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The Administration
HF Tutoring
This lecture note discusses the price theory and its applications. The theory is introduced after a brief review of some basic concepts. The demand and supply of a normal good are defined and explained in detail. Practice problems and examples are used for illustration. The concept of market equilibrium is introduced and the efficiency conditions are explained. The government interventions, through the implementation of price ceilings, floors, taxes, quotas, and subsidies, and the effects of these policies on the market equilibrium are discussed. The notion of elasticity is explored and finally, externalities and the other causes of market failure are explained by means of examples.

\footnote{E-mail address: hany.fahmy@hf-consultingco.com}
Introduction and Basic Concepts

A. The Economic Concept

Economics is defined as a social science that aims to study how the society allocates its scarce resources to satisfy the society’s unlimited needs and wants in the most efficient way. Since resources are limited (scarce) and the needs and wants are unlimited, therefore, we can say that economics is the study of how people make choices.

**Definition 1** Resources (factors of production) are things that are used to produce other things to satisfy people’s wants.

**Definition 2** Production is defined as any activity that leads to converting resources into products for consumption. The resources used in production are called the factors of production (FOP). The FOP can be classified into land, labor, capital, and entrepreneurship.

**Definition 3** Land is the natural (non-human) resource that is available from nature. Land as a resource (factor of production) includes location, minerals, climate, water, and vegetation.

**Definition 4** Labor is the human resource, which includes all contributions by individuals who work.

**Definition 5** Capital can be divided into physical capital and human capital. Physical capital refers to all manufactured resources which includes buildings, equipment, and machines. Human capital refers to the accumulated training and education of workers (investing in people).

**Definition 6** Entrepreneurship (actually a subdivision of labor) involves human resources that perform the functions of organizing, managing, assembling the other factors of production, and making basic decision to improve the business.

**Definition 7** Wants refers to all what people would buy (consume).

B. The Economic Problem

The economic problem, also known as ‘scarcity problem’, refers to the gap between the limited resources and the unlimited needs and wants of the society.\(^2\)

\[
\text{Economic Problem} \implies \text{Choice} \implies \text{Opportunity Cost}
\]

\(^2\)Even if we managed to increase our resources, our needs and wants will also increase and therefore, the gap will always remain.
The scarcity problem, i.e., the economic problem, implies that we must make a choice. This means that we have to choose among different alternatives. Every choice we make involves an opportunity sacrificed (opportunity cost).

Definition 8 The opportunity cost of any decision is the gain that otherwise could have been obtained if we did not make that decision. It is the value of the next best alternative. For example, consider the choice between allocating an extra hour to either study economics or listen to music. If you choose to study economics, the opportunity cost would be the gains forgone from listening to music; if, on the other hand, you choose to listen to music, the opportunity cost of your choice would be the gains forgone from studying economics.

Example 9 The opportunity cost of holding $1000 (instead of depositing it at a bank) is the interest rate forgone. The opportunity cost of depositing $1000 at the bank is the liquidity forgone.

Example 10 Given that the amount of time available for production of two goods X and Y is 10 hours. Using this time, a firm can produce either 10 units of X or 5 units of Y. Therefore, we can say that the opportunity cost of good Y is 2 units of X and the opportunity cost of good X is 0.5 units of Y.

C. The Production Possibility Frontier (PPF) as an Application to the Opportunity Cost Concept

The PPF is a curve that represents all possible combinations of total output that could be produced using a fixed amount (full utilization) of resources in an efficient way. The PPF is used to illustrate the constrained choices that a society has to make due to scarcity of resources. This, in turn, explores the opportunity cost of each choice made.

C.1. Assumptions

1. All Resources are fully employed.

2. We are looking at production over a specific time period, one year for example, i.e., in other words; it is a short run analysis.

3. The resource inputs used to produce the two goods are fixed in both quantity and quality over this time period.

4. Technology does not change over this time period

C.2. Observations

(a) Periods of unemployment corresponds to points inside the PPF.

