Chapter 10 (continued)

Pricing with Market Power

Monopolistic Competition

Topics to be Discussed

- Capturing Consumer Surplus
- Price Discrimination
- Intertemporal Price Discrimination and Peak-Load Pricing
- The Two-Part Tariff
- Bundling
- Monopolistic Competition

Introduction

- Pricing without market power (perfect competition) is determined by market supply and demand
- The individual producer must be able to forecast the market and then concentrate on managing production (cost) to maximize profits

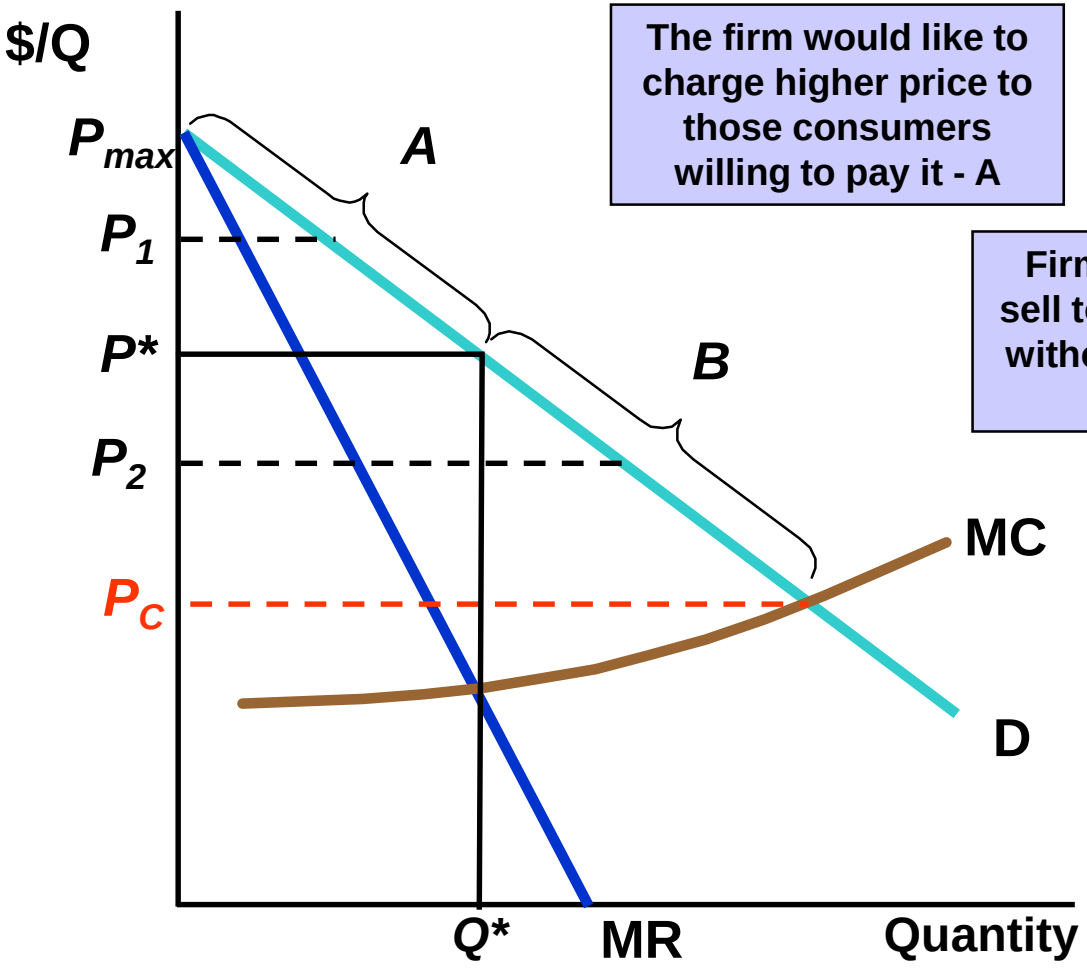
Introduction

- Pricing with market power (imperfect competition) requires the individual producer to know much more about the characteristics of demand as well as manage production
- It also requires the discriminating producer to segment the markets successfully such that no arbitrage across markets occurs

Capturing Consumer Surplus

- All pricing strategies we will examine are means of capturing consumer surplus and transferring it to the producer
- Profit maximizing point of P* and Q*
  - But some consumers will pay more than P* for a good
    - Raising price will lose some consumers, leading to smaller profits
    - Lowering price will gain some consumers, but lower profits

Capturing Consumer Surplus



The firm would like to charge higher price to those consumers willing to pay it - A

Firm would also like to sell to those in area B but without lowering price to all consumers

Both ways will allow the firm to capture more consumer surplus

Capturing Consumer Surplus

- **Price discrimination** is the practice of charging different prices to different consumers for similar goods
  - Must be able to identify the different consumers and get them to pay different prices
- Other techniques that expand the range of a firm's market to get at more consumer surplus
  - Two-Part Tariffs and bundling

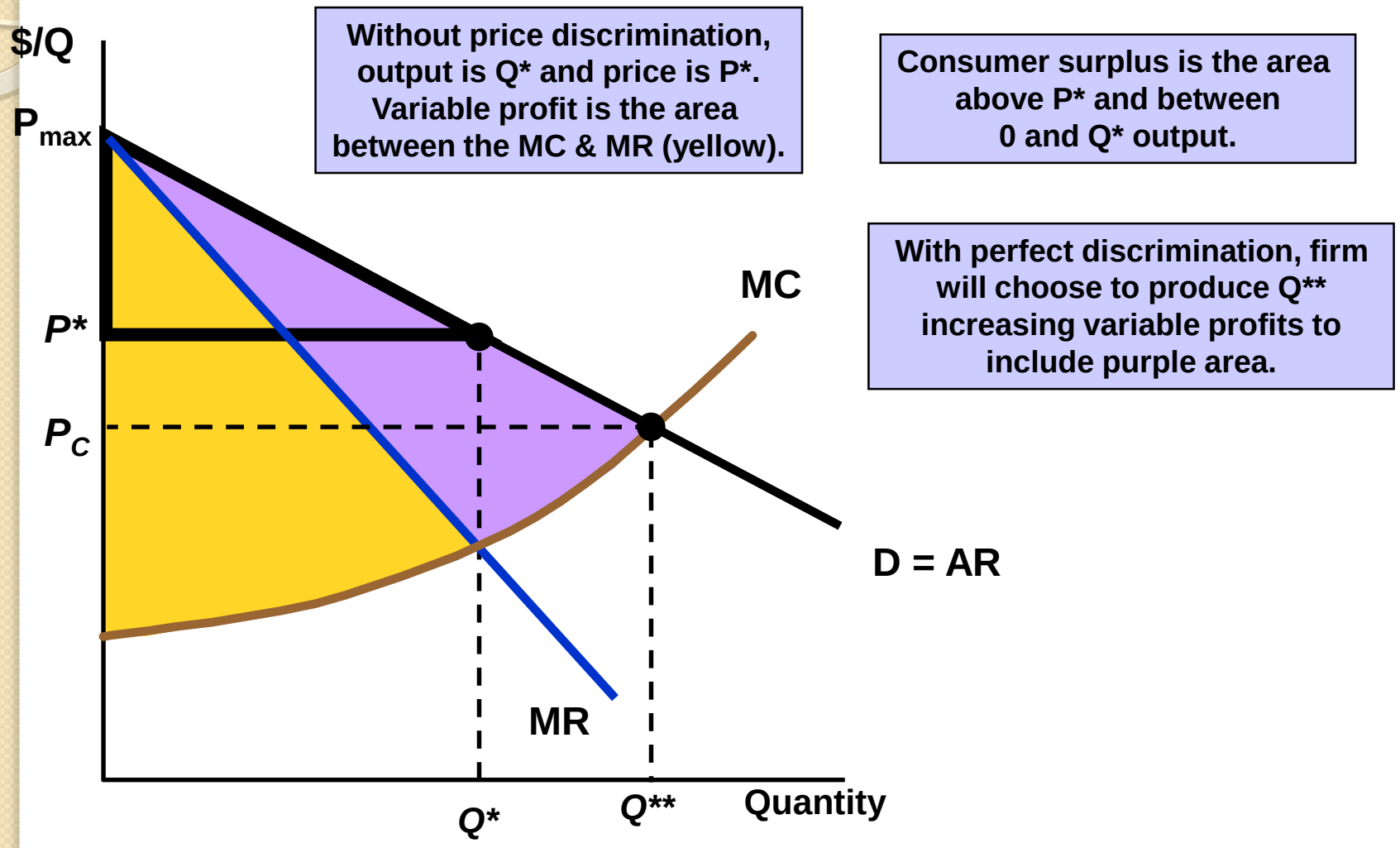
Price Discrimination

- First Degree Price Discrimination
  - Charge a separate price to each customer: the maximum or reservation price they are willing to pay
- How can a firm profit?
  - The firm produces Q* → MR = MC
  - We can see the firm's variable profit – the firm's profit ignoring fixed costs
    - Area between MR and MC
  - Consumer surplus area between demand and price

Price Discrimination

- If the firm can price discriminate perfectly, each consumer is charged exactly what they are willing to pay
  - MR curve is no longer part of output decision
  - Incremental revenue is exactly the price at which each unit is sold – the demand curve
  - *Additional profit from producing and selling an incremental unit is now the difference between demand and marginal cost*

Perfect First-Degree Price Discrimination



Without price discrimination, output is Q* and price is P*. Variable profit is the area between the MC & MR (yellow).

Consumer surplus is the area above P* and between 0 and Q* output.

With perfect discrimination, firm will choose to produce Q** increasing variable profits to include purple area.

First-Degree Price Discrimination

- In practice, perfect price discrimination is almost never possible
  1. Impractical to charge every customer a different price (unless very few customers)
  2. Firms usually do not know reservation price of each customer
- Firms can discriminate imperfectly
  - Can charge a few different prices based on some estimates of reservation prices

First-Degree Price Discrimination

- Examples of imperfect price discrimination where the seller has the ability to segregate the market to some extent and charge different prices for the same product:
  - Lawyers, doctors, accountants
  - Car salesperson (15% profit margin)
  - Colleges and universities (differences in financial aid)

Second-Degree Price Discrimination

- In some markets, consumers purchase many units of a good over time
  - Demand for that good declines with increased consumption
    - Electricity, water, heating fuel
  - Firms can engage in **second-degree price discrimination**
    - Practice of charging different prices per unit for different quantities of the same good or service

Second-Degree Price Discrimination

- Quantity discounts are an example of second-degree price discrimination
  - Ex: Buying in bulk at Sam's Club
- Block pricing – the practice of charging different prices for different quantities of "blocks" of a good
  - Ex: electric power companies charge different prices for a consumer purchasing a set block of electricity

Second-Degree Price Discrimination

- "*What the company is trying to do is prevent the passengers who can pay the second-class fare from travelling third class; it hit the poor not because it wants to hurt them, but to frighten the rich…; Having refused the poor what is necessary, they give the rich what is superfluous*" Emile Dupuit

Airline Fares

- Differences in elasticities imply that some customers will pay a higher fare than others
- Business travelers have few choices and their demand is less elastic
- Casual travelers and families are more price-sensitive and will therefore be choosier

Airline Fares

- There are multiple fares for every route flown by airlines
- They separate the market by setting various restrictions on the tickets
  - Must stay over a Saturday night
  - 21-day advance, 14-day advance
  - Basic restrictions – can change ticket to only certain days
  - Most expensive: no restrictions – first class

Third-Degree Price Discrimination

- Practice of dividing consumers into two or more groups with separate demand curves and charging different prices to each group
  1. Divides the market into two groups
  2. Each group has its own demand function

Third-Degree Price Discrimination

- Same characteristic is used to divide the consumer groups
- Typically, elasticities of demand differ for the groups
  - College students and senior citizens are not usually willing to pay as much as others because of lower incomes
  - These groups are easily distinguishable with ID's

Creating Consumer Groups

- If third-degree price discrimination is feasible, how can the firm decide what to charge each group of consumers?
  1. Total output should be divided between groups so that MR for each group is equal
  2. Total output is chosen so that MR for each group of consumers is equal to the MC of production

Third-Degree Price Discrimination

- Algebraically
  - P_1: price first group
  - P_2: price second group
  - $C(Q_T)$ = total cost of producing output
    $Q_T = Q_1 + Q_2$
  - Profit: $\pi = P_1Q_1 + P_2Q_2 - C(Q_T)$

Third-Degree Price Discrimination

- Firm should increase sales to each group until incremental profit from last unit sold is zero

$$\frac{d\pi}{dQ_1} = \frac{d(P_1(Q_1)Q_1)}{dQ_1} - \frac{dC}{dQ_1} = MR_1 - MC = 0$$

$$\frac{d\pi}{dQ_2} = \frac{d(P_2(Q_2)Q_2)}{dQ_2} - \frac{dC}{dQ_2} = MR_2 - MC = 0$$

$$MR_1 = MR_2 = MC$$

Third-Degree Price Discrimination

- Determining relative prices
  - Thinking of relative prices that should be charged to each group of consumers and relating them to price elasticities of demand may be easier

Recall: $MR = P\left(1+1/E_d\right)$

Then: $MR_1 = P_1(1+1/E_1) = MR_2 = P_2(1+1/E_2)$

E_1 *and* E_2 *elasticities of demand for each group*

Third-Degree Price Discrimination

- Determining relative prices
  - Equating MR_1 and MR_2 gives the following relationship that must hold for prices
  - The higher price will be charged to consumer with the lower demand elasticity

$$\frac{P_1}{P_2} = \frac{(1+1/E_2)}{(1+1/E_1)} = \frac{1-\frac{1}{|E_2|}}{1-\frac{1}{|E_1|}}$$

$$P_1 > P_2 \Leftrightarrow |E_2| > |E_1|$$

Third-Degree Price Discrimination

- Example
  - E_1 = -2 and E_2 = -4
  - P_1 should be 1.5 times as high as P_2

$$\frac{\boldsymbol{P}_1}{\boldsymbol{P}_2} = \frac{(1-1/4)}{(1-1/2)} = \frac{3/4}{1/2} = 1.5$$

The Economics of Coupons and Rebates

- Those consumers who are more price elastic will tend to use the coupon/rebate more often when they purchase the product than those consumers with a less elastic demand
- Coupons and rebate programs allow firms to price discriminate

The Economics of Coupons and Rebates

- About 20 – 30% of consumers use coupons or rebates
- Firms can get those with higher elasticities of demand to purchase the good who would not normally buy it

