OLIGOPOLY

EE311

11 November 2020

CHARACTERISTICS

- Mutually interdependent
- Strategic actions to deter entry
  - Threaten to decrease price against new competitors by keeping excess capacity
- Rival behaviour
  - Because only a few firms, each must consider how its actions will affect its rivals and in turn how their rivals will react.
- Different rival assumptions lead to different models

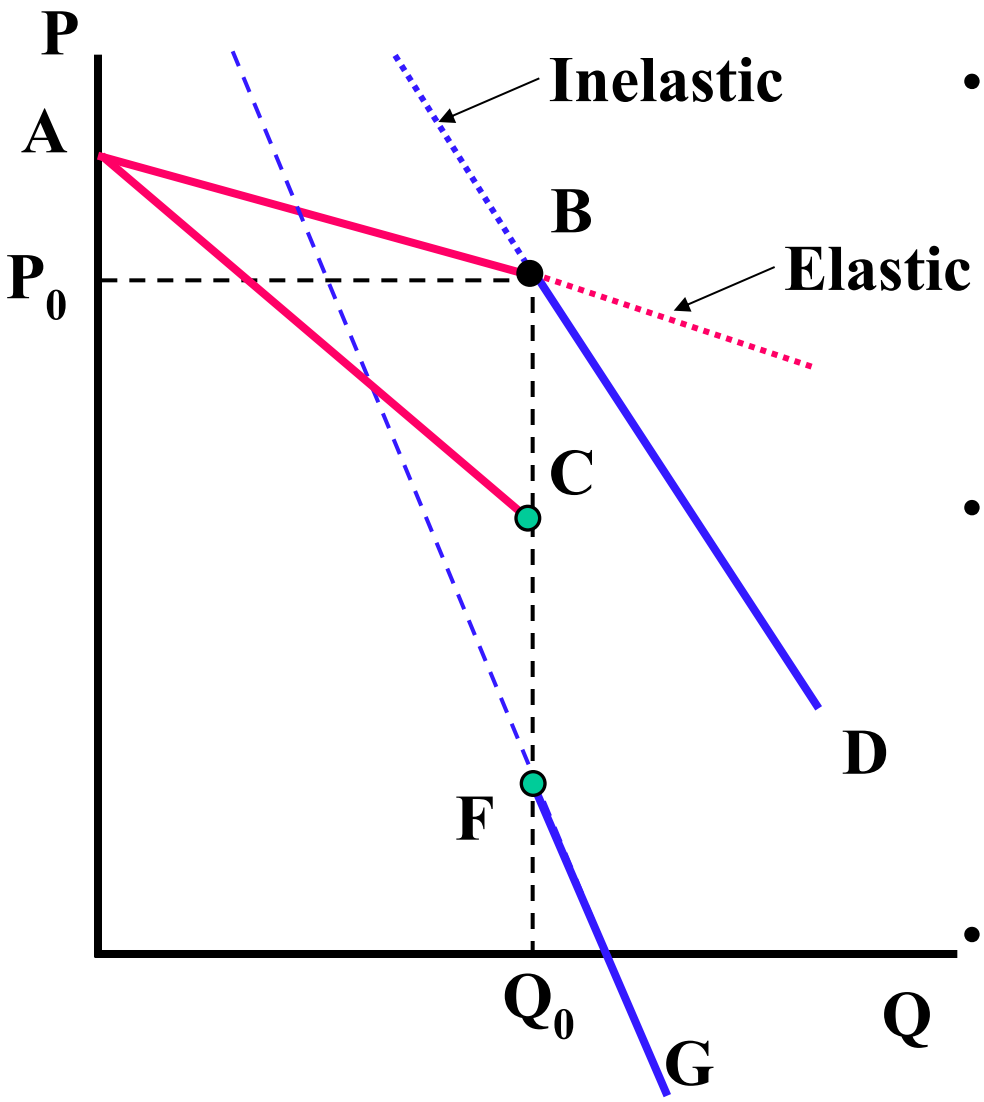
Kinked Demand Curve Model

- Rival firms respond to direction of price change of a firm differently.
- If a firm decides to decrease its price to attract more customers, other firms will match the price reduction to protect their market share. Hence, it can attract less customers.
- If the firm decides to increase its price instead, no other firms will match the price increase since they will get more customers.

Kinked Demand Curve Model

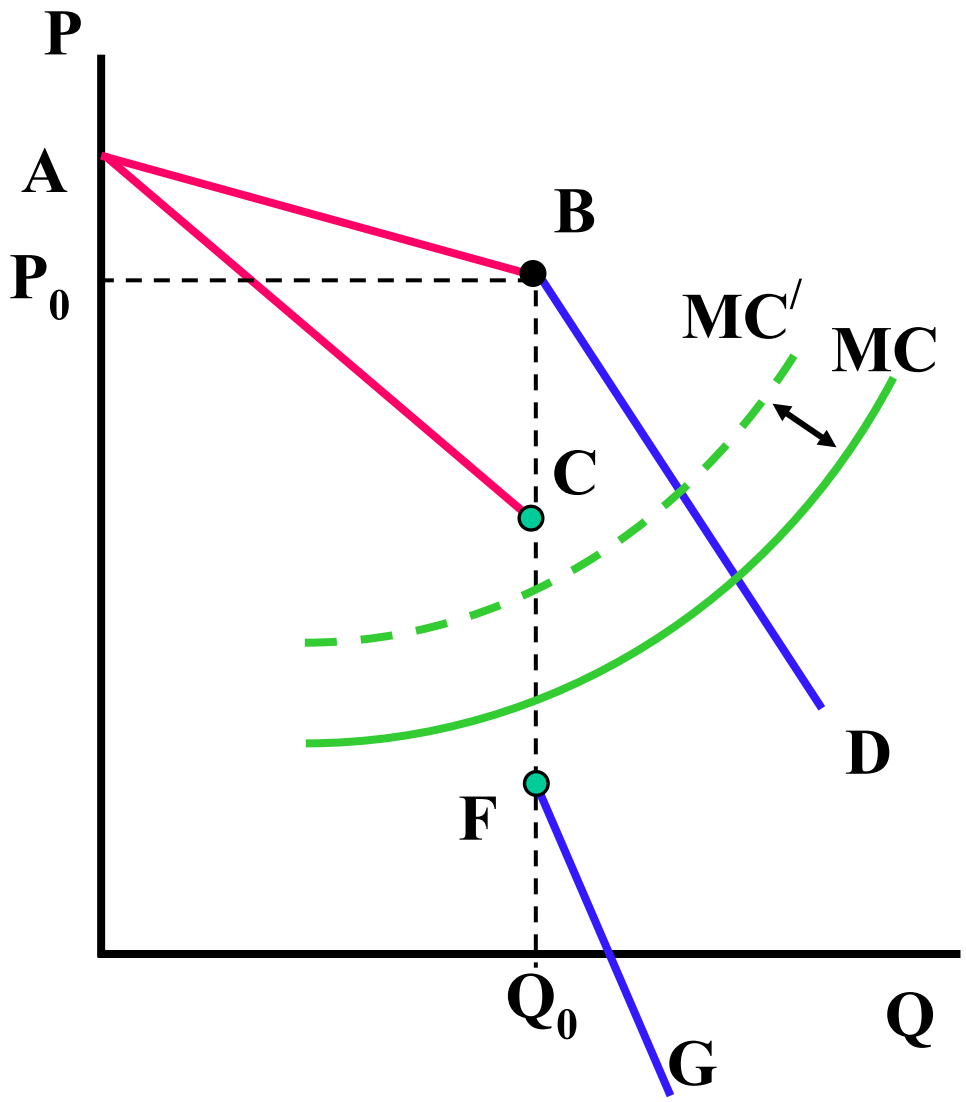
- The demand facing by a firm when it tries to decrease the price is inelastic.
- The demand facing by a firm when it tries to increase the price is elastic.
- Its demand curve is kinked at the original price and given by line ABD.
- The corresponding MR curve is given by line ACFG with a gap between CF.