(b) Although an economy may be operating at full employment, i.e. full utilization of its land, capital, and labor resources, it may be still operating inside the PPF. Why? Because it uses its resources inefficiently (miss allocation of resources).
(c) Any point above the PPF, such as point G, represents combinations of capital and consumer goods that can not be reached.

(d) Point A represents the maximum amount of capital goods that can be produced if all resources are devoted to the production of capital goods and zero of consumer goods.

(e) Point B represents the maximum amount of consumer goods that can be produced if all resources are devoted to the production of consumer goods and zero of capital goods.

(f) Any point along the PPF is a point satisfying both:

   i. **Full employment**, i.e., there is no waste of resources.
   
   ii. **Production efficiency** which means that the mix of outputs is produced at least cost.

### C.3. Negative Slope and the Opportunity Cost

Scarcity is illustrated by the negative slope of the PPF. In other words, the PPF is negatively sloped because resources are limited. This point is illustrated using Figure 1.

If the society is operating along the PPF at a point F, where all resources are fully employed to produce a mix of 800 units of capital goods and 1100 units of consumer goods, and the society decided to increase its production of capital goods. In this case, resources should be shifted from its use in consumer goods to the production of capital goods because they are limited (scarcity). That is why we say the slope of the PPF is negative; if the society increases its production of capital goods, it will have to reduce its production of consumer goods.

**The Opportunity Cost** concept is also illustrated by the PPF. The opportunity cost of additional capital is the forgone production of consumer goods. For instance, considering the above case, the opportunity cost of producing one extra unit capital goods is 2 units of consumer goods.

### C.4. The Law of increasing Opportunity Cost

The negative slope of the PPF indicates the trade off that the society faces between the two goods but why it takes that shape (bowed Shape)? The answer is based on the law of increasing opportunity cost. To illustrate the concept of increasing cost, we consider the following example:

**Example 11 Production possibility schedule for total corn and wheat in country A**

<table>
<thead>
<tr>
<th>Point on PPF</th>
<th>Corn (million of bushels)</th>
<th>Wheat (millions of bushels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>700</td>
<td>100</td>
</tr>
<tr>
<td>B</td>
<td>650</td>
<td>200</td>
</tr>
<tr>
<td>C</td>
<td>510</td>
<td>380</td>
</tr>
<tr>
<td>D</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>E</td>
<td>300</td>
<td>550</td>
</tr>
</tbody>
</table>
Figure 1: Graphical Presentation of the Production Possibility Frontier

Shaded area: All points below the curve (shaded area) represent combinations of capital goods and consumer goods that are possible for the society (attainable) given the resources available and the existing technology.

Notes: Points on the shaded area, but not on the frontier, are produced with part (not all) the resources. Here all resources are not fully utilized (there is a waste of resources). Hence, we can say that any point inside the PPF is a point of both resources unemployment and production inefficiency.

Figure 2: Negative Slope of the Production Possibility Frontier

Figure 1: Graphical presentation of the production possibility frontier.
The PPF illustrates that the opportunity cost of corn increases as we shift resources from wheat production to corn production. Suppose that the society’s demand for corn increases. Farmers, in this case, will shift some resources from wheat production to corn production (moving from point C to point B than to A). The more they shift resources and move along the PPF towards A, the more it becomes difficult to produce additional corn because the suitable resource (best land) for corn production was already used and the best resource (best land) for wheat production was also used. Thus, the resources (land) become less and less suitable for the corn. This means that the opportunity cost of more corn, measured in terms of more wheat, is increasing. This is the law of increasing cost.

**Remark 12** The more specialized the resources, the more bowed the PPF is.

### C.5. Special case of PPF: Straight Line Production Possibility Frontier

In such case the opportunity cost is constant along the PPF, i.e., the slope of the PPF is constant and the rate of exchange of the two goods remains fixed from one point to the other along the frontier.

### D. How Economists Work

Economists can either follow the **theoretical approach** in their work, which is based on developing economic theories using scientific methods, or they can follow the **empirical approach**, which is based on testing these theories against actual data.

