15.010/15.011: ECONOMIC ANALYSIS FOR BUSINESS DECISIONS

MIDTERM EXAM REVIEW SESSION
OCTOBER 9, 2004

PAGE

Market Definition

A market is a collection of buyers and sellers, resulting in the possibility for exchange.

Market boundaries are defined in both geographic terms and in terms of a range of products.

- Demand Substitutability:
  - Would consumers adjust purchases of good A when the price of good B changes?

- Supply Substitutability:
  - Would producers modify production of good A as a result of a change in the price of good B?

Market Definition

Example:

True / False: Fast food chains like McDonald's, Burger King, and Wendy's operate all over the United States. Therefore, from the consumer's perspective, the market for fast food is a national market.

Answer:

False. San Francisco consumers won't travel to New York to buy a BigMac there even if the price is lower (or has decreased) in New York.

Supply and Demand

Where do the curves come from and what do they represent?

- Demand
    - Aggregate reservation prices of the market. What consumers are willing to pay.
    - How much consumers will buy at a particular price
    - Linear Demand: $Q_d = a - b\,P$
    - Isoelastic Demand: $\ln(Q_d) = a - b\,\ln(P)$

- Supply
    - Aggregate marginal cost curves of an industry
    - How much will producers provide at a particular price
    - Linear Supply: $Q_s = c + d\,P$
    - Isoelastic Supply: $\ln(Q_s) = c + d\,\ln(P)$

Elasticities

An elasticity is a measure of the sensitivity of one variable to another. For our purposes, it is the percentage change in quantity (demanded / supplied) in response to a 1 percent increase in price, income, etc.

- Price elasticity of demand

    – Linear Demand: $E_d = -b\dfrac{P}{Q}$

    – Isoelastic Demand: $E_d = -b$

- Price elasticity of supply

    – Linear Supply: $E_d = d\dfrac{P}{Q}$

    – Isoelastic Supply: $E_d = d$

- Cross-price elasticity of demand

    – Substitutes: positive cross price elasticity (butter and margarine)

    – Complements: negative cross price elasticity (cars and gasoline)

- Short run and long run elasticities may be different.
    - Consumable Goods: $E_{SR} < E_{LR}$ (example: orange juice)
    - Durable Goods: $E_{SR} > E_{LR}$ (example: cars)

Example:

True / False: The potential gain to the OPEC cartel from agreeing to production cutbacks and adhering to the agreement is greater if the elasticity of supply is low rather than if it is high.

Answer:

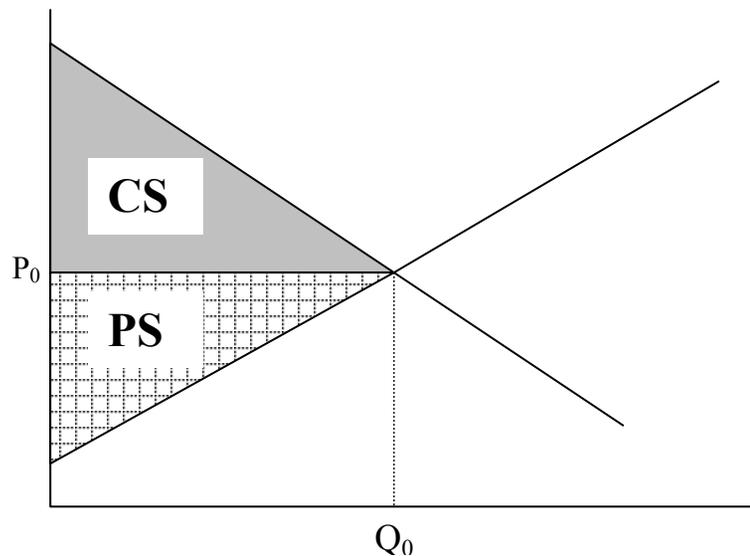**True.** If supply is inelastic (e.g., low), a small production cutback will result in a large price increase.

Example:

What happens to elasticity along a linear demand curve as Q increases?

$Ed = -b*P/Q$

Thus, as Q increases, demand becomes less elastic.

Government Policies:

Unregulated, Competitive Market

- Consumers and producers buy and sell at market clearing price

- Consumer surplus: for some consumers, the value of the good exceeds the market price

- Producer surplus: some producers produce units at a cost lower than the market price
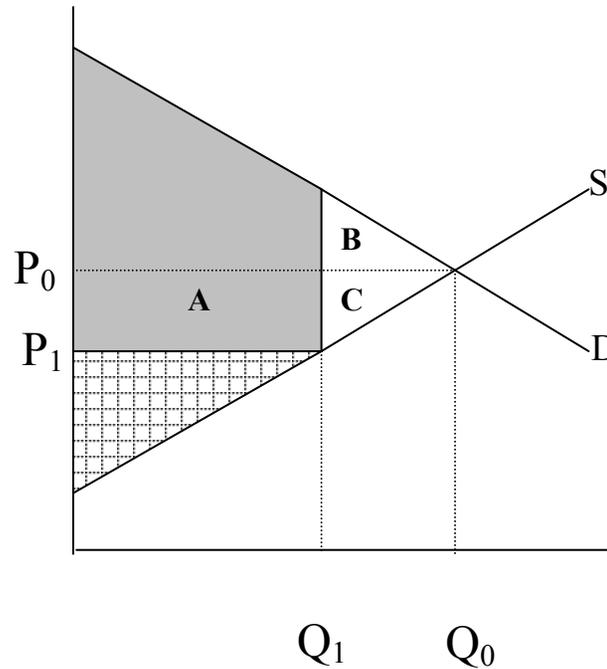
Measuring Impact of Government Policies:

- Start with unregulated competitive market
- Determine new price, quantity given government policy
- DWL is resultant loss of welfare after all transfer of surplus between producers, consumers, government and foreign entities.

