

Prerequisites

Almost essential

Firm: Demand and Supply

The Firm and the Market

MICROECONOMICS

Principles and Analysis

Frank Cowell

Introduction

- In previous presentations we've seen how an optimising agent reacts to the market.
 - Use the comparative statics method
- We could now extend this to other similar problems.
- But first a useful exercise in microeconomics:
 - Relax the special assumptions
- We will do this in two stages:
 - Move from one price-taking firm to many
 - Drop the assumption of price-taking behaviour.

Overview...

*Issues in
aggregating
supply curves of
price-taking firms*

The Firm and the
Market

Market supply
curve

- **Basic aggregation**
- Large numbers
- Interaction amongst firms

Size of the
industry

Price-setting

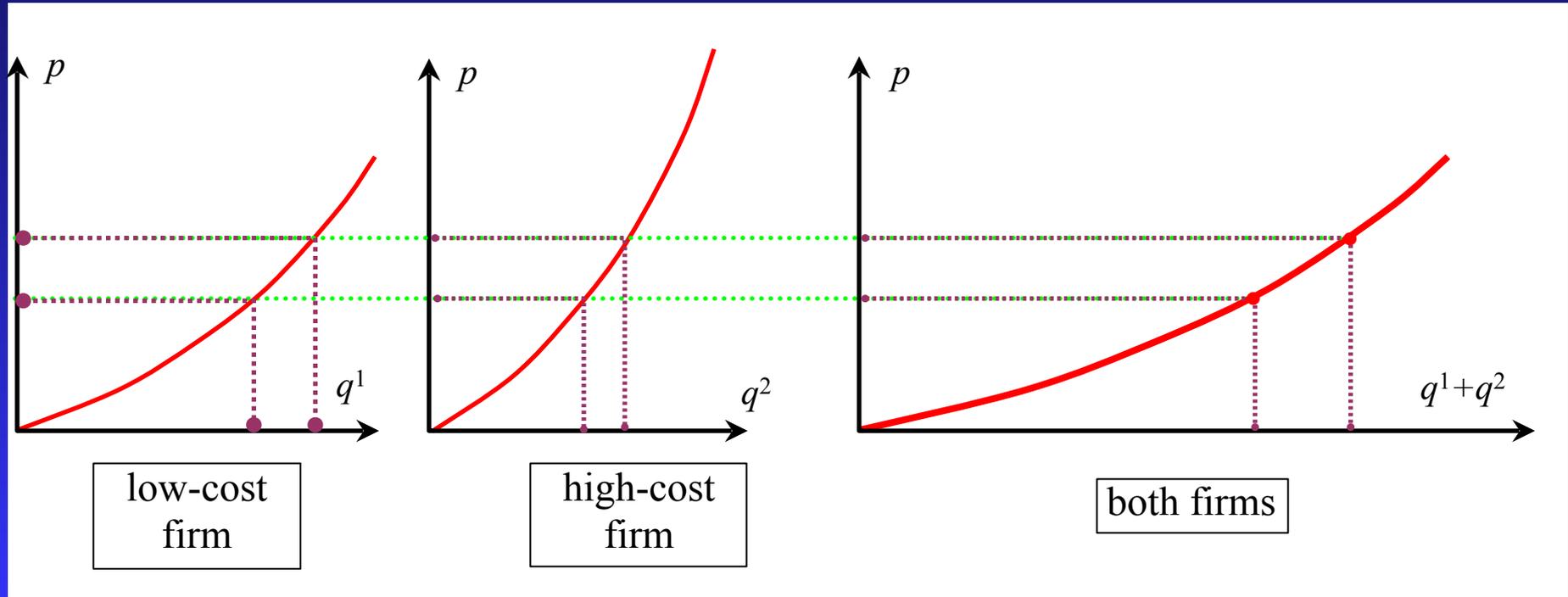
Product variety

Aggregation over firms

- We begin with a very simple model.
- Two firms with similar cost structures.
- But using a very special assumption.
- First we look at the method of getting the market supply curve.
- Then note the shortcomings of our particular example.

A market with two firms

- Supply curve firm 1 (from MC).
- Supply curve firm 2.
- Pick any price
- Sum of individual firms' supply
- Repeat...
- The market supply curve



Simple aggregation

- Individual firm supply curves derived from MC curves
- “Horizontal summation” of supply curves
- Market supply curve is flatter than supply curve for each firm
- But the story is a little strange:

See presentation
on duopoly

📁👉 Each firm act as a price taker even though there is just one other firm in the market.

📄👉 Number of firms is *fixed* (in this case at 2).

Later in this
presentation

📄👉 Firms' supply curve is different from that in previous presentations

Try another
example

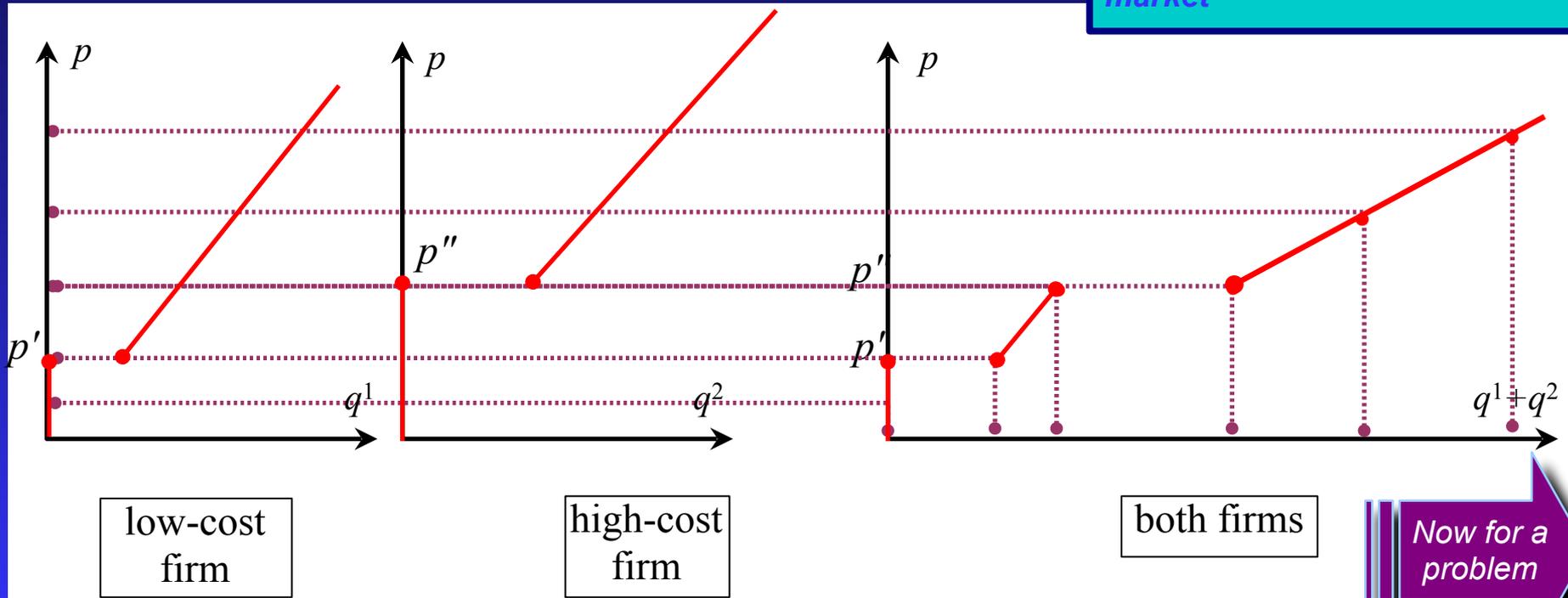
Another simple case

- Two price-taking firms.
- Similar “piecewise linear” MC curves:
 - Each firm has a fixed cost.
 - Marginal cost rises at the same constant rate.
 - Firm 1 is the low-cost firm.
- Analyse the supply of these firms over three price ranges.



