Regulation Policy and Economics of Regulation Class No. 2 (file 2): Basis and Regulation of Oligopolistic Model

Objectives of Today's Class

(1) To introduce a variety of oligopolistic models that will be used in this course

(2) To comprehend a relationship between regulation and competition policy

Oligopolistic Market Models

2-1 Seller’s monopoly

2-2 Cournot Model

2-3 Cournot’s Limit Theorem

2-4 Bertrand Model

2-5 Quantity competition, price competition

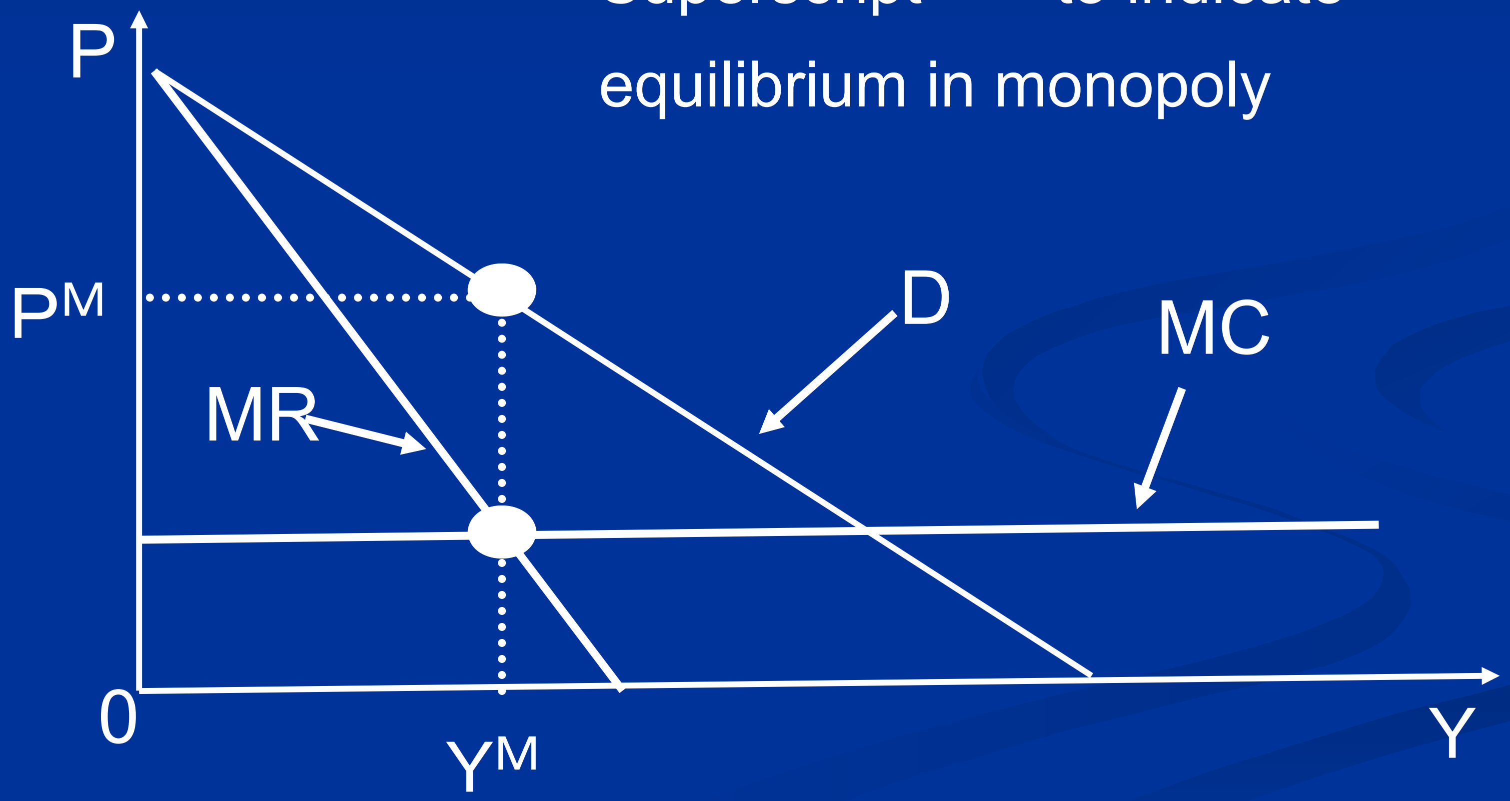
2-6 Contestable Market

2-7 Barriers to entry

2-8 Product differentiation

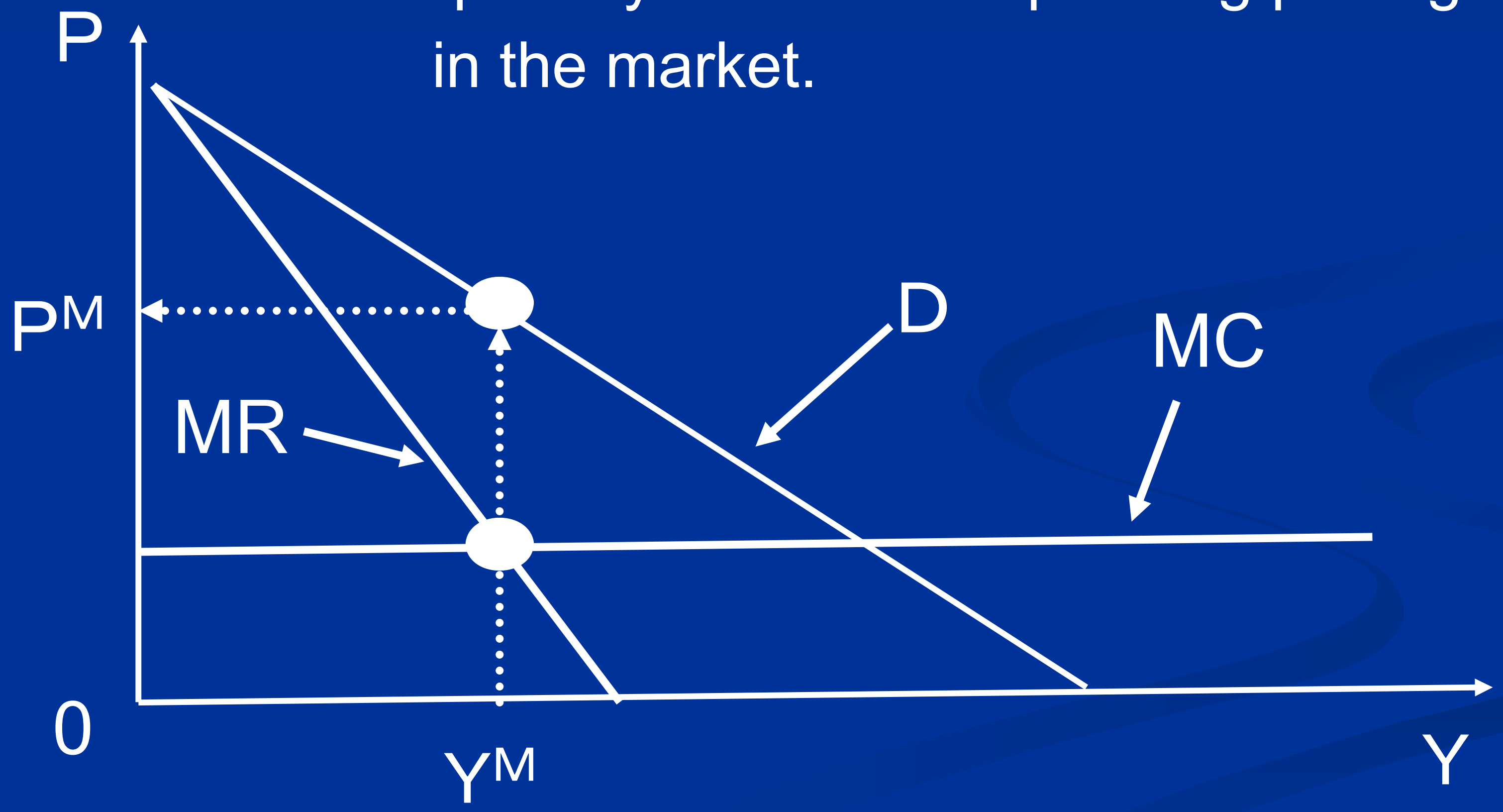
Equilibrium in Seller's Monopoly

Superscript ^{M} to indicate equilibrium in monopoly



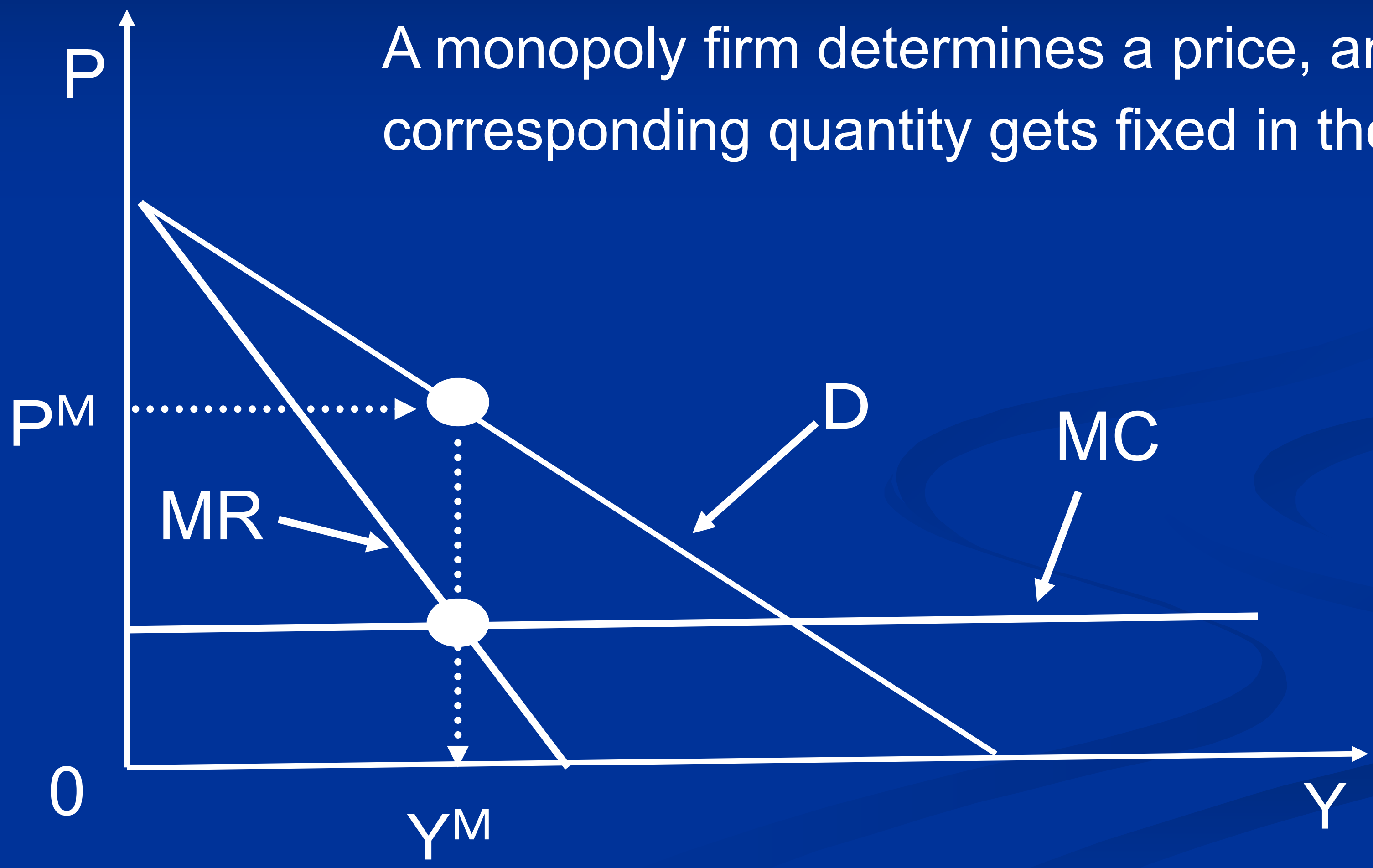
Realm of Marshall-atic Market View

A monopoly firm determines a production quantity and a corresponding price gets fixed in the market.

