UNIT EC407, LEVEL 2

INDUSTRIAL ECONOMICS COMPONENT: THE INTERACTIVE TEXTBOOK

Semester 1 1998/99

Lecturer: K. Hinde
Room: 427 Northumberland Building
Tel: 0191 2273936
email: kevin.hinde@unn.ac.uk
Web Page: http://www.unn.ac.uk/~egv8

Lecture Topic 2: Oligopolistic Conduct and Welfare

Aim

- To demonstrate how conjectures made by firms about the behaviour of rivals affect economic welfare.

Learning Outcomes

Students will be able to

- draw reaction functions
- derive reaction functions under Cournot assumptions.
- Calculate welfare losses from a Cournot oligopoly using a numerical example, and contrast the results with that of perfect competition and monopoly.
- carry out tasks set in the notes.

Further Activities

Having read the notes, attended the lecture and examined some further reading can you summarise the debate in 250 words?

Detailed Notes: Oligopolistic Conduct and Welfare

Welfare and (Tight) Oligopoly

To understand the welfare implications of oligopoly we need to examine interdependence between firms in the market. Welfare depends upon the number of firms in the industry and the conduct they adopt.

More formally, in oligopoly models we endogenise assumptions about the conduct of firms and then assess the level of economic performance they offer to society.

We examine 2 models of oligopoly, following Augustin Cournot and Heinrich von Stackelberg and compare these with a competitive and collusive (monopoly) equilibrium. Finally, but briefly, we mention the work of Joseph Bertrand.

Augustin Cournot (1838)

Cournot's model involves competition in quantities (sales volume, in modern language) and price is less explicit. Cournot's initial model assumed competition between 2 firms (a Duopoly) selling mineral water at zero cost. These assumptions were later dropped by Cournot with no major impact on the results.

The biggest assumption made by Cournot was that a firm will embrace another's output decisions in selecting its profit maximising output but take that decision as fixed, i.e. unalterable by the competitor. This means that each firm is "naively" conjecturing that should either one of them alter their output decisions the other will not react. This assumption has led to the development of the "conjectural variations" approach to the original Cournot model (which assumed a zero conjectural variation).

A Graphical Example of Cournot

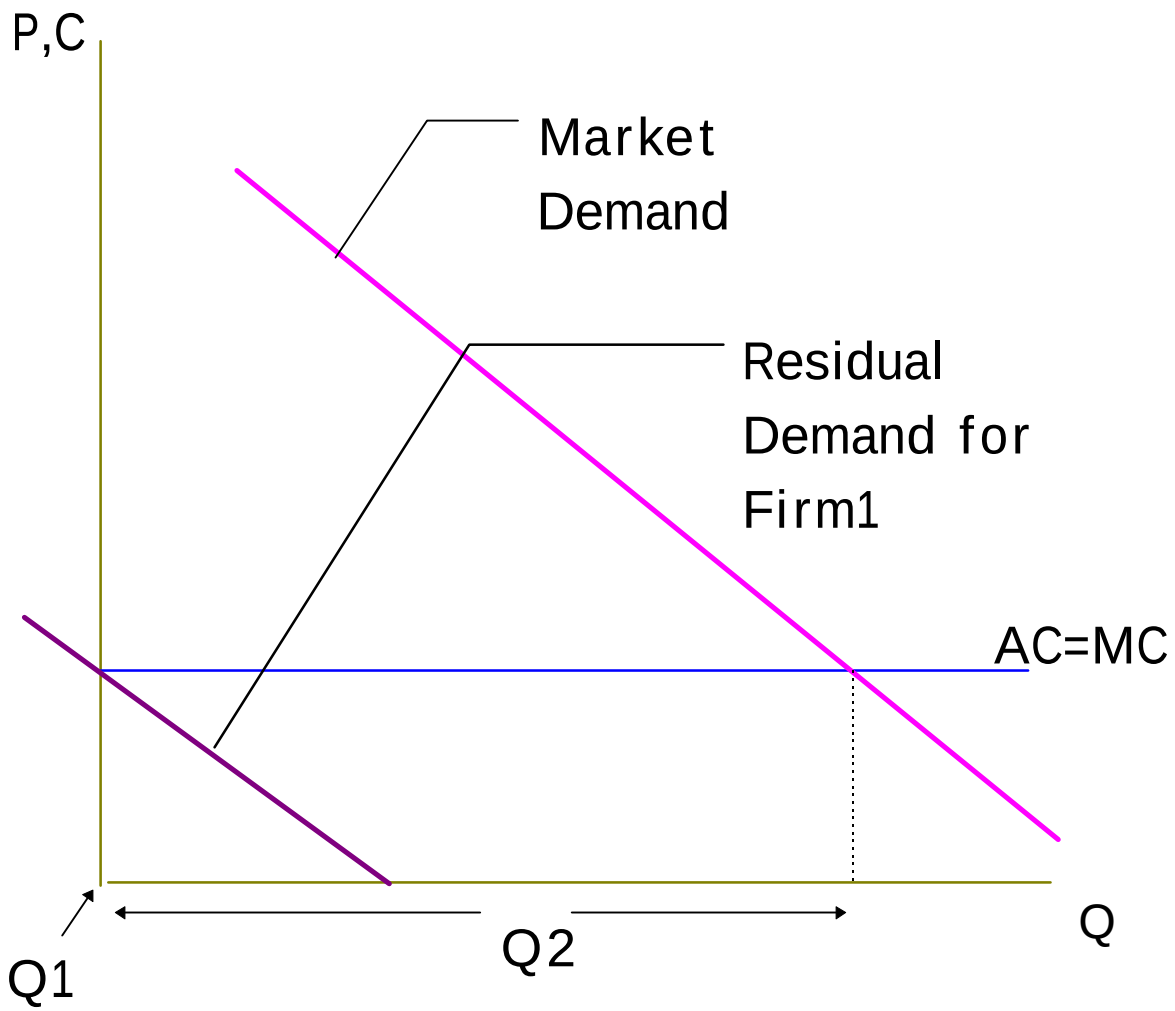
We will assume a duopoly situation in which both firms, Firm 1 and Firm 2, have constant marginal costs and zero fixed costs.

To see how the Cournot (and Stackelberg) model(s) work out we need to understand the idea of the reaction curve.

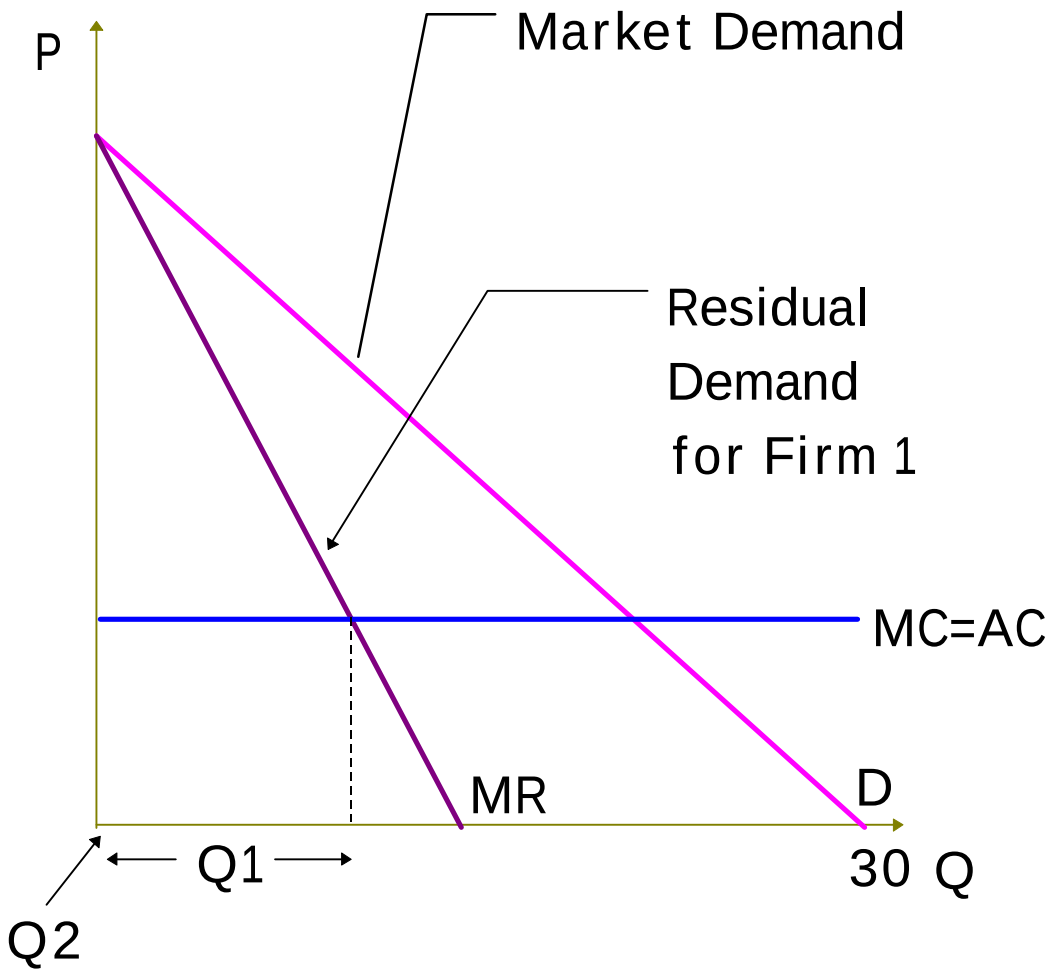
A reaction curve for Firm 1 represents its profit maximising output level given what it believes the other firm will produce. And vice versa for firm 2.

