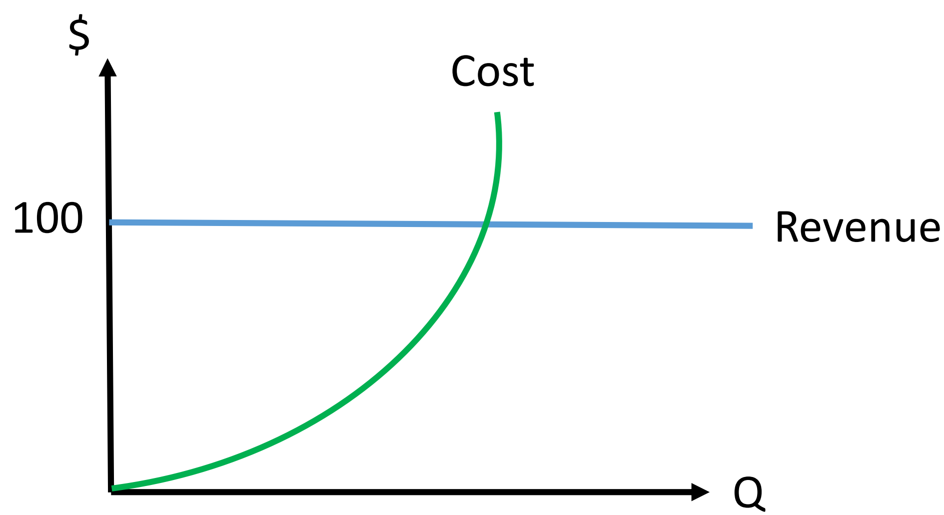
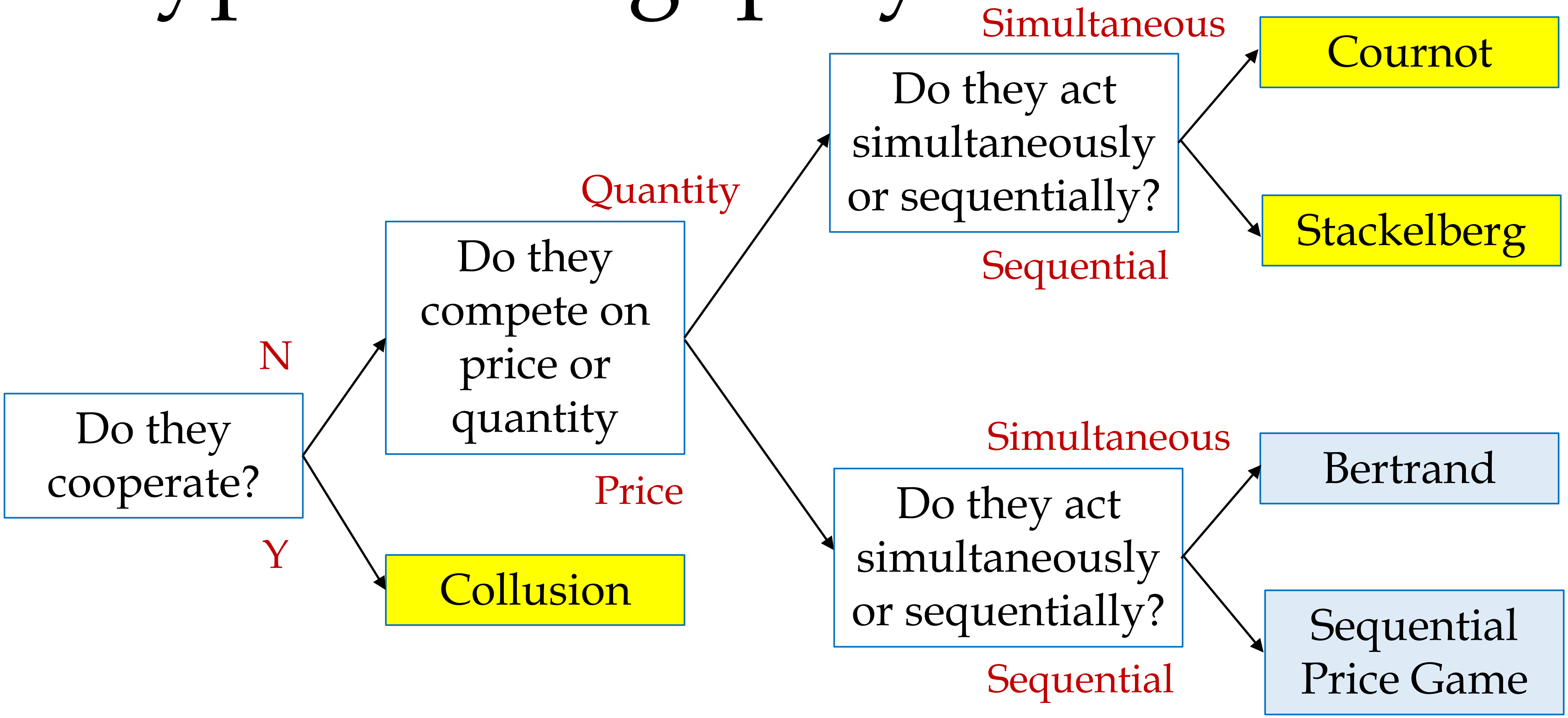
Chapter 28: Oligopoly

Problem Set #3: Question 1(c)

- Demand is $P = \frac{100}{Q}$
- Cost is $4Q^2$
- What is the profit maximizing price and quantity?



Types of Oligopoly Markets



Collusion

- From last week's example:
- In the Cournot equilibrium, profits were:
  - $\pi_{SQ} = 900, \pi_{MH} = 900; \pi_{total} = 1800$
- In the Stackelberg equlibirum, profits were:
  - $\pi_{SQ} = 1012.5, \pi_{MH} = 506.25, \pi_{total} = 1518.75$
- Can airlines do better than these outcomes?

Collusion

- What if SQ and MH decided to collude, that is instead of competing against each other, they cooperated in choosing quantities. Will that yield them a better outcome?

Collusion

- If SQ and MH collude, then they in effect act like a monopolist.
- Let's represent their joint quantity decision as $Q = X + Y$.
- Recall that the inverse demand curve is
$$\begin{aligned} P &= 100 - X - Y \\ &= 100 - Q \end{aligned}$$
- Marginal Cost, MC=10.