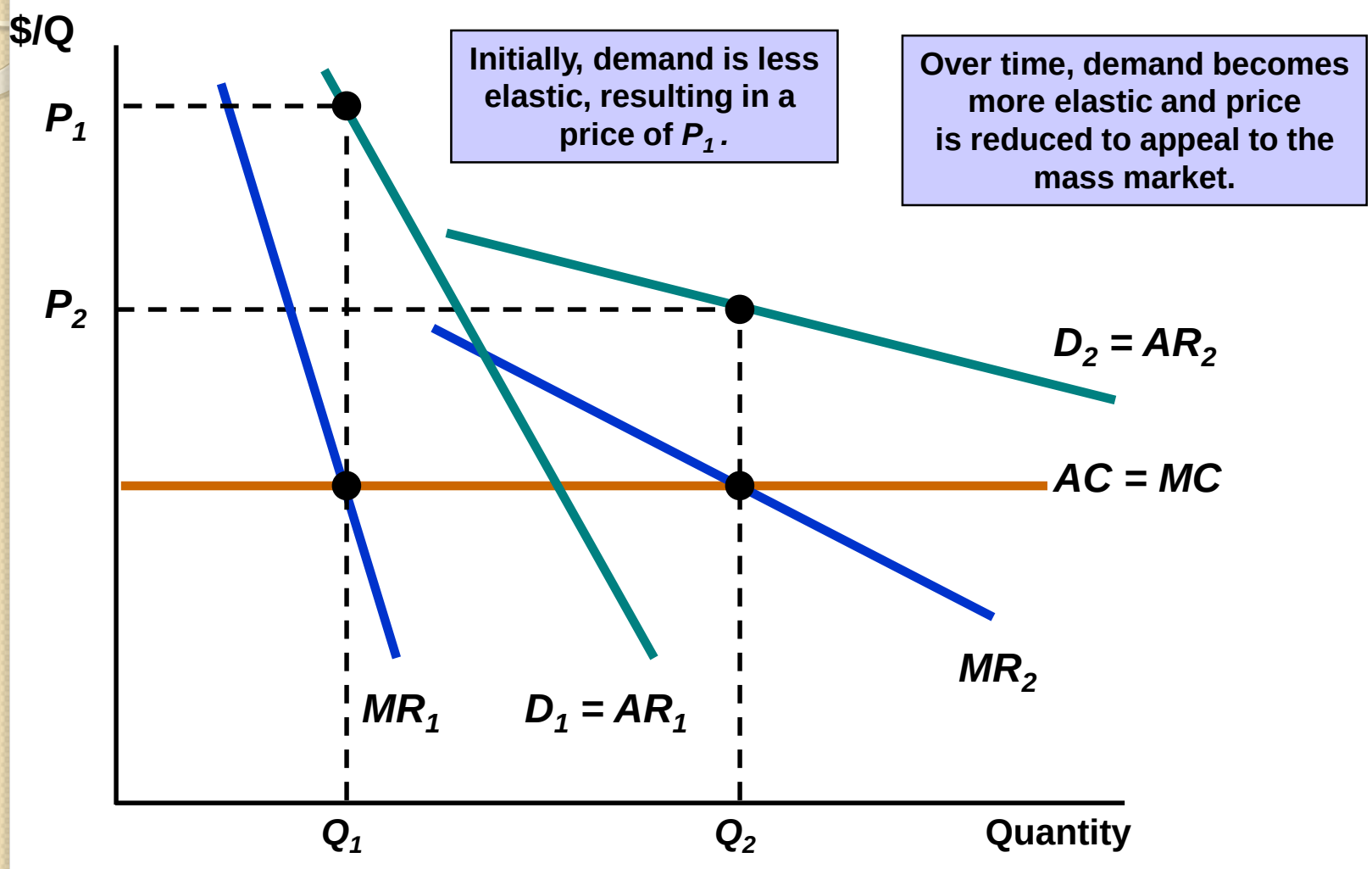
Other Types of Price Discrimination

- Intertemporal Price Discrimination
  - Practice of separating consumers with different demand functions into different groups by charging different prices at different points in time
  - Initial release of a product, the demand is inelastic
    - Hard back vs. paperback book
    - New release movie
    - Electronic products
    - Selling apartments in the reverse order of quality

Intertemporal Price Discrimination

- Once this market has yielded a maximum profit, firms lower the price to appeal to a general market with a more elastic demand
- This can be seen graphically looking at two different groups of consumers – one willing to buy right now and one willing to wait

Intertemporal Price Discrimination



Peak-Load Pricing

- Practice of charging higher prices during peak periods when capacity constraints cause marginal costs to be higher
- Demand for some products may peak at particular times
  - Rush hour traffic
  - Electricity - late summer afternoons
  - Ski resorts on weekends

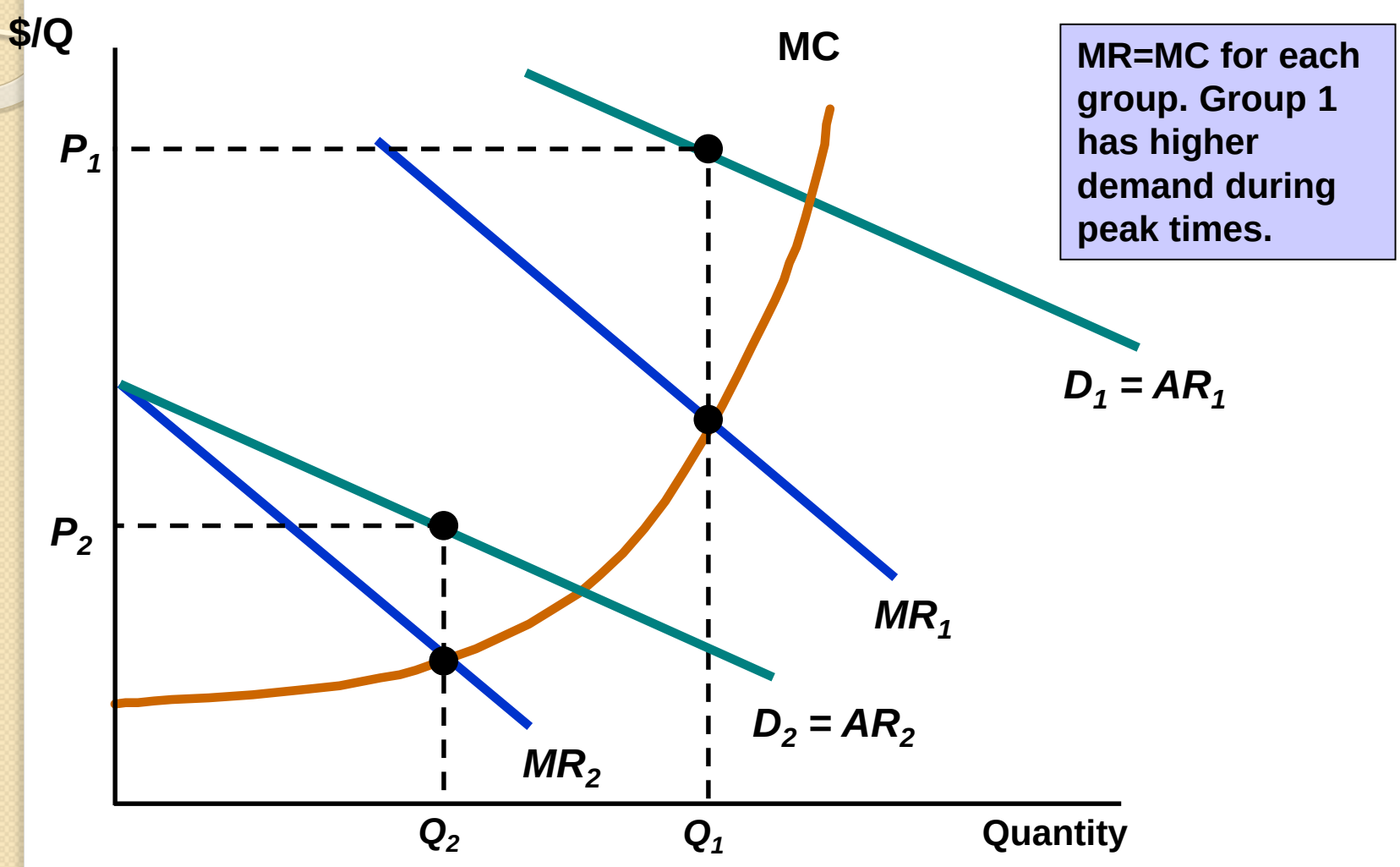
Peak-Load Pricing

- Objective is to increase efficiency by charging customers close to marginal cost
  - Increased MR and MC would indicate a higher price
  - Total surplus is higher because charging close to MC
  - Can measure efficiency gain from peak-load pricing

Peak-Load Pricing

- With third-degree price discrimination, the MR for all markets was equal
- MR is not equal for each market because one market does not impact the other market with peak-load pricing
  - Price and sales in each market are independent
  - Ex: electricity, movie theaters

Peak-Load Pricing



MR=MC for each group. Group 1 has higher demand during peak times.

The Two-Part Tariff

- Form of pricing in which consumers are charged both an entry and usage fee
  - Ex: amusement park, golf course, telephone service
- A fee is charged upfront for right to use/buy the product
- An additional fee is charged for each unit the consumer wishes to consume
  - Pay a fee to play golf and then pay another fee for each game you play

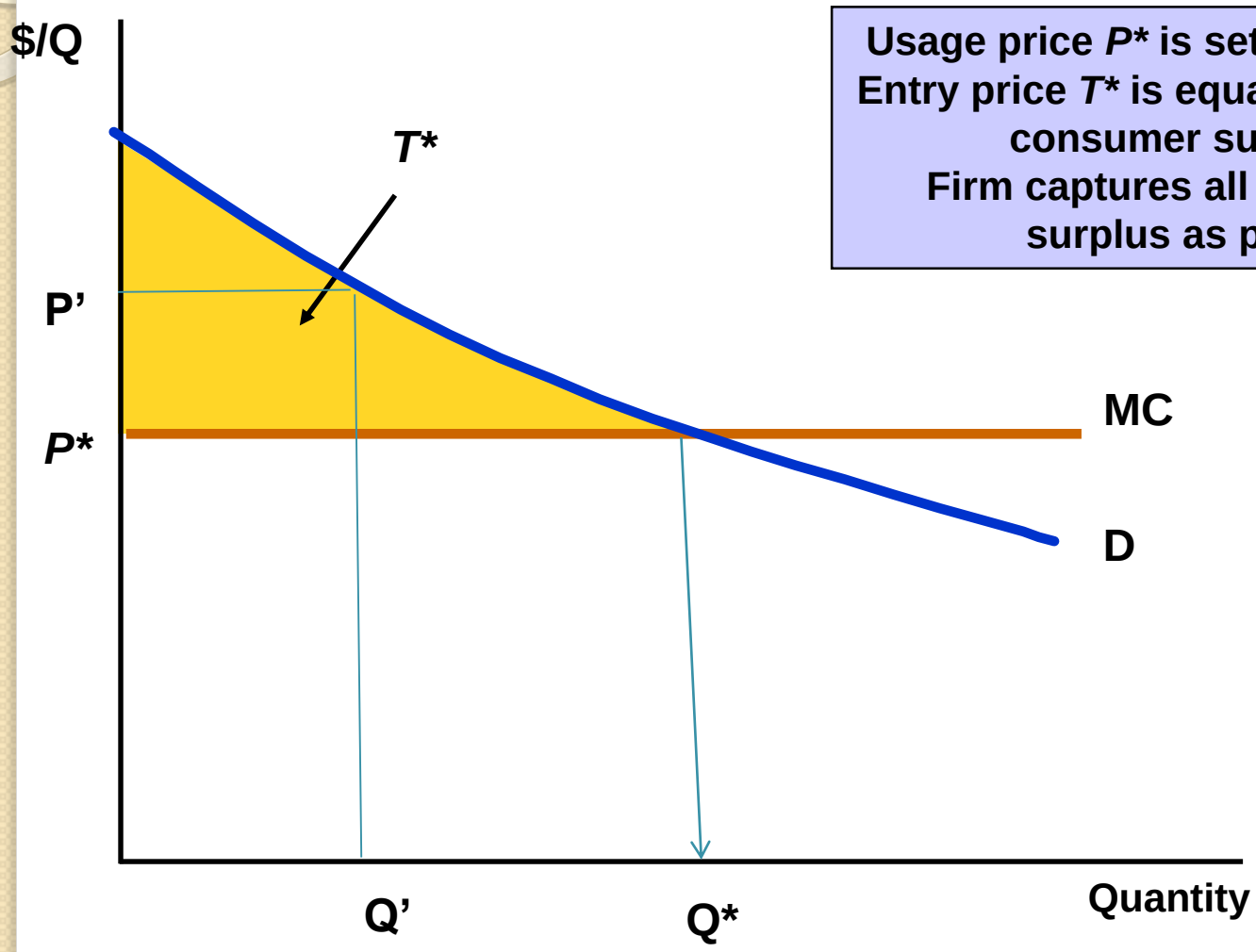
The Two-Part Tariff

- Pricing decision is setting the entry fee (T) and the usage fee (P)
- Choosing the trade-off between free-entry and high-use prices or high-entry and zero-use prices
- Single Consumer
  - Assume firm knows consumer demand
  - Firm wants to capture as much consumer surplus as possible

Disneyland Dilemma

- How set entrance fee and marginal price? For an amusement park like Disneyland?
- Assumptions:
  - There is only one kind of ride in Disneyland
  - People only desire to go to Disneyland for the rides
  - Everyone has the same taste for the rides or there is only one single consumer

Two-Part Tariff with a Single Consumer

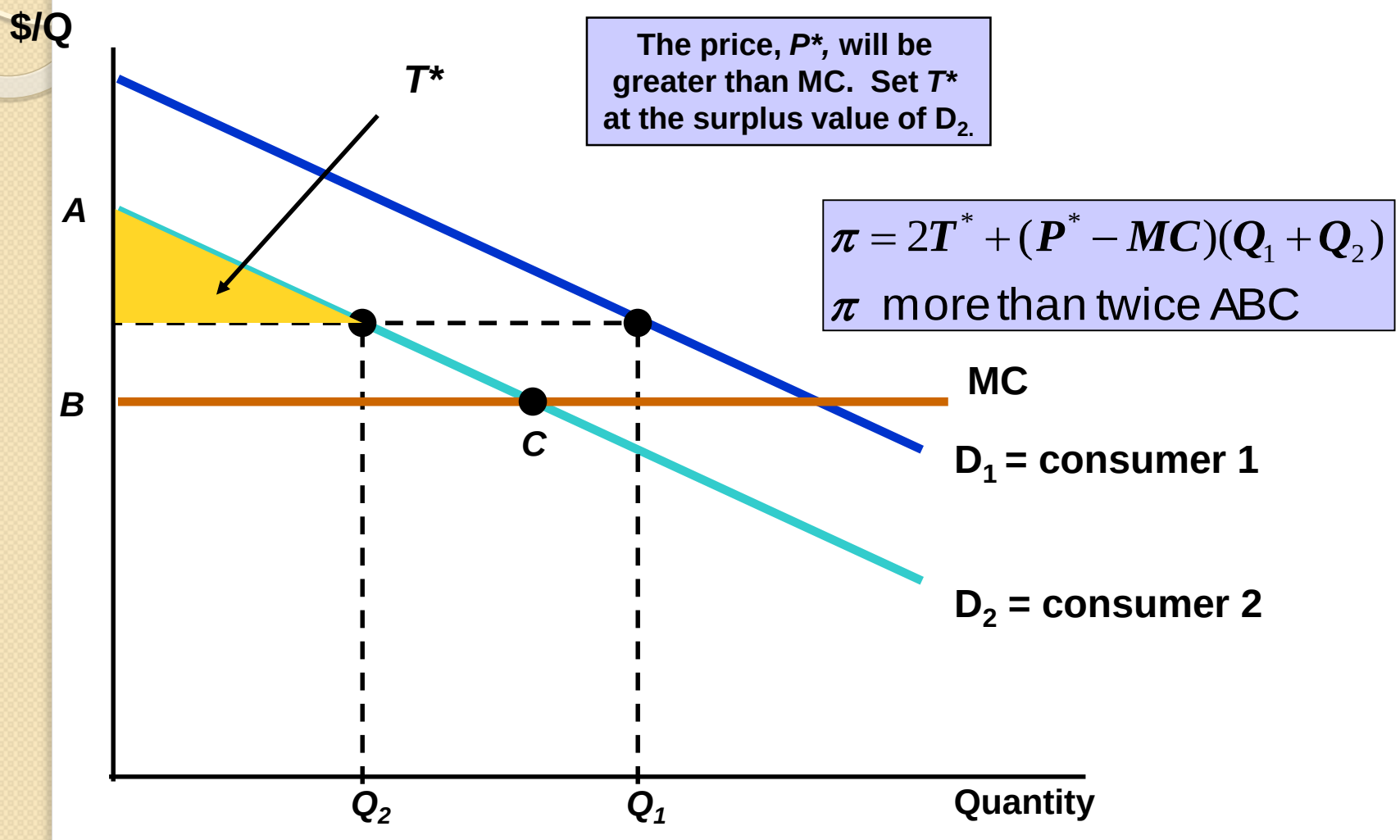


Usage price *P is set equal to MC. Entry price *T** is equal to the entire consumer surplus. Firm captures all consumer surplus as profit.**

Two-Part Tariff with Two Consumers

- Two kinds of consumers, but firm can only set one entry fee and one usage fee
- Will no longer set usage fee equal to MC
  - Could make entry fee no larger than CS of consumer with smallest demand
- Firm should set usage fee *above* MC
- Set entry fee equal to remaining consumer surplus of consumer with smaller demand
- Firm needs to know demand curves

Two-Part Tariff with Two Consumers



Bundling

- Bundling is packaging two or more products to gain a pricing advantage
- Conditions necessary for bundling
  - Heterogeneous customers
  - Price discrimination is not possible
  - Demands must be negatively correlated

Bundling

- When film company leased "Gone with the Wind," it required theaters to also lease "Getting Gertie's Garter"
- Why would a company do this?
  - Company must be able to increase revenue
  - We can see the reservation prices for each theater and movie