Kinked Demand Curve Model



- Demand curve above P_0 is elastic because no other firm matches the price increase.
- Demand curve below P_0 is inelastic because all other firms match the price decrease.
- MR curve is ACFG.

Kinked Demand Curve Model



- Suppose MC passes between the gap CF, equilibrium price and quantity will be P_0 and Q_0.
- A small change in MC will not change the equilibrium price.
  - Price is sticky at P_0.

Kinked Demand Curve Model

Criticism:

- Empirical evident does not support "sticky price" conclusion.
- Changing price tag every time that the cost change is not practical and may create confusion → infrequent change in price does not need to be explained by kinked demand curve.
- No explanation is given how P_0 is chosen at the first place.
- Need new models that can explain better.

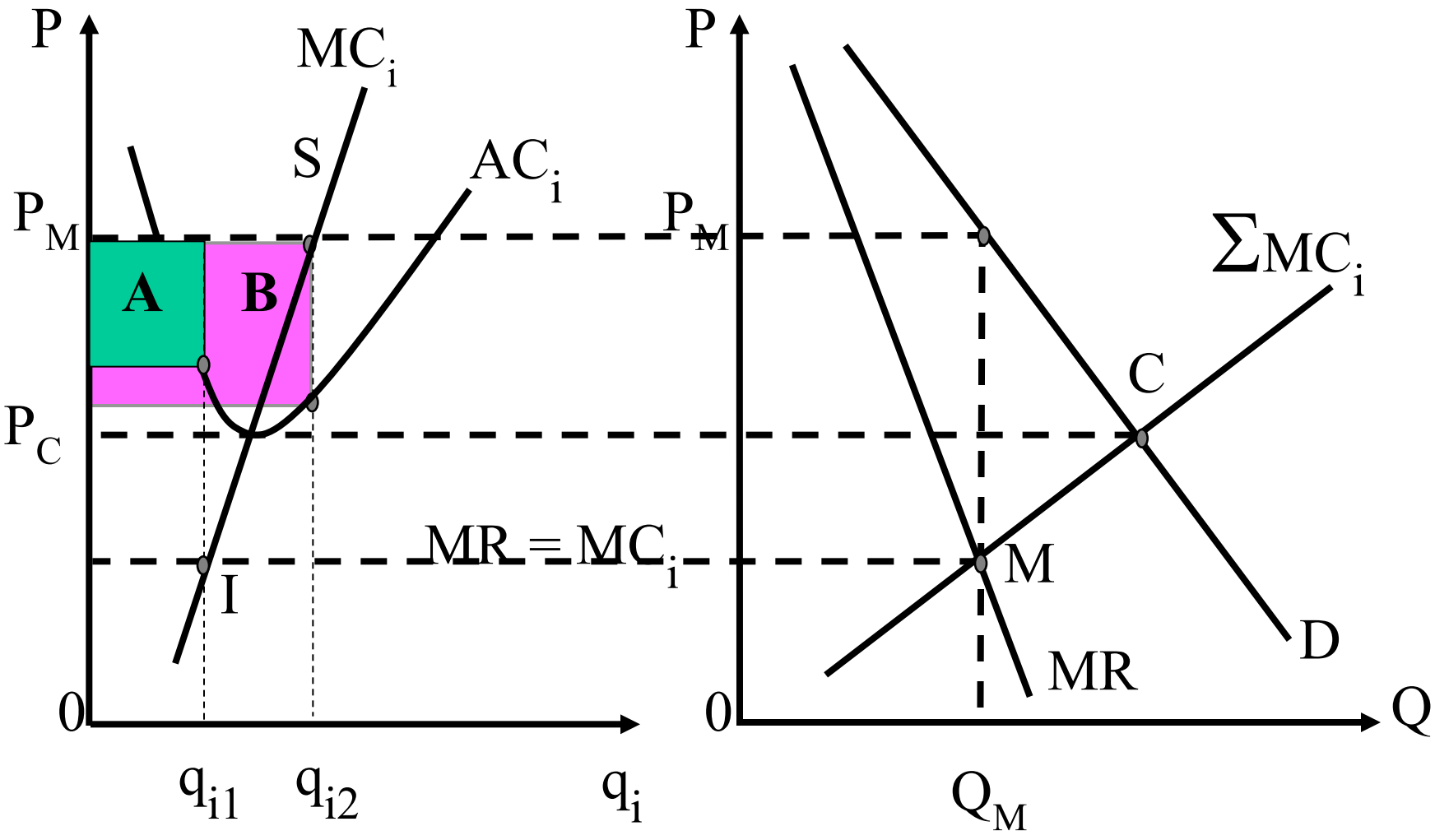
Model summary

	Non Cooperative		Cooperative
Leader	Quantity strategy	Price strategy	
No	Cournot	Bertrand	Collusion or
yes	Stackelberg	Price Leadership	Cartels