Collusion

- The two firms set price by maximizing joint profits:
- $\pi_J = (100 - Q)Q - 10Q$
- $MR = 100 - 2Q, \qquad MC = 10$

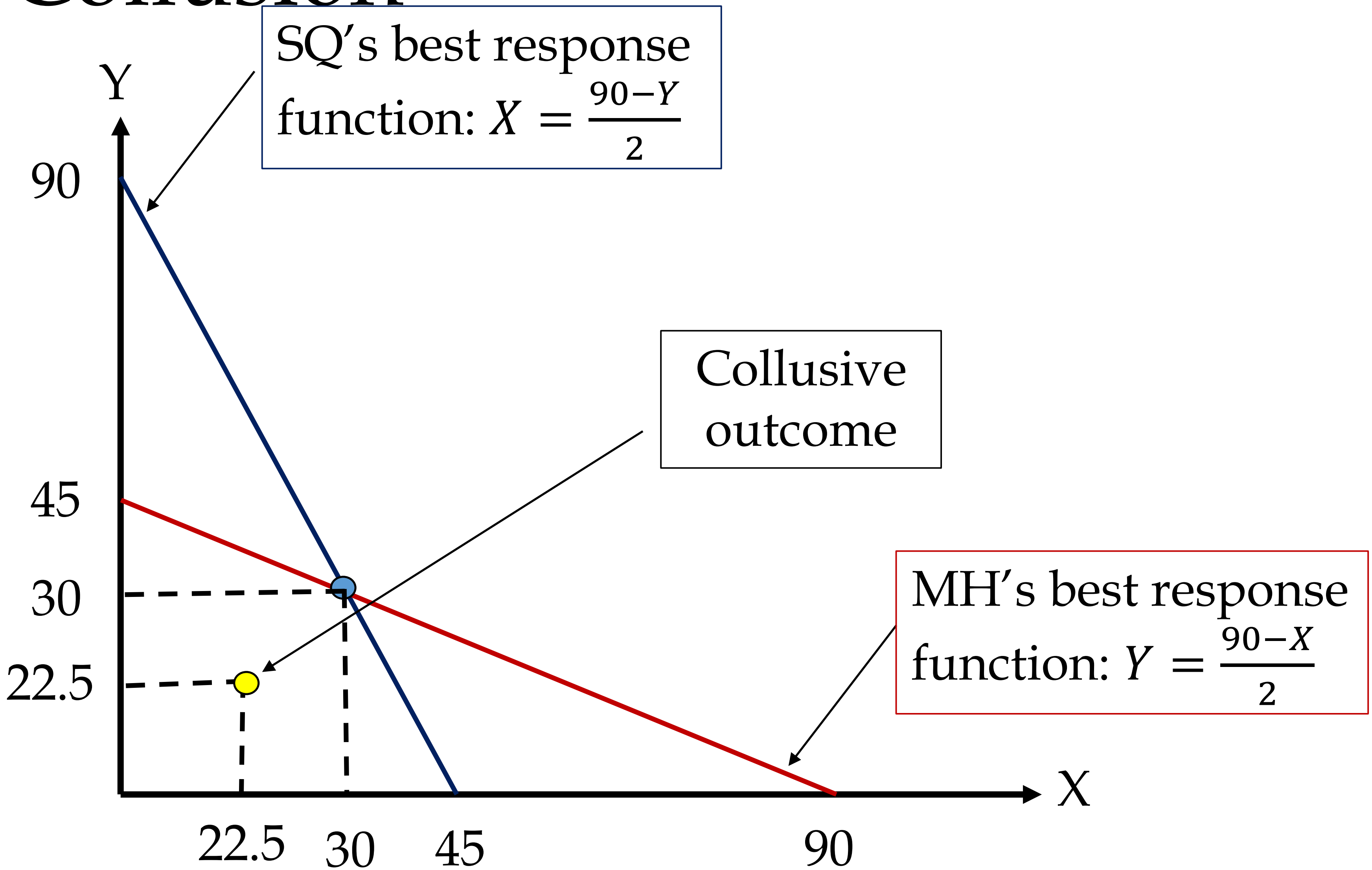
$$MR = MC$$
$$100 - 2Q = 10$$
$$Q = \frac{100 - 10}{2}$$
$$\underline{Q = 45}$$

Collusion

$$P = 100 - 45 = 55$$

- Total profit is $(55 - 10) \times 45 = 2025$.
- If SQ and MH split the profit equally, each will get 1012.5.
- This is greater than profits in the Cournot equilibrium ($900) and equal to the Stackelberg leader's profits.

Collusion



SQ's best response function: $X = \frac{90-Y}{2}$
Y
90
45
30
22.5
Collusive outcome
MH's best response function: $Y = \frac{90-X}{2}$
X
22.5
30
45
90

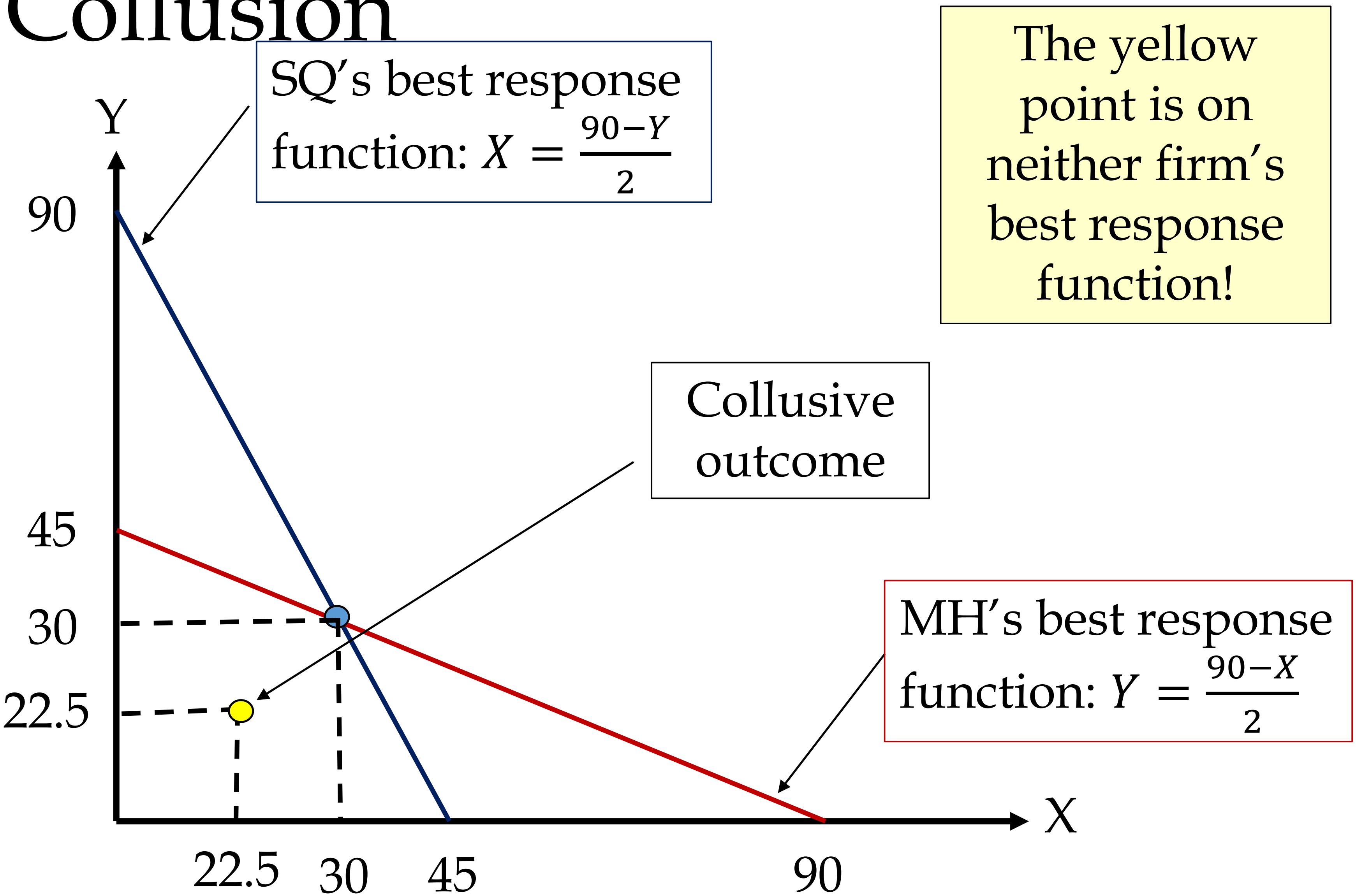
Cournot vs Stackelberg vs Collusion

	Cournot	Stackelberg	Collusion
Equilibrium Price	40	32.5	55
Equilibrium Quantity	60 (SQ=30, MH=30)	67.5 (SQ=45, MH=22.5)	45 (SQ=22.5, MH=22.5)
Profit	SQ=900, MH=900	SQ=1012.5, MH=506.25	SQ=1012.5, MH=1012.5

Collusion

- Is the collusive outcome stable?
- Given that SQ produces 22.5, is it profit maximizing for MH to produce 22.5 as well?
- Likewise, given MH produces 22.5, is SQ’s best response to produce 22.5?

