CHAPTER 1: ANALYZING ECONOMIC PROBLEMS

1 A GLOBAL CHALLENGE AND A MICRO-ECONOMIC SOLUTION

Example of a cap and trade system for CO^2 pollution.

1.1 Why study microeconomics?

Microeconomics helps us understand the pieces that collectively make up a model of an entire economy.

1.2 Three Key Analytical Tools

Economists study economic models: formal descriptions of the problems they are adressing.
Exogenous variable: value of the variable is taken as given in the analysis.
Endogenous variable: value is determined within the economic system being studied.

Three key analytical tools:

1. Constrained optimalization
2. Equilibrium analysis
3. Comparative statics

1.2.1 Constrained optimization

When a decision-maker needs to make the best choice. Two parts:

- Objective function: the relationship that the decision-maker seeks to optimize (maximize or minimize)
- Constraints: restrictions of limits that are imposed on the decision-maker.

1.2.1.1 Marginal reasoning and constrained optimization

The obvious answers to economic questions are not always correct, because the solution to any constrained optimization problem depends on the marginal impact of the decision variables on the value of the objective function.

Marginal: how a dependent variable changes as a result of adding one unit of an independent variable, it measures the incremental impact of the last unit of the independent variable on the dependent variable.

1.2.2 Equilibrium Analysis

Equilibrium: a state or condition that will continue indefinitely as long as factors exogenous to the system remain unchanged.

Relation to supply and demand: in a competitive market, equilibrium is achieved at a price at which the market clears: supply = demand.

There is no upward or downward pressure on the price, there is no excess demand or excess supply.

Excess demand causes upward pressure on the price, and excess supply causes downward pressure on the price.

1.2.3 Comparative Statics

Analysis used to examine how a change in some exogenous variable will affect the level of some endogenous variable in an economic system. Comparative statics analysis can be applied to both constrained optimization problems or equilibrium analysis.

"Before-and-after" analysis by comparing two snapshots of an economic model:

- First snapshot: levels of endogenous variables at the initial values of some exogenous variable.
- Second snapshot: how an endogenous variable has changed in response to an exogenous shock.

1.3 Positive and Normative Analysis

Positive analysis: analysis that attempts to explain how an economic system works or to predict how it will change over time.

Normative analysis: analysis that typically focuses on issues of social welfare, examining what will enhance or detract from the common good, for example to examine how to achieve a socially desirable goal.
Often positive before normative analysis.

CHAPTER 2: DEMAND AND SUPPLY ANALYSIS

2.1 Demand, Supply & Market Equilibrium

Apply equilibrium and comparative statics tot he analysis of perfectly competitive markets. Perfectly competitive markets:

- Comprise of large numbers of buyers and sellers
- Transactions of individuals are very small in comparison to total volume
  => each individual 'takes' market price as given
- Model of price-taking behaviour

3 dimensions that characterize a market:

1. Commodity: the product bought and sold
2. Geography: location in which purchases are being made
3. Time: period of time during which transactions are occurring

2.1.1 Demand curves

Market demand curve: a curve that shows the quantity of goods that consumers are willing to buy at different prices.

Derived demand: demand for a good that is derived from the production and sales of other goods; e.g. the demand for steel is derived from the production of cars.

Law of demand: The inverse relationship between the price of a good and the quantity demanded, when all other factors that influence demand are held fixed. The example of luxury goods do NOT violate this law because the perceptions of the quality of these goods have also changed, thus not all other factors were held fixed, as the ceteris paribus proposition demands.

2.1.2 Supply curves

Market supply curve: a curve that shows the total quantity of goods that their suppliers are willing to sell at different prices. A market supply curve is constructed from the sum of the supply curves of all individual suppliers in a given market.

Law of supply: the positive relationship between a price and quantity supplied, when all other factors that influence supply are held fixed.

Factors of production: resources that are used to produce a good (typically labor and raw materials).

2.1.3 Market Equilibrium

Equilibrium: a point at which there is no tendency for the market price to change as long as exogenous variables remain unchanged.

Excess supply: quantity supplied > quantity demanded.
Excess demand: quantity demand > quantity supplied.

2.1.4 Shifts in supply and demand

2.1.4.1 Shifts in either supply or demand

Calculating equilibrium price: at equilibrium: demand = supply => equate demand equation to supply equation and solve for equilibrium price.

Four basic laws of supply and demand:

1. Increase in demand + unchanged supply curve = higher price and larger quantity
2. Decrease in supply + unchanged demand curve = higher price and smaller quantity
3. Decrease in demand + unchanged supply curve = lower price and smaller quantity
4. Increase in supply + unchanged demand curve = lower price and larger quantity

2.1.4.2 Shifts in both supply and demand

Combined (gross) impact of both shifts: ++ ; -- ; +- ; -+

Net impact depends on the magnitude of each shift (in comparison to the other)

2.2 Price Elasticity of Demand

A measure of the rate of percentage change of quantity demanded with respect to price, holding all other determinants of demand constant.

$e_{Q,P}$ = percentage change in quantity / percentage change in price

Value of $e_{Q,P}$	Classification	Meaning
0	Perfectly inelastic demand	Quantity demanded is completely insensitive to price
Between 0 and -1	Inelastic demand	Quantity demanded is relatively insensitive to price
-1	Unitary elastic demand	$\Delta Q=\Delta P$
Between -1 and -∞	Elastic demand	Quantity demanded is relatively sensitive to price
-∞	Perfectly elastic demand	Increase in price => $Q_d = 0$ Decrease in price => $Q_d = \infty$

Usefulness:

- Decide how to price products
- Important determinant of the structure and nature of competition in particular industries
- Determine effects of various kinds of governmental interventions

2.2.1 Elasticities along specific demand curves

2.2.1.1 Linear Demand Curve

Linear demand curve: Q=a-bP
Inverse demand curve: P= a/b – 1/b*Q (price expressed as a function of quantity
Choke price: price at which quantity demanded falls to 0.
Price elasticity for demand in linear demand curve : -b*P/Q

2.2.1.2 Constant elasticity demand curves

A demand curve of the form $Q = aP^{-b}$ where a and b are positive constants. The term –b is the price elasticity of demand along this curve.

2.2.2 Price Elasticity of Demand and Total Revenue

Total revenue : selling price*quantity sold; P*Q
The benefit of a higher price is offset by the cost due to the reduction in quantity. Businesses must consider this tradeoff.

2.2.3 Determinants of the Price Elasticity of Demand

- Demand tends to be more price elastic when there are good substitutes for a product.
- Demand tends to be more price elastic when a consumer's expenditure on the product is large.
- Demand tends to be less price elastic when the product is seen by consumers as being a necessity.