Cooperative oligopoly: Cartels

- Producers in a cartel explicitly agree to cooperate in setting prices and output.
- Typically only a subset of producers are part of the cartel and others benefit from the choices of the cartel
- If demand is sufficiently inelastic and cartel is enforceable, prices may be well above competitive levels
- Example: OPEC

Cartels: profits and an incentive to cheat

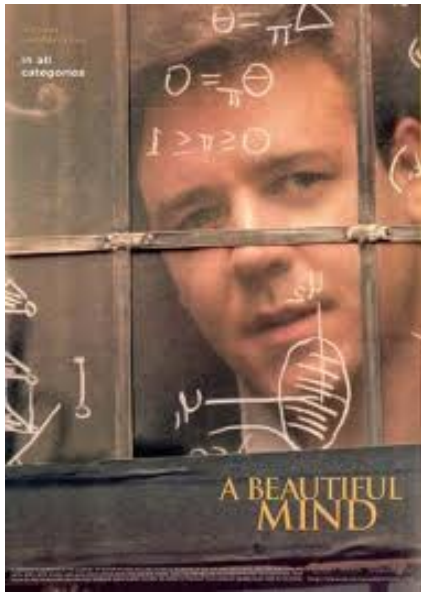


Cartels

- To be successful:
  - Total demand must not be very price elastic
  - Tempting to cheat by lowering price to capture larger market share
  - less possibilities of substitutes
  - Either the cartel must control nearly all of the world's supply or the supply of non-cartel producers must not be price elastic

Non cooperative Oligopoly

- Defining Equilibrium
  - Firms are doing the best they can 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.*
  - Each firm correctly assumes its competitor's strategy.
- We will focus on duopoly

The Cournot Model

- Assumptions
- homogeneous goods
- each firm treats the output of its competitors as fixed*
- all firms decide simultaneously how much to produce*
- Firm will adjust its output based on what it thinks the other firm will produce*
- Note: * important assumptions

Bangkok Post

THE NATION
INSIGHTFUL, IN TREND, INDEPENDENT

Cournot Equilibrium

- Each firm correctly assumes how much its competitor will produce and sets its own production level accordingly.
- It says nothing about the dynamics of the adjustment process.
- Cournot equilibrium is an example of a Nash equilibrium (Cournot-Nash Equilibrium)

An Example of the Cournot Equilibrium

- The Linear Demand Curve
  - Two firms face linear market demand curve
  - Market demand is $P = 100 - Q$
  - Q is total production of both firms:

$$Q = Q_1 + Q_2$$

  - Both firms have $MC_1 = MC_2 = 10$ for simplicity

The Cournot Model: Example

- To maximize profits, Firm 1 will choose Q_1 that make MR=MC
- Total Revenue:

$$TR_1 = PQ_1 = (100 - Q_1 - Q_2)Q_1$$

$$= 100Q_1 - (Q_1)^2 - Q_1Q_2$$

- Marginal Revenue:

$$MR_1 = dR_1/dQ_1 = 100 - 2Q_1 - Q_2$$

The Cournot Model: Example

- Set $MR_1 = MC_1 = 10$,

$$100 - 2Q_1 - Q_2 = 10$$

$$Q_1 = 45 - (Q_2 / 2)$$

This equation is the Firm 1's Reaction Curve.

Similarly, Firm 2's Reaction Curve is

$$Q_2 = 45 - (Q_1 / 2)$$

The Cournot Model

- The Reaction Curve
  - 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 Firm 2.

Firm 1's Output Decision

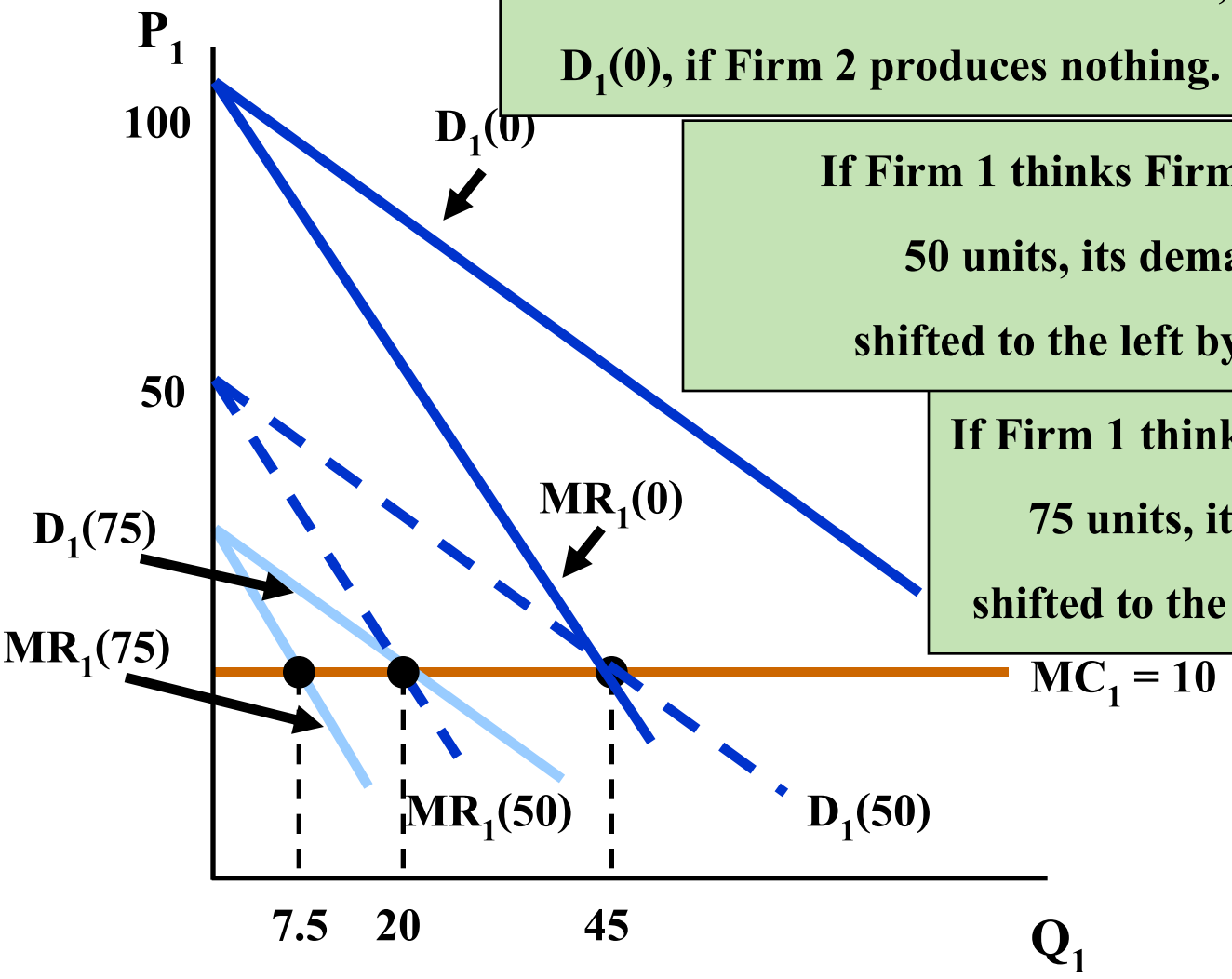
Q_2	$MR_1 = 100 - 2Q_1 - Q_2$	$Q^*_1 = 45 - Q_2/2$
0	$100 - 2Q_1$	45
50	$50 - 2Q_1$	20
75	$25 - 2Q_1$	7.5
90	$10 - 2Q_1$	0

