

**MICROECONOMICS**

*Principles and Analysis*

**THE FIRM AND THE MARKET**

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# INTRODUCTION

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- ✘ 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

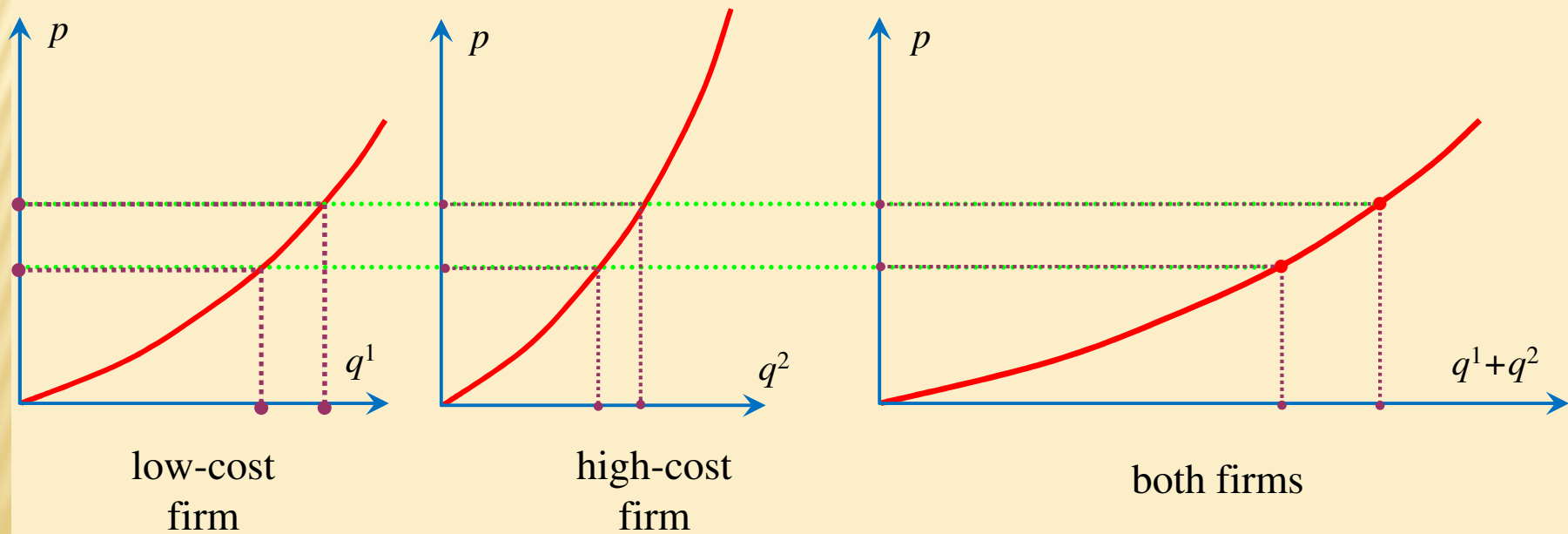
# AGGREGATION OVER FIRMS

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- ✘ 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:
  1. Each firm act as a price taker even though there is just one other firm in the market.
  2. Number of firms is *fixed* (in this case at 2).
  3. Firms' supply curve is different from that in previous presentations

See presentation  
on duopoly

Later in this  
presentation

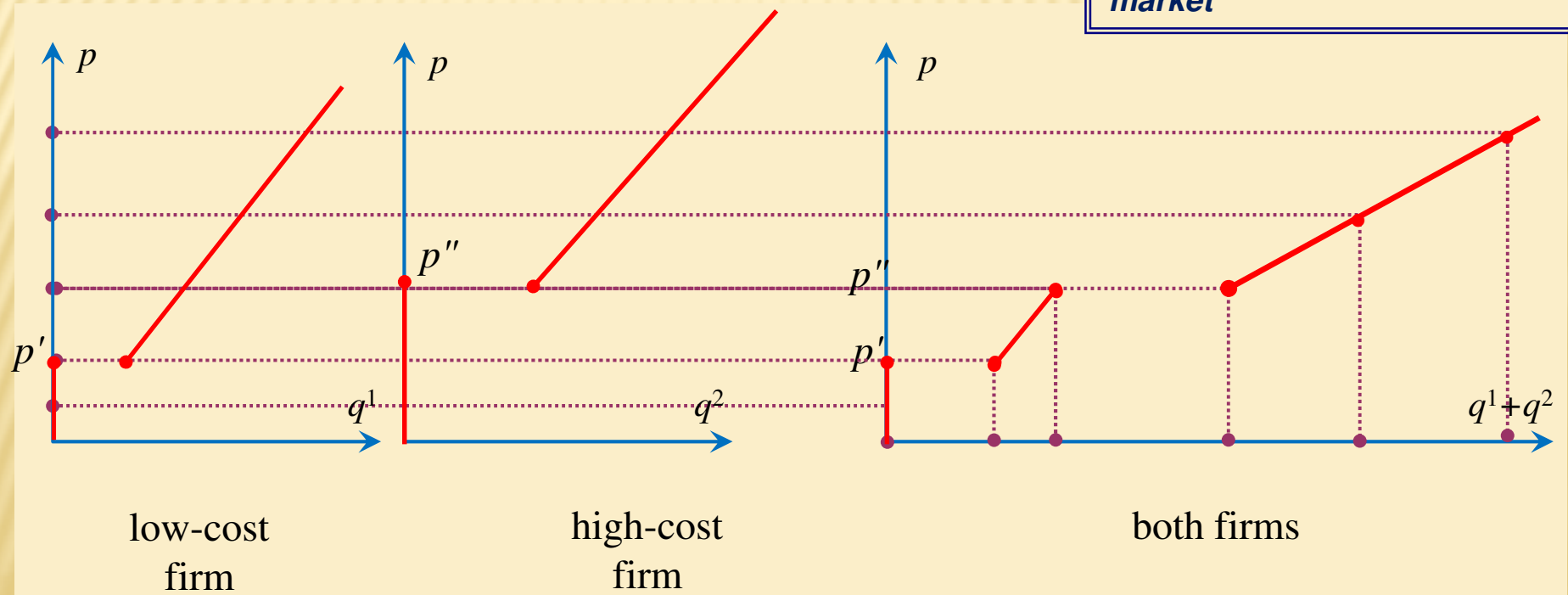
# ANOTHER SIMPLE CASE

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- ✘ 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.