Collusion


SQ's best response function: $X = \frac{90-Y}{2}$
The yellow point is on neither firm's best response function!
Collusive outcome
MH's best response function: $Y = \frac{90-X}{2}$
Y
90
45
30
22.5
X
22.5
30
45
90

Collusion

- Is the collusive outcome stable?
- Given that SQ produces 22.5, is it profit maximizing for MH to produce 22.5 as well?
- Likewise, given MH produces 22.5, is SQ's best response to produce 22.5?
- The answer is NO

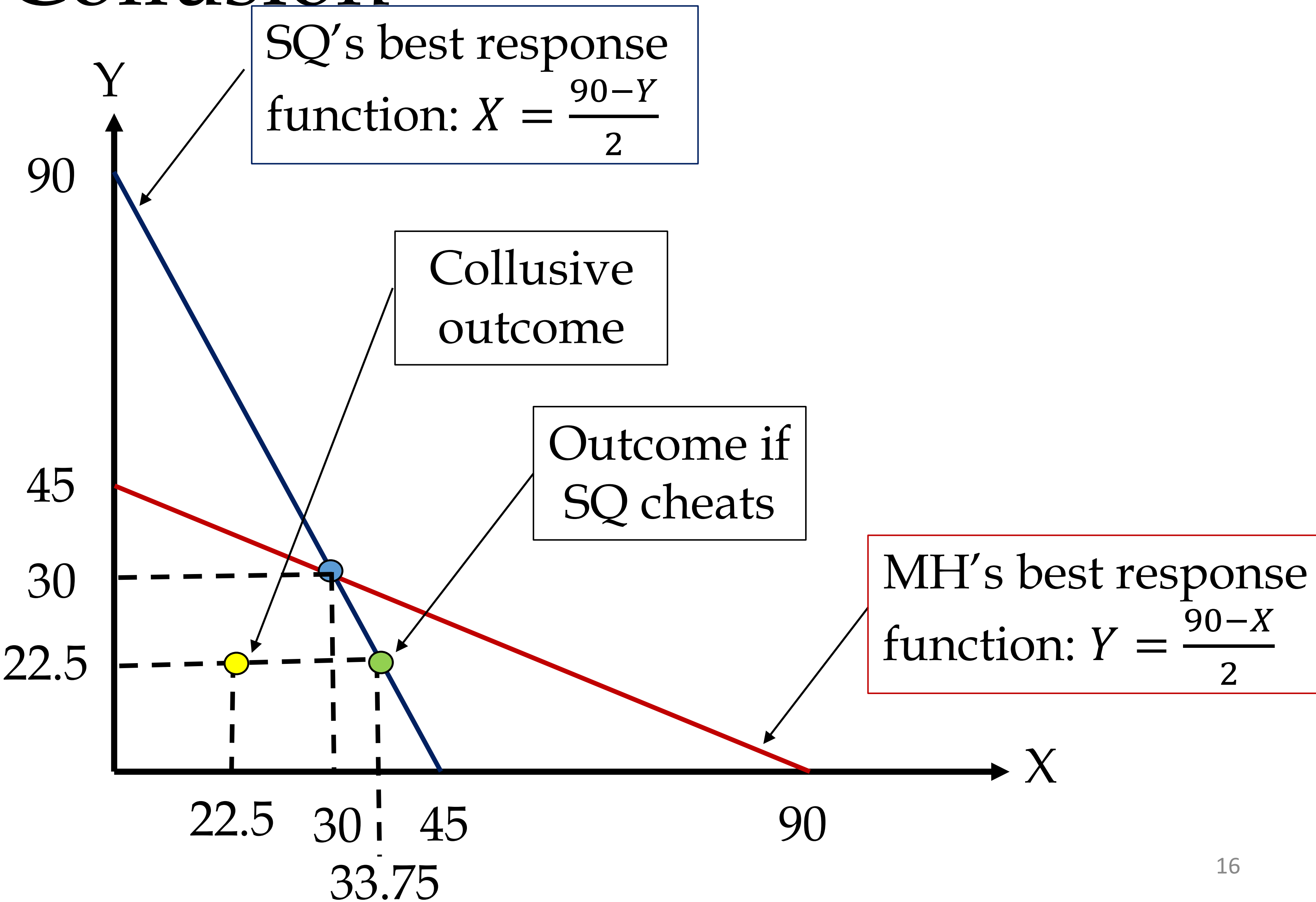
Collusion

- Remember that SQ's best response function is $\frac{90-Y}{2}$
- If MH produces 22.5, SQ's best response is $\frac{90-22.5}{2} = 33.75$,