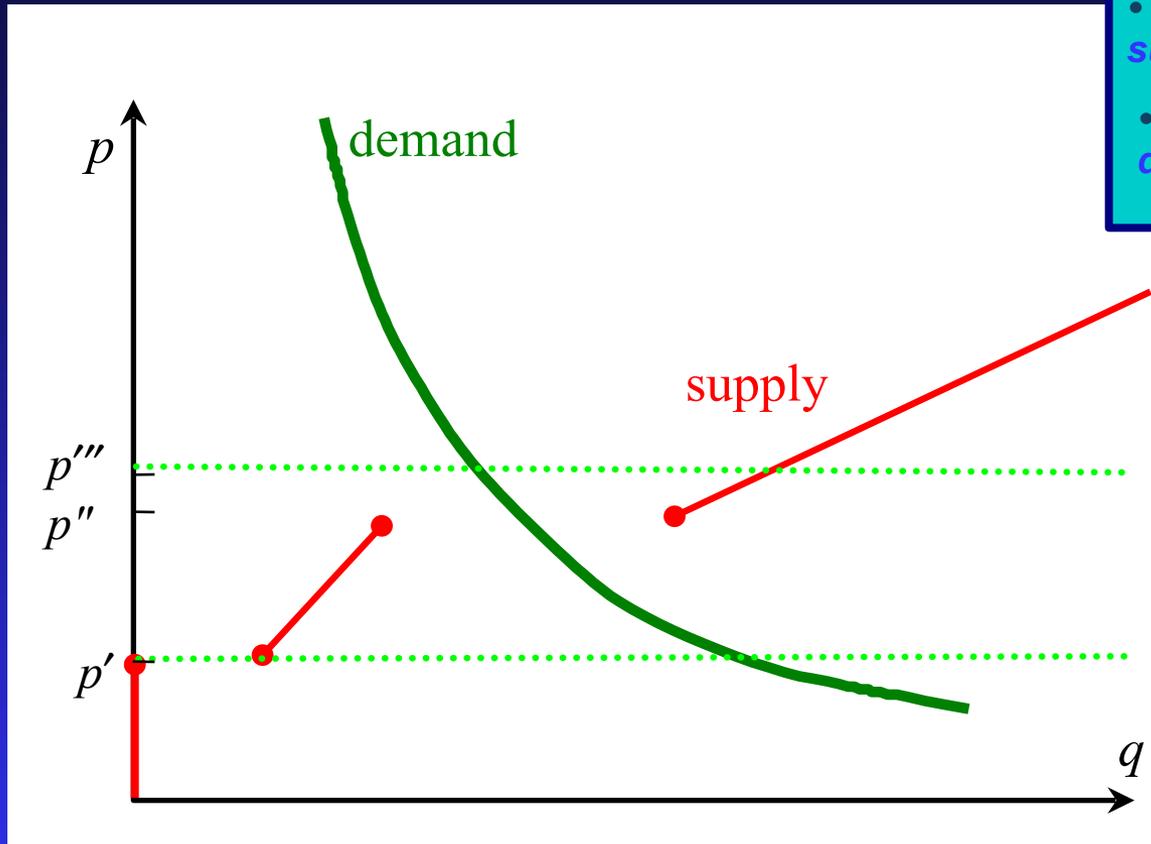
Market supply curve (2)

- Below p' neither firm is in the market
- Between p' and p'' only firm 1 is in the market
- Above p'' both firms are in the market



Now for a problem

Where is the market equilibrium?



- Try p' (demand exceeds supply)
- Try p''' (supply exceeds demand)

- There is no equilibrium at p''

Lesson 1

- Nonconcave production function can lead to discontinuity in supply function.
- Discontinuity in supply functions may mean that there is no equilibrium.

Overview...

*A simplified
continuity
argument*

The Firm and the
Market

Market supply
curve

- Basic aggregation
- **Large numbers**
- Interaction amongst firms

Size of the
industry

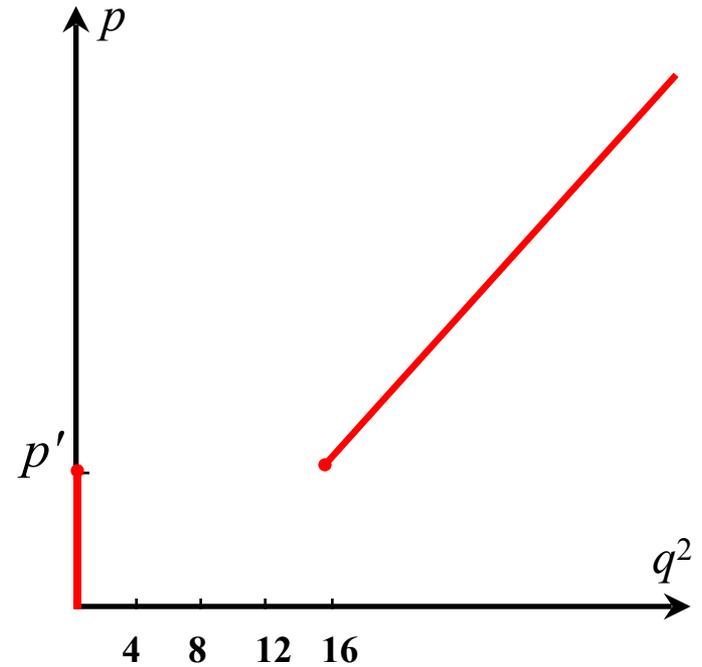
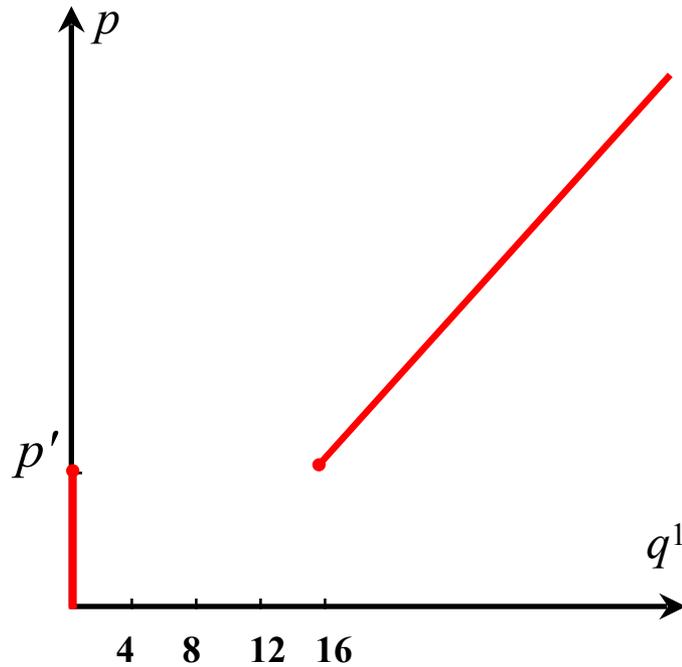
Price-setting