#### D.1. The Theoretical Approach

A theory is an abstraction from reality. It consists of a set of assumptions, variables, and relations among these variables. Variables could be endogenous or exogenous. Endogenous variable (also called explanatory variables) are variables based on which the theory is built. Exogenous variables are variables outside the control of the researcher; they are, therefore, treated as fixed.

**Positive Versus Normative Statements**

A positive statement is based on cause and effect. It is an objective statement and it does not include any value judgements or opinions. An example of a positive statement would be:

**Example 13** Negative externalities (pollution) resulting from economic activities have been increasing lately.

A normative statement is a subjective statement. It is based on opinions and value judgements. The following are examples of normative statements.

**Example 14** The government should lower the goods and services tax (GST).

**Example 15** The Bank of Canada should reduce the interest rate to face the current recession.
Causality Versus Correlation

Two variables are said to be correlated if they tend to move together but not necessarily influence each other. On the other hand, causality involves an influence of one variable (independent) on the other (dependent). Correlation does not imply causality.

D.2. The Empirical Approach (the Data)

An empirical approach is based on testing the existing theories against actual data. Data types can be classified as follows:

D.2.1. Time Series Data

Time series data are observations on one individual or variable over time.

D.2.2. Cross-Section Data

Cross-section data are observations on different individuals or variables at the same point in time.

D.3. Using Data: How to Construct an Index Number

To construct an index number of a given variable, we need first to choose some point in time (a base) to which the values of the variable over time can be compared. The formula for an index number is

\[
\text{Value of the index in any period} = \frac{\text{Absolute Value at that period}}{\text{Absolute Value at base period}} \times 100.
\]

For instance, consider the construction of the consumer price index (CPI). The CPI is a weighted average of the prices of a basket of goods and services produced in an economy over a period of time and is calculated as

\[
CPI_{\text{current year}} = \frac{\text{Value of the basket at current prices}}{\text{Value of the basket at base year prices}} \times 100
\]

**Example 16** Assume for simplicity that our basket consists of only two goods: Wheat and cloth, were 2003 and 2004 prices are reported in the following table

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cloth</td>
<td>12</td>
<td>16</td>
</tr>
</tbody>
</table>

Assume further that the representative consumer in the Canada buys 5 units of each consumer good. Compute the 2004 CPI using 2003 as the base year.

**Example 17** The value of the bundle (basket) at the base year is

\[(5 \text{ wheat} \times 4) + (5 \text{ cloth} \times 12) = 80\]
The value of the bundle in 2004 is

\[(5 \text{ wheat} \times 5) + (5 \text{ cloth} \times 16) = 105\]

The CPI in 2003 is

\[Index_{2003} = \frac{80}{80} \times 100 = 100\]

and the CPI in 2004 is

\[Index_{2004} = \frac{105}{80} \times 100 = 131.25\]

D.4. Nominal versus Real Variables

To nominal values are the values denominated in dollars that economic variables take. For example, if you want to calculate the nominal GDP of a country using the output approach, you can simply multiply all the final goods and services produced in the economy by the general price level, CPI, say, that is

\[\text{Nominal GDP} = Q \times P.\]

Economists, however, are more interested in the real values of the economic variables. The real value of an economic variable is computed by dividing its nominal value by a price index. In our case, the price index is called the GDP deflator, then

\[\text{Real GDP} = \frac{\text{Nominal GDP}}{\text{GDP Deflator}}.\]

E. Economic Systems

Societies are organized through different economic systems that can be summarized in the following three systems:

E.1. Market Economies (laissez faire)

A market economy is one in which individuals and private firms decide what to produce and what to consume. There is no government intervention in the market to determine what, how and for whom to produce rather they are determined by the interaction of market forces (demand and supply).

E.2. Command Economies

A command economy is one in which the government makes all important decisions about production and distribution; that is, the government owns all the means of production (land and capital). An example of command economy is the Soviet Union.