Bundling

	Gone with the Wind	Getting Gertie's Garter
Theater *A*	**$12,000**	**$3,000**
Theater *B*	**$10,000**	**$4,000**

- Renting the movies separately would result in each theater paying the lowest reservation price for each movie:
  - Maximum price Wind = $10,000
  - Maximum price Gertie = $3,000
- Total Revenue = $26,000

Bundling

- If the movies are bundled:
  - Theater A will pay $15,000 for both
  - Theater B will pay $14,000 for both
- If each were charged the lower of the two prices, total revenue will be $28,000
- The movie company will gain more revenue ($2000) by bundling the movie

Relative Valuations

- More profitable to bundle because relative valuation of two films are reversed
- Demands are negatively correlated
  - A pays more for Wind ($12,000) than B ($10,000)
  - B pays more for Gertie ($4,000) than A ($3,000)

Relative Valuations

- If the demands were positively correlated (Theater A would pay more for both films as shown) bundling would not result in an increase in revenue

	Gone with the Wind	Getting Gertie's Garter
Theater *A*	$12,000	$4,000
Theater *B*	$10,000	$3,000

Bundling

- If the movies are bundled:
  - Theater A will pay $16,000 for both
  - Theater B will pay $13,000 for both
- If each were charged the lower of the two prices, total revenue will be $26,000, the same as by selling the films separately

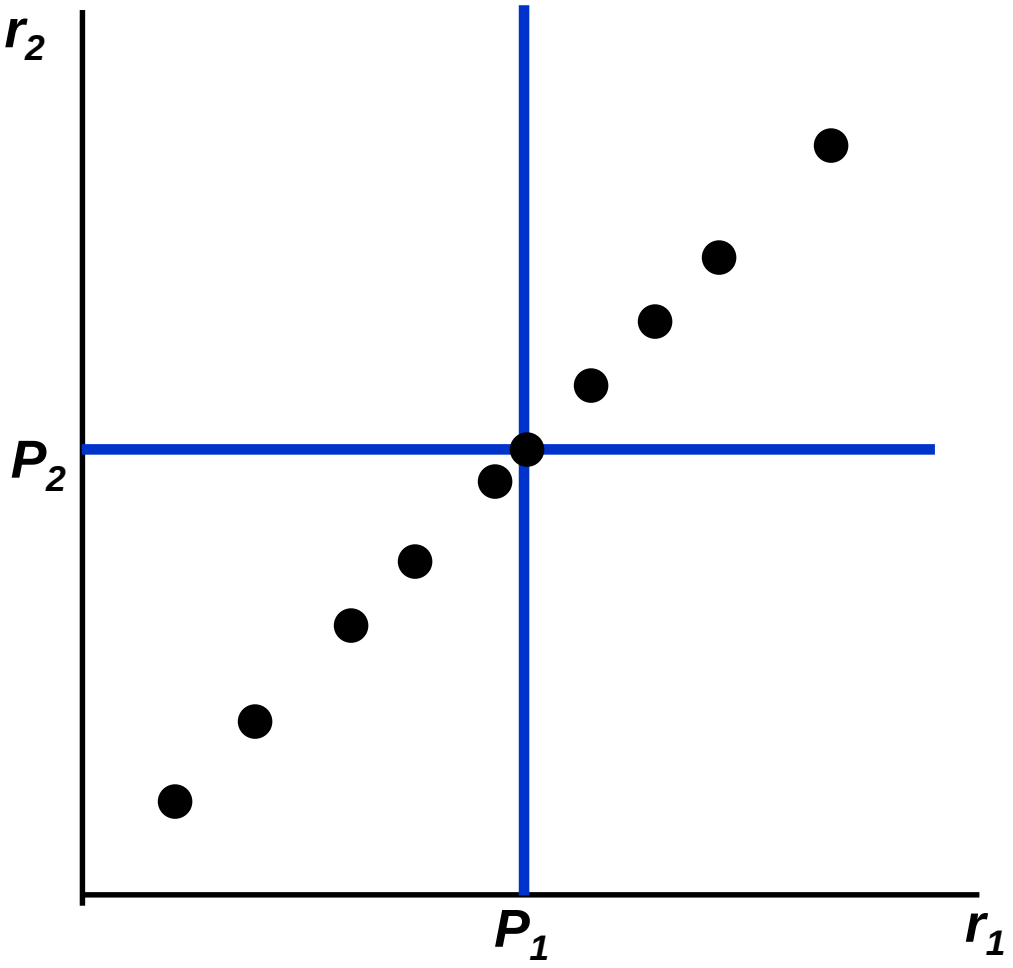
Bundling

- Bundling Scenario: Two different goods and many consumers
  - Many consumers with different reservation price combinations for two goods
  - Can show graphically the preferences of consumers in terms of reservation prices and consumption decisions given prices charged
  - r_1 is reservation price of consumer for good 1
  - r_2 is reservation price of consumer for good 2

Consumption Decisions When Products are Bundled

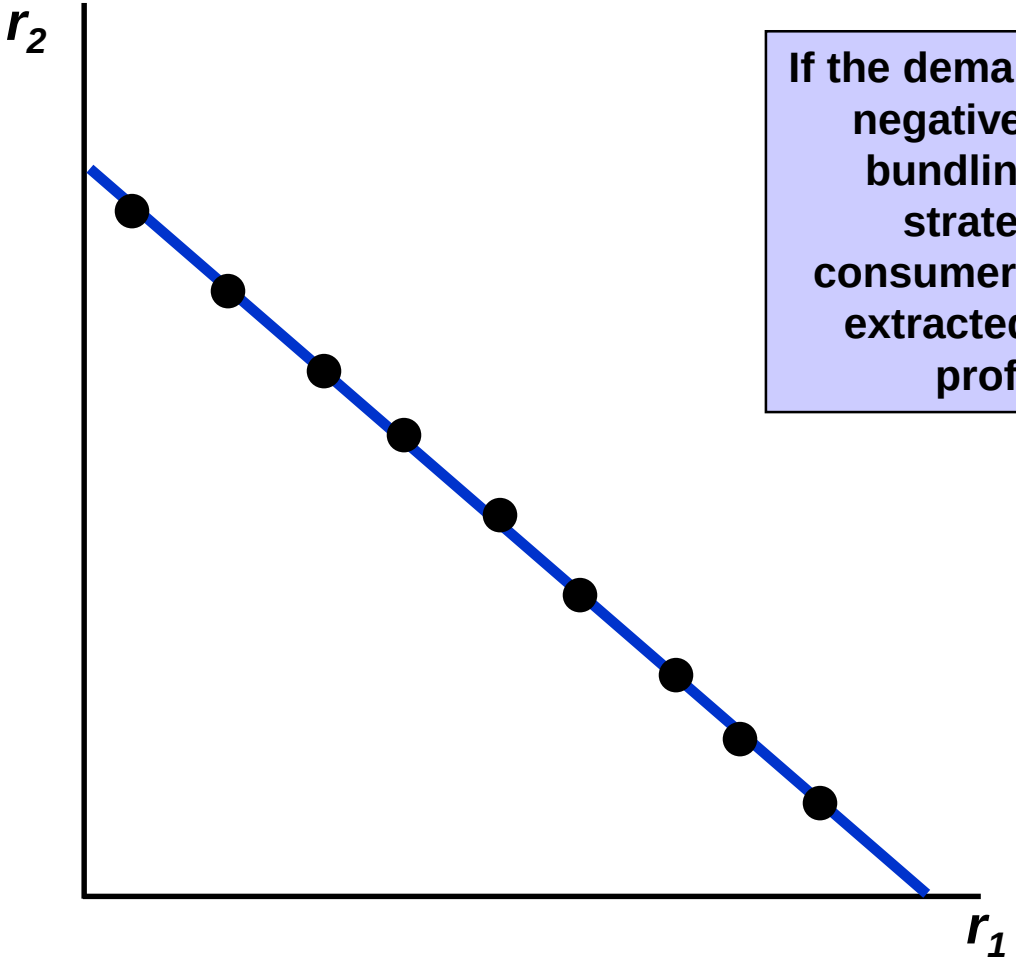
- The effectiveness of bundling depends upon the degree of negative correlation between the two demands
  - Best when consumers who have high reservation price for Good 1 have a low reservation price for Good 2 and vice versa
  - Can see graphically looking at positively and negatively correlated prices

Reservation Prices



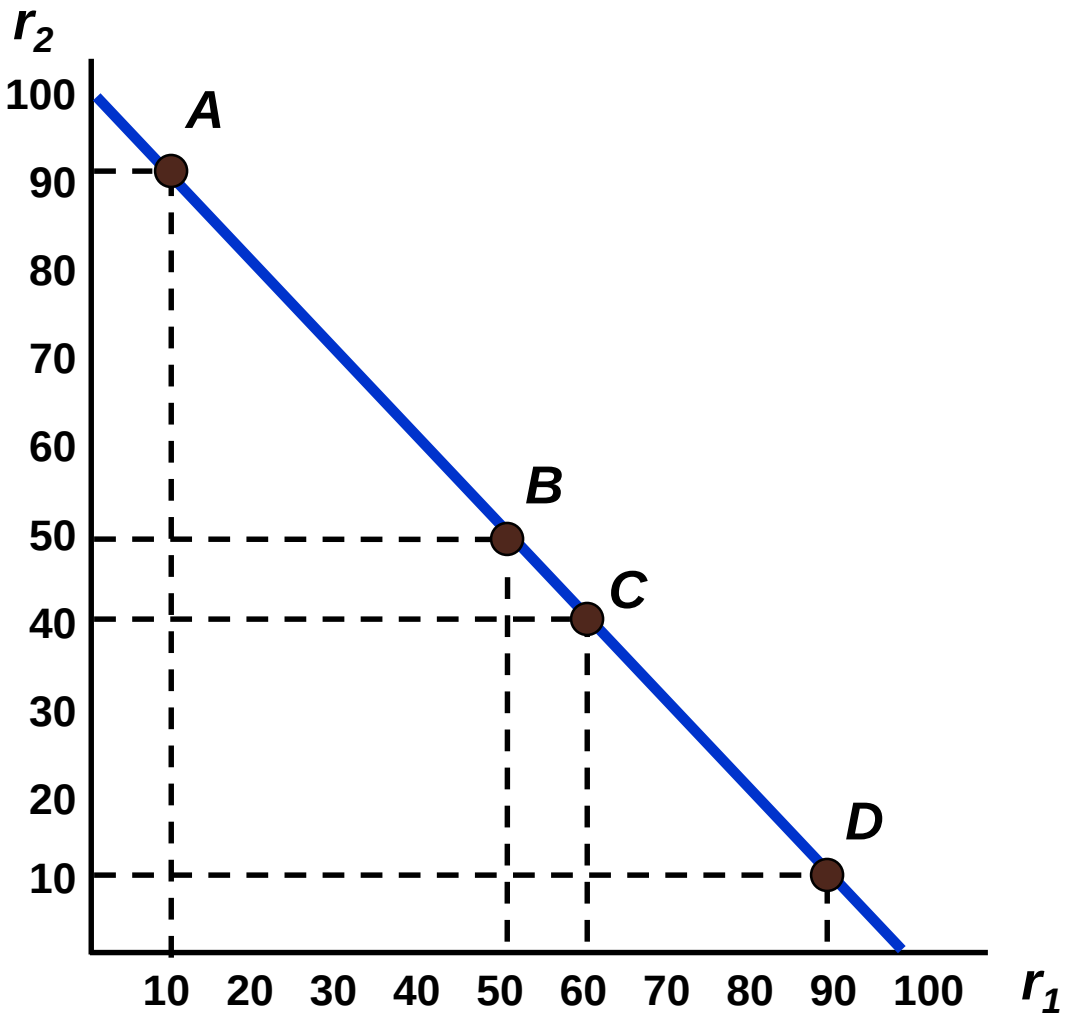
If the demands are perfectly positively correlated, the firm will not gain by bundling. It would earn the same profit by selling the goods separately.

Reservation Prices



If the demands are perfectly negatively correlated, bundling is the ideal strategy – all the consumer surplus can be extracted and a higher profit results.

Bundling


r_2
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100
r_1

Monopolistic Competition

- Characteristics
  1. Many firms
  2. Free entry and exit
  3. Differentiated products

Monopolistic Competition

- The amount of monopoly power depends on the degree of differentiation
- Examples of this very common market structure include:
  - Toothpaste
  - Soap
  - Cold remedies

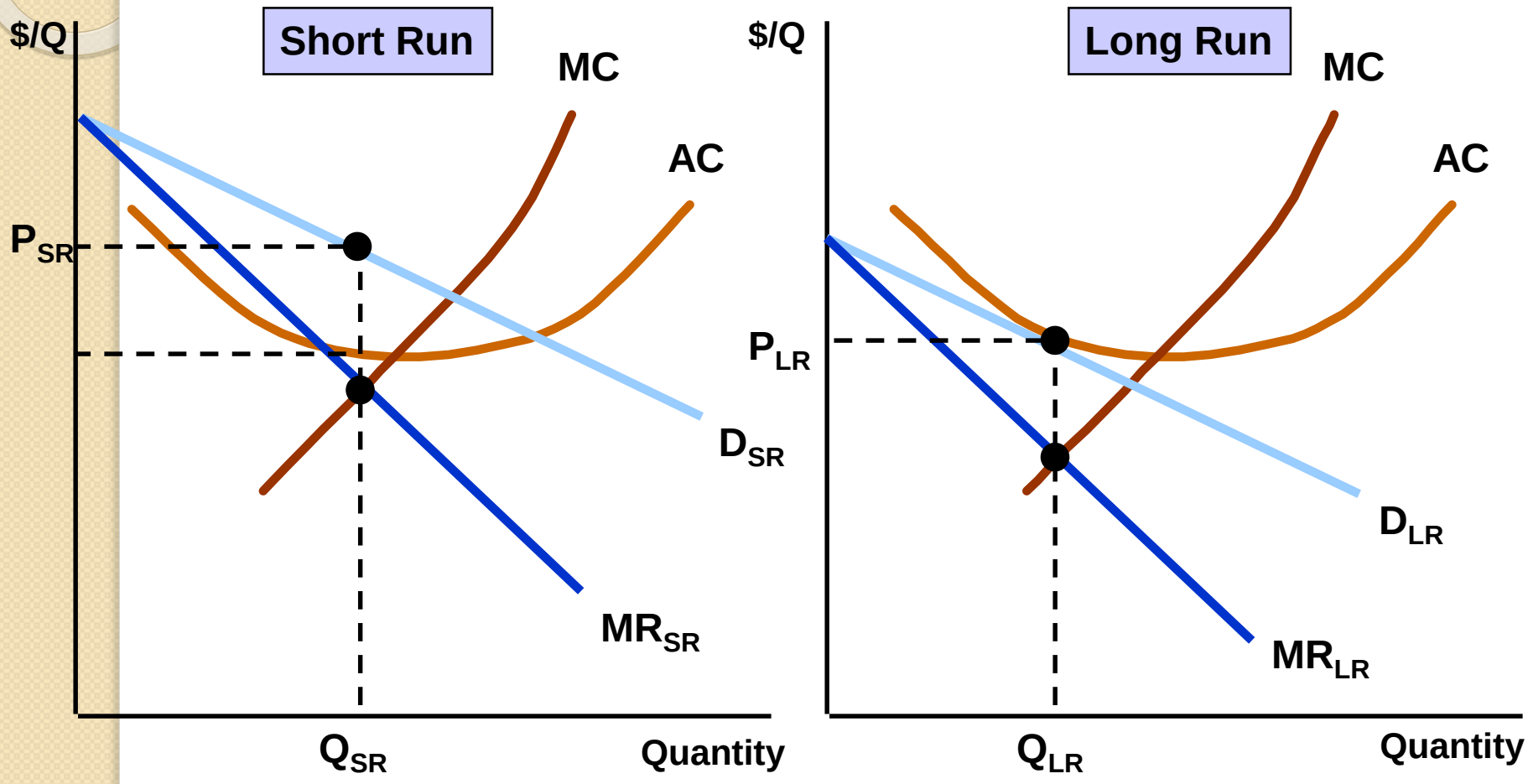
Monopolistic Competition

- Toothpaste
  - Crest and monopoly power
    - Procter & Gamble is the sole producer of Crest
    - Consumers can have a preference for Crest – taste, reputation, decay-preventing efficacy
    - The greater the preference (differentiation) the higher the price

