OLIGOPOLY

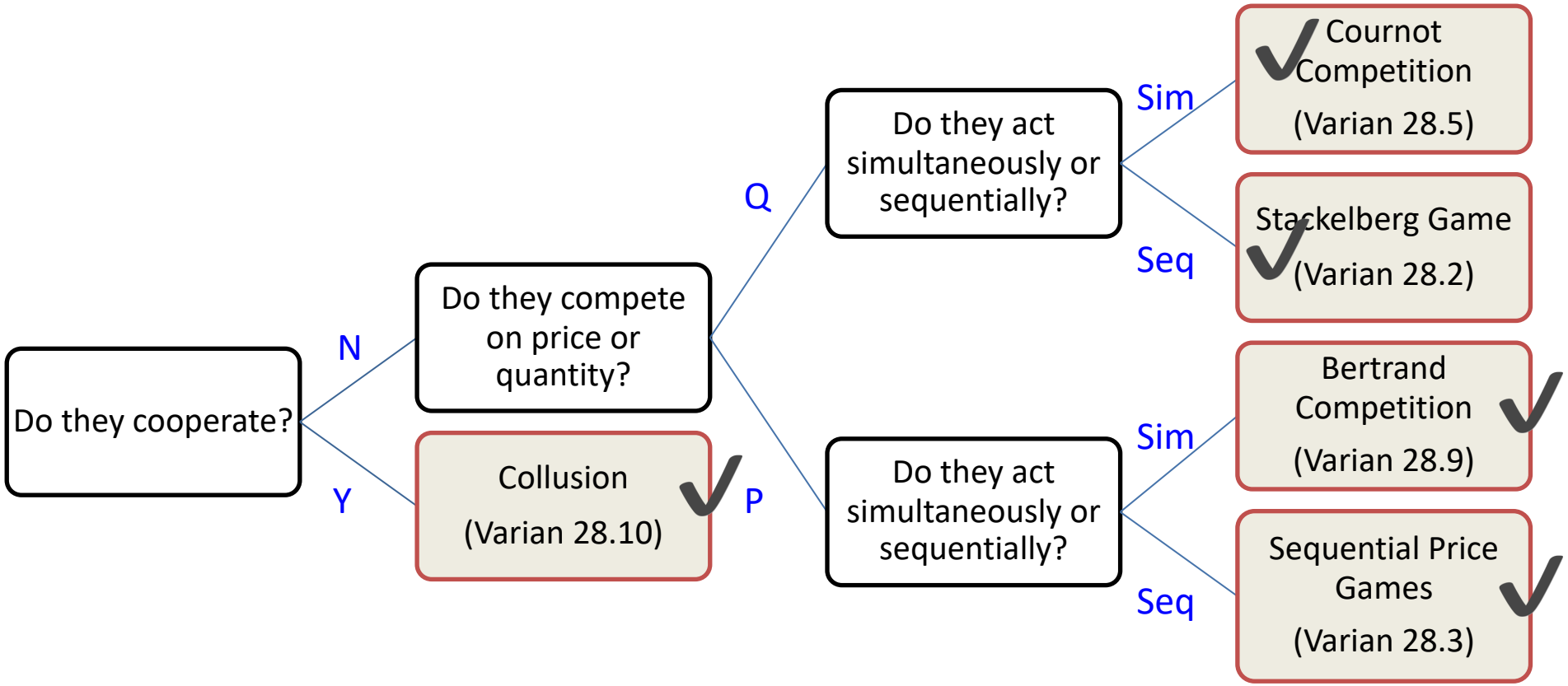
PART II : COLLUSION & PRICE COMPETITION

Weeks 4–5

(Chapter 28 optional reading)

The Big Picture

Nature of competition among oligopolistic firms depends on how they interact



Cournot Competition

- Coke and Pepsi compete in the cola market
- The product is homogeneous
- Coke and Pepsi decide quantity/capacity simultaneously and independently
- Market demand is $P = 100 - X - Y$
- Marginal cost is $MC = 10$

Cournot Equilibrium

- Coke chooses a quantity that maximizes Coke's profit given the actual quantity choice of Pepsi
- Pepsi chooses a quantity that maximizes Pepsi's profit given the actual quantity choice of Coke
- Cournot equilibrium quantities are Coke and Pepsi's mutual best responses

What if Coke and Pepsi collude?