Government Policies: Price Control

Unregulated Market:
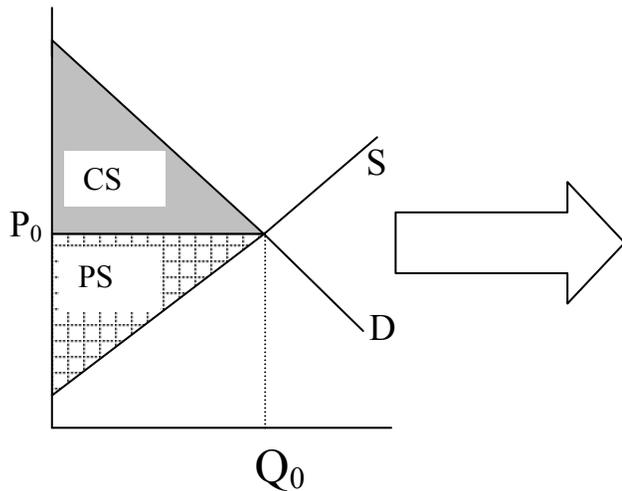
Price Control: Maximum Price P_1

A – Transfer from producers to consumers. Consumers who can purchase good do so at a lower P

B – some consumers can no longer buy the good.

C – some producers can no longer sell the good

$\Delta CS = A - B$
$\Delta PS = -(A + C)$
$DWL = -(B + C)$

Example: If supply is very inelastic, do consumers gain or lose on net from imposition of P_{max}? Why? – If $P_{max} > P_{Free}$, then the price ceiling is irrelevant. Consumers will gain when $P_{max} < P_{Free}$ when $\Delta \mathbf{CS}$ is positive. Obviously, $\Delta \mathbf{CS}$ will be positive when A > B as shown above. Given the demand curve depicted above, for very inelastic supply curves, A > B, therefore consumers will be better off.

Government Policies: Taxes

Unregulated Market:
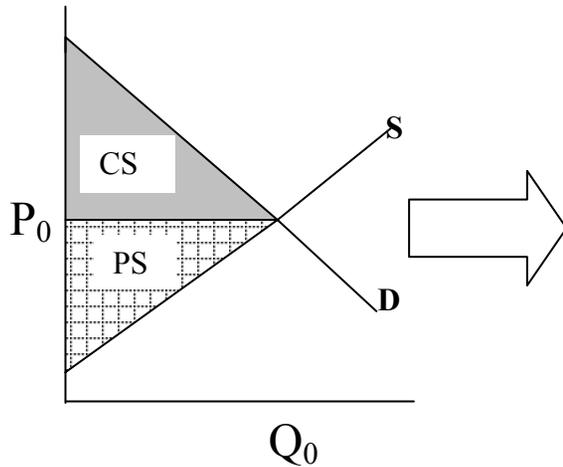
Taxes: t
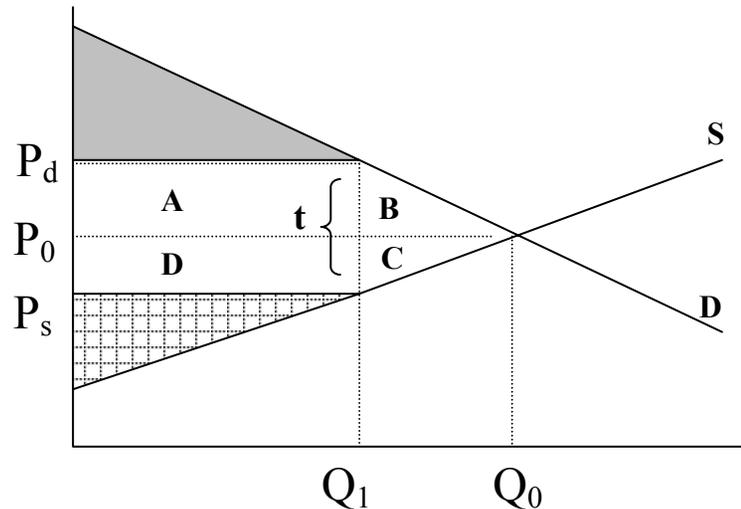
$P_d = P_s + t$
$Q_D = Q_D(P_d)$
$Q_S = Q_S(P_s)$
$Q_D = Q_S = Q_1$

$\Delta CS = -(A + B)$
$\Delta PS = -(C + D)$
$Govt = A + D$
$DWL = -(B + C)$

To solve taxes exercises, follow these steps:
1) **Express $Q_D = Q_D(P_d)$ and $Q_S = Q_S(P_s)$** [Demand and Supply in terms of P_d and P_d]
2) **Use [$P_d = P_s + t$]** to replace P_d in the demand curve (or alternatively replace P_s in supply curve)
3) **Equate $Q_D = Q_S$** and **solve for price** P_d (or alternative P_s). **Find Q_1** using one of the equations and the price.
4) If you are asked for CS, PS and DWL, use the **graph to calculate areas** (remember to find the intercepts of the curves on the y-axis by making Q=0 in each curve).