Note that the above two economic systems are the extremes. In reality, we can find neither a pure laissez faire economy nor a pure command one, rather all societies are mixed economies that combine both the free market approach and the command approach.
The Basics of Demand and Supply

A. Demand

**Definition 18** The demand for a good or a service is the amount of that good or service that the consumers are willing and able to buy at a certain price in a given period of time. The market demand (aggregate demand) shows the total demand of all consumers in the market in a given period of time.

The demand curve expresses the relation between the price of a normal good and the quantity demanded of that good. Each point on the demand curve represents the maximum amount that the consumers are willing to pay at every price. The more the quantity consumed, the lower is the amount that the consumers are willing to pay. This follows from the law of diminishing marginal utility and hence, the demand curve is negatively sloped.\(^3\) The negative relation between the quantity demanded and the price is referred to as the demand law.

### A.1. The Demand Law

\[ Q_d = f(P) \]

The demand law states that the quantity demanded of a good is a function of its own price such that as the price of a good increases, the quantity demanded of that good must decrease. This negative relation can be expressed from the following linear demand equation

\[ Q_d = a - bP \]

where \(a\) is the intercept of the equation. It shows the maximum amount demanded by the consumers when the good is freely available, i.e., when \(P = 0\). The parameter \(b\) is the slope of the demand equation as

\[ \text{Slope} = \frac{\Delta Q}{\Delta P} = -b, \]

where the negative sign confirms the demand law stated above.

---

\(^3\)The marginal utility (MU) is the additional utility that the consumer receives per additional unit consumed of a given good. The law of diminishing MU says that the MU of the additional unit consumed is less than the previous one and hence, the consumer is willing to pay less for each additional unit consumed.
A.2. The Determinants of Demand

\[ Q^d_x = f( P_x, P_S, P_C, Y, P^e, Taste, N, T ), \]

where \( P_S \) is the price of substitutes, \( P_C \) is the price of complementary goods, \( Y \) is the consumers' income, \( P^e \) is the expected price, \( N \) is the number of consumers, and \( T \) denotes taxes. The expected signs are shown beneath the variables.

**Remark 18** Before explaining the determinants of the demand, it is useful to distinguish between two concepts: The change in quantity demanded and the change in demand. A change in the quantity demanded is a change in the amount of a good demanded resulting solely from a change in price. Hence, Changes in quantity demanded are shown by movements along the demand curve. A change in demand, on the other hand, is a change in the amount of a good demanded resulting from a change in something other than the price of the good. It is represented by a shift (either upward or downward) of the demand curve.

Now we consider each factor affecting the demand in turn as follows:

1. **Change in the price of the good:** \( \Delta P_x \)

   Given that \( x \) is a normal good; as \( P_x \) increases, holding all other factors constant, the quantity demanded of good \( x \) decreases and vice versa (the law of demand). This is represented by a movement along the demand curve

   ![Change in Quantity Demanded](figure2.png)

2. **Change in the price of substitutes:** \( \Delta P_S \)

   Two goods are said to be substitutes, if the consumer can substitute one for another and still maintain the same satisfaction. Consider, for instance, frozen yogurt and ice cream. If the price of substitute goods, the frozen yogurt, increases, the quantity demanded of ice cream would increase. This is represented by a right shift of the demand curve for ice cream (see figure below)

   ![Change in Demand](figure3.png)
3. Change in the price of complements: $\Delta P_C$

Two goods are said to be complements, if they are consumed together. sugar and tea is a typical example. Consider a fall in the price of sugar, holding all other factors constant, the quantity demanded of the tea, the complementary good, increases. This is represented by a right shift of the demand curve for tea.

4. Change in income: $\Delta Y$

For normal goods, an increase in income leads to an increase in demand for that good. This is represented by a rightward shift of the demand curve. We are only considering normal goods here. However, there are other types of goods that are defined according to their relation with income:

(a) Inferior goods: As income increases, the consumer buy less of the good. Here the demand curve shifts to the left.

(b) Neutral goods: As income increases or decreases, the consumer buys the same amount of the good. Here the demand curve stays unchanged.

