Managerial Economics

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Decision Making

- Decision making lies at the heart of most important problems managers face. Managerial economics applies the principles of economics to analyze business and government decisions.
- The prescription for sound managerial decisions involves six steps
  1. Define the problem
  2. determine the objective
  3. explore the alternatives
  4. predict the consequences
  5. make a choice
  6. perform sensitivity analysis

The objective of economic agents (1)

- In the private sector the principal goal is maximizing the value of the firm
- The firm's value is the present value of its expected future profits
- In the public sector, government programs and projects are evaluated on the basis of net social benefits, the difference between benefits and costs of all kinds.

The objective of economic agents (2)

- The principal objective of management is to maximize the value of the firm by maximizing operating profits. Other management goals include maximizing sales and taking actions in the interests of stakeholders (its workers, customers, neighbors...).
- the principal goal of public managers and government regulators is to maximize social welfare.
- sensitivity analysis considers how an optimal decision would change if key economic facts or conditions are altered.

Profit maximizing firms?

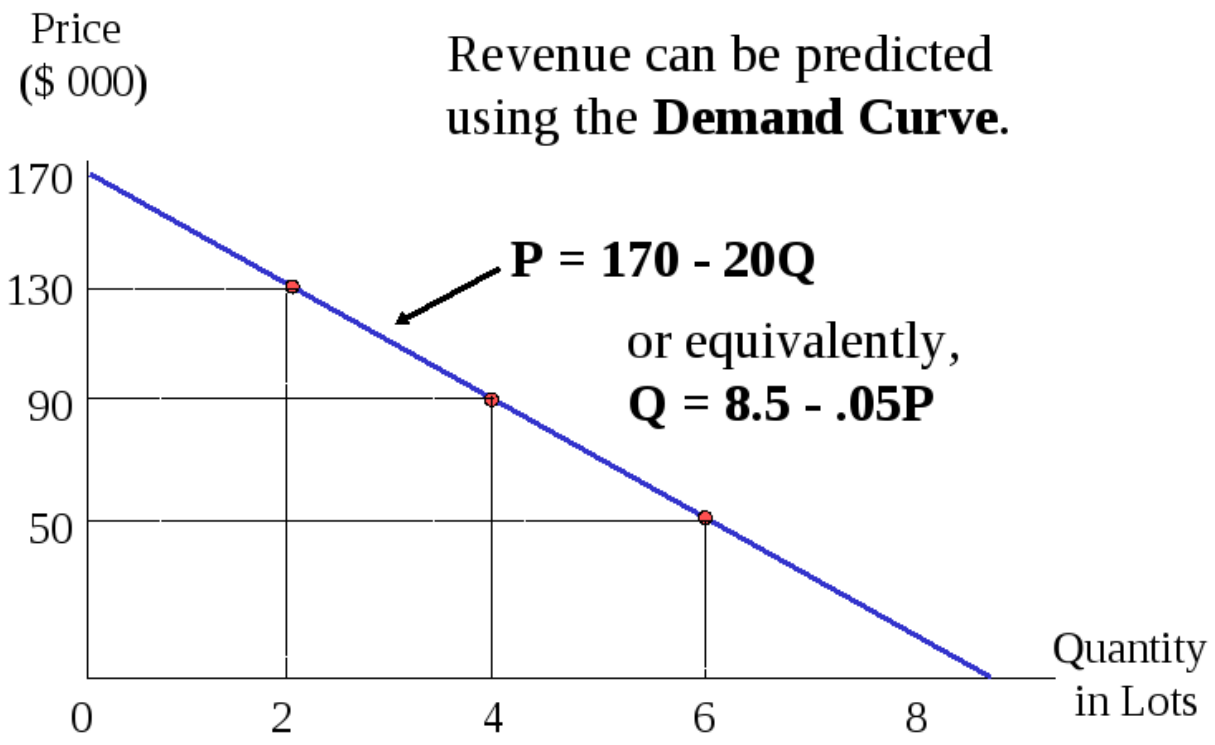
- The fundamental decision problem of the firm is to determine the profit-maximizing price and output for the good or service it sells
- the firm's profit from any decision is the difference between predicted revenues and costs. Increasing output and sales will increase profit, so long as the extra revenue gained exceeds the extra cost incurred. Conversely, the firm will profit by cutting output if the cost saved exceeds the revenue given up.
- if economic conditions change, the firm's optimal price and output will change according to the impact on its marginal revenues and marginal costs.

Demand curve

- The basic building blocks of the firm's price and output problem are its demand curve and cost function.
- the demand curve describes:
  1. the quantity of sales for a given price or, conversely
  2. the price needed to generate a given level of sales
- multiplying prices and quantities along the demand curve produces the revenue function.
- combining the revenue and cost functions generates a profit prediction for any output Q.

A Microchip Manufacturer

- Profit is the difference between revenue and cost: $\pi = R - C$
- The analysis of revenue rests on the law of demand.
- All other factors held constant, the higher the unit price of a good, the fewer the number of units demanded by consumers.



Revenue

- Since $R = P \times Q$
- if the market-cleaning price satisfies $P = 170 - 20Q$
- substituting the latter equation into the former yields the revenue function:

$$R = P \times Q = (170 - 20Q)Q = 170Q - 20Q^2 \tag{1}$$

Cost

- to produce chips the firm requires a plant, equipment, and labor.
- the firm estimates that it costs \$380 for each chip it produces that is \$38.000 per lot.
- in addition it incurs fixed costs of \$100.000 per week to run the plant whether or not chips are produced.

COST FUNCTION:

$$C = 100 + 38Q \tag{2}$$

The firm optimal output decision (1)

The Firm determines Output where $MR = MC$.

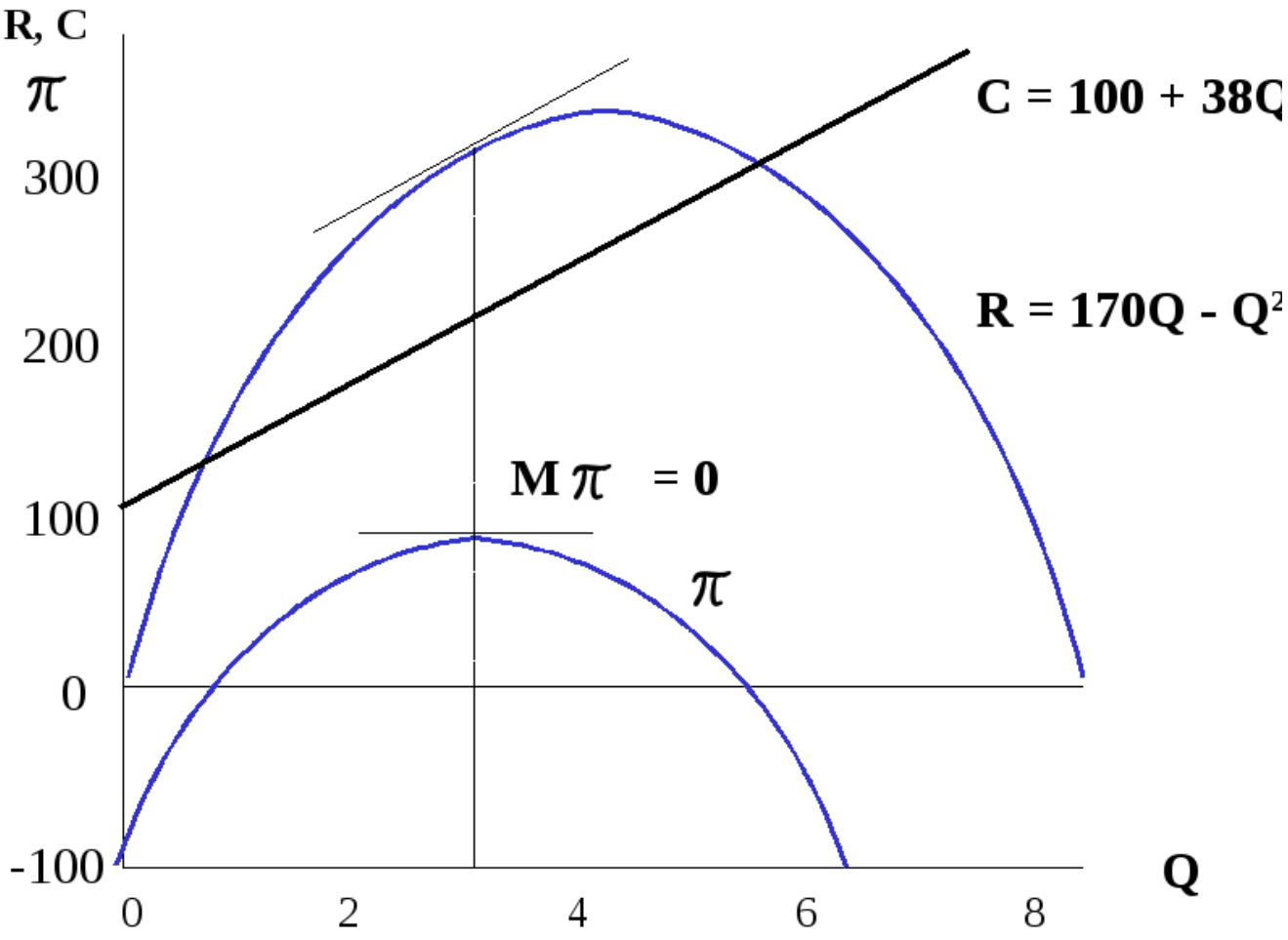


Figure: Firm optimal output decision

Marginal Analysis

The next step in finding the firm's optimal decision is to determine the firm's marginal profit, marginal revenue and marginal cost.

- Marginal profit ($M\pi$) is the extra profit earned from producing and selling an additional unit of output
- Marginal revenue (MR) is the extra revenue earned from selling an additional unit of output
- Marginal cost (MC) is the extra cost of producing an additional unit of output
- $M\pi = MR - MC$. The $M\pi$, MR and MC expressions can be found by taking the derivatives of the respective profit, revenue and cost functions.
- The firm's optimal output is characterized by $M\pi = 0$ or $MR = MC$. Optimal price and profit can be estimated accordingly.

The firm optimal output decision (2)

Algebraic solution

- Start with Demand and Cost Information: $P = 170 - 20Q$ and $C = 100 + 38Q$
- therefore, $R = 170Q - 20Q^2$ so $MR = 170 - 40Q$ and $MC = 38$
- setting $MR = MC$ implies $170 - 40Q = 38$ or $132 = 40Q$
- thus $Q^* = 132/40 = 3.3$ lots
- $P^* = 170 - (20)(3.3) = \$104$
- and $\pi^* = 343.2 - 225.4 = 117.8$

OBJECTIVES

1. To take a closer quantitative look at demand starting with a multi-variable demand equation;
2. to present the price elasticity of demand, other elasticities, and show how elasticities can be used to predict sales;
3. to show the relationship between price elasticity and revenue changes i.e. marginal revenue. Maximum revenue occurs at $E_P = -1$ or $MR = 0$.
4. to demonstrate how the firm can maximize its profit by using optimal markup pricing and price discrimination;
5. to examine the demand and pricing of information goods.

Pricing Software

- Consider a firm that produces a best-selling software program. The firm continues to spend a great deal of money revising and improving its software in an effort to maintain its market share lead over its next two or three strongest competitors. In fact, its last revision and update cost much more than the company expected.
- In light of these added development costs and any other relevant factors, how should top management determine its pricing policy for the updated program?

A firms quantity of sales depends on multiple economic factors.

For instance, an airlines seat demand might be described by the equation:

$$Q = 25 - 2P + 3Y + P^{\circ} \tag{3}$$

Here, demand depends on: customer income (Y), the rivals price (P°), and the airlines price (P).

Demand Analysis

- A product is called normal good if an increase in income raises its sales;
- A product is called inferior good if an increase in income causes a reduction in spending;
- A substitute good competes with and can substitute for another good. An increase in the price of the substitute good causes an increase in the demand for the good in question.
- A pair of goods is complementary if an increase in demand for one causes an increase in demand of the other. An increase in the price of a complementary good reduces demand for the good in question.

Shifts in Demand

- Any change in the firms own price shows up as a movement along the firms demand curve;
- A change in any other variable constitutes a shift in the position of the demand curve;
- For instance, an increase in a competitors price would cause a favorable demand shift as shown.

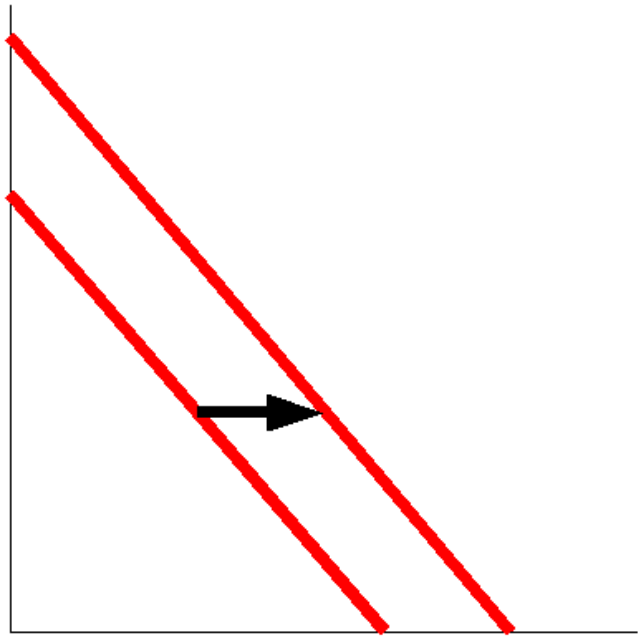


Figure: demand shift

Elasticity of Demand

How responsive are sales to changes in price? The concept of elasticity supplies the answer.

$$E_p = \frac{\text{\% change in Q}}{\text{\% change in P}} = \frac{\Delta Q/Q}{\Delta P/P} = \frac{(Q_1 - Q_0)/Q_0}{(P_1 - P_0)/P_0} \tag{4}$$

we can rearrange this expression to read

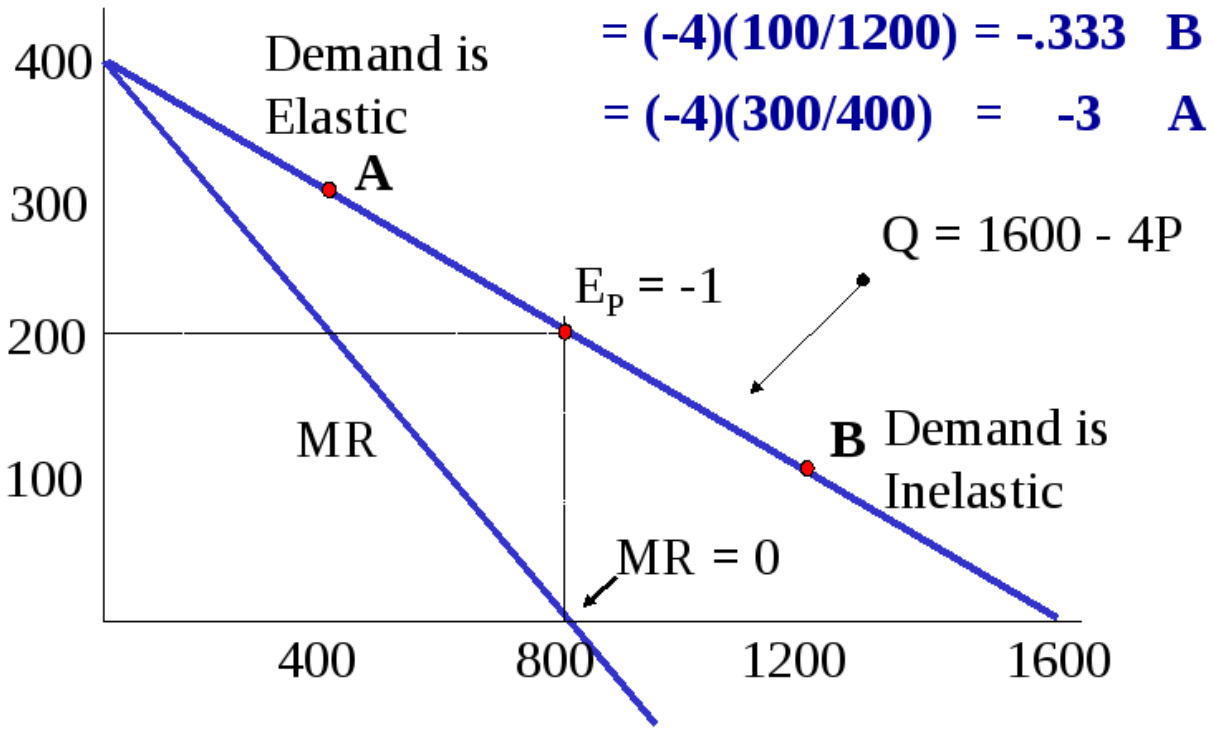
$$E_p = dQ/dP \times P/Q \tag{5}$$

$$E_p = \frac{(110 - 100)/100}{(235 - 240)/240} = \frac{10.0\%}{-2.1\%} = -4.8 \tag{6}$$

Properties of Elasticity

- Unitary elastic: $E_p = 1$
- Inelastic: $-1 < E_p < 0$
- Elastic: $-\infty < E_p < -1$

Elasticity Varies along a Linear Demand Curve.