2.2.4 Market-level versus Brand-level Price Elasticity of Demand

Even if demand is inelastic at market level, it can be highly elastic at the individual brand level. The distinction between Market- and Brand-level elasticity is determined by the impact of substitution possibilities on the degree to which consumers are sensitive to price: it depends on whether the substitution possibilities are located on a market or brand level.

2.3 Other Elasticities

2.3.1 Income Elasticity of Demand

The ratio of the percentage change of quantity demanded to the percentage change of income. Can be positive as well as negative.

2.3.2 Cross-price Elasticity of Demand

The ratio of the percentage of change of the quantity of one good demanded with respect to the percentage change in the price of another good.

$e_{QiPj} = (\Delta Q_i/\Delta P_j)\ (P_j/Q_i)$

$e_{QiPj} > 0$: higher price for good j increases the quantity of good i. Demand substitutes: two goods related in such a way that if the price of one increases, demand for the other increases.

$e_{QiPj} < 0$: demand complements: higher price for good j decreases, the quantity of good I demanded.

2.3.3 Price Elasticity of Supply

The percentage change in quantity supplied for each percent change in price holding all other determinants of supply constant.
Firm-level price elasticity of supply: sensitivity of an individual firm's supply to price.
Market-level price elasticity of supply: sensitivity of market supply to price.

2.4 Elasticity in the Long Run versus the Short Run

Long-run demand curve: consumers can adjust their purchase decisions to changes in price.
Short-run demand curve: consumers cannot fully adjust their purchase decisions to changes in price.

Long-run supply curve: producers can fully adjust their supply decisions to changes in price.
Short-run supply curve: sellers cannot fully adjust their supply decisions in response to changes in price.

2.4.1 Greater Elasticity in the Long Run than in the Short Run

For products for which consumption is tied to physical assets whose stocks change slowly, the long-run demand curve would be more price elastic than the short-run demand curve.

2.4.2 Greater Elasticity in the Short Run than in the Long Run

For durable goods, long-run market demand can be less elastic than short-run demand. Durable goods are goods that provide valuable services over many years.

2.5 Back-of-the-envelope calculations

How to derive the equation of a demand curve:

1. Collect data on quantity of good purchased, prices and possible other determinants => apply statistical methods to estimate the equation that best fits the date.
2. Back-of-the-envelope calculations: techniques that allow economists to infer the shape of the equation of a demand curve from fragmentary information about prices, quantities and elasticities.

2.5.1 Fitting linear demand curves using quantity, price and elasticity information

Intercept a: $a=(1 - e_{Q,P})Q^*$

Slope b: $b= - e_{Q,P} (Q^*/P^*)$

Equation: $Q = a-bP$

2.5.2 Identifying Supply and Demand curves on the back of an envelope

Given ΔP and ΔQ

Fill in in price elasticity formula for demand.

$e_{Q,P} = \Delta Q/\Delta P$

CHAPTER 3: CONSUMER PREFERENCES AND THE CONCEPT OF UTILITY

3.1 Representations of preferences

Market basket: a combination of goods and services that an individual might consume.

Consumer preferences: Indications of how a consumer would rank any two possible baskets by comparing the desirability thereof, assuming the baskets were available to the consumer at no cost.

3.1.1 Assumptions about Consumer Preferences

1. Preferences are complete: consumer is always able to rank any of two baskets.
2. Preferences are transitive: A>B + B>C => A>C
3. More is better: having more of a good is always better for the consumer.

Observed choices are not always transitional, sometimes they appear to be intransitional. This could be explained by external considerations that affect your choices that might not e apparent to someone observing the behaviour.
Solution: Economists developed a model in which people's preferences change in a random fashion with the randomness representing the host of factors that can cause the preferences to change.

3.1.2 Ordinal and Cardinal Ranking

Ordinal ranking: ranking that indicates whether a consumer prefers one basket to another but does not contain quantitative information about the intensity of that preference.

Cardinal ranking: a quantitative measure of the intensity of a preference for one basket over another.

3.2 Utility functions

Utility function: function that measures the level of satisfaction a consumer receives from any basket of goods and services.

3.2.1 Preferences with a Single Good. The concept of marginal Utitility

Marginal utility: the rate at which total utility changes as the level of consumption rises.

$MU_y = \Delta U / \Delta y$

3.2.1.1 Principle of Diminishing Marginal Utility

Important notes on drawing total and marginal utility curves:

- Never plot them on the same graph vertical axes are not the same
- MU is the slope of U: derivative
- The relationship between total and marginal functions holds for other measures in economics: same as above.

Principle of diminishing marginal utility: after some point of increasing consumption, the marginal utility of a good will fall. More is not always better: marginal utility can become negative. Although more may not always be better, it is nevertheless reasonable to assume that more is better for amount of a good that a consumer might actually purchase.

3.2.2 Preferences with Multiple Goods: Marginal Utility Indifference curves and the Marginal Rate of Substitution

Graph of Utility function for 2 goods: 3 axis, 3-dimensional
Marginal Utility of a good is positive if:
- Total Utility function increases as more of the good is consumed.
- Marginal Utility is a positive number.

3.2.2.1 Indifference curves

Indifference curve: a curve connecting a set of baskets that yields the same level of satisfaction to the consumer.

4 properties of indifference curves:

1. When both goods have positive marginal utility, all indifference curves have a negative slope.
2. Indifference curves cannot intersect.
3. Every consumption basket lies on one and only one indifference curve.
4. Indifference curves are not 'thick': Two distinctly different baskets of the same goods cannot lie on the same place on the indifference curve.

3.2.2.2 The Marginal Rate of Substitution

Marginal Rate of Substitution: the rate at which the consumer will give up one good to get more of another, holding the level of utility constant.

3.2.2.3 Diminishing Marginal Rate of Substitution

Some preferences exhibit a diminishing marginal rate of substitution. This is a feature of consumer preferences for which the marginal rate of substitution of one good for another good diminishes as the consumption of the first good increases along an indifference curve.

Indifference curves with diminishing marginal rate of substitution are bowed towards the origin.
Indifference curves with increasing marginal rate of substitution are bowed away from the origin.

3.3 Special preferences

The rate of substitution always depends on the commodities in question. Special utility functions cover special cases of substitution rates.

3.3.1 Perfect substitutes

Two goods are perfect substitutes when the marginal rate of substitution of one for the other is a constant. The marginal rate of substitution does not necessarily have to be 1.

3.3.2 Perfect complements

Consumers are completely unwilling to substitute one good for another. Perfect complements are two goods that a consumer always wants to consume in fixed proportions to eachother.