Monopolistic Competition

- Two important characteristics
  - Differentiated but highly substitutable products
  - Free entry and exit

A Monopolistically Competitive Firm in the Short and Long Run



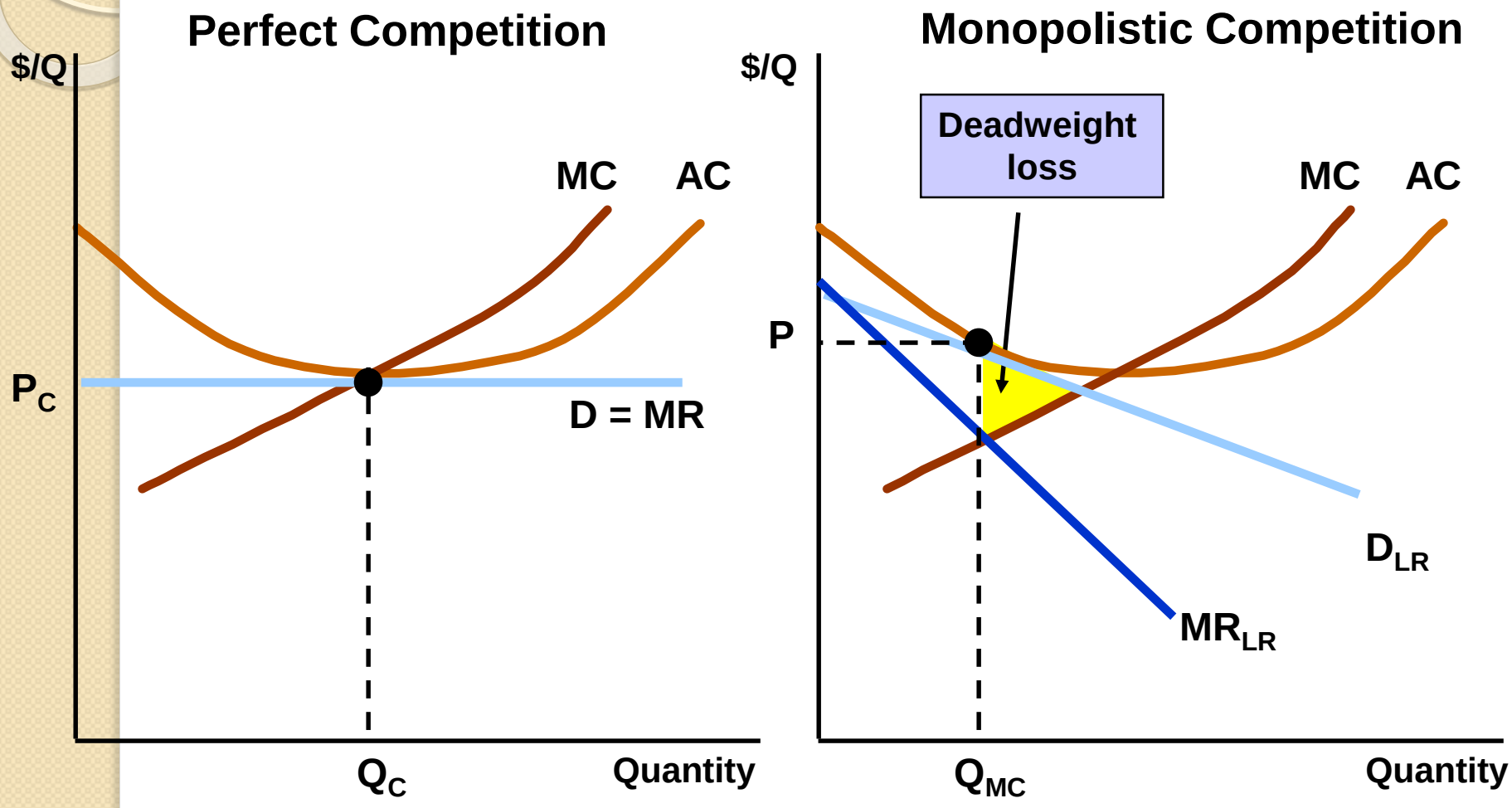
A Monopolistically Competitive Firm in the Short and Long Run

- Short run
  - Downward sloping demand – differentiated product
  - Demand is relatively elastic – good substitutes
  - MR < P
  - Profits are maximized when MR = MC
  - This firm is making economic profits

A Monopolistically Competitive Firm in the Short and Long Run

- Long run
  - Profits will attract new firms to the industry (no barriers to entry)
  - The old firm's demand will decrease to DLR
  - Firm's output and price will fall
  - Industry output will rise
  - No economic profit (P = AC)
  - P > MC → some monopoly power

Monopolistically and Perfectly Competitive Equilibrium (LR)



Monopolistic Competition and Economic Efficiency

- The monopoly power yields a higher price than perfect competition. If price was lowered to the point where MC = D, consumer surplus would increase by the yellow triangle – deadweight loss.
- With no economic profits in the long run, the firm is still not producing at minimum AC and excess capacity exists.

Monopolistic Competition and Economic Efficiency

- Firm faces downward sloping demand so zero profit point is to the left of minimum average cost
- Excess capacity is inefficient because average cost would be lower with fewer firms
  - Inefficiencies would make consumers worse off

Monopolistic Competition

- If inefficiency is bad for consumers, should monopolistic competition be regulated?
  - Market power is relatively small. Usually there are enough firms to compete with enough substitutability between firms – deadweight loss small.
  - Inefficiency is balanced by benefit of increased product diversity – may easily outweigh deadweight loss.

Chapter 11

Oligopoly

Oligopoly

- A monopoly is an industry consisting a single firm.
- An oligopoly is an industry consisting of a few firms. Particularly, each firm's own price or output decisions affect its competitors' profits.

Oligopoly

- Examples
  - Automobiles
  - Steel
  - Aluminum
  - Petrochemicals
  - Electrical equipment

Oligopoly

- How do we analyze markets in which the supplying industry is oligopolistic?
- Consider the duopolistic case of two firms supplying the same product.

Oligopoly – Equilibrium

- If one firm decides to cut their price, they must consider what the other firms in the industry will do
  - Could lead to price war and drastic fall in profits for all
- Actions and reactions are dynamic, evolving over time

Comparison with Other Market Structures

- In perfect competition, monopoly or monopolistic competition, each firm takes price or market demand as given
- No worry about how its competitors respond
- In oligopoly, a firm sets its price or output based on strategic considerations regarding the behavior of its competitors
- At the same time, the competitors' decision depend on the firm's decision

Oligopoly – Equilibrium

- Defining Equilibrium
  - Firms are doing the best they can given other firms are doing and have no incentive to change their output or price
  - All firms assume competitors are taking rival decisions into account
- Nash Equilibrium
  - **Each firm is doing the best it can *given what its competitors are doing***

Oligopoly

- The Cournot Model
  - Oligopoly model in which two firms produce a homogeneous good
  - Two firms decide *simultaneously* how much to produce
  - Firm will adjust its output based on what it thinks the other firm will produce

Quantity Competition

- Assume that firms compete by choosing output levels.
- If firm 1 produces y_1 units and firm 2 produces y_2 units then total quantity supplied is $y_1 + y_2$.
- The market price will be $p(y_1 + y_2)$.
- The firms' total cost functions are $c(y_1)$ and $c(y_2)$.

Quantity Competition

- Suppose firm 1 takes firm 2's output level choice y_2 as given. Then firm 1 sees its profit function as

$$\Pi_1(y_1; y_2) = p(y_1 + y_2)y_1 - c_1(y_1).$$

- Given y_2, what output level y_1 maximizes firm 1's profit?

Quantity Competition

- The profit-max problem for firm 1 is

$$\underset{y_1}{Max}\ p(y_1 + y_2^e)y_1 - c(y_1)$$

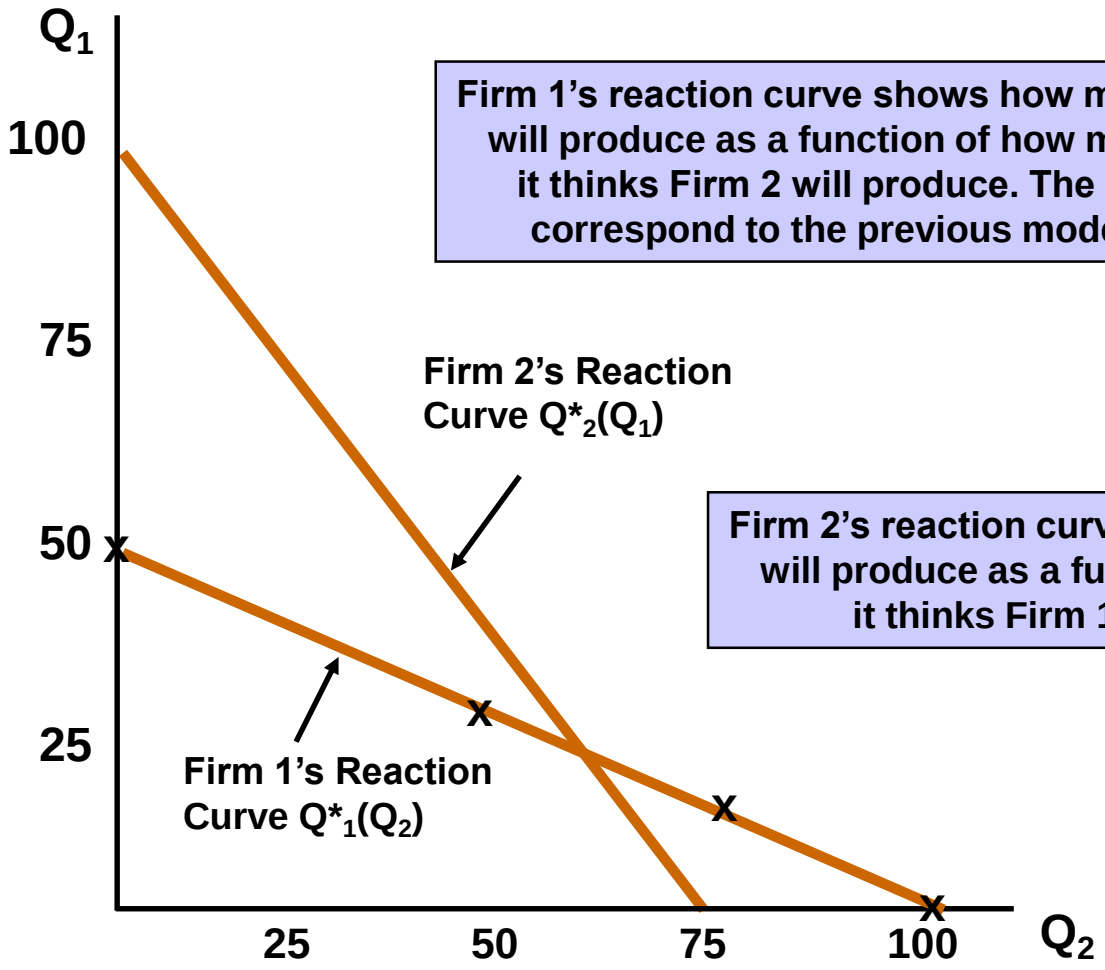
$$F.O.C \Rightarrow y_1 = f_1(y_2^e)$$

$$Similarly,\ y_2 = f_2(y_1^e)$$

Reaction Function

- Reaction function
  - It gives one firm's optimal choice as a function of its beliefs about the other firm's choice
  - The relationship between a firm's profit-maximizing output and the amount it thinks its competitor will produce
  - A firm's profit-maximizing output is a decreasing schedule of the expected output of the other firm

Reaction Curves



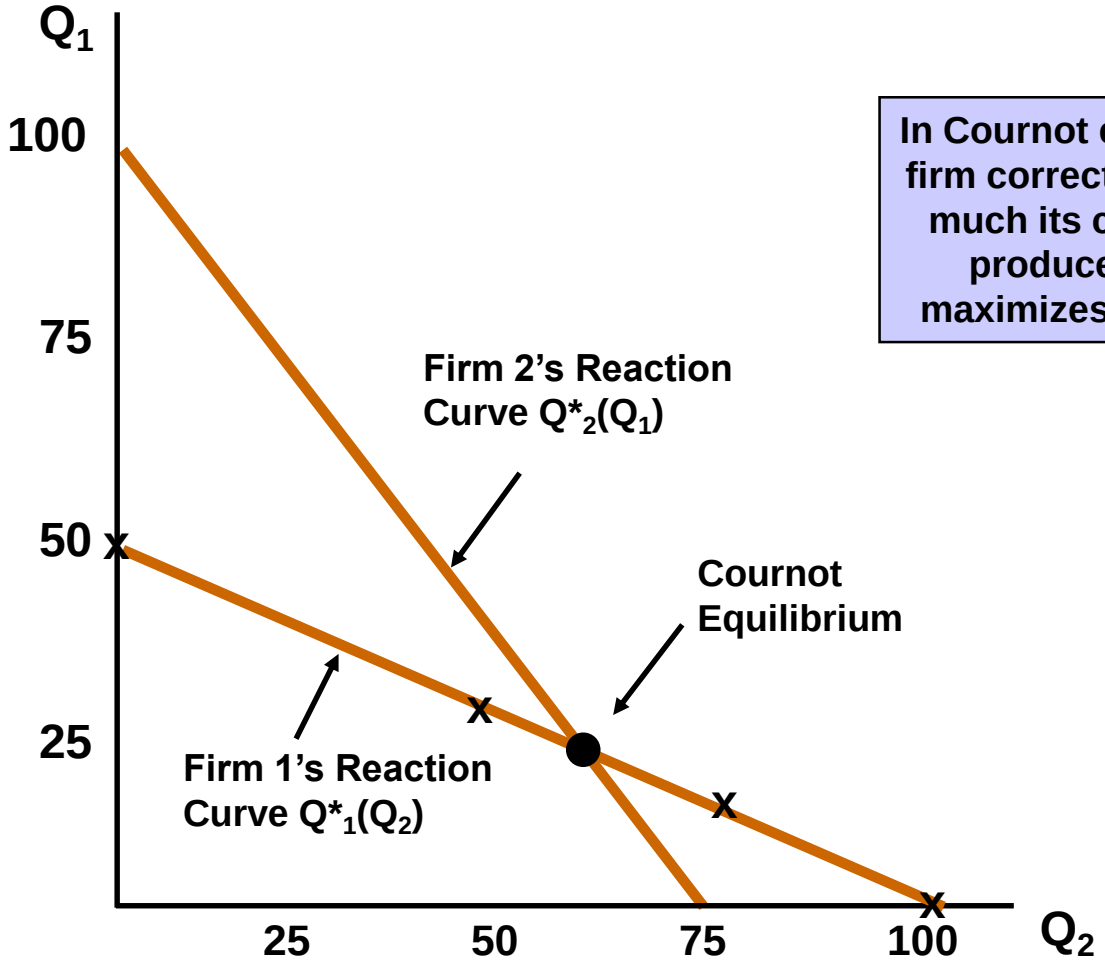
Cournot Equilibirim

- In a Cournot equilibrium, each firm is maximizing its profits, given its beliefs about the other firm's output, and furthermore, those beliefs are correct in the equilibrium
-

$$y_1^* = f_1(y_2^*)$$

$$y_2^* = f_2(y_1^*)$$

Reaction Curves and Cournot Equilibrium



In Cournot equilibrium, each firm correctly assumes how much its competitors will produce and thereby maximizes its own profits.

