of 20 being q: the demand function being P=100-Y. A monopoly firm engages in production in this market; the government establishes the pricing and subsidy S. (If S is negative, it means imposition of taxes.) The firm does not produce unless its profit should be nonnegative.

Aggregate surplus ＝CS（consumer surplus）＋PS（producer surplus）－ (1+λ)S ：λ being a positive constant

The government settles on the pricing and subsidy so as to maximize the aggregate surplus.

Question: What is the price the government sets? And the subsidy？

Example 5

The government's choice:

(1) To present a single schedule, and if the firm is a type H (having high cost), then approve of the situation for the firm to discontinue production

→ To be reasonable when λ is positive and q is close to 0

In this case, it is a combination of the price and subsidy derived in the example 3.

Example 5

(2) To present the two schedules, and have the firm produce whichever type it belongs to (p^H, S^H) (p^L, S^L)

Inducement for a firm of the type L (having a low cost) to overreport its cost

When the type-L firm has selected the schedule designed for the type H, it is necessary to pay a subsidy to the type-L firm so that it can obtain at least the same amount of profit.

$(p^H-20)(100-p^H)-100+S^H \geqq 0$ (binding)

$(p^L-10)(100-p^L)-100+S^L \geqq 0$ (non-binding)

$(p^L-10)(100-p^L)-100+S^L \geqq (p^H-10)(100-p^H)-100+S^H$ (binding)

Example 5

$S^H = -(p^H - 20)(100 - p^H) + 100$

$S^L = 10(100 - p^H) - (p^L - 10)(100 - p^L) + 100$

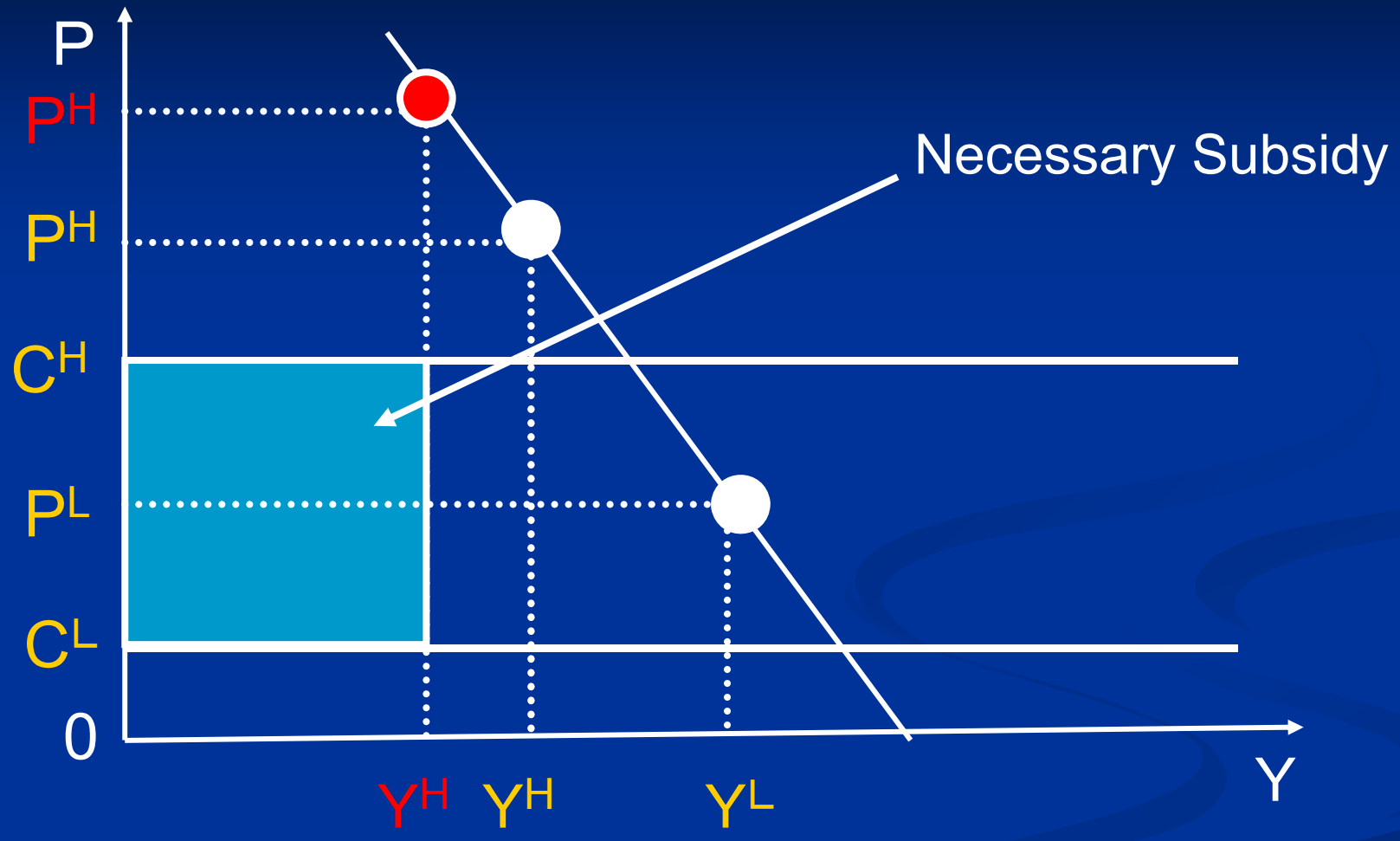
$W = q\{(100 - p^H)^2/2 - (1+\lambda)(100 - (p^H - 20)(100 - p^H))\}$