5. Change in consumers’ price expectations: $\Delta P^e$

If the consumers, for instance, anticipate that there will be a future price increase (inflation), then demand for the current products, with low prices, will increase. This is represented by a rightward shift of the demand curve.

6. Change in fashion and tastes

Changes in fashion and taste, e.g. food, clothing and entertainments, affect also the demand for a given good and causes the demand curve to shift either to the right or to the left.

7. Change in the number of buyers served by the market: $\Delta N$

An increase in the number of buyers, holding other factors constant, will shift the demand curve to the right and vice versa.

8. Change in government taxation policy: $\Delta T$

Whether the government increases or decreases the income tax, this would definitely affect the people’s disposable income and consequently their demand. The higher the taxation, the lower the disposable income and the lower the demand in general.

B. The Supply

Definition 20 It refers to the quantity of a good or a service that suppliers are able and willing to offer for sale to the market at various market prices during a specified period of time. The market supply (aggregate supply) shows the total quantity of goods supplied in an economy.
B.1. The Supply Law

\[ Q_s = f(P) \]

The law of supply states that an increase in the price of a good motivates the producer to increase production and thus the quantity supplied of that good must increase. The supply curve illustrates the maximum quantity of a good sellers are willing and able to produce at each and every price, all else equal. It is a curve that slopes upward and to the right showing that as the price increases the quantity supplied increases because the good becomes more profitable and vice versa. This positive relation can be expressed from the following linear supply equation

\[ Q_s = c + dP \]

where \( c \) is the intercept of the equation and the parameter \( d \) is the slope of the supply equation as

\[ \text{Slope} = \frac{\Delta Q_s}{\Delta P} = d, \]

where the positive sign confirms the supply law stated above.

B.2. The Determinants of Supply

\[ Q_s^* = f(\begin{array}{c} P_s \\ \text{change in } Q_s \\
\text{Movement} \\
\text{Shift in the Supply curve} \\
\text{shift the demand curve up or down} \\
C, L, i, \Omega \end{array}) \]

where \( C \) is the cost of raw materials, \( L \) is cost of labor, \( i \) is the interest charges, and \( \Omega \) denotes technology. The expected signs are shown beneath the variables. The analysis of the determinants of supply is the same as the one for the determinants of demand explained above.

C. The Market Equilibrium and its mechanism

The intersection between demand and supply yields the equilibrium quantity and equilibrium market price. Observe the following:
• If the actual price in the market is above the equilibrium price, then the supply exceeds the demand in the market and therefore, we have a **market surplus**.

• If the actual price in the market is below the equilibrium price, then the demand exceeds the supply in the market and therefore, we have a **market shortage**.

We need to distinguish between the above two cases and their **automatic adjustments** as follows:

**C.1. Case of Market Surplus: \( S > D \)**

When \( S > D \), the excess supply will push the price down. As price goes down, both the quantity demanded and supplied will react to this change in price such that the quantity demanded will increase (following the demand law) and the quantity supplied will decrease (following the supply law). Both changes are represented by a movement along the demand and supply curve respectively till the new equilibrium is restored. Figure 4 illustrates this market mechanism.

**C.2. Case of Market Shortage: \( D > S \)**

When \( D > S \), the excess demand will push the price up. As the price goes up, both the quantity demanded and supplied will react to this change in price such that the quantity demanded will decrease (following the demand law) and the quantity supplied will increase (following the supply law). Both changes are represented by a movement along the demand and supply curve respectively till the new equilibrium is restored as seen from Figure 5.
D. Applications: Effects of change in demand and supply on the market equilibrium

D.1. Effect of a change in demand only on equilibrium

D.2. Effect of a change in supply only on equilibrium

D.3. Effect of a change in both demand and supply on equilibrium

The above effects are summarized in the following table (see more elaboration in class)

