

Agenda

1. Cournot Model of Oligopoly
2. Bertrand Model of Oligopoly
3. Stackelberg Model of Oligopoly
4. Dominant Firm Market
5. Product Differentiation
6. Monopolistic Competition

Duopoly and Oligopoly

- ▶ **Duopoly Market:** A market with just two firms.
- ▶ **Oligopoly Market:** A market with a small number of firms (two or more).
- ▶ Types of Duopoly Models:
 - ▶ **Cournot Model**
 - ▶ **Bertrand Model**
 - ▶ **Stackelberg Model**
- ▶ Some models make more sense in different contexts.
- ▶ All models can have more than two firms.

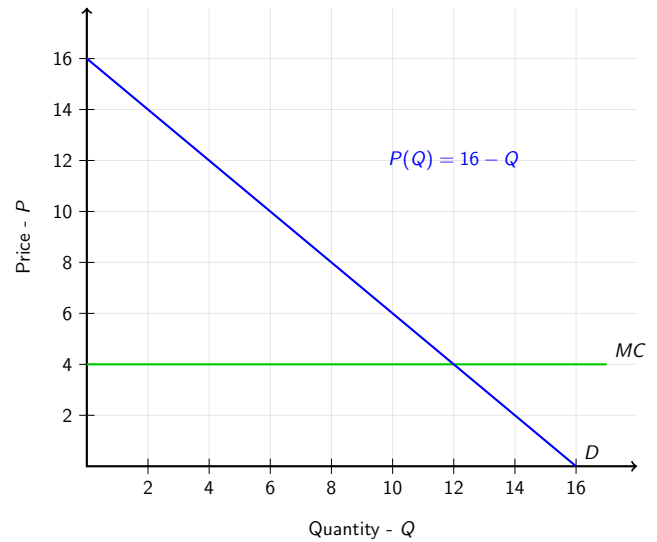
Cournot Model of Oligopoly

▶ Cournot Duopoly Model

- ▶ Two firms competing in one industry. (A and B)
- ▶ Firms may have different cost curves.
- ▶ The industry has one demand curve.
- ▶ Firms choose quantity simultaneously, without talking. (Q_A and Q_B)
- ▶ Market price depends on combined output.

$$Q^M = Q_A + Q_B$$

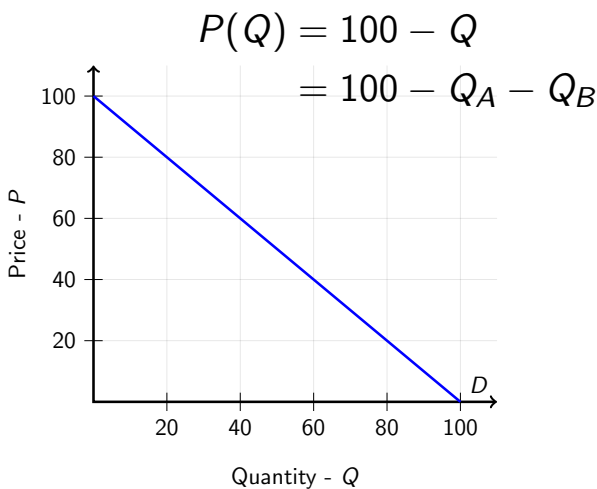
- ▶ In equilibrium, neither firm wants to change quantity, even if they know what the other firm is producing.



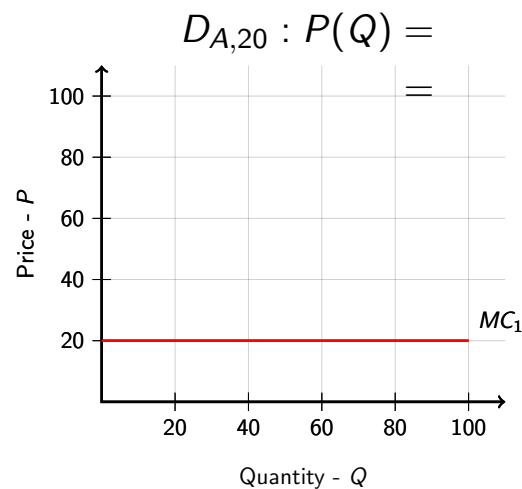
Q_A	Q_B	Q^M	$P(Q^M)$
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Residual Demand