- Suppose now Coke and Pepsi collude, so they act like a monopolist in the market
- Their goal is to maximize their joint monopoly profit
- $Q=X+Y$ is the joint output of Coke and Pepsi
- The inverse demand curve is

$$P = 100 - X - Y = 100 - Q$$

Coke and Pepsi's joint monopoly price

- Then marginal revenue is $MR = 100 - 2Q$
- Coke and Pepsi should set *MR* = *MC*

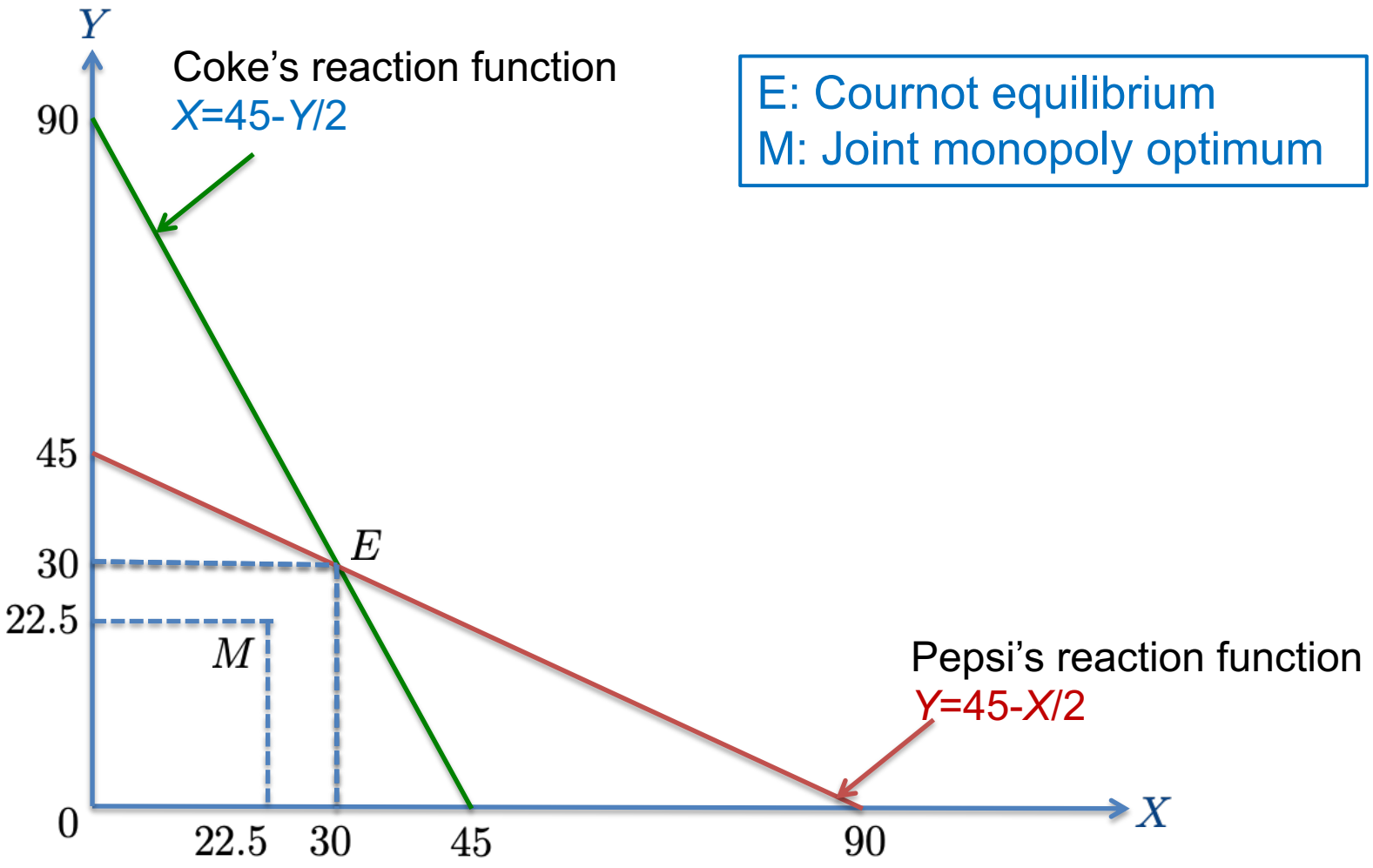
$$100 - 2Q = 10 \implies Q = 45$$

- The profit-maximizing price is $P = 100 - 45 = 55$
- Coke and Pepsi's joint monopoly profit is

$$\pi = TR - TC = 55 \times 45 - 10 \times 45 = 2025$$

- If they split the profit equally, each will get 1012.5