Firm 1's Output Decision

Firm 1 and market demand curve, $D_1(0)$, if Firm 2 produces nothing.

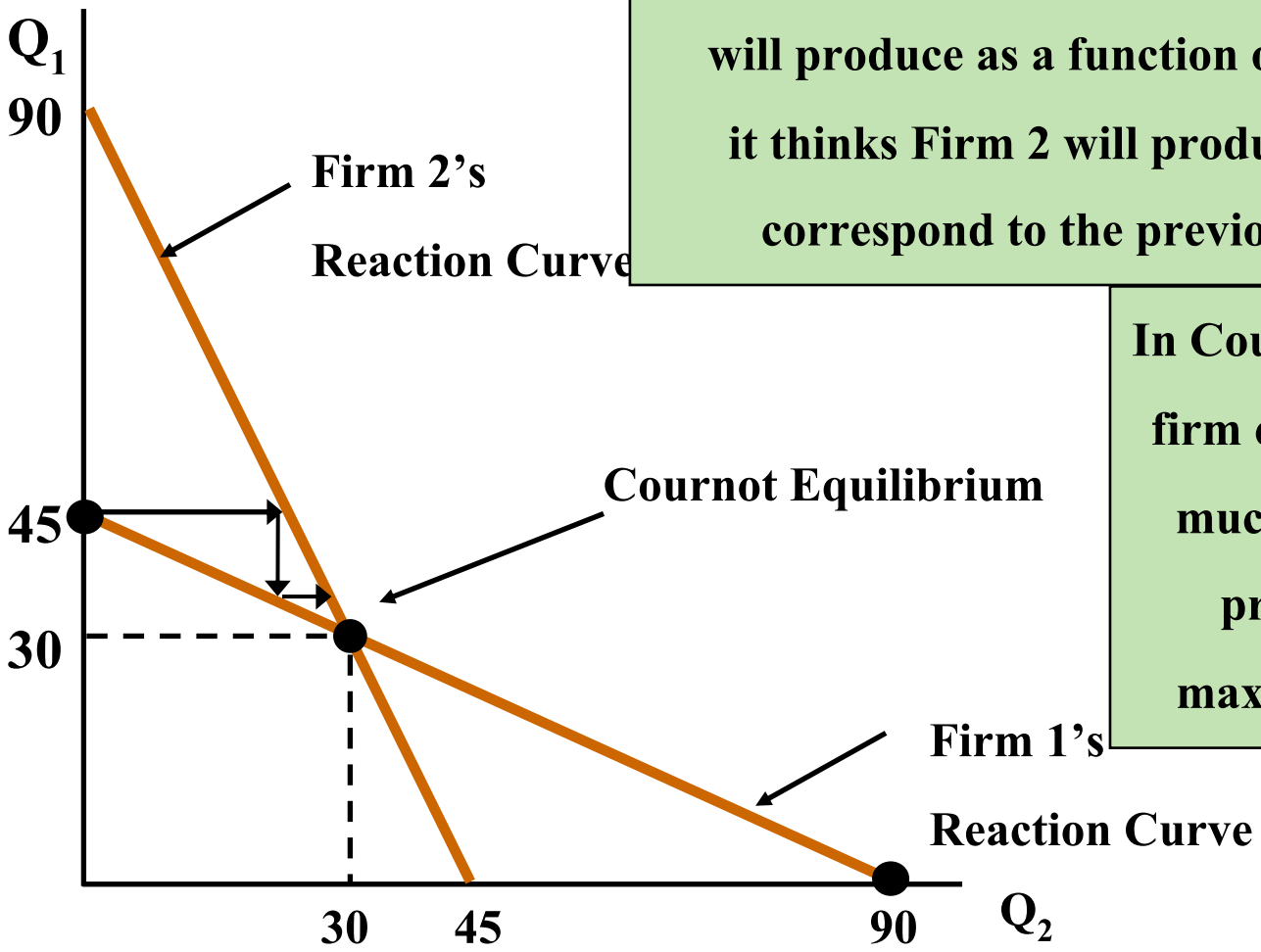
If Firm 1 thinks Firm 2 will produce 50 units, its demand curve is shifted to the left by this amount.

If Firm 1 thinks Firm 2 will produce 75 units, its demand curve is shifted to the left by this amount.



The Cournot Model: Example

Firm 1's reaction curve shows how much it will produce as a function of how much it thinks Firm 2 will produce. The x's correspond to the previous model.



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

The Cournot Model: Example

- The Cournot Equilibrium can be solved by substituting Q_1 into Q_2

$$Q_1 = 45 - \frac{1}{2}(45 - \frac{Q_1}{2}) \Rightarrow Q_2 = Q_1 = 30$$

$$Q = Q_1 + Q_2 = 60, \quad P = 100 - Q = 40$$

$$\pi_1 = (40 - 10)30 = 900 = \pi_2$$

Collusion: Example

- Profit Maximization with Collusion

$TR = PQ = (100-Q)Q = 100Q-Q^2$

$MR = dTR/dQ = 100 - 2Q$

$MR = MC = 10$

$Q = 45, P = 55$

$\pi = (55-10)45 = 2025,$

$\pi_1 = \pi_2 = 1012.5$

Profit Maximization w/Collusion

- Contract Curve or Collusion Curve
  - $Q_1 + Q_2 = 45$
    - Shows all pairs of output Q_1 and Q_2 that maximizes total profits
  - $Q_1 = Q_2 = 22.5$
    - Less output and higher profits than the Cournot equilibrium