3.3.3 The Cobb-Douglas Utility Function

The Cobb-Douglas Utility Function is a function of the form: $U = Ax^{\alpha}y^{\beta}$, where U measures the consumer's utility for x units of one good and y units of another good and where A, α and β are positive constants.

3 properties:

1. The marginal utilities are positive for both goods. This means that the "more is better" assumption is satisfied.
2. The indifference curves are downward sloping.
3. The function exhibits a diminishing marginal rate of substitution => indifference curve bowed toward the origin.

3.3.4 Quasilinear Utility Functions

A utility function that is linear in at least one of the goods consumed but may be a nonlinear function of the other goods.

Distinguishing characteristic:

- All indifference curves have the same MRS of x for y.
- At any value of x, the slopes of all the indifference curves are the same.
- The indifference curves are parallel to eachother.

CHAPTER 4: CONSUMER CHOICE

4.1 The Budget Constraint

The budget constraint defines the set of baskets that a consumer can purchase with a limited amount of income.
The budget line is the set of baskets that a consumer can purchase when spending all of his or her available income:

$P_x x + P_y y = I$

The slope of the budget line ($\Delta y/\Delta x$) tells how many units of the good on the vertical axis a consumer must give up to obtain an additional unit of the good on the horizontal axis.

4.1.1 How does a change in Income affect the budget line?

An increase in income shifts the budget line outward in a parallel fashion.
A decrease in income shifts the budget line inward in a parallel fashion.

4.1.2 How does a change in Price affect the budget line?

An increase in the price of one good moves the intercept on that good's axis toward the origin.
Conversely, a decrease in the price of one good moves the intercept on that good's axis away from the origin.

4.2 Optimal Choice

Optimal choice: consumer choice of a basket of goods that maximizes satisfaction (utility) while allowing to live within budget constraint.
Interior optimum: an optimal basket at which a consumer will be purchasing positive amounts of all commodities.
Tangency condition: the optimum occurs at a point where the budget line is tangent to the indifference curve.

4.2.1 Using the tangency condition to understand when a Basket is not optimal

In a not optimal basket, a consumer is willing to give up more of one good than he needs to give up to get additional units of another good.
Also, the marginal utility of both goods is not equal, thus the basket is not optimal.

4.2.2 Finding an optimal consumption basket

When both marginal utilities are positive, an optimal consumption basket will be on the budget line. When there is a diminishing marginal rate of substitution, an interior optimal consumption basket will occur at the tangency between and indifference curve and the tangency line.

4.2.3 Two ways of thinking about optimality

Way 1: Choosing the optimal basket in a given budget constraint to max U.
Way 2: Choosing the optimal basket to achieve a given level of utility while minimizing expenditures. = Expenditure minimization problem.

4.2.4 Corner points

Optimal consumer basket = interior: consumer purchases positive amounts of all available goods.
If the consumer cannot find an interior basket at which the budget line is tangent to an indifference curve, then the consumer might find an optimal basket at a corner point. (When budget line intersects highest indifference curve at a corner point).

4.3 Consumer choice with composite goods

If focus on one particular good or service, plot that good on one axis and all other goods on the other axis, this is called a composite good.
A composite good is a good that represents the collective expenditures on every other good except the commodity being considered.

4.3.1 Application: Coupons and Cash Subsidies

Use the theory of consumer choice to examine how a government program might increase the amount of housing chosen by a consumer.
Government wants to induce consumer to increase his consumption of housing:

- Income subsidy
- Housing coupons only to be spent on housing

4.3.2 Application: Joining a club

Consumer has to decide whether to join a club which gives him a discount on buying CD's.

4.3.3 Application: Borrowing / Lending

Consumer has to decide whether he wants to borrow from or lend to the bank.

4.3.4 Application: Quantity discounts

Quantity discounts expand the set of baskets a consumer will buy a total of 16 units when he or she is offered the quantity discount. The budget line in the indifference map is composed of two segments.

4.4 Revealed preference

Revealed preference is an analysis that enables us to learn about a consumers ordinal ranking of baskets by observing how his or her choices of baskets change as prices and income vary.

4.4.1 Are observed choices consistent with utility maximisation?

Inferences that can be drawn from revealed preference analysis:

- Knowing that the consumer is not always maximizing utility without knowing the consumer's indifference map.
- How the consumer is ranking baskets if he is maximizing utility with a budget constraint without knowing the utility function or indifference map.

CHAPTER 5: THE THEORY OF DEMAND

5.1 Optimal Choice and Demand

5.1.1 The Effects of a change in price

There are two ways to determine what happens to the consumer choice of one good when the price of that good changes while the price of the other good and the amount of income remain constant.

5.1.1.1 Looking at an optimal choice diagram

x-axis: quantity of good 1
y-axis: quantity of good 2

Consider the consumers choices of two different goods at different price points. This leads to an optimal choice diagram.
The price consumption curve is the set of utility maximizing baskets as the price of one good varies and is located on the optimal choice diagram.

5.1.1.2 Changing Price: Moving along a Demand Curve

You can derive the demand curve for both goods from the optimal choice diagram.
A decrease in price leads the consumer to move down and to the right along the demand curve for that good.
An increase in price leads the consumer to move up and to the left along the demand curve for that good.

5.1.1.3 The Demand Curve is also a 'Willingness to pay' curve

A demand curve can also be seen as a curve that represents the willingness to pay of a customer because the willingness to pay falls as the consumer buys more and more units of the good.

5.1.2 The effects of a change in income

An increase in income results in an outward parallel shift of the budget line. We can describe how changes in income affect the consumers purchases by drawing the income consumption curve: this is a curve that connects all the baskets that are optimal as income changes.

5.1.2.1 Changing Income: Shifting a demand curve

An increase in income results in a rightward shift in her demand curve for each good.

5.1.2.2 Engel Curves

Engel curve: a curve that relates the amount of a commodity purchased to the level of income, holding constant the prices of all goods. Another way of showing how a consumer's choice of a particular good varies with income.
Normal good: a good that a consumer purchases more of as income rises. For a normal good, the Engel curve will have a positive slope. A normal good has a positive income elasticity of demand.
Inferior good: a good that a consumer purchases less of as income rises. For an inferior good, the Engel curve will have a negative slope. An inferior good has a negative income elasticity of demand.