Impact of a tax depends on ε_s and ε_d.

Fraction of tax borne by consumers $= \dfrac{\varepsilon_s}{\varepsilon_s - \varepsilon_d} = $ PASS THROUGH FORMULA

Note: the higher the elasticity of demand (supply), the less the burden for consumers (producers)

Elastic Demand

Inelastic Demand

Elastic Supply

Inelastic Supply
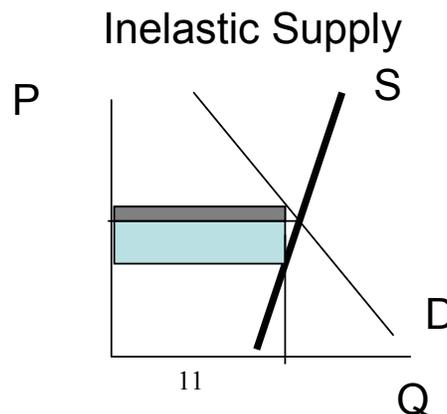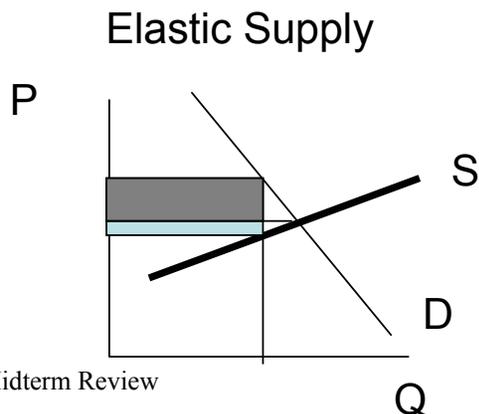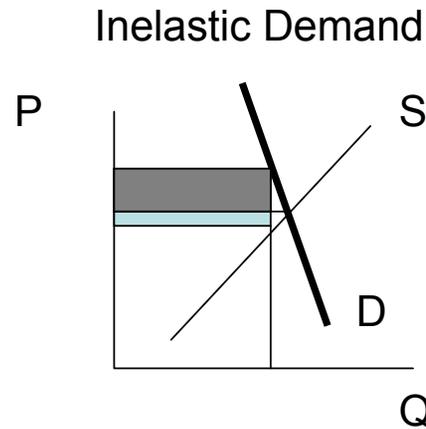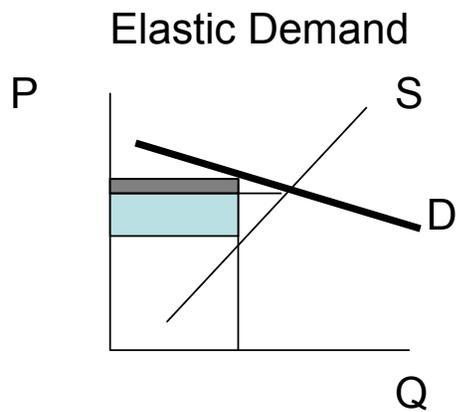
Government Policies: Tariffs/Quotas

Without a tariff or quota, a company will import a good when $P_{world} < P_{market}$ if there were no imports

Unregulated Market:

Tariff OR Quota
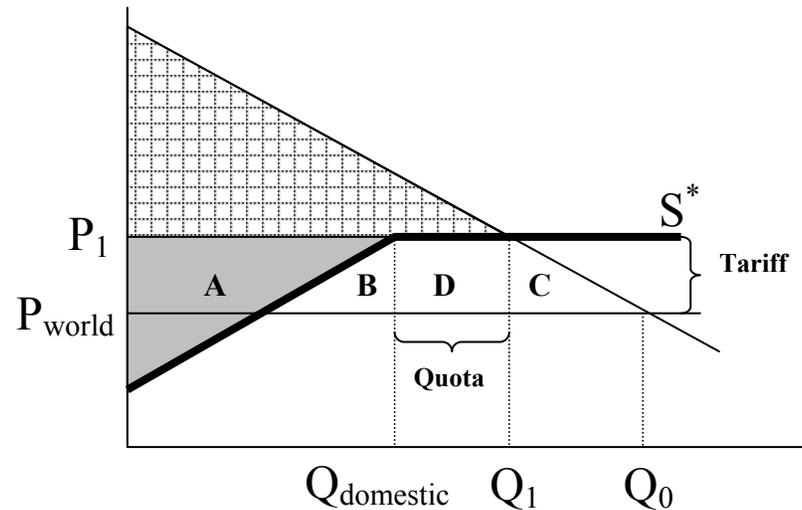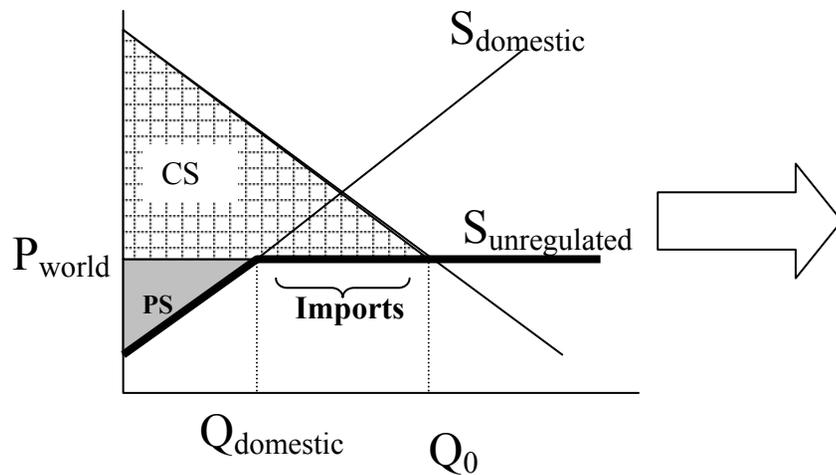
$\Delta CS = -(A + B + C + D)$