Competitive solution

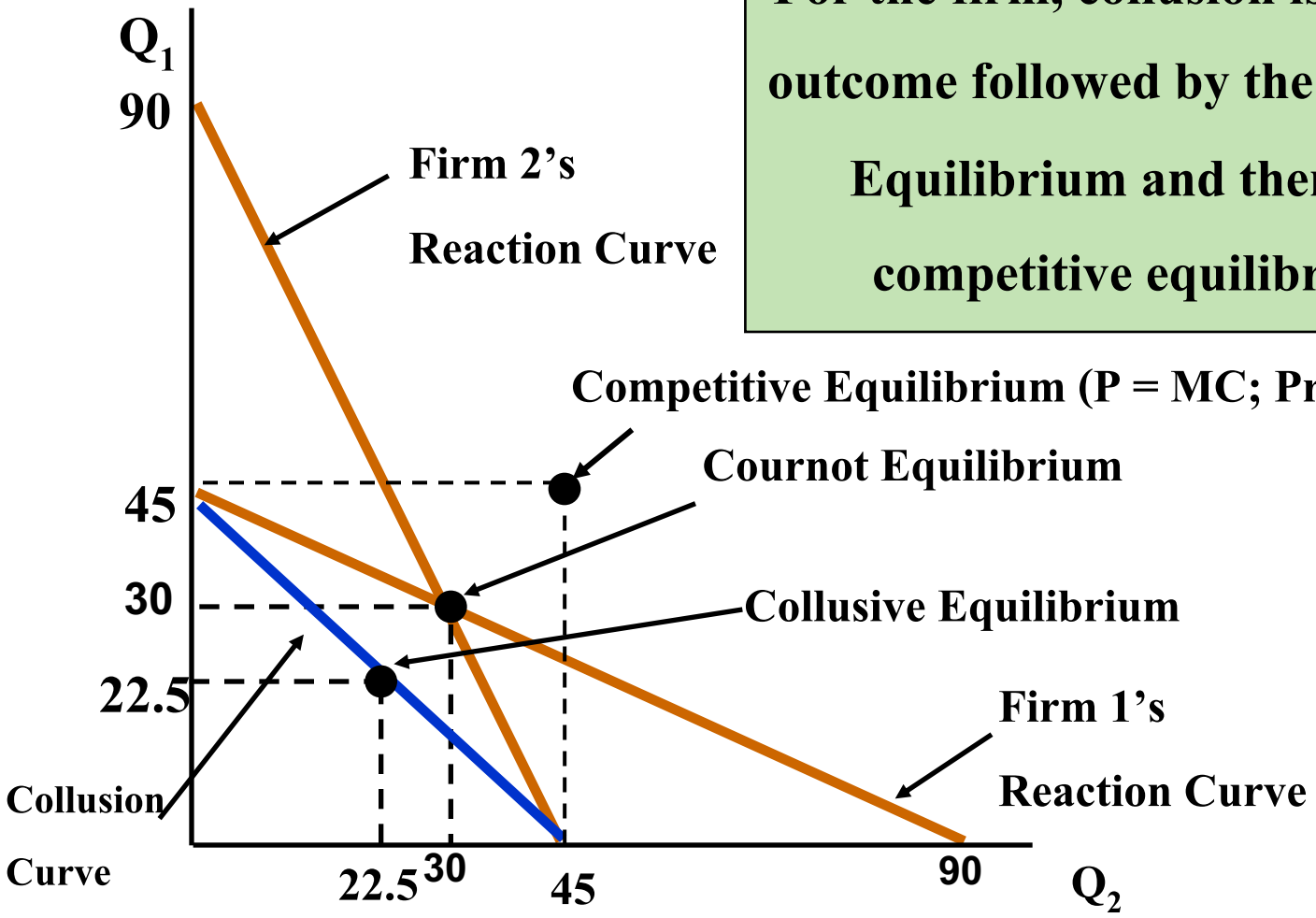
- Firms in a perfectly competitive market should maximize profits at P = MC = 10

$$10 = 100 - Q \text{ --> } Q = 90$$

$$Q_1 = Q_2 = 45$$

- Total output is higher than that in the Cournot case and the profit is normal

Duopoly Example



For the firm, collusion is the best outcome followed by the Cournot Equilibrium and then the competitive equilibrium

First Mover Advantage – The Stackelberg Model

- homogeneous goods
- one firm sets its output before other firm does.*
- simplify assumptions
  - MC = 10
  - Market demand is P = 100 - Q where Q is total output
  - Firm 1 sets output first and Firm 2 then makes an output decision seeing Firm 1 output

First Mover Advantage – The Stackelberg Model

- 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: $Q_2 = 45 - \frac{1}{2}Q_1$
- Method 1: Find residual demand for firm 1 is $P_R = 100 - Q_1 - (45 - \frac{1}{2}Q_1) = 55 - \frac{1}{2}Q_1$