Oligopoly

- Cournot equilibrium is an example of a Nash equilibrium (Cournot-Nash Equilibrium)
- The Cournot equilibrium says nothing about the dynamics of the adjustment process
  - Since both firms adjust their output, neither output would be fixed

The Linear Demand Curve

- An Example of the Cournot Equilibrium
  - Two firms face linear market demand curve
  - We can compare competitive equilibrium and the equilibrium resulting from collusion
  - Market demand is $P = a - bQ$
  - Q is total production of both firms:

$$Q = Q_1 + Q_2$$

  - Both firms have $MC_1 = MC_2 = 0$

Oligopoly Example

- Firm 1's Reaction Curve → MR = MC

$$\text{Total Revenue}: R_1 = PQ_1 = (a - bQ)Q_1$$

$$= aQ_1 - b(Q_1 + Q_2)Q_1$$

$$= aQ_1 - bQ_1^2 - bQ_2Q_1$$

Oligopoly Example

- An Example of the Cournot Equilibrium

$$MR_1 = dR_1/dQ_1 = a - 2bQ_1 - bQ_2$$

$$MR_1 = 0 = MC_1$$

Firm 1's Reaction Curve

$$Q_1 = a/2b - Q_2/2$$

Firm 2's Reaction Curve

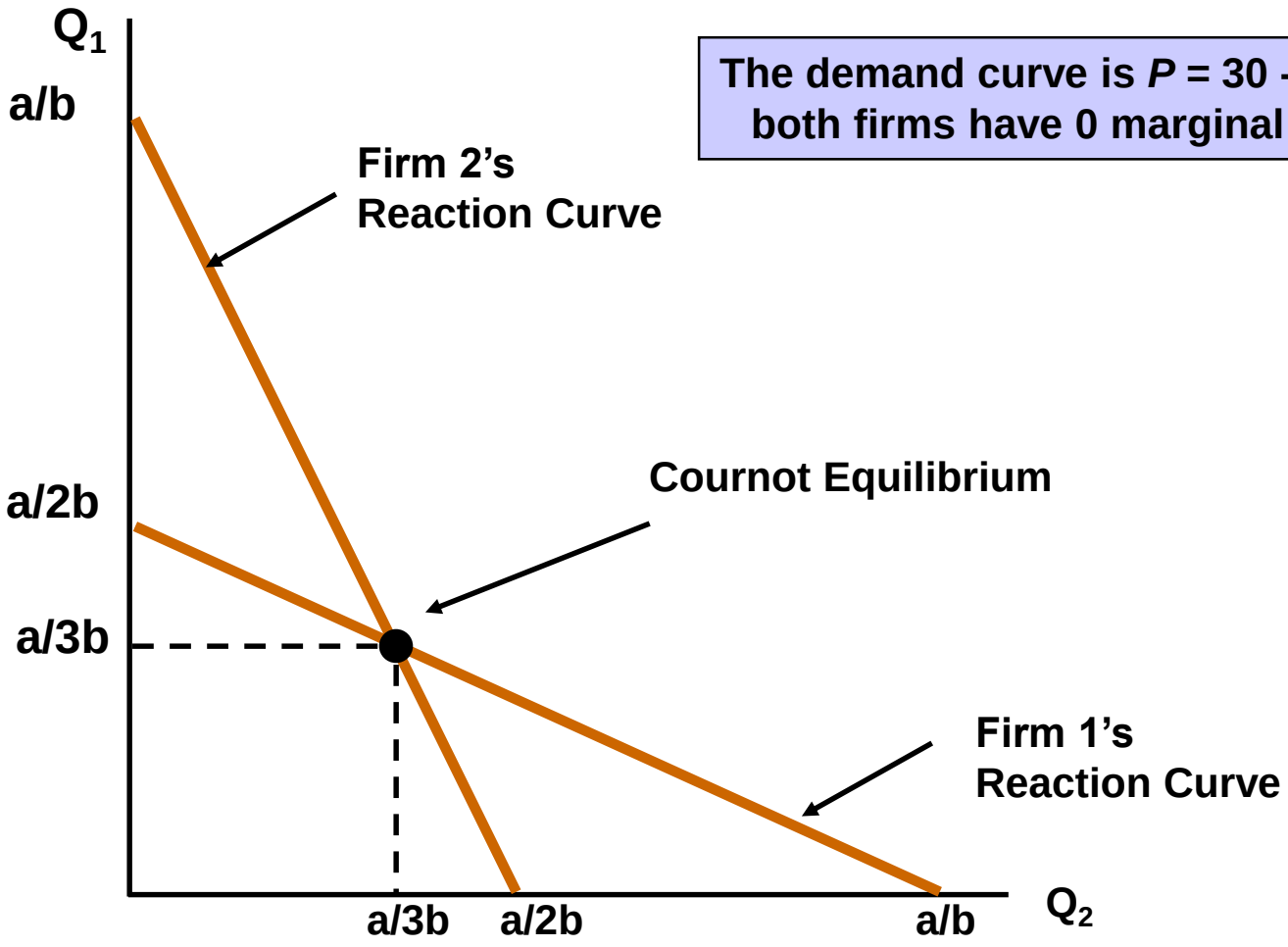
$$Q_2 = a/2b - Q_1/2$$

Oligopoly Example

- An Example of the Cournot Equilibrium

$$\text{Cournot Equilibrium}: Q_1^* = Q_2^* = \frac{a}{3b}$$

Duopoly Example



The demand curve is *P* = 30 - *Q* and both firms have 0 marginal cost.

Many Firms in Cournot Equilibrium

$$Y = \sum_{i=1}^{N} y_i$$

$$F.O.C.\ for\ \ firm\, i : P(Y) + P'(Y) y_i = C'(y_i)$$

$$P(Y)\left[1 + \frac{dP}{dY}\frac{Y}{P(Y)}\frac{y_i}{Y}\right] = C'(y_i)$$

$$P(Y)\left[1 - \frac{1}{|E_d| / s_i}\right] = C'(y_i) \quad s_i = \frac{y_i}{Y}$$

$$P(Y) \to C'(y_i)\ as\ s_i \to 0$$

First Mover Advantage – The Stackelberg Model

- Oligopoly model in which one firm sets its output before other firms do
- Assumptions
  - One firm can set output first
  - MC = 0
  - Market demand is P = a - bQ where Q is total output
  - Firm 1 sets output first and Firm 2 then makes an output decision seeing Firm 1's output

The Follower's Problem

- Firm 1
  - Must consider the reaction of Firm 2
- Firm 2
  - Takes Firm 1's output as fixed and therefore determines output with the Cournot reaction curve: $Q_2 = a/2b - \frac{1}{2}(Q_1)$
- Firm 1 knows Firm 2 will choose output based on its reaction curve. We can use Firm 2's reaction curve as Q_2

The Leader's Problem

$$\underset{y_1}{Max}\ P(Q)Q_1 - C(Q_1) \quad s.t.\ Q_2 = f_2(Q_1)$$

$$\underset{y_1}{Max}\ P(Q_1 + Q_2(Q_1))Q_1 - C(Q_1)$$

$$= aQ_1 - bQ_1^2 - bQ_1\frac{a - bQ_1}{2b} = \frac{a}{2}Q_1 - \frac{b}{2}Q_1^2$$

$$\Rightarrow Q_1^* = \frac{a}{2b},\ Q_2^* = \frac{a}{4b}$$

First Mover Advantage – The Stackelberg Model

- Conclusion
  - Going first gives Firm 1 the advantage
  - Firm 1's output is twice as large as Firm 2's
  - Firm 1's profit is twice as large as Firm 2's
- Going first allows Firm 1 to produce a large quantity. Firm 2 must take that into account and produce less unless it wants to reduce profits for everyone
- Going first gives Firm 1 an advantage

Iso-Profit Curves

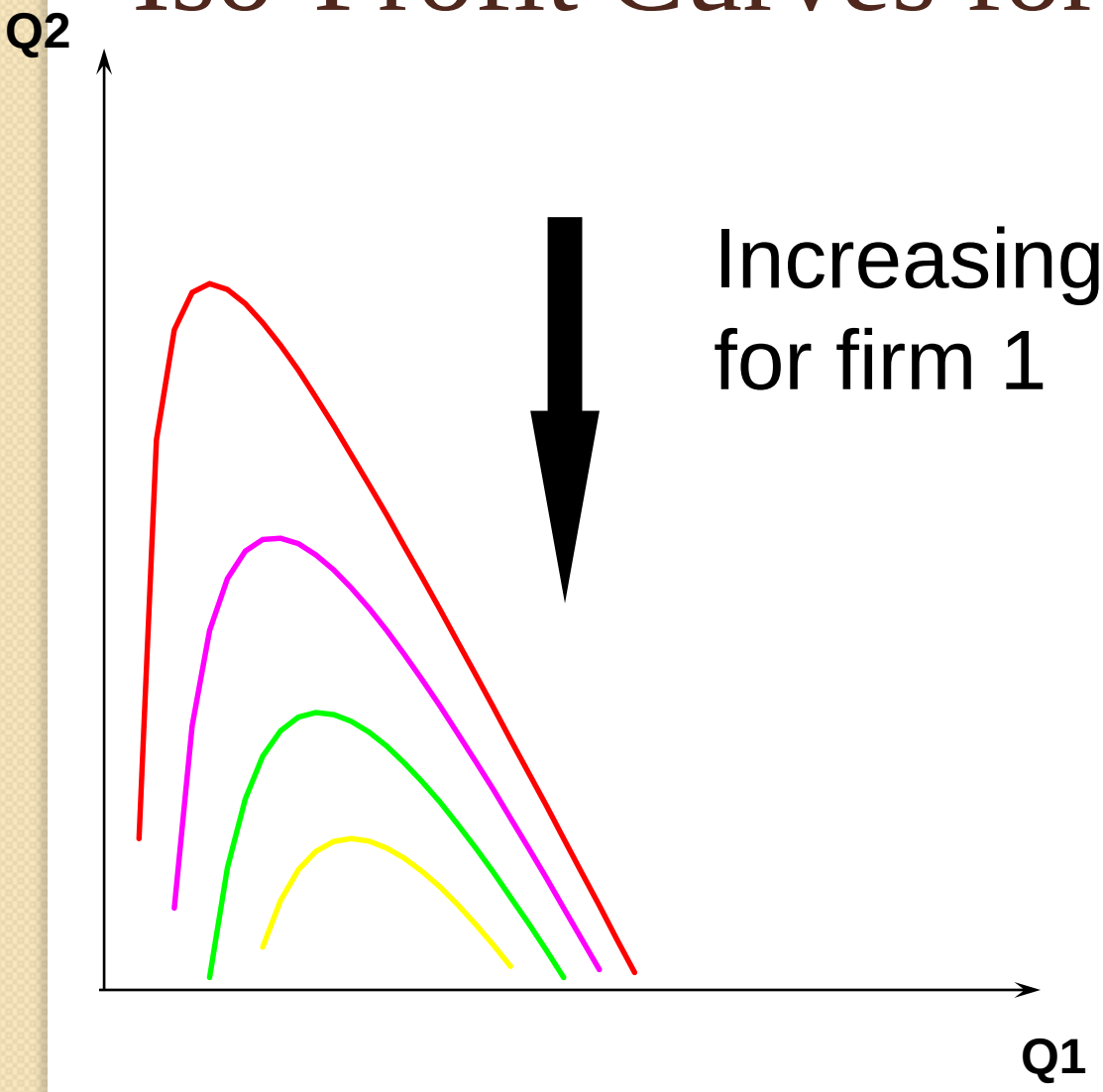
- For firm 1, an iso-profit curve contains all the output pairs (Q_1, Q_2) giving firm 1 the same profit level Π_1.
- What do iso-profit curves look like?

$$\Pi = [a - b(Q_1 + Q_2)]Q_1 = aQ_1 - bQ_1Q_2 - bQ_2^2 = \Pi_0$$

Iso-Profit Curves for Firm 1

With Q_1 fixed, firm 1's profit increases as Q_2 decreases.

Iso-Profit Curves for Firm 1



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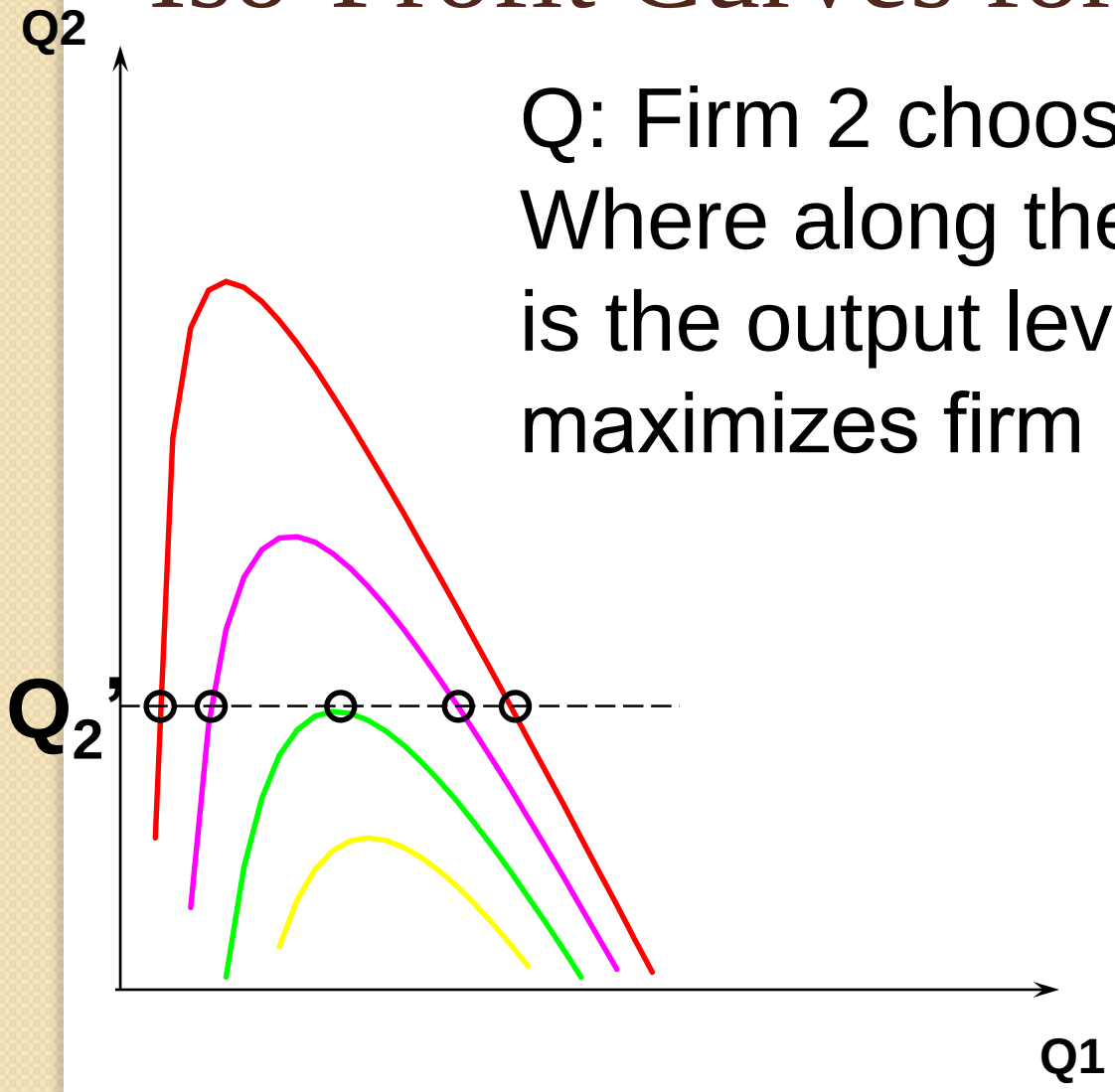
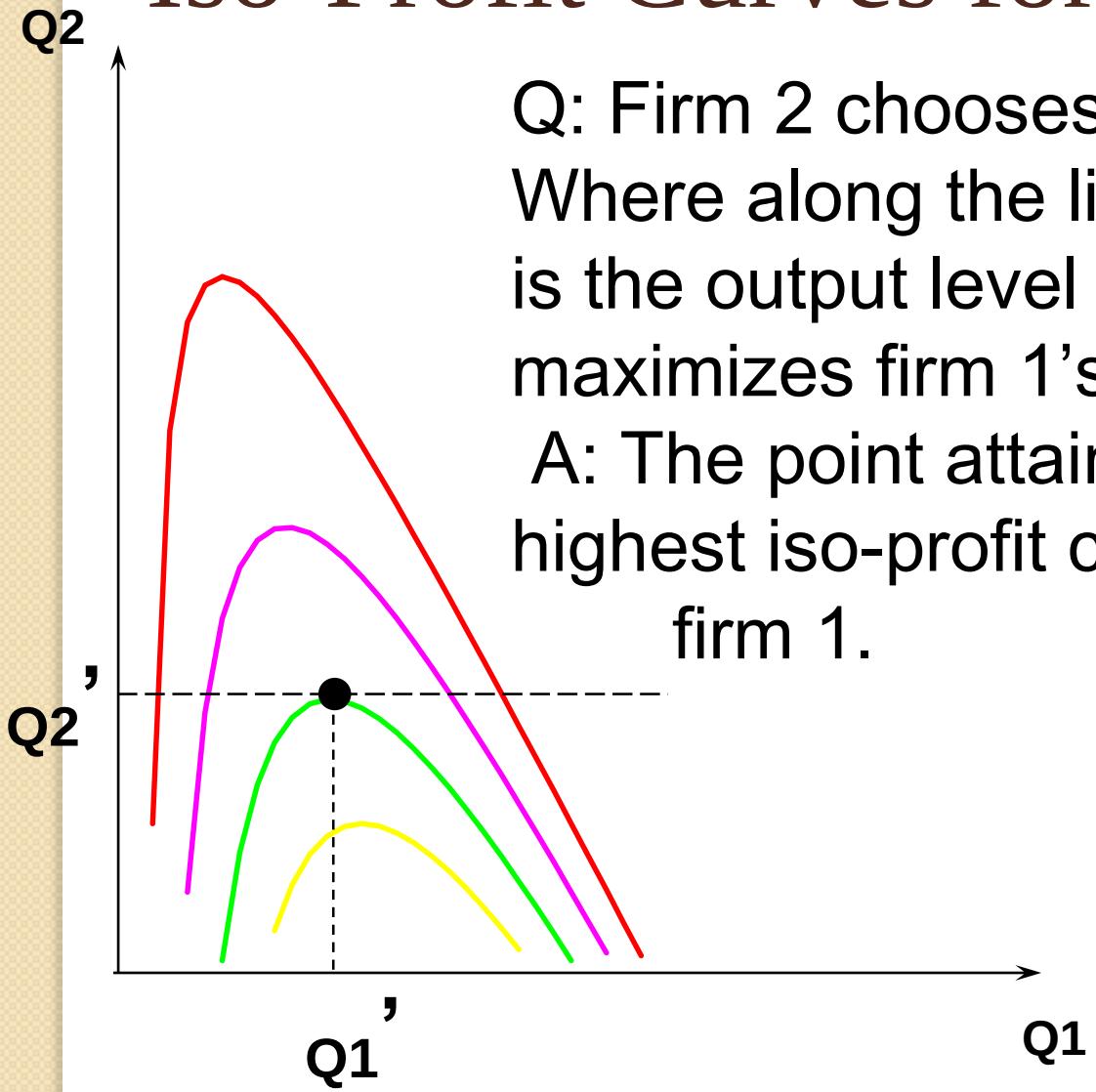


Q: Firm 2 chooses $y_2 = y_2'$. Where along the line $y_2 = y_2'$ is the output level that maximizes firm 1's profit?