$\Delta PS = A$

Quota: Gain to Foreign Producers $= D$

Tariff: Gain to Government $= D$

$DWL = -(B + C)$

Production Costs: Terms

- **Economies of Scale**
    - ➢ Means you can double output without a doubling of costs
    - ➢ Marginal costs are less than average costs

- **Diseconomies of Scale**
    - ➢ Means that if you double output, you more than double costs
    - ➢ Marginal costs are greater than average costs

- **Constant Costs**
    - ➢ If you double output, your costs exactly double
    - ➢ Point where marginal costs *equal* average costs

Total Cost

Fixed cost

$$\text{TC} = \boxed{5000} + \boxed{20Q + 0.5Q^2}$$

Variable cost (anything with 'Q' in it)

Average Total Cost

$$\text{ATC} = \text{TC}/Q$$
$$= 5000/Q + 20 + 0.5Q$$

Fixed costs distributed over larger production volume

Rising marginal cost (cost of producing one more unit rises as more units are produced)
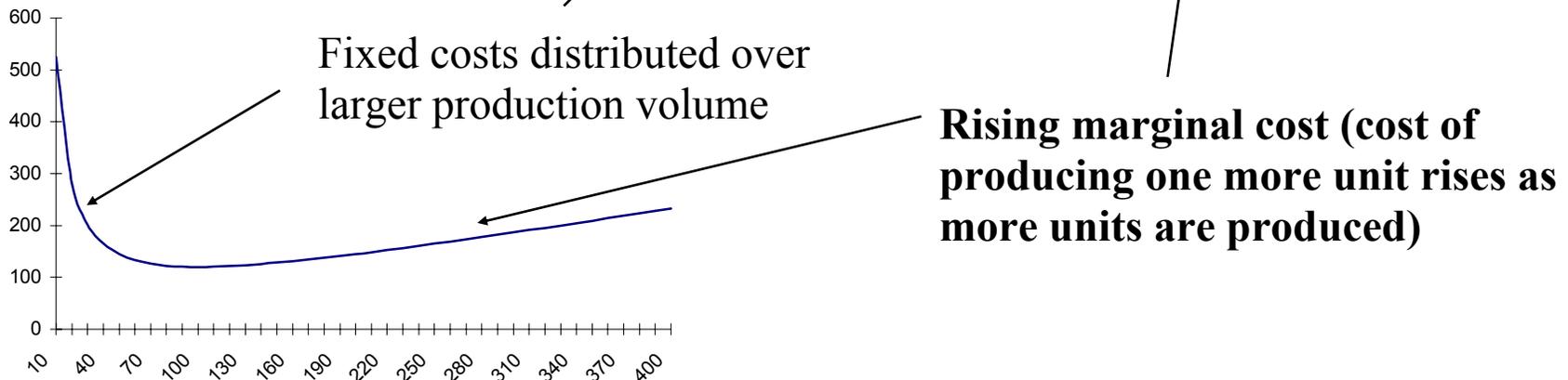
How do we find the minimum ATC?

Note, before we reach minimum ATC, each additional unit costs LESS than the ATC (and results in a lower ATC); after we've passed minimum ATC, each additional unit costs MORE than the ATC (resulting in a higher ATC). At the minimum ATC, an additional unit produced costs the SAME as the ATC.

Marginal Cost

$$MC = \partial TC / \partial Q$$
$$= \partial[5000 + 20Q + 0.5Q^2] / \partial Q$$
$$= 20 + Q$$

Minimum ATC at intersection of ATC and MC:

$$20 + Q = 5{,}000/Q + 20 + 0.5Q$$
$$Q = 5{,}000/Q + 0.5Q$$
$$0.5Q = 5{,}000/Q$$
$$0.5Q^2 = 5{,}000$$
$$Q^2 = 5{,}000/0.5$$
$$= 10{,}000$$
$$Q = 100 \text{ units}$$

Economic vs. Accounting Cost

Opportunity costs ➔ Economists include opportunity costs as part of cost - accountants do not. Opportunity costs are the cost of opportunities forgone by not putting a resource to the highest value alternative use.

Depreciation ➔ Economists and accountants measure depreciation differently. Economists focus on actual wear-and-tear of equipment when determining the decline in economic value of machines - accountants will classify assets according to tax rules to allocate the cost of an investment over time.

How do you measure wear-and-tear on a machine? *determine the current market value of the asset and then deduct the value of the same asset manufactured one year earlier.* What if you bought a highly specialized machine, and its value in the marketplace is now zero (e.g. machine which is obsolete)? *It is a sunk cost.*

Sunk costs ➔ these are costs already spent and unrecoverable - Economists exclude these from consideration once expended; accountants may include them under certain conditions (e.g. if an obsolete machine which cannot be resold is not fully depreciated for accounting purposes, it is still a "cost" for the accountant).