Using Elasticity (1)

Other elasticities

- Income elasticity: $E_Y = \dfrac{\%\text{ Change Q}}{\%\text{ Change Y}}$;
- Cross price elasticity: $E_{P^\circ} = \dfrac{\%\text{ Change Q}}{\%\text{ Change } P^\circ}$

Necessities: $0 < E_Y < 1$; Discretionary goods: $E_Y > 1$

Predicting sales

$$\Delta Q/Q = (E_P)(\Delta P/P) + (E_Y)(\Delta Y/Y) + (E_P^\circ)(\Delta P^\circ/P^\circ). \quad (7)$$

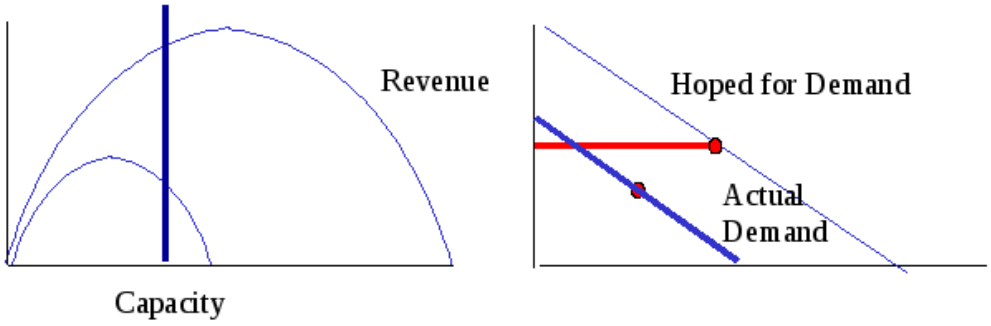
Using Elasticity (2)

Maximizing profit and revenue in pure selling problems ($MC = 0$).
Examples: Selling information goods (Software, CD...) Optimal

Solution: $MR = 0$ or equivalently: $EP = -1$.
Utilizing a sport stadium:

- with high demand: price to fill the stadium
- with low demand: do NOT cut price to fill the stadium

Pricing Olympics Cable Coverage on Triple Cast: Minimize loss, by drastically cutting price.



Optimal Pricing

The Markup Rule

$$[P - MC]/P = -1/E_P \tag{8}$$

or

$$P = [E_P/(1 + E_P)]MC \tag{9}$$

If $MC = 100$ for different prices (P) we have the following elasticity:

E_p	-2	-3	-4	-6
P	200	150	133	120

Price Discrimination

Apply Markup rule to separate segments. More inelastic segments get the higher markups (over common MC).
Equivalently, Set $MR_1 = MR_2 = MC$.

Examples: Airlines tickets (business class vs vacationers), branding, providers of professional services set different rates for different clients, skimming and penetration prices, publisher of academic journals, student and senior discounts, retail vs wholesale markets, "first-run" theaters vs suburban theaters.

Forms of Price Discrimination

- First-degree (perfect) price discrimination occurs when a firm sets a different price for each customer and by doing so extracts the maximum possible sale revenue (es. auto dealer)
- Second-degree price discrimination occurs when the firm offers different price schedules, and customers choose the terms that best fit their needs (es. quantity discounts and two-part pricing).
- Third-degree price discrimination: firms charge different prices for different market segments for which the firm's costs are identical (es. airline tickets).

Limited Capacity

Airline Yield Management: Maximizing Revenue utilizing Business Class and Economy Class seats. The key is to set: $MR_B = MR_E$.

Example: Airline has 180 seats and faces demand:

$P_B = 330 - Q_B$ and $P_E = 250 - Q_E$. Therefore,
$MR_B = 330 - 2Q_B = MR_E = 250 - 2Q_E$.
We also know that: $Q_B + Q_E = 180$.
The solution to these simultaneous equations is: $Q_B = 110$ seats and $Q_E = 70$ seats.
In turn, $P_B = \$220$ and $P_E = \$180$.

Information goods

- An information good can be a database, game catridge, news article, piece of music, software or the like.
- Information services ranges from e-mail and instant messaging, to electronic exchanges and auctions, to brokerage and other financial services, to job placements

Information is costly to produce but cheap (often costless) to reproduce. (high fixed costs but low or negligible marginal costs, so that average cost per unit sharply declines as output increases).

Pure market problem: how to market, promote and price its product to maximize revenue (and thereby profit).

Summary (1)

The demand function shows the relationship between the unit sales of a good or service and one ore more economic variables

1. A change in price is represented by a movement along the demand curve. A change in any other variable shifts the demand curve
2. a pair of goods are substitutes if an increase in demand for one causes a fall in demand for the other. A price cut for one good reduces sales of the other.
3. A pair of goods are complements if an increase in demand for one causes an increase in demand for the other. A price cut for one good increases sales of the other.
4. A good is normal if its sales increase with increases in income.

Summary (2)

The price elasticity of demand measures the percentage change in sales for a given percentage change in the good's price, all other factors held constant: $E_p = (\Delta Q/Q)/(\Delta P/P)$.

5. Demand is unitary elastic if $E_p = -1$. Demand is elastic if $E_p < 1$ and inelastic if $-1 < E_p < 0$.
6. Revenue is maximized at the price and quantity for which marginal revenue is zero or the price elasticity of demand is unity.

Summary (3)

7. The optimal markup rule is $(P - MC)/P = -1/E_p$. The firm's optimal markup above marginal cost and expressed as a percentage of price varies inversely with the price elasticity of demand for the good or service.
8. Price discrimination occurs when a firm sells the same good or service (same production cost) to different buyers at different prices (based on different price elasticities of demand). Price in various market segments are determined according to the optimal markup rule.

OBJECTIVES

1. To introduce the concept of production and to lay the groundwork for the later discussion about cost;
2. to explain and contrast short-run concepts (fixed inputs, marginal product, diminishing marginal returns, etc.) and long-run concepts (returns to scale, output elasticity, etc.);
3. to examine different types of production functions and their graphical representations;
4. to explore optimization in the context of production using marginal analysis.

Short and Long Run

In the short run some inputs of the production function are fixed.

Short Run	Long Run
Some inputs are fixed	All inputs are variable
Law of diminishing marginal returns	Returns to scale
Marginal product	Input elasticity
Total product curve	Isoquants

Production

- The firm will organize its means of production to maximize profit;
- To do this it must balance input productivity and input costs;
- The firms production function: $Q = F(L, K)$, lists the amount of output it can produce with specified amounts of labor and capital.

Production in the Short Run (1)

- In the short run, only 1 input is variable (labor, L) and the other inputs are fixed (capital, K);
- For instance, with the firms plant and capital fixed, it increases output by using more and more labor hours.

The "Law" of Diminishing Returns: With other inputs fixed, the marginal product of labor declines as more and more hours are added.

`Knowledge is the only instrument of production that is not subject to diminishing returns.` (J.M. Clarke)

Production in the Short Run (2)

Optimal use of the Variable Input occurs at L^* where:
Marginal Revenue Product = Marginal Cost of Input or

$$P \times MP_L = Wage \tag{10}$$

where MP_L is the marginal productivity of labor and P is the price.

Production in the Short Run (3)

Example: Suppose that the short run production function is
$Q = 60L - L^2$
(note that the marginal productivity of labor is decreasing)
suppose $P = \$2$ per unit, and wage $= \$16$ per hour. Then,
$MP_L = 60 - 2L$, so we have $(2)(60 - 2L) = 16$, implying, $L^* = 26$ hours.
In turn, $Q^* = (60)(26) - (26)2 = 884$ units, and
Profit $= (\$2)(884) - (\$16)(26) = \$1,352$.

Production in the Long Run (1)

- In the long run, the firm can vary all its inputs and change the scale of its operations;
- returns to scale measures the percentage change in output for a given percentage change in all inputs.

1. Constant return to scale: The output incresases in the same proportion as the proportional increase in all factors of production, thus the average cost of production is constant by increasing the production scale.
2. Increasing return to scale: The output increases more than proportionally to a proportional increase in all factors of production, thus the average cost of production is decreasing by increasing the production scale.
3. Decreasing return to scale: The output increases less than proportionally to a proportional increase in all factors of production, thus the average cost of production is increasing by increasing the production scale.

Long Run Decisions (1)

In the long run, how can the firm produce a given quantity of output at least cost?
By equating the ratios of the marginal productivity (MP) to input costs for all inputs:

$$MP_L/P_L = MP_K/P_K \tag{11}$$

Long Run Decisions (2)

Graphical demonstration: At the optimal tangency $MP_L/MP_K = P_L/P_K$, which (after rearrangement) is equivalent to condition above.

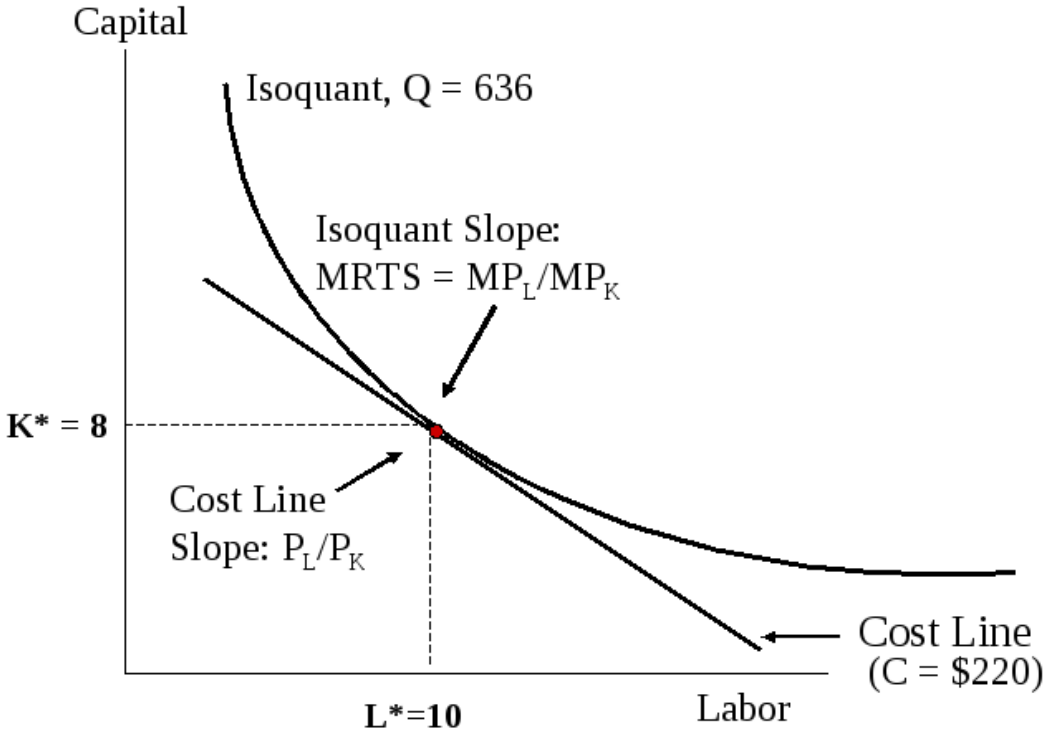


Figure: Long run decision

Measuring Production Functions

We can assume different shapes of the production function.
Linear Production:

$$Q = aL + bK \tag{12}$$

Isoquants are straight lines. Input allocation is "all or nothing".
Fixed Proportions: No substitution between inputs.
Cobb-Douglas production function (most widely used):

$$Q = cL^{\alpha}K^{\beta} \tag{13}$$

1. Each input has diminishing returns;
2. returns to scale depends on whether $\alpha + \beta <$ (decreasing) or $>$ (increasing) or $= 1$ (constant).

Maximizing profit with limited inputs

- How should the firm allocate crude oil across two of its production facilities?
- Answer: The allocation should ensure that the plants marginal products are equal: $MP_A = MP_B$

Example:
Refinery A: $Q = 24M_A - .5M_A^2$
Refinery B: $Q = 20M_B - M_B^2$.
$M_A + M_B = 10$ thousand barrels of oil
Equating $MP_A = MP_B$ implies $24 - M_A = 20 - 2M_B$.
The solution to these simultaneous equations is:
$MA = 8$ and $MB = 2$.

Designing the Boing 777 (1)

When Boeings first twin-engine long-haul aircraft rolled out of the assembly hanger, it was in record time and represented the single most ambitious experiment in computer-aided design (CAD).
Computer-aided design permits "virtual" manufacturing: realistic simulation of the most important aspects of products and processes.
For Boeing, CAD greatly enhances precision, allows designs to be transmitted instantly among company personnel and subcontractors, and dramatically cuts the time it takes to translate design into production.
Indeed, for high-tech, complex systems such as aircraft, more than 50 percent of eventual life-cycle product costs depend on early design decisions.

Designing the Boing 777 (2)

Computer-aided design is changing the ways managers think about production.

Beyond the customary, tangible production inputs (labor, capital, and materials), managers have come to recognize information as a fourth input.

By using information more intensively, production managers can economize on the use of the other three inputs, as Boeing has done successfully.

As computing costs decline, managers will increasingly turn to CAD systems, particularly when they deliver significant savings on expensive labor and capital.

Designing the Boing 777 (3)

Moreover, information has two features not shared by other inputs.

1. information is not used up. Setting up information systems involves certain fixed costs, but, once established, information can be used and reused at relatively low marginal costs.
2. information enhances manufacturing flexibility. In modern information-based manufacturing, there are innumerable ways to produce a given quantity of output and myriad trade-offs among them.

As the example of the Boeing 777 demonstrates, accelerated manufacturing and just-in-time production methods save time as well as money.

Summary (1)

1. Production is the process of turning inputs into outputs;
2. to maximize profit, the firm should increase usage of a variable input up to the point where the input's marginal cost equals its marginal revenue product.
3. to minimize the cost of producing a given output, the firm should choose an input mix such that the ratio of the marginal product to the input's cost is the same across all inputs;
4. in allocating an input among multiple plants, the firm maximizes total output when marginal products are equal across facilities.
5. in allocating an input among multiple products, the firm maximizes total profit when marginal profits per unit input are equal across products.

Summary (2)

6. The production function indicates the maximum amount of output the firm can produce for any combination of inputs
7. in the short run (the period of time in which one of more firm's inputs are fixed):
   - marginal product (MP) is the additional output producted by an additional unit of an input, all other inputs held constant;
   - the law of diminishing returns states that, as units of one input are added (with all other inputs held constant), a point will be reached where the resulting additions to output will begin to decrease; that is, marginal product will decline.
   - an input's marginal revenue product (MRP) is the extra revenue generated by a unit increase in the input. For input A, $MRP_A = (MR)(MP_A)$.

Summary (3)

8. The long run in an amount of time long enough to allow the firm to vary all of its inputs
   - Constant returns to scale occur if a given percentage change in all inputs results in an equal percentage change in output;
   - Increasing (decreasing) returns to scale occur if a given increase in all inputs results in a greater (lesser) proportionate change in output.
9. Production functions are estimated by specifying a variety of mathematical forms and fitting them to production data derived from engineering studies, economic time series or cross sections.

Differentials opportunity costs

- Cost is an important consideration in decision making. In deciding among different courses of action, the manager need only consider the differential revenues and costs of the various alternatives
- the opportunity cost associated with choosing a particular decision is measured by the forgone benefits of the next-best alternative. Opportunity costs must be always considered.

Economic profit

- Economic profit is the difference between total revenues and total costs (i.e. explicit costs and opportunity costs).
- Managerial decisions should be based on economic profit, not accounting profit.
- Costs which are fixed (or sunk) with respect to alternative courses of action are irrelevant.