Iso-Profit Curves for Firm 1



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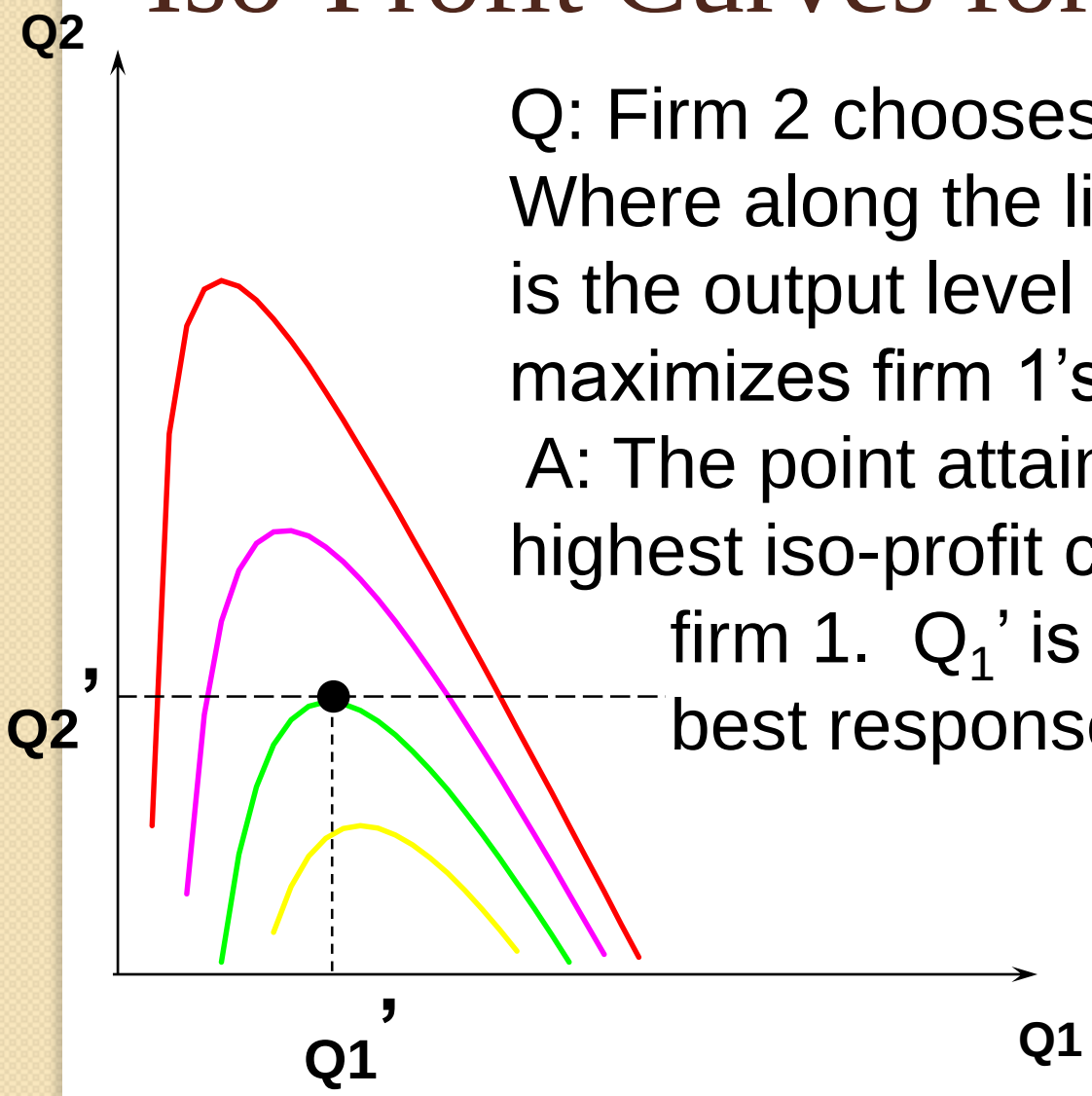
A: The point attaining the highest iso-profit curve for firm 1.

Iso-Profit Curves for Firm 1



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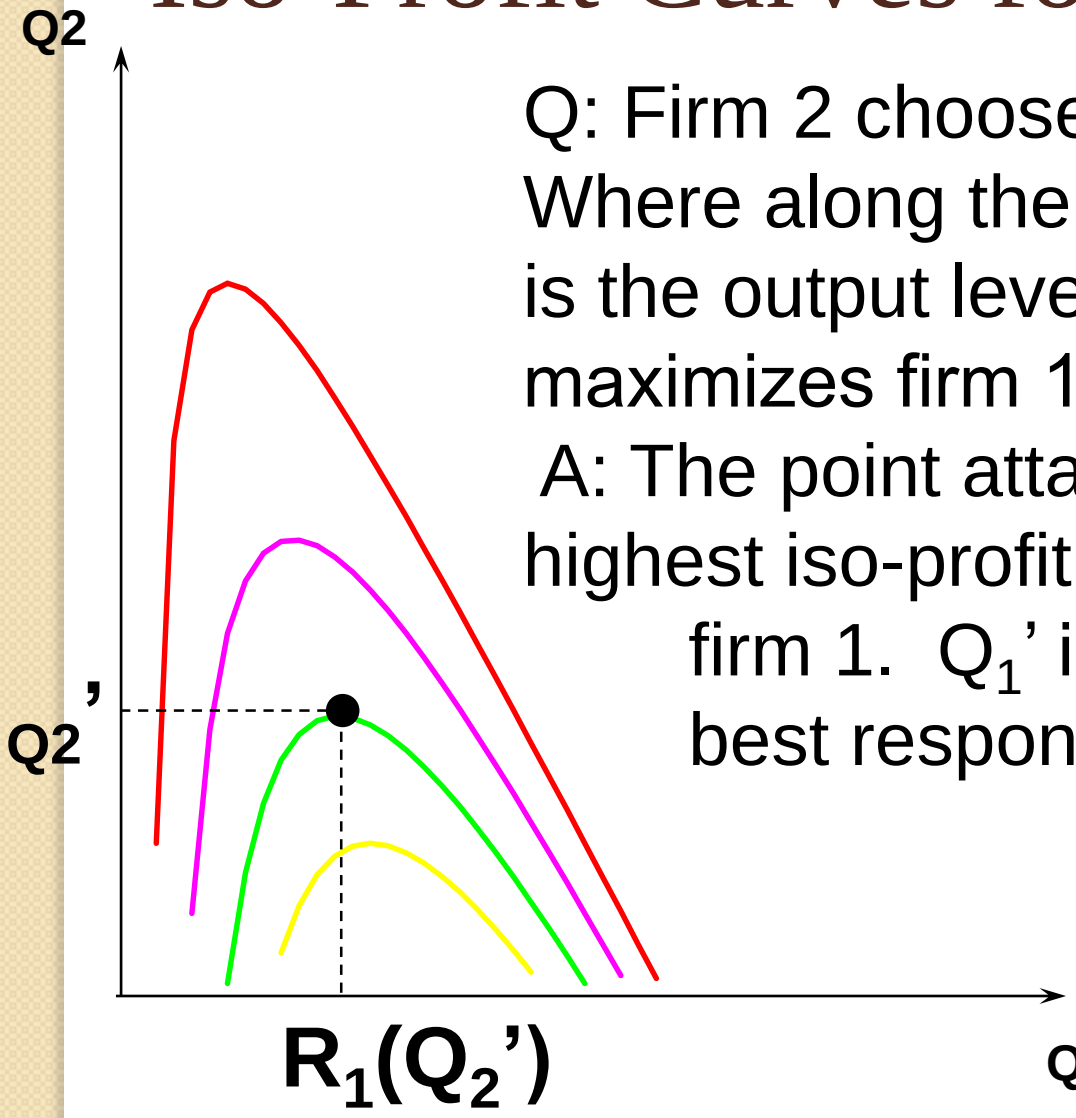

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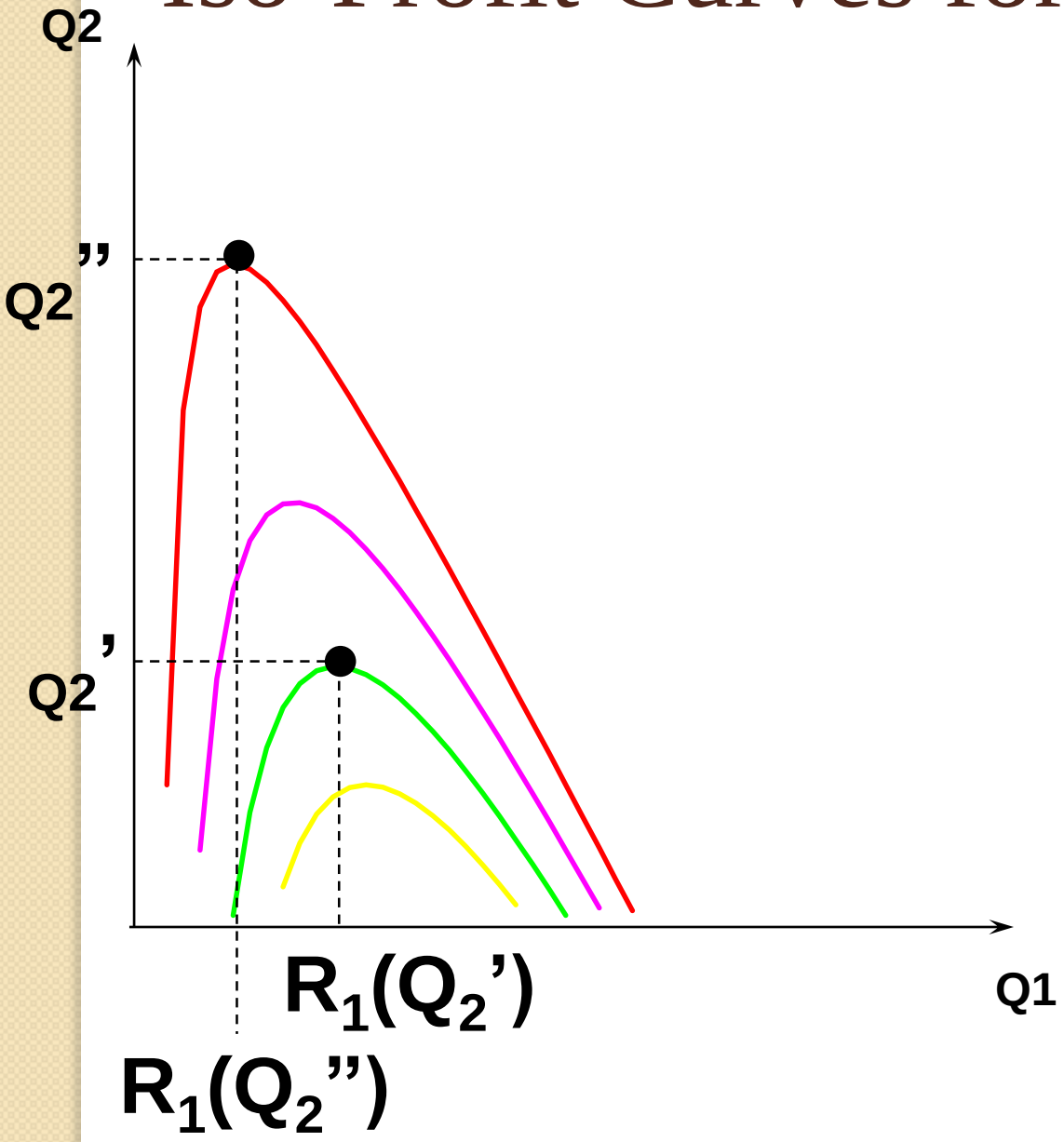
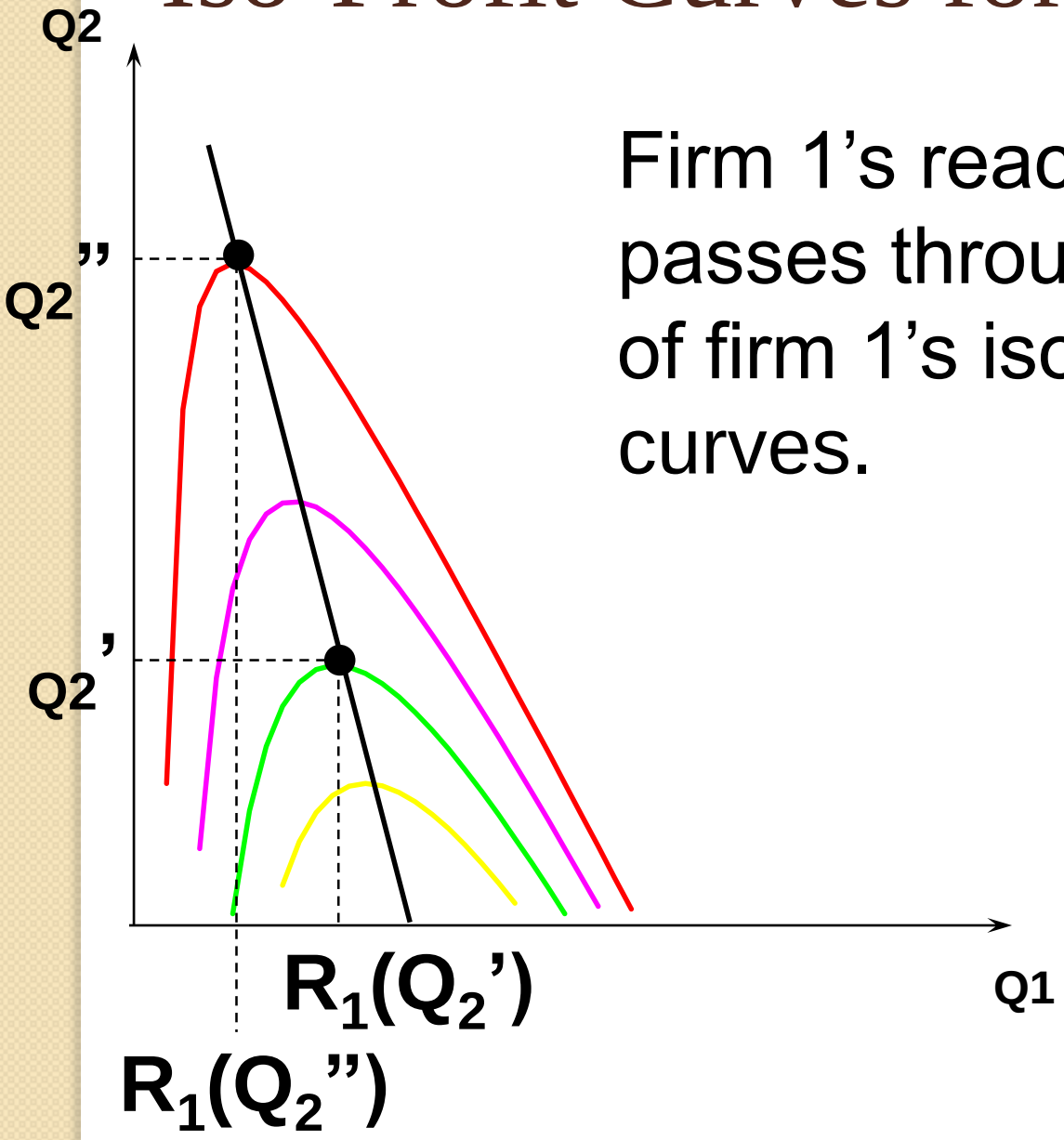
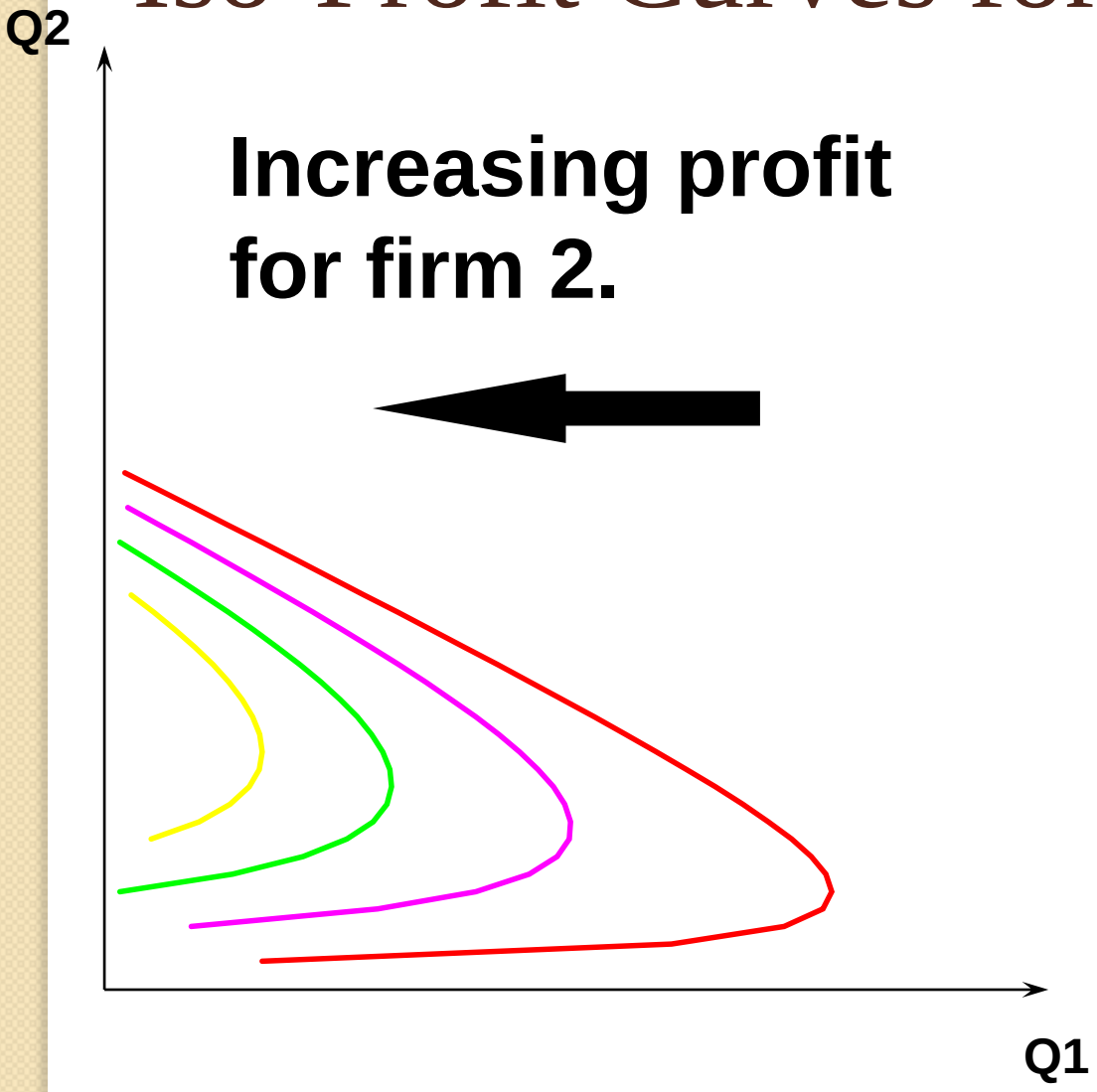