Product variety

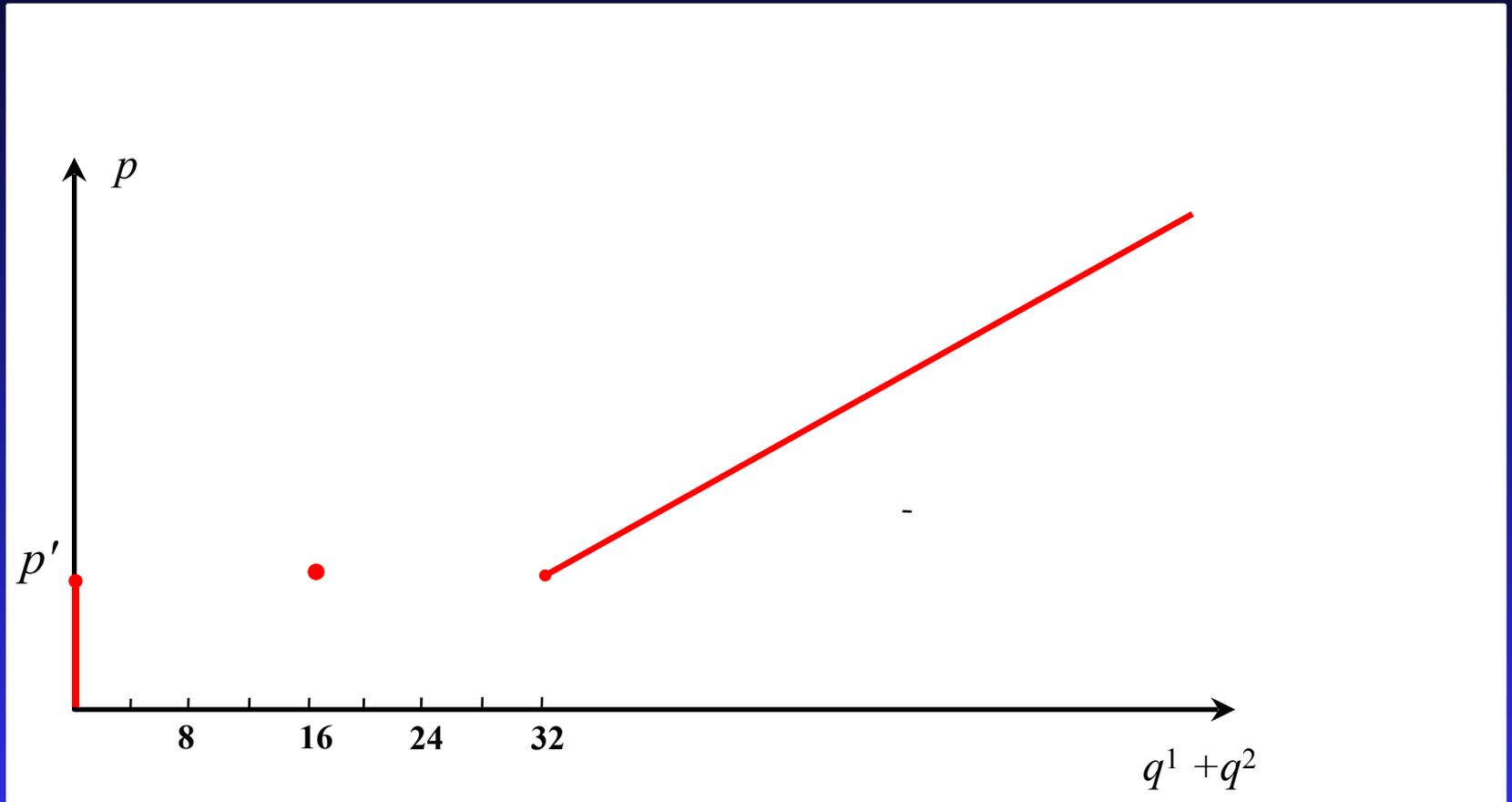
A further experiment

- The problem of nonexistent equilibrium arose from discontinuity in supply.
- But is discontinuity likely to be a serious problem?
- Let's go through another example.
 - Similar cost function to previous case
 - This time – *identical* firms
 - (Not essential – but it's easier to follow)

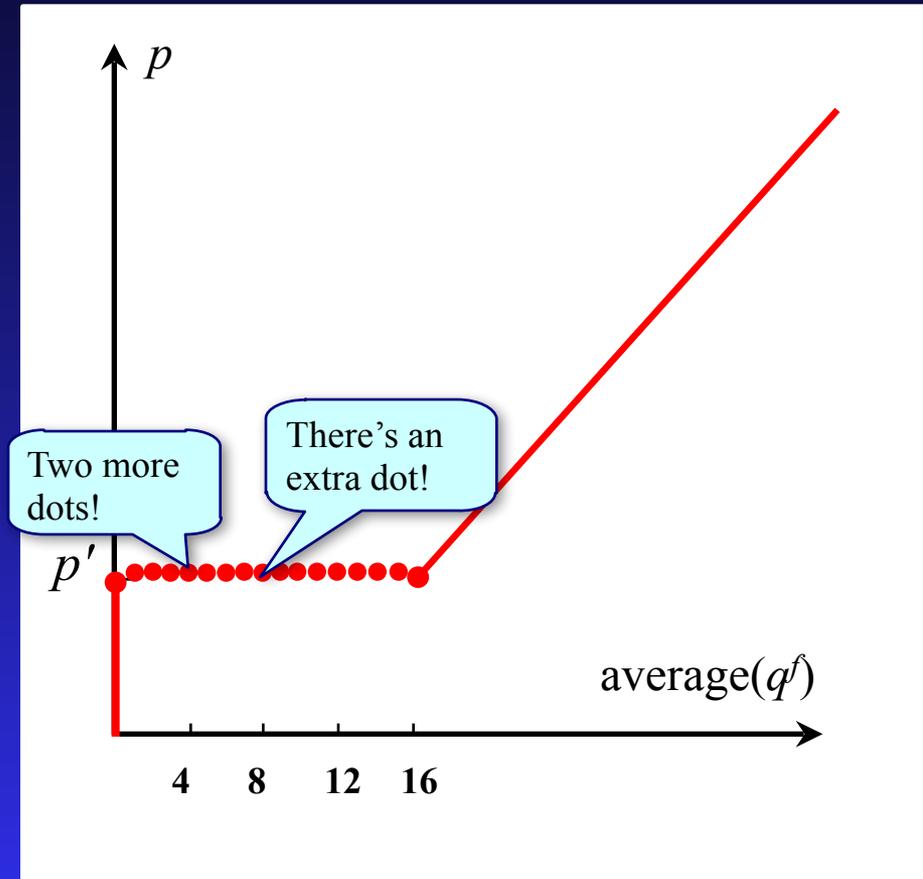
Take two identical firms...



Sum to get aggregate supply

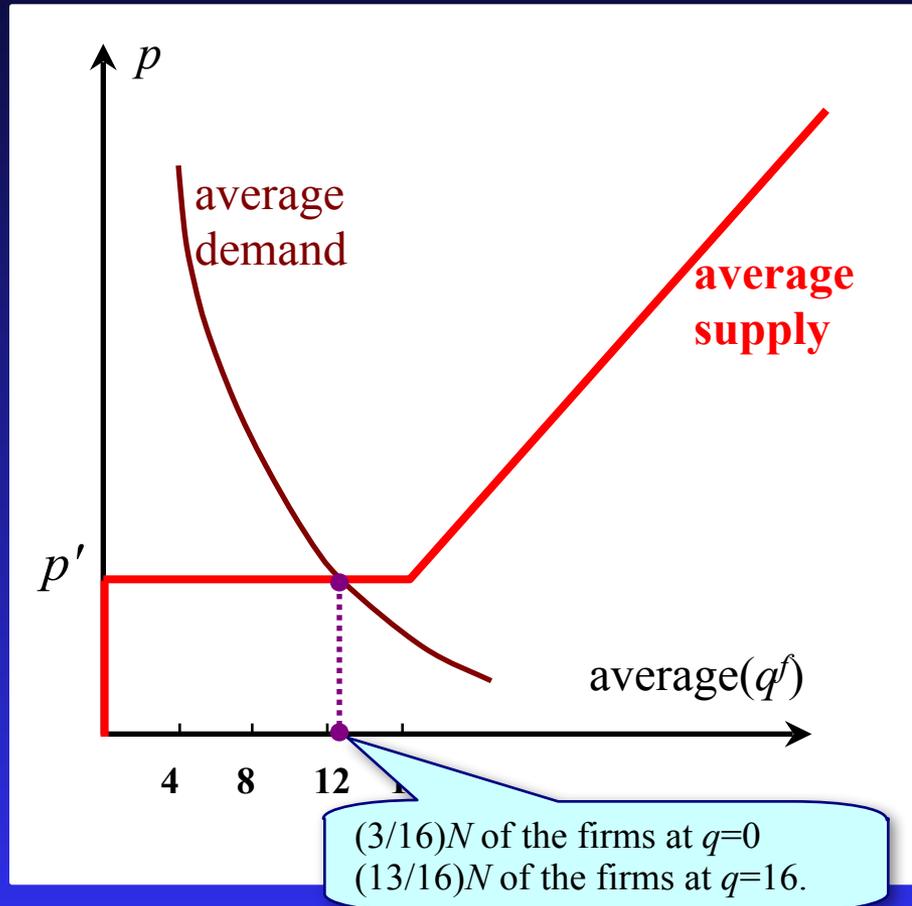


Numbers and average supply



- Rescale to get the average supply of the firms...
- Compare with S for just one firm
- Repeat to get average S of 4 firms
- ...average S of 8 firms
- ... of 16 firms

The limiting case



- In the limit draw a continuous "averaged" supply curve
- A solution to the non-existence problem?
- A well-defined equilibrium
- Firms' outputs in equilibrium

Lesson 2

- A further insight into nonconcavity of production function (nonconvexity of production possibilities).
- Yes, nonconvexities can lead to problems:
 - Discontinuity of response function.
 - Nonexistence of equilibrium.
- But if there are large numbers of firms then then we may have a solution.
- The *average* behaviour may appear to be conventional.