$+(1-q)\{(100 - p^L)^2/2 - (1+\lambda)(10(100 - p^H) + 100 - (p^L - 20)(100 - p^L))\}$

Question (1): Is p^L either higher than, or lower than, or the same with the regulation price under perfect information?

(2) Is p^H either higher than, lower than, or the same with the regulation price under perfect information?

Imperfect information (Excess Burden of Tax in Existence)



Stranded Cost

Setup costs are sunk costs, as a firm has already invested.

Normally to be recovered through fare receipts

Monopoly to date; the firm has intended to recover with the regulation price under noncompetition over a long term.

⇒Abrupt liberalization or a change in the regulatory regime, making certain costs irrecoverable

Costs that have become uncollectible due to a change in the framework ~ Stranded cost

How to recover this is a big problem.

Allocation of Common Cost

To have plural monopoly sectors, and/or a monopoly sector and a competitive sector at the same time

（E.g.）

- Partially liberalized market (electric power, city gas)
- Simultaneous management of an essential facilities sector and a competitive sector (telecommunications, electric power, city gas)
- Business having a reserved area (the postal business in each country)
- Simultaneously management of a universal service sector and a competitive sector (telecommunications, electric power, city gas, postal service)

Allocation of Common Cost

To have plural monopoly sectors, and/or a monopoly sector and a competitive sector at the same time ~ There are expenses to be borne commonly.

（E.g.） ・Personnel expenses of employees administering both sectors

・Expenses for accounting and taxation business

・Power station to be used for the ancillary service and generation of electricity

・Facilities to be used for the ancillary service and gas supply

・Power transmission cable and gas pipeline to be used both for regulated and liberalized fields

How should these be distributed among various sectors?