- ▶ To find equilibrium, need to determine what to do given other firm's production.
- ▶ **Residual Demand Curve:** In a Cournot model, the curve that traces out the relationship between the market price and a firm's quantity when rival firms hold their outputs fixed.
- ▶ **Example:** Market Demand:

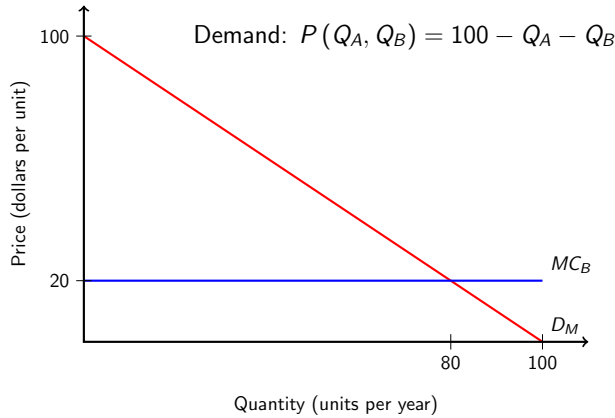


- ▶ If $Q_B = 20$, then Residual Demand:



Best Response

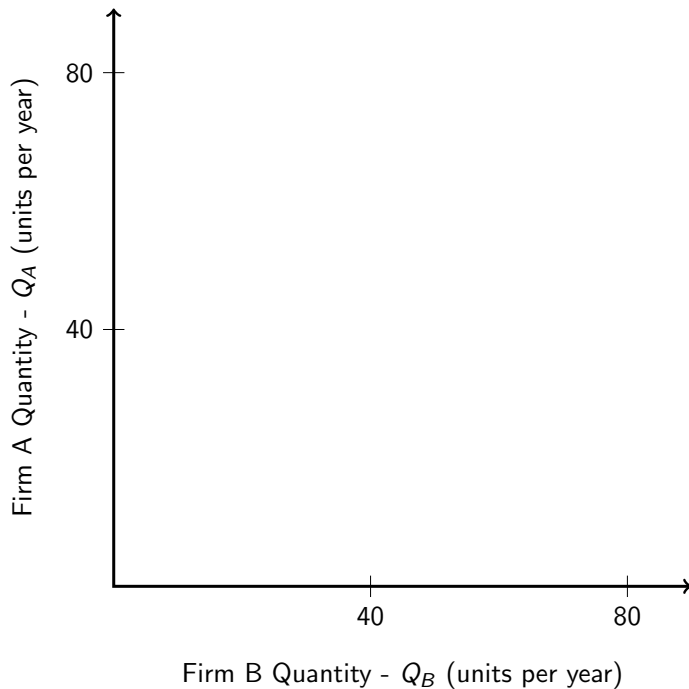
- ▶ **Best Response:** A firm's profit-maximizing choice of output given the level of output by rival firms.



Firm A (Q_A)	Firm B's BR (Q_B)
0	
20	
60	
80	
Q_A	

Reaction Function

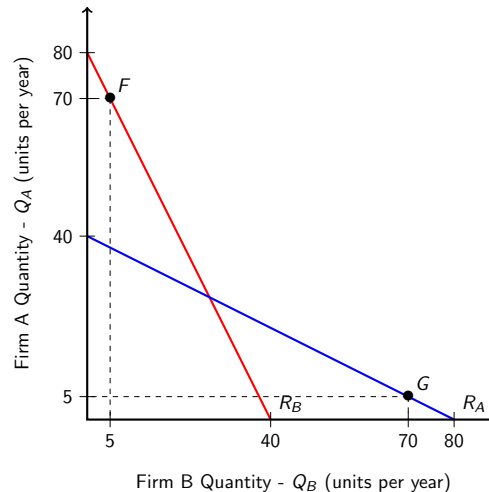
- ▶ **Reaction Function:** A graph that shows a firm's best response for each possible action of a rival firm.



Firm A (Q_A)	Firm B's BR (Q_B)
0	
20	
60	
80	
Q_A	

Cournot Equilibrium

- ▶ **Cournot Equilibrium:** An equilibrium in an oligopoly market in which each firm chooses a profit-maximizing output



- ▶ At any level of output other than equilibrium,

Cournot Exercise

- ▶ Suppose that the industry demand is given by,

$$P(Q) = 75 - Q$$

where Q is the total produced by all firms.