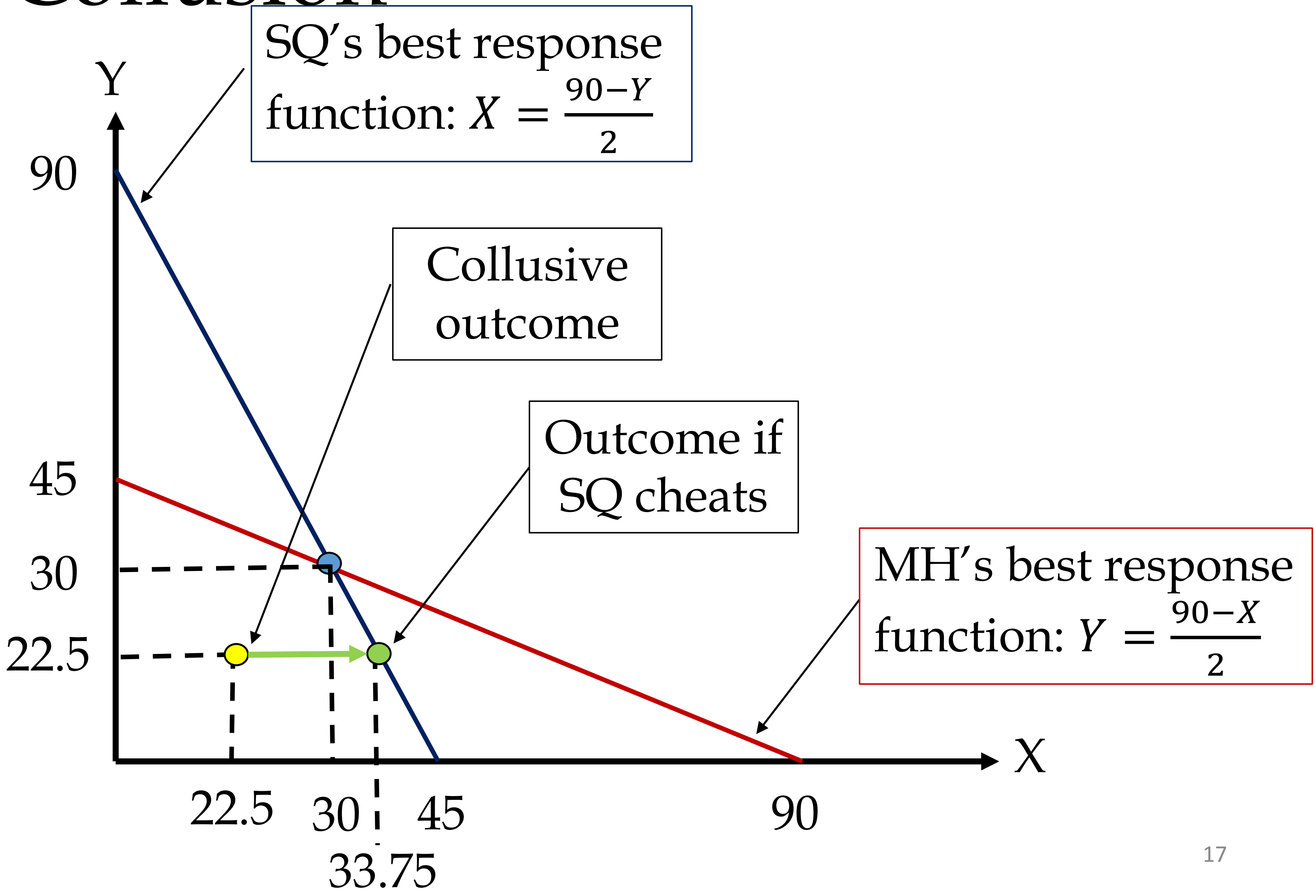
Collusion

- If SQ produces 33.75, then
$$P = 100 - 33.75 - 22.5 = 43.75$$
- SQ's profit will be
$$\pi_{SQ} = (43.75 - 10) \times 33.75 = 1139.06$$
- $1139.06 > 1012.5$
- SQ is better off cheating on its deal with MH!
- Therefore, this outcome is not stable.

Collusion

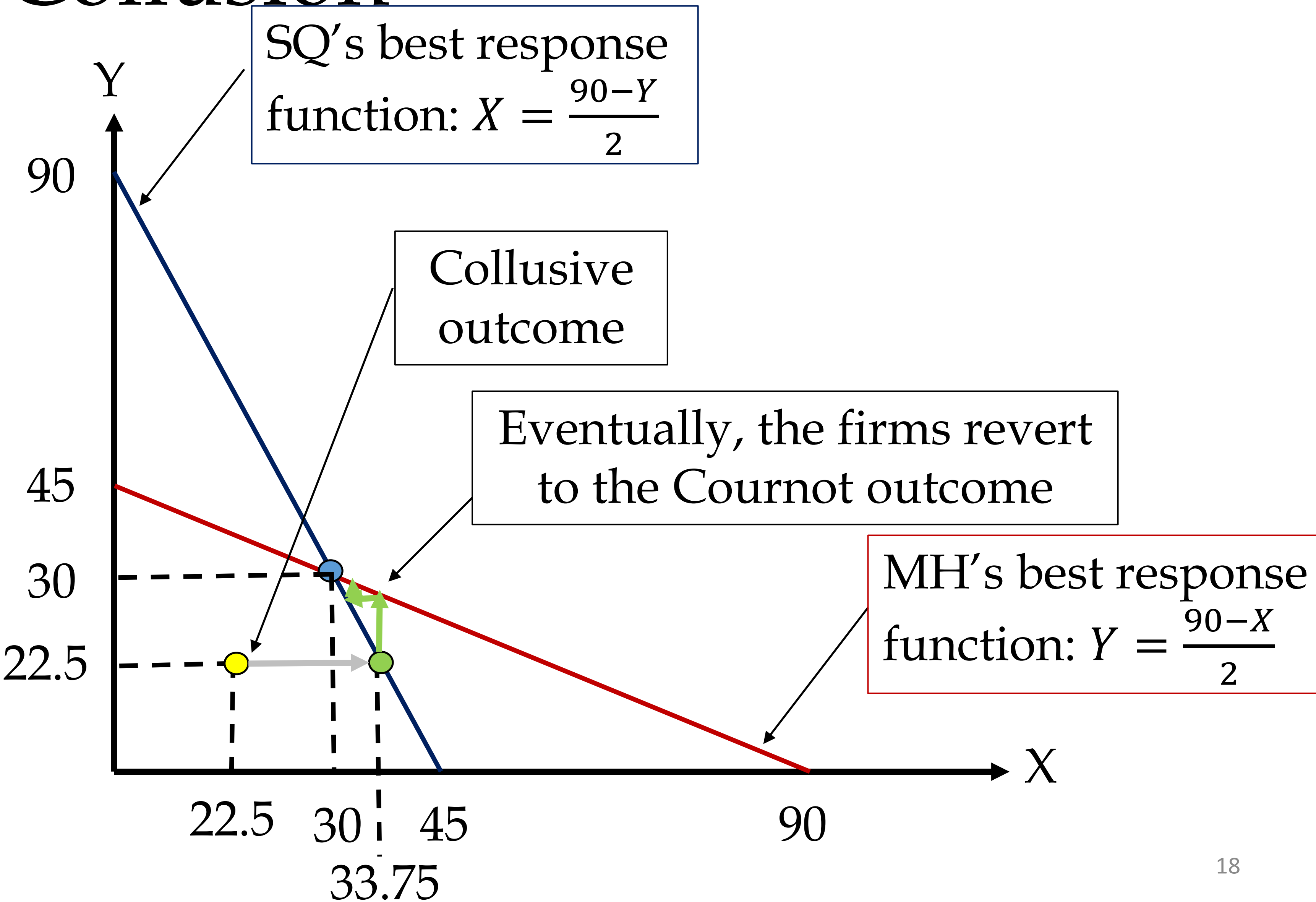

SQ's best response function: $X = \frac{90-Y}{2}$
Collusive outcome
Outcome if SQ cheats
MH's best response function: $Y = \frac{90-X}{2}$
Y
90
45
30
22.5
X
22.5
30
45
90
33.75

Collusion



SQ's best response function: $X = \frac{90-Y}{2}$
Y
90
Collusive outcome
Outcome if SQ cheats
45
30
22.5
MH's best response function: $Y = \frac{90-X}{2}$
X
22.5
30
45
90
33.75

Collusion


SQ's best response function: $X = \frac{90-Y}{2}$
Collusive outcome
Eventually, the firms revert to the Cournot outcome
MH's best response function: $Y = \frac{90-X}{2}$
Y
90
45
30
22.5
X
22.5
30
45
90
33.75

Collusion

- One-off cooperation between firms is fundamentally unstable.
  - Example: Organization of the Petroleum Exporting Countries (OPEC) in the 1980s
- But a cartel may be stable if the game is repeated many times instead of only once.
- With repeated interactions, players can punish those who cheat

Collusion

- To determine whether a cartel can be made stable we need to know 4 things:
  - What is each firm's per period profit in the cartel?
  - What is each firm's profit if it cheats in the first period?
  - What is a firm's profit in each period after it cheats?

    What is the firm's discount factor?

Collusion

- If there is a way to punish a cheater severely from the second period onwards, it could incentivize the cheater to cooperate right from the start.
- If SQ cheats, one way MH could punish SQ is to never cooperate with it again.