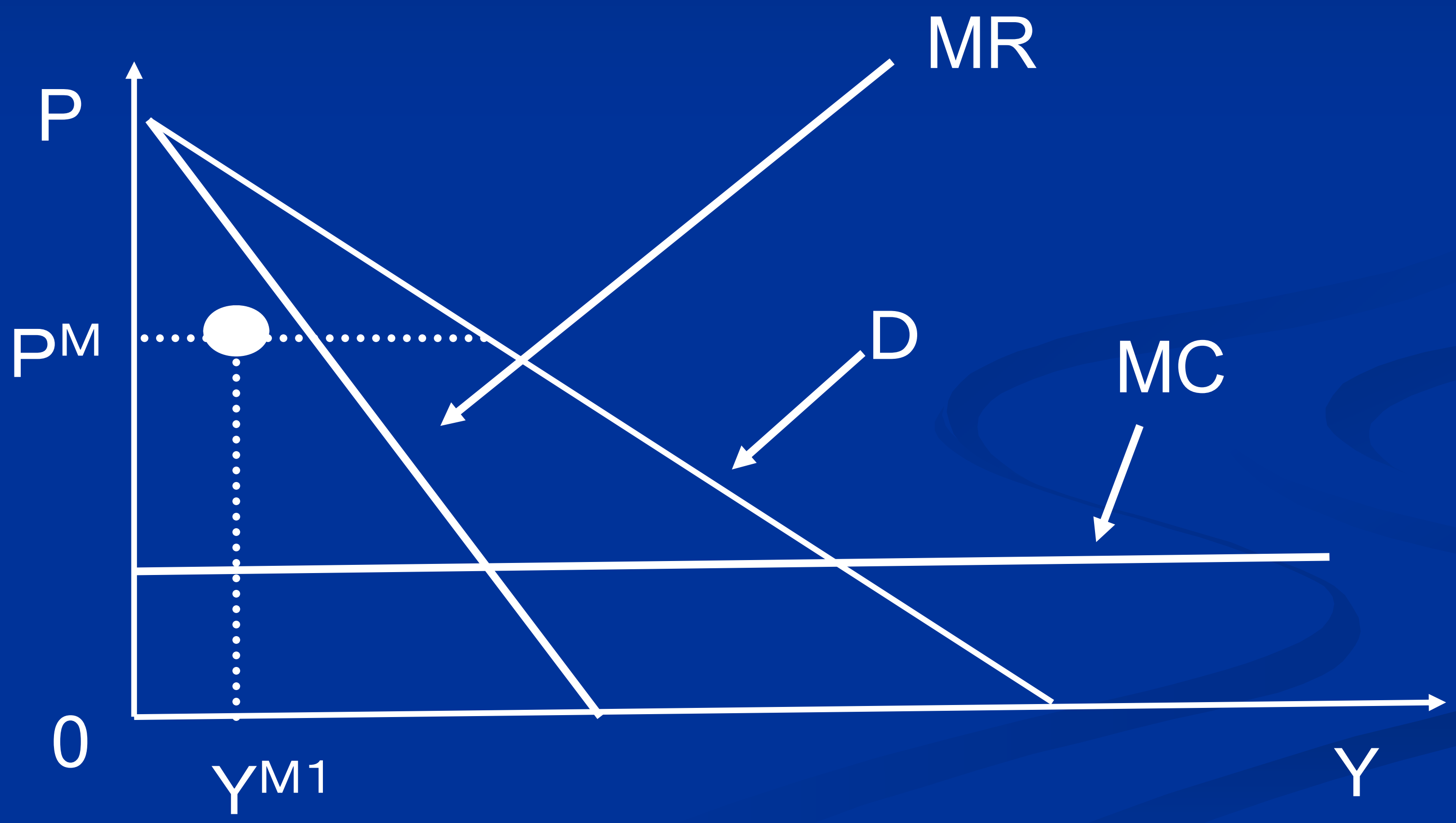


Realm of Walras-atic Market View

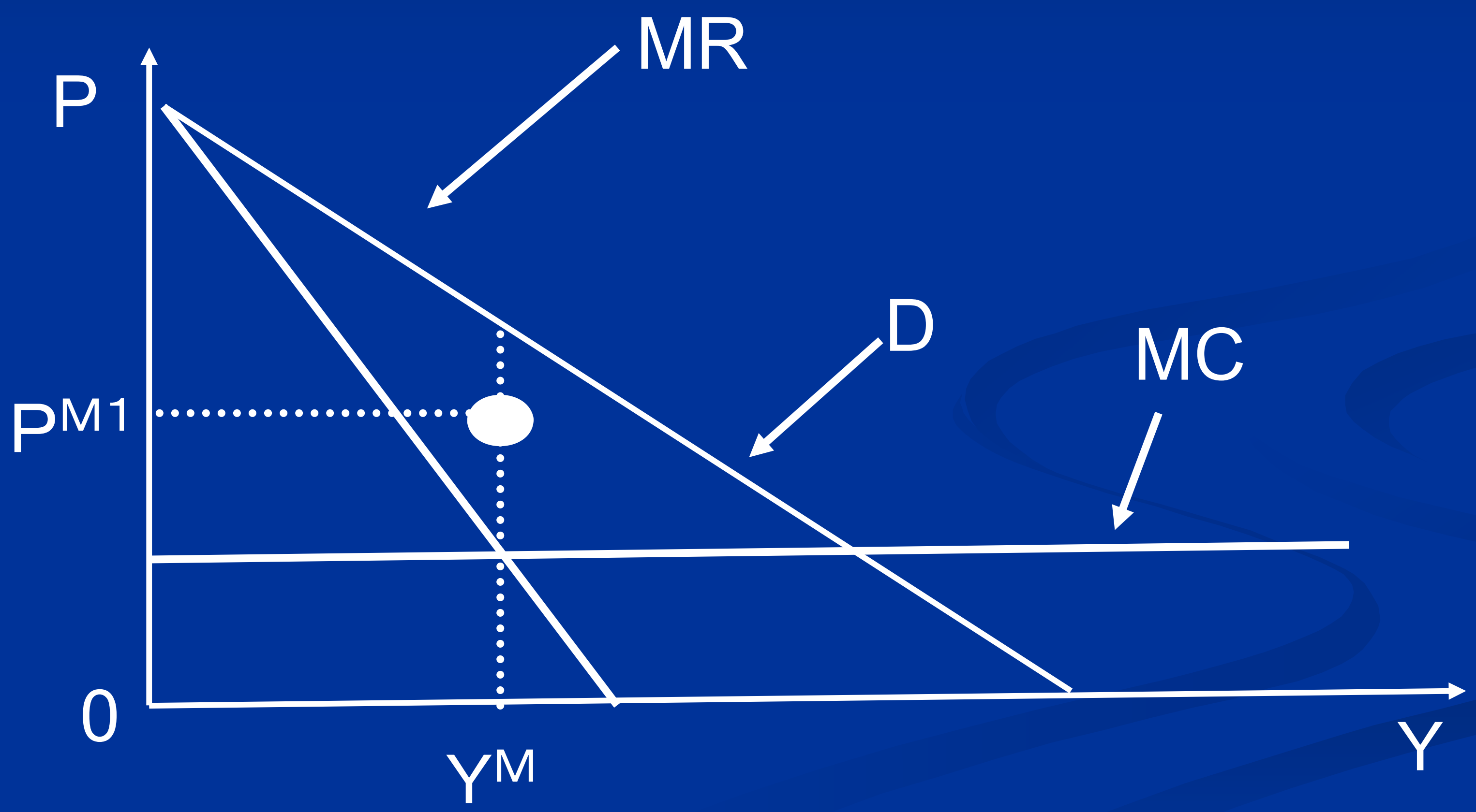
A monopoly firm determines a price, and a corresponding quantity gets fixed in the market.



Fix Quantity and Price Concurrently?



Fix Quantity and Price Concurrently?



Oligopoly

- Number of firms is more than 1.

~ Although one determines its production quantity, the price doesn't get fixed. ← Dependent on rivals' production quantity

~ Although one determines its price, its sales quantity doesn't get fixed. ← Dependent on rivals' pricing

Structure of competition differs depending on which gets fixed; the price or quantity.

⇒Need to differentiate the model; one to fix the price, or one to fix the quantity.

Cournot Duopoly

Firm 1 and Firm 2 compete in a homogeneous goods market.

Firm 1 and Firm 2 determine respective production quantities simultaneously and independently.

Each firm's benefit is own firm's profits.

$\Pi_1 = P(Y)Y_1 - C_1(Y_1)$

Y_i : Firm i's production quantity, $Y \equiv Y_1 + Y_2$,