- ▶ Suppose that all firms face marginal cost,

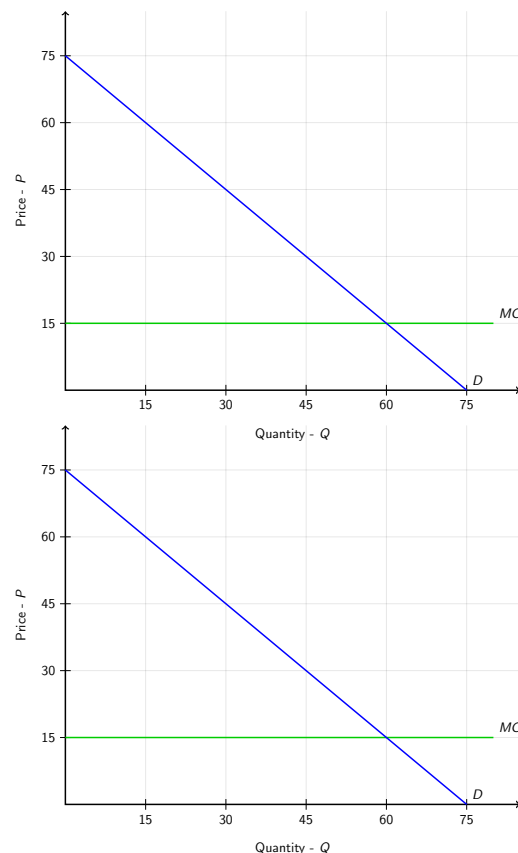
$$MC(Q) = 15$$

- ▶ Exercise:
 1. Find the profit maximizing price if there is a monopolist in this market.
 2. Calculate the monopolists profits and consumer surplus.
 3. Find the Cournot duopoly price if there are two firms in this market.
 4. Calculate the industry profits and consumer surplus.

Solution

Monopolist

Cournot



Cournot Oligopoly (2 or more firms)

- ▶ Market has N identical firms.
- ▶ Market demand is linear $P(Q) = a - bQ$.
- ▶ All firms face constant marginal cost $MC(Q) = c$.
- ▶ Find Reaction for Firm 1:
 - ▶ Given that all other firms produce $X = Q_2 + Q_3 + \dots + Q_N$, the demand for Firm 1 is,
 - ▶ The corresponding Marginal Revenue is,
 - ▶ Setting $MR = MC$ gives,

Cournot Oligopoly (2 or more firms)

- ▶ Since all firms are identical, all firms will produce the same amount in equilibrium.

$$X = Q_2 + Q_3 + \dots + Q_N =$$

- ▶ Using the reaction function, determine production level for each firm.

- ▶ Quantity produced by market is,

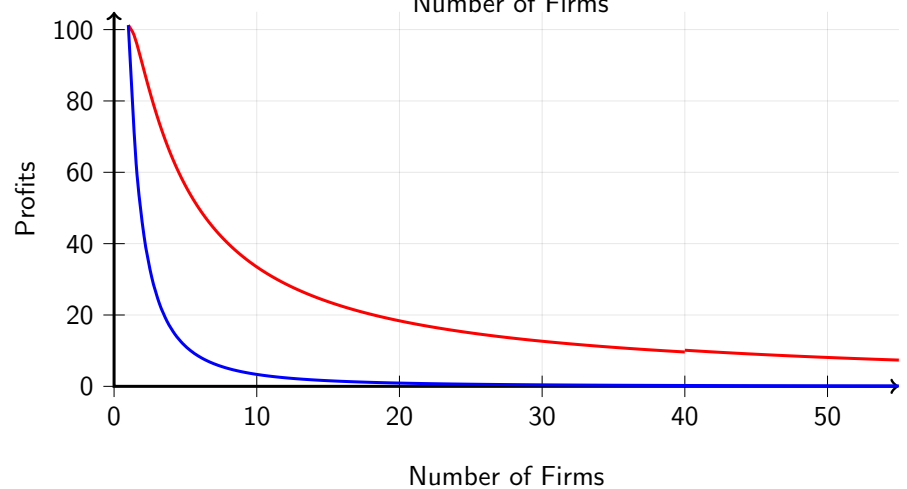
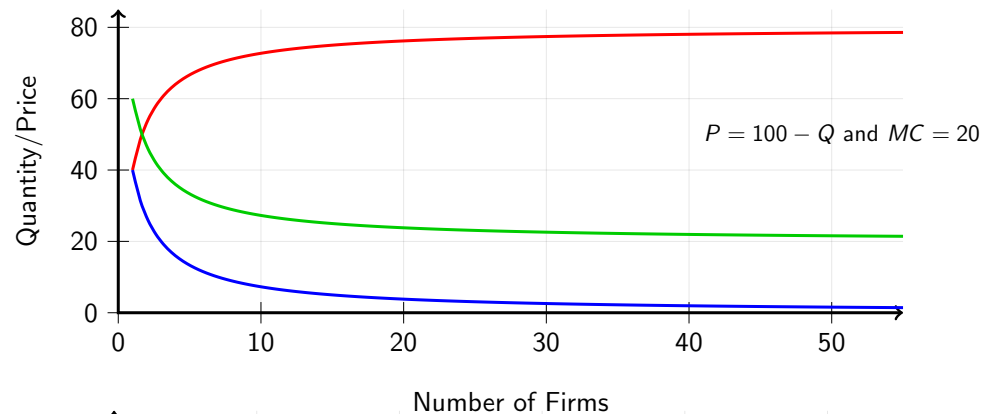
$$Q_M =$$

