# Contents

## I Lecture Note

1 September 14th  
1.1 What is “Economics”? .............................................. 1  
1.2 Guide to Economic Reasoning .................................. 1  
1.3 Economic Cost ...................................................... 2  

2 September 16th  
2.1 Positive and Normative Economic Statement ................. 3  
2.2 Production Possibility Model .................................. 4  

3 September 21st  
3.1 Production Trade-off Opportunity Cost ....................... 5  
3.2 Comparative Advantage .......................................... 6  
3.3 Benefits of Trade ................................................ 7  

4 September 30th  
4.1 Demand Analysis .................................................. 8  
4.2 Supply Analysis .................................................... 10  

5 October 5th  
5.1 Supply Analysis .................................................... 11  
5.2 Market Mechanism ............................................... 12

*The part of lecture note is taken in Tade’s class and the part of discussion session is written by me. I thanks Tomoko Wada for sharing her materials of discussion session of APEC 1101 Spring 2015.
<table>
<thead>
<tr>
<th>Date</th>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 October</td>
<td>6.1 Example of Tax</td>
<td>13</td>
</tr>
<tr>
<td>7 October</td>
<td>7.1 Elasticity</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>7.2 Computing The Coefficient of Price Elasticity</td>
<td>15</td>
</tr>
<tr>
<td>8 October</td>
<td>8.1 Computation The Coefficient of Price Elasticity of Demand</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>8.2 Elasticity of Demand Along A Linear Demand Curve</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>8.3 Elasticity of Demand and Total Revenue</td>
<td>17</td>
</tr>
<tr>
<td>9 October</td>
<td>9.1 Elasticity, Total Revenue, and Demand</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>9.2 Income Elasticity of Demand</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>9.3 Cross-Price Elasticity of Demand</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>9.4 Elasticity of Supply</td>
<td>20</td>
</tr>
<tr>
<td>10 October</td>
<td>10.1 Elasticity of Supply</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>10.2 In Class Exercise</td>
<td>21</td>
</tr>
<tr>
<td>11 November</td>
<td>11.1 Consumer Demand</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>11.2 Law of Diminishing Marginal Utility</td>
<td>23</td>
</tr>
<tr>
<td>12 November</td>
<td>12.1 Utility Analysis</td>
<td>25</td>
</tr>
<tr>
<td>13 November</td>
<td>13.1 Indifference Curve Analysis</td>
<td>26</td>
</tr>
<tr>
<td>14 November</td>
<td>14.1 Indifference Curve</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>14.2 Consumer Equilibrium</td>
<td>29</td>
</tr>
<tr>
<td>15 November</td>
<td>15.1 Production</td>
<td>30</td>
</tr>
<tr>
<td>16 November</td>
<td>16.1 Costs of Production in the Short-Run</td>
<td>32</td>
</tr>
<tr>
<td>Date</td>
<td>Event</td>
<td>Page</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>------</td>
</tr>
<tr>
<td>17 December</td>
<td>Profit Maximization</td>
<td>34</td>
</tr>
<tr>
<td>17 December</td>
<td>Types of Profits</td>
<td>34</td>
</tr>
<tr>
<td>18 December</td>
<td>Pure or Perfect Competition</td>
<td>37</td>
</tr>
<tr>
<td>18 December</td>
<td>Short-Run Output/Behavior</td>
<td>38</td>
</tr>
<tr>
<td>19 December</td>
<td>Shut-Down Price</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Long-Run Equilibrium/Adjustment</td>
<td>39</td>
</tr>
<tr>
<td>II Appendix (Discussion Session)</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>September 18th (TA)</td>
<td>The Cost-Benefit Principle:</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Positive/Normative Economics</td>
<td>42</td>
</tr>
<tr>
<td>September 25th (TA)</td>
<td>Opportunity Cost</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Production Possibility Frontier (PPF)</td>
<td>43</td>
</tr>
<tr>
<td>September 25th (TA)</td>
<td>Quiz 1</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Opportunity Cost</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Consumer Demand</td>
<td>46</td>
</tr>
<tr>
<td>October 8th (TA)</td>
<td>Review Terms</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Practice Questions</td>
<td>47</td>
</tr>
<tr>
<td>October 15th (TA)</td>
<td>Review for HW1</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Price Elasticity of Demand</td>
<td>49</td>
</tr>
<tr>
<td>November 5th (TA)</td>
<td>Quiz 2</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Consumer Theory</td>
<td>53</td>
</tr>
</tbody>
</table>
G  November 13th (TA)  
G.1  Review Some HW Questions  54  
G.2  Budget Constraint  55  
G.3  Utility Maximization  55  