C : cost function, P : demand function

P is assumed to be reduction function, C increasing function and 凸 convex function. (Same assumptions stay hereafter unless expressly provided.)

Reaction Function

Firm 1's reaction function $R_1(Y_2)$: function to express production quantity that maximizes Firm 1's benefit (profits), given Firm 2's production quantity Y_2.

First-order assumption for maximizing Firm1's profits

$P+P'Y_1 = C_1'$ ⇒to basically compute reaction function out of this equation

Second-order assumption for maximizing Firm 1's profits $2P'+P''Y_1 - C_1'' < 0$

The assumption that Firm 1's profit function is Y_1 and concave function stay hereafter unless expressly provided.

Caution needed when analyzing electric power market as there are fairly complicated problems (file 8)

Cournot Equilibrium

Nash equilibrium in Cournot Model～Cournot equilibrium

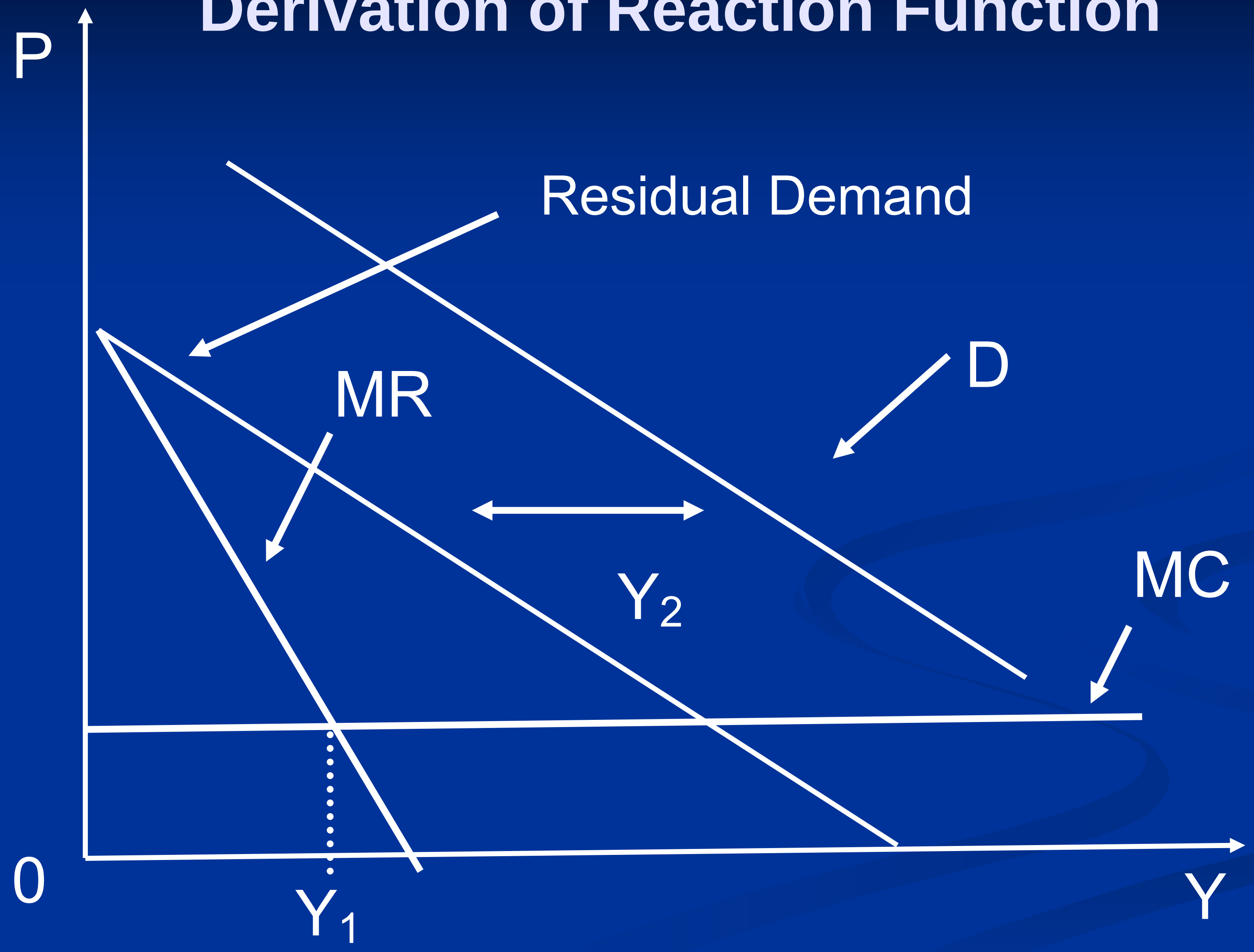
As Cournot formulated the problem/solution first, some call it Cournot-Nash equilibrium.