Cournot vs. Joint Monopoly



Cournot vs. Joint Monopoly

	Cournot Equilibrium	Joint Monopoly Optimum
Price	40 ($P>MC$)	55 ($P>MC$)
Quantity	60 (30 each)	45 (22.5 each)
Profit	900 each	1012.5 each

Cournot vs. Stackelberg vs. Joint Monopoly

	Cournot Equilibrium	Stackelberg Equilibrium	Joint Monopoly Optimum
Price	40	32.5	55
Quantity	30 each	45 (Coke) 22.5 (Pepsi)	22.5 each
Profit	900 each	1012.5 (Coke) 506.25 (Pepsi)	1012.5 each

Collusion

- Is such a cartel stable?

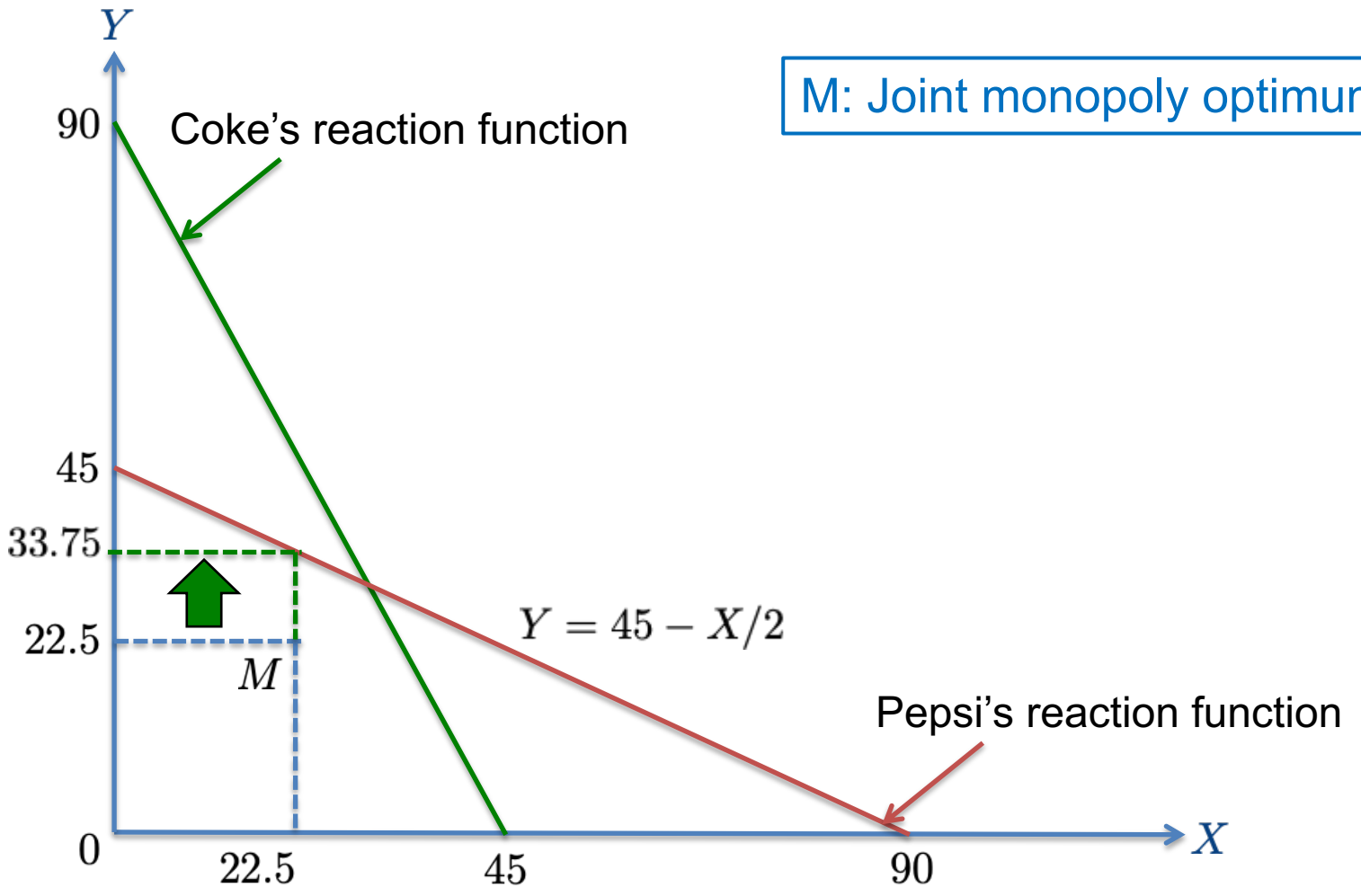
- Does one firm have an incentive to cheat on the other?
  - If Coke produces 22.5 units, is it profit-maximizing for Pepsi to produce 22.5 units?
  - **NO**