Starting a business (1)

Estimates of annual revenues and costs (on average) over the first three years of business

Management fees	$140,000
Miscellaneous revenues	12,000
Office rent	-36,000
Other office expenses	-18,000
Staff wages (excl. self)	-24,000

Accounting profit: $74,000

Starting a business (2)

If the working capital is \$80.000 and the Normal return is 8% the opportunity cost of capital is \$6.400.
If current manager's compensation is \$56.000, the opportunity cost of labor is \$56.000.
Thus total opportunity cost is \$ 62.400.
Economic profit = Accounting profit - Opportunity Costs
Economic profit = \$74.000- \$62.400 = \$11,600.
Since the expected profit is positive, the manager's best decision is to start up the new business.

Fixed costs

- A production manager must decide whether to retain his current production method or switch to a new method
- The easier approach is to ignore all fixed costs.
- The only differential costs concern the equipment modification and the reduction in labor
- the new method should be chosen if and only if its labor savings exceed the extra equipment cost
- Very different if management were tackling the larger decision of whether to continue production or shut down
- the optimal decision depends on the costs saved versus revenues sacrificed from discontinuing production.

Sunk costs

- A sunk cost is an expense that already has been incurred and cannot be recovered.
- Sunk costs cast their shadows in sequential investment decisions
- A firm has spent $20 million in research and development (R&D) of a new product. Additional $10 million is needed to complete a prototype product. Should the firm make the additional investment in the product?

The Psychology of Sunk Costs

- Research by psychologists testing decision behavior of individuals clearly shows that sunk costs can adversely affect judgement.
- After having make a substantial initial investment in a project they continue to make cash investments even when new information is highly unfavorable.
- It is difficult to be objective when one is already psychologically invested in the initial decision.

Short and Long Run

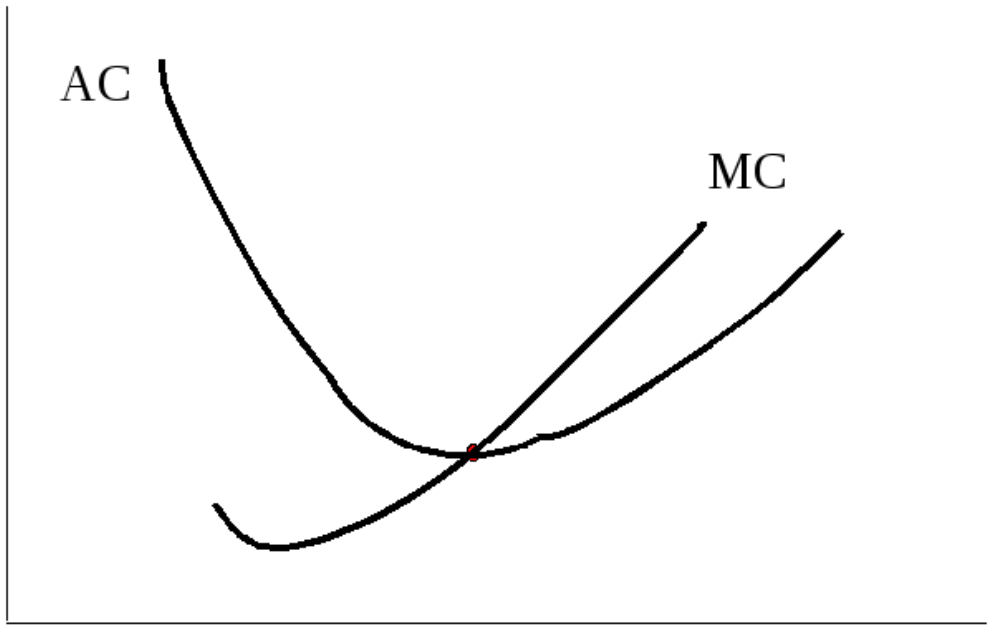
- In the short run, the firm should continue to produce so long as price exceeds average variable cost. Assuming it does produce, the firm maximizes its profit (or minimizes its loss) by setting marginal revenue equal to marginal cost.
- in the long run, all revenues and costs are variable. The firm should continue production if, and only if, it earns a positive economic profit.
- a multiproduct firm should continue operating in the long run only if total revenue exceeds total costs. There is no need to allocate shared costs to specific products.

Cost analysis: Short Run

- The firm's cost function indicates the (minimum) total cost of producing any level of output given existing production technology, input prices, and any relevant constraints.
- in the short run, one or more of the firm's inputs are fixed. Short-run total cost is the sum of fixed cost and variable cost.
- marginal cost is the additional cost of producing an extra unit of output. In the short run, there is an inverse relationship between marginal cost and the marginal product of the variable input: $MC = P_L/MP_P$.
- marginal cost increases due to diminishing returns.
- the short run cost curve is U-shaped.

cost analysis

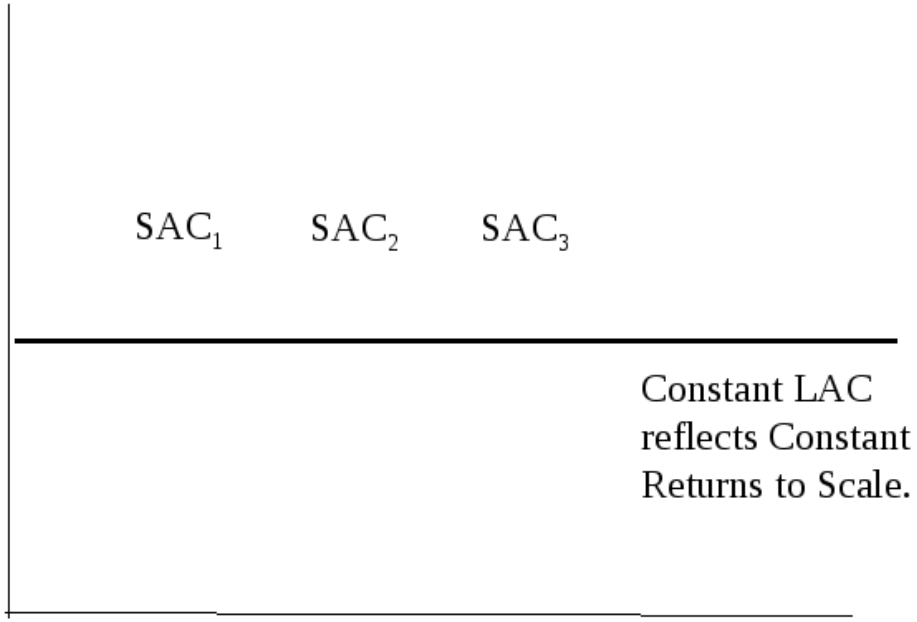
- Short-Run Cost Behavior: Diminishing Marginal Productivity leads to Increasing MC.
- Example: $MC = \text{Wage}/MP_L$
- Wage = \$12 per Hour, $MP_L = 4$ units of output per Hour, then MC = \$3 per unit.



Cost analysis: Long Run

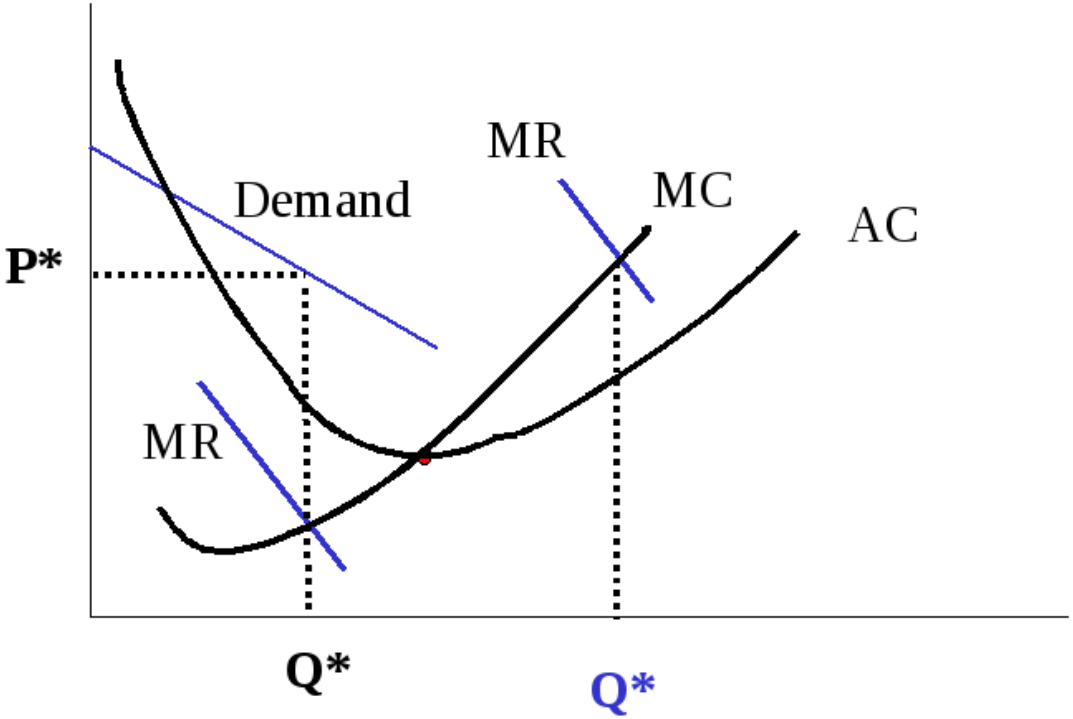
- In the long run, all inputs are variable.
- the firm chooses input proportions to minimize the total cost of producing any given level of output.
- the shape of the long-run average cost curve is determined by returns to scale
- If there are constant return to scale, long-run average cost is constant; under increasing returns, average cost decreases with output; and, under decreasing returns, average cost rises.
- Empirical studies indicate L-shaped (or U-shaped) long-run average cost curves for many sectors and products

- The shape of Long-Run average cost depends upon returns to scale.
- Flat LAC reflects Constant Returns to Scale.
- With plant fixed, SAC is U-shaped and lies above LAC.



Optimal output

- Low Demand versus High Demand
- In either case, the firms optimal output occurs where: $MR = MC$



Economies of scope (1)

A production process exhibits economies of scope when the cost of producing multiple goods is less than the aggregate cost of producing each item separately. A convenient measure of such economies is

$$\frac{C(Q_1) + C(Q_2) - C(Q_1, Q_2)}{C(Q_1) + C(Q_2)} \tag{14}$$

where Q_1 (Q_2) is the output of the first (second) good.

Economies of scope (2)

Sources of economies of scope includes

- a single production process yields multiple outputs
- transferable know-how
- the consumption of many clusters of goods and services is complementary

The shut down rule (1)

In the short run many of the firm's inputs are fixed. The firm's profit is

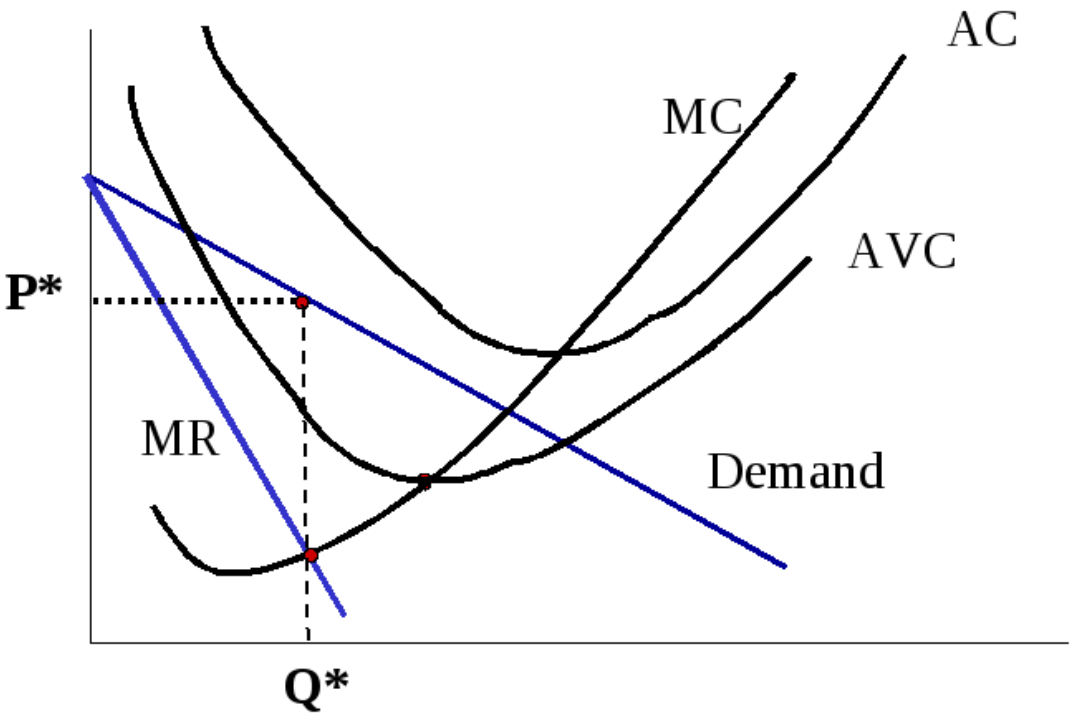
$$\pi = (R - VC) - FC = (P - AVC)Q - FC \tag{15}$$

where VC is variable cost, FC is fixed cost and AVC is average variable cost. The first term $(R - VC)$ is the product's contribution.
with multiple products

$$\pi = (R_1 - VC_1) + (R_2 - VC_2) - FC \tag{16}$$

The shut down rule (2)

1. In the long run, the firm should shut down when: $P < AC$.
2. In the short run, the firm should produce Q^* because: $P > AVC$.



Comparative Advantage

- Comparative advantage refers to the ability of a person or a country to produce a particular good at a lower marginal cost and opportunity cost than another person or country.
- it is the ability to produce a product most efficiently given all the other products that could be produced.
- it can be contrasted with absolute advantage which refers to the ability of a person or a country to produce a particular good at a lower absolute cost than another.

Economies of scope & comparative advantages

- Many firms supply multiple products. Economies of scope exist when the cost of producing multiple goods is less than the aggregate cost of producing each good separately.
- comparative advantage (not absolute advantage) is the source of mutually beneficial global trade.
- the pattern of comparative advantage between two countries depends on relative productivity, relative wages and the exchange rate.

Betting the Planet

The economist bet: the price of the resources chosen by the scientist P.E. would be lower at the future date than they were at the present time.

P.E. selected five resources (copper, chrome, nickel, tin and tungsten) for which he predicted increasing scarcity overt the next decade. He hypothetically purchased $200 worth of each metal at 1981 prices. Then he waited and watched price movements over the next 10 years.

What can the economics of supply and demand tell us about the debate about limited resources? If the bet were to be made today, which side would you take?

Market structures

Market are typically divided into four main categories:

1. perfect competition
2. monopolistic competition
3. oligopoly
4. pure monopoly

Perfect competitive markets are supplied by a large number of competitors. Because each firm claims only a very small market share, none has the power to control price. Rather price is determined by supply and demand. There are no barriers preventing new firms from entering the market.

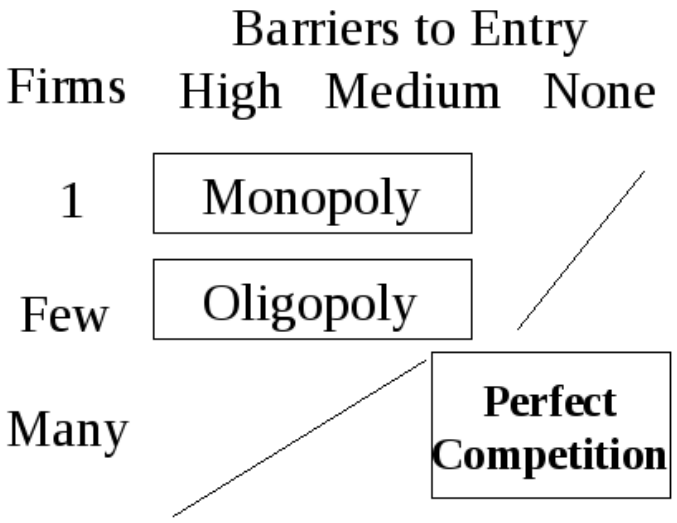


Figure: Market structures

In oligopolistic markets a small number of large firms dominate the market. Each firm must anticipate the effect of its rivals' actions. Moderate or high barriers are necessary to insulate the oligopolists from would-be entrants.

Monopoly and monopolistic competition

In monopolistic markets a single firm supplies the market and has no direct competition. Clearly, prohibitive entry barriers are a precondition for pure monopoly.