Cournot vs Stackelberg vs Collusion

	Cournot	Stackelberg	Collusion
Equilibrium Price	40	32.5	55
Equilibrium Quantity	60 (SQ=30, MH=30)	67.5 (SQ=45, MH=22.5)	45 (SQ=22.5, MH=22.5)
Profit	SQ=900, MH=900	SQ=1012.5, MH=506.25	SQ=1012.5, MH=1012.5

- Recall that as long as the firms cooperate, they get 1012.5 each in every period, and if one cheats, they get 900 forever.

Collusion

- To determine whether a cartel can be made stable we need to know 4 things:
  - What is each firm's per period profit in the cartel? $1012.5
  - What is each firm's profit if it cheats in the first period? $1139.06
  - What is a firm's profit in each period after it cheats? $900
    What is the firm's discount factor?

Collusion

- What is the firm's discount factor?
- The discount factor captures how much the firm cares about future profits.
- Let's denote the discount factor by δ and bound δ between 0 and 1.
- If $\delta = 0$, the firm doesn't value the future at all.
- If $\delta = 1$, the firm values the future equally as the present.

Collusion

- What are the outcomes SQ must consider:
  - Cooperate
  - Cheat

care less about future profit than current profit.

- $\pi_{coop} = 1012.5 + (\delta \times 1012.5) + (\delta^2 \times 1012.5) + (\delta^3 \times 1012.5) + \cdots$
- $\pi_{cheat} = 1139.06 + (\delta \times 900) + (\delta^2 \times 900) + (\delta^3 \times$

Collusion

- Let's look closer at profits from cooperation.
- $\pi_{coop} = 1012.5 + (\delta \times 1012.5) + (\delta^2 \times$

Collusion

- $\pi_{coop} = 1012.5 + (\delta \times 1012.5) + (\delta^2 \times 1012.5) + (\delta^3 \times 1012.5)$

$\pi_{coop} = 1012.5 + \delta \pi_{coop}$

$\pi_{coop} = 1012.5 + \delta [1012.5 + \ldots]$

$\pi_{coop} - \delta \pi_{coop} = 1012.5$

$\pi_{coop} = \frac{1012.5}{1-\delta}$

Collusion

- How about the profits from cheating?
- $\pi_{cheat} = 1139.06 + (\delta \times 900) + (\delta^2 \times 900) + (\delta^3 \times 900) + \cdots$
- $\pi_{cheat} = 1139.06 + \underline{\delta[900 + \delta(\times 900) + (\delta^2 \times}$
$\underline{900) + ,,,,}$

$$\boxed{a + ar + ar^2 + ar^3 + ,,,,, = \frac{a}{1-r}}$$

$$\pi_{cheat} = 1139,06 + \delta\left[\frac{900}{1-\delta}\right]$$
$$= 1139,06 + \frac{\delta}{1-\delta}(900)$$

Collusion

the higher the delta, the higher unlikely to cheat as they care more about future profit.

- SQ will cheat if $\pi_{cheat} > \pi_{coop}$

$$1139.06 + \frac{\delta}{1-\delta}(900) > \frac{1012.5}{1-\delta}$$

$$1139.06 > \frac{1012.5}{1-\delta} - \frac{\delta}{1-\delta}(900)$$

$$1139.06(1-\delta) > 1012.5 - 900\delta$$

$$1139.06 - 1012.5 > 1139.06\delta - 900\delta$$

$$126.56 > 239.06\delta$$

$$0.53 > \delta$$

$$\underline{\delta < 0.53}$$

Collusion

- SQ will cheat if $\delta < 0.53$, that is, if SQ doesn't value the future highly
- SQ will cooperate if $\delta > 0.53$, that is, if SQ values the future sufficiently high
- This makes sense because punishment only takes effect in the future. If SQ values the present much more than the future, the punishment will have little effect.

Collusion

- There are alternative ways to support collusions without threat of punishment from the other firm(s).
- In fact, SQ and MH did collude on the Singapore-Kuala Lumpur route from 1984 to 2008.
- They did this through the 1984 Air Service Agreement that only SQ and MH could operate the route, and specified strict frequency and capacity rules.

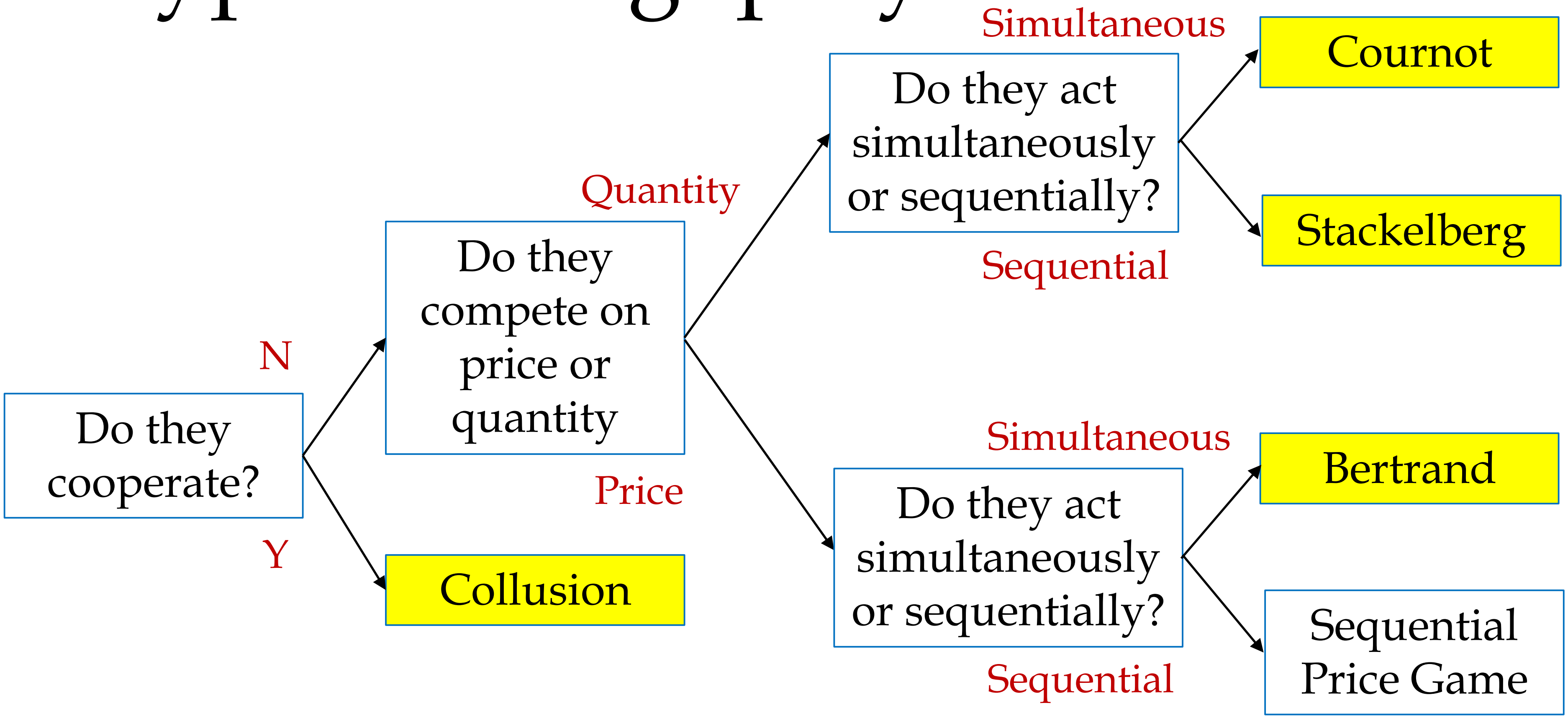
Collusion

- SQ and MH operated a combined 200 flights between them each week, and fares were on average S$450 round trip.
- The governments of Singapore and Malaysia made collusion a law! There was no need for the firms to threaten to punish each other.
- The law served also as a barrier to entry for other firms.