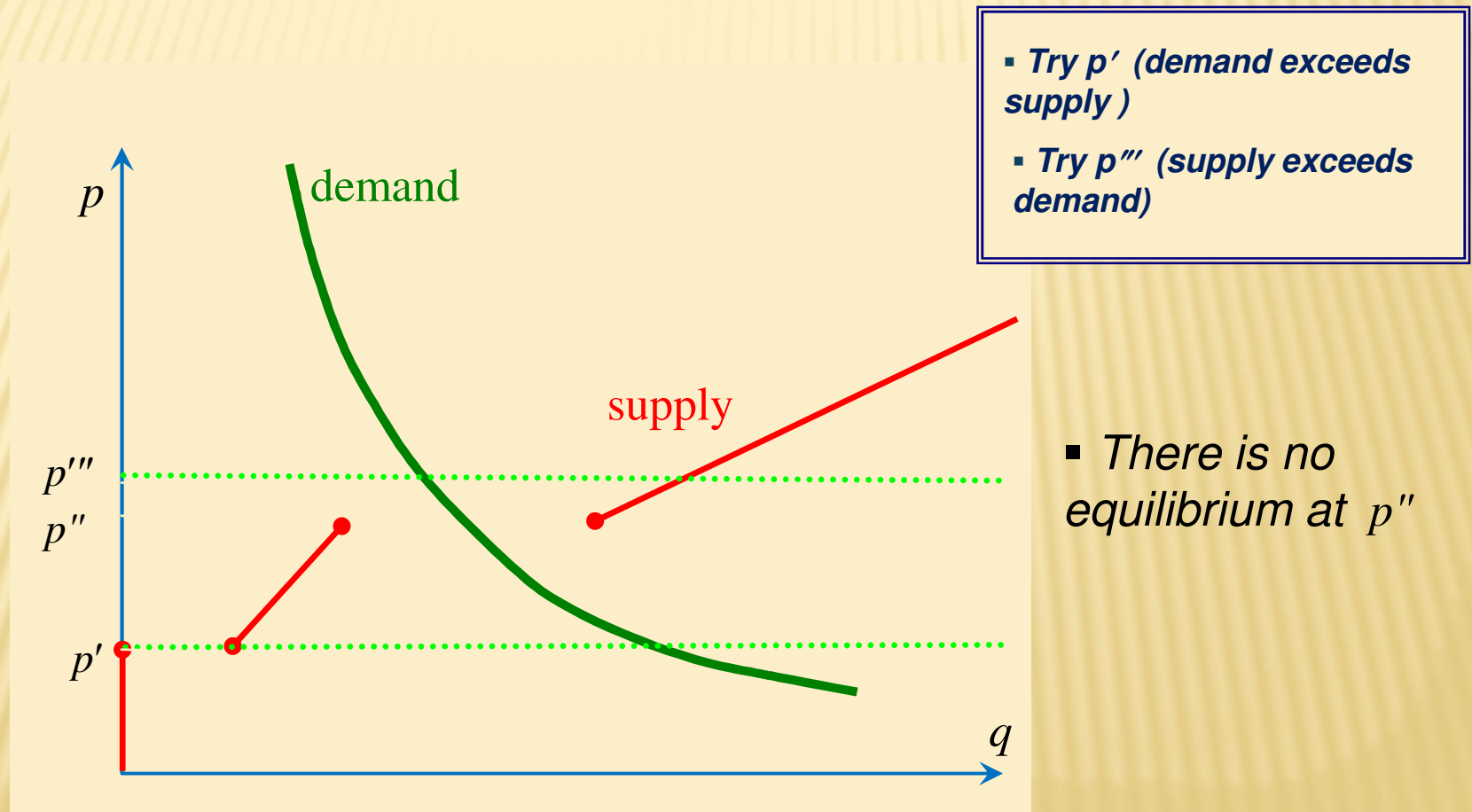
# MARKET SUPPLY CURVE (2)

- 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





# WHERE IS THE MARKET EQUILIBRIUM?



# LESSON 1

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- ✘ 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