Monopolistic competition shares several characteristics of perfect competition. However whereas perfect competition is characterized by firms producing identical products, monopolistic competition is marked by product differentiation.

The increase (shift) in demand results in a higher price and a greater output.

The basics of supply and demand (1)

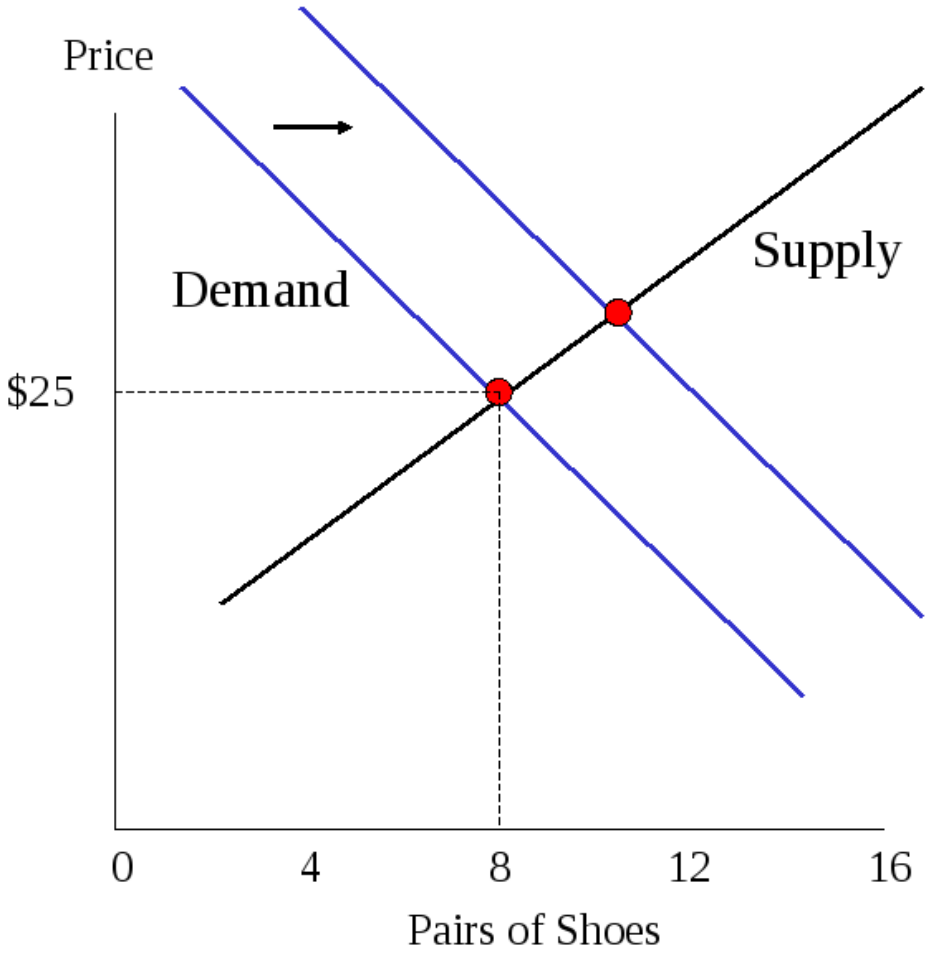


Figure: Supply and demand: the intersection of supply and demand determines the equilibrium price ($25) and quantity (8000 pairs)

The basics of supply and demand (2)

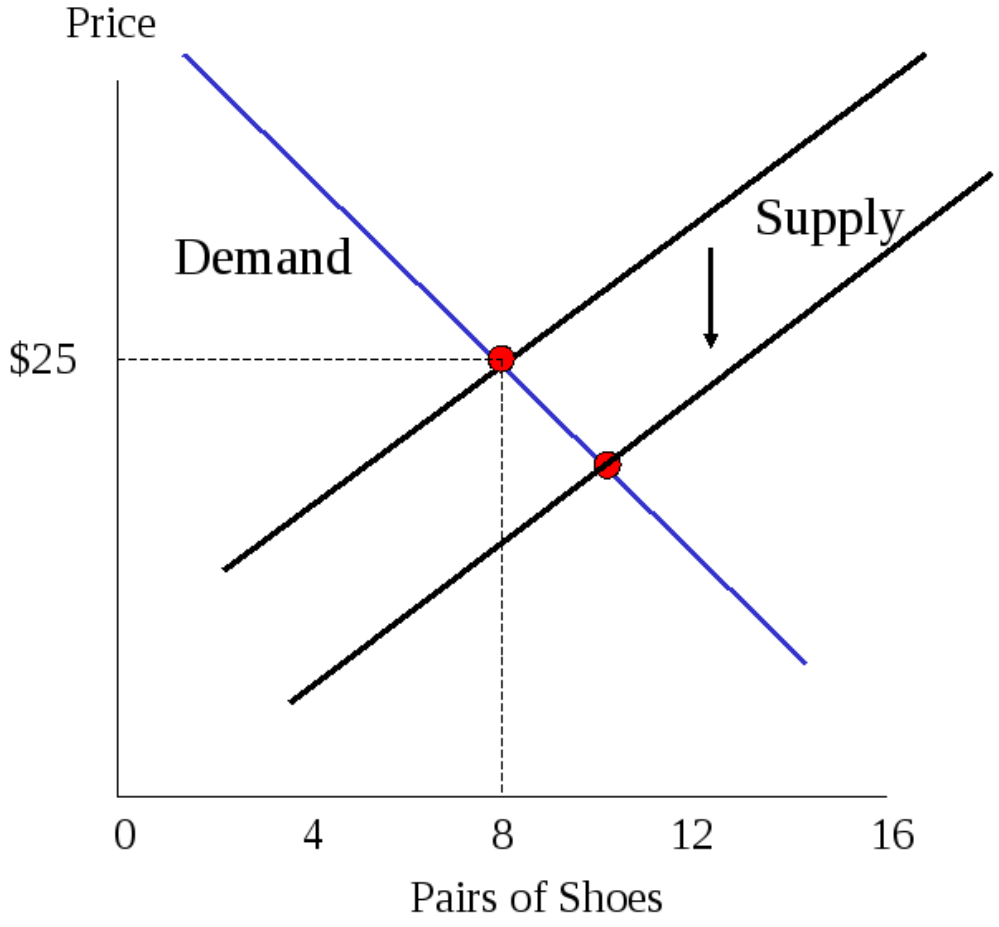


Figure: The fall in the marginal cost of production causes a favorable shift in supply and a lower price accompanied by greater output.

Competitive equilibrium

Perfect competition is commonly characterized by four conditions:

1. A large number of firms supply a good or service for a market consisting of a large number of customers;
2. There are no barriers with respect to new firms entering the market. As a result, the typical competitive firm will earn a zero economic profit;
3. All firms produce and sell identical standardized products. Therefore, firms compete only with respect to price. In addition, all consumers have perfect information about competing prices. Thus, all goods must sell at a single market price;
4. Firms and customers are price takers. Each firm sells a small share of total industry output, and, therefore, its actions, have no impact on price.

Decisions of the competitive firm

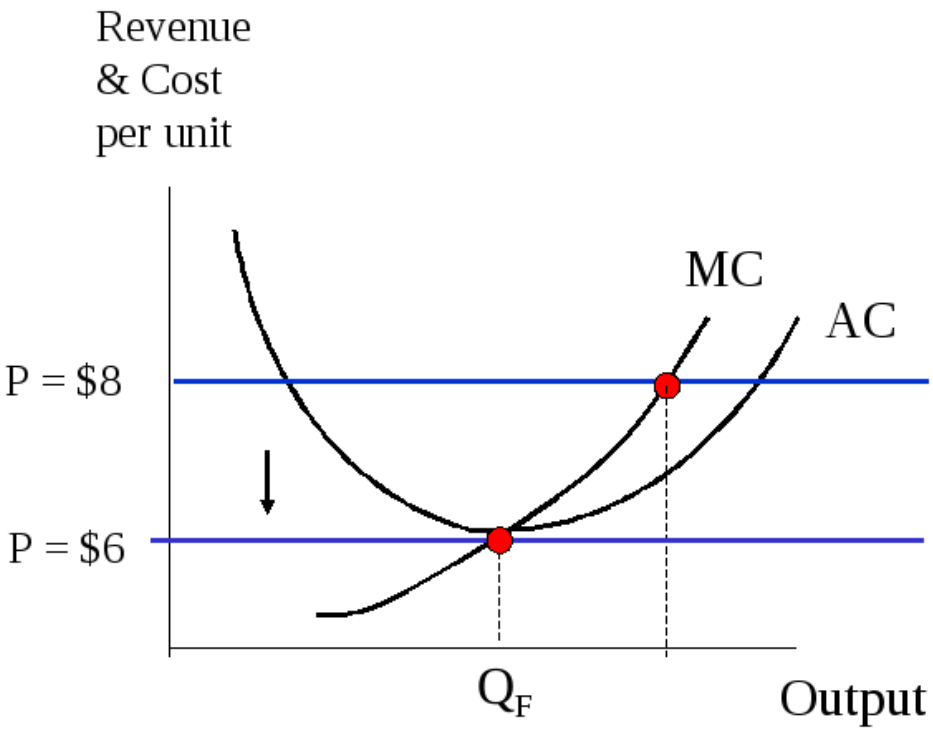
Firms are price takers. Two conditions are key:

1. A large number of sellers (and buyers) each of which is small relative to the total market;
2. Firms' outputs are perfect substitutes: standard, homogeneous, undifferentiated product. Buyers have perfect information about cost, price and quality of competing goods.

Together these two conditions ensure that the firm's demand curve is perfectly (or infinitely) elastic.

The firm's supply curve

A firm in a perfectly competitive market maximizes profit by producing up to an output such that its marginal cost equals the market price



Long-run equilibrium

In the long-run firms can freely enter or exit the market thus each profit opportunity is temporary.

Here the typical firm is earning a positive economic profit that comes to $\pi = (\$8,00 - \$6,50)(6000) = \$9000$

As new firms enter and produce output, the current market price will be bid down. The competitive price will fall to the point where all economic profits are eliminated.

The long-run market price is \$6 per unit (5000 units).

The paradox of profit-maximizing competition

The simultaneous pursuit of maximum profit by competitive firms results in zero economic profits and minimum-cost production for all.

Remember that a zero economic profit affords the firm a normal rate of return on its capital investment.
This normal return already is included in its estimated cost.

The paradox of profit-maximizing competition

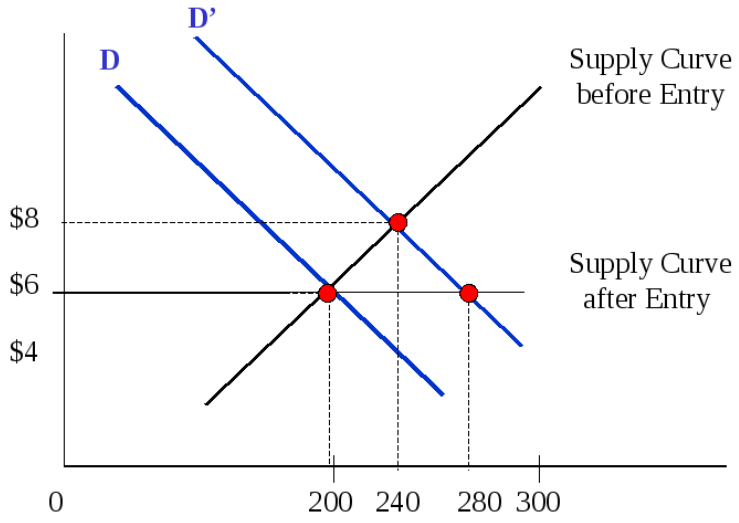


Figure: An increase in demand form D to D' has two effects. In the short run, the outcome is E'; in the long run (after entry of new firms), the outcome is E^*

Long-run market supply (1)

- The horizontal line represents the case of a constant-cost industry.
- The long-run market supply curve is a horizontal line at a level equal to the minimum Long-run Average Cost (LAC) of production.
- In a constant-cost industry, the inputs needed to produce the increased output can be obtained without bidding up their prices.
- For an increasing-cost industry, output expansion causes increases in the price of key inputs.

Long-run market supply (2)

If U.S. drilling activity increased by 30% the typical oil company's average cost per barrel of oil could be expected to rise for a number of reasons:

- bid up the price of drilling rigs and sophisticated seismic equipment;
- skilled labor (such as chemical engineering graduates) being in greater demand would receive higher wages;
- most promising sites are limited, oil companies would resort to drilling marginal sites, yielding less oil on average.

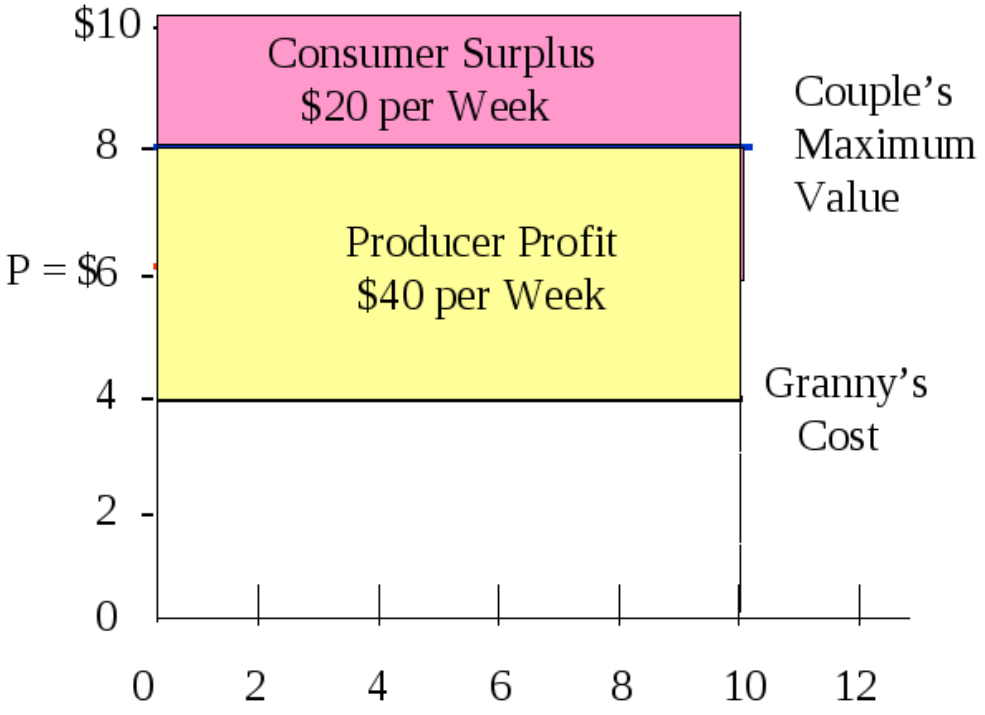
Market efficiency

Adam Smith's notion of an "invisible hand":

Every individual endeavors to employ his capital so that its produce may be of greatest value. he generally neither intends to promote the public interest, nor knows how much he is promoting it. He intends only his own security, only his gain. And he is in this led by an invisible hand to promote an end which was no part of his intention. By pursuing his own interest he frequently promotes that of society more effectively that when he really intends to promote it

A day-care example

Parents of a Two-Year Old are Willing to Pay $8 per hour for up to 10 hours of Day Care per Week. The Granny down the street will provide care for $4 per hour. Can the parties bargain to a mutually beneficial agreement? What if a second couple is willing to pay $10 per hour?