Overview...

*Introducing
“externalities”*

The Firm and the
Market

Market supply
curve

- Basic aggregation
- Large numbers
- **Interaction amongst firms**

Size of the
industry

Price-setting

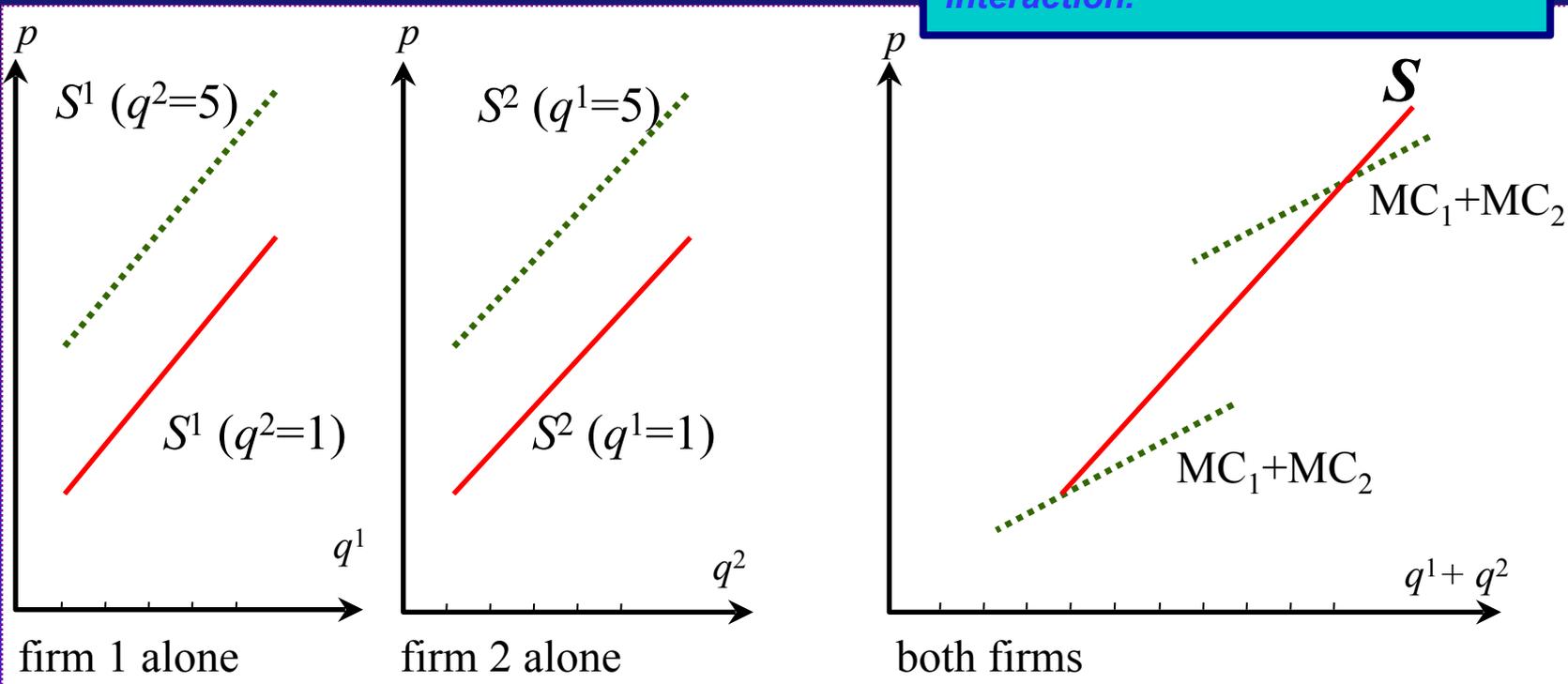
Product variety

Interaction amongst firms

- Consider two main types of interaction
- Negative externalities
 - Pollution
 - Congestion
 - ...
- Positive externalities
 - Training
 - Networking
 - Infrastructure
- Other interactions?
 - For example, effects of one firm on input prices of other firms
 - Normal multimarket equilibrium
 - Not relevant here

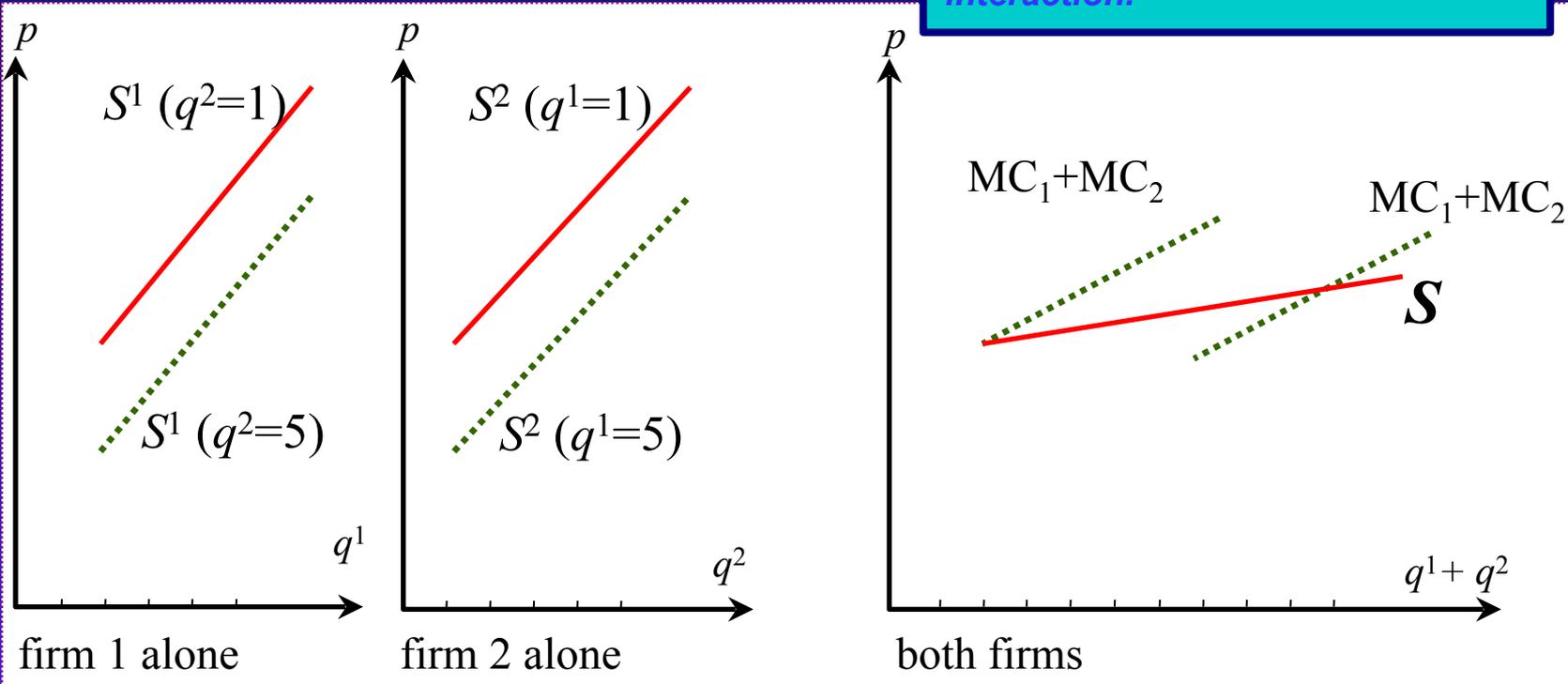
Industry supply: negative externalities

- Each firm's S-curve (MC) shifted by the other's output
- The result of simple ΣMC at each output level
- Industry supply allowing for interaction.