Collusion

- Lobbying by budget airlines caused the governments to revoke the law in 2008.
- By 2013, there were 334 flights a week and fares were much lower.

Types of Oligopoly Markets



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.

Bertrand Games

- Products are identical for all firms
- Each firm's marginal production cost is constant and identical $MC = c$.
- All firms set their prices simultaneously.
- Q: Is there a Nash equilibrium?

Bertrand Games

- Demand Under Bertrand Competition
  - Consider the Singapore Airlines (SQ)-Malaysia Airlines (MH) example.
  - Demand is $100 - X - Y, MC = 10$.

  - If SQ charges a lower price than MH, then all consumers buy from SQ.
    - MH demand is 0
    - SQ demand is $100 - Q$

  - If MH charges a lower price than SQ, then all consumers buy from MH.
    - SQ demand is 0
    - MH demand is $100 - Q$

Bertrand Games

- If SQ and MH charge the same price, then consumers are indifferent. We assume here that both firms split the market equally.
- Demand for each firm = $\frac{100-Q}{2}$

- Bertrand Equilibrium:
  - SQ chooses a price that maximizes its profits given the actual price charged by MH,

    AND

  - MH chooses a price that maximizes its profits given the actual price charged by SQ.

Bertrand Games

- Can the Cournot equilibrium outcome be sustained under Bertrand competition?
- In the Cournot equilibrium, both firms produce 30, and price is 40.
- Profit for each firm is $(40 - 10) \times 30 = \$900$
- Does SQ want to change a price different from $40?
- The answer is YES!

Bertrand Games

- By charging a price just one dollar lower ($39), SQ can steal all of MH’s consumers.
- Since $P = 100 - Q$, $Q = 100 - P$.
- Therefore, at $39, SQ sells $100 - 39 = 61$ airline seats.
- SQ’s profit is $(39 - 10) \times 61 = 1769$
- MH’s profit is 0.

Bertrand Games

- MH can respond by charging a price one additional dollar lower (\$38). Now MH steals all of SQ's consumers.
- Since $P = 100 - Q$, $Q = 100 - P$.
- Therefore, at \$38, MH sells $100 - 38 = 62$ airline seats.
- MH's profit is $(38 - 10) \times 62 = 1736$
- SQ's profit is 0.

Bertrand Games

- Now, SQ responds by charging a price one additional dollar lower ($37) and steals all of MH’s consumers.
- SQ’s profit is $(37 - 10) \times 63 = 1701$
- MH’s profit is 0.

Bertrand Games

Price ($)	Singapore Airlines	Malaysia Airlines
40	$900	$900
39	$1769	$0
38	$0	$1736
37	$1701	$0
36	$0	$1664
35	$1625	$0
	…	
10	$0	$0

Profits are falling!

Bertrand Games

- As long as price is above marginal cost, the firms have incentive to lower price.
- At $P = MC$ (in this case $10)
- $Q = 100 - P = 100 - 10 = 90$
- Therefore each firm produces $\frac{90}{2} = 45$.
- $\pi = (10 - 10) \times 45 = 0$.
- Both firms make zero profits!

Bertrand vs Cournot vs Stackelberg vs Collusion

	Bertrand	Cournot	Stackelberg	Collusion
Equilibrium Price	10	40	32.5	55
Equilibrium Quantity	90 (SQ=45, MH=45)	60 (SQ=30, MH=30)	67.5 (SQ=45, MH=22.5)	45 (SQ=22.5, MH=22.5)
Profit	SQ=0, MH=0	SQ=900, MH=900	SQ=1012.5, MH=506.25	SQ=1012.5, MH=1012.5

Bertrand Games

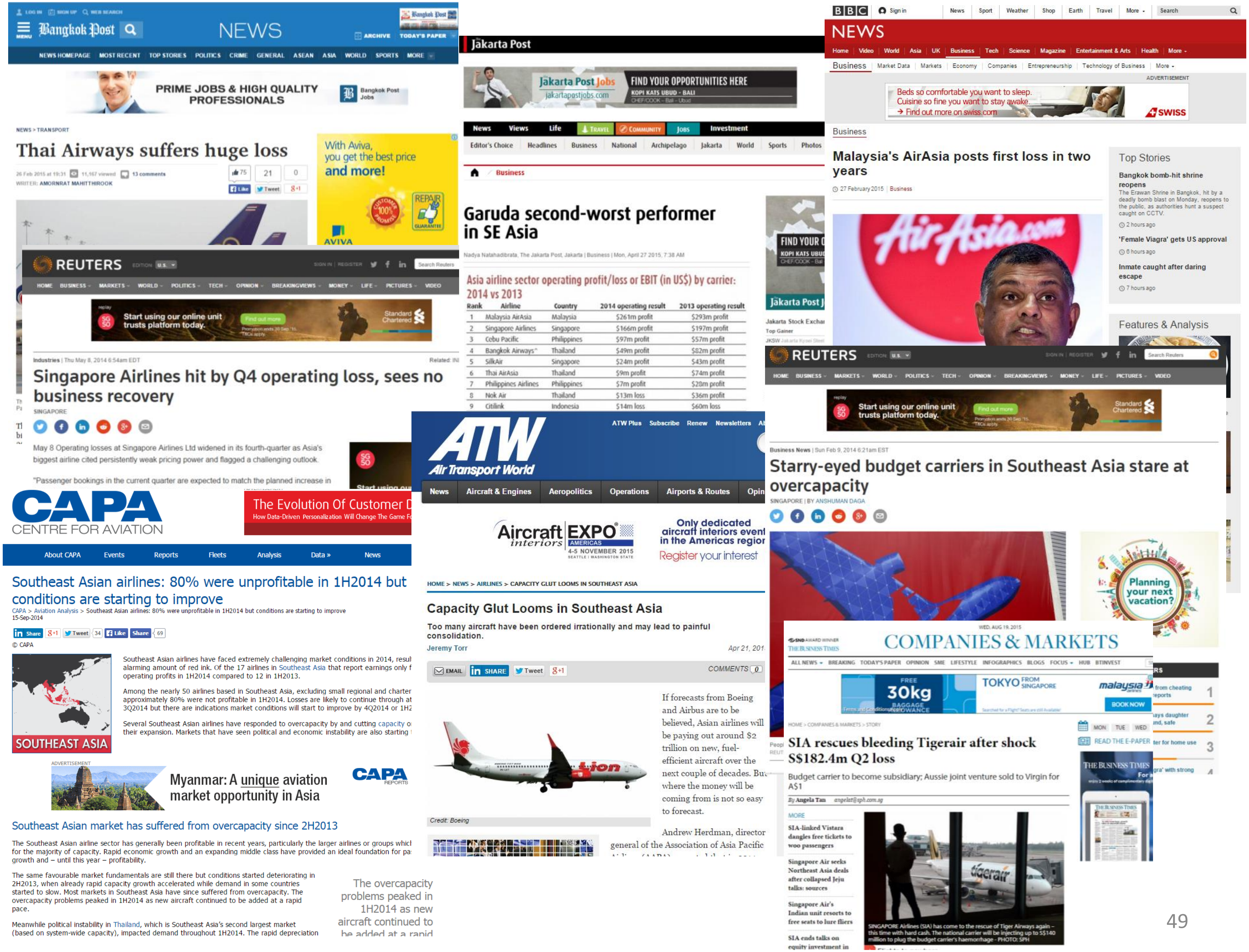
- In the Betrand model, we have a competitive equilibrium with just two firms!
- What have we assumed?
  - Firms have identical products. Or at least, consumers are indifferent between the products of each firm. There is no brand loyalty.
  - No capacity constraints. A single firm can satisfy the entire market.