Trade barriers and deadweight loss (1)

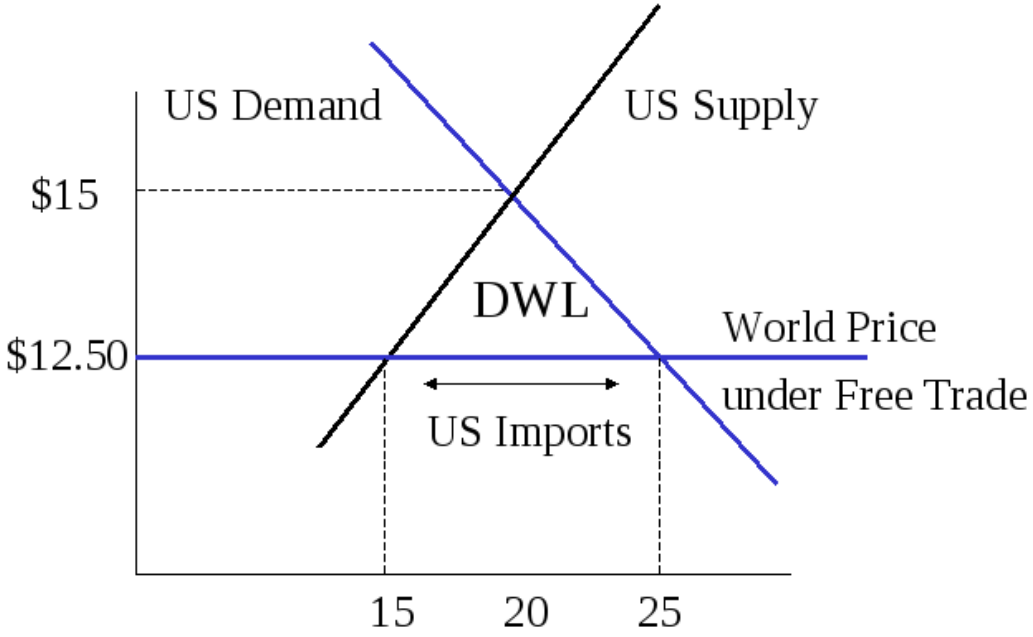


Figure: Deadweight loss under trade prohibition

Trade barriers and deadweight loss (2)

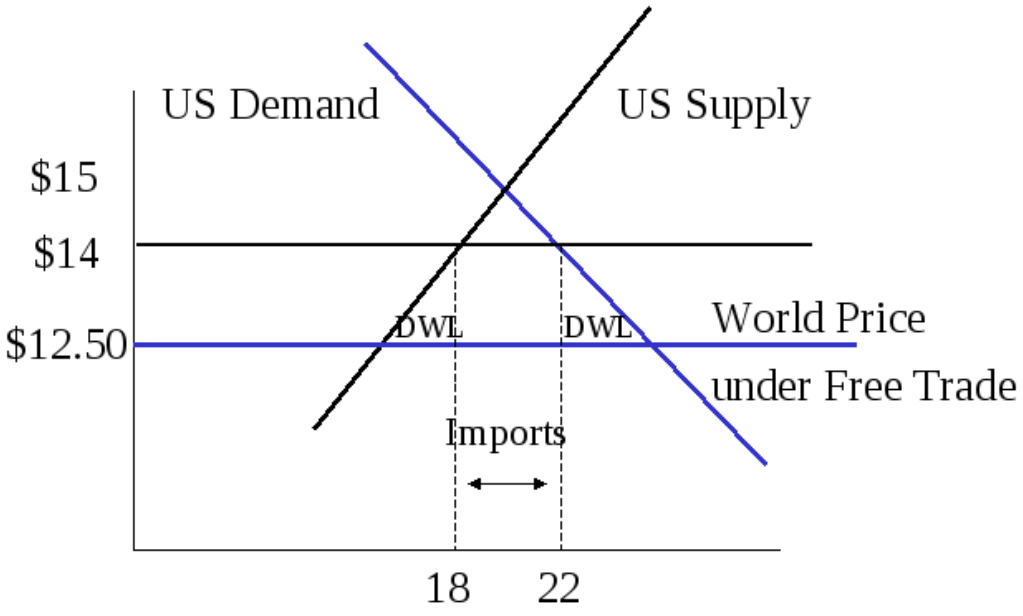


Figure: Deadweight loss under trade prohibition is greater than with a $1.50 tariff

Summary (1)

- Whatever the market environment, the firm maximizes profit by establishing a level of output such that marginal revenue equals marginal cost;
- In perfect competition, the firm faces infinitely elastic demand. Marginal revenues (MR) equal the market price (P). Thus the firm follows the optimal output rule $P = MC$. In the long-run equilibrium, the firm's output is marked by equalities $P = MR = MC = AC_{min}$, and the firm earns zero economic profit.

Summary (2)

- Economic transactions are voluntary. Buyers and sellers participate in them if and only if the transactions are mutually beneficial
- Competitive markets provide the efficient amounts of goods and services at minimum cost to the customers who are most willing (and able) to pay for them. Worldwide competition and free trade promote global efficiency.
- In a perfect competitive market, a large number of firms sell identical products, and there are no barriers to entry by new suppliers. Price tends toward a level where the market demand curve intersects the market supply curve. In the long run, price coincides with minimum average cost, and all firms earn zero economic profits

- The total value associated with an economic transaction is the sum of consumer and producer surplus. Consumer surplus is the difference between what individual is willing to pay and what she or he actually pays.
- For any market, the height of the demand curve shows the monetary value that consumers are willing to pay for each unit. Consumer surplus in the market is given by the area under the demand curve and above the market price line.
- In equilibrium, a competitive market generates maximum net benefits. The optimal level of output is determined by the intersection of demand and supply, that is, marginal benefit exactly equals marginal cost.

Monopoly (1)

- In the case of monopoly the industry is dominated by a single producer
- the demand curve is the same (downward-sloping).
- unlike the perfectly competitive firm, which produces too small a proportion of total industry output to significantly affect the market price, the output of the monopolist is total industry output.
- thus, for the monopolist, market prices are no longer parametric (price maker).

Definition: The term monopoly is used to describe the market structure in which there is only one producer of a good or service for which there are no close substitutes and entry into and exit from the industry is impossible.

Monopoly (2)

- In the case of monopoly the number and size distribution of buyers is largely irrelevant, since the buyers of the firm's output have no bargaining power
- such bargaining power is usually manifested through the threat to obtain the desired product from a competing firm, which is nonexistent in a monopolistic market
- for the firm to continue as a monopolist in the long run, there must be barriers that prevent the entry of other firms in the industry
- such restrictions may be the result of control over scarce productive resources, patent rights, access to unique managerial talent, economies of scale, location, government franchise...

Barriers to competition

A barrier is any factor that blocks or impedes entry of new firms into a particular market. There is a wide variety of barriers to entry that are more or less important. In some cases, one or more barriers are sufficient to support single dominant firm in the market. In others, entry barriers are not absolute but limit the market to a small number of firms. It is also useful to speak of barriers to competition that is factors that insulate a given firm from direct competition.

Economies of Scale

When average cost falls significantly with increases in scale, a new firm must enter the market with a large market share to be competitive.

In so-called natural monopolies average cost continually decreases with output: a single firm achieves the lowest possible unit cost by supplying the entire market.

Control of resources

Until the 1940s the Aluminum Company of America owned or controlled nearly 100% of the world's bauxite deposits. Since bauxite is needed to manufacture aluminum, that company, now known as Alcoa, was the sole producer and distributor of aluminum.
The price of a unique item at auction is determined by what the market will bear, not by competitive supply (es. French champagne, De Beers, OPEC).

In some industries (automobiles, defense, oil refinement, deep-see drilling) the capital requirements of production are enormous. In others (chemicals, pharmaceutical, ICT), large investments in research and development are necessary. When large sunk costs are required, entry is particularly risky (no way to recover investments).

Patents and copyrights

A legal barrier to the entry of new firms into an industry is the patent.

A patent is the exclusive right to a product or process by its inventor granted *to promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries*.

Rationale: patents provide an incentive for product research, development, invention, and innovation

without such protection investors are less likely to incur the substantial development cost and risks associated with bringing a new product to market.

Switching costs

Switching costs can be an important barrier to competition in markets for information-intensive goods and services. When customers have invested in learning to use a particular software program, navigate a Web site, or set up online accounts, they are less likely to switch to competitive (perhaps even superior) alternatives

Strategic barriers

The dominant firm may take actions explicitly aimed at erecting entry barriers: limiting pricing to discourage new entry, retaliatory pricing, advertising and brand proliferation, patents & trademarks, excess productive capacity.

Government franchise

A government franchise is a publicly authorized monopoly.

Many firms are monopolies because the government has granted them the sole authority to supply a particular product within a given region. Public utilities are the most recognizable of government franchises. Government-franchised monopolies are usually justified on the grounds that it is more efficient for a single firm to produce say electricity because of the large economies of scale involved and the desire to eliminate competing power grids.

In many states local telephone service is subject to regulation to ensure that consumers have access to affordable service: profit earned by telephone companies from business users subsidize private household use, which is billed to individual consumers at below cost.

Lawsuits

Monopolists can attempt protect exclusive market power positions by filing lawsuits against potential competitors claiming patent or copyright infringement. Some cash-poor companies are financially and legally unprepared to weather these legal challenges. In the end, companies can be forced out of business or may even be acquired by the monopolist.

Other barriers

Sometimes a single firm has absolute quality or cost advantages over all potential competitors.
Cost advantages may be due to superior technology, more efficient management, economies of scope, or learning (es. Intel, Wal-Mart, Boing, Airbus...)
In many e-commerce markets, network externalities (making larger networks more valuable to customers) bestow an important quality advantage on the market leader (es. eBay).
Advertising and marketing campaigns, brand proliferation (es. ready-to-eat breakfast cereals) provide barriers to entry.

Intel: Monopoly Inside? (1)

AMD sues Intel over monopoly abuses.
The complaint details numerous examples of "a pervasive, global scheme to coerce Intel customers from freely dealing with AMD to the detriment of customers and consumers worldwide.":

- Forcing major customers such as Dell, Sony, Toshiba ... into Intel-exclusive deals in return for outright cash payments, discriminatory pricing or marketing subsidies conditioned on the exclusion of AMD;
- Forcing other major customers such as NEC, Acer, and Fujitsu into partial exclusivity agreements by conditioning rebates, allowances and market development funds on customers agreement to severely limit or forego entirely purchases from AMD; Intel paid NEC several million dollars for caps on NECs purchases from AMD. Those caps assured Intel at least 90% of NECs business in Japan and imposed a worldwide cap on the amount of AMD business NEC could do.

Intel: Monopoly Inside? (2)

- Establishing a system of discriminatory and retroactive incentives triggered by purchases at such high levels as to have the intended effect of denying customers the freedom to purchase any significant volume of processors from AMD;
- Threatening retaliation against customers for introducing AMD computer platforms, particularly in strategic market segments such as commercial desktop;
- Establishing and enforcing quotas among key retailers such as Best Buy and Circuit City, effectively requiring them to stock overwhelmingly or exclusively, Intel computers, artificially limiting consumer choice;
- Forcing PC makers and tech partners to boycott AMD product launches or promotions;

Intel: Monopoly Inside? (3)

- Abusing its market power by forcing on the industry technical standards and products that have as their main purpose the handicapping of AMD in the marketplace. Intel denied AMD access to the highest level of membership for the Advanced DRAM technology consortium to limit AMDs participation in critical industry standard decisions that would affect its business. Intel designed its compilers, which translate software programs into machine-readable language, to degrade a programs performance if operated on a computer powered by an AMD microprocessor.

To view the full text of the complaint, visit http://www.amd.com/breakfree

As usual, total cost is an increasing function of output.
Now, however we assume that the selling price is a function of Q that is $P = P(Q)$ where $dP/dQ < 0$.

Substituting price into the profit function yields

$$\pi(Q) = P(Q)Q - TC(Q) \tag{17}$$

For a profit maximum

$$d\pi/dQ = P + Q(\frac{dP}{dQ}) - \frac{dTC}{dQ} = 0 \tag{18}$$

or

$$P + Q(\frac{dP}{dQ}) = MC \tag{19}$$

The term on the left-hand side is the expression of marginal revenue (MR).

If we assume that the demand equation is linear

$$P = a + bQ \tag{20}$$

the profit is

$$\pi(Q) = (a + bQ)Q - TC(Q) = aQ + bQ^2 - TC(Q) \tag{21}$$

thus the profit-maximizing condition is

$$a + 2bQ = MC \tag{22}$$

Note that the marginal revenue has the same vertical intercept but twice the (negative) slope of the demand curve.

Monopoly and the price elasticity of demand (1)

Remember that the profit-maximizing condition is

$$\frac{d\pi(Q)}{dQ} = P + Q(\frac{dP}{dQ}) - MC = 0 \tag{23}$$

rearranging we obtain

$$-Q(\frac{dP}{dQ}) = P - MC \tag{24}$$

Monopoly and the price elasticity of demand (2)

Dividing both sides by P

$$\frac{-Q}{P}\frac{d\pi(Q)}{dQ} = \frac{P - MC}{P} = 0 \tag{25}$$

thus

$$\frac{-1}{E_p} = \frac{P - MC}{P} \tag{26}$$

Since marginal cost is normally positive the left-hand side of eq. 26 implies $-1 \leq E_p \leq -\infty$ (demand is price elastic). Thus a monopolist will produce and price along the elastic portion of the demand curve

Lerner Index

Equation 26 (the negative of the inverse of the price elasticity of demand) is referred to as the Lerner index. The index is a measure of monopoly power and takes on values between 0 and 1.

The monopolist applies the optimal mark-up rule.

The greater $P - MC$ the greater the monopoly power of a firm.

Consumer and Producer surplus

- Consumer surplus is the difference between what consumers are willing to pay for a given quantity of a good or service and the amount that they actually pay.
- Producer surplus is the difference between the total revenues earned from the production and sale of a given quantity of output and what the firm would have been willing to accept for the production and sale of that quantity of output
- Consumer deadweight loss represents the reduction in consumer surplus that is not captured as an income transfer to a monopolist
- Producer deadweight loss arises when society's resources are inefficiently employed because the monopolist does not produce at minimum per-unit cost.

Collusion

- Suppose that an industry initially comprised several firms which decided to coordinate their pricing and output decisions to limit competition and maximize profits for the group. Such an arrangement is referred to as collusion.
- In most countries collusive agreements are illegal.
- A cartel is a group of producers that enter into a collusive agreement aimed at controlling price and output in a market.
- The incentive for individual members to sell extra output at discounted prices is the main source of cartel instability.

Pure Monopoly vs. Market Competition

The monopolist sets higher prices ($p_M > p_C$), sells less ($Q_M < Q_C$) and make higher profits ($\pi_M > \pi_C$) than in perfect competition.

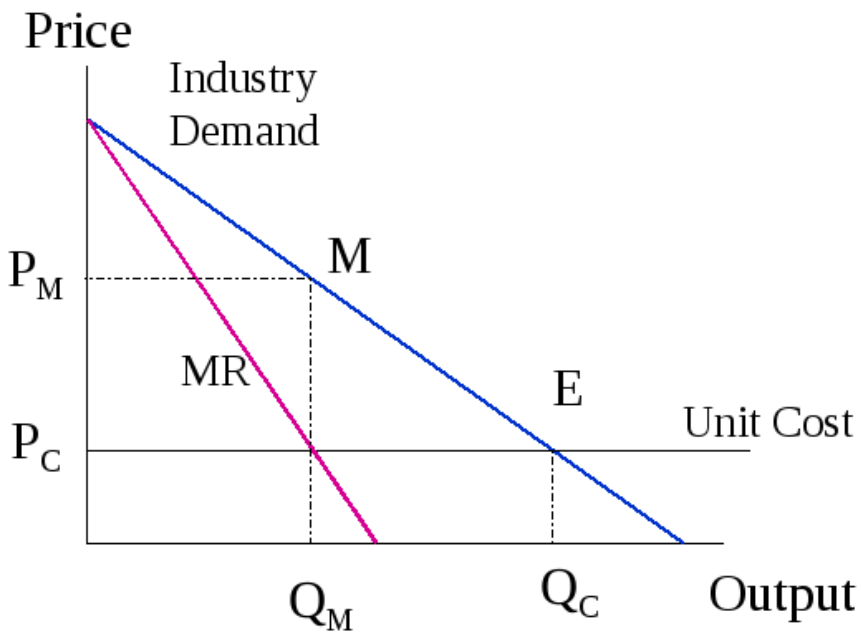


Figure: Pure Monopoly vs. Market Competition

Natural Monopoly (1)

- A natural monopoly occurs when the average cost of production declines throughout the relevant range of product demand. Utilities (water, electric power, gas, telephone) typically fall into this category.
- It is costly and inefficient for multiple competing firms to share the market
- A single firm can always produce Q at a lower average cost than it could if the same output were supplied by n firms each producing Q/n.
- Regulation can be based on average-cost pricing, marginal-cost pricing and two part pricing

Natural Monopoly (2)

Unregulated Pricing: Q_M, p_M
Average-Cost Pricing: Q_R, p_R

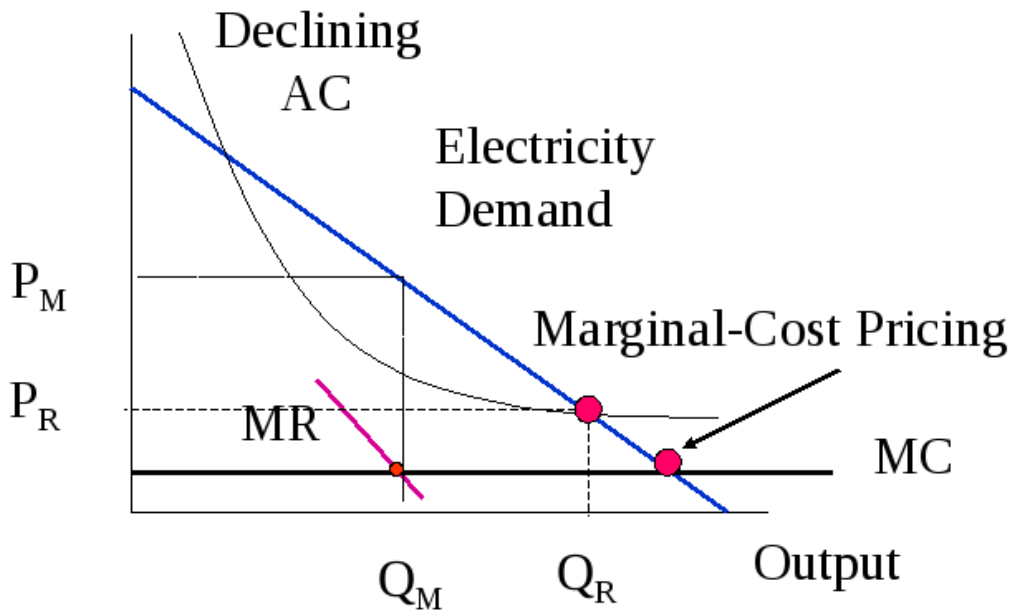


Figure: Natural Monopoly

A "natural" telecom monopoly?