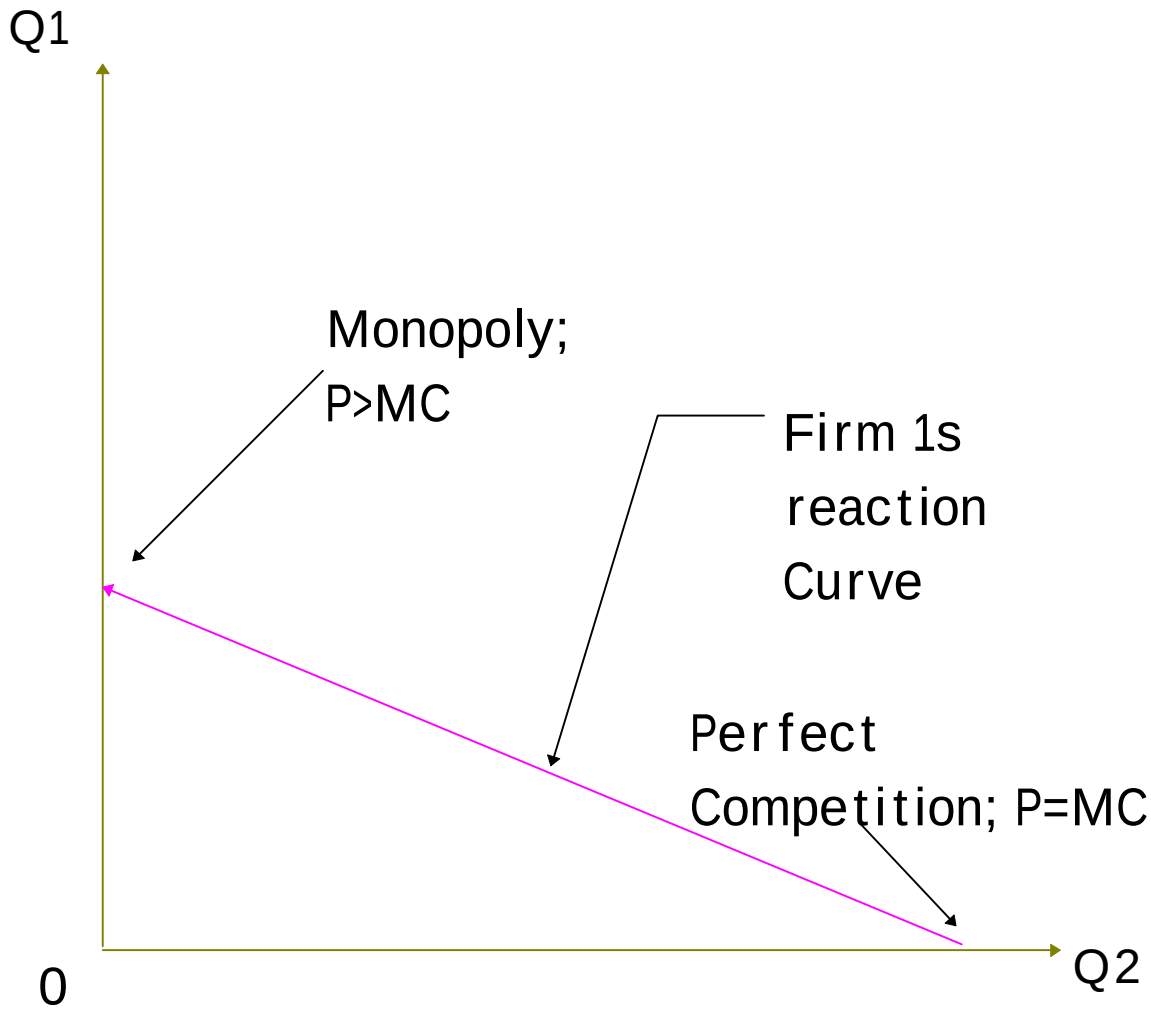
Deriving Reaction Curves

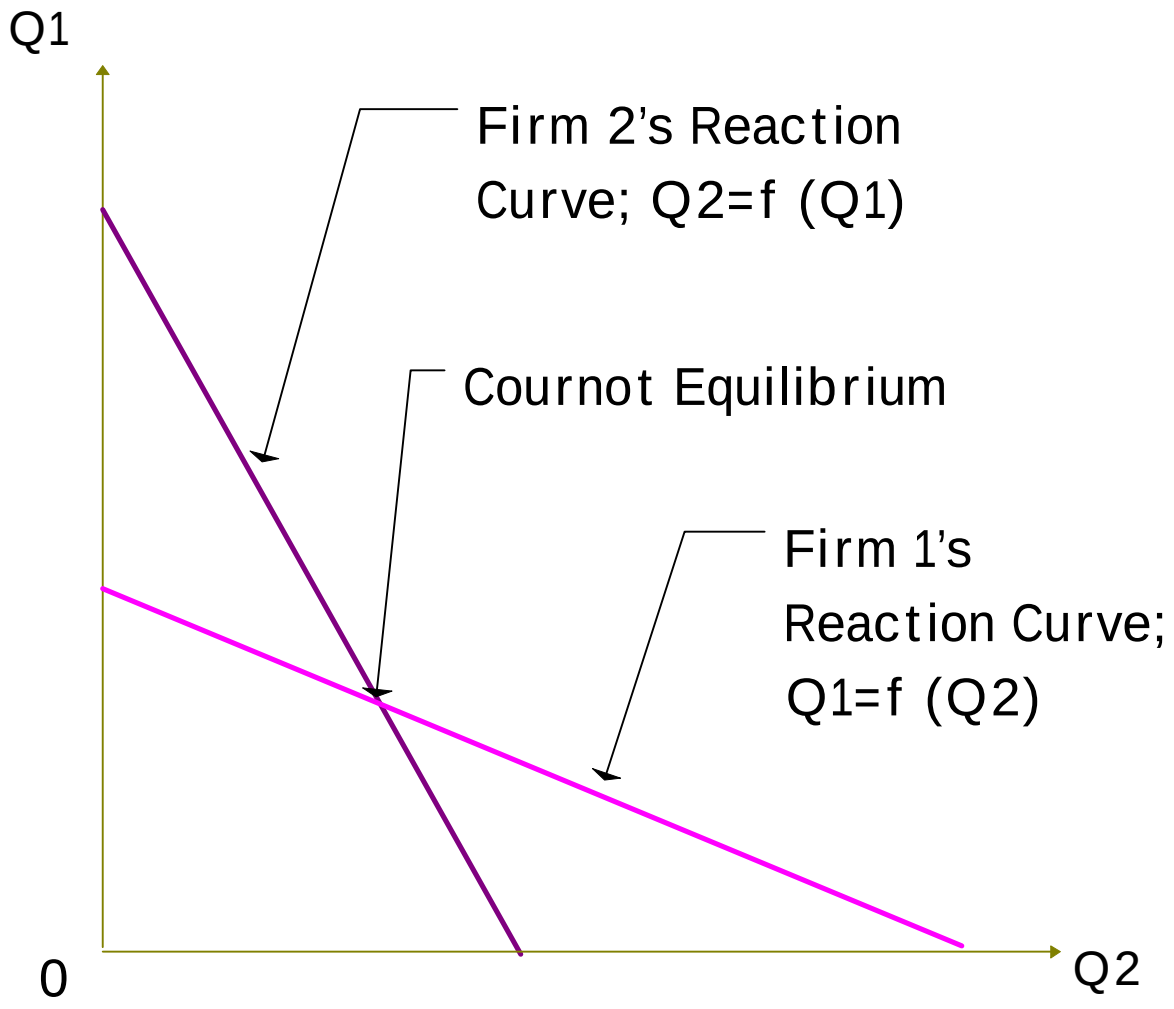
If Firm 1 believes that Firm 2 will supply the entire market then it will supply nothing
Firm 2 is acting as if it is in a perfectly competitive industry.



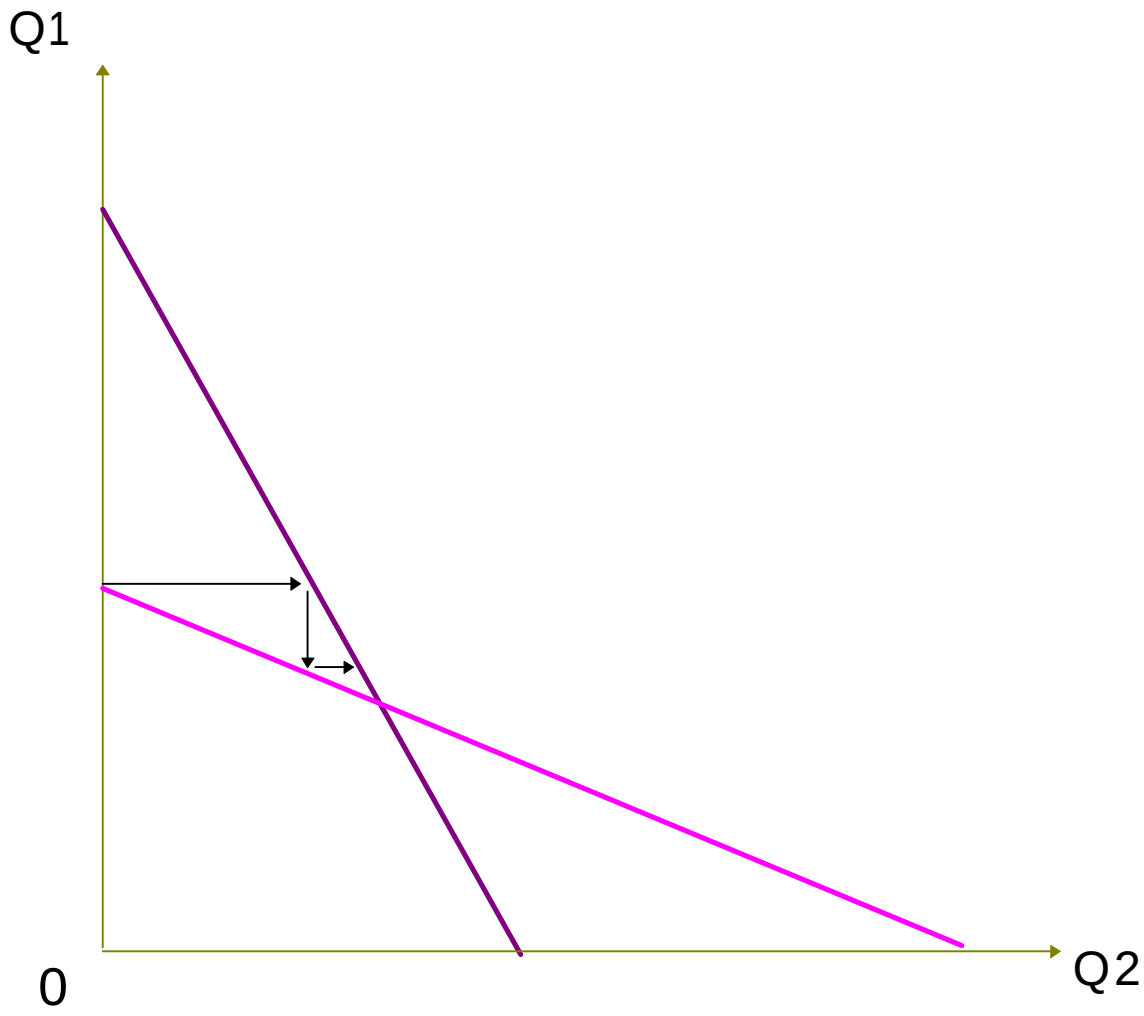
If Firm 1 believes that Firm 2 will supply zero output it becomes a monopoly supplier.


P
Market Demand
Residual
Demand
for Firm 1
MC=AC
MR
D
Q1
30 Q
Q2


Q1
Monopoly;
P>MC
Firm 1s
reaction
Curve
Perfect
Competition; P=MC
0
Q2


Q1
Firm 2's Reaction Curve; Q2=f (Q1)
Cournot Equilibrium
Firm 1's Reaction Curve; Q1=f (Q2)
0
Q2

Convergence to Equilibrium



A numerical example

Assume there are 2 firms who supply salt in the country of Acirema and that entry to that market is blockaded. Further assume that market demand takes the following form

$$P = 30 - Q$$

where $Q = Q1 + Q2$ and $Q1 = Q2$

i.e. industry output constitutes firm 1 and firm 2's output respectively and both firms share the market.