Collusion

- Recall that Pepsi's reaction function is $Y = 45 - \frac{X}{2}$
- If Coke produces 22.5 units, Pepsi's best response is to produce 33.75 units
- It's profit will then be

$$\begin{aligned}\pi &= PY - 10Y \\ &= (100 - 22.5 - 33.75)33.75 - 10(33.75) \\ &= 1139.1 > 1012.5\end{aligned}$$

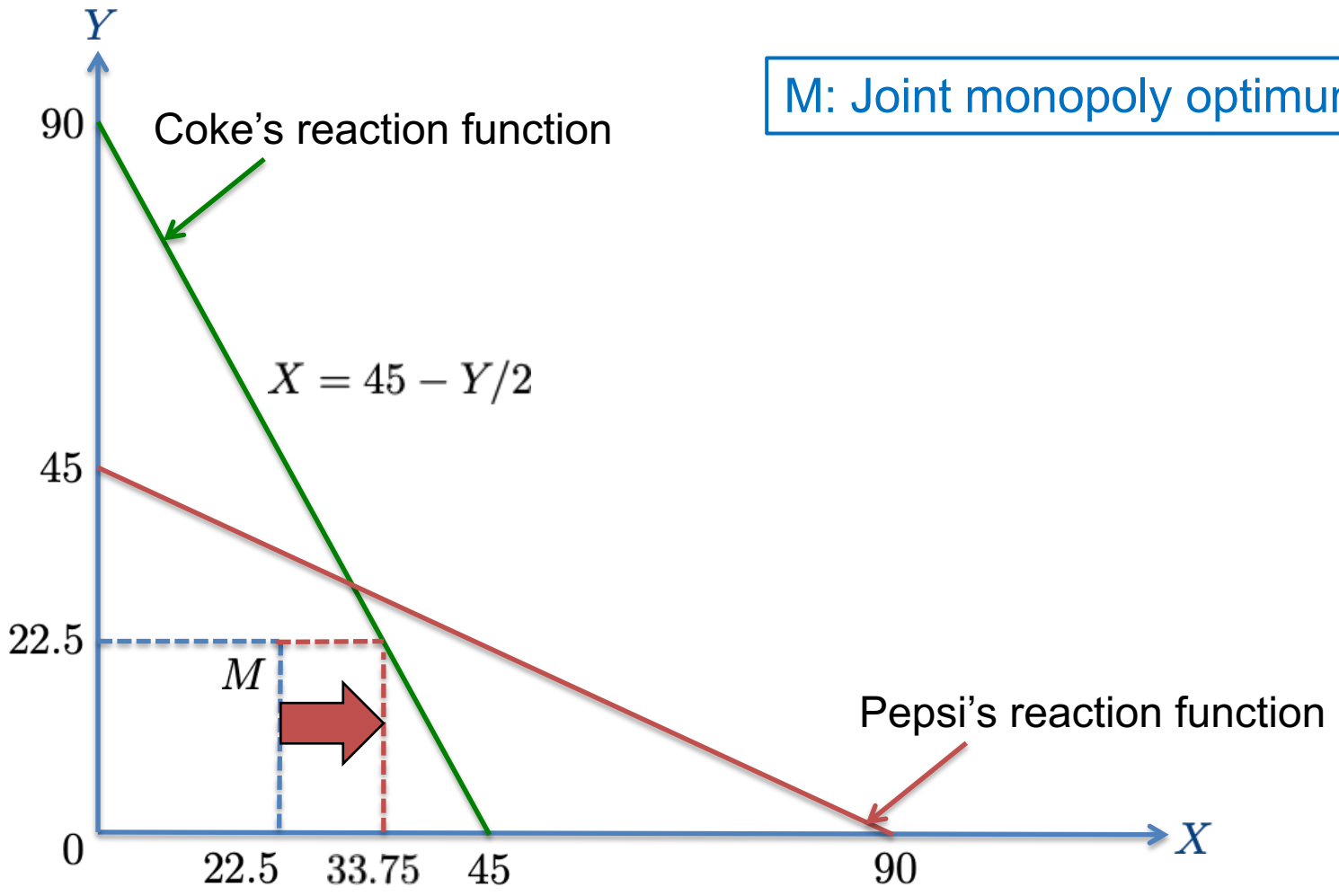
Incentive to cheat under Joint Monopoly



Pepsi has the incentive to cheat

- Pepsi's profit-maximizing response to $X = 22.5$ is $Y = 33.75 > 22.5$
- Pepsi's profit increases if it cheats on Coke by increasing its output level from 22.5 to 33.75

How about Coke?



M: Joint monopoly optimum

Coke has the incentive to cheat too

- Coke's best response is $X = 45 - \frac{Y}{2}$

- Similarly, Coke has the incentive to cheat

- If Pepsi produces 22.5, Coke's profit increases if it cheats on Pepsi by increasing its output level from 22.5 to 33.75

One-off cooperation is unstable

- A profit-seeking cartel in which firms cooperatively set their output levels is inherently unstable
- *E.g.:* OPEC's broken agreements
- But the cartel may be stable if the game is repeated many times, instead of being played only once
- With repeated interactions, there is an opportunity to punish a cheater

Punishing the Cheat

- Basic idea: if there is a way to ensure that the cheat suffers from the next period onward, and if the suffering is sufficiently painful, cheating will not occur in the current period

- If Pepsi cheats, one way for Coke to punish Pepsi is to refuse to cooperate with Pepsi forever (Fool me once, shame on you; fool me twice, shame on me)

Punishing the Cheat

To determine if such a cartel can be stable we need to know 4 things:

1. What is each firm's per period profit in the cartel?

2. What is the profit a cheat earns in the first period in which it cheats?

3. What is the profit the cheat earns in each period after it first cheats?

4. What is the discount factor?

Cournot Equilibrium vs. Joint Monopoly

	Cournot	Joint Monopoly
Price	40	55
Quantity	30 each	22.5 each
Profit	900 each	1012.5 each

- If Coke and Pepsi interact repeatedly over time
- If Coke and Pepsi maximize their joint monopoly profit and split the profit equally, each will get $1012.5
- If cooperation breaks down, Coke and Pepsi revert back to Cournot competition, Pepsi will get $900 each period

Punishing the Cheat

To determine if such a cartel can be stable we need to know 4 things:

1. What is each firm's per period profit in the cartel? $1012.5
2. What is the profit a cheat earns in the first period in which it cheats? $1139.1
3. What is the profit the cheat earns in each period after it first cheats? $900
4. What is the discount factor?

What is the discount factor?