Before 1996, most communities in the US received local telephone & cable television services by single, separate companies. Crated by the breakup of AT&T in the 1980s the "Baby Bells" provided local telephone services and local authorities granted a legally protected monopoly based on a natural monopoly argument. Over the last decade, the advent of deregulation and the development of advanced telecom services have reduced monopoly barriers and greatly increased competition. Today local telephone services are provided by the Baby Bells, long-distance companies, internet companies and cable companies. Network broadcasters, cable companies and satellite operators provide television services. Several firms coming from different original markets are competing to offer the most attractive bundled services to consumers

Summary (1)

1. Whatever the market environment, the firm maximizes profit by establishing a level of output such that marginal revenue equals marginal costs;
2. A monopolist sets $MR = MC$, where MR is determined by the industry demand curve. The magnitude of monopoly profit depends on demand (the size and elasticity of market demand) and on the monopolist's average cost.
3. Under pure monopoly, a single producer is shielded from market entrants by some form of barrier to entry
4. To maximize profit, the monopolist restricts output (relative to the competitive outcome) and raises price above the competitive level

Summary (2)

5. A cartel is a group of producers that enter into a collusive agreement aimed at controlling price and output a market.
6. The cartel restricts output and raises price to maximize the total profits of its members.
7. The incentive for individual members to sell extra output (at discounted prices) is the main source of cartel instability

Summary (3)

8. A natural monopoly occurs when the average cost of production declines throughout the relevant range of product demand.
9. Regulation via average-cost pricing is the most common response to natural monopoly

Oligopoly

- "Oligopoly "refers to the condition in which industry output is dominated by relatively few large firms.
- Although there is no precise definition attached to the word "few"two to eight firms controlling 75% or more of a market could be defined as an oligopoly
- However an oligopolistic market is defined by strategic interaction, which refers to the extent to which pricing, output and other decisions on one firm affect, and are affected by, the decisions of other firms.

Oligopolistic conditions

- A oligopoly is an industry comprising a few firms producing homogeneous or differentiated products; it is difficult to enter or leave the industry (es. automobile, chemicals, steel, microchips, PC software);
- A duopoly is an industry comprising two firms producing homogeneous or differentiated products; it is difficult to enter or leave the industry (es. Coca Cola vs. Pepsi).

Porter's Five-Forces

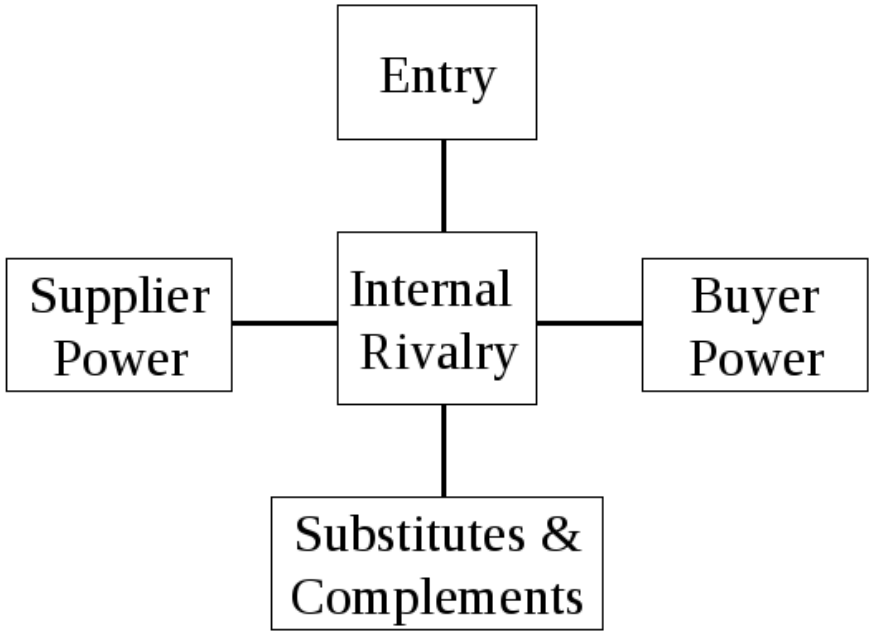


Figure: The Five-Forces Framework

Industry concentration

- the n-firms concentration ratio (CR_n) is the percentage of sales accounted for by the top n firms in a market or industry
- effective monopoly: $CR_1 > 90\%$; effectively competitive market: $CR_4 < 40\%$; loose oligopoly: $40\% < CR_4 < 60\%$; tight oligopoly: $CR_4 > 60\%$.
- 3/4 of the total dollar value of goods and services (gross domestic product, GDP) in the US originate in competitive markets, pure monopoly accounts for 2-3%, tight oligopolies for about 10% and loose oligopolies compose about 12%.
- The most serious limitation of the concentration indices lies in the identification of the relevant market.

Relevant market

- We do not want to restrict ourselves to the homogeneous-good case: if we posit that two goods belong to the same market if and only if they are perfect substitutes, then virtually all markets would be served by a single firm.
- All goods are at least slightly differentiated (other physically, by location, availability, consumer information or other factors) but an increase in price leads consumers to substitute somewhat toward a small number of alternative goods.
- One criterion looks at the correlation between the pries of goods. However the "right 'definition of a market depends on the use.

Industry concentration, some examples

Good or Service	**Concentration Ratio**	
	4 Firms	8 Firms
Glass Containers	91	97
Beer	90	93
Breakfast Foods	83	94
Motor Vehicles	80	96
Tires	68	86
Book Stores	65	71
Snack Foods	57	64
Motion Pictures	51	67
Fast Food	44	57
Lawn Equipment	40	57
Air Flights	34	51

Figure: Concentration ratios for selected goods

More: www.census.gov/epcd/www/concentration.html

Other concentration indices

The Herfindahl-Hirshman Index (HHI):

$$HHI = \sum_{i=1:n} S_i^2 \tag{27}$$

where n is the number of companies in the industry and S_i is the ith company's market share.
The Entropy Concentration Index:

$$E = -\sum_{i=1:n} S_i \ln S_i \tag{28}$$

Quantity competition: A dominant firm

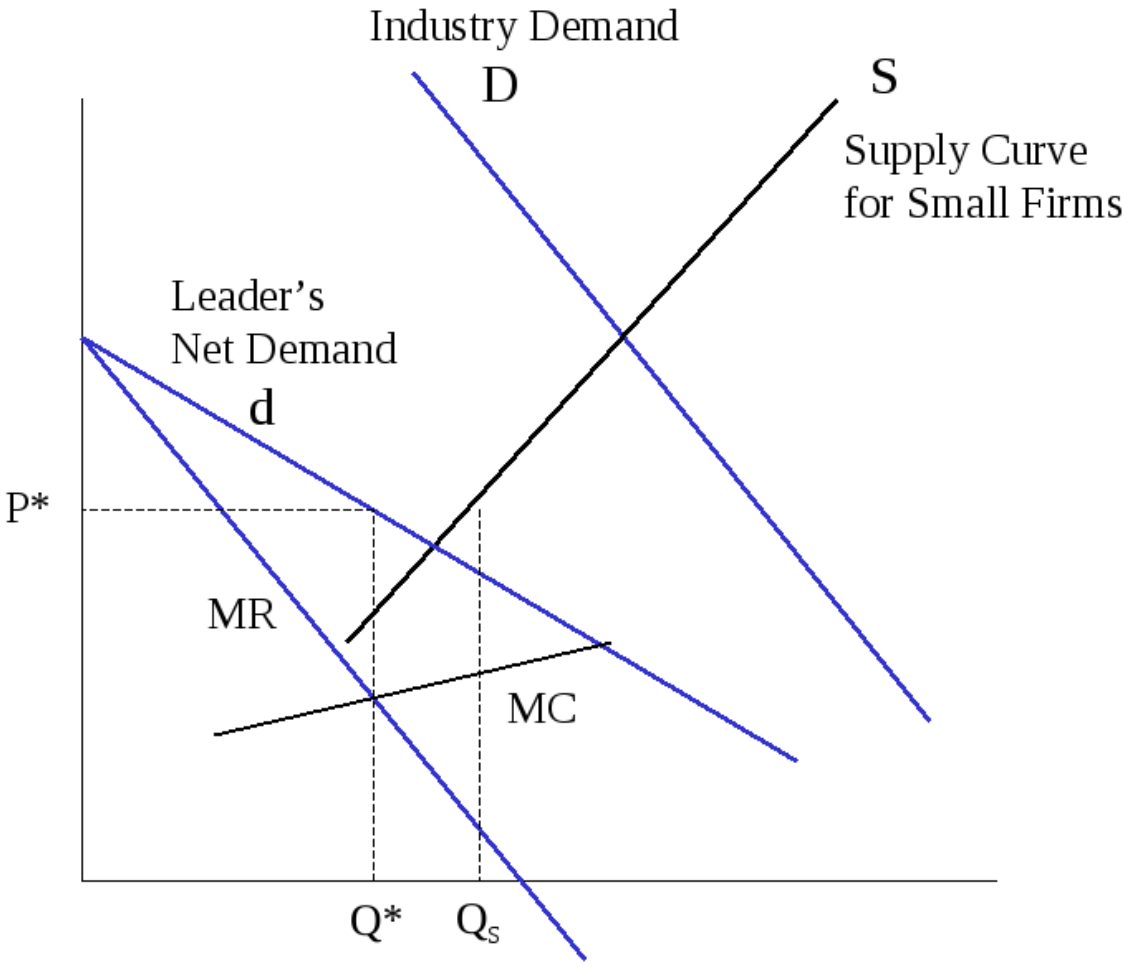


Figure: Optimal output for a dominant firm

Cournot Competition (1)

- A classic treatment of duopolies (and oligopolies) was first formulated by the French economist Augustin Cournot (1897).
- Cournot assumes that duopolies a produce homogeneous product.
- Each firm decide how much to produce and total output equals the sum of the production of the two firms.

Cournot Competition (2)

- Two firms compete by selling quantities of identical goods in a market
- Each firm's average cost is constant at \$6 per unit.
- Market demand is given by: $P = 30 - (Q_1 + Q_2)$ where Q_1 and Q_2 denote the firms' respective outputs
- Each firm's profit depends on both quantities
- The firm's revenue is $R_1 = (30 - Q_2 - Q_1)Q_1 = (30 - Q_2)Q_1 - Q_1^2$.
- Marginal revenue in turn is: $MR = (30 - Q_2) - 2Q_1$.

Cournot Competition (3)

- Setting marginal revenue equal to the \$6 marginal cost, we find: $Q_1 = 12 - .5Q_2$.
- this is the firm 1 optimal reaction function
- In equilibrium (Nash equilibrium) each firm makes a profit-maximizing decision, anticipating profit maximizing decisions by all competitors
- By solving the system made by the firms' optimal reaction function we find that the equilibrium is $Q_1 = Q_2 = \$8$.

Cournot Competition (4)

- The duopoly equilibrium lies between the pure monopoly and the purely competitive outcomes
- As the number of firms increases the quantity equilibrium played by identical oligopolists approaches the purely competitive (zero-profit) outcome

Stable Prices with Kinked Demand

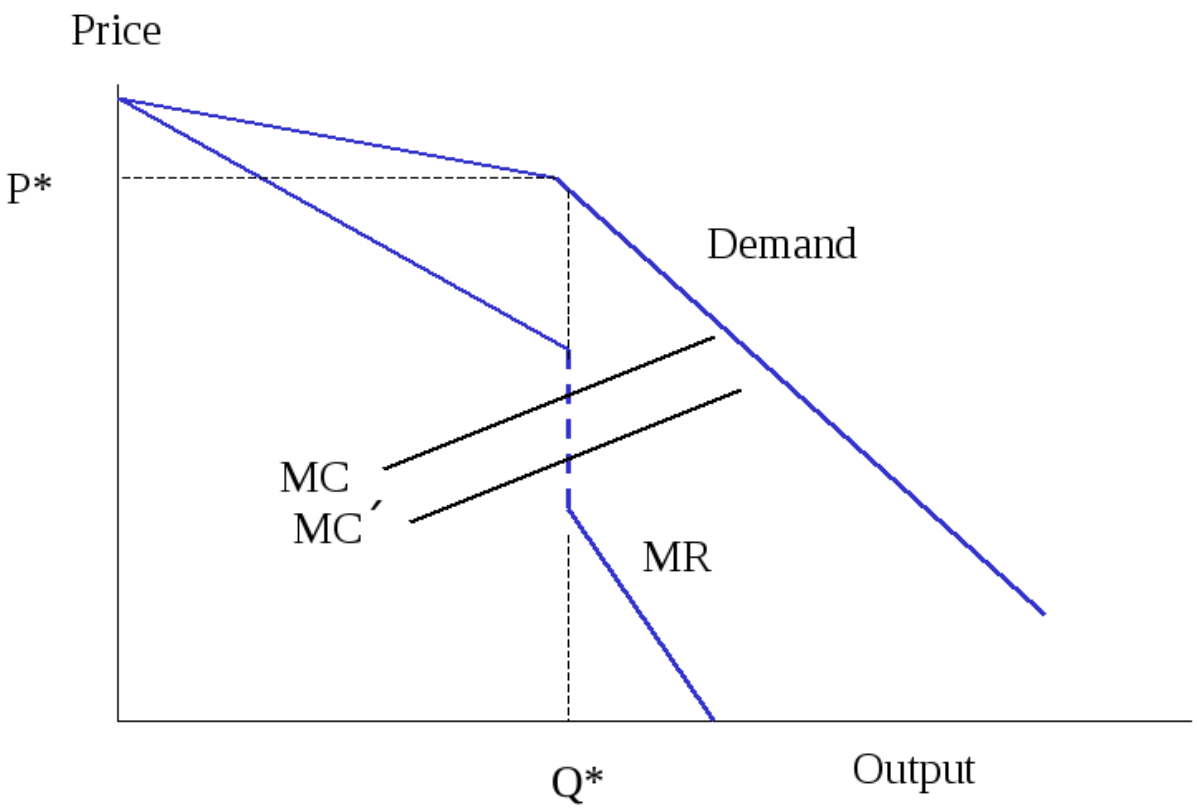


Figure: Optimal output with kinked demand

Price and Nonprice Competition

- Firms can use may instruments to compete in a market
- We can classify these instruments according to the speed at which they can be altered
- In the short run, price is often the main instrument that a firm can change easily (other instruments include advertising and sales-force effort).
- In the long run, cost structures and product characteristics (quality, design, delivery delay, location of outlets...) can be altered.
- Ultimately, there is the decision of weather or not to enter or stay in the market
- Research and development allows firms to expand their choice sets: process innovation alters the technological production possibilities and product innovation affords the creation of new products.