- ▶ Use market demand curve to find price,

$$P = a - bQ_M =$$

Cournot Markets

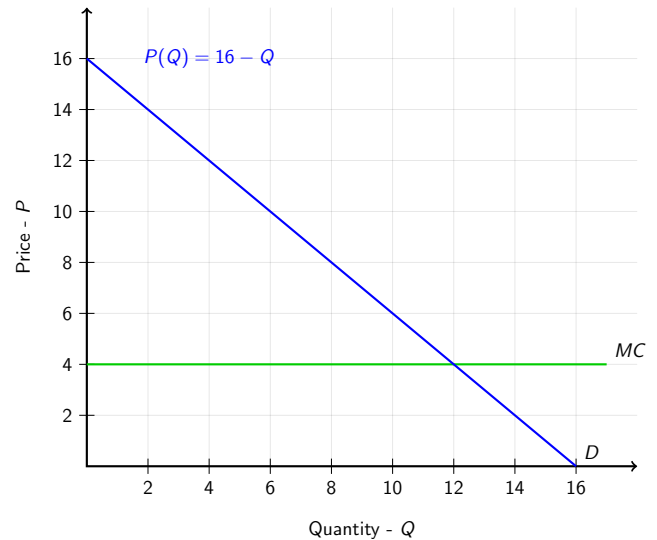
# Firms					
1	60.00	40.00	40.00	1600	1600
2	46.67	26.67	53.33	711	1422
3	40.00	20.00	60.00	400	1200
5	33.33	13.33	66.67	178	888
10	27.27	7.27	72.72	53	529
50	21.57	1.57	78.43	2.46	123
100	20.79	0.79	79.21	0.63	63
∞	20.00	0	80.00	0	0



Bertrand Model of Oligopoly

► Bertrand Duopoly Model

- Two firms competing in one industry. (A and B)
- Firms may have different cost curves.
- The industry has one demand curve.
- Firms choose price simultaneously, without talking. (P_A and P_B)
- Market price is the lowest $P^M = \min \{P_A, P_B\}$.
- If $P_A = P_B$, then firms split profits.
- In equilibrium, neither firm wants to change price, even if they know the price of the other firm.



P_A	P_B	P^M	Q^M
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Bertrand Model

- **Bertrand equilibrium:** An equilibrium in which each firm chooses a profit maximizing price given the price set by the other firm.