<table>
<thead>
<tr>
<th>Change in D</th>
<th>Change in S</th>
<th>Effect on equilibrium P</th>
<th>Effect on Equilibrium Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase</td>
<td>Increase</td>
<td>Indeterminate</td>
<td>Increase</td>
</tr>
<tr>
<td>Increase</td>
<td>Decrease</td>
<td>Increase</td>
<td>Indeterminate</td>
</tr>
<tr>
<td>Decrease</td>
<td>Decrease</td>
<td>Indeterminate</td>
<td>Decrease</td>
</tr>
<tr>
<td>Decrease</td>
<td>Increase</td>
<td>Decrease</td>
<td>Indeterminate</td>
</tr>
</tbody>
</table>

E. Government Policies: Price Ceilings/Floors/Subsidies/Taxes and Quotas

The government can intervene in the market and sets a maximum or a minimum price. The term **price ceiling** is used when the government sets a price in the market that is below the equilibrium price. Price ceilings create situations of excess demand (a shortage at the government-regulated price). On the other hand, when the government sets a price that is above the equilibrium price, it is called a **price floor**. Price floors create excess supply (a surplus at the government-regulated price). Although price ceiling or price floor prevents the market from being in equilibrium, they are policies implemented by the government to achieve other social goals. Subsidies, taxes, and quotas are different forms of government interventions. Before explaining these policies, we need to consider the welfare implications of implementing such policies. In other words, we need to assess the effect on consumer surplus, producer surplus, and on the government due to such policies. To this ends, we define

**Definition 20**  **Consumer Surplus** is the benefit enjoyed by the consumer from consuming a certain amount of a good or service. It is the difference between his/her willingness to pay (point on the demand curve) and the actual price paid (see Figure 6 below)

**Definition 21** The producer surplus is the benefit enjoyed by the producer from selling certain output. It is the difference between what they are willing to accept and the market price (see Figure 6 below)
E.1. Price Ceiling

Governments introduce a price ceiling when they think that the price of an essential product is too high to the general public, e.g., prescription drugs or rent controls.

**Definition 22** Price ceiling is setting a maximum price under the free market price (the equilibrium price). Price ceiling creates shortage in the market.

**The Net Welfare Effects of Price Ceiling Policies**

Consider Figure 7 below, where \( P_{\text{ceiling}} \) is the ceiling price implemented.

\[
\begin{align*}
(1) & \quad \Delta PS = -A - C \\
(2) & \quad \Delta CS = +A - B \\
\text{Net Welfare Effect} & = -B - C \quad \text{(dead weight loss)}
\end{align*}
\]

This is the total loss to the society as a result of such a policy.

Note that this policy will NOT help the consumers if the demand on the product is inelastic, because in such a case the area B will be bigger than the area A, and consumers will end up losing overall.

E.2. Price Floor (Minimum Price)

Governments introduce a price floor when they think that the price of a product is too low to be produced under the equilibrium (free market). This usually happens with products from farmers (grains for instance) and minimum wages.

**Definition 23** Price floor is setting a minimum price above the free market price (the equilibrium price), forcing people to pay more than what they are willing to at the quantity consumed. The price floor creates a surplus in the market.

**The Net Welfare Effects of Price Floor Policies**

Consider Figure 8 below, where \( P_{\text{floor}} \) is the floor price implemented.

\[
\begin{align*}
(1) & \quad \Delta PS = +A - C \\
(2) & \quad \Delta CS = -A - B \\
\text{Net Welfare Effect} & = -B - C \quad \text{(dead weight loss)}
\end{align*}
\]
Observations:

- When the government imposes a price ceiling below the equilibrium price, the effect on consumer surplus is ambiguous (not clear). As seen from Figure 7 above, consumers as a result of this policy will gain area A and will lose area B. Therefore, the net effect on consumer surplus is not clear; if $A > B$, consumer surplus will increase; if $A < B$, consumer surplus will decrease.

- Using a similar argument, we can also say that when the government imposes a price floor above the equilibrium price, the effect on producer surplus is not clear.

- The consumer surplus and the producer surplus are maximized at the efficient output (equilibrium).