Derivation of Cournot equilibrium

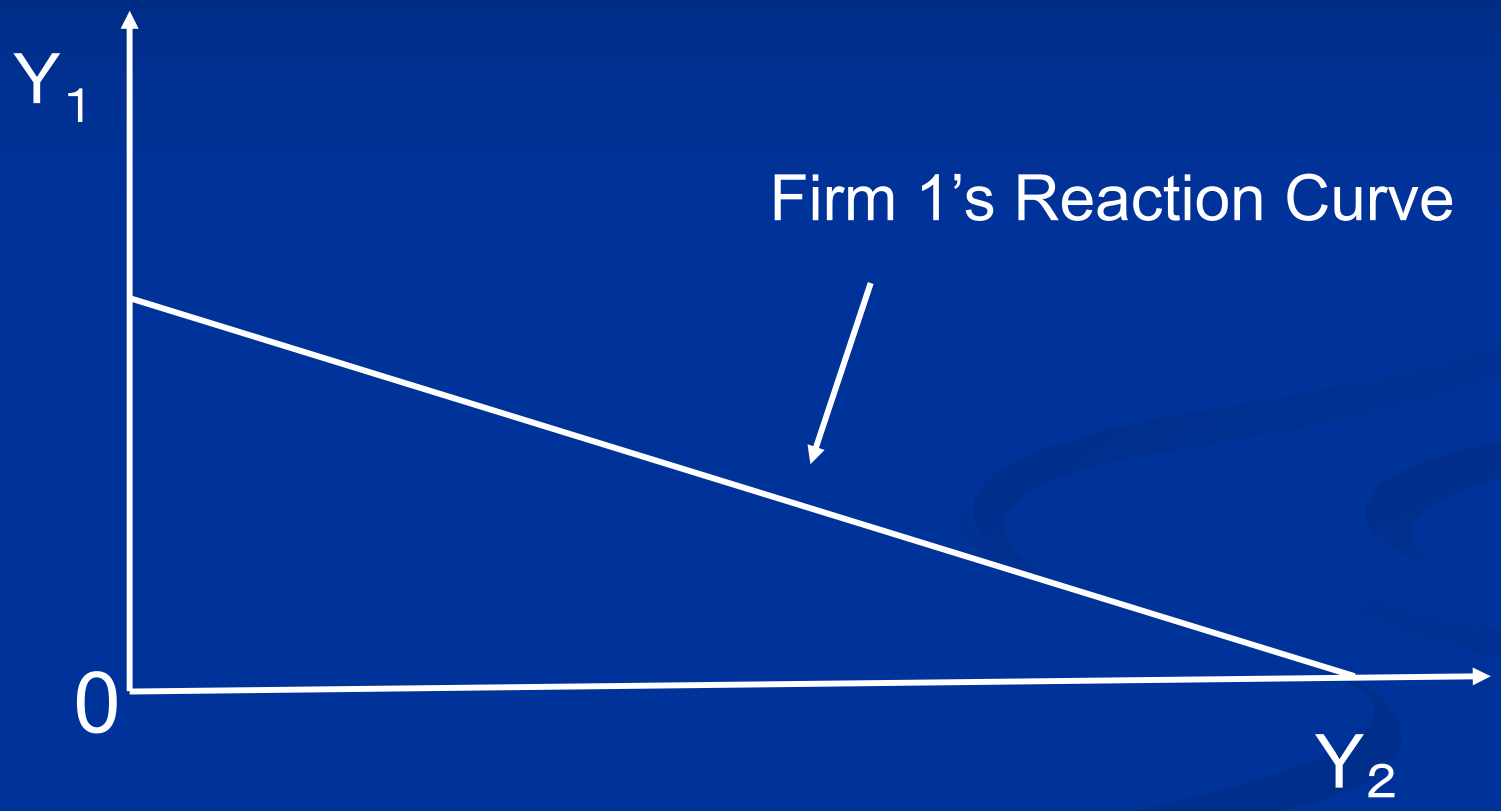
Simply to solve the simultaneous equations of

$P+P'Y_1=C_1'$, $P+P'Y_2=C_2'$

Derivation of Reaction Function



Firm 1's Reaction Curve



Strategic Substitute and Complement

When a rival becomes more offensive (increasing production quantity, reducing price), one's own optimum reaction becomes more offensive.

～Reaction curve to be upward-sloping

→Strategic complement

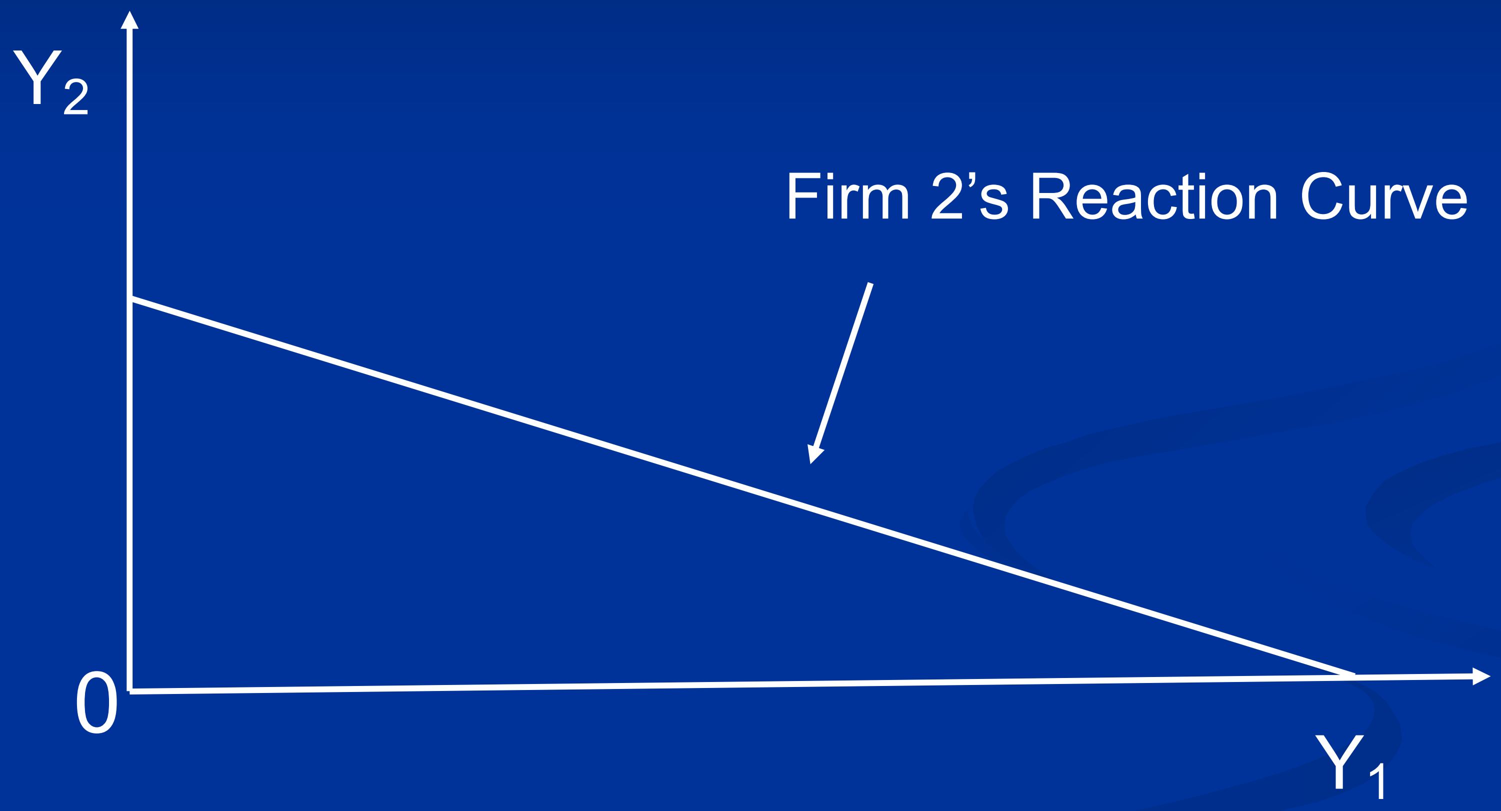
When a rival becomes more offensive (increasing production quantity, reducing price), one's own optimum reaction becomes less offensive.