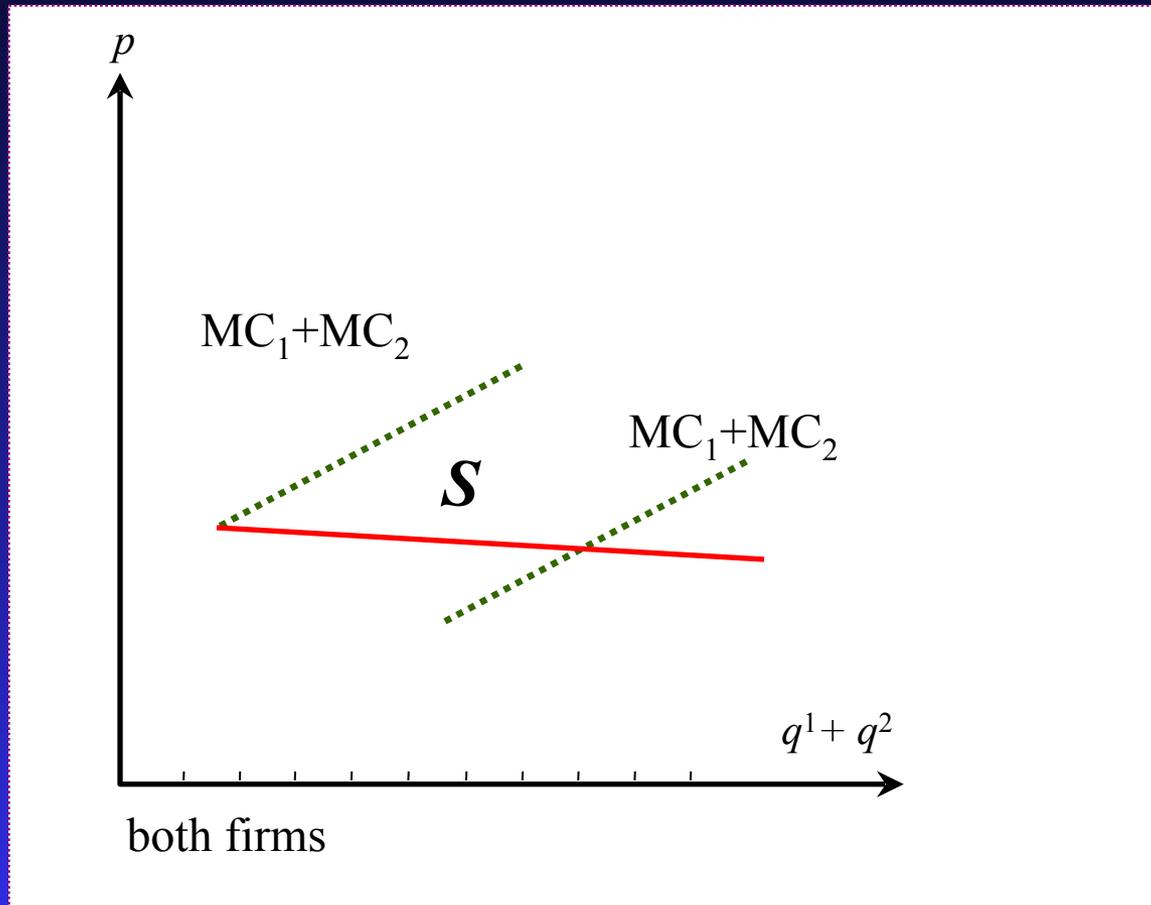


Industry supply: positive externality

- Each firm's S-curve (MC) shifted by the other's output
- The result of simple ΣMC at each output level
- Industry supply allowing for interaction.



Positive externality: extreme case



Externality and supply: summary

- Externalities affect properties of response function.
- Negative externality:
 - Supply less responsive than the “sum-of-the-MC” rule indicates.
- Positive externality:
 - Supply more responsive than the “sum-of-the-MC” rule indicates.
- Could have forward-falling supply curve.

Overview...

*Determining the
equilibrium
number of firms*

The Firm and the
Market

Market supply
curve

Size of the
industry

Price-setting

Product variety

The issue

- Previous argument has taken given number of firms.
- This is unsatisfactory:
 - How is the number to be fixed?
 - Should be determined within the model
 - ...by economic behaviour of firms
 - ...by conditions in the market.
- Look at the “entry mechanism.”
 - Base this on previous model
 - Must be consistent with equilibrium behaviour
- So, begin with equilibrium conditions for a single firm...

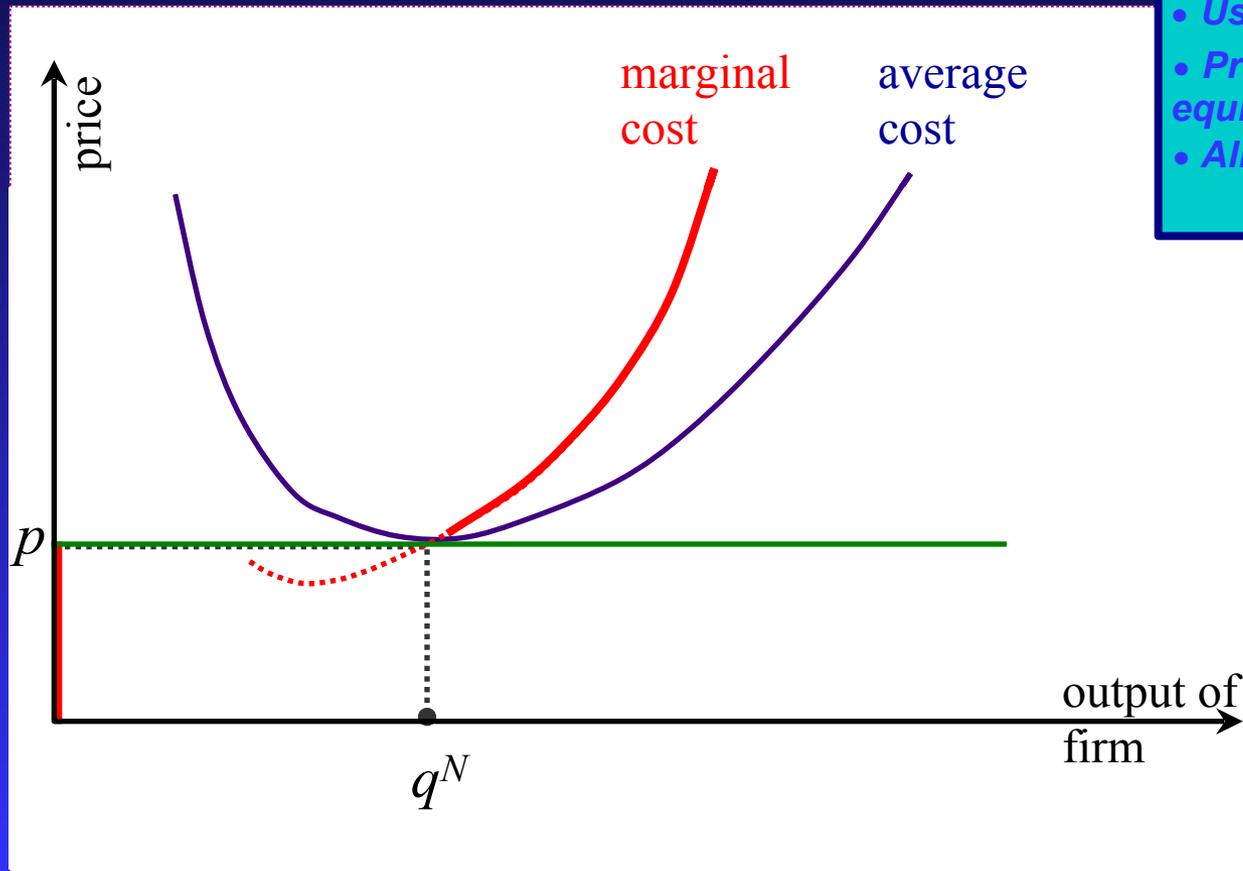
Analysing firms' equilibrium

- price = marginal cost
 - determines output of any one firm.
- price \geq average cost
 - determines number of firms.
- An entry mechanism:
 - If the $p - C/q$ gap is large enough then this may permit another firm to enter.
 - Applying this rule iteratively enables us to determine the size of the industry.

Outline of the process

- (0) Assume that firm 1 makes a positive profit
- (1) Is $pq - C \leq$ set-up costs of a new firm?
 - ...if YES then stop. We've got the eqm # of firms
 - ...otherwise continue:
- (2) Number of firms goes up by 1
- (3) Industry output goes up
- (4) Price falls (D -curve) and individual firms adjust output (individual firm's S -curve)
- (5) Back to step 1

Firm equilibrium with entry



- Draw AC and MC
- Get supply curve from MC
- Use price to find output
- Profits in temporary equilibrium
- Allow new firms to enter

• In the limit entry ensures profits are competed away.

$$p = C/q$$

$$n_f = N$$

Overview...