5.1.3 The effects of a Change and in Price in Income: An algebraic approach

Describe the demand curve algebraically: given a utility function and a budget constraint, we can find the equation of the consumer's demand curve.
To determine optimal choice of food:
Budget line equation: $P_x x + P_y y = I$
Tangency condition equation: $y = (P_x/P_y)x$
To find equation of demand curve: solve for x by substitution y into budget line equation : $x = I/(2P_x)$

5.2 Change in the price of a good: Substitution effect and Income effect

The overall effect of a change in the price of a good can be broken down into two components:

- The Substitution effect: the change in the amount of a good that would be consumed as the price of that good changes, holding constant all other prices and the level of utility.
- The Income effect: the change in the amount of a good that a consumer would buy as purchasing power changes, holding all prices constant.

5.2.1 The substitution effect

Steps involved in finding the substitution effect associated with a decrease in price:

1. Find the initial basket
2. Find the final basket
3. Find an intermediate decomposition basket that will enable us to identify the portion of the change in quantity due to the substitution effect.
   Find the decomposition basket by keeping two things in mind:
   - the decomposition basket lies on a budget line that is parallel to the budget line the final basket is on.
   - the decomposition basket is on the same utility curve as the initial basket because that is the assumption in the definition of the substitution effect.

The substitution effect accounts for the consumer's movement from basket A to basket B.

5.2.2 The Income Effect

The income effect accounts for the consumer's movement form the decomposition basket B to the final basket C.

5.2.3 Income and Substitution Effects when goods are not normal

Income and Substitution effects do not always work in the same direction. When the good is neither normal nor inferior, the income effect is 0. When the good is inferior, the income effect is negative.
Giffen good: a good so strongly inferior that the income effect outweighs the substitution effect, resulting in an upward sloping curve over some region of prices.

5.3 Change in the price of a Good: the Concept of Consumer Surplus

Consumer surplus is the difference between the maximum amount a consumer is willing ot pay for a good and the amount he must actually pay to purchase the good in the marketplace.

5.3.1 Understanding Consumer Surplus form the Demand Curve

Without knowing the utility function, we can use the concept of consumers surplus to measure the impact of a price change on the consumer when we know the equation for the demand curve.

The consumer surplus is the net economic benefit of a purchase, it is the willingness to pay minus the amount paid for a good. The consumer surplus is the area below the demand curve and above the price that the consumer must pay for the good.

5.3.2 Understanding consumer surplus from the optimal choice diagram: compensating variation and equivalent variation

To estimate the monetary value that a consumer would assign to a change in the price of a good:

- Compensating variation: a measure of how much money a consumer would be willing to give up after a reduction in the price of a good to be just as well off as before the price decrease.
- Equivalent variation: a measure of how much additional money a consumer would need before a price reduction to be as well off as after the price decrease.

In general, these variations will not be the same. But if the utility function is quasilinear, the variations will be the same because the price change would have a zero income effect. The variations will also be equal to the change in consumer surplus.
When the income effect is not zero, the consumer surplus (area under demand curve) will not exactly measure either the compensating variation or the equivalent variation.

5.4 Market Demand

The market demand curve is the horizontal sum of the demands of the individual consumers.
Be careful when constructing market demand curves:

1. Write the demand curves in the normal form before adding them to each other.
2. Pay attention to how the underlying individual demands vary across the range of prices.

5.4.1 Market Demand with Network Externalities

Network Externalities: a demand characteristic present when the amount of a good demanded by one consumer depends on the number of other consumers who purchase the good.
The externality is positive if one consumer's demand for a good increases with the number of other consumers who buy the good.
The externality is negative if one consumer's demand for a good decreases with the number of other consumers who buy the good.
Positive network externalities can occur if a good or service is a fad. Examples of fads are: fashion in clothing, toys or beer.
Bandwagon effect: a positive network externality that refers to the increase in each consumer's demand for a good as more consumers buy the good.
Snob effect: a negative network externality that refers to the decrease in each consumer's demand as more consumers buy the good.

5.5 The Choice of Labor and Leisure

5.5.1 As wages rise, leisure first decreases, then increases

As the wage rate rises, the number of hours of leisure falls. Howerver, as the wage rate continues to rise, the consumer begins to increase his amount of leisure.

5.5.2 The Backward-Bending Supply of Labor

An increase in the wage rate reduces the amount of work required to buy a unit of the composite good, and this leads to both a substitution and an income effect.
The substitution effect on the labor supply is positive: induces consumer to substitute more of the composite good for leisure.
The income effect on the labor supply is negative: leisure is a normal good; consumer wants more leisure as income rises.
In the backward-bending part of the labour supply curve, the income effect outweighs the substitution effect.

5.6 Consumer Price Indices

The CPI is a measure of the change in the cost of living.
Governments use CPI to determine how much to pay to retired citizens. CPI is calculated as the change in expenditures necessary to buy a fixed basket as prices change; where the fixed basket is the amount of food and clothing purchased in year 1.

CHAPTER 6: INPUTS AND PRODUCTION FUNCTIONS

6.1 Introduction to Inputs and Production Functions

Inputs: resources that are combined to produce finished good.
= Factors of production: Resources that are used to produce a good.
Output: The amount of a good of service produced by a firm.

Production function: a mathematical representation that shows the maximum quantity of output a firm can produce given the quantities of inputs that it might employ.
Production set: the set of technically feasible combinations of inputs and outputs.

Technically inefficient: The set of points in the production set at which the firm is getting less output from its labor than it could.
Technically efficient: The set of points in the production function at which the firm is producing as much output as it possibly can, given the amount of labour it employs.

Labor requirements function: a function that indicates the minimum amount of labor required to produce a given amount of output.

6.2 Production Function with a single output

6.2.1 Total Product Functions

Total product function: a production function with a single input that shows how total output depends on the level of input.

A total product function graph will have 3 different phases:

1. Increasing marginal returns to labor: output rises with additional labor at increasing rate.
2. Diminishing marginal returns to labor: output rises with additional labor but at a decreasing rate.
3. Diminishing total returns to labor: output decreases with additional labor.

6.2.2 Marginal and Average Product

2 notions of productivity can be derived from the production output:

- Average product of labor: average amount of output per unit of labor
- Marginal product of labor: rate at which total output changes as the quantity of labor the firm uses is changed.

Law of diminishing returns: principle that as the usage of one input increases, the quantities of other inputs being held fixed, a point will be reached beyond which the marginal product of the variable input will decrease.

6.2.3 Relationship between Marginal and Average Product

Systematic relationship between average product and marginal product:

- When average product is increasing in labor, marginal product is greater than average product.
- When average product is decreasing in labor, marginal product is less than average product.
- When average product neither increases nor decreases in labor because we are at a point at which AP_L is at a maximum, then marginal product is equal to average product.