Bertrand Games

- Brand Loyalty
  - This is why airlines have frequent flyer programs
    - Singapore Airlines: KrisFlyer
    - Malaysia Airlines: Enrich
- Nevertheless, airlines in Southeast Asia have displayed Bertrand like behavior as recent as 2014.
- Because of over-optimistic projections beginning in the late 2000s, many new airlines were founded and existing airlines ordered many new planes.

Bertrand Games

- As a result, few airlines had capacity constraints.
- Airlines began competing on price rather than quantity. This resulted in many airlines making losses.



Bangkok Post NEWS

NEWS > TRANSPORT

Thai Airways suffers huge loss

26 Feb 2015 at 19:31 | 11,167 viewed | 13 comments

WRITER: AMORNRAT MAHITTHIROOK

REUTERS

Industries | Thu May 8, 2014 6:54am EDT

Singapore Airlines hit by Q4 operating loss, sees no business recovery

SINGAPORE

May 8 Operating losses at Singapore Airlines Ltd widened in its fourth-quarter as Asia's biggest airline cited persistently weak pricing power and flagged a challenging outlook.

"Passenger bookings in the current quarter are expected to match the planned increase in

Jakarta Post

Business

Garuda second-worst performer in SE Asia

Nadya Natahadibrata, The Jakarta Post, Jakarta | Business | Mon, April 27 2015, 7:38 AM

Asia airline sector operating profit/loss or EBIT (in US$) by carrier: 2014 vs 2013

Rank	Airline	Country	2014 operating result	2013 operating result
1	Malaysia AirAsia	Malaysia	$261m profit	$293m profit
2	Singapore Airlines	Singapore	$166m profit	$197m profit
3	Cebu Pacific	Philippines	$97m profit	$57m profit
4	Bangkok Airways*	Thailand	$49m profit	$82m profit
5	SilkAir	Singapore	$24m profit	$43m profit
6	Thai AirAsia	Thailand	$9m profit	$74m profit
7	Philippines Airlines	Philippines	$7m profit	$28m profit
8	Nok Air	Thailand	$13m loss	$36m profit
9	Citilink	Indonesia	$14m loss	$60m loss

BBC NEWS

Business

Malaysia's AirAsia posts first loss in two years

27 February 2015 | Business

Top Stories

Bangkok bomb-hit shrine reopens

'Female Viagra' gets US approval

Inmate caught after daring escape

Features & Analysis

REUTERS

Business News | Sun Feb 9, 2014 6:21am EST

Starry-eyed budget carriers in Southeast Asia stare at overcapacity

SINGAPORE | BY ANSHUMAN DAGA

ATW Air Transport World

News | Aircraft & Engines | Aeropolitics | Operations | Airports & Routes

HOME > NEWS > AIRLINES > CAPACITY GLUT LOOMS IN SOUTHEAST ASIA

Capacity Glut Looms in Southeast Asia

Too many aircraft have been ordered irrationally and may lead to painful consolidation.

Jeremy Torr

Apr 21, 201

Credit: Boeing

If forecasts from Boeing and Airbus are to be believed, Asian airlines will be paying out around \$2 trillion on new, fuel-efficient aircraft over the next couple of decades. But where the money will be coming from is not so easy to forecast.

Andrew Herdman, director general of the Association of Asia Pacific

CAPA CENTRE FOR AVIATION

Southeast Asian airlines: 80% were unprofitable in 1H2014 but conditions are starting to improve

15-Sep-2014

SOUTHEAST ASIA

Southeast Asian airlines have faced extremely challenging market conditions in 2014, resul alarming amount of red ink. Of the 17 airlines in Southeast Asia that report earnings only f operating profits in 1H2014 compared to 12 in 1H2013.

Among the nearly 50 airlines based in Southeast Asia, excluding small regional and charter approximately 80% were not profitable in 1H2014. Losses are likely to continue through at 3Q2014 but there are indications market conditions will start to improve by 4Q2014 or 1H2

Several Southeast Asian airlines have responded to overcapacity by and cutting capacity o their expansion. Markets that have seen political and economic instability are also starting

Southeast Asian market has suffered from overcapacity since 2H2013

The Southeast Asian airline sector has generally been profitable in recent years, particularly the larger airlines or groups whic for the majority of capacity. Rapid economic growth and an expanding middle class have provided an ideal foundation for pa growth and – until this year – profitability.

The same favourable market fundamentals are still there but conditions started deteriorating in 2H2013, when already rapid capacity growth accelerated while demand in some countries started to slow. Most markets in Southeast Asia have since suffered from overcapacity. The overcapacity problems peaked in 1H2014 as new aircraft continued to be added at a rapid pace.

The overcapacity problems peaked in 1H2014 as new aircraft continued to be added at a rapid

Meanwhile political instability in Thailand, which is Southeast Asia's second largest market (based on system-wide capacity), impacted demand throughout 1H2014. The rapid depreciation

THE BUSINESS TIMES COMPANIES & MARKETS

WED, AUG 19, 2015

SIA rescues bleeding Tigerair after shock S$182.4m Q2 loss

Budget carrier to become subsidiary; Aussie joint venture sold to Virgin for A$1

By Angela Tan

MORE

SIA-linked Vistara dangles free tickets to woo passengers

Singapore Air seeks Northeast Asia deals after collapsed Jeju talks: sources

Singapore Air's Indian unit resorts to free seats to lure fliers

SIA ends talks on equity investment in

SINGAPORE Airlines (SIA) has come to the rescue of Tiger Airways again – this time with hard cash. The national carrier will be injecting up to S\$140 million to plug the budget carrier's haemorrhage - PHOTO: SPH

Product Differentiation

- What if the products are not identical?
- The Bertrand model can still apply.

Problem Set #4

- The demand function for chicken rice from seller A is $21 - 2P_a + P_b$ while the demand function for chicken rice from seller B is $21 + P_a - 2P_b$. Assume that marginal costs are zero. Each chicken rice seller maximizes its revenue assuming that the other's price is independent of its own price. If the chicken rice sellers are competing against each other, what price and quantities will we see in the market?

Problem Set #4

1. Differentiated products. An increase in price does not cause symmetric responses.

   Example of symmetric response:

   $$Q_a = 21 - P_a + P_b$$

2. The question isn't clear on which dimension one should compete (price or quantity)
3. You get different answers if you solve based on price or quantity because the Bertrand and Cournot models are not the same, even for differentiated goods!