User cost of capital ➔ Cost of holding onto capital. **UCC** $= (r + \text{depr } \%) V_t$

Network Externalities

- Quantity Demanded depends on belief / knowledge about demand of others

- Direct network externalities (e.g., email, IM, telephone)

- Indirect network externalities (e.g., platforms like Windows, XBox)

- Snob effect (e.g., works of art, sports cars)

Network Externalities

see Figure 4.15: Positive Network Externality: Bandwagon Effect
Robert Pindyck and Daniel Rubinfeld, Microeconomics, 5th edition, (Upper Saddle River, NJ: Prentice-Hall, 2000)

TRUE/FALSE

The snob effect makes market demand more elastic.

FALSE: If Rolex lowers its prices, many consumers will purchase Rolex watches because of the price effect (i.e., from the definition of the demand curve, when P goes down, Q demanded goes up). Because there is a snob effect, however, the value of a Rolex will decline, and the extent to which Q demanded increases will be reduced. Thus, the snob effect makes market demand less elastic.

Learning Curves

When do they occur? When costs decrease with <u>cumulative</u> production (workers and managers learn how to "optimize" as they keep producing).
Examples: aircraft assembly, chip production, etc.

NO LEARNING	LEARNING

NO LEARNING

Period	Q_t		AC_t
1	10	$	975
2	30	$	375
3	30	$	375
4	30	$	375

LEARNING

Period	Q_t	CP_{t-1}		AC_t
1	10	0	$	975
2	30	10	$	262
3	30	40	$	215
4	30	70	$	198

NO LEARNING
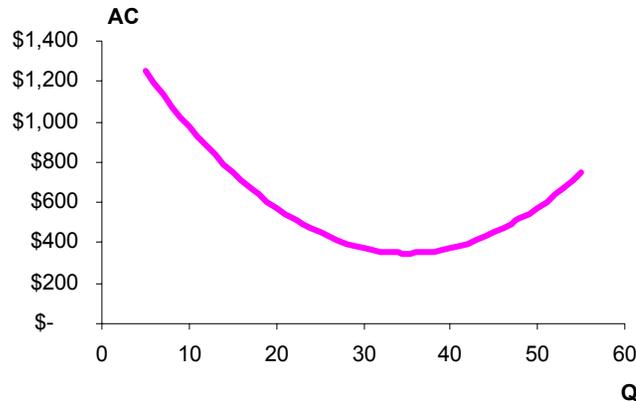
LEARNING

The AC curve stays there! Any changes in AC are due to Economies or Diseconomies of Scale only.
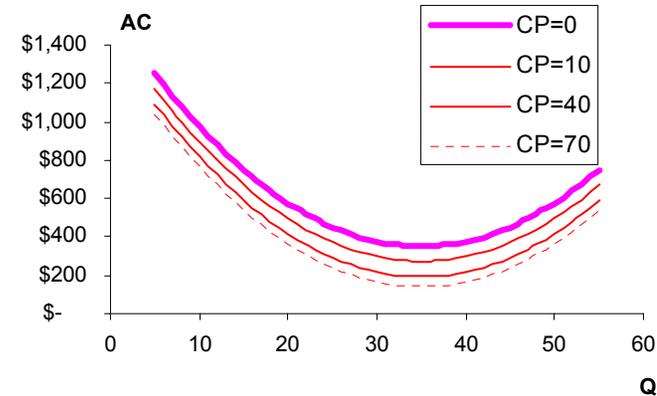
The AC curve SHIFTS DOWN *because* there is learning: As CP go up, the AC shifts down
Important: The AC curve does not shift down indefinitely. There are limits for learning!

What is NOT a learning curve?

- When the reduction in costs is due to reduction in input prices (not to increased CP)

How does it look like in the equations?

Basically, wherever you see "CP" on it, *and* the more CP the less costs (holding everything else equal), chances are there is learning going on. Examples:

- $\ln AC_t = 1.75 - 0.20 \ln Q_t - 0.25 \ln CP_{t-1}$
- $TC = 5{,}000 + (100 \times 0.8^{CP}) \times Q + 0.05 \times Q^2$
- Etc.

Pricing with Learning

Objective: Maximize TOTAL profits ($\Pi_{total}=\pi_{today}+\pi_{tomorrow}+\pi_3+\pi_4+\ldots$)

- Myopic output/pricing decision (*wrong*): **Set MR in every period = MC in every period.** This way we ignore the learning benefit of producing extra units.
- Correct approach:

Set MC = MR + *correction for reduced future costs from producing one more unit today*

This way we recognize the future learning benefits of producing more today.

Pricing with Network Externalities

The concept is similar to pricing with learning curves.

In the presence of Network Externalities:

Set MC = MR + correction for additional MR realized in the future due to bandwagon effect of one more unit now

Wait a minute! If I start selling at this low P*, I won't be maximizing my current profits because MR<current MC. Does it make sense? YES. Here is why:

- Part of the benefit of producing an additional unit of output today is the implicit investment in reducing *future* costs. This savings is not explicitly included in the marginal revenue. The learning gained from the additional production today can be leveraged in all subsequent periods.
- Still skeptical? Try this one: Assume you are optimizing your *current* profits, so MR = current MC. What happens if you produce a little more? You will be sacrificing today's profits only (now MR is < current MC), but you will get cost savings for tomorrow, the day after tomorrow, and so on. In other words, you will have increased cumulative production (CP), moved down the learning curve, and enjoy cost savings for ALL the subsequent periods.