6.3 Production functions with more than 1 input

6.3.1 Total Product and Marginal Product with two inputs

A productions function with 2 inputs and 1 output is three-dimensional.
Total product hill: a three-dimensional graph of a product function. You can derive the marginal product of one input by holding the other one constant.

6.3.2 Isoquants

Isoquant: a curve that shows all of the combinations of labor and capital that can produce a given level of output. Iso + quant = same + quantity.
Downward sloping isoquant: Economic tradeoff: A firm can substitute capital for labor and keep its output unchanged.

6.3.3 Economic and Uneconomic Regions of Production

Uneconomic region: backward-bending or upward sloping isoquant regions of the production function: corresponds to a situation in which one output has negative marginal returns and is therefore uneconomic.

6.3.4 Marginal rate of technical substitution

The rate at which the quantity of capital can be reduced for every one-unit increase in the quantity of labor, holding the quantity of output constant.
Diminishing marginal rate of technical substitution: a feature of a production function in which the marginal rate of technical substitution of labor for capital diminishes as the quantity of labor increases along an isoquant.
The marginal rate of technical substitution of labor for capital is equal to the ratio of the marginal product of labor to the marginal product of captital.
Significance: a firm would want to know the marginal productivity of both inputs before making an investment decision.

6.4 Subsitutionability among outputs

Describe the ease or difficulty with which a firm can substitute between different inputs.

6.4.1 Describing a Firm's Input Substitution Opportunities Graphically

- When the production function offers limited input substitution opportunities, the marginal rate of technical substitution changes substantially as we move along an isoquant.
- When the production function offers abundant input substitution opportunities, the marginal rate of technical substitution changes gradually.

6.4.2 Elasticity of Substitutability

A measure of how easy it is for a firm to substitute labor for capital: it is equal to the percentage change in the capital-labor ratio for every 1% change in the marginal rate of technical substitution of labor for capital as we move along an isoquant.

Capital-labor ratio: ratio of the quantity of capital to the quantity of labor.

Significance:

- Close to 0: little opportunity to substitute between inputs.
- If the elasticity of substitution is large, there is plenty of opportunity to substitute between inputs.

6.4.3 Special Production Functions

6.4.3.1 Linear Production Function (Perfect Substitutes)

Production function with a marginal rate of technical substitution of one input for another.
A linear production function is a production function of the form $Q = aL + bK$, where a and b are positive constants.
Perfect substitutes: Inputs in a production function with a constant marginal rate of technical substitution.

6.4.3.2 Fixed-Proportions Production Function (Perfect Complements)

A production function where the inputs must be combined in a constant ratio to one another.
Perfect complements: Inputs in a fixed-proportions production function.

6.4.3.3 Cobb-Douglas Production Function

A production function of the form $Q = AL^{\alpha}K^{\beta}$, where Q is the quantity of output from L units of Labor and K units of capital and where A, α andβ are positive constants.

It is a production function that is intermediate between a linear production function and a fixed-proportions production function.
Properties:

- Capital and labor can be substituted for each other.
- Capital and labor can be used in variable proportions (unlike fixed-proportions PF)
- The rate at which labor can be substituted for capital is not constant (unlike linear PF)
- Elasticity of substitution is always 1

6.4.3.4 Constant Elasticity of Substitution Production Function

CES production function: a type of production function that includes linear production functions, fixed-proportions production function and Cobb-Douglas production functions as special cases.

6.5 Returns to Scale

6.5.1 Definitions

Returns to scale: the concept that tells us the percentage by which output will increase when all inputs are increased by a given percentage.
Increasing RTS: a proportionate increase in all input quantities resulting in a greater than proportionate increase in input.
Constant RTS: a proportionate increase in all input quantities resulting in the same percentage increase in input.
Decreasing RTS: a proportionate increase in all input quantities resulting in a less than proportionate increase in input.

6.5.2 Returns to scale versus Diminishing Marginal Returns

Returns to scale can be constant while marginal returns to labor are diminishing: this is due to the fact that capital is not included in marginal returns to labor.

6.6 Technological Progress

A change in production process that enables a firm to achieve more output from a given contribution of inputs or, equivalently, the same amount of output from less inputs.

Neutral technological progress: technological progress that decreases the amounts of labor and capital needed to produce a given output, without affecting the marginal rate of technical substitution of labor for capital.
Labor-saving technological progress: technological progress that causes the marginal product to increase relative to the marginal product of labor.
Capital-saving technological progress: technological progress that causes the marginal prduct of labor to increase relative to the marginal product of capital.

CHAPTER 7: COST AND COST MINIMIZATION

7.1 Cost concepts for Decision Making

Costs are not necessarily synonymous with monetary outlays, it is also the value of sacrificed opportunities.
Explicit costs are costs that involve a direct monetary outlay.
Implicit costs are costs that do not involve outlays of cash.

7.1.1 Opportunity cost

Opportunity cost is the value of the next best alternative that is forgone when another alternative is chosen.

7.1.1.1 Opportunity costs depend on the decision being made

There are different opportunity costs for different decisions under different circumstances.

7.1.1.2 Opportunity costs and Market Prices

The opportunity cost of input services or goods is always the current market price.

7.1.2 Economic versus Accounting costs

Economic costs: the sum of the firm's explicit and implicit costs. Synonymous with opportunity costs.
Accounting costs: the total of explicit costs that have been incurred in the past.

7.1.2.1 Sunk (Unavoidable) vs. Nonsunk (Avoidable) Costs

Sunk costs: costs that have already been incurred and cannot be recovered.
Nonsunk costs: costs that are incurred only if a particular decision is made.

7.2 The Cost-Minimization Problem

Cost-minization problem: the problem of finding the input combination that minizes a firm's total cost of producing a particular level of output.
Cost-minizing firm: a firm that seeks to minimize the cost of producing a given amount of output.

7.2.1 Long Run vs. Short Run

Long Run: The period of time that is long enough for the firm to vary the quantities of all of its inputs as much as it desires.
Short Run: The period of time in which at least one of the firm's input quantities cannot be changed.

7.2.2 The Long-run Cost-Minimization Problem

Labor is an explicit cost if the firm hires workers in the open market.
Labor is an implicit cost if the owner of the firm works in the firm himself.
Capital is an explicit cost if a firm leased capital services form another firm.
Capital is an implicit cost if a firm owned the physical capital and sacrificed the opportunity to rent it to other firms by using it itself.

7.2.3 Isocost lines

Isocost line: the set of combinations of labor and capital that yield the same total cost for the firm.