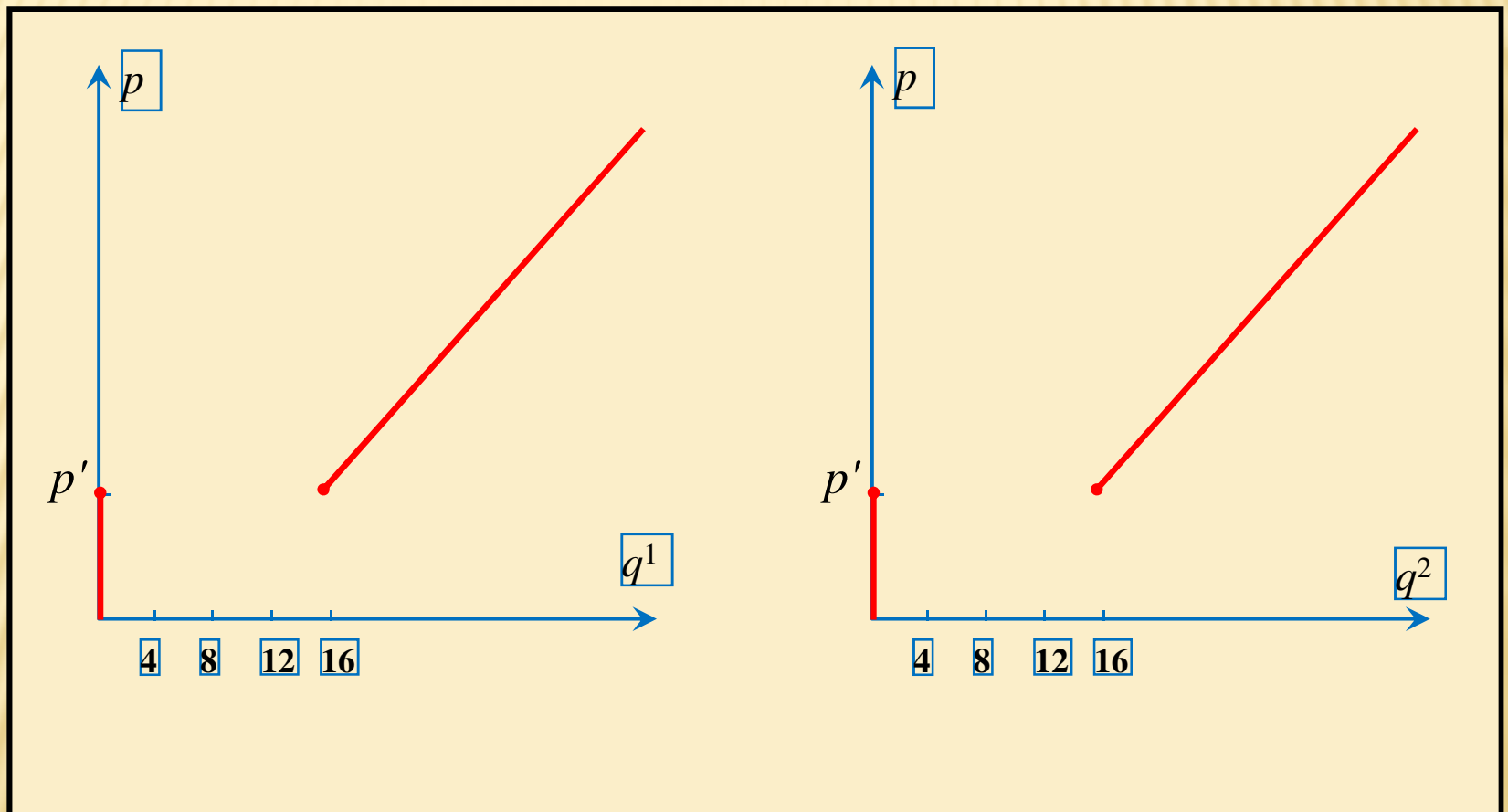
Product variety

# A FURTHER EXPERIMENT

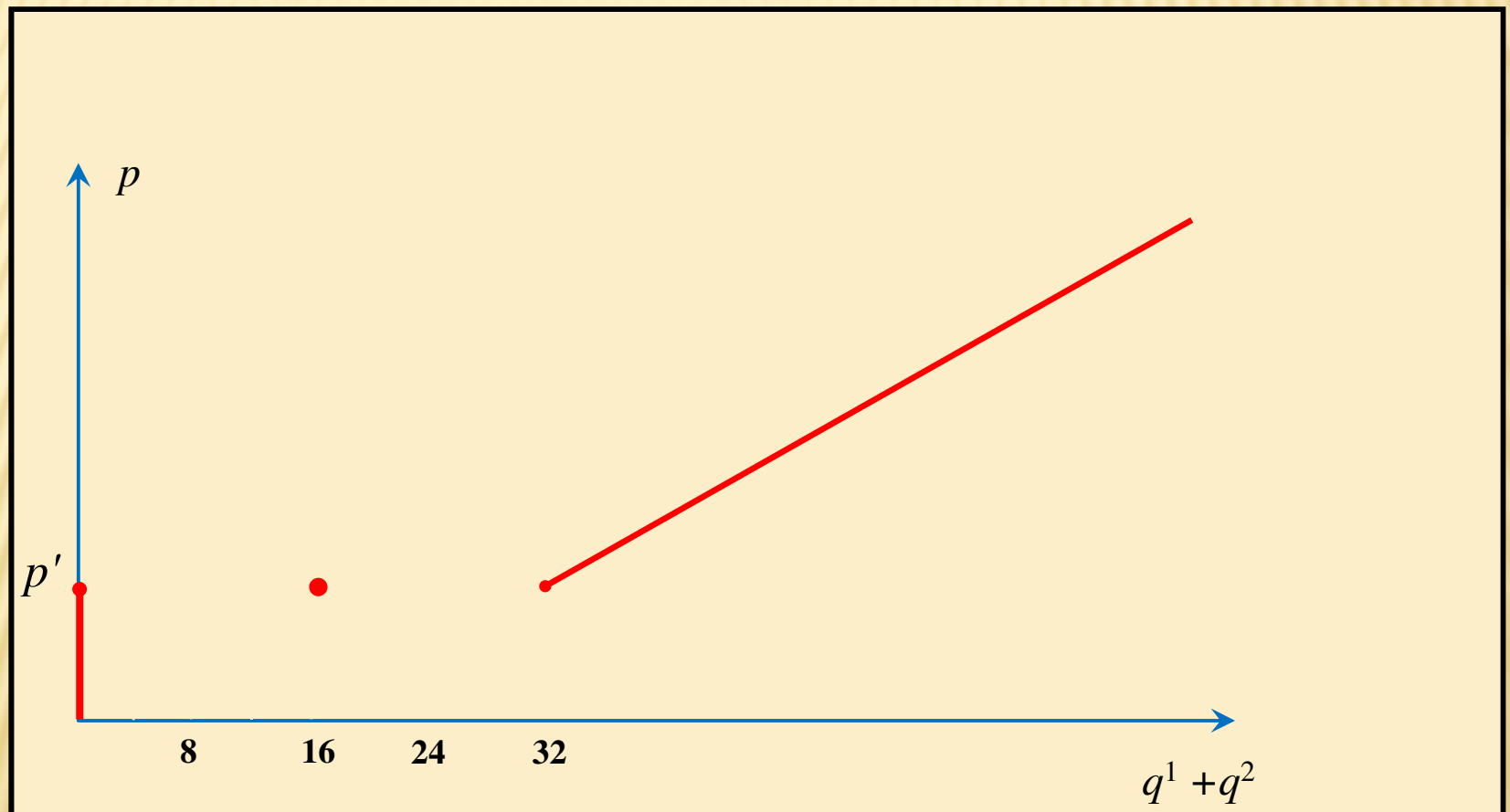
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- ✘ The problem of nonexistent equilibrium arose from discontinuity in supply.
- ✘ But is discontinuity likely to be a serious problem?
- ✘ Let's go through another example.
  - + Similar cost function to previous case
  - + This time – *identical*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

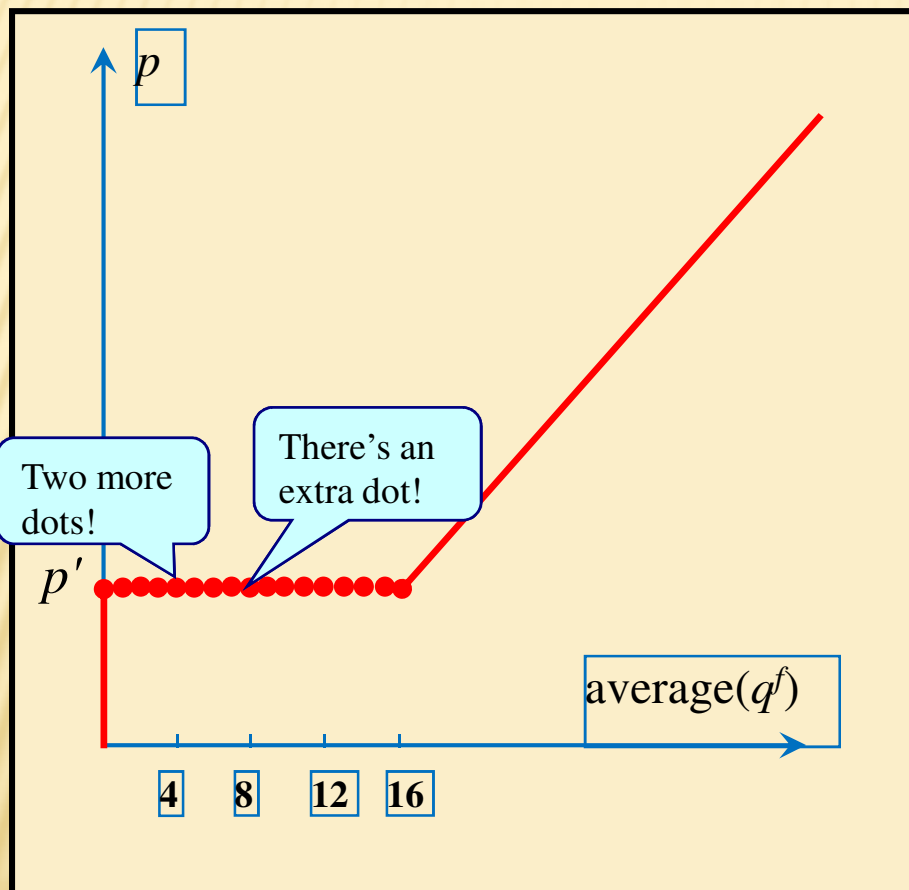
# TAKE TWO IDENTICAL FIRMS...



