

**MICROECONOMICS**  
Principles and Analysis

**THE FIRM AND THE MARKET**

**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...**

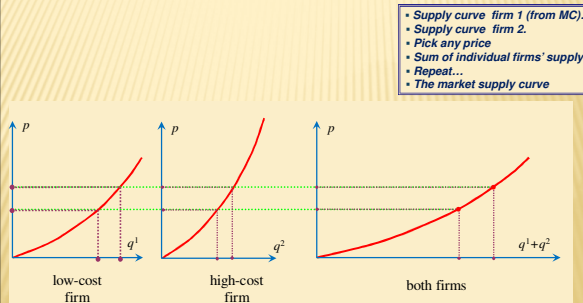
*Issues in aggregating supply curves of price-taking firms*



**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**



**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

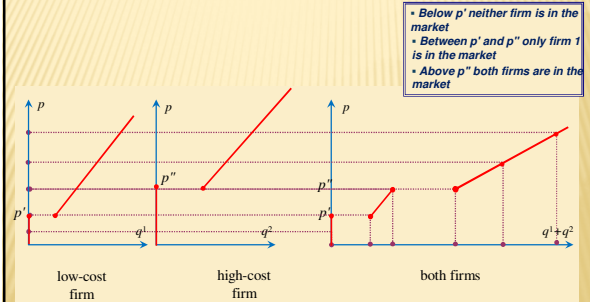
See presentation on duopoly

Later in this presentation

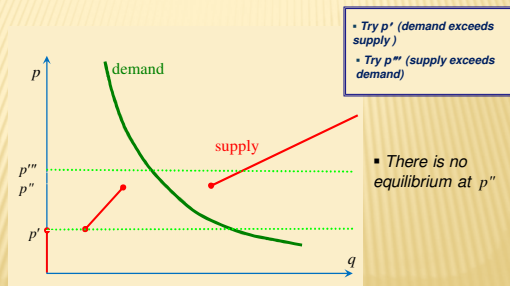
## ANOTHER SIMPLE CASE

- ✘ 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)



## WHERE IS THE MARKET EQUILIBRIUM?



## LESSON 1

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

## OVERVIEW...

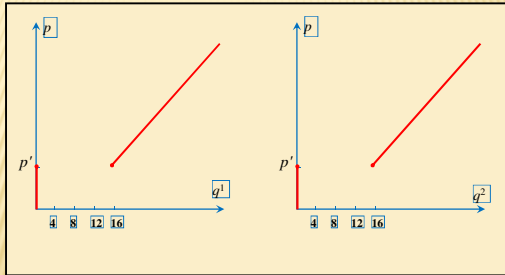
A simplified continuity argument



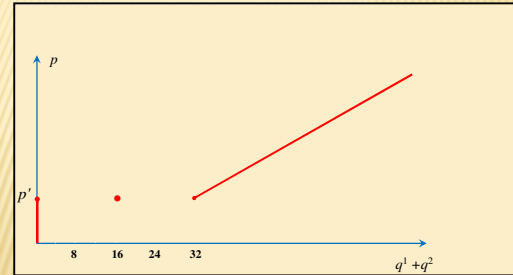
## A FURTHER EXPERIMENT

- ✘ 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)

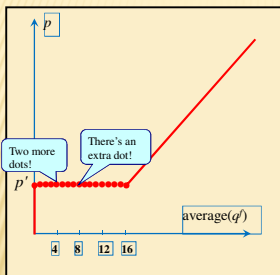
## TAKE TWO IDENTICAL FIRMS...



## SUM TO GET AGGREGATE SUPPLY



## NUMBERS AND AVERAGE SUPPLY

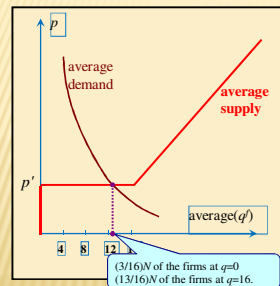


- Rescale to get the average supply of the firms...
- Compare with S for just one firm
- Repeat to get average S of 4 firms
- ...average S of 8 firms
- ... of 16 firms

Two more dots!

There's an extra dot!