～Reaction curve to be downward-sloping

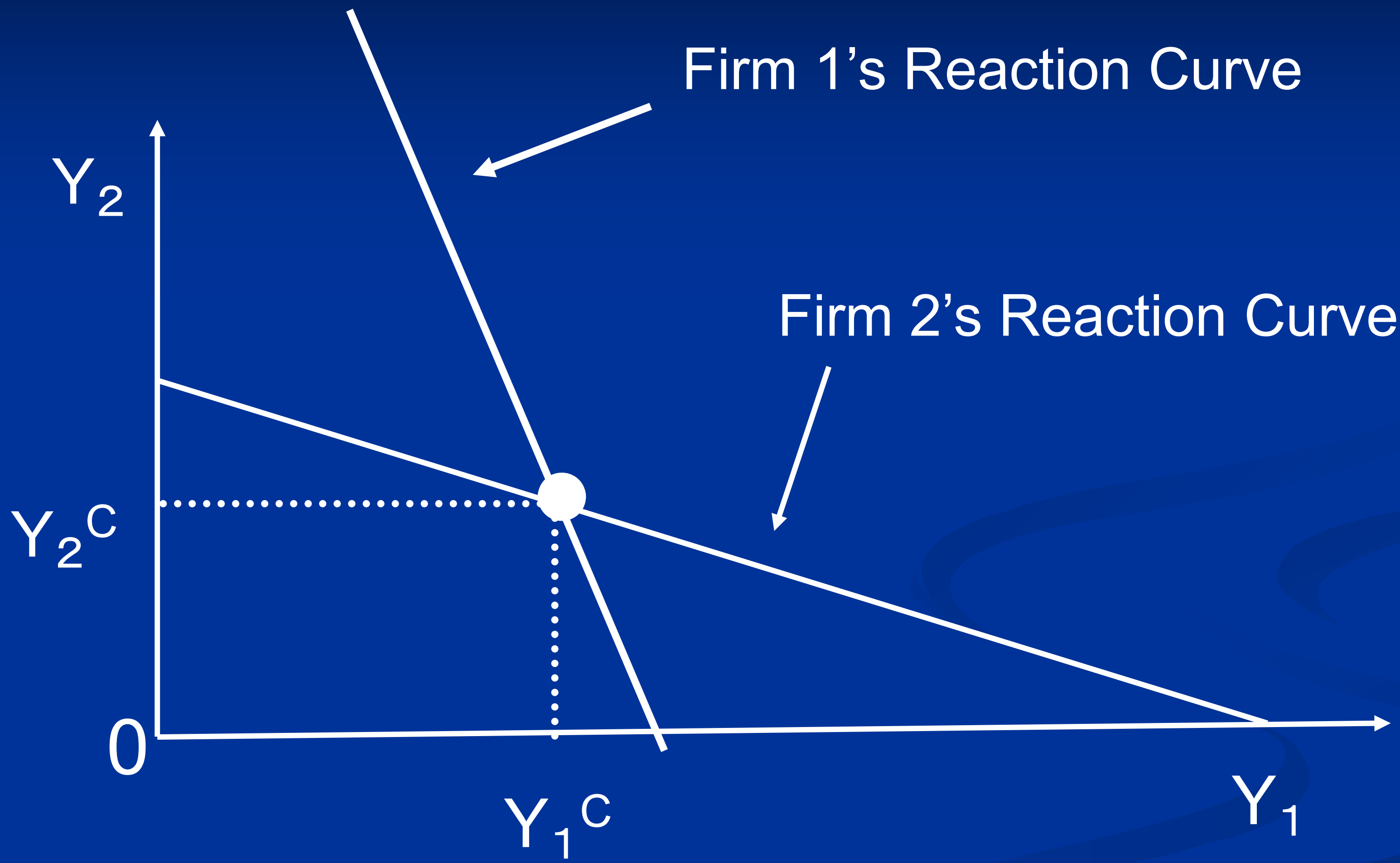
→Strategic substitute

Normally, Cournot competition belongs to this.

Firm 2's Reaction Curve



Cournot Equilibrium



Superscript C indicates Cournot equilibrium.

Cournot Oligopoly

Firm 1, Firm 2 … Firm n compete in a homogeneous goods market

Firm 2 determines its own production quantity simultaneously and independently.

Each firm's benefit is own firm's profits.

Cournot Equilibrium

Derivation of Cournot equilibrium

Simply to solve the simultaneous equations of

$P+P'Y_1 = C_1'$, $P+P'Y_2 = C_2'$,… $P+P'Y_n = C_n'$

If all firms are symmetric, a subject equilibrium can be derived from the simultaneous equations of $P+P'Y_1 = C_1'$、$Y=nY_1$.

Cournot's Limit Theorem

Firm 1's first-order assumption

$P+P'Y_1 = C_1'$

$P(1+P'\ Y/P \cdot Y_1/Y)=C_1'$

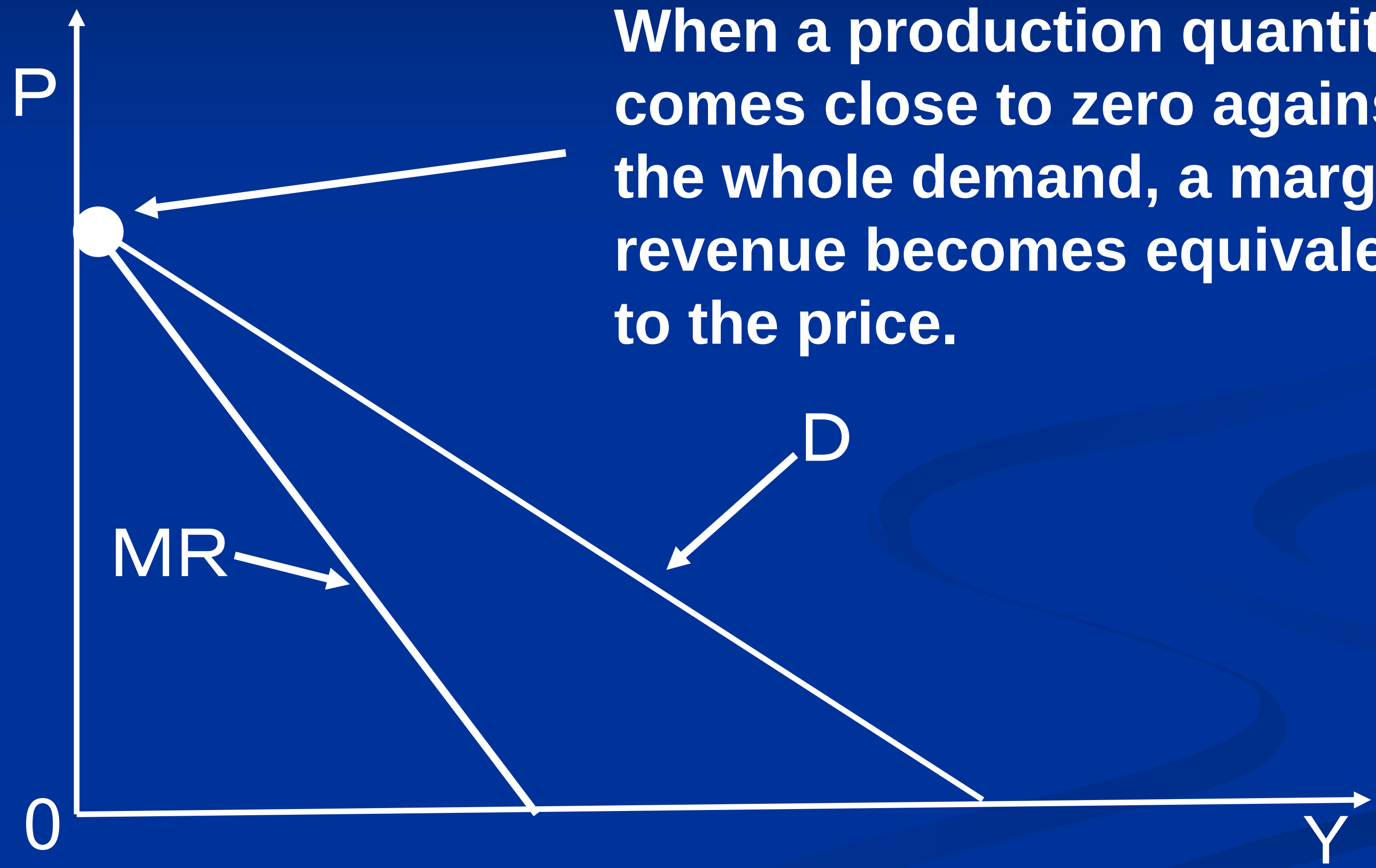
$P(1-\eta^{-1} \cdot Y_1/Y)=C_1'$ (η: price elasticity of demand)

$\eta \to \infty \quad P \to C_1'$ （realm of price taker）

$Y_1/Y \to 0 \quad P \to C_1'$（realm of Cournot's limit theorem）

Cournot's limit theorem: when the number of firms becomes large enough, the price comes close to marginal cost.

Marginal Revenue



When a production quantity comes close to zero against the whole demand, a marginal revenue becomes equivalent to the price.

Perfect Competition

Price taker：one who behaves with a conviction that the price is given.

One who is convinced that even if one increases own production quantity, the price would not change.

In reality, unless price elasticity of demand is infinite, an increase in an amount supplied changes the price. The extent of its change is not affected by the firm’s size.

It is strange to say, “a price take = a business too small to be able to influence the price.” Price changes irrespective of the size of business. ⇒Perfect competition is a fiction.

Cournot's Limit Theorem

Cournot's limit theorem: when the number of firms becomes large enough, the price comes close to marginal cost.

Perfect competition equilibrium ≒ Realm of Cournot's equilibrium where the number of firms is large enough

Perfect competition is an approximation of actuality.

"A firm is small enough. ⇒ Can be approximated as a price taker."

Bertrand Duopoly

Firm 1 and Firm 2 compete in a homogeneous goods market.

Firm 1 and Firm 2 determine respective prices simultaneously and independently.

Each firm's benefit is own firm's profits.