► Example:

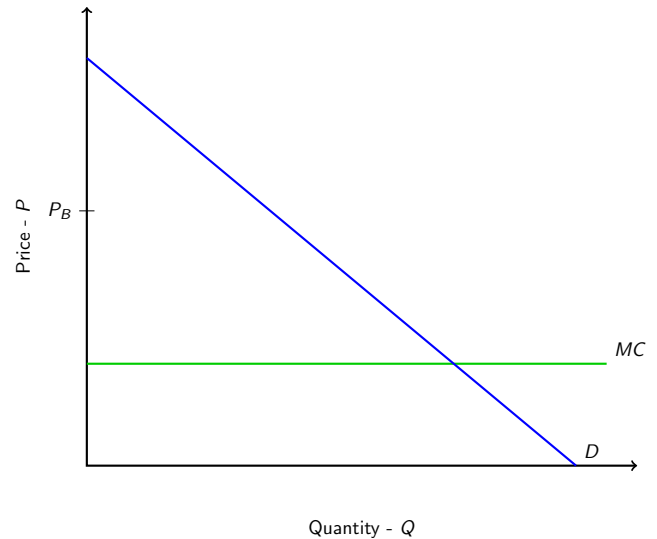
- Industry Demand Curve is,

$$P(Q) = 100 - Q$$

- Marginal Cost for both firms is,

$$MC(Q) = 20$$

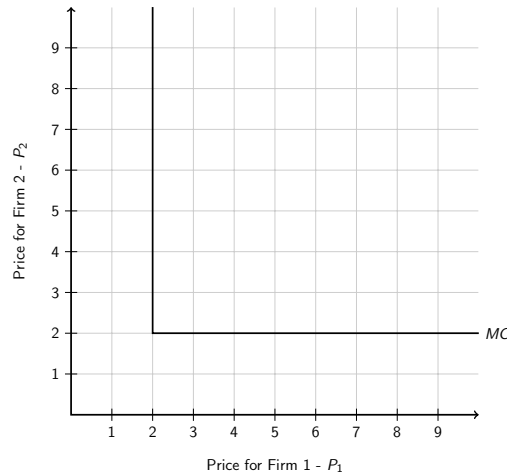
- Given P_B , What should Firm A do?



Price	Q_A	π_A
$P_A > P_B$		
$P_A = P_B$		
$P_A < P_B$		

Bertrand Model

- ▶ What would the reaction function look like?
 - ▶ For simplicity, assume prices can only be dollar amounts (no cents).



Bertrand Example

The Making of a Fly: The Genetics of Animal Design (Paperback)
by Peter A. Lawrence

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Always pay through Amazon.com's Shopping Cart or 1-Click.
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Price at a Glance
List: 670.00
Price: ~~670.00~~
Used: from **\$42.56**
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All **New** (2 from \$18,651,718.08) **Used** (11 from \$42.56)

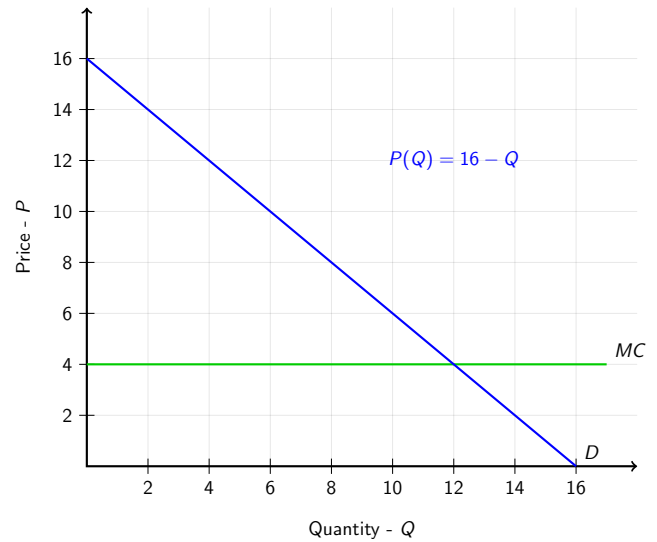
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Price + Shipping	Condition	Seller Information	Buying Options
\$18,651,718.08 + \$3.99 shipping	New	Seller: profnath Seller Rating: ★★★★★ 93% positive over the past 12 months. (8,278 total ratings) In Stock. Ships from NJ, United States. Domestic shipping rates and return policy . Brand new, Perfect condition, Satisfaction Guaranteed.	Add to Cart or Sign in to turn on 1-Click ordering.
\$23,698,655.93 + \$3.99 shipping	New	Seller: bordeebok Seller Rating: ★★★★★ 93% positive over the past 12 months. (127,332 total ratings) In Stock. Ships from United States. Domestic shipping rates and return policy . New item in excellent condition. Not used. May be a publisher overstock or have slight shelf wear. Satisfaction guaranteed!	Add to Cart or Sign in to turn on 1-Click ordering.