## 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

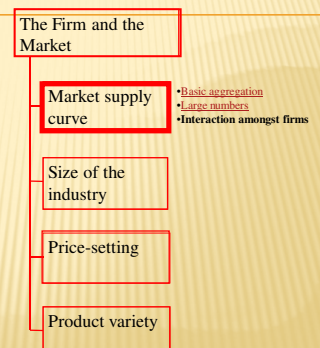
(3/16)N of the firms at  $q=0$   
(13/16)N of the firms at  $q=16$ .

## LESSON 2

- ✗ A further insight into nonconvexity 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...

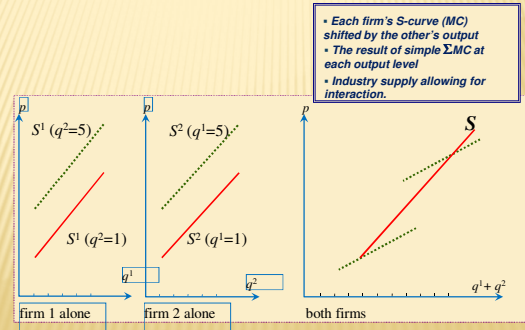
Introducing "externalities"



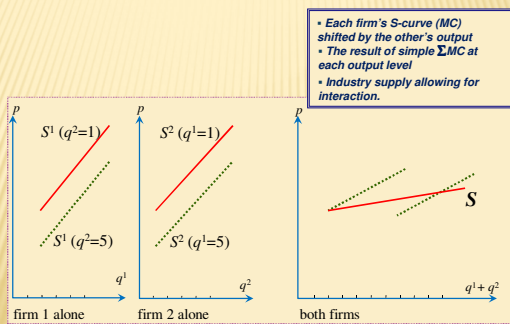
## INTERACTION AMONGST FIRMS

- ✘ 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

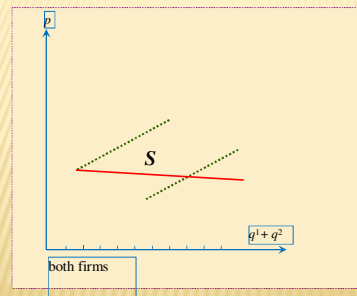
## INDUSTRY SUPPLY: NEGATIVE EXTERNALITY