$\Pi_1 = P(Y)Y_1 - C_1 Y_1$ (marginal cost being fixed)

Y_i : Firm i's production quantity, $Y \equiv Y_1 + Y_2$,

C_i : marginal cost, $P(Y)$: inverse demand function, P being reduction function

Bertrand Model (Integer Constraints Version)

Marginal costs of Firm 1 and 2 are integers. ($C_1 \leqq C_2 < P_1^M$)

Respective firms determine their margins simultaneously and independently.

$P_1 \in \{C_1+\varepsilon, C_1+2\varepsilon, C_1+3\varepsilon, \ldots\}$

$P_2 \in \{C_2+\varepsilon, C_2+2\varepsilon, C_2+3\varepsilon, \ldots\}$

Rationing Rule

$P_1 < P_2$ Firm 1 obtains the whole demand.

$P_1 > P_2$ Firm 2 obtains the whole demand.

$P_1 = P_2$ Firm 1 and 2 share the demand fifty-fifty.

Bertrand Duopoly Model (Integer Constraints Version)

Marginal costs of Firm 1 and 2 are integers. ($C_1 \leqq C_2 < P_1^M$)

Firm 1 determines its margin simultaneously and independently.

$P_1 \in \{C_1+\varepsilon, C_1+2\varepsilon, C_1+3\varepsilon,...\}$

$P_2 \in \{C_2+\varepsilon, C_2+2\varepsilon, C_2+3\varepsilon,...\}$

$C_1<C_2$ being assumed. How about the pure strategy Nash equilibrium?

$P_1 = \mathrm{Min}\{C_2, P_1^M\}$ $P_2 = C_2+\varepsilon$

Features of Bertrand Model with Cost Disparity

A firm of the lowest cost monopolizes the market. Its price conforms to the marginal cost of another firm with the second lowest cost.

Cost disparity becomes small.

⇒The gap between the price and marginal cost becomes small.

If there is little difference between these two firms, an equilibrium comes close to the state of perfect competition.

Only with the two firms, conditions are the same as in ones under perfect competition (Bertrand Paradox). ← In actuality, as products are being differentiated, competition does not grow this much acute (or, firms aggressively differentiate themselves trying to avoid this type of competition).

Bertrand Duopoly Model (Integer Constraints Version)

Marginal costs of Firm 1 and 2 are integers. （$C_1 \leqq C_2$）

Firm 1 determines its margin simultaneously and independently.

$P_1 \in \{C_1+\varepsilon, C_1+2\varepsilon, C_1+3\varepsilon, \ldots\}$

$P_2 \in \{C_2+\varepsilon, C_2+2\varepsilon, C_2+3\varepsilon, \ldots\}$

$C_1=C_2$ being assumed. How about the pure strategy Nash equilibrium?

$P_1 = P_2 = C_2+\varepsilon$

Bertrand Paradox presents itself more clearly.

Quantity-setting or Price-setting

Results are largely different between quantity competition model and price competition model.

Which model is more feasible? (or, realistic?)

→Different depending on a market structure

Quantity competition model: a change of the quantity is more difficult than that of the price

（It takes time to change, cost …)

Price competition model: a change of the price is more difficult than that of the quantity.

Common Misunderstanding

Quantity competition model

（１） Market where the price is regulated and competition is focused only on the quantity as in an expansion of outlets ←In Cournot Model, the price gets determined as the result of firms' choice of quantities.

（２） Market where the price is unimportant ← This expression is correct as long as it refers to a market where a choice of the price comes after that of the quantity. In general, it is not right to say that a variable to be determined afterwards is unimportant.

Examples of Inflexibility of Prices

・Mail-order sales by catalogue mailing

Mail order through mailing catalogues 4 times a year. Additional expenses are immense to change prices over and above the quarterly chances.

On the other, additional orders can be flexibly placed to manufacturers when purchase quantities increase.

・While prices are not regulated, there are regulations as to their publications.

（E.g.）the notification system regarding stipulations/charges, obligation on publicizing stipulations

～Any change of a pricing structure takes a great deal of money in its own way.

Examples of Inflexible Quantity Choice

▪Required for a production increase are capital investment and hiring new employees.

On the other, prices per se can be changed in a shorter period than the above.

～Applicable to ordinary manufacturers on the whole

Which may not apply to a situation where a firm has enough production capacity and can easily increase production.

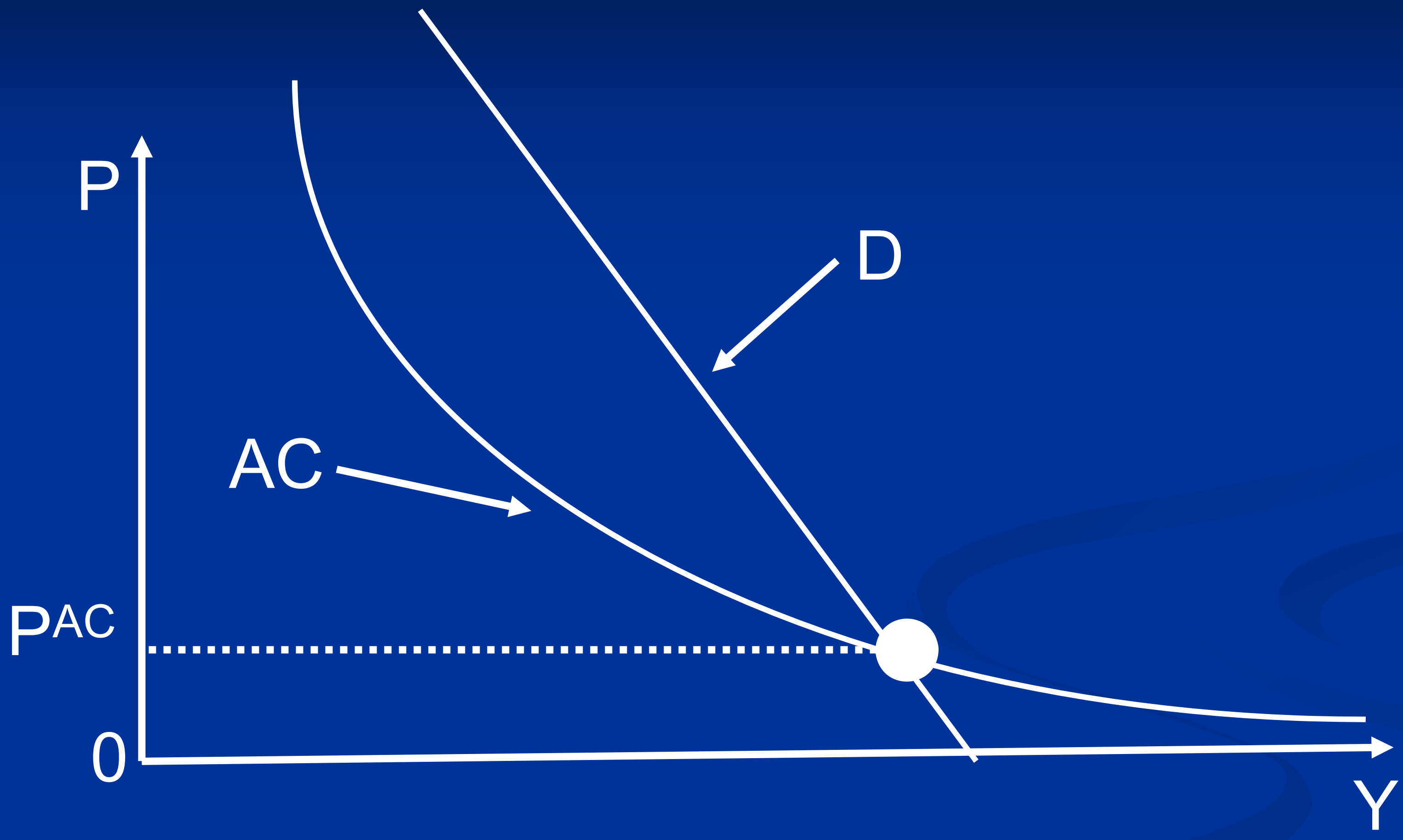
Still there remains a problem as to why the firm has such an idle facility.

Contestable Market Theory

Even if it is monopolistic, when entries and exits are unrestricted, efficient resource allocation can be realized.

→Which, in fact, is just a modern version of Bertrand Model.

Contestable Market



Contestable Market Theory

To set a price higher than P^{AC}

→A rival enters with a price ε lower than that.

→To prevent it, setting P^{AC} price is inevitable.

Refutation of Contestable Market Theory

To set a price higher than P^{AC}

→ A rival enters with a price ε lower than that.

→ To prevent it, setting P^{AC} price is inevitable.