- Suppose the discount factor of Pepsi (and Coke) is δ, where $0 \leq \delta \leq 1$
- δ=0, Pepsi does not value future at all
- δ=1, Pepsi values future as much as today
- δ=0.5, Pepsi values future half as much as today

Is it worth cheating?

Hence, if Pepsi refrain from cheating, the present value of its stream of profits is

$$PV_{nocheat} = 1012.5 + \delta \cdot 1012.5 + \delta^2 \cdot 1012.5 + \delta^3 \cdot 1012.5 + ...$$

$$PV_{nocheat} = 1012.5 + \delta \cdot [1012.5 + \delta \cdot 1012.5 + \delta^2 \cdot 1012.5 + ...]$$

$$PV_{nocheat} = 1012.5 + \delta \cdot PV_{nocheat}$$

$$PV_{nocheat} = \frac{1}{1-\delta} \cdot 1012.5$$

Is it worth cheating?

If Pepsi cheats, the present value of its stream of profits is

$$PV_{cheat} = 1139.1 + \delta \cdot 900 + \delta^2 \cdot 900 + \delta^3 \cdot 900 + ...$$

$$PV_{cheat} = 1139.1 + \delta \cdot [900 + \delta \cdot 900 + \delta^2 \cdot 900 + ...]$$

$$PV_{cheat} = 1139.1 + \frac{\delta}{1-\delta} \cdot 900$$

Is it worth cheating?

Pepsi will not cheat if

$$PV_{cheat} < PV_{nocheat}$$

$$1139.1 + \frac{\delta}{1-\delta} \cdot 900 < \frac{1}{1-\delta} \cdot 1012.5 \quad \Longrightarrow \quad \delta > 0.53$$

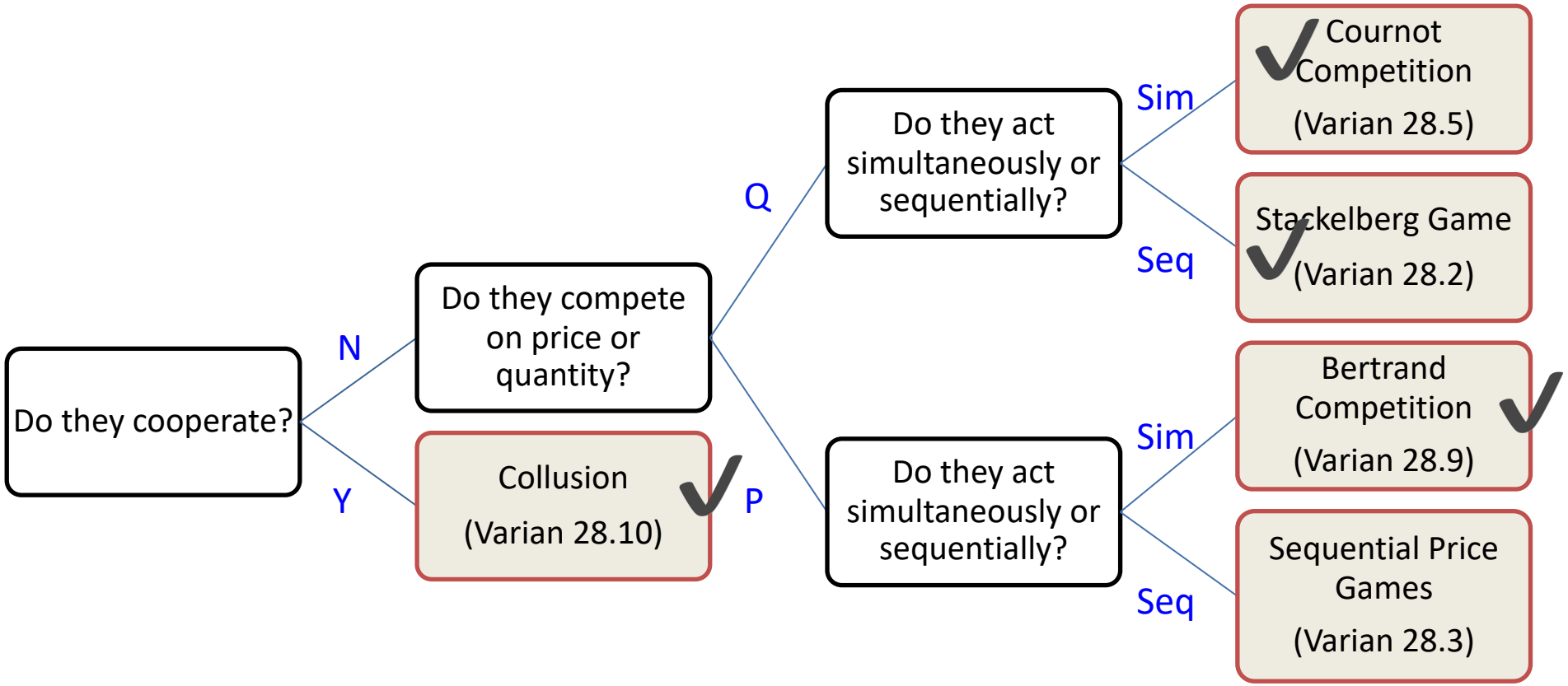
Collusion will be stable if discount factor δ>0.53