The economic analysis of monopoly

The Firm and the Market

Market supply curve

Size of the industry

Price-setting

Product variety

The issues

- We've taken for granted a firm's environment.
- What basis for the given price assumption?
- What if we relax it for a single firm?
- Get the classic model of *monopoly*:
 - An elementary story of market power
 - A bit strange – what ensures there is only one firm?
 - The basis for many other models of the firm.

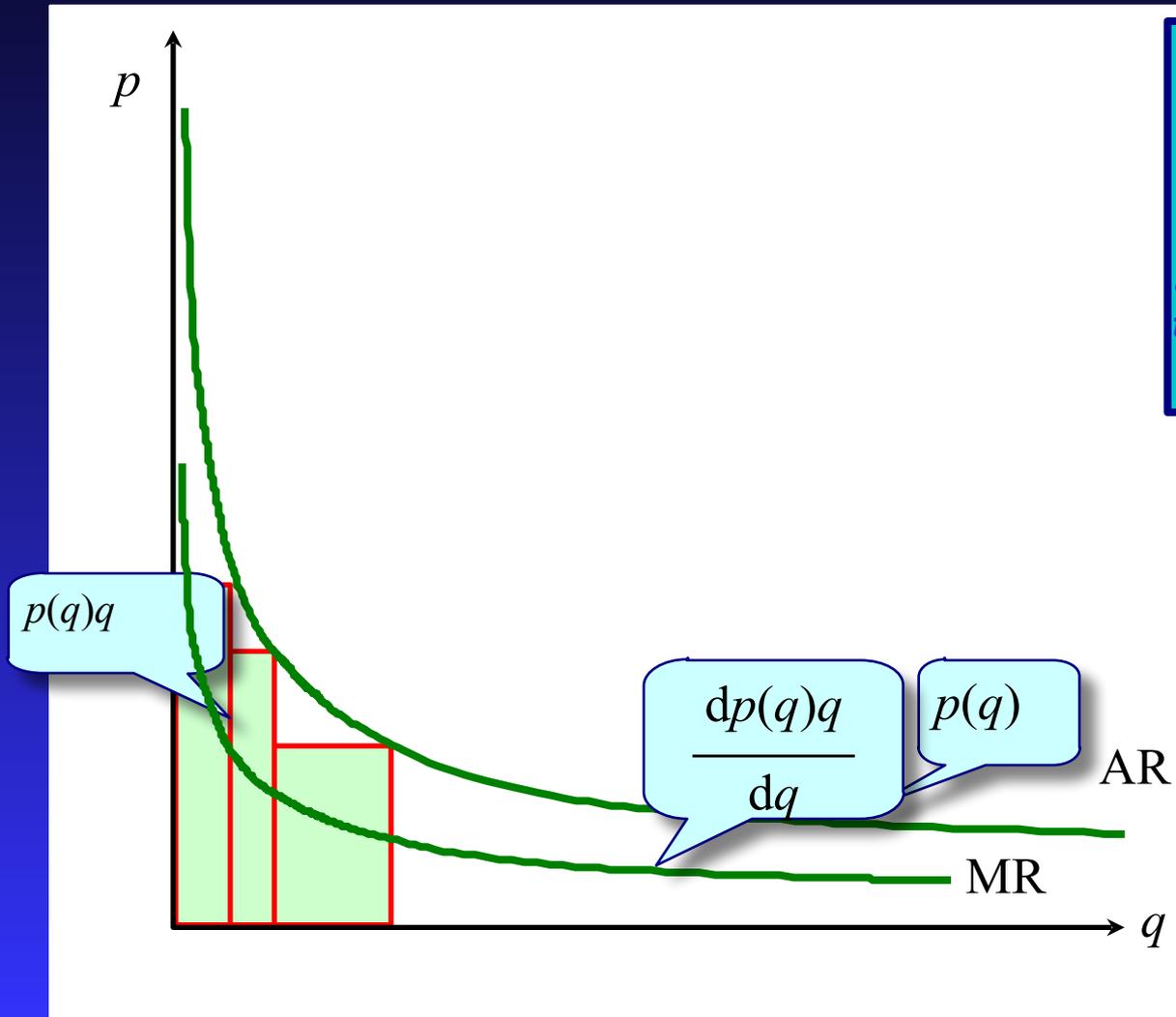
A simple price-setting firm

- Compare with the price-taking firm.
- Output price is no longer exogenous.
- We assume a determinate demand curve.
- No other firm's actions are relevant.
- Profit maximisation is still the objective.

Monopoly – model structure

- We are given the *inverse demand function*:
 - $p = p(q)$
 - Gives the price that rules if the monopolist delivers q to the market.
 - For obvious reasons, consider it as the *average revenue curve* (AR).
- Total revenue is:
 - $p(q)q$.
- Differentiate to get monopolist's *marginal revenue* (MR):
 - $p(q) + p_q(q)q$
 - $p_q(\bullet)$ means $dp(\bullet)/dq$
- Clearly, if $p_q(q)$ is negative (demand curve is downward sloping), then $MR < AR$.

Average and marginal revenue



- AR curve is just the market demand curve...

- Total revenue: area in the rectangle underneath

- Differentiate total revenue to get marginal revenue

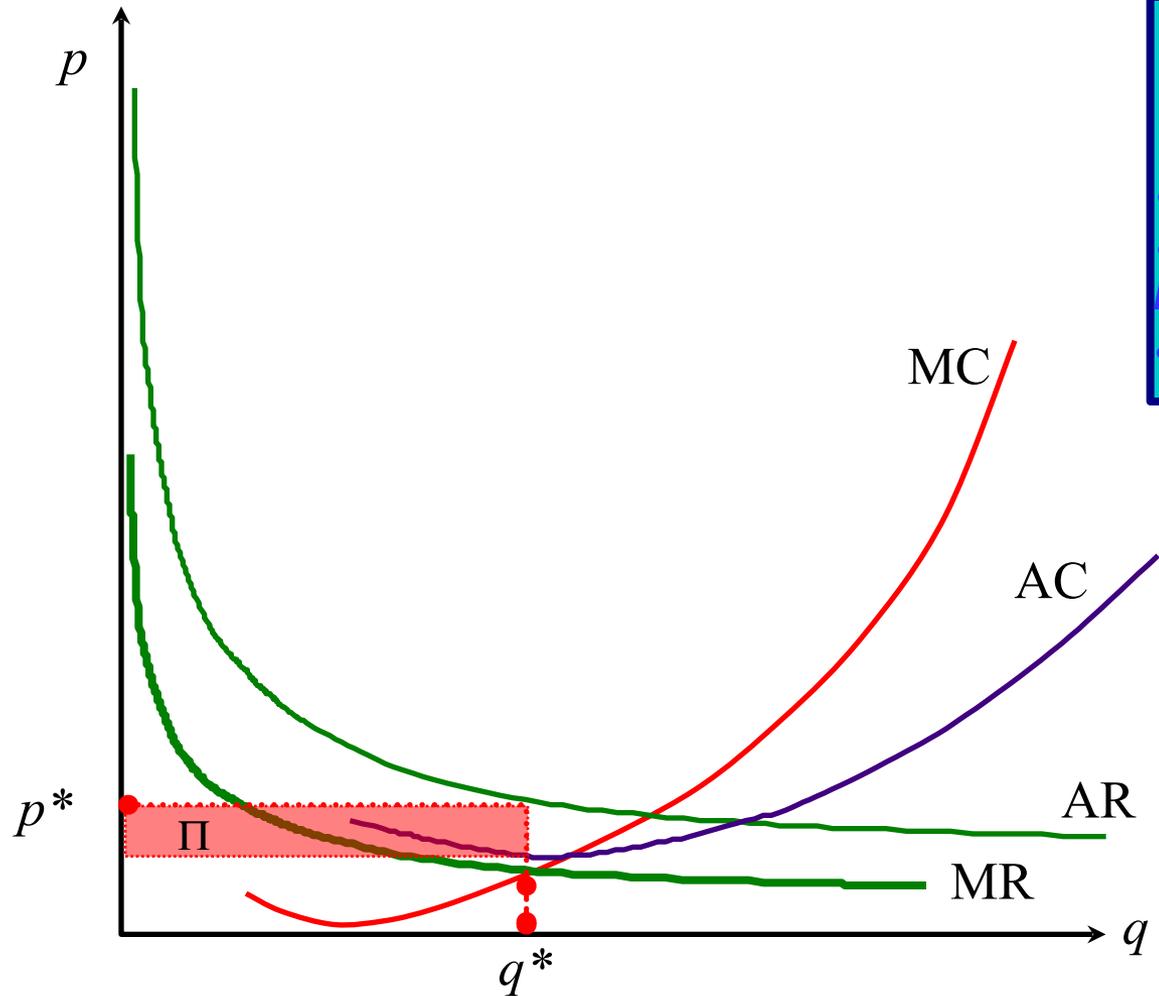
Monopoly – optimisation problem

- Introduce the firm's cost function $C(q)$.
 - Same basic properties as for the competitive firm.
- From C we derive marginal and average cost:
 - MC: $C_q(q)$.
 - AC: $C(q) / q$.
- Given $C(q)$ and total revenue $p(q)q$ profits are:
 - $\Pi(q) = p(q)q - C(q)$.
- The shape of Π is important:
 - We assume it to be differentiable
 - Whether it is concave depends on both $C(\bullet)$ and $p(\bullet)$.
 - Of course $\Pi(0) = 0$.
- Firm maximises $\Pi(q)$ subject to $q \geq 0$.