E.3. Production Quota

Production Quota is also similar to the price floor and price support; however, the production quota is usually used when the government wants to limit the production (quantity) of a specific product. In such a case the government does not offer to buy the excess from the suppliers, but instead offers to pay the producers not to produce the amount they should supply, given the market price.

E.4. Taxes and Subsidies

We shall consider only the per-unit tax case. The following observations should be noted:

1. Tax incidence: The effect of imposing a per-unit tax on the producer is the same as the effect of imposing it on the consumer.

2. Tax burden: The burden of taxation is related to the elasticity of demand and supply; the more inelastic the agent’s demand/supply, the higher the tax burden.

The subsidy, on the other hand, is a financial assistance paid by the government to keep prices below what they would be in a free market (helping consumers), or to keep alive businesses that would otherwise go bankrupt (helping producers. The effects of taxes and subsidies and how to find pre and post equilibrium prices and quantities under both cases are illustrated by means of the following example.

Example 25 Suppose the demand and supply curves of a good $X$ are given as follows

$$Q = 100 - 2P$$

$$Q = -20 + P$$

where $P$ is the price of good $X$ and $Q$ is the quantity.

(a) Solve for the equilibrium price and output. Illustrate your answer graphically

(b) Find the price elasticity of demand and the price elasticity of supply at equilibrium.
(c) Based on your findings in part (b), if a per unit tax is imposed on the consumer or the producer, how the tax burden will be shared between the agents? Explain. (No calculations are needed)

(d) Assume a per unit tax equals to $6 is imposed on the producer. Find the new equilibrium price and output, the change in consumer surplus, the change in producer surplus, the government revenue, and the net welfare effect. Find the change in total revenue for the producer as a result of this tax policy. Find the dead weight loss as a result of this policy.

(e) What is the tax burden of this tax policy? Does your answer confirm your expectations in part (c) above?

(f) Now suppose that the government decided to change its policy so that it now guarantees a price equals to $45 per unit to the producer. Find the subsidy per unit, the total subsidy paid by the government (cost), and the change in producer surplus.

(g) Consider now a third policy, which is imposing a quota equals to 16 units. What is the effect of this policy on the producer revenue and the government?

Solution 26 See solution in class.
Elasticity

The concept of elasticity is used in many disciplines; it measures the extent to which something changes in response to something else. Thus, it is after the degree of responsiveness of one variable to another. The concept of elasticity can be useful for an economist who wants to measure the response of the quantity demanded or the quantity supplied for any change in the price level. In what follows we shall digress on the different types of elasticities that might be useful for us.

A. Price Elasticity of demand $\varepsilon_d$

The price elasticity of demand measures the response of the quantity demanded to any change in the price level. The more the response of the quantity demanded to the change in price, the more elastic the demand curve is and vice-versa.

$$\varepsilon_d = \frac{\% \Delta Q_d}{\% \Delta P}$$

Note that the price elasticity of demand is always negative because of the demand law, however, we express it in absolute terms as we care about its magnitude. We can have the following cases (graphs are omitted):

1. If $\% \Delta Q_d < \% \Delta P \implies |\varepsilon_d| < 1 \implies$ Inelastic demand (steep line)
2. If $\% \Delta Q_d > \% \Delta P \implies |\varepsilon_d| > 1 \implies$ Elastic demand (flat line)
3. If $\% \Delta Q_d = \% \Delta P \implies \varepsilon_d = 1 \implies$ Unit elastic demand (45 degree line)
4. If $\% \Delta Q_d = 0 \implies \varepsilon_d = 0 \implies$ Perfectly Inelastic demand (vertical line)
5. If $\% \Delta P = 0 \implies \varepsilon_d = \infty \implies$ Perfectly elastic demand (horizontal line)

Remark 27 We mentioned earlier that the demand curve is negatively sloped because of the law of diminishing marginal utility. The degree of the decrease in the marginal utility will determine whether the demand is elastic or inelastic. For instance, a good that has an inelastic demand has that characteristic because as the quantity consumed of it rises, the marginal utility falls quickly.