## INDUSTRY SUPPLY: POSITIVE EXTERNALITY



## 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...

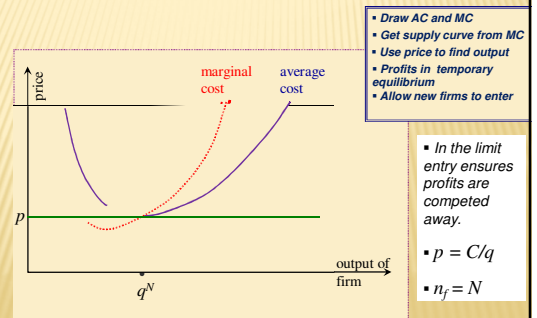
## ANALYSING FIRMS' EQUILIBRIUM

- ✗ 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



## OVERVIEW...

*The economic analysis of monopoly*



## 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.

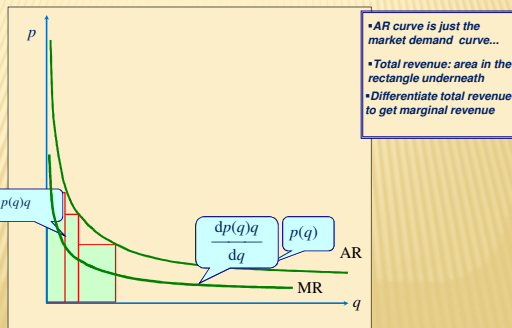
## A SIMPLE PRICE-SETTING FIRM

- ✗ 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



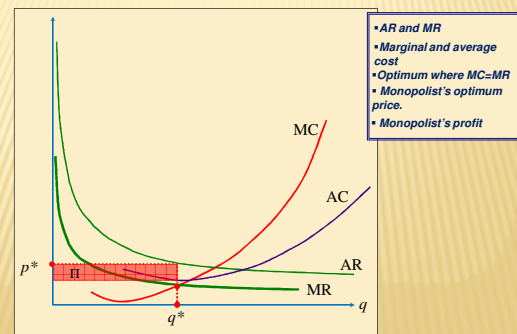
## MONOPOLY – OPTIMISATION PROBLEM

- ✗ 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



## 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  $db > 0$ .

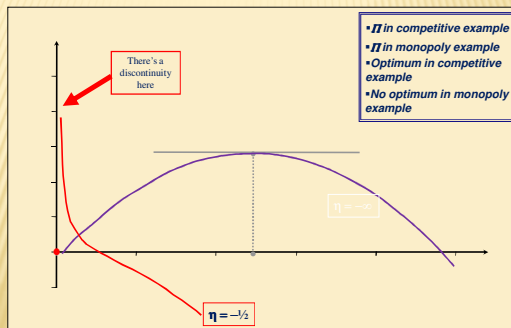
## MONOPOLY – ANALYSING THE OPTIMUM

- ✗ 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?

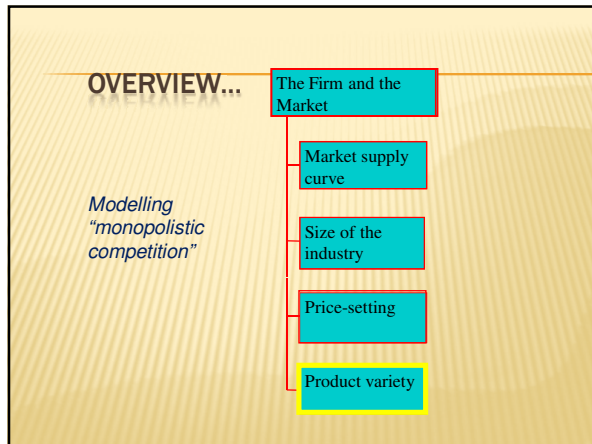
- ✗ To understand why there may be no solution consider two examples.
- ✗ A firm in a competitive market:  $\eta = -\infty$ 
  - +  $p(q) = \bar{p}$
- ✗ A monopoly with inelastic demand:  $\eta = -1/2$ 
  - +  $p(q) = aq^{-2}$
- ✗ Same quadratic cost structure for both:
  - +  $C(q) = c_0 + c_1q + c_2q^2$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

## PROFIT IN THE TWO EXAMPLES

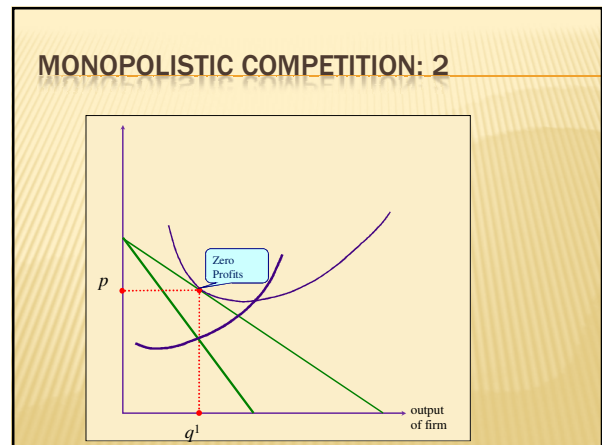
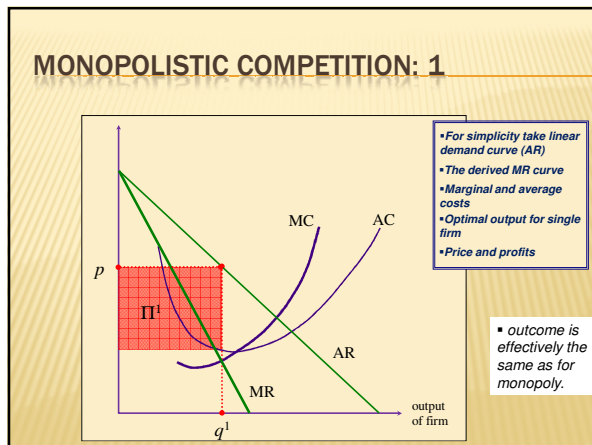


## THE RESULT OF SIMPLE MARKET POWER

- ✗ 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?



- 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.



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