# SUM TO GET AGGREGATE SUPPLY

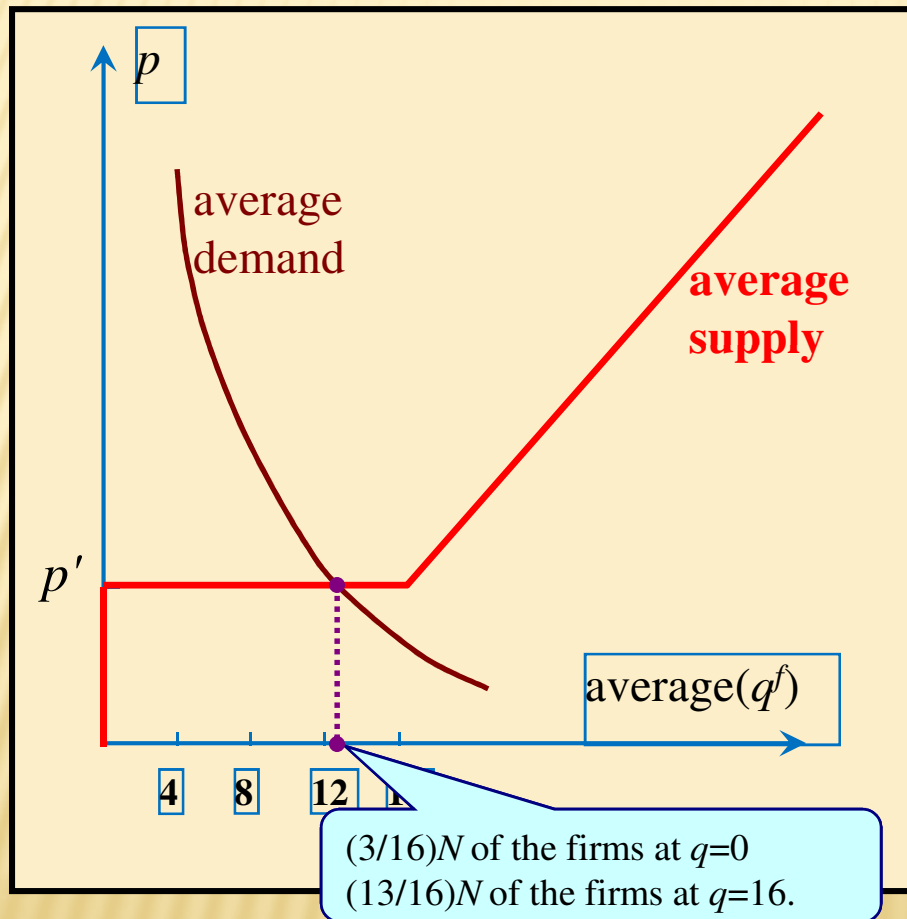


# NUMBERS AND AVERAGE SUPPLY



- *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

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- ✘ 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

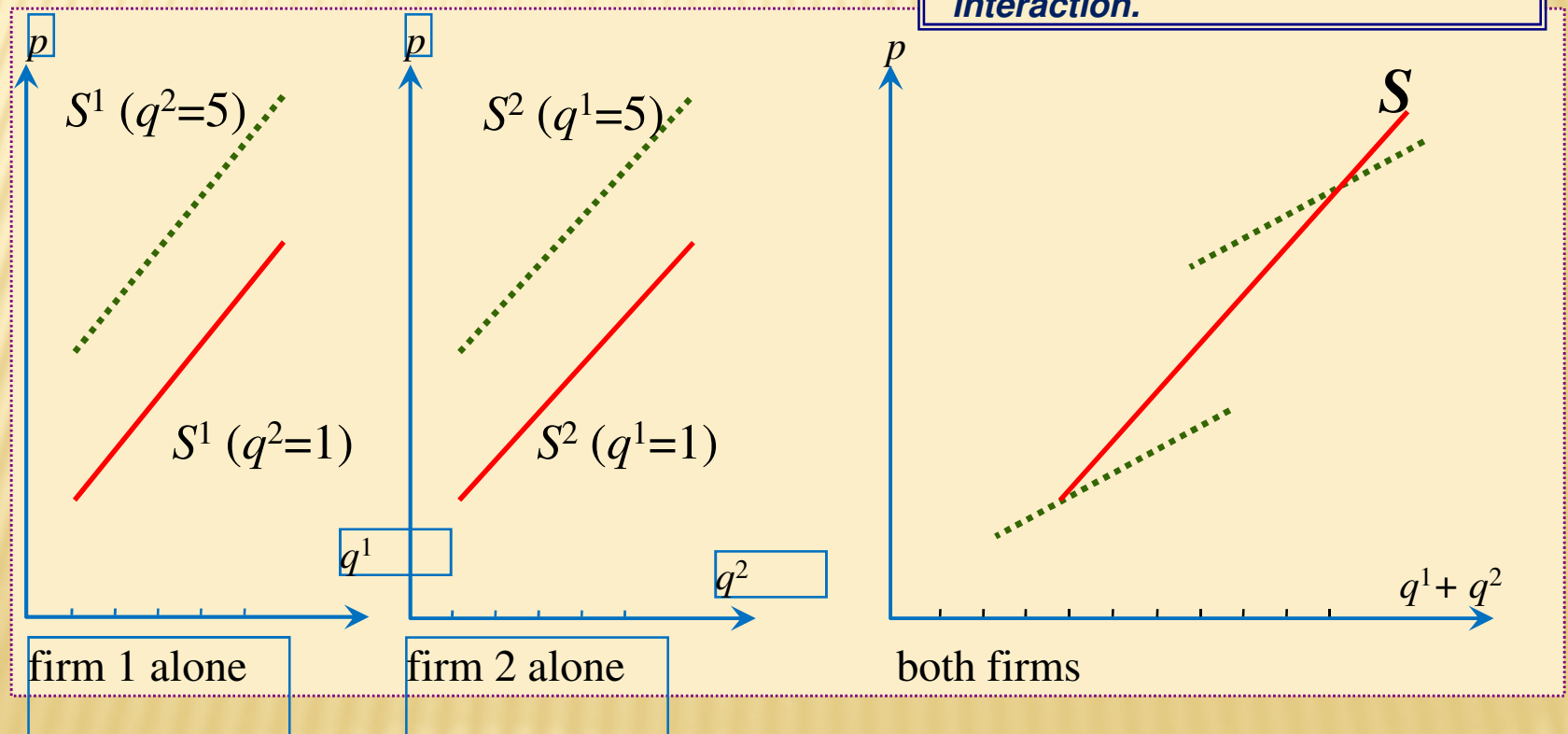
# INTERACTION AMONGST FIRMS

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- ✘ 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