Finally, assume that average (AC) and marginal cost (MC)

$$AC = MC = 12$$

Our task is to find the Cournot (oligopoly) equilibrium in quantity and price and compare this with equilibrium under perfect competition and monopoly. By doing this we can discover the potential welfare outcomes from each model.

To find the profit maximising output of Firm 1 given Firm 2's output we need to find Firm 1's marginal revenue (MR) and set it equal to MC. So,

Firm 1's Total Revenue is

$$R1 = (30 - Q)\,Q1$$

$$R1 = [30 - (Q1 + Q2)]\,Q1$$

$$\underline{= 30Q1 - Q1^2 - Q1Q2}$$

Firm 1's MR is thus

$$\underline{\underline{MR1 = 30 - 2Q1 - Q2}}$$

If MC=12 then

$$Q1 = 9 - \frac{1}{2} Q2$$

This is Firm 1's Reaction Curve.

If we had begun by examining **Firm 2's** profit maximising output we would find its **reaction curve**, i.e.

$$Q2 = 9 - \frac{1}{2} Q1$$

We can solve these 2 equations and find equilibrium quantity and price.

Solving for Q1 we find

$$Q1 = 9 - \frac{1}{2}(9 - \frac{1}{2}Q1)$$

$$\underline{Q1 = 6}$$

Similarly,

$$\underline{Q2 = 6}$$

That is, assuming similar cost structures, equilibrium occurs where both firms supply equal quantities.

Equilibrium Price is given by what demand will bear at this output. In this case

$$\underline{P = 18}$$

This equilibrium can be compared with that of perfect competition and monopoly.

1. Perfect Competition

Under perfect competition firms set prices equal to MC. So,

$$P = 12$$

and equilibrium quantity

$$Q = 18$$

Assuming both supply equal amounts, Firm 1 supplies 9 and so does Firm 2.

2. Monopoly

In this case we need to ask what would be the equilibrium price and output if both firms colluded (assuming that they would not face some regulatory penalty). To understand this we need to consider each firm as part of a multi-plant monopoly.

They would then maximise **industry** profits and share the spoils.

$$TR = PQ = (30 - Q)Q = 30Q - Q^2$$

$$\underline{MR = 30 - 2Q}$$

As MC equals 12 industry profits are maximised where

$$30 - 2Q = 12$$

$$\underline{Q = 9}$$

So

$$\underline{Q1 = Q2 = 4.5}$$

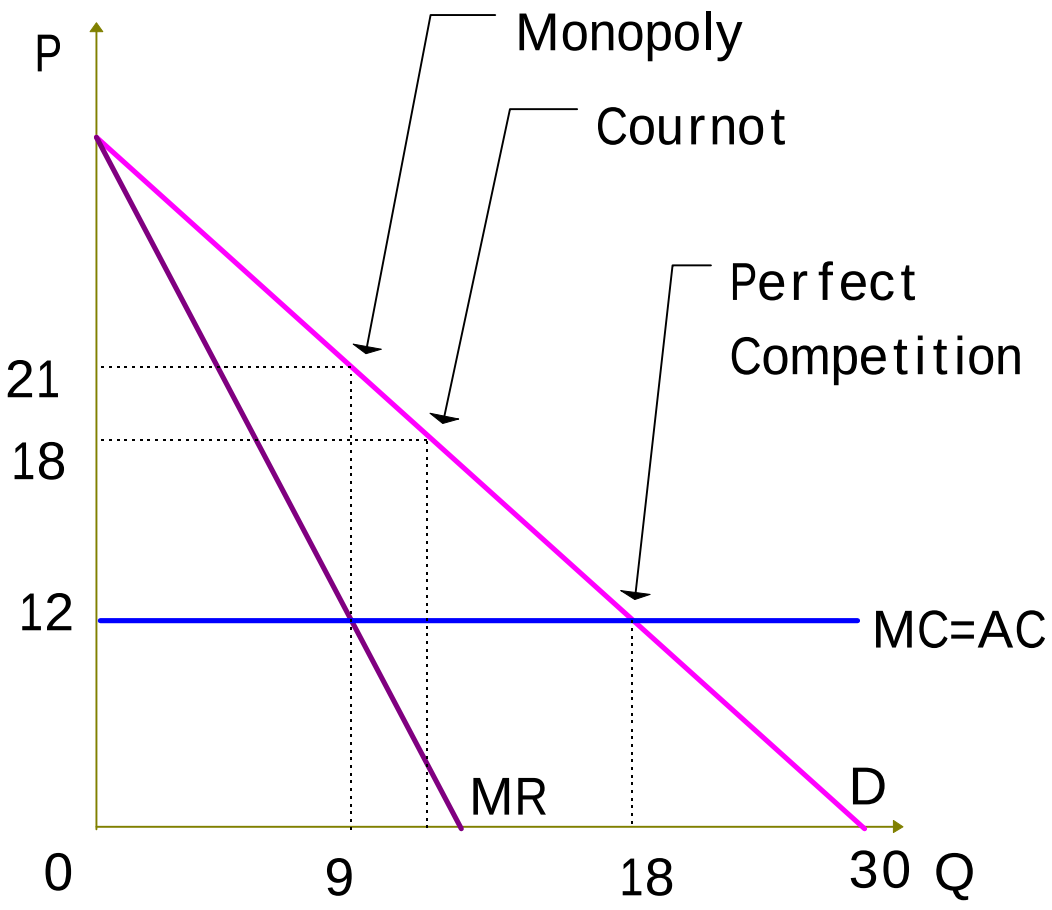
Equilibrium price

$$\underline{P = 21}$$

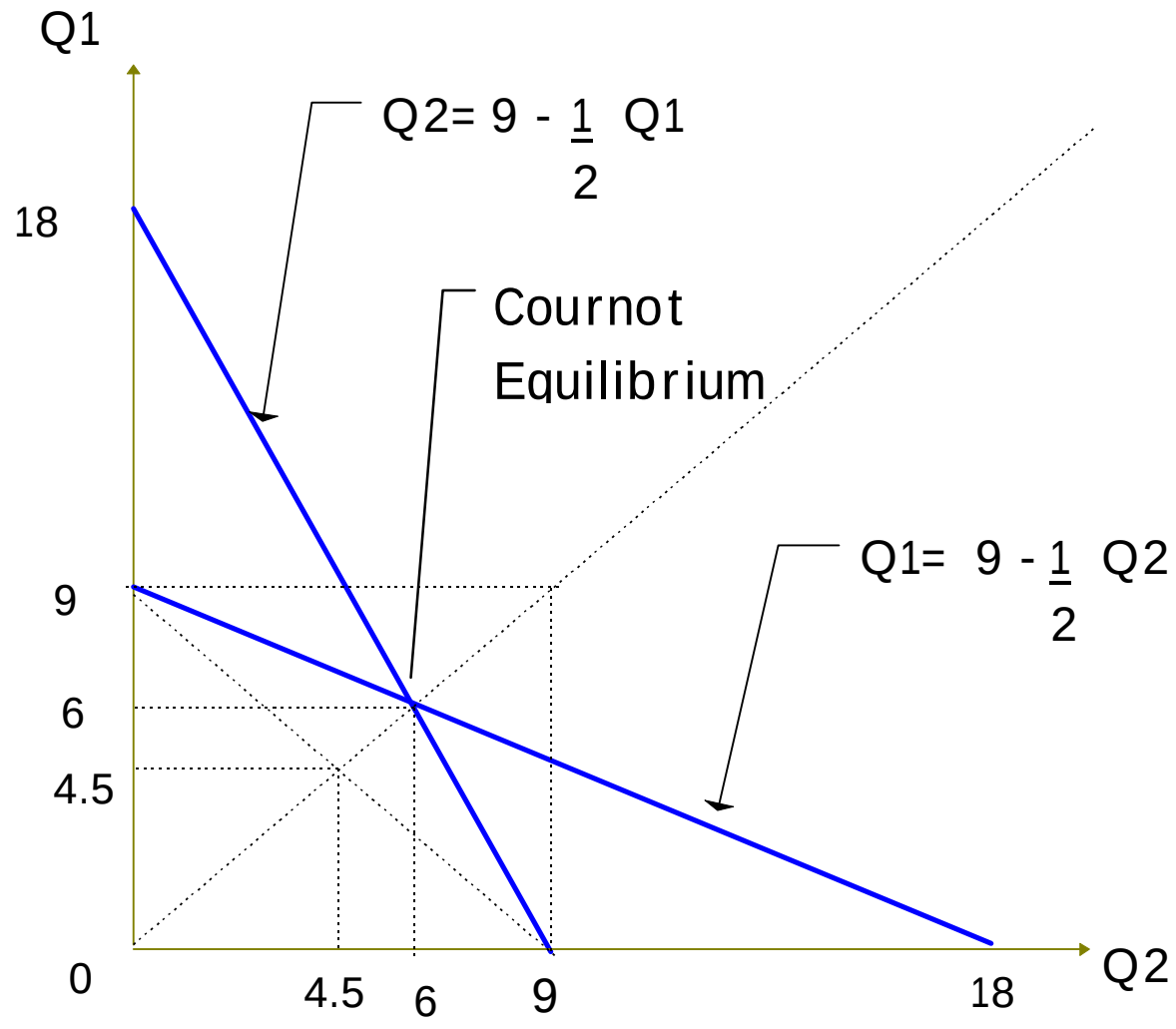
We can use this information to show that two firms operating under Cournot assumptions offer a better welfare outcome than under monopoly.

We first use the traditional monopoly diagram and then show the outcome using reaction curves.

Cournot Equilibrium compared using a traditional Monopoly diagram



Cournot Equilibrium compared using Reaction Curves



A further point that must be considered is that if the number of firms increases then the Cournot equilibrium approaches the competitive equilibrium.

In our example the Cournot equilibrium output was 2/3s that of the perfectly competitive output. It can be shown that if there were 3 firms acting under Cournot assumption then they would produce 3/4s of the perfectly competitive output level. More generally, the equilibrium rate of output under Cournot assumptions, Q, is

$$Q = nq = \frac{n \,.\, Q_{pc}}{(n+1)}$$

where n = number of firms
q = individual firm output
Q_{pc} = output under perfect competition

Heinrich von Stackelberg (1934)

Stackelberg's duopoly model assumed that one firm acts as a dominant firm in setting quantities. Dominance implies knowledge of the way competitors will react to any given output set by the leading firm (in the Cournot model neither firm had the opportunity to react). A dominant firm can then select that output which yields the maximum profit for itself.

We can use our numerical example to show the welfare outcome under Stackelberg's assumption of one dominant firm and one (passive) follower. We will assume that Firm 1 is the dominant firm and thus has prior knowledge of Firm 2s reaction curve.