Maximizing Profits in the Real World

- A true analysis of the optimal price in the presence of learning involves maximizing total profits for today, tomorrow, and all forward time periods, taking into account the appropriate interest rate. This is a problem for Excel Solver, and not likely for an exam problem…
- This pricing approach is correct only for *true* learning. It does *not* apply to situations in which MC drops independently of CP.

TRUE / FALSE / UNCERTAIN

Your firm produces a new, patented Super Gelato home ice cream maker. You are about to begin production, and you must decide what price to use. Your marginal cost in the short run is constant, however, you expect it to drop in a few years, when the cost of the coolant used in the ice cream maker will no longer be patented and will drop in price. You expect this to drop your MC from about $100 to about $50. Thus, in setting your current production as well as your long-run production, you should use a MC figure of $50.

FALSE. This is *not* a learning curve case! The reduction in MC is due to the patent expiration, no matter if I produce or not. Therefore, in each period, Super Gelato production should be based on the marginal cost of producing in *that* period.

Dynamic Demand Response – Non - Durables

- Examples are gasoline, heating oil, coffee. Goods that are *consumed in one period*.

- Model Q_t, Quantity of the good purchased in Period t.

- Think of these goods as *Habit Forming*. The Quantity you buy today (period t) depends on the quantity that you bought yesterday (period t-1).

- Over time, habits can change to reflect a price shock or an income shock

  - Long term Elasticities > Short term Elasticities *(Absolute Value)*

  - If price of good goes down, or if income of consumers goes up, result is a positive shock.

Quantity Sold

Original Equilibrium Sales

New Equilibrium Sales (long term effect after positive shock)

Positive Shock

Time
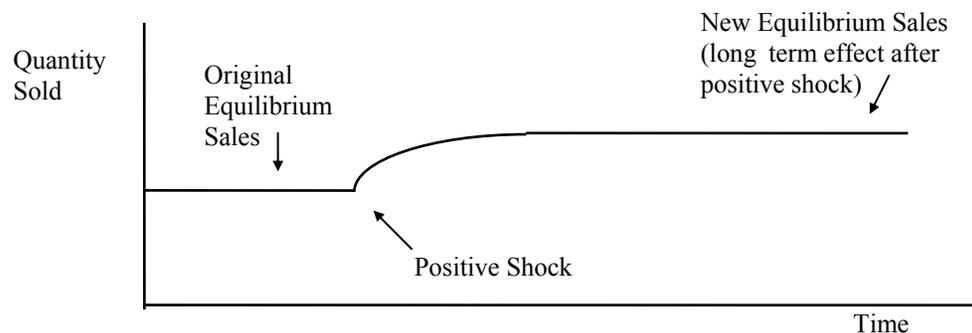
Dynamic Demand Response – Non - Durables (cont.)

- If price goes up or incomes go down, think of a negative shock

Quantity
Sold

Original
Equilibrium
Sales

Negative Shock

New Equilibrium Sales
(long term effect after
negative shock)

Time
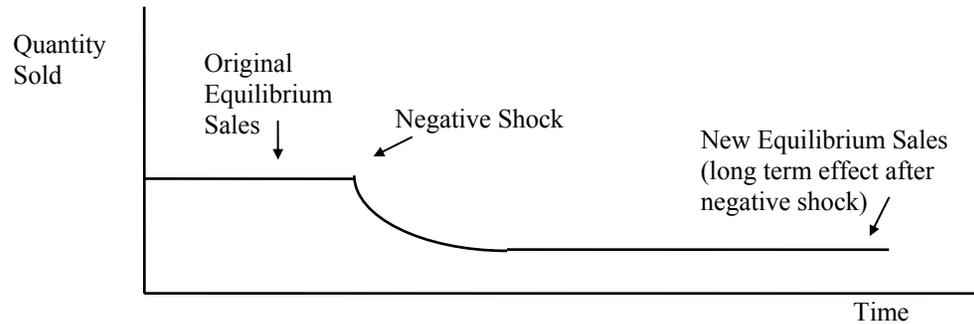
Dynamic Demand Response – Non - Durables (cont.)

- We can also observe the effect of a price increase on quantity sold using supply and demand charts.