In reality, when a rival enters, an existing firm counters by lowering its price. → The rival can profit only for a short period of time. →Unable to collect sunk costs under normal conditions

Markets Contestable Market Theory is More Likely to Apply to

Markets where price changes are relatively difficult

~ Realm of Bertrand Model (price competition)

Markets where sunk costs are small

Outdated Ideas before Contestable Market Theory

Market structure→ Conduct→ Performance

Market structure: coefficient of market concentration, barriers to entry, product differentiation

Conduct: pricing policy, advertising, R & D, investment policy

Performance: economic efficiency, consumer interests, technology advancement

Significance of Contestable Market Theory

(1) To once again irradiate latent competition with importance

(2) To sound an alarm to the outdated idea of competition/regulation policies that only look at market shares

(3) To clearly indicate an obvious fact that market structure, conduct and performance get decided simultaneously

Limitation of Contestable Market Theory

(1) The theory cannot be unconditionally applied to a market where price competition does not seem authentic. (a market where a price adjustment is easy)

(2) This cannot be utilized against an industry with large sunk costs unless prices are rigid to a great extent.

Entry Regulation

Concern about free entry ~ Grounds for entry regulations

Concept positioned directly opposite to that of contestable market

(1) Threat of entry leads to distortion of resource allocation.

(2) Ones that should not enter get into the action.

(a) Entries of low-quality ones (antiselection)

(b) A firm with high costs goes into an attractive market only, and results in increasing costs of whole society.

(c) Number of firms climbing aboard becomes excessive. (Excess Entry Theorem)

→ To be discussed at length in Regulation of Gas Market (file 9)

Cream-Skimming

To enter into a part of the multiple markets that are mutually-connected

→To lessen efficiency as a whole

Then would it work out to set up an appropriate price difference between the markets; one that is easy to enter and attractive, and the other that is contrary to that?

→With economic efficiency in a range, this alone may not work out well.

Product Differentiation

In the world of reality, it is rare that rivals produce mutually identical goods (homogeneous goods).

Even if Firm 1's price is slightly higher than Firm 2's, it is not that the former's product does not sell at all.

An approach to the analysis of differentiated goods

- To set degree of differentiation as an exogenous variable, and express in demand function
- Differentiation per se is chosen by firms too.

Product Differentiation: Example of Approach to Set Demand Function

Firm 1's demand function $P_1=a-Y_1-bY_2$

Firm 1's demand function $P_2=a-Y_2-bY_1$

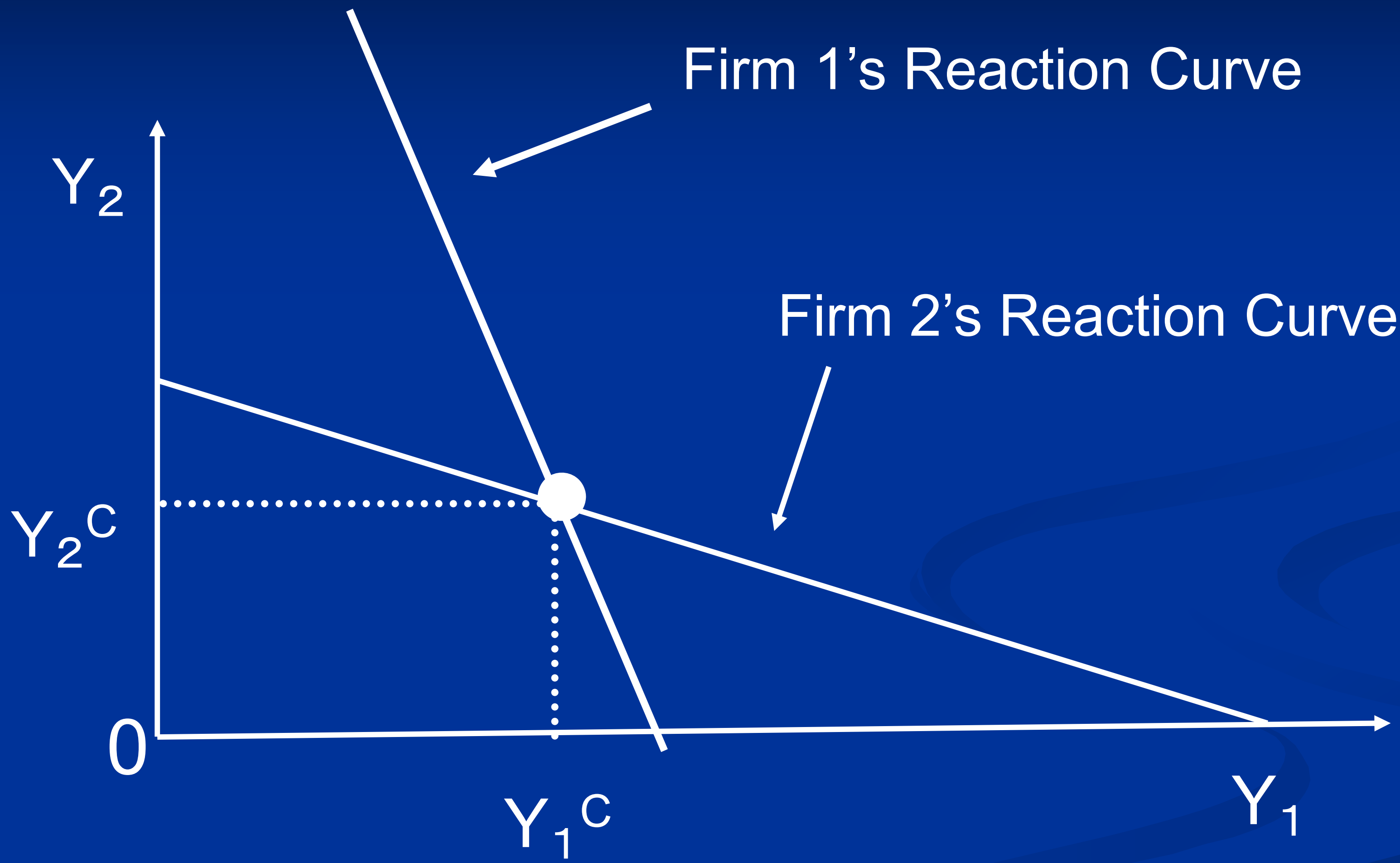
Invariable of $b \in [0,1]$

$b=1$ homogeneous good, $b=0$ no competitive nature

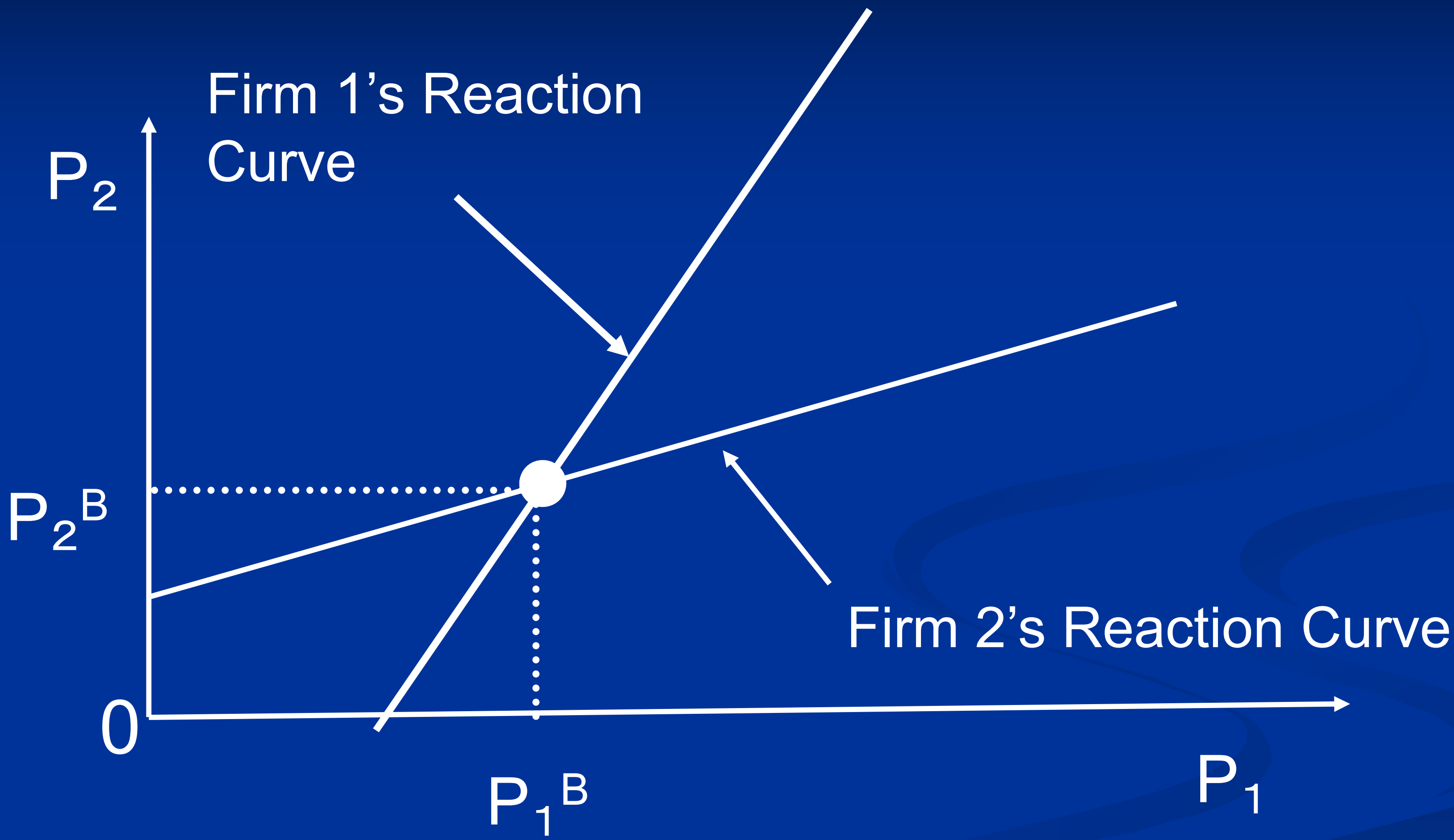
The smaller b is, the greater degree of differentiation is (i.e., less differentiation to mean more competitive, or close to homogeneous goods)

This model is capable to handle both quantity competition and price competition.