Iso-Profit Curves for Firm 1

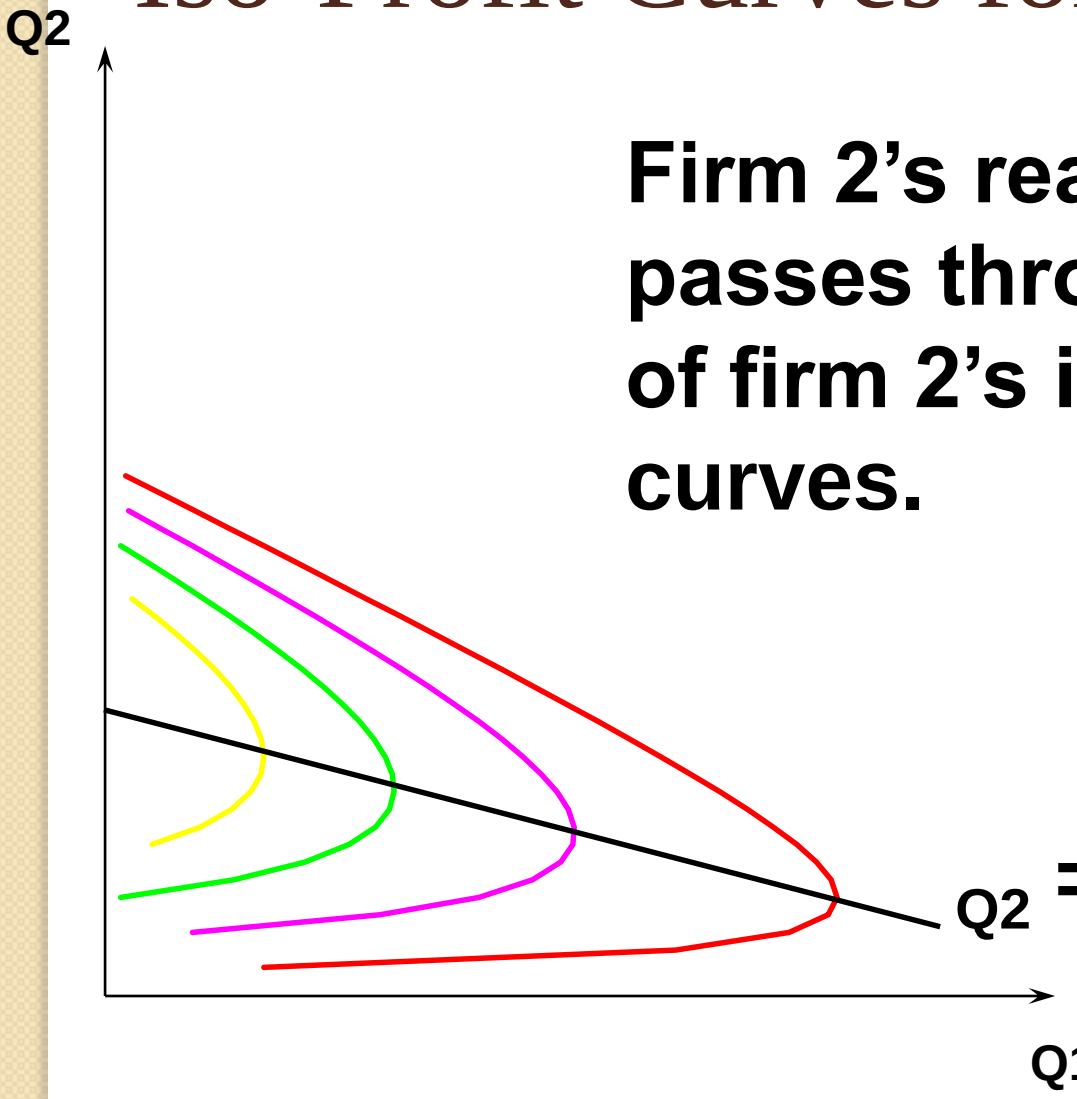


Firm 1’s reaction curve passes through the “tops” of firm 1’s iso-profit curves.

Iso-Profit Curves for Firm 2

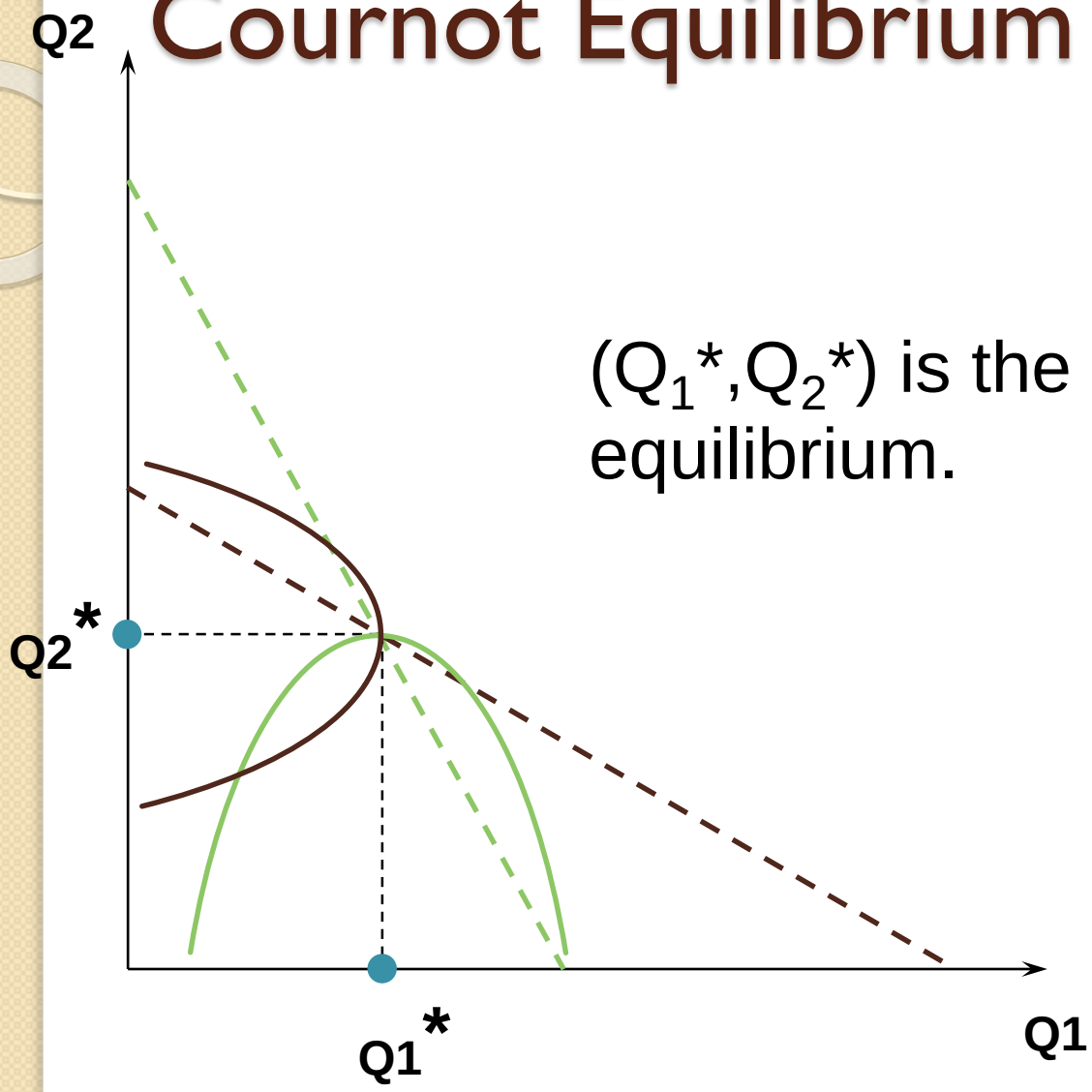


Iso-Profit Curves for Firm 2



Firm 2's reaction curve passes through the "tops" of firm 2's iso-profit curves.

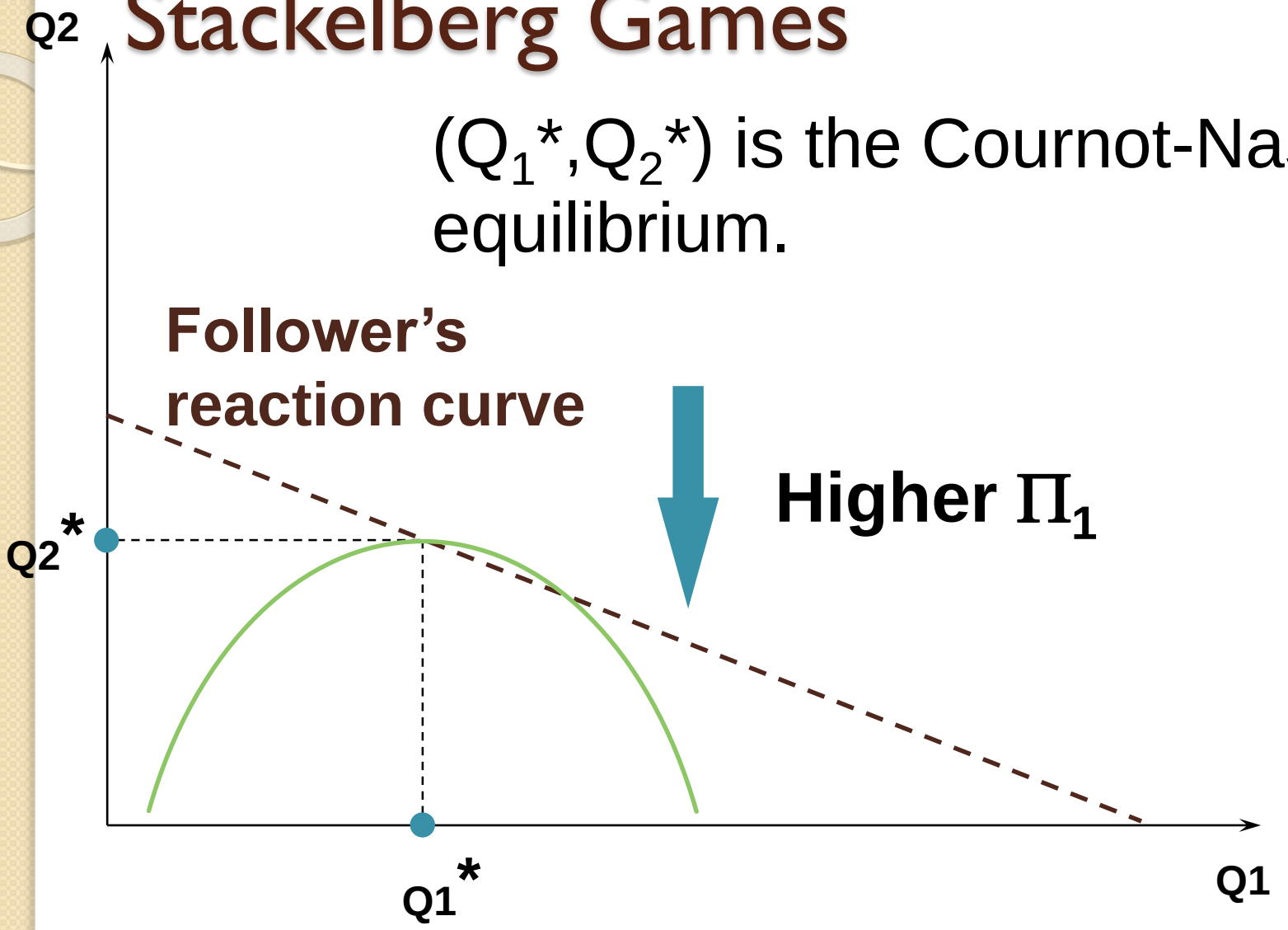
Cournot Equilibrium



(Q_1^*, Q_2^*) is the Cournot-Nash equilibrium.