Stackelberg Model of Oligopoly

▶ Stackelberg Duopoly Model

- ▶ Two firms competing in one industry. (A and B)
- ▶ Firms may have different cost curves.
- ▶ The industry has one demand curve.
- ▶ Firms choose quantity sequentially, without talking. (Q_A and Q_B)
- ▶ Firm B sees Q_A before choosing.
- ▶ Market price depends on combined output.



$$Q^M = Q_A + Q_B$$

Q_A	Q_B	Q^M	$P(Q^M)$
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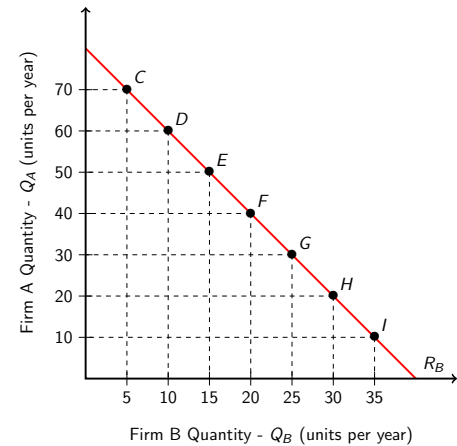
- ▶ In equilibrium, neither firm wants to change quantity, even if they know what the other firm is producing.

Stackelberg Model of Oligopoly

- ▶ **Stackelberg Model of Oligopoly:** A situation in which one firm acts as a quantity leader, choosing its quantity first, with all other firms acting as followers.

▶ Example:

- ▶ Firm A sets quantity first.
- ▶ After Firm A sets their quantity, the Firm B chooses their quantity.
- ▶ Firm A knows Firm B will choose on their reaction curve.



Q_A	Q_B	Market Price	Firm A's Profit	Firm B's Profit
70	5	\$25	\$350	\$25
60	10	\$30	\$600	\$100
50	15	\$35	\$750	\$225
40	20	\$40	\$800	\$400
30	25	\$45	\$750	\$625
20	30	\$50	\$600	\$900
10	35	\$55	\$350	\$1225

Stackelberg Exercise

- ▶ Suppose the demand curve is,

$$P(Q) = 100 - Q$$

- ▶ Firms both face constant marginal cost $MC = 20$.

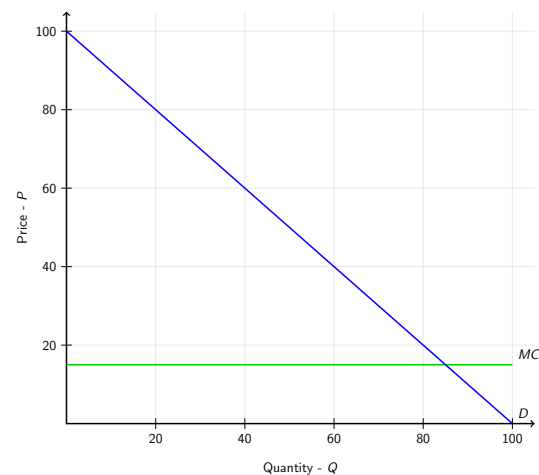
- ▶ Progression

1. Firm 1 sets Q_1 .
2. Firm 2 sees Q_1 .
3. Firm 2 sets Q_2 .

- ▶ Answer the following questions

1. Given that firm 1 sets Q_1 , how much would firm 2 produce?
2. If firm 2 always produces the above amount, how much would firm 1 want to produce to maximize profits?
3. What is the Stackelberg equilibrium price?