7.2.4 Graphical Characterization of the solution to the long-run cost-minimisation problem

To solve cost-minimisation problem: look for point with lowest level of cost tangent to the highest isoquant line:

- Positive amounts of both inputs: L>0; K>0.
- Occurs at a tangency between isoquant and isocost line.
- Ratio of the marginal products of labor and capital equals the ratio of the price of labor to the price of capital.

7.2.5 Corner Point Solution

When a firm uses either no capital or no labor to produce the most output. Every additional dollar spent on one yields more output than every additional dollar spent on the other.

7.3 Comparative Statics Analysis of the Cost-Minimisation Problem

Exploration of how changes in input prices and output affect the solution of a cost-minimisation problem.

7.3.1 Comparative Statics Analysis of Changes in Input Prices

An increase in price of labor makes the isocost lines steeper, which changes the position of the tangency point between the isocost line and the isoquant.
The marginal rate of technical substitution of labor for capital diminishes, the firm will substitute labor for capital and the tangency between the isocost curve and the isoquant will occur further up the isoquant.
2 important assumptions:

- The firm must be using a positive amount of both inputs (no corner point solution).
- The isoquants must be smooth, without kinks.

When the firm has smooth isoquants with a diminishing marginal rate of technical substitution, and is initially using positive quantities of an input, an increase in the price of that input will cause the cost-minimizing quantity of that input to go down.
When the firm is initially using a zero quantity of the input or the firm has a fixed proportions productive function, an increase in the price of the input will leave the cost-minimizing quantity unchanged.

7.3.2 Comparative Statics Analysis of changes in Output

Expansion path: a line that connects the cost-minimizing input combinations as the quantity of output, Q, varies, holding input prices constant.
Normal input: an input whose cost-minimizing quantity increases as the firm produces more output.
Inferior input: an input whose cost-minimizing quantity decreases as the firm produces more output. E.g. automating production process and substituting labor for capital; labor is the inferior good.
Both inputs cannot be inferior, one of both must be normal: inferiority of all inputs is inconsistent with the idea that the firm is getting the most output from its inputs.
When both inputs are normal, the expansion path is upward sloping.
When one input is inferior, the expansion path is downward sloping.

7.3.3 Summarizing the Comparative Statics Analysis: The Input Demand Curves

The solution to the cost-minimization problem is an optimal input combination: a quantity of capital and a quantity of labor. This input combination depends on the amount of output and the prices of both inputs.
Labor demand curve: a curve that shows how the firm's cost-minimizing quantity of labor varies with the price of labor. This curve is generally downward sloping.
Capital demand curve: a curve that shows how the firm's cost-minimizing quantity of capital varies with the price of capital. This curve is similar to the labor demand curve and is generally also downward sloping.
Price elasticity of demand for labor: the percentage change in the cost-minimizing quantity of labor with respect to a 1 percentage change in the price of labor.
Price elasticity of demand for capital: the percentage change in the cost-minimizing quantity of capital with respect to a 1 percentage change in the price of capital.

7.4 Short-Run Cost-Minimization

Short Run means that the firm is unable to alter one or more of the firm's inputs.

7.4.1 Characterizing Costs in the Short Run

7.4.1.1 Fixed versus Variable costs; Sunk versus Nonsunk Costs

Total variable cost: the sum of expenditures on variable inputs, such as labor and materials, at the short-run cost-minimizing input combination.
Total fixed cost: the cost of fixed inputs; it does not vary with output.

Differences between labor and capital:

1. The extent to which they are sensitive to output:
   - Labor constitutes the firm's total variable cost.
   - Capital constitutes the firm's total fixed cost.
2. Variable costs are always nonsunk. (Labor).
   Fixed costs may be sunk or nonsunk. (Capital).
   - Sunk: output insensitive and unavoidable
   - Nonsunk: output insensitive and avoidable

7.4.2 Cost-Minimization in the Short Run

The problem has only one variable factor (labor). The determination of the optimal amount of labor does not involve a tangency condition.

7.4.3 Comparative statics: short-run input demand versus long-run input demand

In the short run, if the firm cannot vary its quantity of capital, its demand for labor will be independent of input prices but will vary with the quantity of output.

7.4.4 More than one variable input in the Short Run

3 inputs: labor, capital and raw materials.
Capital is fixed; labor and raw materials are variable => long-run cost minimization problem analogy.

CHAPTER 8: COST CURVES

8.1 Long-Run Cost Curves

8.1.1 Long-Run Total Cost Curves

Long-run total cost curve: a curve that show how total cost varies with output, holding input prices fixed and choosing all inputs to minimize cost.
The long-run total cost curve must be increasing in Q and must equal o when Q = o.

8.1.2 How does the long-run total cost cure shift when input prices change?

8.1.2.1 What happens when just one input changes?

Holding output fixed, the minimized total cost goes up when the price of an input goes up.
New total cost curve above original total cost curve.

8.1.2.2 What happens when all input prices change proportionally?

A given percentage increase in both input prices leave the cost-minimizing input combination unchanged, while the total cost curve shifts up by exactly the same percentage.

8.1.3 Long-run Aerage and Marginal Cost Curves

8.1.3.1 What are long-run Average and Marginal Costs?

Long-run average cost: the firm's total cost per unit of output. It equals long-run total cost divided by total quantity.
Long-run marginal cost: the rate at which long-run total cost changes with respect to change in output.

8.1.3.2 Relationship between Long-Run Average and Marginal Cost Curves

Systematic relationship:

- If average cost is decreasing as quantity is increasing, then AC(Q) > MC(Q).
- If AC is increasing as quantity is increasing, then AC(Q) < MC(Q).
- If AC is neither increasing nor decreasing as quantity is increasing, than AC = MC.

8.1.3.3 Economies and Diseconomies of Scale

Economies of scale: a characteristic of production in which average cost decreases as output goes up.
Diseconomies of scale: a characteristic of production in which average cost increases as output goes up.
Causes for economies of scale:

- Physical properties of processing units: increasing returns to scale in inputs.
- Specialization of labor
- Need to employ indivisible inputs: an input that is available only in a certain minimum size. Its quantity cannot be scaled down as the firm's output goes to zero. Indivisible outputs lead to decreasing average cost, because when a firm purchases the services of an indivisible input, it can spread the cost of the indivisible input over more units of output as the output goes up.

Causes for diseconomies of scale:

- Managerial diseconomies: a situation in which a given percentage increase in output forces the firm to increase its spending on the services of managers by more than this percentage.

Minimum efficient scale: the smalles quantity at which the long-run average cost curve attains its minimum point. The larger the minimum efficient scale is, the greater the magnitude of economies of scale.