So, Total Revenue for Firm 1 is as under Cournot

$$R1 = 30Q1 - Q1^2 - Q1Q2$$

But Firm 1 knows Firm 2s reaction curve so

$$R1 = 30.Q1 - Q1^2 - Q1 .(9 - \frac{1}{2} Q1)$$

$$R1 = 21.Q1 - \frac{1}{2} Q1^2$$

Thus,

$$MR1 = 21 - Q1$$

which when equated with MC (=12) to find Firm 1s equilibrium output gives

$$12 = 21 - Q1$$

$$\underline{Q1 = 9}$$

$$\underline{Q2} = 9 - \frac{1}{2} Q1) = \underline{4.5}$$

Equilibrium price for this combined output is

$$P = 30 - Q$$

$$\underline{P = 16.5}$$

Thus, we can see that in a duopoly framework Stackelberg assumptions offer better welfare outcomes than Cournot.

Questions

- ***Can you position the Stackelberg equilibrium on the above diagrams?***
- ***What levels of abnormal profit do you associate with each equilibrium position?***
- ***What would happen to the Cournot and Stackelberg equilibriums if the marginal cost of Firm 1 was 10 whilst Firm 2's MC remained unchanged?***

What does all this mean?

In terms of the SCP approach these oligopoly models are addressing the role of conduct (albeit in a simple way) as well as structure. There is clearly a link between these variables and economic performance.

We can predict that if a duopoly exists, and the volume of homogenous goods sold is the main competitive weapon, then it would be better for society if the market operated under Stackelberg assumptions about behaviour. So, if the Government were to consider privatising or liberalising an industry so that two firms were to make up an industry it would be better to allow one firm to have dominance.

If Cournot behaviour prevails then firm numbers becomes important.

Interestingly, if product differentiation prevails then this may increase the level of welfare loss.

The implication of this is that market power still matters and the academic debate is now couched in terms of the nature of conjectural variations within industries, i.e. there is more sophisticated analysis of behaviour.

Joseph Bertrand (1883)

Bertrand argued that a major problem with the Cournot model is that it failed to make price explicit. Indeed, he showed that if firms compete on price when goods are homogenous, at least in consumer's eyes, then a price war will develop such that price approaches marginal cost.

However, when firms produce differentiated products such that all market sales do not disappear for a slightly higher priced firm, then equilibrium at above the competitive price is possible.

In such differentiated product models results much closer in spirit to Cournots may be obtained.

Reading

Shepherd,W.G. (1990) *The Economics of Industrial Organisation*, Prentice Hall International, London. Ch 12. Probably the simplest explanation

Jacobson D & Andreosso-O'Callaghan B (1996) *Industrial Economics and Organisation. A European Perspective*, McGraw Hill, London. Pages 59 - 82.

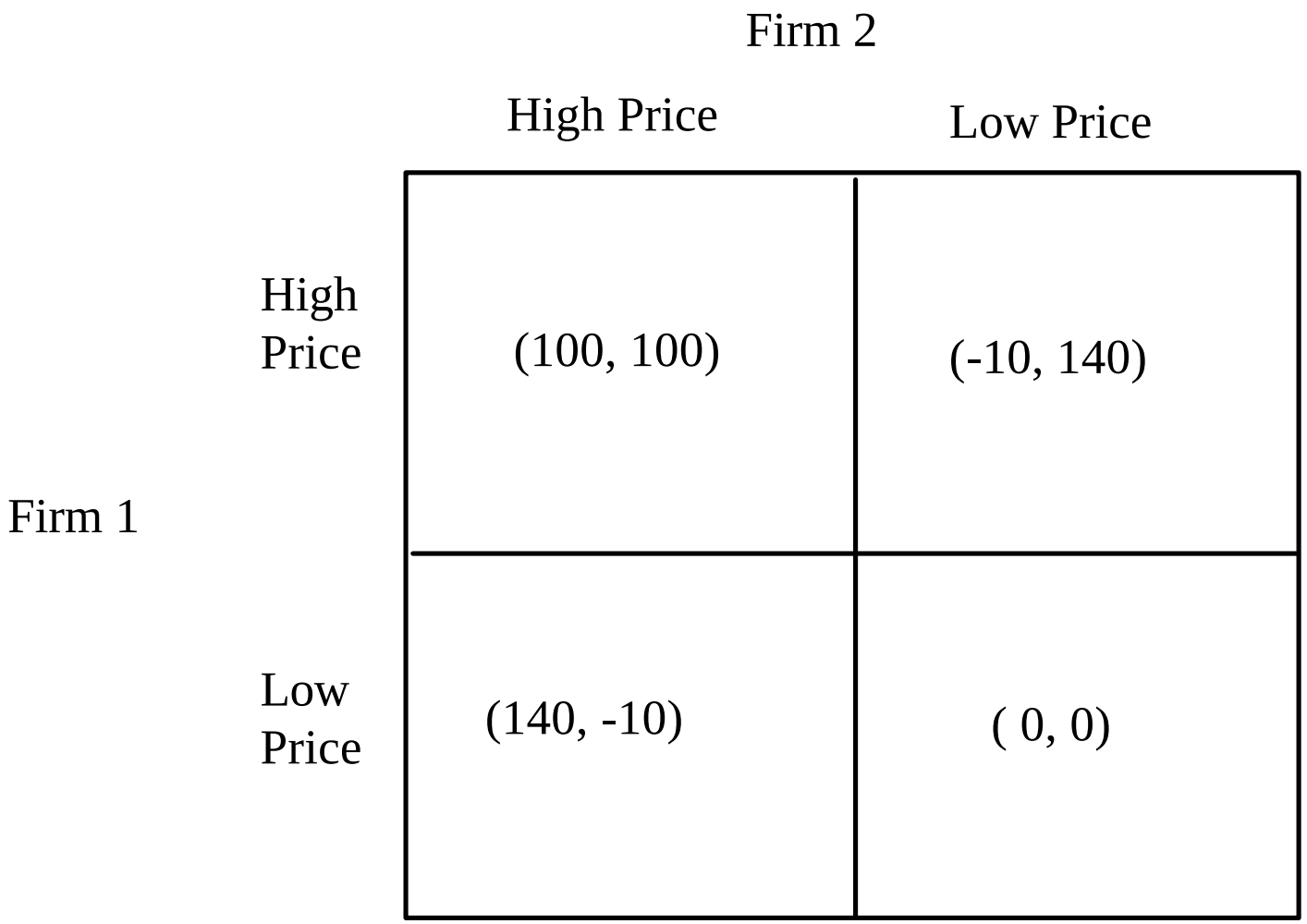


Figure 2a: A Bertrand Duopoly Game

Revision Topic: The Social Costs of Monopoly and Oligopoly

Aims

- To reinforce and extend lecture material demonstrating the extent of welfare losses in monopoly and oligopoly.
- To develop quantitative and economic reasoning skills.

Learning Outcomes

Students will undertake the exercise set out below

In doing so they will be able to

- draw monopoly diagrams and examine the social costs of monopoly.
- draw reaction curves and consider the Cournot, Stackelberg and Bertrand interpretations of oligopolistic conduct.

Questions

1. Assume that there are 2 firms selling a homogenous product at zero cost. Market demand curve given by

$$Q = 240 - 10P \qquad \text{where } Q = Q1 + Q2 \ \& \ Q1=Q2$$

calculate profit maximising output and prices to arrive at the

a. Cournot equilibrium
b. Competitive equilibrium
c. Collusive equilibrium

2. Using the same information calculate a Stackelberg equilibrium if firm 1 acts as the industry leader.

3. Suppose that there are 2 firms who have fixed costs of £20 and zero variable costs. They both face the same demand curve.

$$Q1 = 12 - 2P1 + P2$$

$$Q2 = 12 - 2P2 + P1$$

If both firms were to adapt Bertrand assumptions, i.e. each firm makes its decision about price given what it anticipates its rivals price will be.

a. calculate the equilibrium output and price if firms compete?

b. calculate the equilibrium price and output if firms collude?

Oligopolistic Conduct and Welfare

by

Kevin Hinde

Welfare and (Tight) Oligopoly

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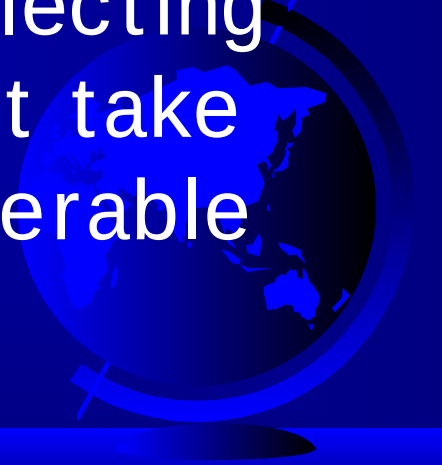
- Welfare depends upon the number of firms in the industry and the conduct they adopt.

Augustin Cournot (1838)

- Cournot's model involves competition in quantities (sales volume, in modern language) and price is less explicit.
- The biggest assumption made by Cournot was that a firm will embrace anothers output decisions in selecting its profit maximising output but take that decision as fixed, ie. unalterable by the competitor.



If Firm 1 believes that Firm 2 will supply the entire industry output it will supply zero.

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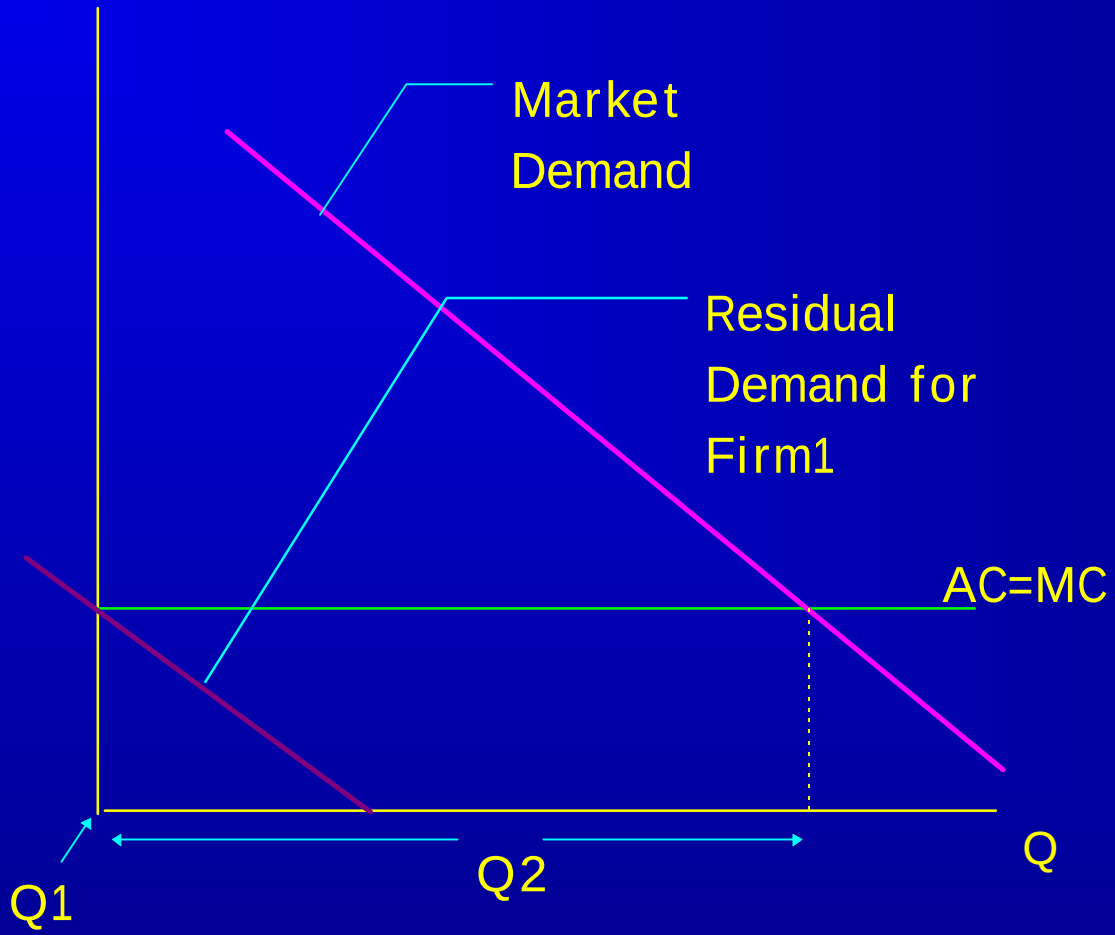