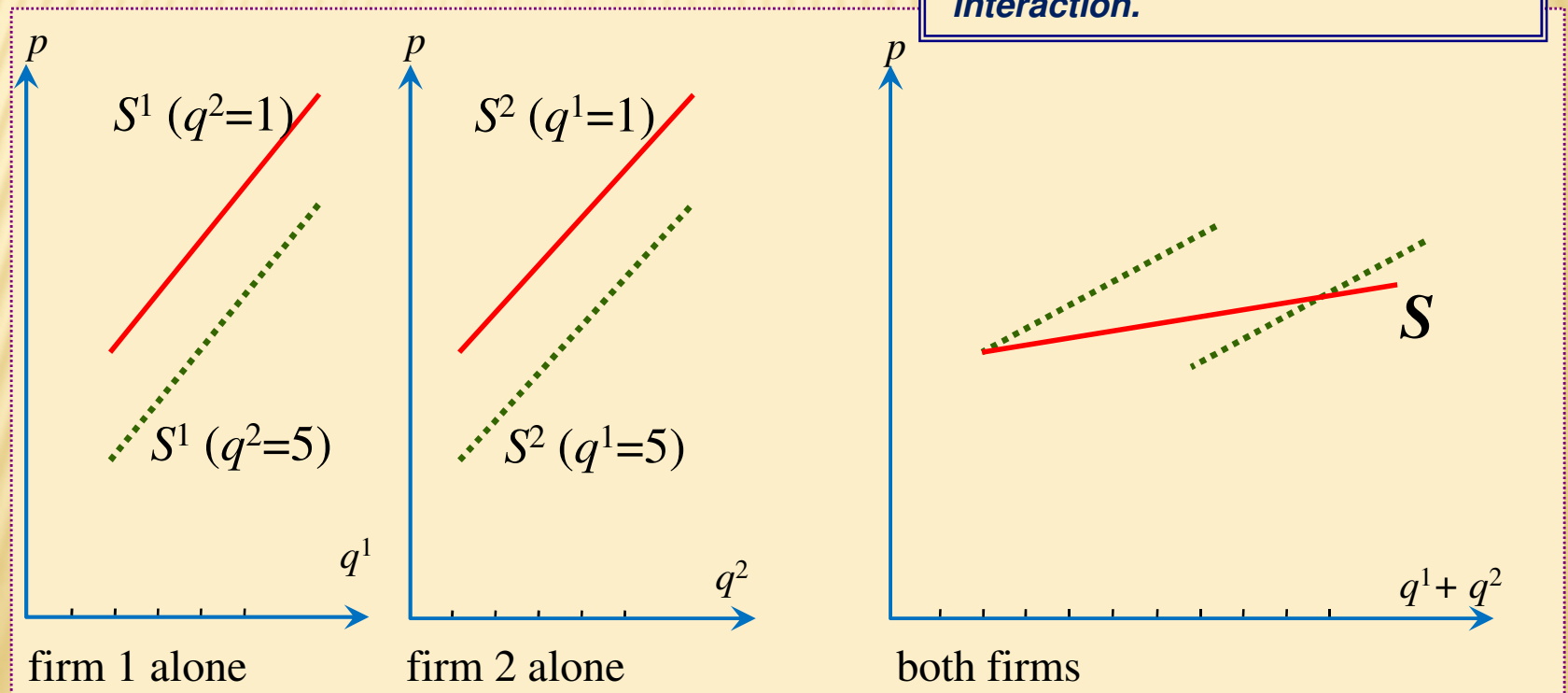
# INDUSTRY SUPPLY: NEGATIVE EXTERNALITY

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

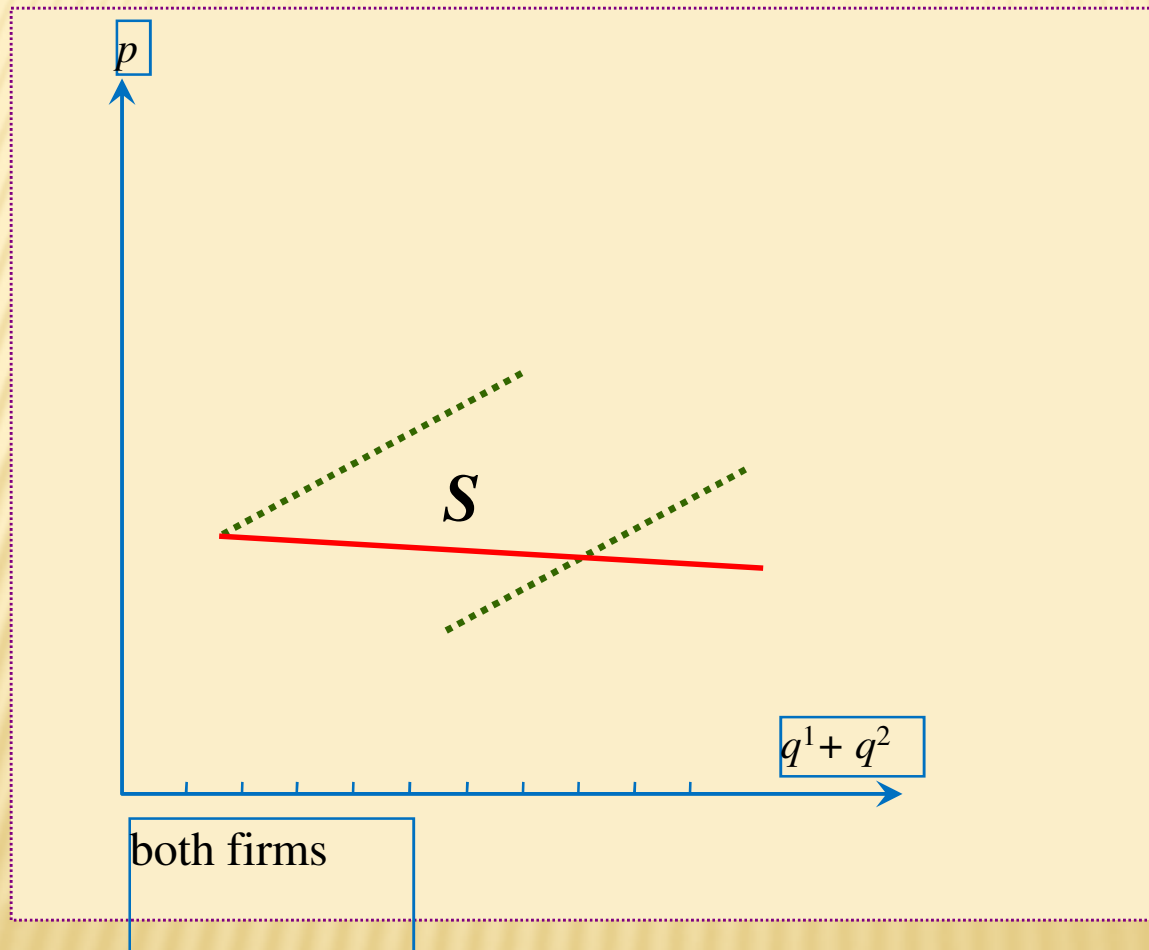


# INDUSTRY SUPPLY: POSITIVE EXTERNALITY

- Each firm's S-curve (MC) shifted by the other's output
- The result of simple  $\Sigma MC$  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

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- ✘ 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

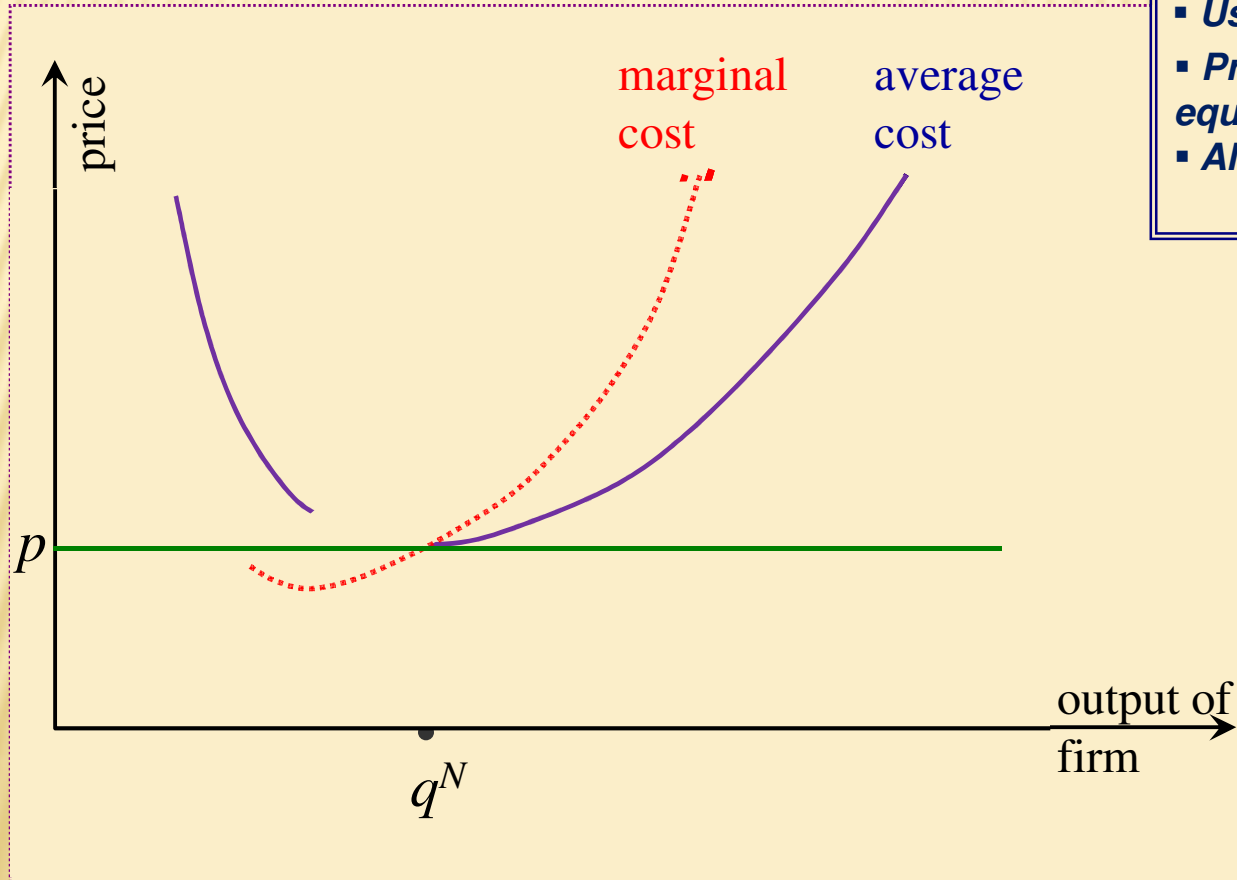
- ✗ price = marginal cost
  - + determines output of any one firm.
- ✗ price  $\geq$  average cost
  - + determines number of firms.
  