Bertrand Paradox

Bertrand paradox: two or more identical firms producing a homogeneous good with a constant-return-to-scale technology in equilibrium sell at marginal cost and make no profit.
Assume that two firms produce identical goods which are perfect substitutes: consumers buy from the producer who charges the lowest price
The market demand function is $p = f(Q)$ and each firm incurs a cost c per unit of production therefore the profit is

$$\pi^i(p_i, p_j) = (p_i - c)D_i(p_i, p_j) \tag{29}$$

Bertand Competition (1)

The demand for the output of firm i is given by

$$D_i(p_i, p_j) = \begin{cases} D(p_i), & \text{if } p_i < p_j \\ \frac{1}{2}D(p_i), & \text{if } p_i = p_j \\ 0 & \text{if } p_i > p_j \end{cases} \tag{30}$$

Bertand Competition (2)

The firms choose their prices both simultaneously and noncooperatively.
Simultaneously means that each firm has not yet observed the other firm's price when choosing its own.
A Nash equilibrium in prices is a pair of prices (p_1^*, p_2^*) such that each firm's price maximizes that firm's profit given the other firm's price. Formally

$$\pi^i(p_i^*, p_j^*) \geq \pi^i(p_i, p_j^*) \tag{31}$$

Bertand Competition (3)

The Bertrand paradox states that the unique equilibrium has the two firms charge the competitive price $p_1^* = p_2^* = c$.
Consider for example: $p_1^* > p_2^* > c$.
The firm 1 has no demand (zero profit). If firm 1 charges
$p_1 = p_2^* - \epsilon$
where ϵ is positive and "small" it obtains the entire demand with positive profit margin.

Bertand Competition (4)

Now suppose that $p_1^* = p_2^* > c$ the profit of firm 1 is $D(p_1^*)(p_1^* - c)/2$. If firm 1 reduces its price slightly to $p_1^* - \epsilon$ its profit becomes:
$D(p_1^* - \epsilon)(p_1^* - \epsilon - c)$ which is greater for small ϵ

Bertand Competition (5)

The conclusion is that firms price at marginal cost and do not make profits. Even a duopoly would suffice to restore competition. In the asymmetric case (say $c_1 < c_2$) both firms charge price $p = c_2$ and firm 1 makes profit of $(c_2 - c_1)D(c_2)$ and firm 2 makes no profit.

Prisoner's Dilemma

The Bertrand paradox exemplifies the outcome of Prisoner's Dilemma games.

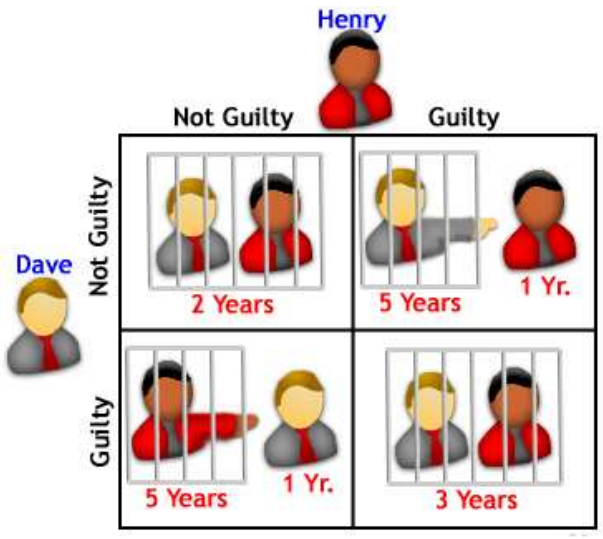


Figure: The Prisoner's Dilemma

Strategic substitutes and complements

- We say that the firm actions are strategic substitutes when increasing one firm's action causes the other firm's optimal reaction to decrease (Cournot case: competition involving quantities).
- we say that the actions are strategic complements when a change in one firm's action causes the other firm's optimal response to move in the same direction (Bertand case: competition involving prices).

Commitments (1)

- When the subsequent competition involves strategic substitutes, a tough commitment by one of the firms will advantageously affect the ensuing equilibrium.
- Here, tough denotes any move that induces an increase in the firm's own output: making product improvements, increasing advertising spending, lowering unit costs ("Top-Dog "strategy).
- The extreme case of this strategy occurs if the firm's first move pushes its rivals out from the market.

Commitments (2)

- The logic of strategic commitment is reversed when the subsequent competition involves strategic complements
- The firm in question should adopt a "Fat-Cat "strategy making a soft first move such as engaging in product differentiation, real (via product innovation) or perceived (via increased advertising spending).
- The effect of any soft move is to induce higher prices for competitors.

Advertising (1)

- Consider a firm that must determine not only the price but also the associated advertising level. At any price an increase in advertising will raise sales to a greater or lesser extent.
- Thus the demand function depends on price and advertising $Q(p, A)$ and the profit is $\pi = pQ(p, A) - C[Q(p, A)] - A$. Taking the derivative and setting equal to zero we find

$$p(dQ/dA) - (dC/dQ)(dQ/dA) - 1 = 0 \tag{32}$$

or

$$(p - MC)(dQ/dA) = 1 \tag{33}$$

Advertising (2)

- Product differentiation. One role of adverting is to underscore real or perceived differences between competing products, that is, to promote product differentiation and brand-name allegiance. Increased product differentiation lessens the substitutability of other goods while reducing the cross-price elasticity of demand.
- Informational advertising. A second major role of advertising is to provide consumers better information about competing goods. When imperfect information is the norm, advertising increase consumers information and lower prices (and profits).
- Thus advertising can increase or reduce prices. Empirical evidence is mixed.

Summary (1)

1. The key to making optimal decisions in an oligopoly is anticipating the actions of one's rivals.
2. In the dominant-firm model, smaller firms behave competitively, that is, take price as given when making their quantity decisions. Anticipating this behavior, the dominant firm maximizes its profit by setting quantity and price (and applying $MR = MC$) along its *net* demand curve.
3. When competition is between symmetrically positioned oligopolists (the Cournot case), each firm maximizes its profit by anticipating the (profit-maximizing) quantities set by its rivals.

Summary (2)

4. Intense price competition (Bertand competition) has the features of the prisoner's dilemma: optimal behavior implies mutual price cuts and reduced profits
5. Advertising should be undertaken up to the point where increased profit from greater sales just covers the last advertising dollar spent
6. An industry's concentration ratio measures the percentage of total sales accounted for by the top n firms in the market. The greater is the index, the more significant the market dominance of a small number of firms.
7. Ceteris paribus, increases in concentration can be expected to be associated with increases in prices and profits.

Summary (3)

8. There are two main models of quantity rivalry: competition with a dominant firm or competition among equals. In each model, equilibrium quantities are determined such that no firm can profit by altering its planned output.
9. In the quantity-setting model, the equilibrium approaches the perfectly competitive outcome as the number of (identical) firms increases without bound

Summary (3)

10 If a firm expects price cuts (but not price increases) to be matched by its rivals, the result is a kink in the firm's demand curve. The price will be relatively stable (because price changes will tend to be unprofitable).

11 The prisoner's dilemma embraces such diverse cases as price wars, cartel cheating, arms races, and resource depletion. In each instance, self-interest behavior by interacting parties leads to an inferior outcome for the group as a whole.

Pricing Models in Synthetic Worlds

- The common pricing model in synthetic wolds is two-part pricing: users buy the client software and then pay a subscription fee on a monthly basis
- Periodically new content modules are released.
- Over time, revenues tend to fluctuate with user numbers and then spike when new content is released
- Nothing advertises the existence of a world better than its presence on store shelves.
- Another possibility is charging fees for in-world goods and services (real cash for virtual items).

- Owners could also cast themselves as landholders and earn revenue form renting or selling land to users (i.e. Second Life).
- Advertising represents another revenue stream
- Revenue enhancement strategies also involve decisions about how much to charge to whom: switchers from world to world must pay less than stayers
- This takes advantage of the lower demand elasticity of those who are not likely to move (people who take the time to cut out coupons are sensitive to price)
- Dilemma: charge high to make my product look trendy or charge low to get the trend going in the first place?

The Firm is to Exercise Monopoly Power (1)

- Various trade practices are banned by antitrust regulations as manifestations of monopoly power: by internalizing these practices, firms can circumvent the legal framework.
- A firm might want to sell a given product in different markets at different prices. This raises the possibility of arbitrage among retailers. To avoid arbitrage the manufacturer may integrate into distribution and serve the low price market himself.

The Firm is to Exercise Monopoly Power (2)

- Suppose the price of an intermediate good is set by regulatory agencies below the market equilibrium price. Vertical integration allows suppliers to circumvent the law by generating internal (unobservable) transactions. The same applies in case of sales tax, but not for value added taxation.
- Horizontal mergers are often meant to eliminate the dissipation of monopoly profit through product competition.

The Firm as a Static Synergy (1)

- The size and the number of firms in an industry are related to the degree of returns to scale or scope.
- Investment in cost-reducing technologies, which allow workers to be more specialized, reduce unit costs (product-specific economies).
- Reduction of risk of random breakdowns (production) and demand shocks (market).
- Demand complementarity and synergies in general services (auditing, marketing, research and development).
- However returns to scale hate their limits (e.g. managerial talent and strategic resources cannot be duplicated as the firm expands).

The Firm as a Static Synergy (2)

- Let $C(q)$ denote a firm's total cost of producing output q: $C(q)$ is the minimum cost of the bundle of inputs that allows the production of q units of output

The cost function is

$$C(q) = \begin{cases} F + \int_0^q C'(x)dx & \text{for } q > 0 \\ 0 & \text{otherwise} \end{cases} \tag{34}$$

where $F \geq 0$ denotes a fixed production cost.

The Firm as a Static Synergy (3)

- Marginal costs are strictly decreasing if $C''(q) < 0$ for all possible q.
- Average costs are strictly decreasing if for all q_1 and q_2 such that $0 < q_1 < q_2$,

$$\frac{C(q_2)}{q_2} < \frac{C(q_1)}{q_1} \tag{35}$$

The cost function is strictly subadditive if, for any n-tuple of outputs $q_1, \cdots, q_n$,

$$\sum_{i=1}^{n} C(q_i) > C(\sum_{i=1}^{n} q_i) \tag{36}$$

For multiproduct firms, subadditivity generalizes naturally (Economies of scope).

The Firm as a Static Synergy (4)

- Declining marginal costs imply decreasing average costs and deceasing average costs imply subadditivity.
- An industry is a natural monopoly if, over the relevant range of outputs, the cost function is subadditive (Baumol, 1982)
- An alternative definition implies that an industry is viable for one firm but not for two or more: $\pi(1) > 0 > \pi(2)$.

The Firm as a Long-Run Relationship (1)

- Long-run relationships are often associated with either switching costs or specific investments. Switching costs are a case of idiosyncratic investment: once two parties have traded, staying together can yield a surplus relative to trading with other parties.
- Asset specificity includes also site specificity and specific investment in human capital
- It is important that there is an efficient amount of trade ex post and that benefits are divided properly in order to induce the efficient amount of specific investment ex ante.

The Firm as a Long-Run Relationship (2)

- Even if the supplier and the buyer may select each other ex ante in a pool of competitive suppliers and buyers, they end up forming an ex post bilateral monopoly
- Let us assume that there are two periods: $t = 1$ (ex-ante) and $t = 2$ (ex-post). In period 2, the volume of trade is either 0 or 1.
- The value of the good to the buyer is v and its production cost to the supplier is c. So the gains from trade to be split (if any) is $v - c$.
- If p is the price the buyer surplus is $v - p$ and the seller's surplus is $p - c$. In the absence of trade surplus is nil.

Asymmetric information

- In situations characterized by asymmetric information one party knows more than another about key economic facts.
- The presence of asymmetric information can lead to adverse selection and moral hazard.
- Many contractual relationships involve an agent in possession of superior information taking actions for another party. The principal must provide incentives or controls to induce the agent to act in the principal's behalf.

Bargaining (1)

- Assume no contract is signed in period 1.
- Then some bargaining occurs in period 2 to determine whether to trade and at what price
- Bargaining under symmetric information is efficient. However often the buyer's value v and the supplier's cost c are private information. In this case the efficient volume of trade could not be reached because of the bilateral monopoly pricing problem.
- Suppose c is known to both parties but v is known to the buyer only and the supplier's beliefs about v are represented by a cumulative distribution $F(v)$ with density $f(v) > 0$ on an interval $[\underline{v}, \overline{v}]$ (with $F(\underline{v}) = 0$ and $F(\overline{v}) = 1$).
- Assume that gains from trade exist with positive probability ($\overline{v} > c$) and that this probability is less than 1 ($\underline{v} < c$)

Bargaining (2)

Suppose the supplier has the bargaining power in period 2: she can make a take or leave it price offer p.
The buyer accepts only if $v \geq p$. Thus the probability of trading is $1 - F(p)$ and the supplier's expected profit is

$$(p - c)[1 - F(p)] \tag{37}$$

Maximizing with respect to p yields the first order condition

$$[1 - F(p)] - (p - c)f(p) = 0 \tag{38}$$

This is the familiar monopoly pricing formula for demand curve $q = D(p) = 1 - F(p)$.

Bargaining (3)

- The increase of price from p to $p + dp$ yields extra profits dp with probability $1 - F(p)$ and leads to a loss of trade and hence to a loss of net profit $p - c$ with probability $f(p)dp$. At the optimum, these two effects cancel.
- The volume of trade is suboptimal. Charging a price equal to cost yields no profit to the supplier; raising the price above cost yields a profit with some probability; the forgone volume of trade associated with this increase is costless because the initial price-cost margin is zero.
- The monopoly-pricing inefficiency is bound to arise if bargainers have incomplete information.

Contracting

- Ex post trade inefficiency gives the parties incentives to contract ex ante to avoid or limit this inefficiency.
- In the previous case it suffices to give the informed party the right to choose the price (to reverse the bargaining power).
- The buyer fixes $p = c$ and ex post appropriates the gains from trade. An unconditional ex ante payment from the buyer to the supplier can be negotiated to create any division of this optimal joint surplus.

Specific Investment and the Hold-up Problem (1)

- Suppose that at date 1 a supplier invests in cost reduction (to decrease c) and a buyer invests in value enhancement (to increase v).
- These investments are specific: they would not reduce cost or increase value if the parties were to trade with other parties.
- If there is too little trade, the parties have an incentive to invest less than under efficient trade, because the probability that their investment are used is smaller than the optimal one.
- To separate the problems, we will assume that ex post v and c are common knowledge.
- We focus on the dependence of ex ante specific investments on the ex post split of gains from trade.

Specific Investment and the Hold-up Problem (2)

- Suppose the buyer's value is known at the contract date to be $v = 3$ and the supplier can invest ($I = 2$) or not invest ($I = 0$).
- If he does invest is marginal cost is $c = 0$ otherwise $c > 3$.
- Suppose that ex post the parties reach a Nash solution: they split evenly any gain from trade.
- The supplier makes profit $-2 + 1.5 < 0$ if he invests. So no investment takes place.
- Investment, however, would be socially desirable: it would yield net gains $3 - 2 > 0$.

Specific Investment and the Hold-up Problem (3)

- The problem is that the party investing does not capture all the cost savings (increments in value) generated by his investment.
- The other party can use the threat of not trading to appropriate some of these savings (opportunism).
- Ex post bilateral monopoly plus bargaining yields underinvestment in specific assets.
- This simple model also allows to see the effect of the degree of asset specificity and the existence of outside opportunities.

Long-Run Relationships (1)

- Let us now assume that the two parties can write ex ante contracts specifying the process through which the amount of trade and the transfer are determined ex post.
- The rough rule is that the party investing should have the authority over the price or over the trading decision if the other party's information is known in advance.
- The most obvious and important limitation of a long-run relationship is the presence of outside opportunities.

Long-Run Relationships (1)

- The contract must find the optimal trade-off between flexibility and the prevention of opportunism.
- Long-run relationships tend to promote collusion between the units' personnel. A long time horizon gives them time to reciprocate favors and to become confident that collusion is sustainable.
- The possibility of collusion calls for the rotation of personnel within each unit.

The Firm as an Incomplete Contract

In practice, contracts are incomplete owing to transaction costs

1. First, some contingencies which the parties will face may not be foreseeable at the contracting date.
2. Second, even if they could be foreseen, there may be too many contingencies to write the contract.
3. Third, monitoring the contract may be costly.
4. Fourth, enforcing contracts may involve considerable legal costs.