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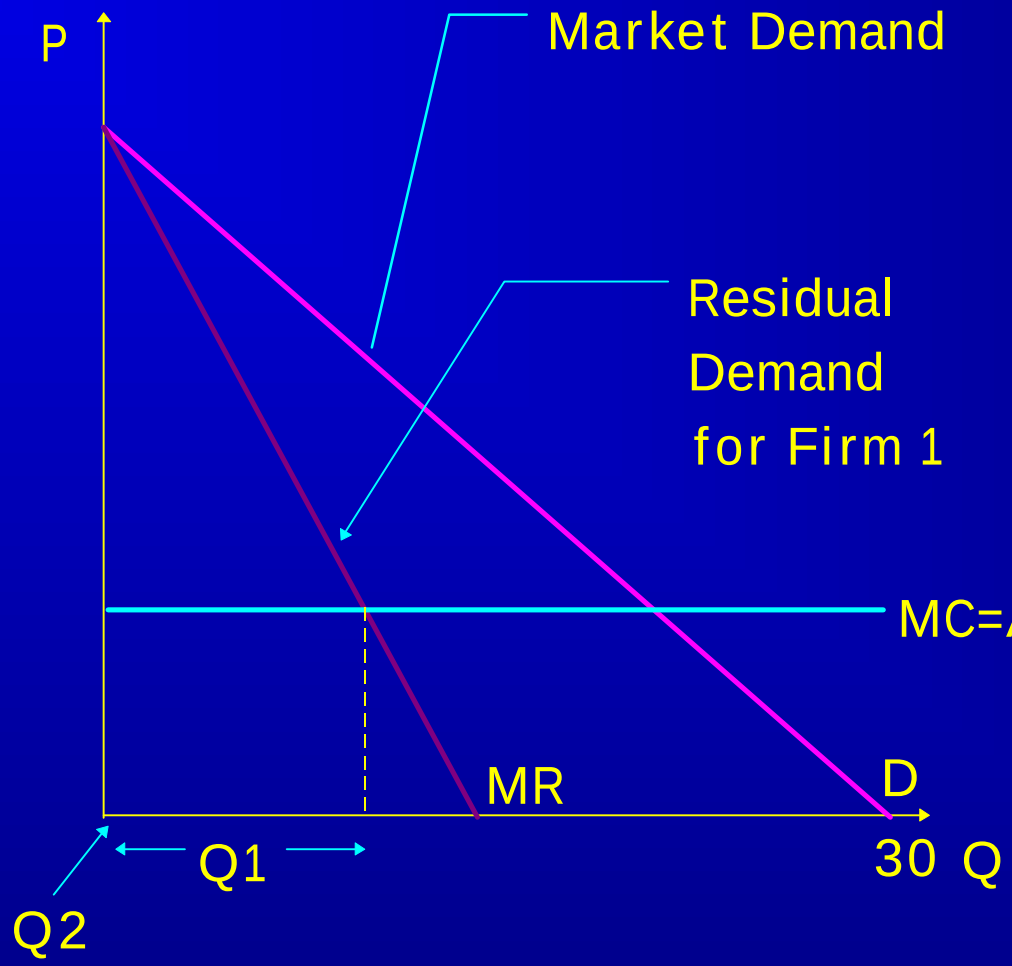
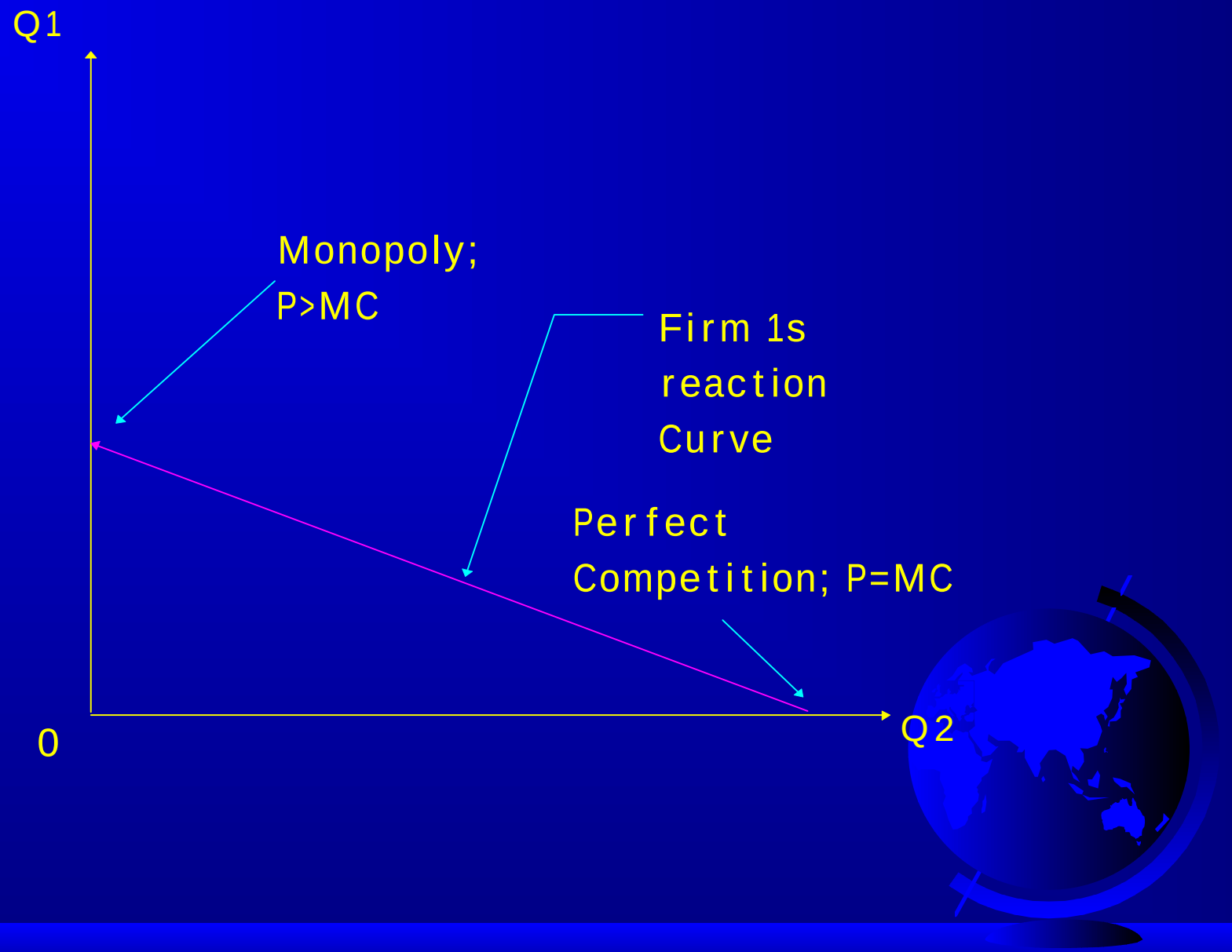
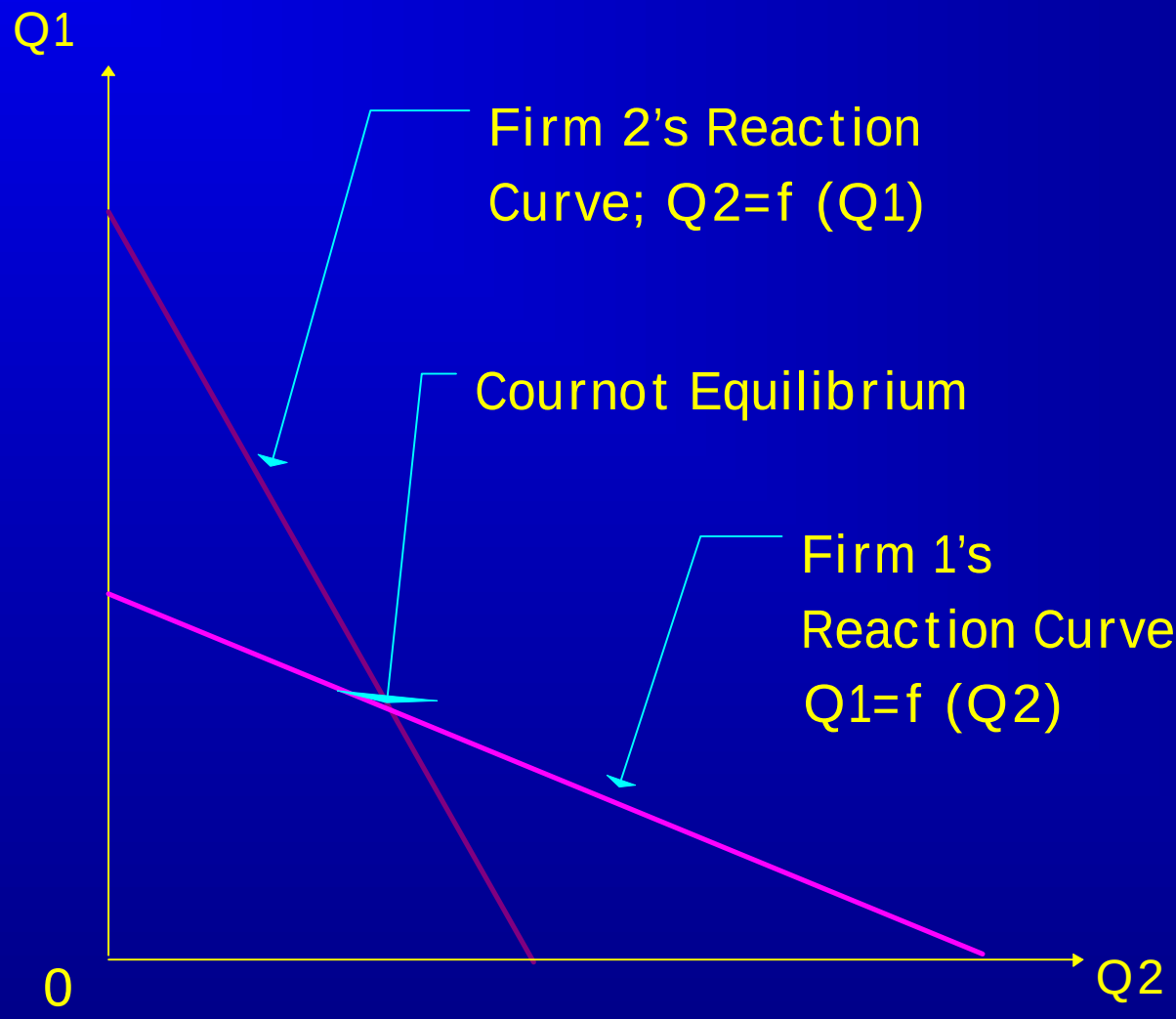