Problem Set #4

- Solving it as a Cournot:

$$Q_a = 21 - 2P_a + P_b$$
$$Q_b = 21 + P_a - 2P_b$$

$$P_a = \frac{21 + P_b - Q_a}{2}$$

$$P_b = \frac{21 + P_a - Q_b}{2}$$

Plug one into the other to get price in terms of quantities only

Problem Set #4

$$P_a = \frac{63 - Q_b - 2Q_a}{3}$$
$$\pi_a = \left(\frac{63 - Q_b - 2Q_a}{3}\right) Q_a$$

Taking derivatives, you can solve for best response functions and obtain $Q_a = Q_b = 12.6$

I gave similar demand functions for product differentiation last week and you can solve them this way as well.

Problem Set #4

- Solving as a Bertrand:

$$\pi_a = (21 - 2P_a + P_b)P_a$$

$$\frac{\partial \pi_a}{\partial P_a} = 21 - 4P_a + p_b = 0$$

$$p_a = \frac{21 + p_b}{4}$$

Solving the best response functions simultaneously, you find that $P_a = P_b = 7, Q_a = 14$

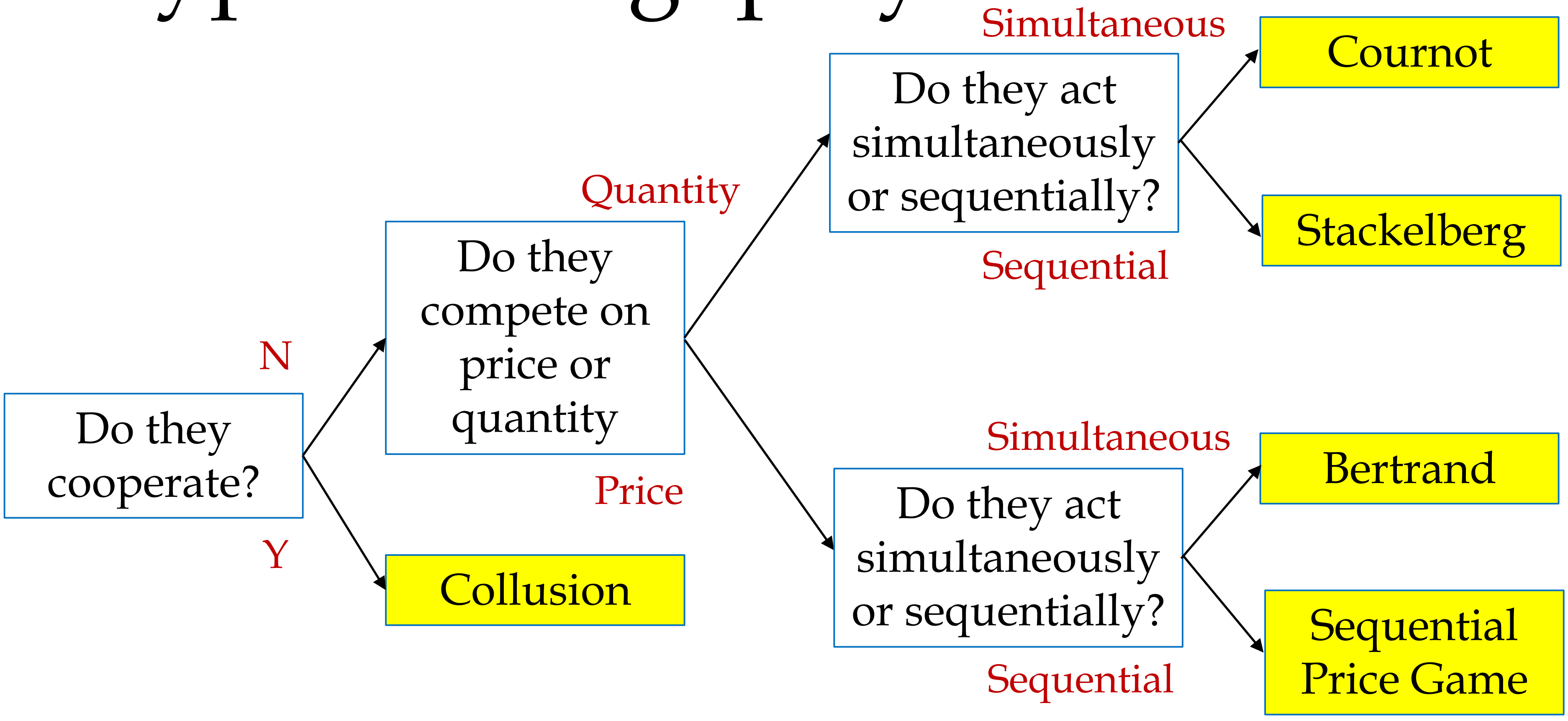
Problem Set #4

- But marginal cost is zero. How can the Bertrand equilibrium not be $p_a = p_b = 0$?
- That is because we have differentiated products.
- If we had homogenous goods, market demand would look something like this:

$$Q = 21 - \min\{P_a, P_b\}$$

and we would have the outcome discussed earlier.

Types of Oligopoly Markets



Sequential Price Games

- What if, instead of simultaneous play in pricing strategies, one firm decides its price ahead of the others.
- This is a sequential game in pricing strategies called a price-leadership game.
- The firm which sets its price ahead of the other firms is the price-leader.
- Once prices are set, they cannot be changed

Sequential Price Games

- The outcome from such a game is not different from the Bertrand game.
- Here's why. Suppose SQ sets its price first.
- As long as $P_{SQ} > MC$, SQ knows MH will enter and set price lower than P_{SQ} and capture the market.
- Knowing this, even as a price leader, SQ will set $P_{SQ} = MC$ just like in the Bertrand equilibrium and MH will follow suit.

Sequential Price Games

- You can ignore section 28.3: Price Leadership in Varian's textbook.

Competition Policy in Singapore

- Competition Commission of Singapore (CCS)
- Oversee competitive practices in Singapore
- Goals:
  - enhance efficient market conduct
  - control practices having adverse effect on competition
  - advise the Government or other public authority on national needs and policies in respect of competition matters
  - promote and sustain competition in markets in Singapore

Competition Policy in Singapore

- They hire economists!

  https://www.ccs.gov.sg/about-ccs/careers

Or you could work for the other side…

- Firms hire economic consulting firms to provide evidence defending them against charges of anti-competitive behavior
- Economic litigation consultants also do pre- and post- merger analysis for firms
  - In Singapore: HoustonKemp Economists
  - Internationally: Analysis Group, Cornerstone Research, Charles River Associates, Bates White Economic Consulting, The Brattle Group, NERA Economic Consulting

Or you could work for the other side…

- Or you could go into management consulting. Management consultants deal more with the actual internal administrative details of mergers, business practices rather than on legal issues. They rely less on technical and econometric tools but still relies heavily on economic principles:
  - Boston Consulting Group, KPMG, Bain, Deloitte

http://www.contactsingapore.sg/key_industries/consulting_services/

Midterm (Very Important!)

- September 29th, 8 a.m. in MPSH1A
- You are allowed to bring in non-programmable calculators.
  - There are 9 multiple choice questions worth 48% of the midterm grade
  - There are 3 short answer questions worth 52% of the midterm grade.
- Material covered: Everything from lectures 1-6
  - Intertemporal Choice, Uncertainty, Exchange, Monopoly, Oligopoly

Monopoly equilibrium

Solve all the stuff, simple