The Firm as an Incomplete Contract

- Most existing contracts do not specify many relevant contingencies. When these unspecified contingencies occur, the actions of the concerned parties are likely to lead to conflicts.
- We can distinguish two decision processes that, ex post, handle the unforeseen contingencies.
- The simplest decision process, bargaining, has been already considered.
- Intermediate forms of contracting which exist between no contract (and unconstrained ex post bargaining) and a complete contract are also available.
- We distinguish two possibilities: arbitration and authority.

Arbitration

- The two concerned parties resort to a third party. This third party is supposed to make the efficient decisions that most closely resemble those that a complete contract would have specified.
- External arbitration is likely to be costly since outsiders may not possess the relevant information with which to formulate an efficient decision.
- An arbitrator must be able to learn about and understand the situation at relatively low cost and must be independent.
- The arbitrator must be trusted, or else must develop a reputation for settling disputes fairly.

Authority (1)

- The power to fill unspecified contingencies (authority) may be given to one of the concerned parties.
- Authority changes the status-quo point in the bargaining process
- Ex post division of the gains from trade will affect ex ante investments.
- Supplier (buyer) control is the situation in which the supplier (the buyer) has the authority over the decision.
- Integration is defined as the allocation of residual rights of control to one of the parties
- Nonintegration refers to the case in which the decision space has at least two dimensions and each party has authority on at least one of its dimensions.

Authority (2)

- The optimal agreement is the one that best protects the specific investments.
- In the absence of complete contracts, ownership is the second-best solution to protect one's investment.
- In professions such as hairdressing and law the customers belong to the firm rather than to the employees (the distribution of ownership is enforced by a noncompetition clause).
- An engineer cannot easily quit his firm and patent an invention made possible by his firm's research effort.

Authority (3)

- Reputation allow a firm to save on the cost of writing complete contracts or even on the costs of distributing authority.
- Informality exposes the firms to the threat of opportunism.
- Thus, one would expect informality to be most prevalent when specific investments are limited and when trade is sufficiently frequent that the incentive to cheat is low.
- An alternative way of avoiding the ex post hold-up problem is to introduce ex post competition whenever that is feasible.
- This can explain why Intel licenses its microprocessor technologies and why IBM adopts an "open architecture" policy in regard to its personal computers.

Ownership

- Ownership is the right to exercise residual control where the contract is silent about decision rights, or the right to receive any residual returns that remain after contractual obligations are fulfilled.
- For simple assets, it can be advantageous to have as many decision rights as possible vested with the person who receives the residual returns for in the process of maximizing his own personal returns, that person will also generally be led to maximize total value.
- When ownership rights are tradable the initial allocation of property rights does not affect efficiency of arrangements because the rights will be traded as necessary to restore efficiency.

The tragedy of the commons

- The limitations on the trading of water rights provides an example. Water is frequently directed to certain low-value uses when farmers who are entitled to cheap water cannot trade their rights to cities who value the rights more highly.
- Similarly, when rights to an asset are insecure, the owner may not find it worthwhile to preserve and enhance the value of the asset because he or she may not be permitted to enjoy the benefits of those efforts.
- Some assets are commonly shared within a community. The result is often what is widely known as the tragedy of the commons in which the shared resource is abused by members of the community because the costs of the abuse are widely shared (i.e. fishing rights).

Property rights allocation (1)

- In socialist countries even farms and factories are often treated as shared resources and accordingly are not properly maintained.
- The Chinese experience during the 1980s demonstrates how ownership incentives can powerfully improve individual performance.
- Property rights in the modern world continue to change with rights to clean air, intellectual property, sea-bed minerals, beach access, fishing rights, broadcast bands and synthetic worlds land rights being examples.
- The rights to use new drugs serve to remind us that the assignment of ownership rights has ethical and distributive aspects in addition to its efficiency ones.

Property rights allocation (2)

- When bargaining costs are low, the theory predicts that actual ownership rights will come to be assigned efficiently.
- When an asset is highly specific to a particular use, meaning that it is much less valuable in its next-best use, then there are gains to assigning ownership to the final user in order to avoid the hold-up problem.
- Simple transactions may be managed by nearly complete contracts, in which case the hold-up problem is of only minor importance (a lease of the asset, for example, may be a good substitute for ownership).
- Long duration of the asset and complexity of the transaction make these alternatives less effective and favor the ownership solution.

Human Capital

Human capital poses a special problem because

- it represents a large fraction of the capital of any advanced industrial country
- it is generally not tradable
- it is quite commonly cospecialized with the human capital of other people

Complex organizational arrangements are often devised to protect investments in human capital

Asymmetric Information

- In conditions characterized by asymmetric information, one party knows more than another about key economic facts.
- In principle, a perfectly fashioned complete contract could solve the motivation problem.
- It would specify precisely what each party is to do in every possible circumstance and arrange the distribution of realized costs and benefits in each contingency.
- In practice, the presence of asymmetric information can lead to adverse selection and moral hazard.

Adverse Selection (1)

- The incentive problem arising from precontractual asymmetries is know as adverse selection.
- The term was coined in the insurance industry: people who purchase insurance is not a random sample of the population but a group of people with private information about their personal situations that makes it likely they will receive a higher-than-average level of benefit under the insurance policy.
- For example: if a company were to issue an individual health insurance policy that covers the medical costs associated with pregnancy and delivery, the policy would be purchased disproportionately by women planning to bear children (private unobserved characteristic).
- In many countries, the inadequacy of private health insurance has led governments to nationalize the provision of health care, although with mixed results.

Adverse Selection (2)

- Adverse selection is a problem of precontractual opportunism.
- Adverse selection is incompatible with the the accounts of impersonal markets.
- When the problem of adverse selection is especially severe there may be no price at all at which the quantity of a good supplied to the market by sellers is equal to the quantity demanded by buyers.
- The problem is that the price must be the same to all buyers, but the only buyers who will pay any given price are those whose private information leads them to believe that the price is advantageous for them.
- These will tend to be those who are most expensive to serve.

Adverse Selection (3)

Let x be the expected benefit or claim payment of buyers. If x were observed, then the insurance company would charge a higher price to customers with higher values of x to offset its higher expected costs.

We assume that x cannot be observed so that the same price P must be offered to all potential buyers.

Suppose that in addition to the expected receipts x a buyer gains some value v form the pure risk reduction that the insurance policy provides.

A buyer will purchase the policy if $P \leq v + x$.

Adverse Selection (4)

Let us suppose that the distribution of claim amounts x in the population uniform between zero and $\overline{x}$.
The average insurance expense is equal to the average of the amounts paid to the customer with the lowest value of x who buys insurance ($x = P - v$) and the customer with the highest value of x who buys the insurance ($x = \overline{x}$): $(P - v + \overline{x})/2$.
The average amount of the insurance expense for those customers who do buy is an increasing function of the price P.
Customers who expect losses greater than x buy insurance, while those who expect lower losses do not.

Adverse Selection (5)

We suppose that the insurance company incurs a claims administration cost of c for each dollar of claims that it pays so that the average cost is $(x + \overline{x})(1 + c)/2$ where $(x + \overline{x})/2$ is the average level of claims in the market if only customers with expected losses greater than x buy the insurance.

Thus the company is willing to supply insurance to the group of buyers with losses of x or more if the price it receives is at least equal to $\frac{1}{2}(x + \overline{x})(1 + c)$.

The buyers will be just those whose expected claims are at least x if the price is $x + v$. If $c\overline{x} > v$ the market does not exist.

Adverse Selection (6)

- For a market to exist it must be economical to provide insurance to those with the highest expected claim payments.
- If an employer or government could provide mandatory coverage to the whole population, its average cost would be $(1+c)\overline{x}/2$ and the average benefit received by the insured people would be $v+\overline{x}/2$ so the average benefit exceed the average cost whenever $v > c\overline{x}/2$
- Whenever $c\overline{x} > v > c\overline{x}/2$ insurance is desirable but private individual insurance markets cannot survive.

Adverse Selection and Rationing

- Standard market theory is based partly on the premise that prices adjust until supply is equal to demand.
- When there is adverse selection, however, changing the price affects not only the revenues of the selling firm but also its cost of supplying the product (i.e. the interest rates that a bank charges can affect the selection of customers who apply for loans).
- When money is scarce, the bank may often find it more profitable to use the opportunity to improve the quality of its loan portfolio rather than to charge a higher rate of interest.
- When there is an excess demand for loans, the bank may prefer rationing credit rather than raising the interest rate it charges to borrowers.

Signaling, Screening and Self-selection (1)

- There is no simple direct way to reveal the private information. In particular, self-serving claims are not likely to be credible.
- In signaling the privately informed parties take the lead in adopting behavior that, properly interpreted, reveals their information.
- Employers can infer individuals' productivity from their educational achievements, and education would be a signal for productivity.

Signaling, Screening and Self-selection (2)

- First condition: the level of education that is taken as signaling high productivity must be such that the low-productivity workers are unwilling or unable to attain it. If this self-selection constraint is not met, then the low-productivity workers would attain as much education as high-ability workers.
- Second condition: failure to obtain the particular level of education should accurately signal that the person in not highly productive

Signaling, Screening and Self-selection (3)

- It is clearly necessary that achieving a given level of education be cheaper for the high-productivity workers that for the low.
- The self-selection constraints ensure that the signals are credible.
- A negative relationship between a person's cost of acquiring education and his or her productivity is required.
- Although the signaling leads to the effective revelation of the private information, this does not come for free
- Thus the expenditure on education is in this example is a pure social waste!

Screening

- Signaling examples: setting low limit prices as a signal of low costs; use seemingly uninformative advertising with newly introduced experience goods to signal their quality; the offering of product warranties and money-back guarantees; to pay high dividends by corporations to signal financial strength..
- Screening refers to activities undertaken by the party without private information in order to separate different types of the informed party along some dimension.
- This is often done by offering a variety of alternatives, each intended for one of the various types of informed parties, whose choices then effectively reveal their private information.

Moral Hazard (1)

- The term moral hazard originated in the insurance industry, where it referred to the tendency of people who purchase insurance to alter their behavior in ways that are costly to the insurance company, such as taking less care to prevent a loss from occurring.
- Within economics, the term has come to refer to any behavior under a contract that is inefficient, arises from the differing interests of the contracting parties, and persists only because one party to the contract has private information.
- Moral hazard problems arise frequently in principal-agent relationships, where one party (the agent) is called upon to act on behalf of another (the principal), because the agent's interest commonly differ from the principal's and the principal cannot tell how well the agent has worked or whether the agent has been honest.

Moral Hazard (2)

- Normally, lenders protect their money by imposing controls and requiring reporting by and audits of the borrower. Problems of fraud and excessive risk taking arise.
- Moral hazard is not only a problem of markets, but exists in other kinds of organizations as well.
- Various means are available to control the moral hazard problem. One is explicit monitoring, which can reduce the information problem that is a fundamental component of moral hazard.
- A second is the use of incentive contracts that pay for output performance when inputs cannot be measured.
- An especially important category of moral hazard is the category of influence activities.

Principal-Agent (1)

Suppose the agent evaluates wage income and effort according to a utility function of the form

$$U(w, e) = \sqrt{w} - (e - 1) \tag{39}$$

where w is wage and e is the effort level.
Suppose that two effort levels are possible: $e = 1$ and $e = 2$.
The agent has outside options: suppose the minimum acceptable utility level is 1.

Principal-Agent (2)

The revenues of the firm depends on the agent's effort and some random effect.
When $e = 1$, revenue is 10 with probability $2/3$ and 30 with probability $1/3$.
When $e = 2$, revenue is 20 with probability $1/3$ and 30 with probability $2/3$.

Principal-Agent (3)

With $e = 1$ the expected revenues are $(2/3) \times 10 + (1/3) \times 30 = 50/3$, whereas lifting the effort to $e = 2$ raises the expected receipts to $70/3$.
If e were observable and the parties wanted it set at 2, the solution would be for the contract to specify that $e = 2$ and that the agent be paid enough to get him or her agree to take the job when she provides $e = 2$ and to be paid nothing if the agent picks $e = 1$.
The pay needed to get the agent to agree to the contract is determined by the utility function and the minimum available elsewhere:

$$\sqrt{w} - (e - 1) = \sqrt{w} - (2 - 1) \geq 1 \tag{40}$$

or $w \geq 4$. The net return of the principal is $(70/3) - 4 = 58/3$

Principal-Agent (4)

Things are different when only the level of revenues, but not the level of effort e is observable.
If the principal wants $e = 2$ then the agent's expected utility when she picks $e = 2$ must exceed that when she picks $e = 1$.
Let y be the amount received by the agent when the outcome is 10 and z the pay when the receipts are 30.
thus the incentive compatibility constraint is

$$(1/3)(\sqrt{y} - 1) + (2/3)(\sqrt{z} - 1) \geq (2/3)(\sqrt{y} - 0) + (1/3)(\sqrt{z} - 0) \tag{41}$$

or $(1/3)\sqrt{z} - 1 \geq (1/3)\sqrt{y}$

Principal-Agent (5)

Another constraint is the participation constraint:

$$(1/3)(\sqrt{y} - 1) + (2/3)(\sqrt{z} - 1) \geq 1 \tag{42}$$

The problem of the principal is to find the values of y and z that satisfy these constraints and give the maximum expected returns net of pay to the agent. Because the principal's net return is largest when the expected pay to the agent is smallest the best contract from the principal's point of view is $y = 0$ and $z = 9$ with expected return of $(1/3)(10 - 0) + (2/3)(30 - 9) = (52/3)$.

Principal-Agent (6)

The agent is no better off whereas the principal's payoff has fallen from (58/3) to (52/3) because the expected wage paid the agent has risen from 4 to 6.

Thus the unobservability of effort and the consequent moral hazard has an efficiency cost.

The cost arises from having to load too much risk on the agent.

Principal-Agent (7)

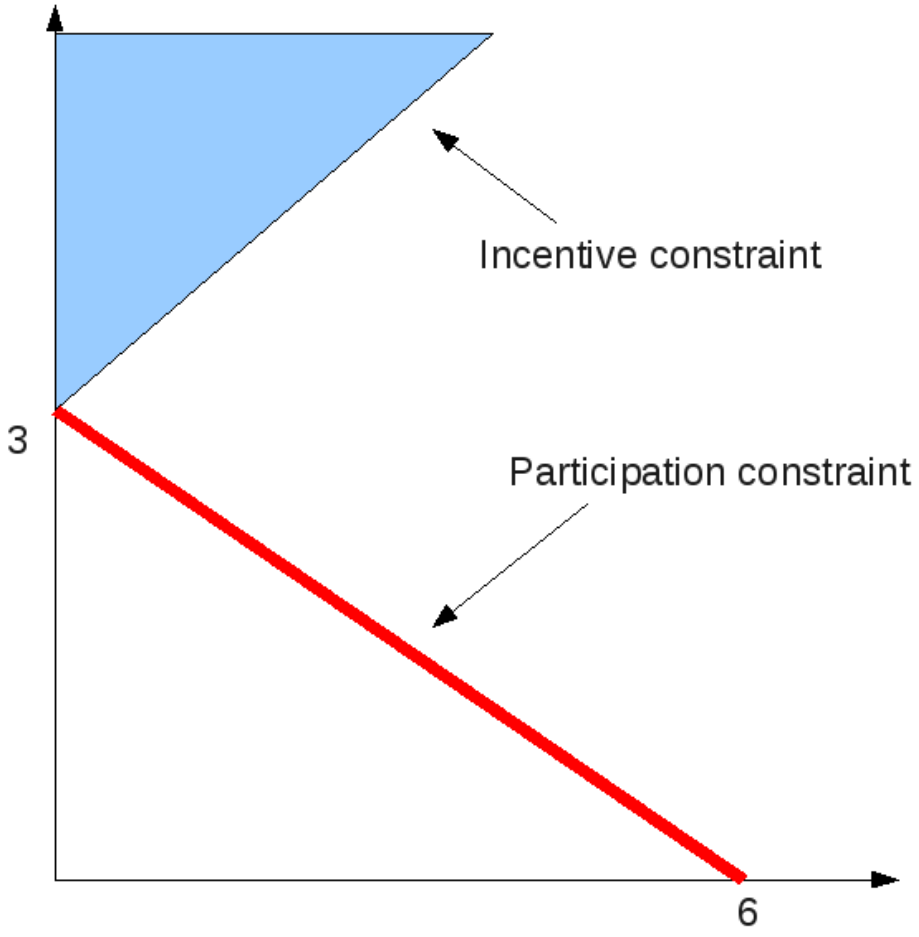


Figure: The Principal Agent solution. On the x-axis: $\sqrt{y}$, on the y-axis: $\sqrt{z}$.