Is it worth cheating?

- If Pepsi cares about the future, it has a high discount factor δ
- It will be unwilling to give up future benefits of cooperation for a one-off gain if discount factor is above 0.53

The Big Picture

Nature of competition among oligopolistic firms depends on how they interact



Types of Competition

	Simultaneous	Sequential
Quantity	Cournot	Stackelberg
Price	**Bertrand**	-

Bertrand Competition

French mathematician
Joseph Bertrand

- Coke and Pepsi set their prices simultaneously and independently
- Once the prices are set, each firm's supply will be adjusted to satisfy demand

Demand under Bertrand Competition

- (Assume product is homogenous)

- If Coke charges a lower price
  - All consumers will buy from Coke; Pepsi's demand is 0
  - Coke's demand is $100 - P_{coke}$

- If Pepsi charges a lower price
  - All consumers will buy from Pepsi; Coke's demand is 0
  - Pepsi's demand is $100 - P_{pepsi}$

- If Coke and Pepsi charge the same price, consumers are indifferent
  - Let us assume that Coke and Pepsi split demand equally
  - Demand for each is $(100 - P)/2$

Bertrand Equilibrium

- Coke chooses the price that maximizes its profit given the price choice of Pepsi, and
- Pepsi chooses the price that maximizes its profit given the price choice of Coke
- (No one has the incentive to deviate unilaterally)

At Cournot equilibrium price 40

- Suppose Coke and Pepsi choose the Cournot equilibrium price 40
- Market demand is 100-40 = 60
- If Coke and Pepsi split demand equally, each firm gets 30
- Each firm gets a profit of (40-10)*30 = 900
- Does Coke want to charge a different price given that Pepsi sets a price of 40?
- YES (Reverse is true too)

(40, 40) is not an equilibrium

- By lowering its price by a little bit, Coke can steal all consumers from Pepsi
- If Coke charges a price of 39
- Demand for Coke is 100-39 = 61
- Demand for Pepsi is 0
- Coke's profit is (39-10)*61 = 1769>900

But neither is (39,40) an equilibrium

- Pepsi can set an even lower price and steal all consumers back from Coke
- If Pepsi sets a price of 38
- Demand for Pepsi is 100-38 = 62
- Pepsi's profit is (38-10)*62 = 1736
- Coke's profit is 0

Bertrand equilibrium *P=MC*

- As long as price is above marginal cost 10, each firm will have an incentive to lower its price and increase its profit
- The Bertrand equilibrium price is 10
- If each firm charges a price of 10
  - No firm has an incentive to raise its price (because raising price implies it will lose all consumers)
  - No firm has an incentive to lower its price (because lowering price implies price will be lower than marginal cost)
- Market demand is 100-10=90
- Each firm earns a profit of (10-10)*45=0

Cournot vs. Bertrand vs. Joint Monopoly

	Cournot Equilibrium	Bertrand Equilibrium	Joint Monopoly Optimum
Price	40 ($P>MC$)	10 ($P=MC$)	55 ($P>MC$)
Quantity	30 each	45 each	22.5 each
Profit	900 each	0	1,012.5 each