- ✗ An entry mechanism:
  - + If the  $p - C/q$  gap is large enough then this may permit another firm to enter.
  - + Applying this rule iteratively enables us to determine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

# OUTLINE OF THE PROCESS

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- ✘ (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

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- ✘ 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

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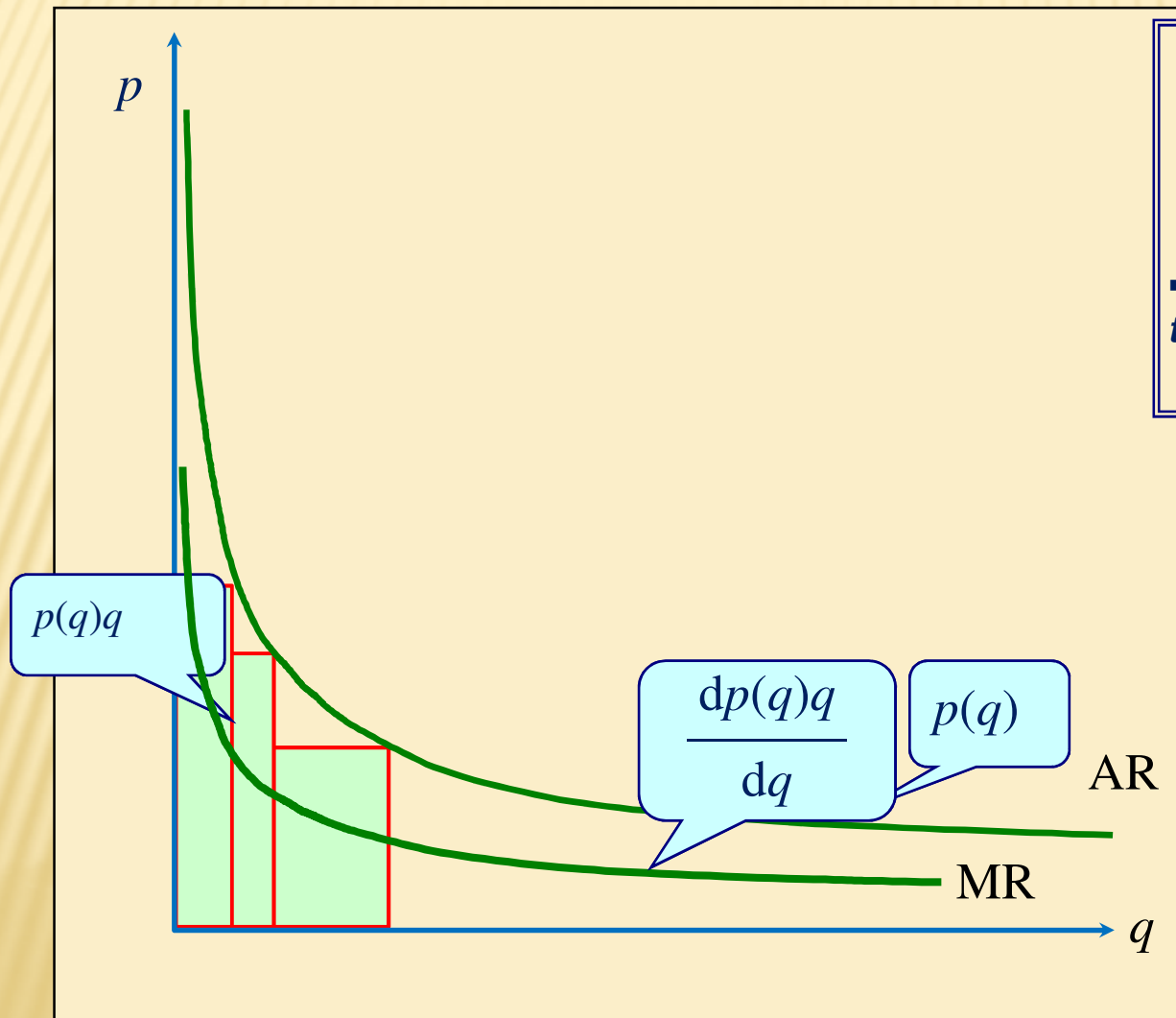
- ✘ Compare with the price-taking firm.
- ✘ Output price is no longer exogenous.
- ✘ We assume a determinate demand curve.
- ✘ No other firm's actions are relevant.
- ✘ Profit maximisation is still the objective.