○ Initial Equilibrium

● S.T. Equilibrium
  ➢ Q decreases a little initially

● L.T. Equilibrium
  ➢ Q decreases more later
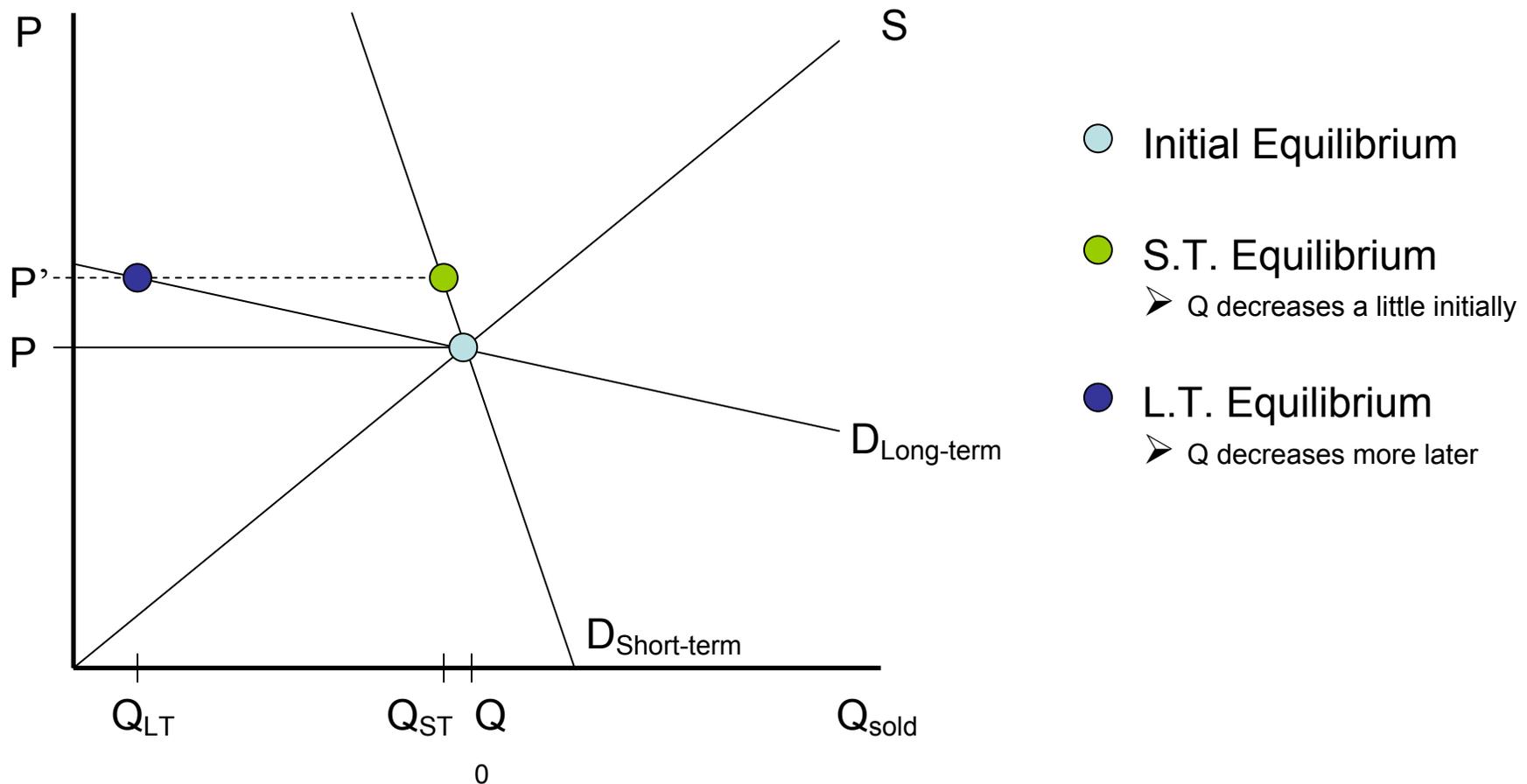
Dynamic Demand Response – Durable Goods

- Examples are Automobiles, Washing Machines, Televisions. Items that are useful for a number of periods.

- Quantity that you buy today depends on last period stock level, this period's desired stock level, and number of units that go out of service and need replacing.

- Right after a shock, the gap between actual stock and desired stock is the largest.

  - Short Term Elasticities > Long Term Elasticities *(Absolute Value)*

Time and Uncertainty – Present Value

- Cash received at different points in time has differing values for a firm or individual

- Present Value allows us to take a future stream of cash flow, profits, revenue, costs, etc. and convert them to a single comparable value for the present

- Use interest rate or discount rate (R) to 'convert' future values to present values

- NPV can be used for capital budgeting decisions—only choose projects with NPV > 0

$$PV = C_0 + C_1/(1+R) + C_2/(1+R)^2 + \ldots + C_T/(1+R)^T$$
$$\text{where } C_t \text{ is the (positive or negative) cash flow at time t}$$

Time and Uncertainty – Uncertainty and Risk Aversion

- Events and cash flows in the future are often uncertain, but can be modeled as a random variable

- Expected value represents 'average' cash flow

$$E(X) = p_1X_1 + p_2X_2 + p_3X_3 + \ldots + p_NX_N$$

- Firms can use expected value of cash flows to make capital budgeting decisions

- Attitudes toward risk often dictate behavior:
  - **Risk averse:** These people prefer a certain outcome over an uncertain, or risky, outcome with the same expected value.
  - **Risk neutral:** These people have no preference for a certain outcome over an uncertain, or risky, outcome with the same expected value.
  - **Risk loving:** These people prefer an uncertain, or risky, outcome over a certain outcome with the same expected value.

Time and Uncertainty – Option Value

- Uncertainty of future events often means there is value to waiting until the uncertainty is reduced or eliminated

- The value of an option can be calculated based on the outcome of the uncertain events

Example:

A firm can develop a new line of either laptops or PDAs. Each will take have a development cost of $1,000,000. If the economy recovers, they can sell 1000 laptop units at $1500 each, or they can sell 5500 PDAs at $250 each. If the economy does not recover, they can sell 800 laptop units at $1000 each, or 5000 PDAs at $225 each. There is a 50-50 chance that the economy recovers. How much should the firm be willing to pay to keep both development options alive until they find out if the economy recovers?