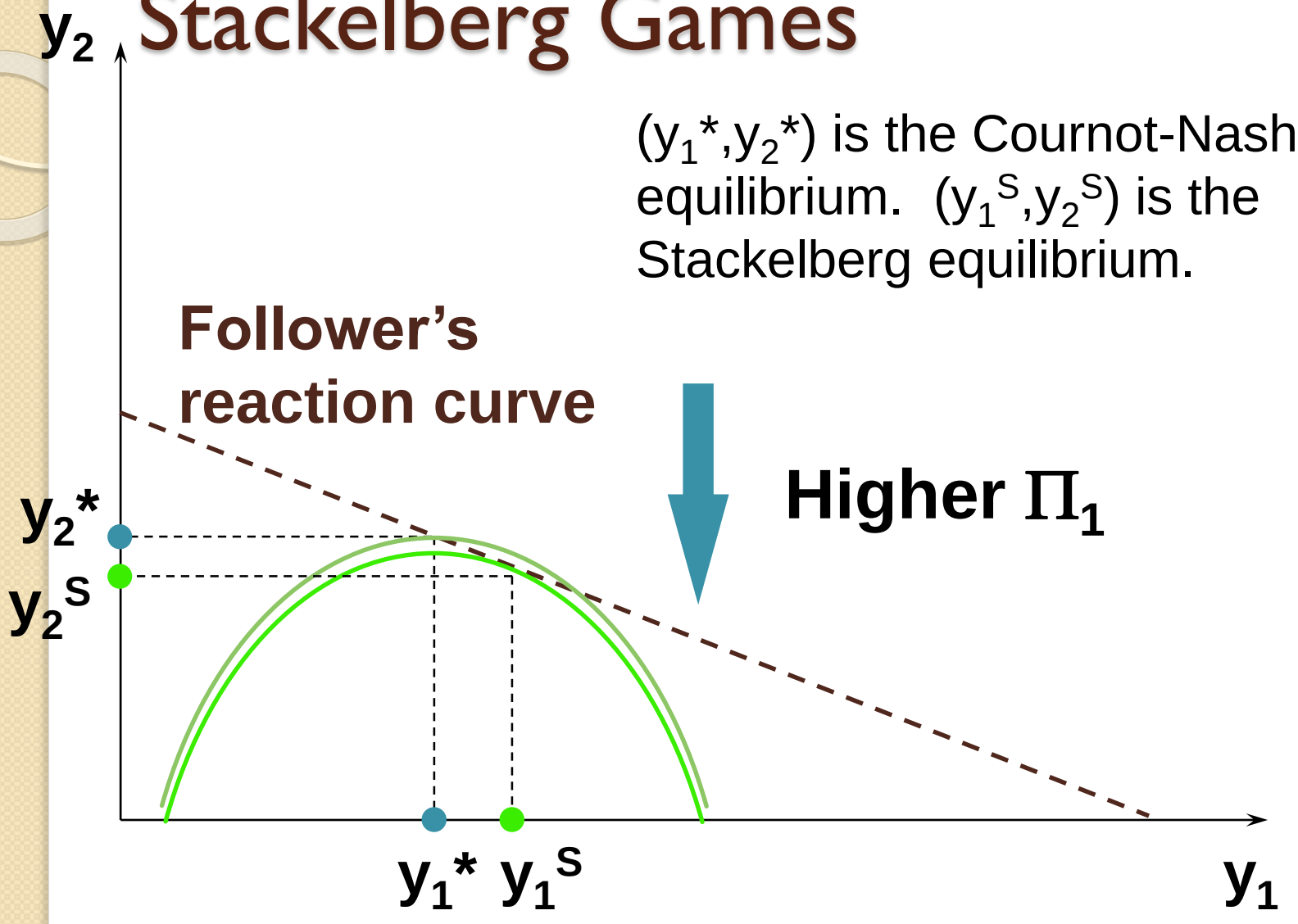
Stackelberg Games

(Q_1^*, Q_2^*) is the Cournot-Nash equilibrium.

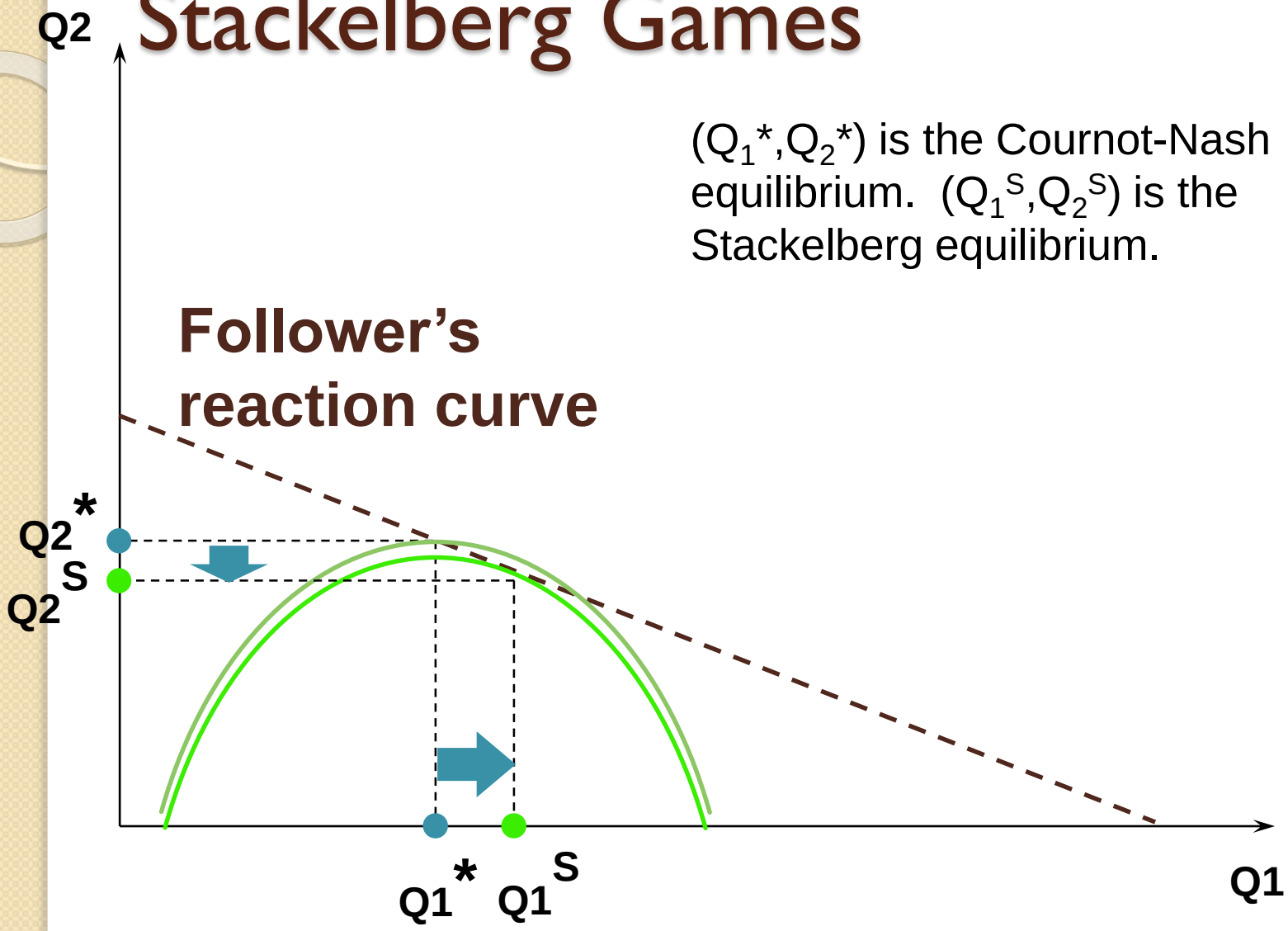


Stackelberg Games

(y_1^*, y_2^*) is the Cournot-Nash equilibrium. (y_1^S, y_2^S) is the Stackelberg equilibrium.



Stackelberg Games



(Q_1^*, Q_2^*) is the Cournot-Nash equilibrium. (Q_1^S, Q_2^S) is the Stackelberg equilibrium.

Price Competition

- What if firms compete using only price-setting strategies, instead of using only quantity-setting strategies?
- Games in which firms use only price strategies and play simultaneously are Bertrand games.
- As with the Cournot model, firms produce a homogenous product

Bertrand Games

- Each firm's marginal production cost is constant at c. MC1=MC2=c
- All firms set their prices simultaneously.
- Q: Is there a Nash equilibrium?

Bertrand Games

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- A: Yes. Exactly one.

Bertrand Games

- Each firm's marginal production cost is constant at c.
- All firms simultaneously set their prices.
- Q: Is there a Nash equilibrium?
- A: Yes. Exactly one. All firms set their prices equal to the marginal cost c. Why?

Bertrand Games

- Suppose one firm sets its price higher than another firm's price.

Bertrand Games

- Suppose one firm sets its price higher than another firm's price.
- Then the higher-priced firm would have no customers.

Bertrand Games

- Suppose one firm sets its price higher than another firm's price.
- Then the higher-priced firm would have no customers.
- Hence, at an equilibrium, all firms must set the same price.

Bertrand Games

- Suppose the common price set by all firm is higher than marginal cost c.

Bertrand Games

- Suppose the common price set by all firm is higher than marginal cost c.
- Then one firm can just slightly lower its price and sell to all the buyers, thereby increasing its profit.

Bertrand Games

- Suppose the common price set by all firm is higher than marginal cost c.
- Then one firm can just slightly lower its price and sell to all the buyers, thereby increasing its profit.
- The only common price which prevents undercutting is c. Hence this is the only Nash equilibrium.

Price Competition – Differentiated Products

- Example
  - Duopoly with fixed costs of $20 but zero variable costs
  - Firms face the same demand curves
    - Firm 1's demand: $Q_1 = 12 - 2P_1 + P_2$
    - Firm 2's demand: $Q_2 = 12 - 2P_1 + P_2$
  - Quantity that each firm can sell decreases when it raises its own price but increases when its competitor charges a higher price

Price Competition – Differentiated Products

- Firms set prices at the same time

$$\text{Firm } 1: \pi_1 = P_1 Q_1 - \$20$$
$$= P_1(12 - 2P_1 + P_2) - 20$$
$$= 12P_1 - 2P_1^2 + P_1 P_2 - 20$$

Price Competition – Differentiated Products

- If P_2 is fixed:

$$\text{Firm 1's profit maximizing price} =$$

$$\partial \pi_1 / \partial P_1 = 12 - 4P_1 + P_2 = 0$$

$$\text{Firm 1's reaction curve} =$$

$$P_1 = 3 + 1/4 P_2$$

$$\text{Firm 2's reaction curve} =$$

$$P_2 = 3 + 1/4 P_1$$

Nash Equilibrium in Prices

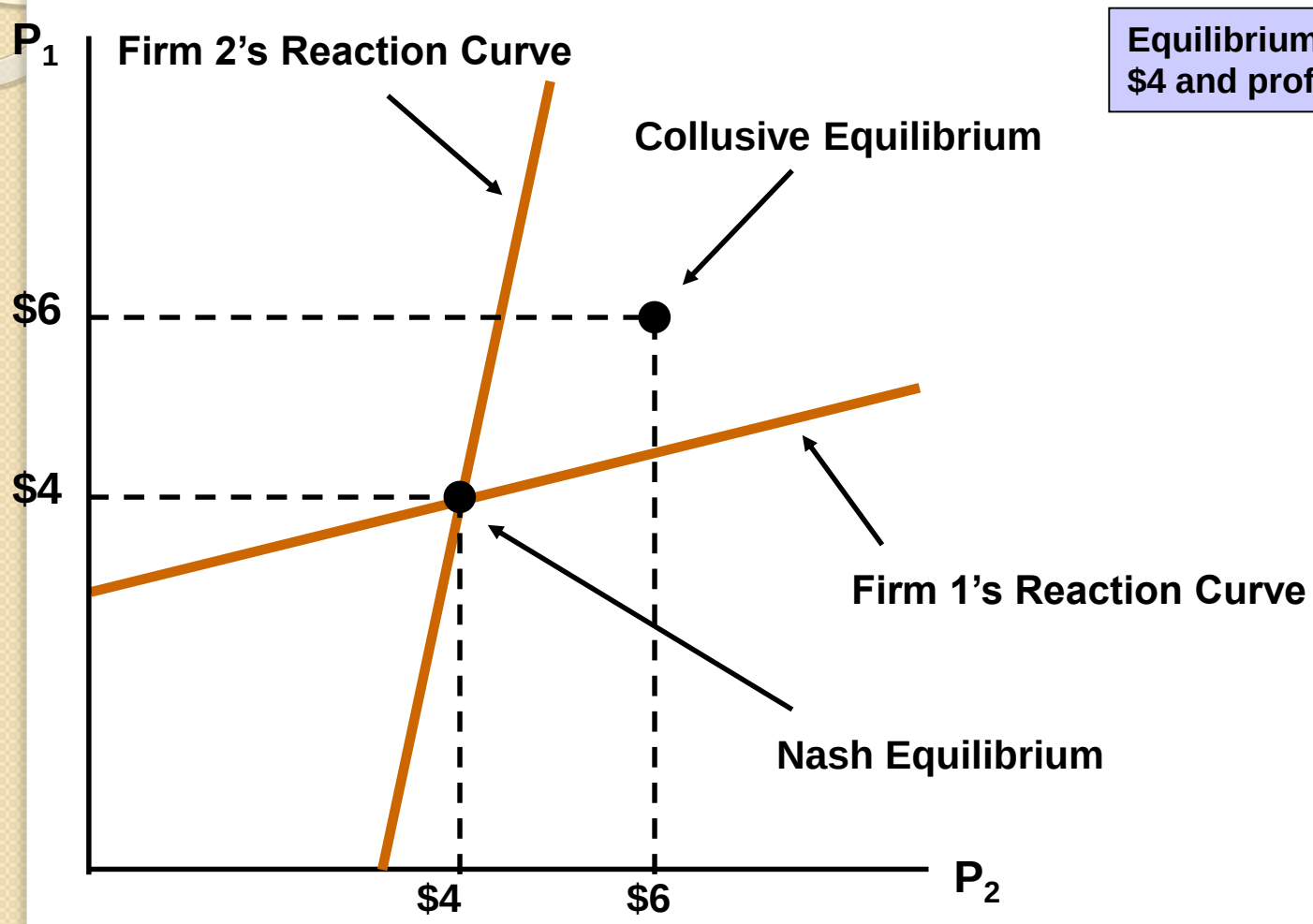
- What if both firms collude?
  - They both decide to charge the same price that maximizes both of their profits

$$\Pi = \Pi_1 + \Pi_2 = 24P - 4P^2 + 2P^2 - 40 = 24P - 2P^2 - 40$$

$$\frac{d\Pi}{dP} = 24 - 4P = 0 \Rightarrow P^* = 6$$

  - Firms will charge $6 and will be better off colluding since they will earn a profit of $16

Nash Equilibrium in Prices



Collusion is a Nash Equilibrium

- Suppose that firm 1 sticks to the $6 collusive price, what if firm 2 charges $4 instead?

$$\Pi_2 = P_2 Q_2 - 20 = 4[12 - (2)4 + 6] - 20 = \$20$$
$$\Pi_1 = P_1 Q_1 - 20 = 6[12 - (2)6 + 4] - 20 = \$4$$

- That means that firms have incentives to deviate from collusive prices

Nash Equilibrium in Prices

- If Firm 1 sets price first and then Firm 2 makes pricing decision:
  - Firm 1 would be at a distinct disadvantage by moving first
  - The firm that moves second has an opportunity to undercut slightly and capture a larger market share