Allocation of Common Cost

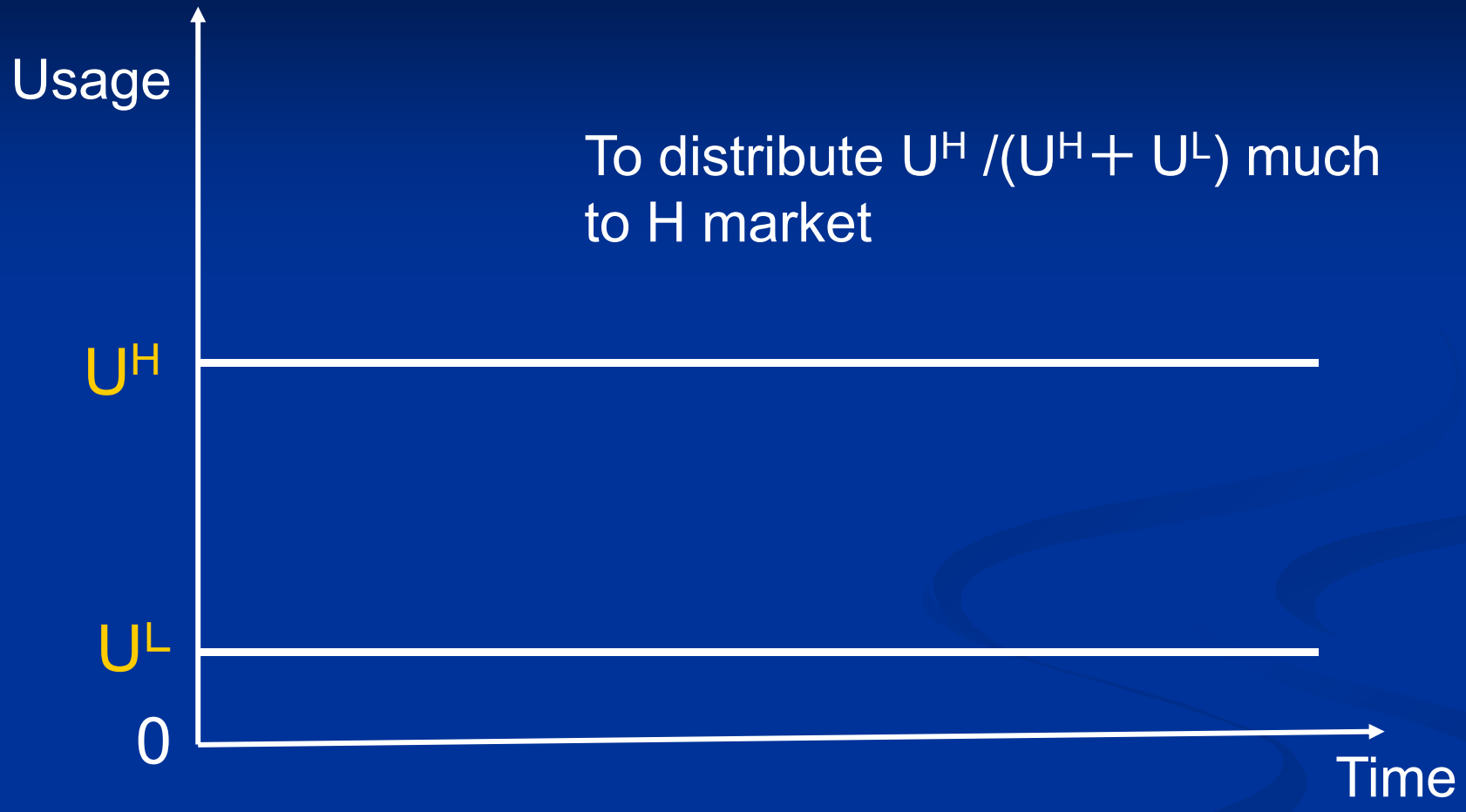
To have a monopoly sector and a competitive sector at the same time ~ There are expenses to be borne commonly. How should they be distributed between these sectors?