# 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

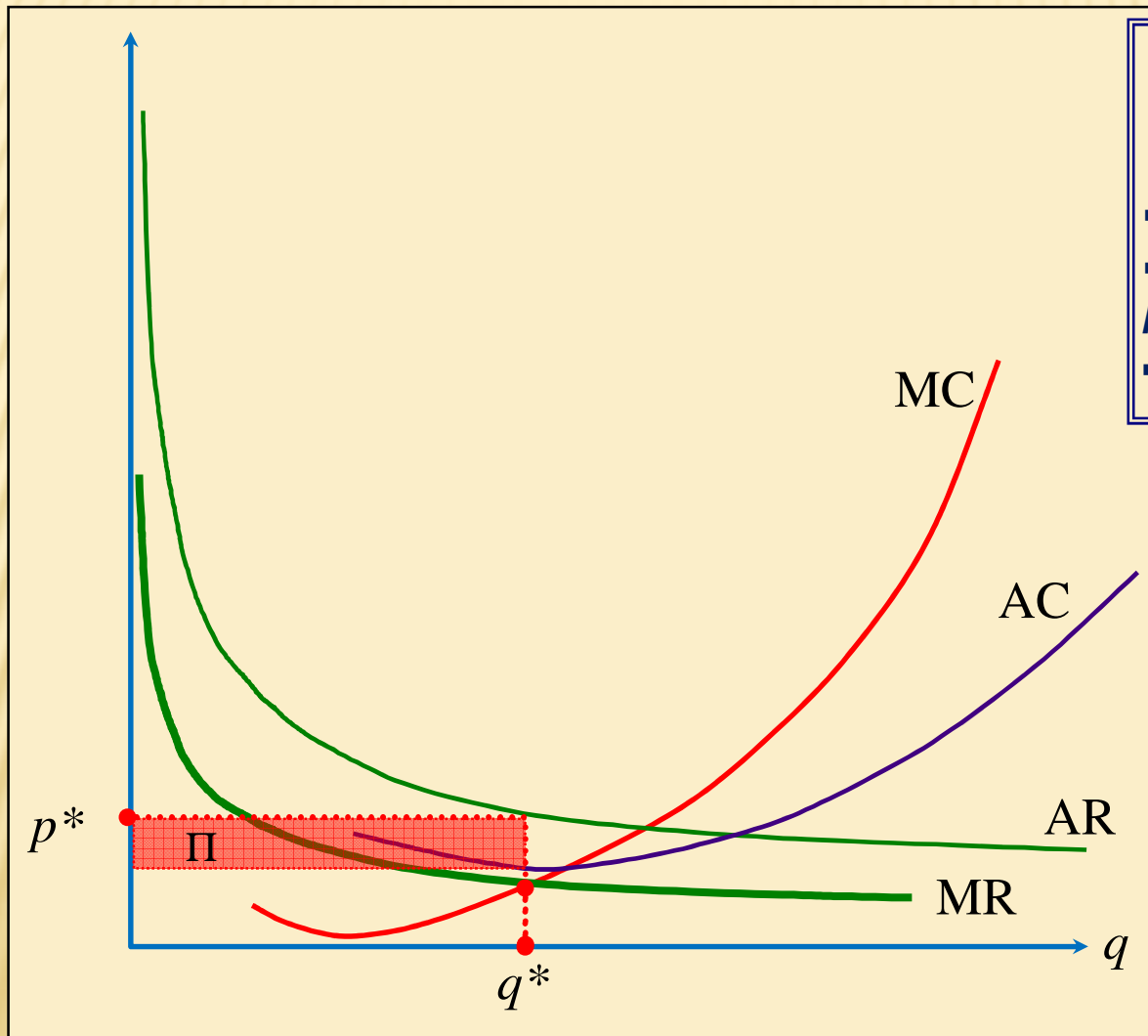
# MONOPOLY – OPTIMISATION PROBLEM

- ✘ 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  $\Pi$  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:
  - +  $p^* = p(q^*)$ .

# 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*  $\eta$ :
  - +  $\eta := d(\log q) / d(\log p)$
  - +  $= p(q) / qp_q(q)$
  - +  $\eta < 0$
- ✘ 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 – THE ROLE OF DEMAND

- ✗ Suppose demand were changed to
  - +  $a + bp(q)$
  - +  $a$  and  $b$  are constants.
- ✗ Marginal revenue and demand elasticity are now:
  - +  $MR(q) = bp_q(q)q + [a + bp(q)]$
  - +  $\eta = [a/b + p(q)] / qp_q(q)$
- ✗ Rotate the demand curve around  $(p^*, q^*)$ .
  - +  $db > 0$  and  $da = -p(q^*)db < 0$ .
  - + Price at  $q^*$  remains the same.
  - + Marginal revenue at  $q^*$  increases –  $dMR(q^*) > 0$ .
  - + Abs value of elasticity at  $q^*$  decreases –  $d|\eta| < 0$ .
  - + But what happens to optimal output?
- ✗ Differentiate FOC in the neighbourhood of  $q^*$ :
  - +  $dMR(q^*)db + \Pi_{qq} dq^* = 0$
- ✗ So  $dq^* > 0$  if  $db > 0$ .

# 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  $|\eta| \leq 1$  ( $\eta \geq -1$ )?

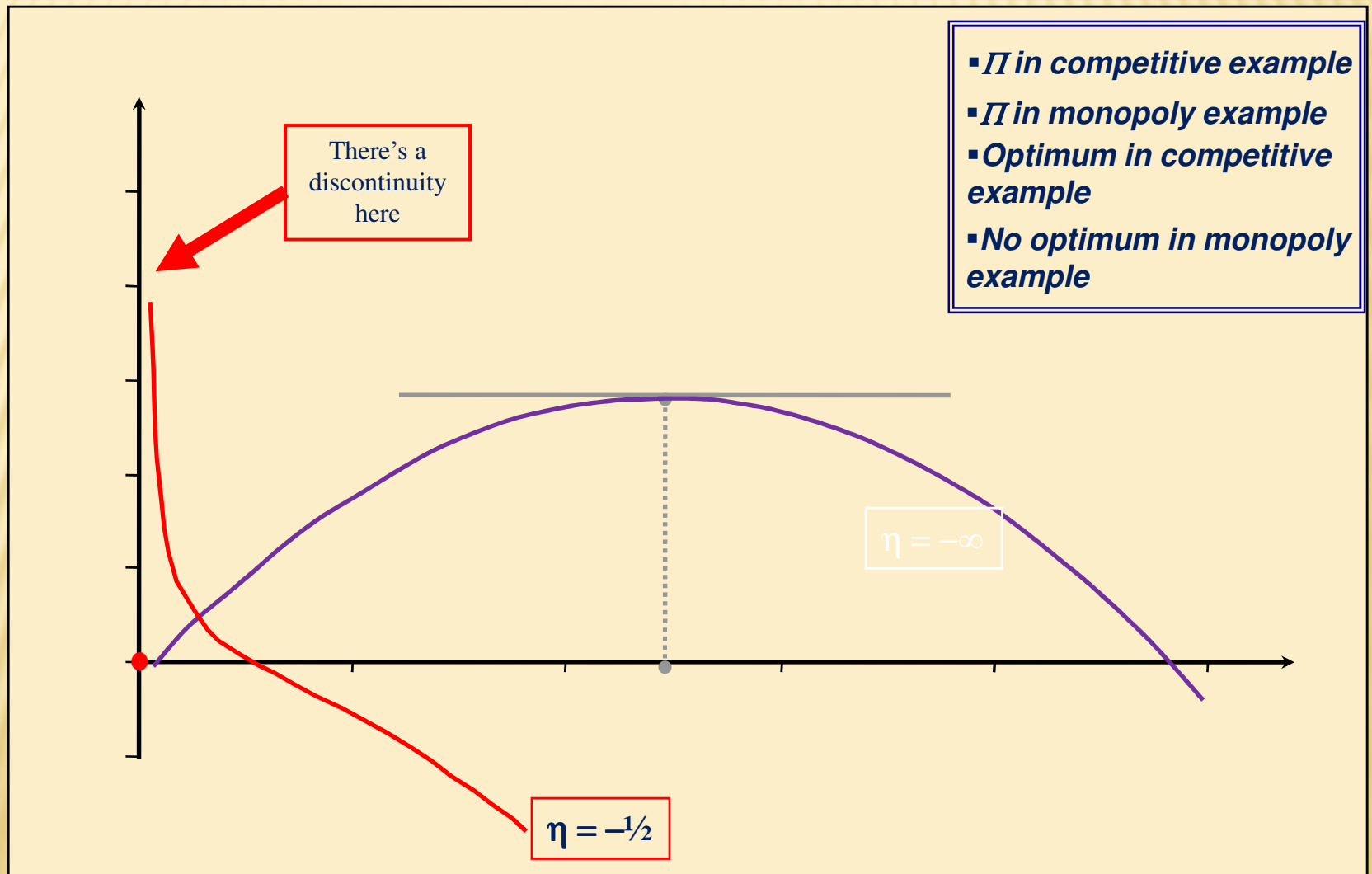
# WHAT IS GOING ON?