First Mover Advantage – The Stackelberg Model

- Method 1: Find residual demand for firm 1 is

$$P_R = 100 - Q_1 - (45 - \tfrac{1}{2}Q_1) = 55 - \tfrac{1}{2}Q_1$$

$$TR_R = 55Q_1 - \tfrac{1}{2}Q_1^2$$

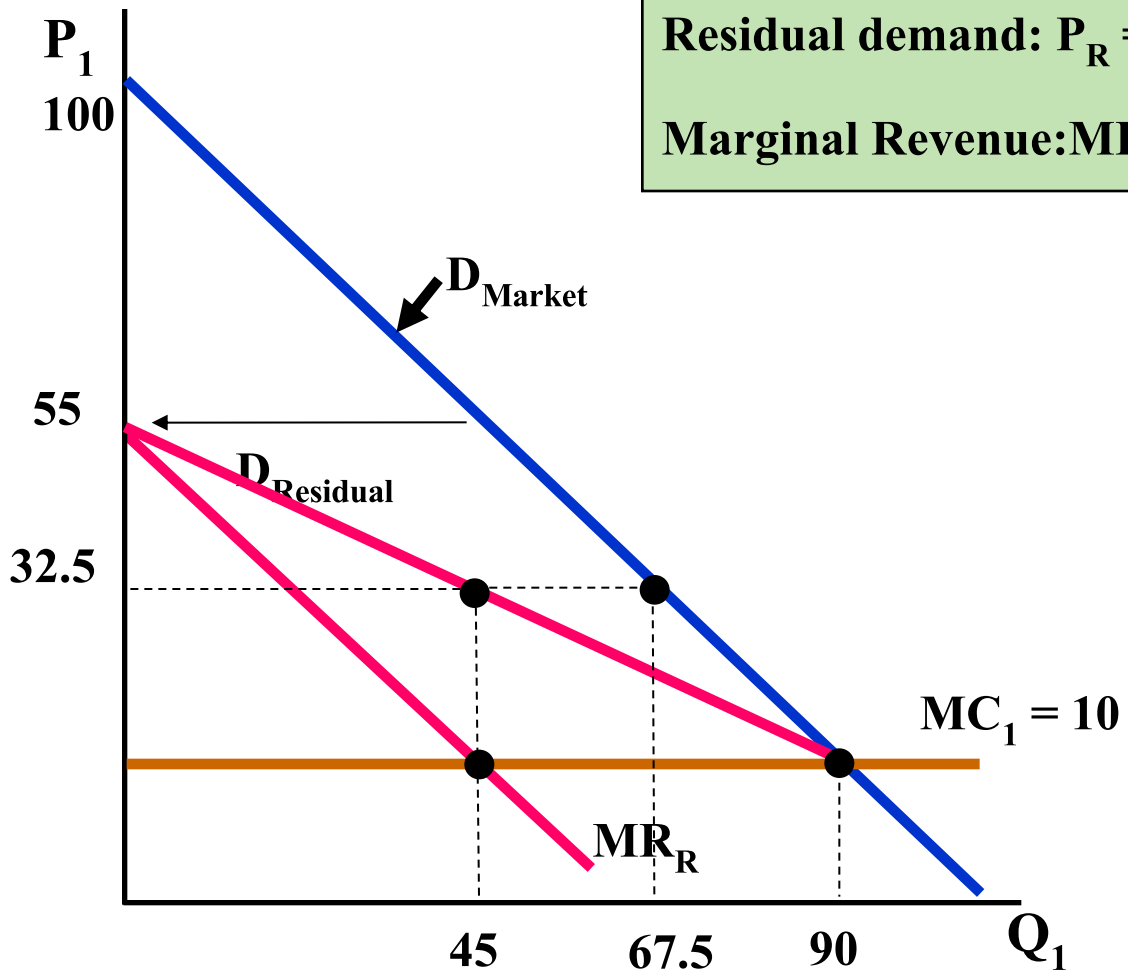
$$MR_R = 55 - Q_1$$

Then equate $MR_R = MC = 10$ to find Q_1

$$55 - Q_1 = 10$$

$$Q_1 = 45,\ Q_2 = (45\text{-}45/2) = 22.5$$

First Mover Advantage – The Stackelberg Model



Residual demand: $P_R = 55 - Q_1/2$

Marginal Revenue: $MR_R = 55 - Q_1$

First Mover Advantage – The Stackelberg Model

- Method 2: Firm 1 try to maximize profit by choosing Q_1 so that:

$$MR = MC = 10$$

$$TR_1 = PQ_1 = 100Q_1 - Q_1^2 - Q_2Q_1$$

- Firm 1 knows firm 2 will choose output based on its reaction curve. We can use firm 2's reaction curve as Q_2

First Mover Advantage – The Stackelberg Model

- Using Firm 2's Reaction Curve for Q_2:

$$TR_1 = PQ_1 = 100Q_1 - (Q_1)^2 - Q_1Q_2$$

$$= 100Q_1 - (Q_1)^2 - Q_1[45 - \tfrac{1}{2}Q_1]$$

$$= 55Q_1 - \tfrac{1}{2}Q_1^2$$

$$MR_1 = dR_1/dQ_1 = 55 - Q_1$$

- $MR_1 = MC = 10$: $Q_1 = 45$, $Q_2 = (45\text{-}45/2) = 22.5$
- $Q = 45 + 22.5 = 67.5$, $P = 100 - 67.5 = 32.5$

$\pi_1 = (32.5-10)45 = 1{,}012.5$, $\pi_2 = (32.5-10)22.5 = 506.25$

First Mover Advantage – The Stackelberg Model

- Conclusion
  - Going first gives firm 1 the advantage
  - Firm 1's output and profit are 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 wants to reduce profits for everyone

Price Competition: Bertrand

- a homogeneous good
- each firm treats the price of its competitors as fixed*
- all firms decide simultaneously what price to charge*
- simplify assumptions
  - Market demand is $P = 100 - Q$ where $Q = Q_1 + Q_2$
  - $MC_1 = MC_2 = \$10$

Price Competition: Bertrand

- For Bertrand, since good is homogeneous, consumers will buy from lowest price seller
  - If firms charge different prices, consumers buy from lowest priced firm only
  - If firms charge same price, consumers are indifferent who they buy from
  - The equilibrium price can't be lower than MC since firms can't survive
  - The equilibrium price can't be higher than MC since one of them can under cut the price.

Price Competition: Bertrand

- Nash equilibrium is competitive output since have incentive to cut prices
- Both firms set price equal to MC
  - $P = MC$; $P_1 = P_2 = \$10$
  - $Q = 90$; Q_1 & $Q_2 = 45$
- Both firms earn zero profit
- Can show the Cournot equilibrium is $Q_1 = Q_2 = 30$ and market price is \$40 giving each firm a profits of \$900.
- The Bertrand model demonstrates the importance of the strategic variable: price versus output

Bertrand Model – Criticisms

- When firms produce a homogenous good, it is more natural to compete by setting quantities rather than prices.
- Even if the firms do set prices and choose the same price, what share of total sales will go to each one?
  - It may not be equally divided.

Price Competition – Differentiated Products

- Market shares are now determined not just by prices, but by differences in the design, performance, and durability of each firm's product.
- In these markets, more likely to compete using price instead of quantity

Price Competition – Differentiated Products

- 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: $Q_2 = 12 - 2P_2 + P_1$
  - 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, assuming fixed cost = 20
- Firm 1: $\pi_1 = P_1Q_1 - 20$

$$= P_1(12 - 2P_1 + P_2) - 20$$

$$= 12P_1 - 2P_1^2 + P_2P_1 - 20$$

Price Competition – Differentiated Products

- If P_2 is fixed:

  Firm 1's profit maximizing price =

  $$d\pi_1/dP_1 = 12 - 4P_1 + P_2 = 0$$

  Firm 1's reaction curve =

  $$P_1 = 3 + \tfrac{1}{4} P_2$$

  Firm 2's reaction curve =

  $$P_2 = 3 + \tfrac{1}{4} P_1$$

Price Competition – Differentiated Products

- Bertrand equilibrium

$$P_1 = 3 + (3 + P_1/4)/4$$

$$P_1 = P_2 = 4,$$

$$Q_1 = Q_2 = 8,$$

$$\pi_1 = \pi_2 = 12$$

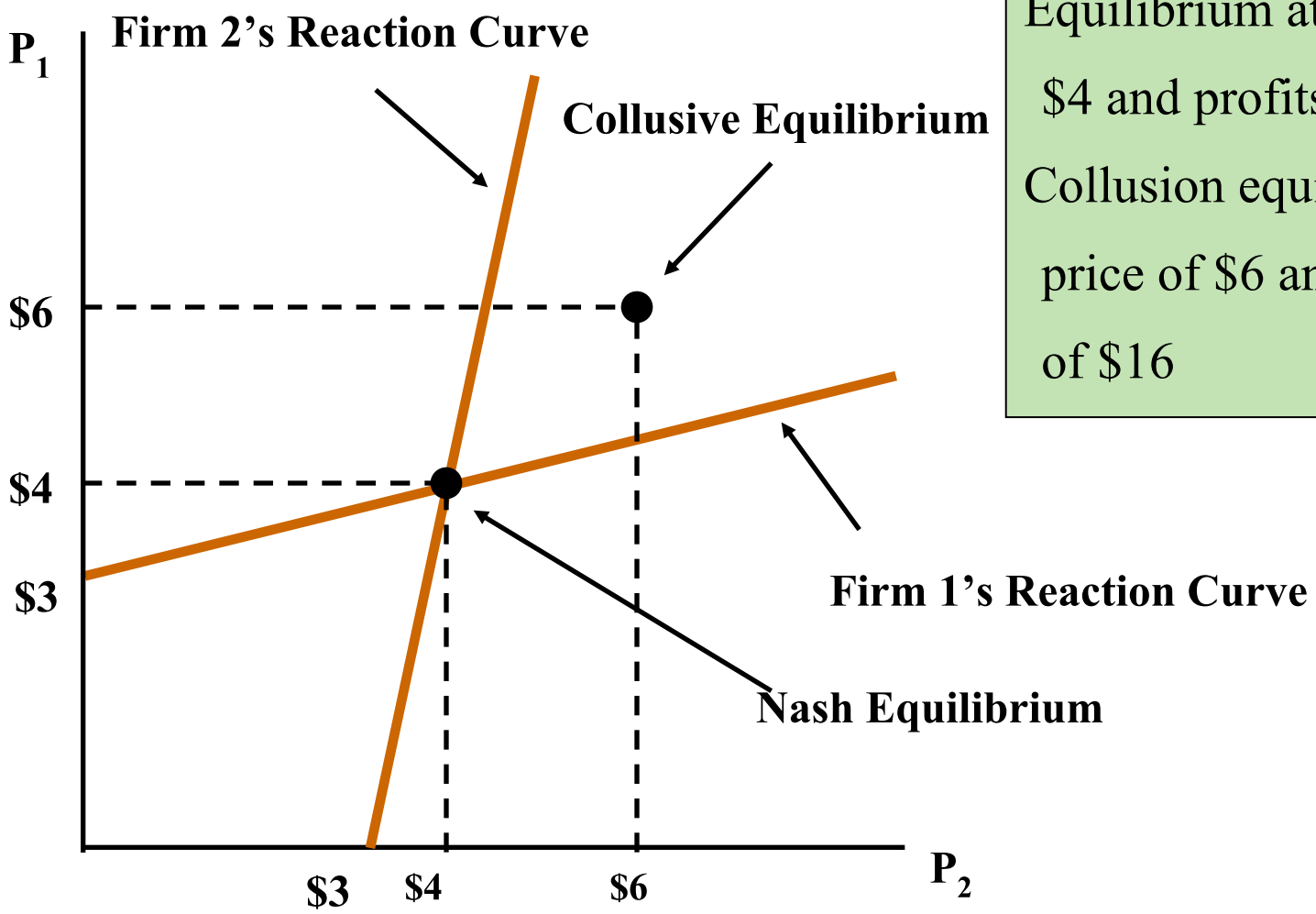
Nash Equilibrium in Prices

- What if both firms collude
  - They both decide to charge the same price that maximized both of their profits
  - Firms will charge \$6 and will be better off colluding since they will earn a profit of \$16