Q1
Monopoly;
P>MC
Firm 1s
reaction
Curve
Perfect
Competition; P=MC
0
Q2

If Firm 2 makes the same conjectures then we get the following:



Convergence to Equilibrium

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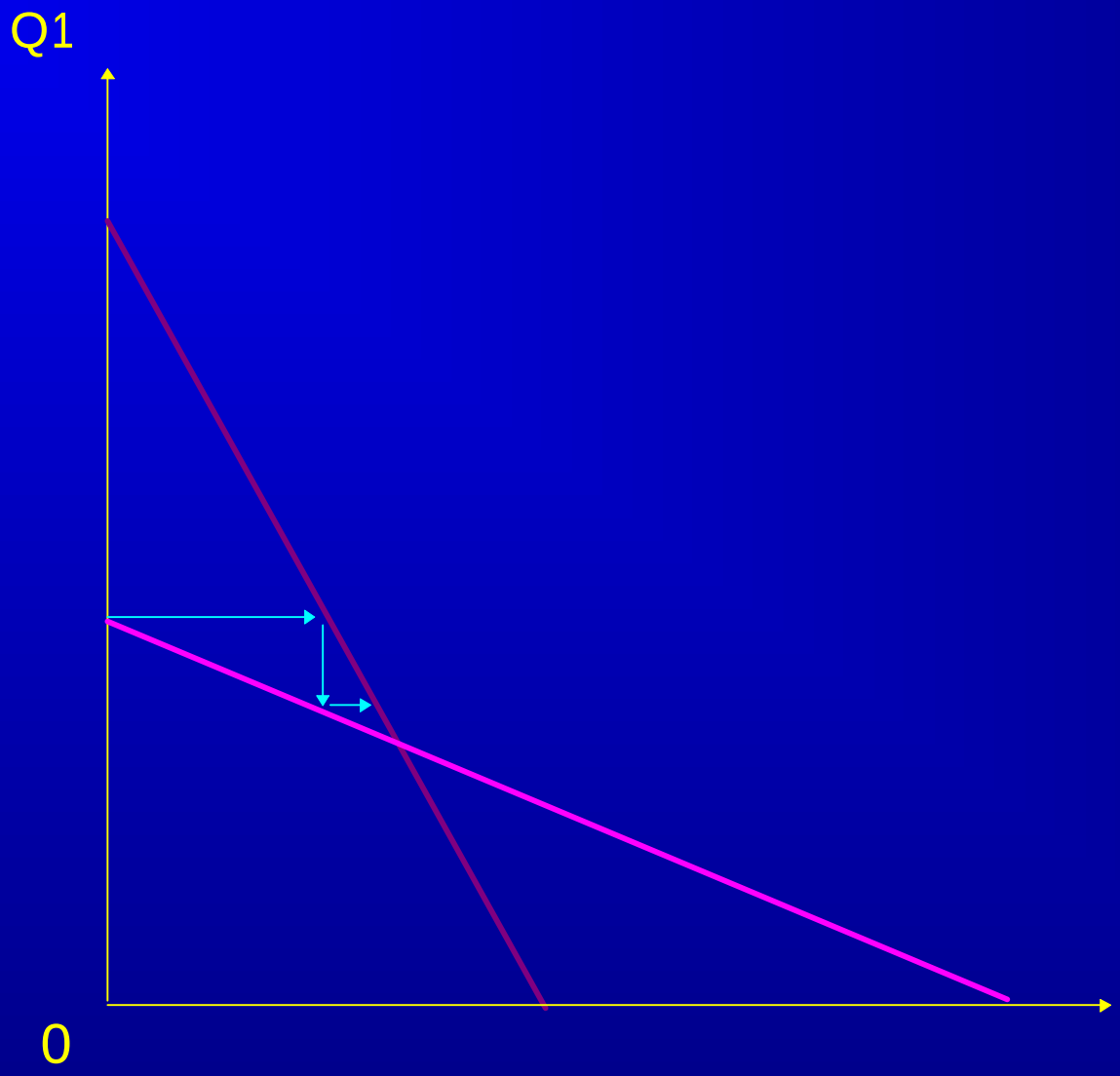


A numerical example

- Assume market demand to be

  $P = 30 - Q$

where $Q = Q1 + Q2$

ie industry output constitutes firm 1 and firm 2's output respectively

- Further, assume $Q1 = Q2$
- and average (AC) and marginal cost (MC)

  $AC = MC = 12$

- To find the profit maximising output of Firm 1 given Firm 2's output we need to find Firm 1's marginal revenue (MR) and set it equal to MC. So,
- Firm 1's Total Revenue is

$$R1 = (30 - Q)\,Q1$$

$$R1 = [30 - (Q1 + Q2)]\,Q1$$

$$= 30Q1 - Q1^2 - Q1Q2$$

- Firm 1's MR is thus

$$MR1 = 30 - 2Q1 - Q2$$

- If MC=12 then

$$Q1 = 9 - \frac{1}{2} Q2$$

This is Firm 1's Reaction Curve.

- If we had begun by examining **Firm 2's** profit maximising output we would find its **reaction curve**, i.e.

$$Q2 = 9 - \frac{1}{2} Q1$$

- We can solve these 2 equations and find equilibrium quantity and price.
- Solving for Q1 we find

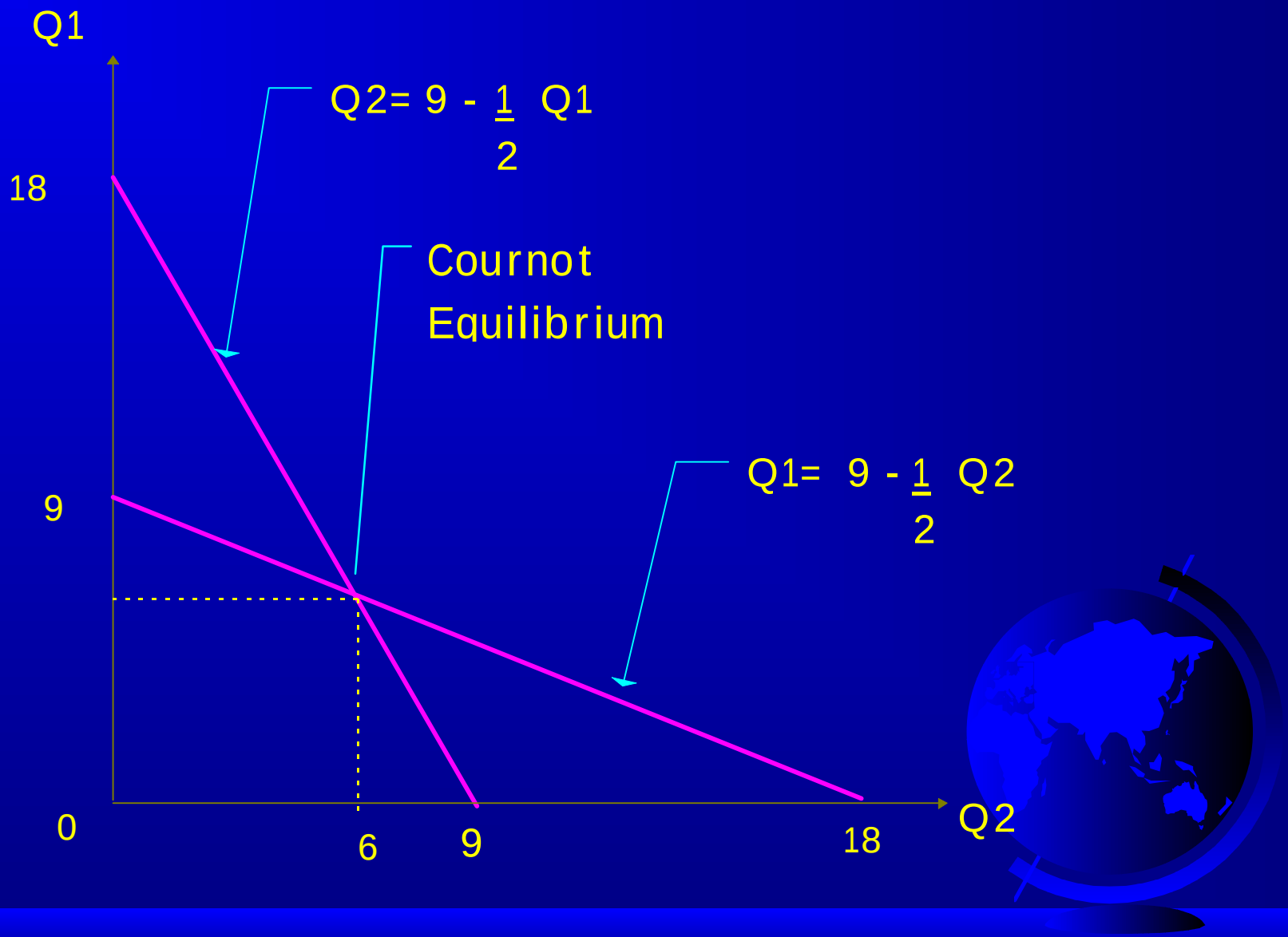
$$Q1 = 9 - \frac{1}{2}(9 - \frac{1}{2} Q1)$$