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- ✘ 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

Market supply  
curve

Size of the  
industry

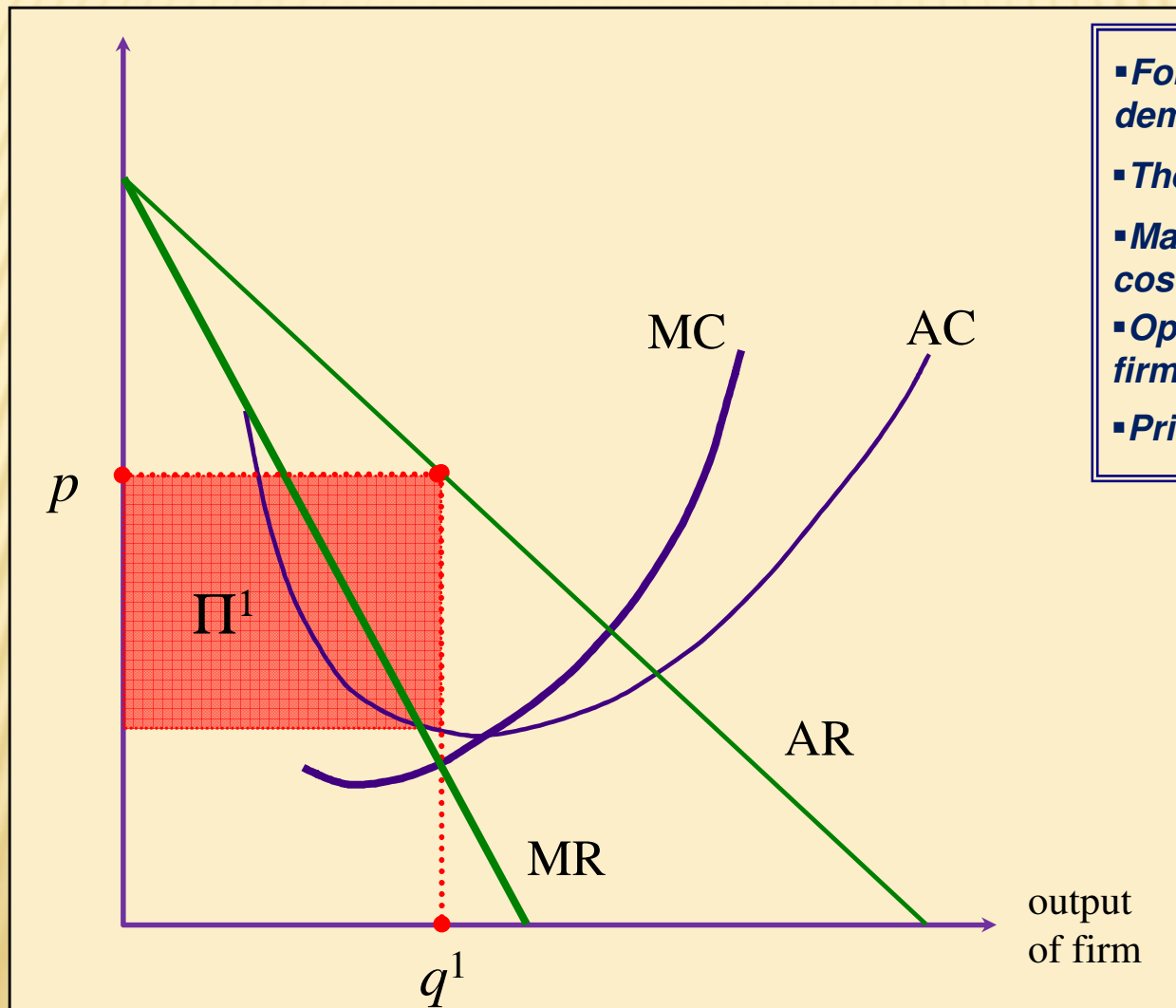
Price-setting

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.

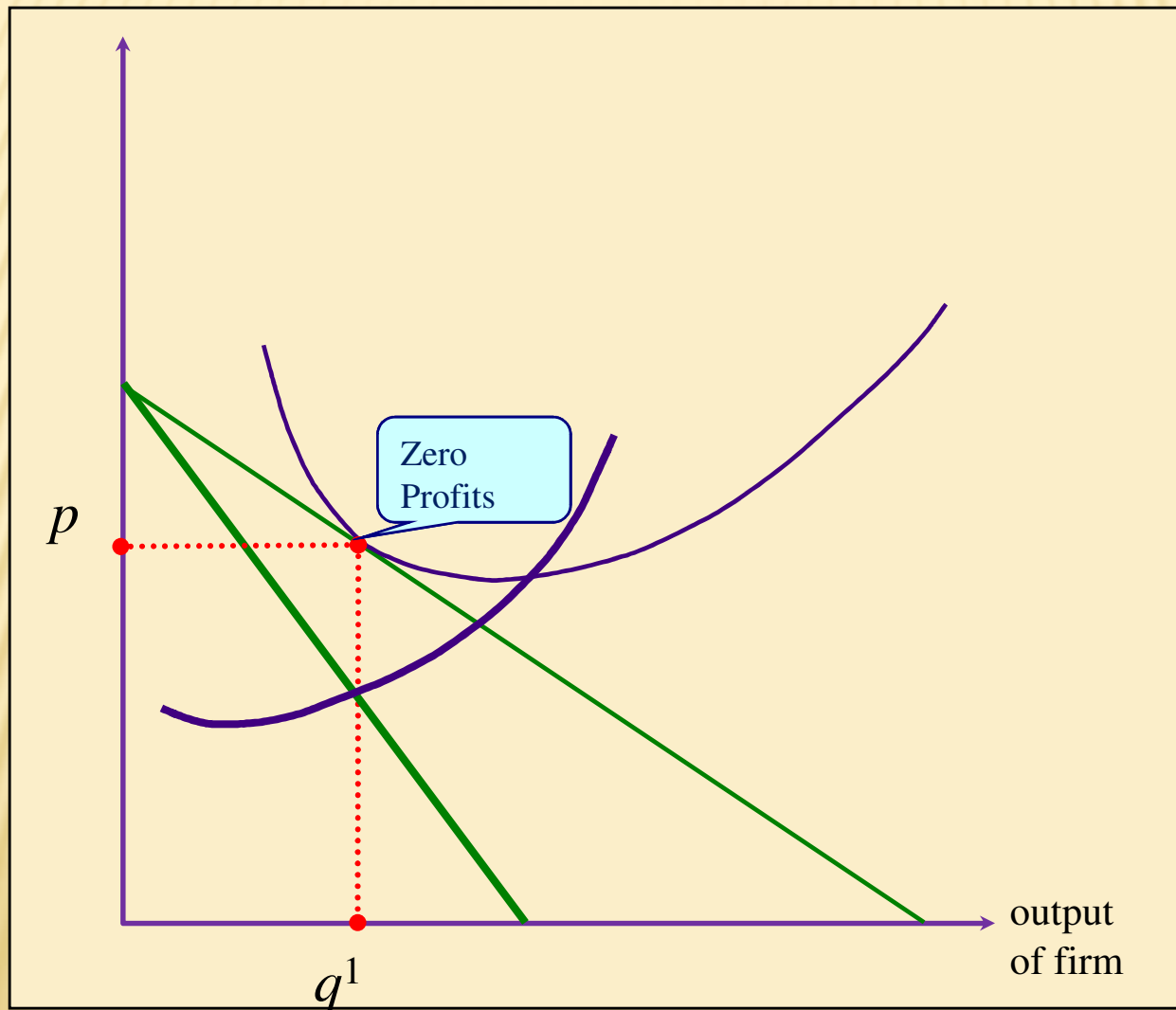
# MONOPOLISTIC COMPETITION: 1



- 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

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- ✘ Individual supply curves are discontinuous: a problem for market equilibrium?
- ✘ A large-numbers argument may help.
- ✘ The size of the industry can be determined by a simple “entry” model
- ✘ With monopoly equilibrium conditions depend on demand elasticity
- ✘ Monopoly + entry model yield monopolistic competition.

# WHAT NEXT?

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