$$\pi = 24P - 4P^2 + 2P^2 - 40 = 24P - 2P^2 - 40$$

$$d\pi/dP = 24 - 4P = 0, \; P = 6$$

Nash Equilibrium in Prices



Equilibrium at price of $4 and profits of $12

Collusion equilibrium at price of $6 and profits of $16

Price Signaling and Price Leadership

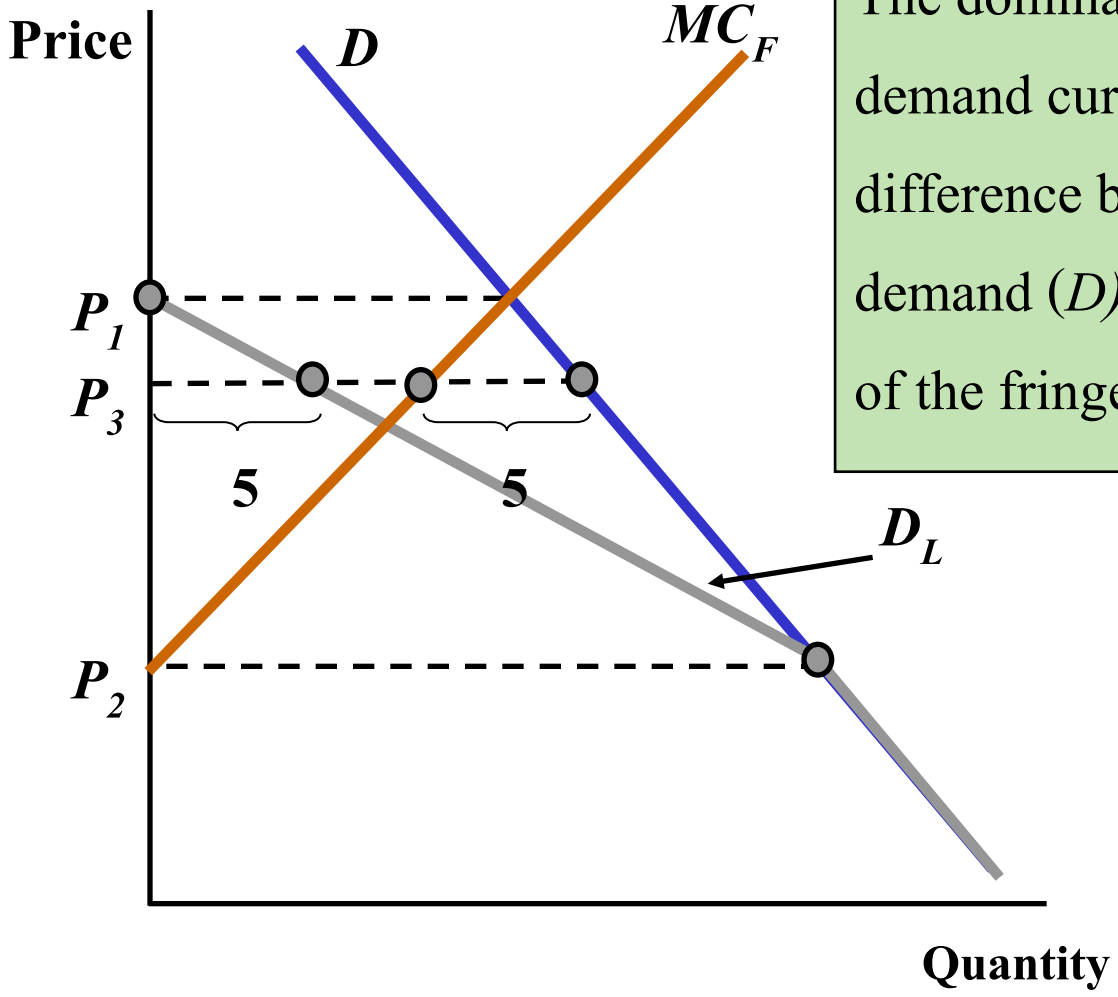
- The Dominant Firm Model (OPEC v.s. Non-OPEC)
  - In some oligopolistic markets, one large firm has a major share of total sales, and a group of smaller firms supplies the remainder of the market.
  - The large firm might then act as the dominant firm, setting a price (P_L) that maximizes its own profits.
  - The fringe firm takes P_L as given and sell at MC = P_L

http://peak-oil.org/peak-oil-reference/peak-oil-data/production-and-peak-dates-by-country/

The Dominant Firm Model

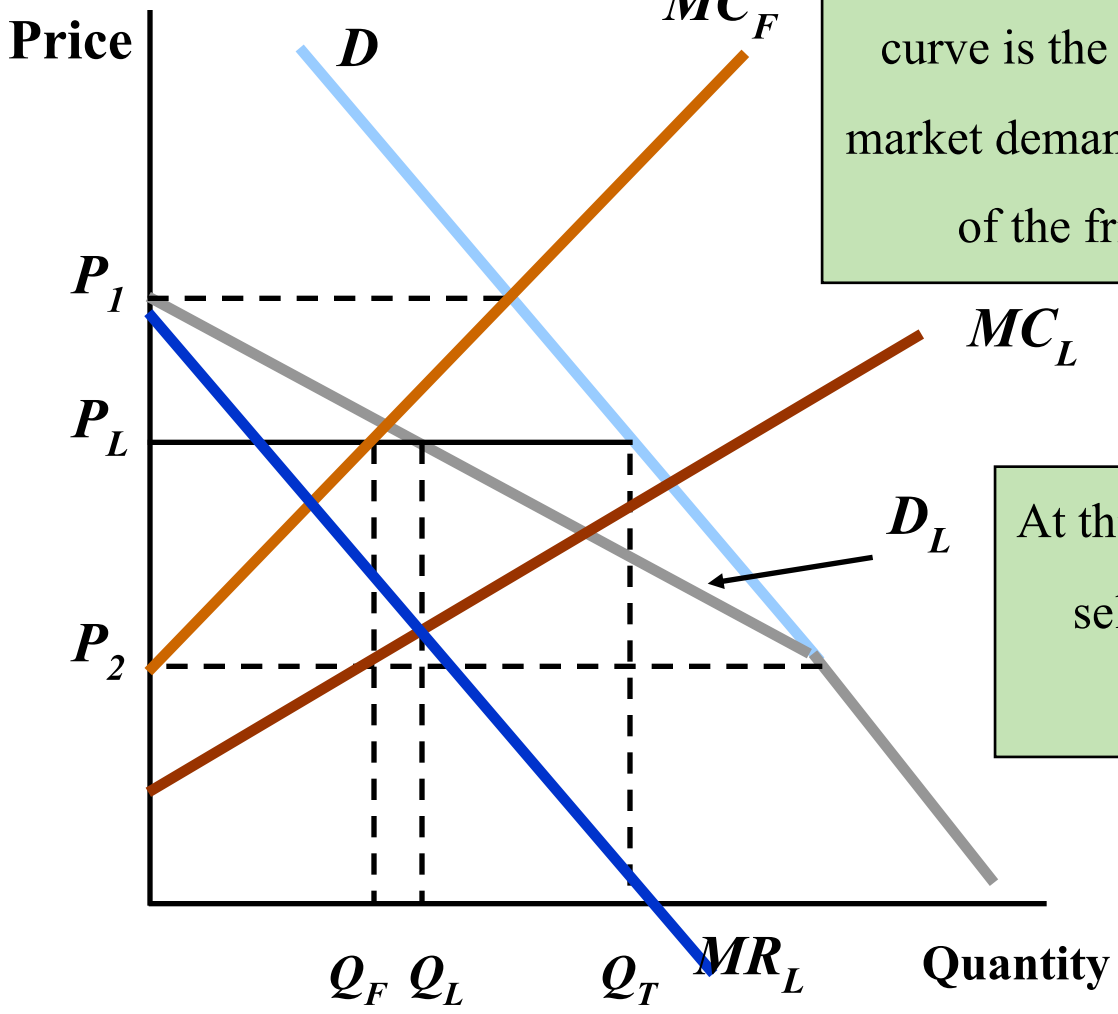
- Dominant firm must determine its demand curve, D_L.
  - Difference between market demand and the MC of the follower.
- To maximize profits, dominant firm produces Q_L where MR_L and MC_L cross.
- At P*, fringe firms sell Q_F and total quantity sold is $Q_T = Q_L + Q_F$

Price Setting by a Dominant Firm



The dominant firm's demand curve is the difference between market demand (*D*) and the supply of the fringe firms (S_F).

Price Setting by a Dominant Firm



The dominant firm's demand curve is the difference between market demand (*D*) and the supply of the fringe firms (S_F).

At this price, fringe firms sell Q_F, so that total sales are Q_T.