(1) To distribute common expenses to both sectors as per a definite rule

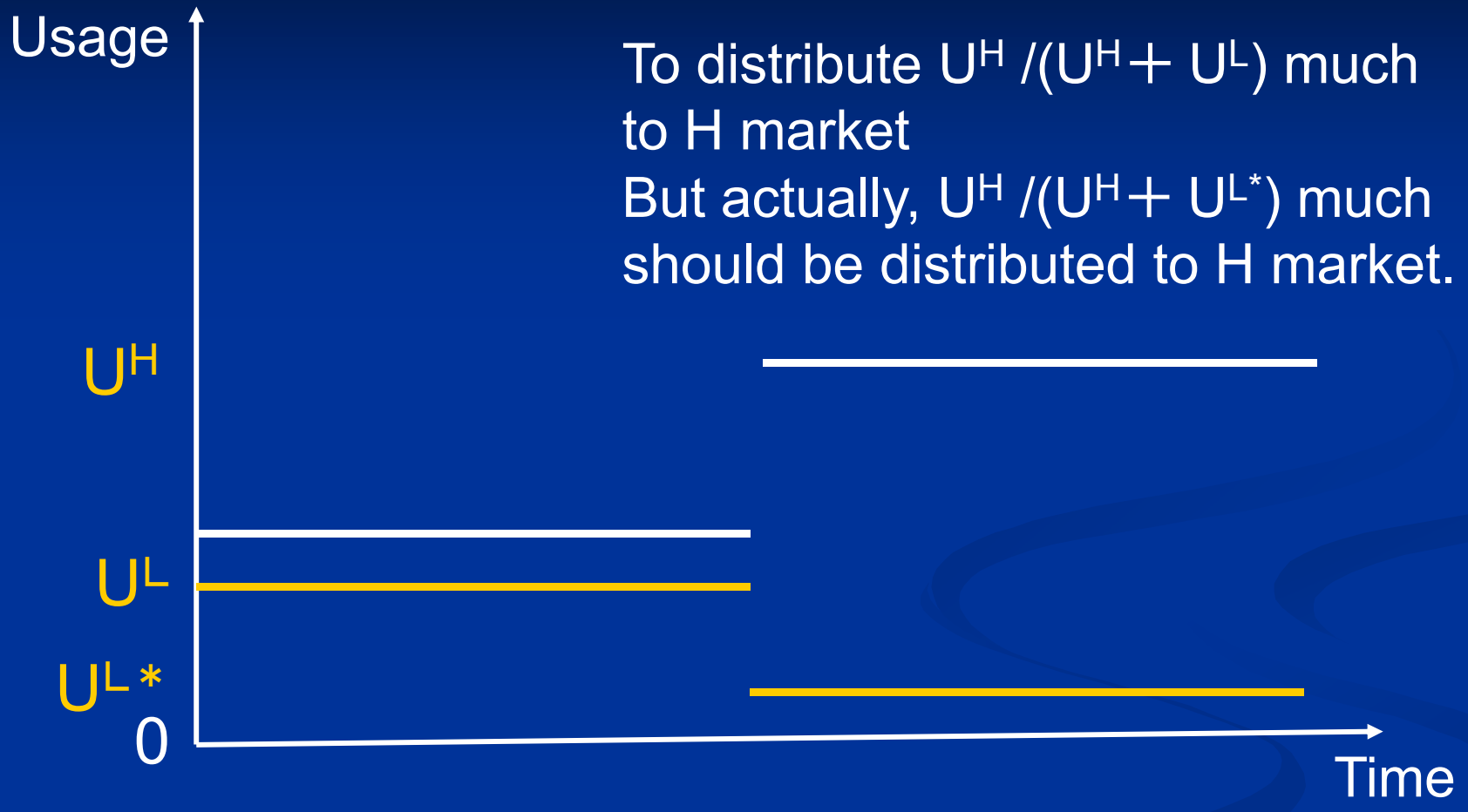
(E.g.)

- Distribute personnel expenses by estimating how much work has been done for which sector in practice (ABC accounting).
- Distribute customer expenses (costs of metering and such) in accordance with the number of customers.
- Distribute power transmission (conduits) expenses in proportion to the ratio of the maximum amount used.

Distribution of Expenses of Installed Capacity



Distribution of Expenses of Installed Capacity



To distribute $U^H/(U^H + U^L)$ much to H market

But actually, $U^H/(U^H + U^{L*})$ much should be distributed to H market.

Allocation of Common Cost

To have a monopoly sector and a competitive sector at the same time ~ There are expenses to be borne commonly. How should they be distributed between these sectors?

(2) To distribute common expenses to the competitive sector

To calculate how much expenses would be if it were the competitive sector alone

→ Deduct these from the entire expenses, and calculate ones for the monopoly (regulated) sector.

～To distribute the whole economic profit in the confines to the monopoly (regulated) sector

⇒ An inducement to spin off the competitive sector (as compared to the other rules)

～Risk that even an originally desirable integration might be split off

Allocation of Common Cost

To have a monopoly sector and a competitive sector at the same time ~ There are expenses to be borne commonly. How should they be distributed between these sectors?

(3) To distribute common expenses to the monopoly (regulated) sector

To calculate expenses for the monopoly (regulated) sector alone

⟶ Deduct these from the entire expenses, and calculate ones for the competitive sector. ～ To distribute the whole economic profit in the confines to the competitive sector

⇒To distort competition ～ Normally this kind of rule does not get adopted. But which can be discussed as the upper limit price for the monopoly (regulated) sector.