8.1.3.4 Economies of scale and Returns to scale

Close relationship:

- If average cost decreases as output increases: economies of scale + increasing returns to scale.
- If average cost increase as output increases: diseconomies of scale + decreasing returns to scale.
- If average cost stays the same as output increases: neither economies nor diseconomies of scale + constant returns to scale.

8.1.3.5 Measuring the extent of Economies of Scale: The output Elasticity of TC

Output elasticity of total cost: the percentage change in total cost per 1 percentage change in output. It is equal to the ratio of marginal to average cost.

$E_{TC,Q} = MC / AC$

Relationship between economies of scale and returns to scale: table 8.2 p 247.

Relationship between output elasticity of total cost and economies of scale: table 8.3 p 248.

8.2 Short-Run Cost Curves

8.2.1 Short-Run Total Cost Curve

Short-Run Total Cost Curve: a curve that shows the minimized total cost of producing a given quantity of output when at least one input is fixed.
Total variable cost curve: a curve that shows the sum of expenditures on variable inputs, such as labor and materials at the short-run cost-minimizing input combination.
Total fixed cost curve: a curve that shows the cost of fixed inputs and does not vary with output.

8.2.2 Relationship between Long-run and Shot-run total cost curves

Total costs are generally higher in the short run than in the long run because experience accumulates over time and reduces costs.

8.2.3 Short-Run Average and Marginal Cost Curves

Short-run average cost: the firms total cost per unit of output when it has one or more fixed inputs.
Short-run marginal cost: the slope of the short-run total cost curve.
Average variable cost: total variable cost per unit of output.
Average fixed cost: total fixed cost per unit of output.

8.2.4 Relationships between the Long-Run and the Short-run Average and Marginal Cost Curves

8.2.4.1 The Long Run Average Cost Curve as an Envelope Curve

The long-run average cost curve forms a boundary around the set of short-run average cost curves corresponding to different levels of output and fixed input. The long-run average cost curve is sometimes referred to as the envelope curve.

8.2.4.2 When are long-run and short-run average and marginal costs equal?

When the firm's short-run and long-run average costs are equal, its short-run and long-run marginal costs must also be equal.

8.3 Special Topics in Cost

8.3.1 Economies of Scope

Economies of scope: a production characteristic in which the total cost of producing given quantities of two goods in the same firm is less than the total cost of producing those quantities in two single-product firms.
Stand-alone cost: the cost of producing a good in a single-product firm.

8.3.2 Economies of experience: The experience curve

8.3.2.1 Learning-by-Doing and the experience curve

Economies of experience: cost advantages that result from accumulated experience, or as it is sometimes called, learning-by-doing.

Experience curve: a relationship between average variable cost and cumulative production volume. It is used to describe the economies of experience.
Experience elasticity: the percentage change in average variable cost for every 1 percent increase in cumulative volume.
Slope of the experience curve: how much average variable costs go down, as a percentage of an initial level, when cumulative output doubles.

Causes for economies of experience to arise:

- Workers improve their performance over time
- Engineers perfect product design over time
- Firms become more adept at handling and processing materials over time

Example: slope of 80%: each doubling of cumulative output reduces average variable costs to 80% of what they were before.

8.3.2.2 Economies of Experience versus Economies of Scale

One can be high while the other is minimal.
Aluminum can manufacturing: high economies of scale, low economies of experience
Production of handmade watches: high economies of experience, low economies of scale

8.4 Estimating Cost Functions

Total cost function: a mathematical relationship that shows how total costs vary with the factors that influence total costs, including the quantity of output and the price of inputs.
Cost driver: a factor that influences or "drives" total or average costs:

- Input prices
- Scale: volume of output
- Scope: variety of goods produced
- Cumulative experience

8.4.1 Constant Elasticity Cost Function

A cost function that specifies constant elasticity of total cost with respect to output and input prices.

8.4.2 Translog Cost Function

A cost function that postulates a quadractic relationship between the log of total cost and the logs of input prices and output.
The constant elasticity cost function is a special case of the translog cost function.

CHAPTER 9: PERFECTLY COMPETITIVE MARKETS

A perfectly competitive market consists of firms that produce identical products that sell at the same price. Each firm's volume of output is so small in comparison to overall market demand that no single firm has an impact on the market price.
Reasons for studying perfect competition:

1. Some real-world markets are perfect competition
2. The theory of perfect competition forms an important foundation for the rest of micro-economics.

9.1 What is perfect competition?

Perfectly competitive markets have 4 characteristics:

1. Fragmented industry: it consists of many buyers and sellers; each buyer's purchase have an imperceptible impact on the market price.
2. Firms produce undifferentiated products: products that consumers perceived as being identical.
3. Consumers have perfect information about prices: full awareness by consumers of the prices charged by all sellers in the market.
4. Equal access to resources: a condition in which all firms (currently in industry + prospective) have access to the same technology and inputs.

9.2 Profit maximization by a Price-Taking Firm

9.2.1 Economic Profit vs. Accounting profit

Economic profit: the difference between a firm's sales revenue and the totality of its economic costs, including all relevant opportunity costs.
Accounting profit does not include these opportunity costs.
Economic profit is the appropriate objective for a firm that is acting on its owner's behalf.

9.2.2 The Profit-maximizing output choice for a Price-taking Firm

Economic value added: a widely used measure of economic profit, equal to the company's accounting profit minus the minimum return on invested capital demanded by the firm's investors.
Economic profit: TC
$TC = TR(Q) - TC(Q)$
$TR(Q) = PQ$
$TC(Q) = wL + rK$

Marginal Revenue: the rate at which total revenue changes with repsect to output. $MR = \Delta TR / \Delta Q$. For a price-taking firm: MR = P.
At the profit maximizing output. P = MC. A price-taking firm maximizes its profit when it produces a quantity Q* at which the marginal cost equals the market price. MR = P = MC.
Two profit-maximization conditions for a price-taking firm:

- P = MC
- Mc must be increasing

9.3 How the Market Price is Determined: Short-Run Equilibrium

Study how the market price is determined in the short run.
The short run is the period of time in which:

1. Number of firms in industry is fixed
2. At least one input of each firm is fixed

The market price is determined by the interaction of the market supply curve and the market demand curve.

9.3.1 The Price-Taking Firm's Short-Run Cost Structure

Typical short-run total cost structure:

STC (Q) = SFC + NSFC + TVC(Q); when Q>0
SFC ; when Q=0

- TVC(Q): total variable costs: output sensitive costs: go up or down as the firm increases or decreases output. Are always nonsunk.
- SFC: sunk fixed costs: unavoidable costs.
- NSFC: nonsunk fixed costs: fixed cost that must be incurred if the firm is to produce any output, but does not have to be incurred when the firm produces no output.