Monopoly – solving the problem

- Problem is “max $\Pi(q)$ s.t. $q \geq 0$,” where:
 - $\Pi(q) = p(q)q - C(q)$.
- First- and second-order conditions for *interior* maximum:
 - $\Pi_q(q) = 0$.
 - $\Pi_{qq}(q) < 0$.
- Evaluating the FOC:
 - $p(q) + p_q(q)q - C_q(q) = 0$.
- Rearrange this:
 - $p(q) + p_q(q)q = C_q(q)$
 - “Marginal Revenue = Marginal Cost”
- This condition gives the solution.
 - From above get optimal output q^* .
 - Put q^* in $p(\bullet)$ to get monopolist’s price:
 - $p^* = p(q^*)$.
- Check this diagrammatically

Monopolist's optimum



- AR and MR
- Marginal and average cost
- Optimum where $MC = MR$
- Monopolist's optimum price.
- Monopolist's profit

Monopoly – pricing rule

- Introduce the *elasticity of demand* η :
 - $\eta := d(\log q) / d(\log p)$
 - $= p(q) / qp_q(q)$
 - $\eta < 0$
- First-order condition for an interior maximum
 - $p(q) + p_q(q)q = C_q(q)$
- ...can be rewritten as
 - $p(q) [1+1/\eta] = C_q(q)$
- This gives the monopolist's pricing rule:
 - $p(q) = \frac{C_q(q)}{1 + 1/\eta}$

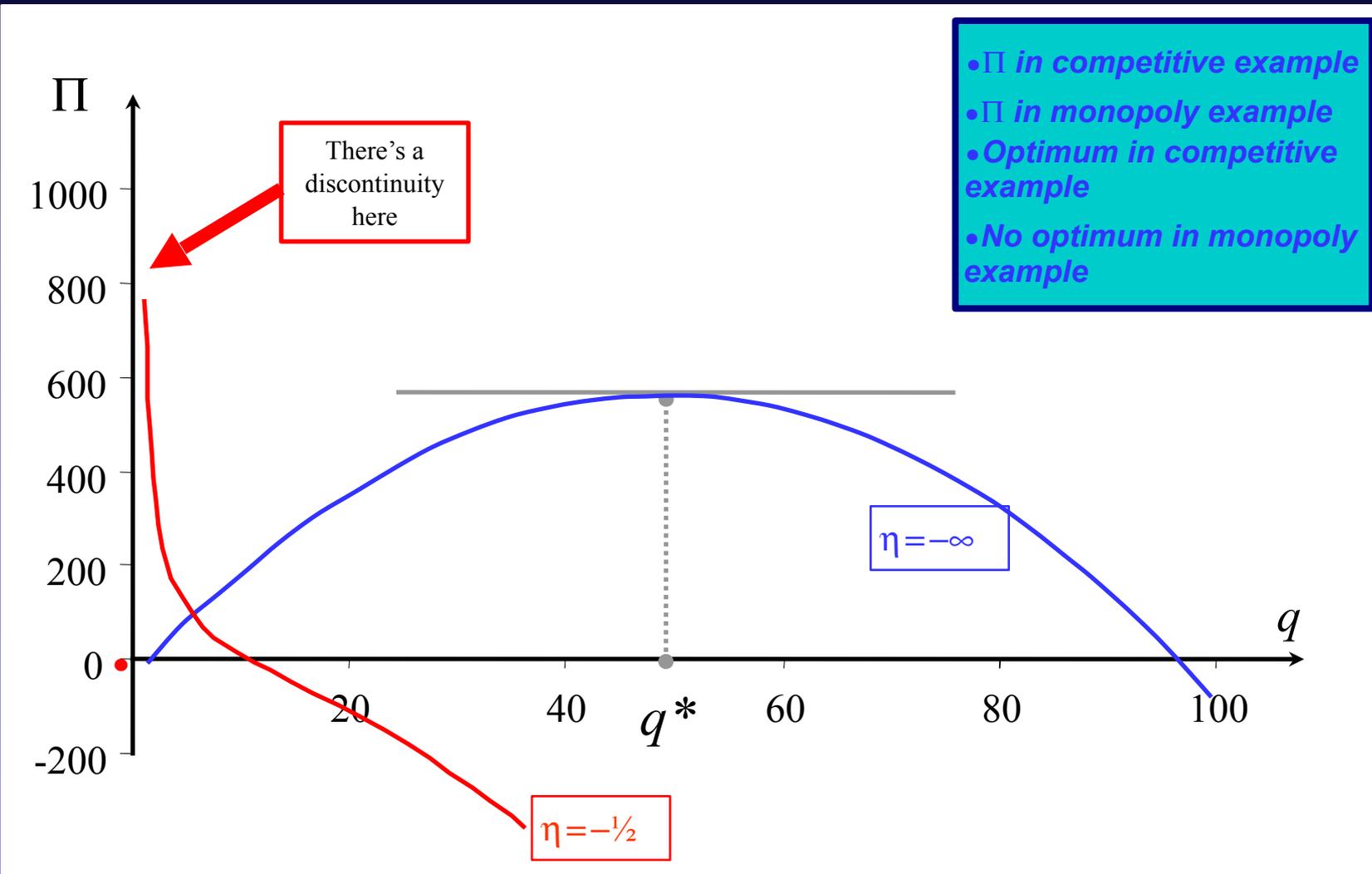
Monopoly – analysing the optimum

- Take the basic pricing rule
 - $p(q) = \frac{C_q(q)}{1 + 1/\eta}$ 
- Use the definition of demand elasticity
 - $p(q) \geq C_q(q)$
 - $p(q) > C_q(q)$ if $|\eta| < \infty$.
 - “price > marginal cost”
- Clearly as $|\eta|$ decreases:
 - output decreases.
 - gap between price and marginal cost increases.
- What happens if $|\eta| \leq 1$ ($\eta \geq -1$)?

What is going on?

- To understand why there may be no solution consider two examples.
- A firm in a competitive market: $\eta = -\infty$
 - $p(q) = \bar{p}$
- A monopoly with inelastic demand: $\eta = -1/2$
 - $p(q) = aq^{-2}$
- Same quadratic cost structure for both:
 - $C(q) = c_0 + c_1q + c_2q^2$
- Examine the behaviour of $\Pi(q)$.

Profit in the two examples



The result of simple market power

- There's no supply curve:
 - For competitive firm market price is sufficient to determine output.
 - Here output depends on *shape* of market demand curve.
- Price is artificially high:
 - Price is above marginal cost
 - Price/MC gap is larger if demand is inelastic
- There may be no solution:
 - What if demand is very inelastic?

Overview...