Solution



Product Differentiation

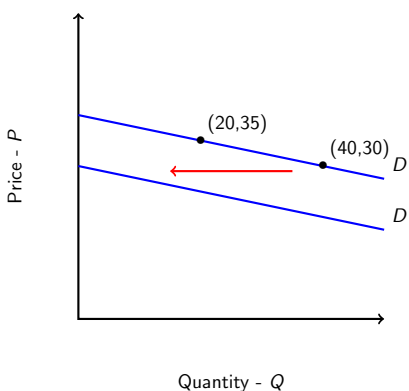
- ▶ **Vertical Differentiation:** A situation involving two products such that consumers consider one product better or worse than the other.
- ▶ **Horizontal Differentiation:** A situation involving two products such that some consumers view one as a poor substitute for the other and thus will buy the one even if its price is higher than the other's.
 - ▶ Example:



Product Differentiation

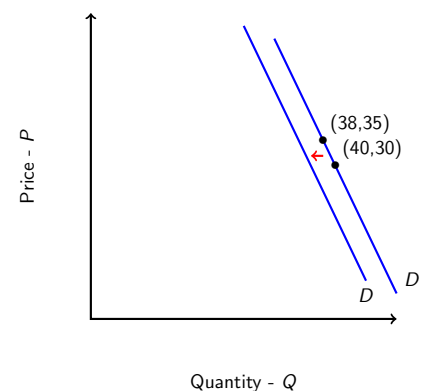
▶ Weak Differentiation

- ▶ Quantity demanded very sensitive to price changes.
- ▶ Competitor reducing prices causes large shift in demand.



▶ Strong Differentiation

- ▶ Quantity demanded not sensitive to price changes.
- ▶ Competitor reducing prices causes small shift in demand.



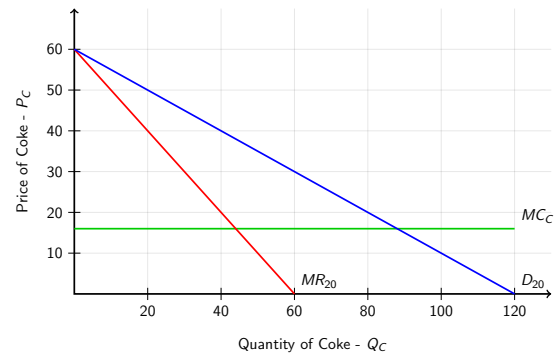
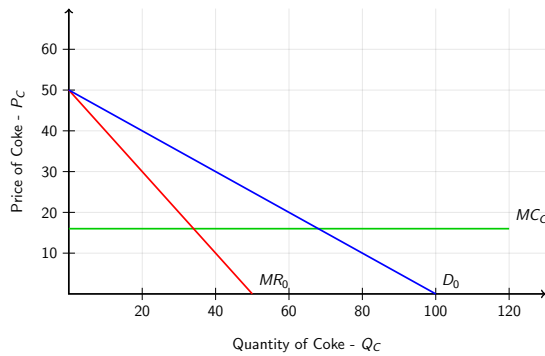
Bertrand with Horizontally Differentiated Prices

- Suppose there are two firms (C and P) with residual demand curves,

$$Q_C = 100 - 2P_C + P_P, MC_C = 16$$

$$Q_P = 30 - 5P_P + 4P_C, MC_P = 18$$

- Residual Demand Curves for Coke:



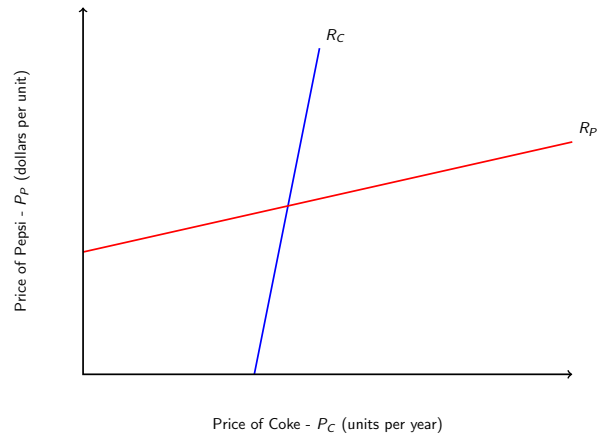
Solution

$$Q_C = 100 - 2P_C + P_P \quad MC_C = 16$$

$$Q_P = 30 - 5P_P + 4P_C \quad MC_P = 18$$

Bertrand with Horizontally Differentiated Prices

- ▶ Reaction functions for Firm 1 and Firm 2.



Summary

	Identical Products	Differentiated Products
Many Firms	Perfect Competition (corn)	Monopolistic Competition (restaurants)
Few Firms	Homogeneous Products Oligopoly (salt)	Differentiated Products Oligopoly (soda)
One Dominant Firm	Dominant Firm	N/A
One Firm	Monopoly	N/A