9.3.2 Short-Run Supply Curve for a Price-Taking Firm when all fixed costs are sunk

NSFC = 0 ; FC = SFC
Short-run supply curve: the supply curve that shows how the firm's profit-maximizing output decision changes as the market price changes, assuming that the firm cannot adjust all of its inputs.
The firm's short-run supply curve is the proportion of its short-run marginal cost above the minimum level of average variable cost, denoted by P_S. This is the firm's shutdown price, the firm supplies zero output, and its supply curve is a vertical line coinciding with the vertical axis.

- A profit-maximizing price-taking firm, if it produces positive output, produces where P = SMC and SMC slopes upward.
- A profit-maximizing price-taking firm never produces where P < AVC.

9.3.3 Short-Run Supply Cure for a Price-Taking Firm when some Fixed Costs are sunk and some are nonsunk

TFC = SFC + NSFC ; NSFC > 0
Maximize profit by equation price marginal cost.
Because some fixed costs are sunk and other are nonsunk, the firm is better off cutting its short-run losses by not producing if the market price is less than the average nonsunk cost ANSC(Q*) at the output Q* at which P equals short-run marginal cost, P<ANSC(Q*).

The firm's short-run supply curve consists of two portions:

- A profit-maximizing price-taking firm, if it produces output, produces where P = SMC and SMC slopes upward.
- A profit-maximizing price-taking firm with nonsunk fixed costs would never produce where P<ANSC = P_S (shutdown price)

The concept of average nonsunk cost is sufficiently flexible that we can identify the firm's supply curve and shutdown price for 3 special cases:

1. All fixed costs are sunk.
2. All fixed costs are nonsunk.
3. Some fixed costs are sunk, some are nonsunk.

9.3.4 Short-Run Market Supply Curve

How to go from the firm's supply curve to the supply curve for the entire industry.
The number of producers in the industry is fixed; the market supply at any price is equal to the sum of the quantities that each established firm supplies at that price.
Short-run market supply curve: the supply curve that shows the quantity supplied in the aggregate by all firms in the market for each possible market price when the number of firms in the industry is fixed. It is derived by horizontally summing the supply curves of the individual firms.
Important qualification: this only works if the prices that firms pay for their input are constant as the market output varies.

9.3.5 Short-Run Perfectly Competitive Equilibrium

The market price and quantity at which quantity demanded equals quantity supplied in the short run. It is also the intersect of the market demand curve and the market supply curve.

9.3.6 Comparative Statics Analysis of the Short-Run Equilibrium

To better understand the factors that determine the market equilibrium price.

- Number of firms in the market goes up => quantity supplied goes up => price falls => market supply curve moves rightward
- Market demand increases => equilibrium price and quantity both go up
- A shift in demand will have a higher impact in a market with elastic supply.

9.4 How the market price is determined: Long-Run Equilibrium

In the long run, established firms can adjust their plant sizes and can even leave the industry altogether.

9.4.1 Long-Run Output and Plant-Size Adjustments by Established Firms

In the long run, a firm can increase its profits by expanding its plant size. The long-run profit-maximizing output is the point at which long-run marginal cost equals the market price. To produce this quantity the firm utilizes a plant size that is cost-minimizing for this output level.

9.4.2 The Firm's Long-Run Supply Curve

The firm's long run supply curve coincides with its long-run marginal cost curve for prices above the minimum long-run average cost. For prices below the minimum long-run average cost, its best course of action would be to leave the industry.

9.4.3 Free Entry and Long-Run Perfectly Competitive Markets

The market price and quantity at which supply equals demand, established firms have no incentive to exit the industry, and prospective firms have no incentive to enter the industry.
3 conditions:

1. Each firm maximizes its long run profit with respect to output and plant size. P* = MC(Q*).
2. Each firm's economic profit is zero. P*=AC(Q*)
3. Market demand equals market supply, given the number of firms n* and individual firm supply decision Q*. D(P*) = n*Q*

9.4.4 Long-Run Market Supply Curve

A curve that shows the total quantity of output that will be supplied in the market at various prices, assuming that all long-run adjustments take place. There is no fixed set of individual firm supply curve to sum together.
In a perfectly competitive market that is initially in long-run equilibrium at a price P, additional market demand will be satisfied in the long run by the entry of new firms. Although the equilibrium price may increase in the short run, in the long run this process of new entry will drive the equilibrium price back down to its original level.

The long-run market supply curve will be a horizontal line corresponding to the long-run equilibrium price P.

9.4.5 Constant-cost, Increasing-cost and Decreasing-Cost Industries

9.4.5.1 Constant-cost Industry

An industry in which the increase or decrease of industry output does not affect the prices of inputs.

9.4.5.2 Increasing-cost Industry

An industry in which increases in increases in industry output increases the prices of inputs. Likely when firms use industry-specific inputs: scarce inputs that are used only by firms in a particular industry and not by other industries in the economy.

In an increasing-cost industry, the long-run supply curve is upward sloping. Increases in price are needed to elicit additional industry output in the long run, they compensate for the increases in the minimum level of long-run average cost that are driven by the increase in industry output and the resulting increase in input prices.

9.4.5.3 Decreasing-cost Industry

An industry in which increases in industry output decrease the prices of some or all inputs. (ex. Cost-reducing techniques at higher outputs).
In a decreasing-cost industry, the long run supply curve is downward sloping. Producers face lower input prices when the market produces larger quantities.

9.5 Economic rent and Producer Surplus

Two concepts to describe the profitability of firms and input owners in perfectly competitive markets: economic rent and producer surplus.

9.5.1 Economic rent

Economic rent: the economic return that is attributable to extraordinary productive inputs whose supply is scarce.
Reservation value: the return that the owner of an input could get by deploying the input in its best alternative use outside the industry.

Economic rent: willingness to pay of firms for input – input's reservation value.
Don't confuse economic rent with economic profit.

9.5.2 Producer Surplus

A measure of the monetary benefit that producers derive from producing a good at a particular price.

9.5.2.1 Producer Surplus for an Individual Firm

The producer surplus of a firms is the difference between the firm's total revenue at a particular price.

9.5.2.2 Producer Surplus for the Entire Market: Short Run

The sum of the producer suprluses of the individual firms in the market.

9.5.2.3 Producer Surplus for the Entire Market: Long Run

The producer surplus for a perfectly competitive firm in a long run equilibrium is equal to zero.
The area etween the long run supply curve and the equilibrium price is the economic rent of owners of scarce industry-specific output.

9.5.3 Economic Profit, Producer Surplus, Economic Rent

Tabel p. 312.