A.1. Calculations

There are two methods to calculate the elasticity; namely (1) Arc Elasticity and (2) Point Elasticity. We shall consider both methods in what follows
Arc Elasticity (Two Points)

Arc elasticity will calculate the elasticity of demand between two points. The elasticity along the arc is calculated using the following formula

\[ \varepsilon_d = \frac{\frac{(Q_d - Q_f)}{Q_d + Q_f}/2}{\frac{(P_d - P_f)}{(P_d + P_f)/2}} \]

Point Elasticity (a Point + Slope of Demand)

Point Elasticity is calculated by knowing the demand curve equation and any given point at which we can calculate the elasticity of demand. The formula used to calculate the point elasticity is

\[ \varepsilon_d = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q} \]

where \( \frac{\Delta Q}{\Delta P} \) is slope of the demand curve.

**Problem 31** Consider the following demand function

\[ Q^d = 60 - 2P_x \]

Calculate the elasticity of demand at a price of 10.

**Solution 32** The quantity demanded at \( P = 10 \) is obtained by substituting \( P \) into the demand equation. This yields \( Q^d_x = 40 \). The price elasticity of demand is then

\[ \varepsilon_d = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q} = -2 \times \frac{10}{40} = -0.5 \]

or

\[ |\varepsilon_d| = 0.5 < 1 \]

and thus, we conclude that the demand is inelastic at \( P = 10 \).

A.2. Elasticity and the slope of the demand curve

Although the slope of the demand curve is constant, the elasticity of demand is changing from one point to the other; moving down to the right along the demand curve, the price elasticity of demand will increase from 0 when \( Q = 0 \) to \( \infty \) when \( P = 0 \) (see Figure 9 below). Therefore, it is not generally true that a steep slope for a demand curve implies inelastic demand, and a flat slope for a demand curve implies elastic demand.
A.3. Elasticity, Marginal Revenue, and Total Revenue

Total revenue, $TR$, is the value of the output sold. It is defined as $TR = P \times Q$, where $P$ is the price per unit and $Q$ is the quantity sold. The marginal revenue is the additional revenue per additional unit sold as 

$$ MR = \frac{\Delta TR}{\Delta Q}. $$

Two particulars are worth noting here:

1. At the mid-point of the linear demand curve, the price elasticity of demand equals 1. It can be shown (see elaboration in class) that if

$$ |\varepsilon^d| = 1 \implies MR = 0 \implies TR = \text{max}. $$

2. The effect of changing price on total revenue. Knowing that $TR = P \times Q$,

an increase or decrease in price will have two contradicting effects on $TR$. Consider, for instance, the case of an increase in price. Two effects are observed:

(a) A direct effect: As $P \uparrow \implies TR \uparrow$.
(b) An indirect effect: As $P \uparrow \implies Q \downarrow$ (demand law) $\implies TR \downarrow$.

The total effect on $TR$ is the sum of (a) and (b). If the direct effect exceeds the indirect effect, $TR$ will increase; if, on the other hand, the indirect effect exceeds the direct effect, $TR$ will decrease. To determine which effect exceeds the other, we have to consider the price elasticity of demand. If the demand is elastic (small increase in $P$ will cause $Q$ to decrease heavily), then the indirect effect will exceed the direct one and eventually $TR$ will fall if you raise the price. If the demand is inelastic, an increase in price will cause $TR$ to increase. That’s why the $TR$ of a monopolist (facing an inelastic demand) will increase if he/she raises the price.

3. Total Revenue, Elasticities and Pricing Strategies. Sometimes the producer can distinguish between his or her consumers’ price elasticity of demand for the product. For instance, consider the case in which the producer can distinguish between two groups: One group likes the product and thus, has low elasticity of demand for the product (inelastic demand); the other group, however, has a relatively high elasticity of demand. In such a case, the producer can increase his or her total revenue by charging a high price for the inelastic demand group and a low price for the elastic demand group.