Answer:

If the economy is good:
  Π (laptop) = 1000*$1500 - $1,000,000 = $500,000
  Π (PDA) = 5500*$250 - $1,000,000 = $375,000
        $\Rightarrow$ produce laptops

If the economy is bad:

Π (laptop) = 800*$1000 - $1,000,000 = -$200,000

Π (PDA) = 5000*$225 - $1,000,000 = $125,000

⇨ produce PDA's

If we don't know the state of the economy:

Π (laptop) = 0.5*1000*$1500 + 0.5*800*$1000 – $1,000,000 = $150,000

Π (PDA) = 0.5*5500*$250 + 0.5*5000*$225 – $1,000,000 = $250,000

⇨ produce PDAs

If we select a product after determining the state of the economy, we can get expected profits of:

0.5*$500,000 + 0.5*$125,000 = $312,500

If we select a product before learning the state of the economy, we can get expected profits of: $250,000

Option value of keeping both options alive until we learn the state of the economy:

$312,500 - $250,000 = $62,500

Question (True or False?)

When choosing between two capital projects, a firm will always choose the project with higher future cash flows in each year.

Answer
False.

Why?
Because of relative riskiness of each project.
A riskier project will have a higher R as compared to a safer project. So although a project has higher future cash flows, it may have a lower NPV than a project with smaller future cash flows.

Monopoly: Market with only one seller (P&R fig. 10.3)

- The objective is to maximize profits: Π=TR-TC

- This requires **MR = MC**

- Demand is the average revenue curve. If demand is linear, *MR* is linear. Therefore, it has the intercept and twice the slope as the inverse demand curve, P(Q).

- Marginal revenue can be calculated from demand equation as:

$$MR = \frac{d}{dQ}(P \cdot Q)$$

- Output is determined by solving MR = MC for quantity. Price is obtained by plugging the optimal output in the demand equation.

- *Reminder:* A monopolistic market does not have a supply curve, in the sense that there is no one-to-one relationship between price and quantity produced. The reason is that the monopolist's output decision depends not only on MC but also on the shape of the demand curve.

Monopoly power

- A firm has monopoly power if it faces a downward sloping demand curve. Remember that in competitive markets firms face flat (completely elastic) demand curves at the market price.

- A firm can have monopoly power even if it is not a monopolist. This happens, for instance, in the case of differentiated consumer goods like clothing.

- The determinants of monopoly power are the *elasticity of market demand*, the *number of firms* in the market, the *interaction among firms*.

- Market power can be measured by the ability of the firm to charge a markup above marginal cost. The degree of markup is related to the elasticity of demand:

$$\frac{P - MC}{P} = -\frac{1}{E_D}$$

- Markup is higher when demand is less elastic. The intuition is that inflexible customers are willing to pay higher prices.

Question:

A firm with monopoly power has a constant marginal cost of $10 per unit, and is charging a price of $20 per unit.
(1) If the firm is maximizing profit, what is the elasticity of demand?
(2) Suppose its elasticity of demand doubles. What price should it then charge?

Answer:
(1) Using the markup formula we have:

$$\frac{P-MC}{P} = -\frac{1}{E_D} \Rightarrow \frac{20-10}{20} = -\frac{1}{E_D} \Rightarrow E_D = -2$$

(2) We use the markup formula again to find the price:

$$\frac{P-MC}{P} = -\frac{1}{E_D} \Rightarrow \frac{P-10}{P} = -\frac{1}{-4} \Rightarrow 4(P-10) = P \Rightarrow P = \frac{40}{3} = 13.33$$

Monopolistic vs. competitive markets

- In a monopolistic market output is lower, price is higher and profit is higher than in a competitive market (where equilibrium is determined by the intersection of demand and supply).

- Monopoly creates deadweight loss, since the firm restricts output to maximize profits.

- Monopolies have social costs. Therefore, they are usually regulated (e.g. with price ceilings) or prohibited (anti-trust laws).

- Natural monopolies exist when firms have economies of scale over the entire output range because multiple competitors could not survive in a competitive market. In this case, the government frequently allows the monopoly and regulates it.

Multi-plant production

Optimal condition is $MR = MC_1 = MC_2 = MC_{total}$. Otherwise, profits could be improved by changing production levels.

1. Find MC_{total} by horizontally adding the individual plants' marginal cost curves. Horizontal sum is obtained by first solving marginal cost equations for quantities [obtaining $Q_1 = f(MC_{total})$, $Q_2 = g(MC_{total})$] and then adding these expressions ($Q = Q_1 + Q_2$).
2. Determine optimal output for the firm by setting $MR = MC_{total}$.
3. Calculate price by plugging total output into demand equation.
4. Determine individual output levels using marginal cost equations, using optimal MC_{total} calculated above.

Question (True or False?)
A monopolist has two plants, one in Italy and another one in France. Due to a new tax on labor, the marginal cost at the Italian plant goes up. *Production at both plants should be reduced to reflect increased total marginal cost.*

Answer
False.

Why?
Before the tax, the monopolist is producing at the point where marginal cost is the same at both plants. When the tax causes the marginal cost to rise at the Italian plant, the firm will shift production away from the Italian plant and to the French plant until the marginal costs are equalized.

Midterm secret key (make sure you absolutely memorize it):

Relax!!

GOOD LUCK!!