$$Q1 = 6$$

- Similarly,

$$Q2 = 6$$

and $$P = 18$$


Q1
Q2= 9 - 1/2 Q1
18
Cournot
Equilibrium
Q1= 9 - 1/2 Q2
9
0
6
9
18
Q2

Perfect Competition

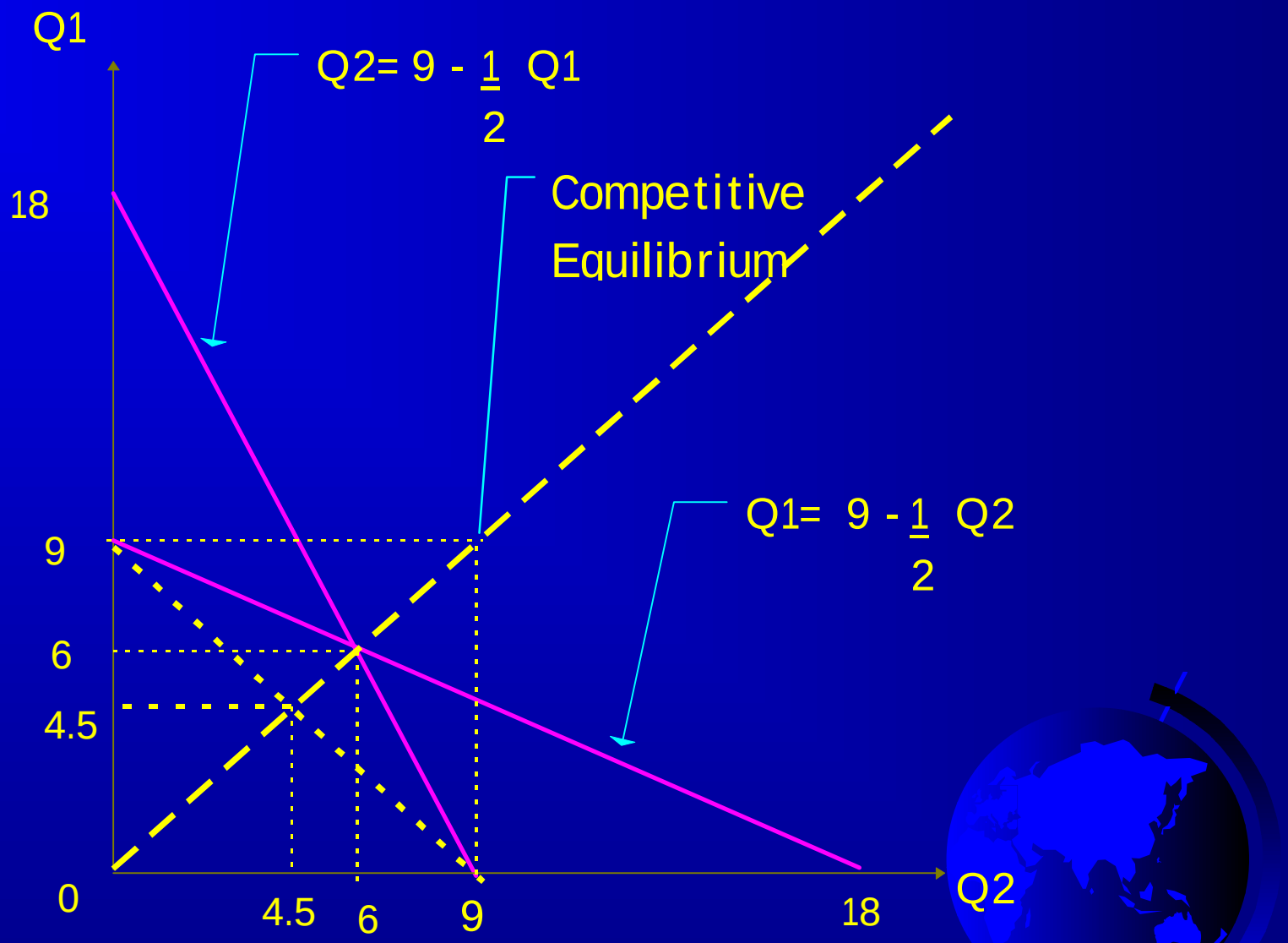
- Under perfect competition firms set prices equal to MC. So,

  P= 12

- and equilibrium quantity

  Q= 18

- Assuming both supply equal amounts, Firm 1 supplies 9 and so does Firm 2.


Q1
Q2= 9 - 1/2 Q1
18
Competitive
Equilibrium
Q1= 9 - 1/2 Q2
9
6
4.5
0
4.5
6
9
18
Q2

Monopoly

- They would then maximise **industry** profits and share the spoils.

$$TR = PQ = (30 - Q)Q = 30Q - Q^2$$

$$MR = 30 - 2Q$$

- As MC equals 12 industry profits are maximised where

$$30 - 2Q = 12$$

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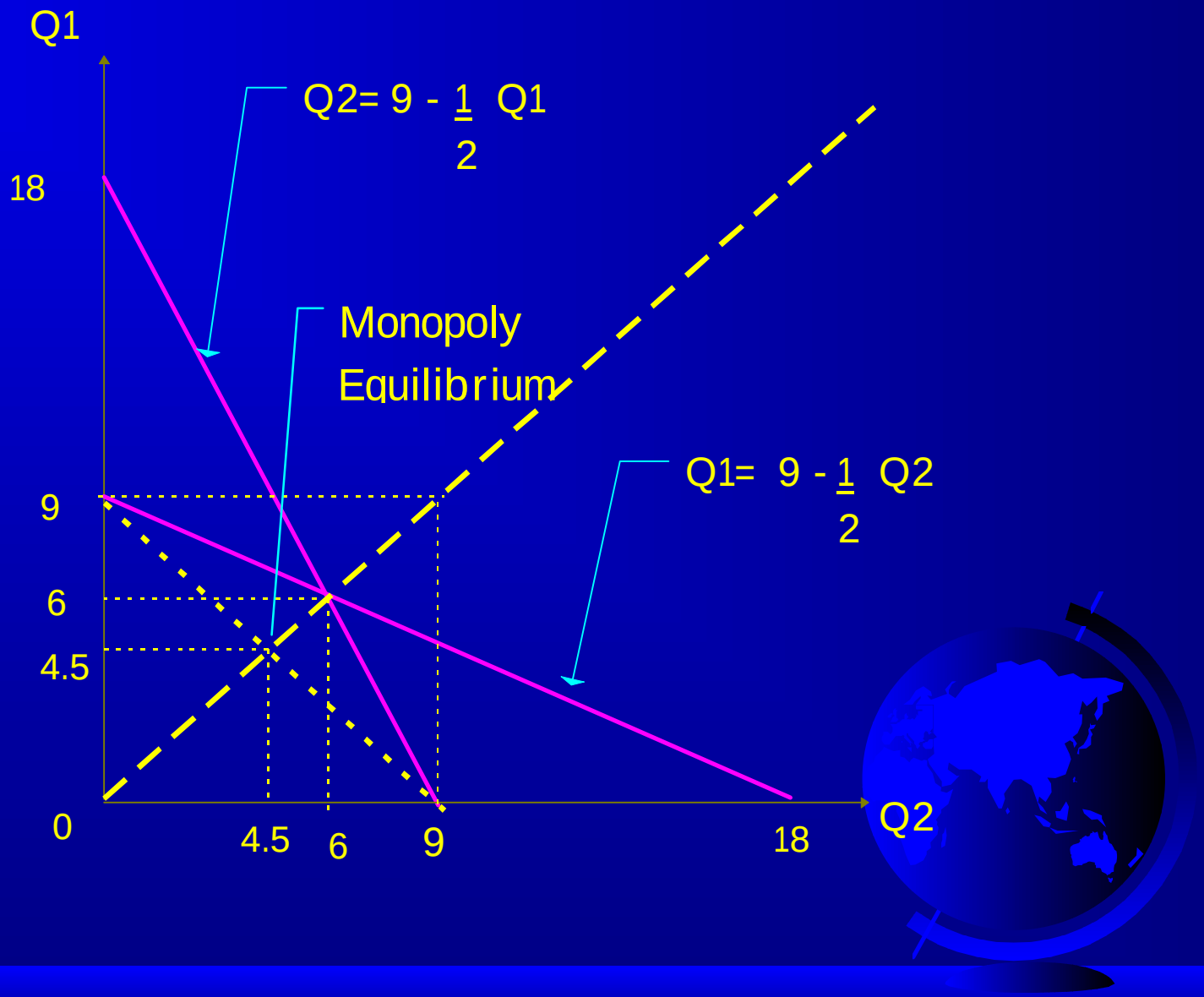
- So $Q1 = Q2 = 4.5$
- Equilibrium price
- $P = 21$


Q1
Q2= 9 - 1/2 Q1
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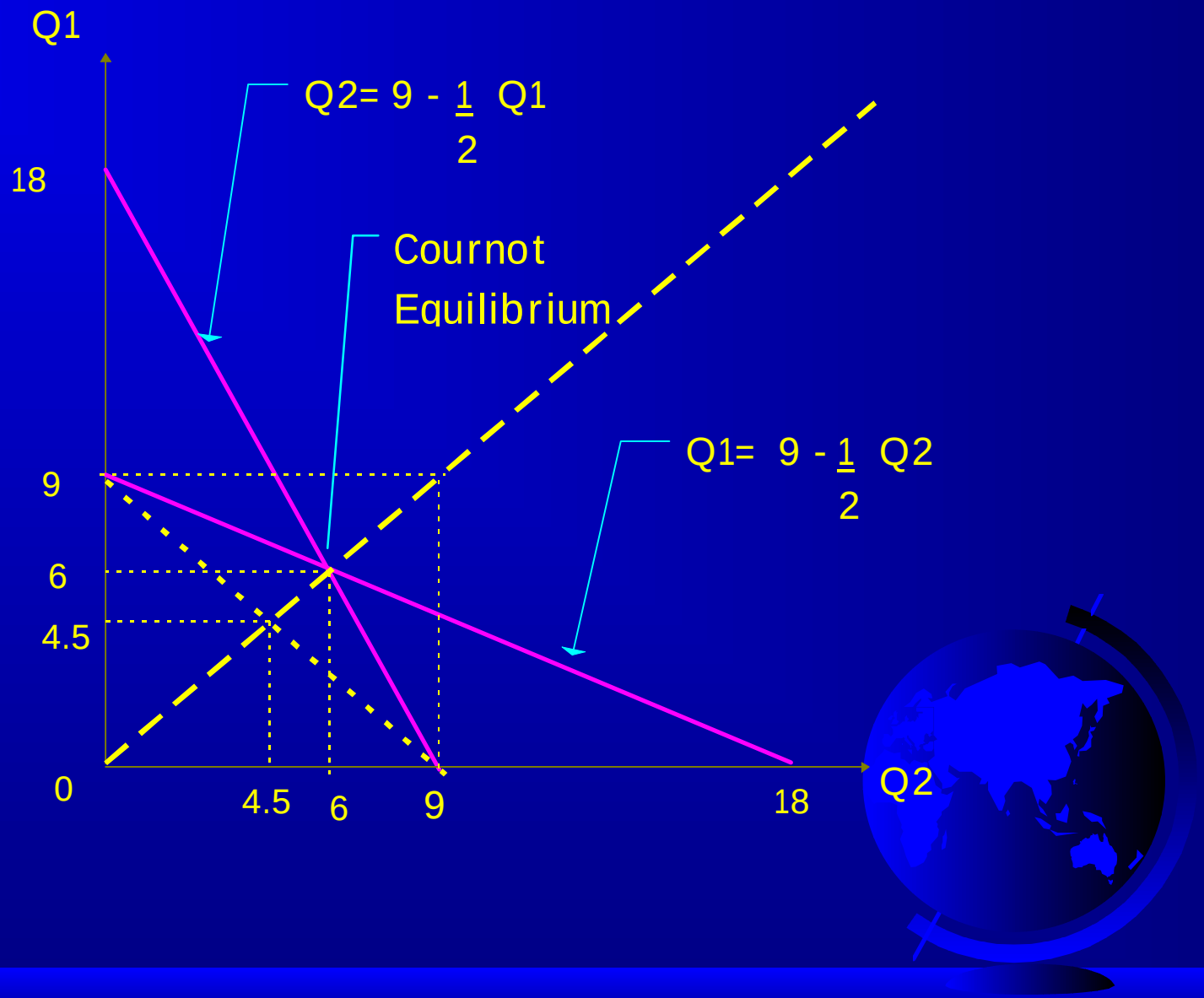
Monopoly
Equilibrium
Q1= 9 - 1/2 Q2
9
6
4.5
0
4.5
6
9
18
Q2