*Modelling
“monopolistic
competition”*

The Firm and the
Market

```
graph TD; A[The Firm and the Market] --- B[Market supply curve]; A --- C[Size of the industry]; A --- D[Price-setting]; A --- E[Product variety];
```

Market supply
curve

Size of the
industry

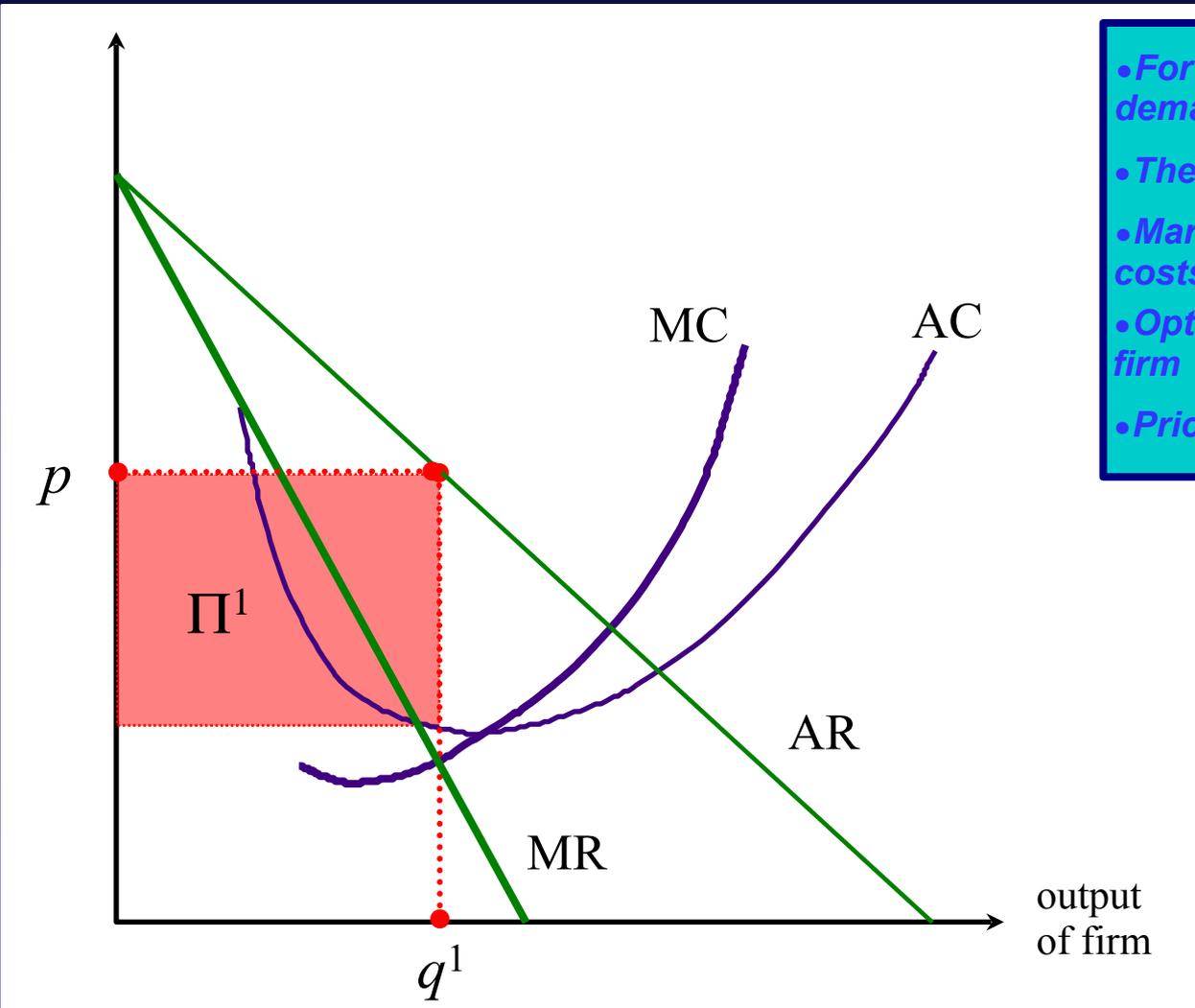
Price-setting

Product variety

Market power and product diversity

- Each firm has a downward-sloping demand curve:
 - Like the case of monopoly.
- Firms' products may differ one from another.
- New firms can enter with new products.
- Diversity may depend on size of market.
- Introduces the concept of “monopolistic competition.”
- Follow the method competitive firm:
 - Start with the analysis of a single firm.
 - Entry of new firms competes away profits.

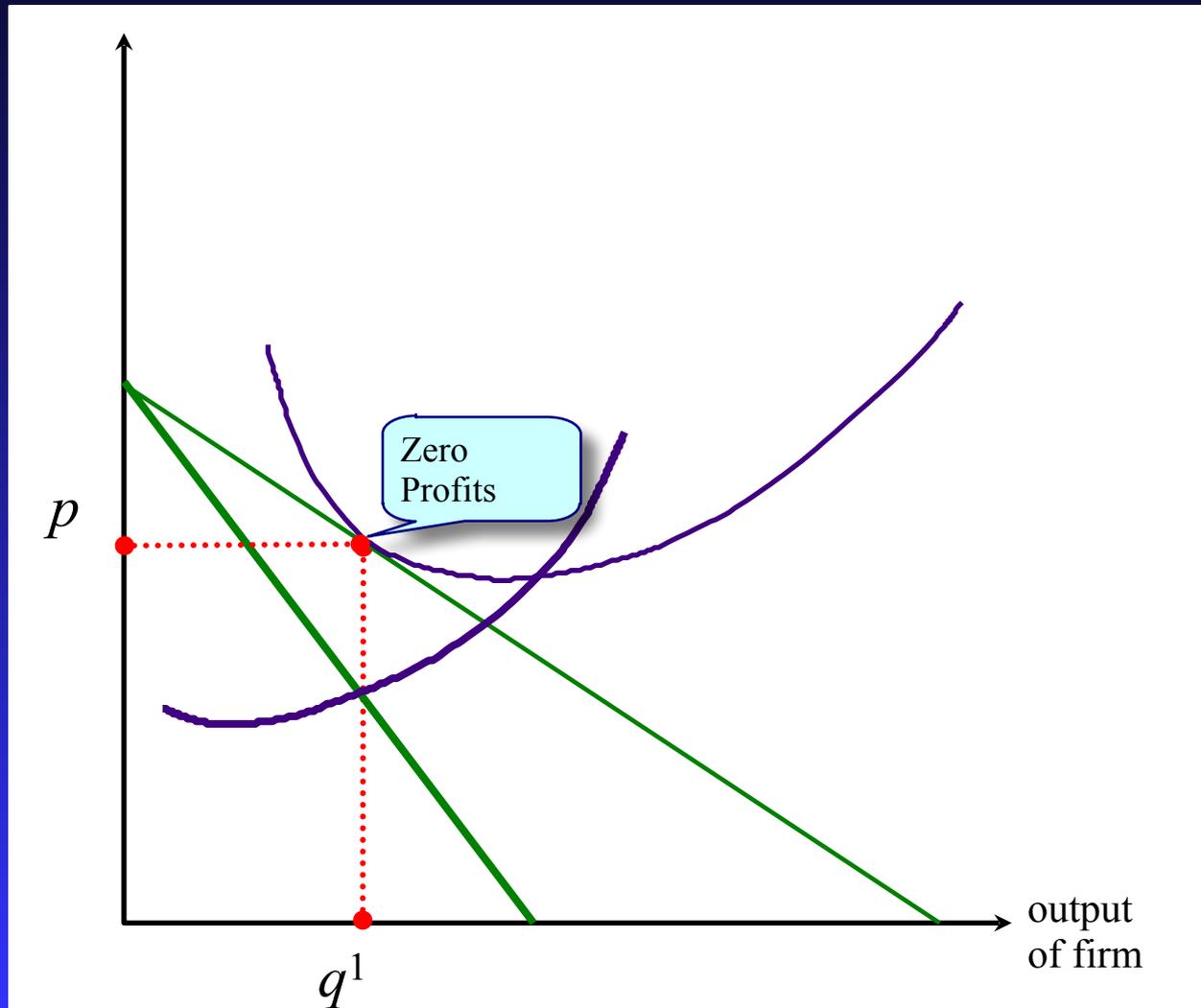
Monopolistic competition: 1



- For simplicity take linear demand curve (AR)
- The derived MR curve
- Marginal and average costs
- Optimal output for single firm
- Price and profits

• outcome is effectively the same as for monopoly.

Monopolistic competition: 2



Review

Review

- Individual supply curves are discontinuous: a problem for market equilibrium?

Review

- A large-numbers argument may help.

Review

- The size of the industry can be determined by a simple “entry” model

Review

- With monopoly equilibrium conditions depend on demand elasticity

Review

- Monopoly + entry model yield monopolistic competition.

What next?

- We could move on to more complex issues of industrial organisation.
- Or apply the insights from the firm to the consumer.