Cournot Equilibrium



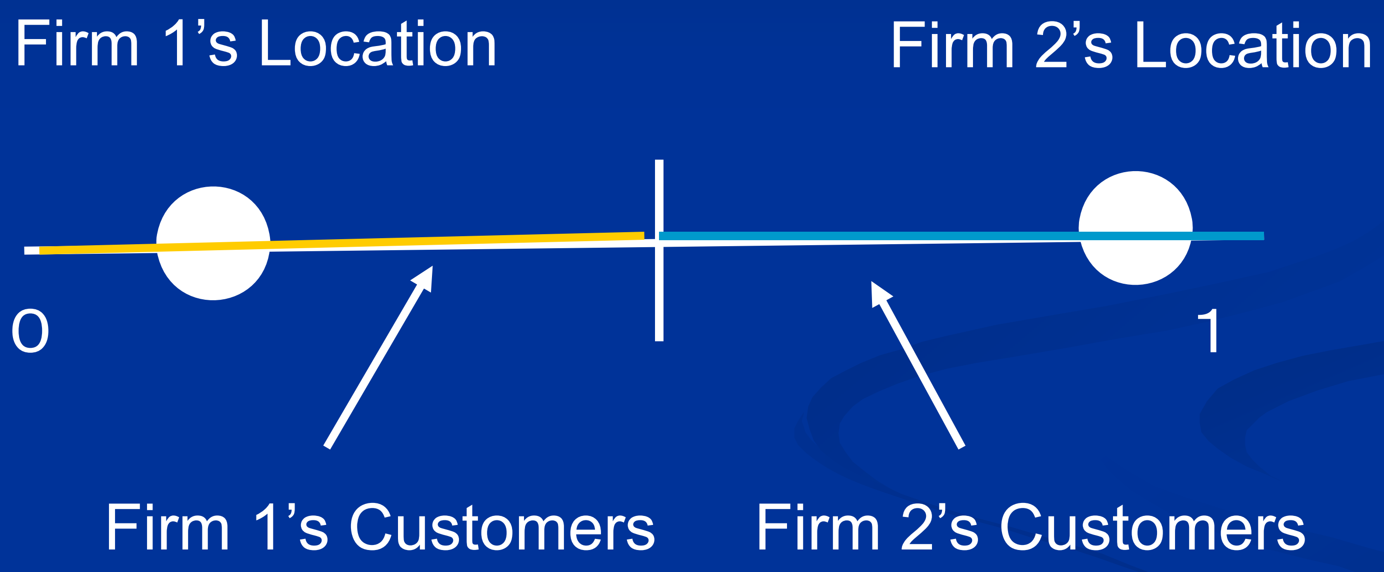
Bertrand Equilibrium



Hotelling

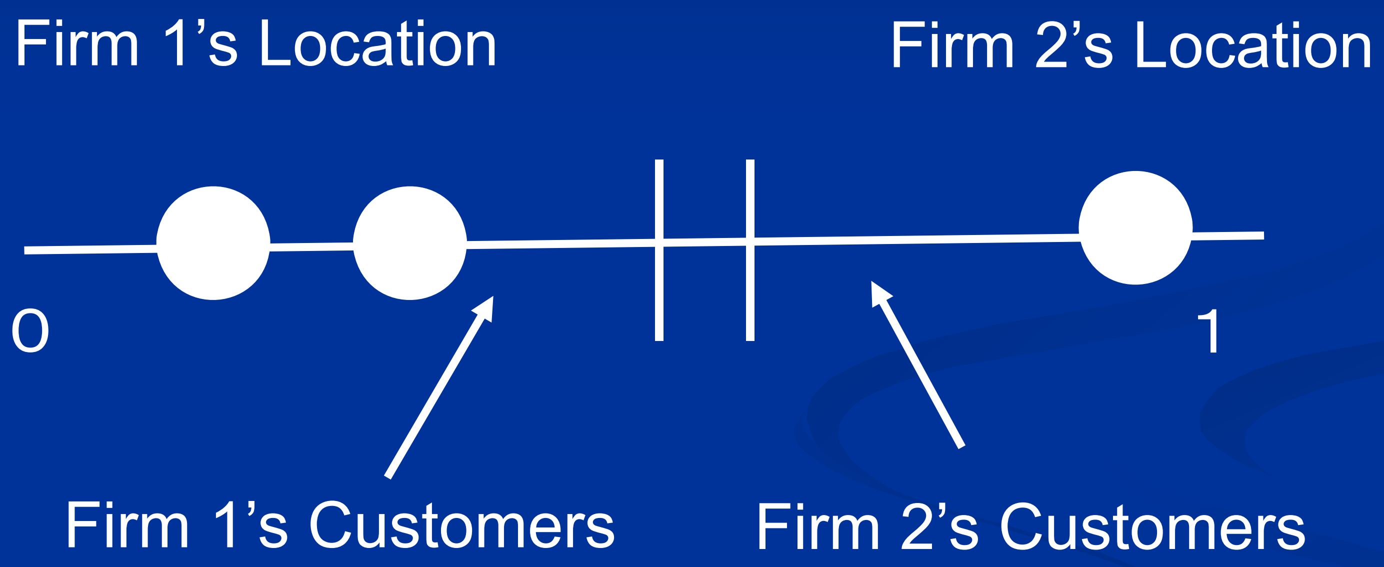
Duopoly Model
Consumers are spread equally along the length of a linear city.
Each consumer makes a purchase of a unit of good from the nearest firm.
Profits of each firm get decided by the number of customers. (Fixed Price model)
Each firm independently chooses own location in a linear city.
~ A typical shopping model

Hotelling



Firm 1's Location
Firm 2's Location
0
1
Firm 1's Customers
Firm 2's Customers

Relocation of Firm 1



As Firm 1 moves toward Firm 2, Firm 1's customers increase.

→It's optimal for Firm 1 to locate itself next to Firm 2.

Equilibrium

Best Response of Firm 1

Firm 2 is located halfway or more.

→Located at Firm 2's neighbor on the left, Firm 1 draws the demand, existing in the left, for Firm 2.

Firm 2 is located halfway or less.

→ Located at Firm 2's neighbor on the right, Firm 1 draws the demand, existing in the right, for Firm 2.

Firm 2's best response is the same.

Equilibrium: the two firms accumulate in halfway.

Interpretation of Linear City

(1) Literal city: spatial interpretation
(2) Product differentiation ～ Horizontal product differentiation
(3) Political footing, preference

An interpretation of an outcome derived from the idea in (3) ~
Under the two-party system, election pledges of both political parties resemble closely.

However, the model is not quite satisfactory in terms of business competition.
~ Because, in practice, consumers act depending not only on business locations but also on prices.

Two-Stage Location, Then Price Model

Duopoly Model

Consumers are spread equally along the length of a linear city. Each consumer makes a purchase of a unit of good from a firm that offers a lower real price (price + travel costs). Travel costs are proportional to the square of the distance.

Profits of each firm get decided by the number of customers * price.

Each firm independently chooses own location in a linear city in the first stage.

Bertrand competition after examining the location in the second stage.

d'Aspremont, Gabszewics, and Thisse, (1979, Econometrica)

Maximal Differentiation

Equilibrium

Each firm gets located on both ends.
→Maximal Differentiation
To avoid price competition

Short distance → Flexible price elasticity of demand
・ Motive for the other to cut prices further
・ Motive for oneself to reduce prices
→To heat up price competition still more through strategic complementarity (the rival's prices to come down)

Question

In this location-price model, what would happen if the prices get regulated and the firms become obliged to sell at such regulated prices?

Question

In this location-price model, what would happen if the maximum prices get regulated?