Q1
Q2= 9 - 1/2 Q1
18
Cournot
Equilibrium
Q1= 9 - 1/2 Q2
9
6
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9
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Q2

Cournot Equilibrium compared using a traditional Monopoly diagram

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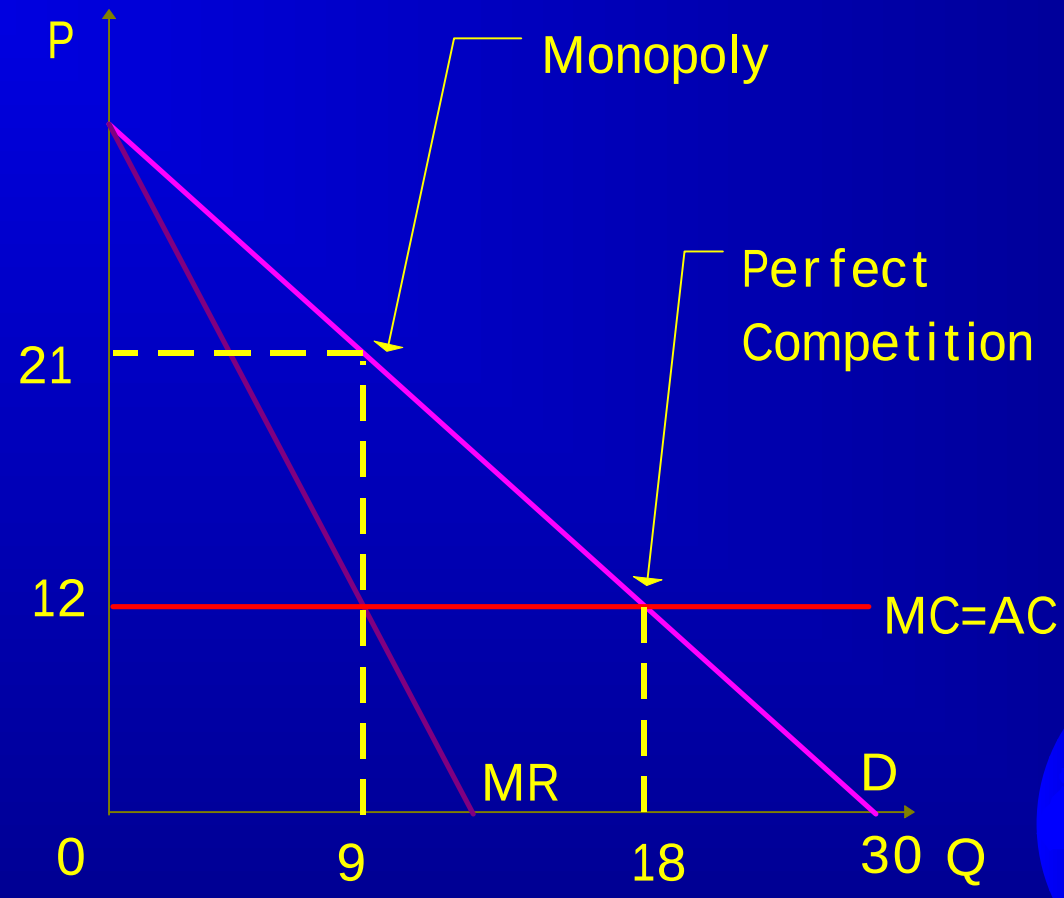
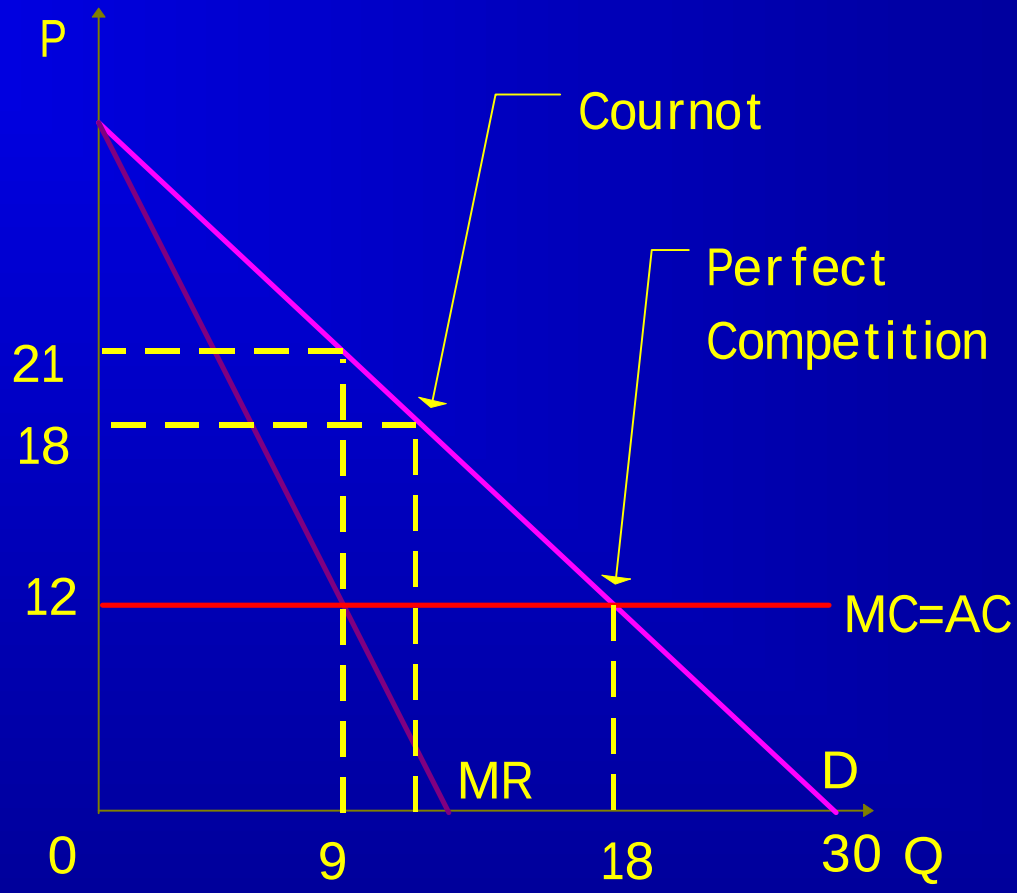


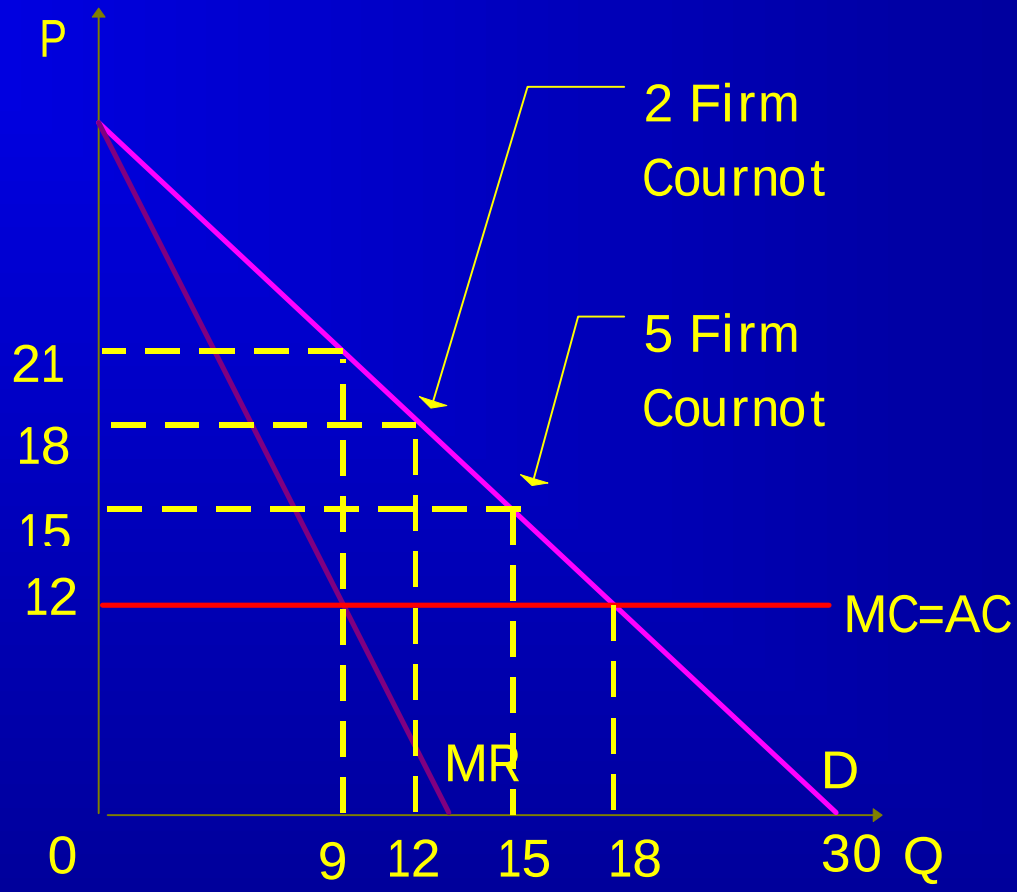
Cournot Equilibrium compared using a traditional Monopoly diagram



- A further point that must be considered is that if the number of firms increases then the Cournot equilibrium approaches the competitive equilibrium.
- In our example the Cournot equilibrium output was 2/3s that of the perfectly competitive output.
- It can be shown that if there were 3 firms acting under Cournot assumption then they would produce 3/4s of the perfectly competitive output level.

Firm numbers matter

Firm numbers matter



Joseph Bertrand (1883)

- Bertrand argued that a major problem with the Cournot model is that it failed to make price explicit.
- He showed that if firms compete on price when goods are homogenous, at least in consumer's eyes, then a price war will develop such that price approaches marginal cost.

Firm1 \ Firm 2	High Price	Low Price
High Price	(100, 100)	(-10, 140)
Low Price	(140, -10)	(0, 0)