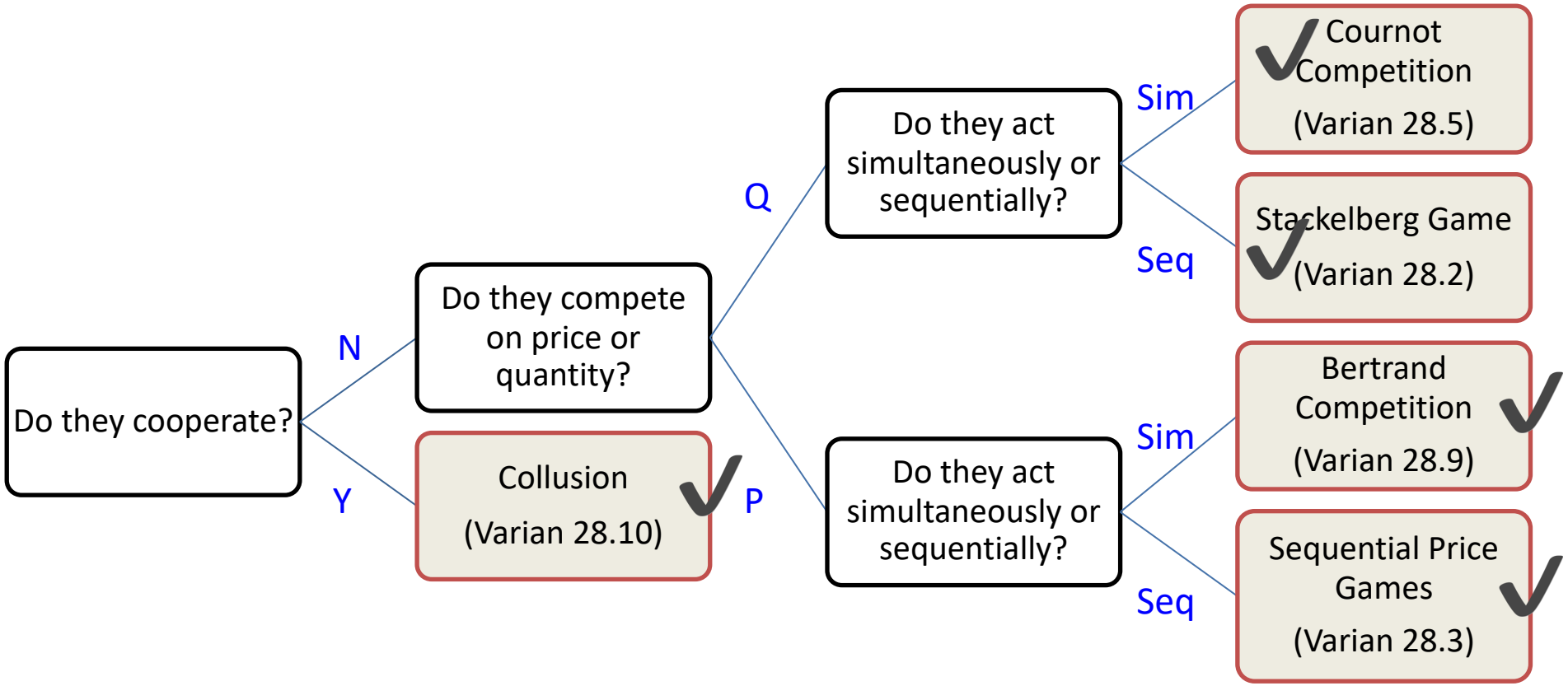
Bertrand Paradox

- Even with only 2 firms, market is perfectly competitive ($P=MC$)

- What do we assume here?
  - No capacity constraint: each firm can satisfy the entire market on its own
  - No “brand loyalty” (homogenous product): consumers will switch products based on small price differences
  - [Both firms have the same MC]

The Big Picture

Nature of competition among oligopolistic firms depends on how they interact



Types of Competition

	Simultaneous	Sequential
Quantity	Cournot	Stackelberg
Price	Bertrand	X

- (ignore Section 28.3 of the textbook)