H  December 4th (TA)  
H.1  Short-Run V.S. Long-Run  57  
H.2  Profit Maximization  58  
H.3  Firms under Perfect Competition  58  
H.4  Consumer and Producer Surplus  58
Part I

Lecture Note

1 September 14th

Objectives

1. Definition concepts and terminology
2. Thinking like an economist

1.1 What is “Economics”?

Definition (Economics). Economics is the study of how individuals coordinates their wants and desires, given the decision-making mechanism, social custom and political realities of a society.

The fundamental idea of economics is scarcity (conflict between resource scarcity and individual unlimited desires).

Note. A key word in our definition of economics is coordination. There are three central features:

1. What and how much to produce;
2. How to produce;
3. For whom to produce.

1.2 Guide to Economic Reasoning

Economists are trained to think critically in a particular way. They are trained to evaluate the cost and the benefit of a particular choice of policy.

Example (Cost Benefit Principle). How to analyze a choice (e.g., highway construction and university enrollment)?

Definition (Marginal Cost). The incremental cost of producing the last unit of output (an additional unit of a good).

Example (Study for An Exam). Your desire to read additional page is decreasing/diminishing.

Definition (Sunk Cost). A cost that has already been incurred and cannot be recovered.

Example (Taxi). $20 commission fee at the beginning and additional $2 per trip after. An individual thereafter the payment of commission fee is to decide whether you are going to make another trip and $20 is the sunk cost which does not affect his decision after the payment of commission fee.

Definition (Marginal Benefit). Incremental gain from consuming an additional unit of a good.
1.3 Economic Cost

Economic reasoning is based on the premise that everything has a reasonable cost which can lead to the following outcomes. For example,

1. For a problem about pollution, additional cost of clean up maybe too high.
2. Providing guaranteed employment for everyone may reduce the ability of the economy to adapt to new technology.

Putting cost benefit principle to work can be a challenging undertaking. In order to do so, we must be able to choose and measure the costs and benefits directly.

**Definition (Opportunity Cost).** To better assess the cost of a good, an opportunity cost is the value of the next best alternative that must be given in order to satisfy a present desire consumption.

**Example.** Payment to a national debt is an opportunity cost (tradeoff) of the funding for Obama care.

**Economic Force and Market Force** The concept of opportunity cost applies to all aspects of life and this is fundamental to our understanding of how society reacts to shortages and surplus.

- Economic force is a necessary reaction (response) to scarcity. For example, how to allocate the dormitory rooms and how to allocate food in U.S.
- Market force is an economic force that is given free reign by society to operate through the market.

A society cannot prevent an economic force to occur but can prevent building a market and hence prevent a market force. For example, consider the following

1. Adoption (v.s. market for children);
2. Responsibility to children (law and moral responsibility);
3. Alcohol purchase (age restriction by law and moral responsibility).
2 September 16th

Objectives

1. Thinking like an economist
2. Definitions and concepts
3. Production Possibility Model
4. Summary

Definition (Invisible Hand). Households and firms interact in markets as if guided by an invisible hand which leads to desirable market outcomes that benefits society. (Smith, Adam. 1776. The Wealth of Nations.)

Invisible hand is also known as market mechanism.

It implies the commodities you purchase are at the value of your payments.

Definition (Methods in Economics). Economists have examined/thought about the economy for a long time. On the basis of their examination they have developed insights into how the economy works. These insights are often based on generalizations called theorems.

Definition (Economic Model). An abstract representation of economic reality.

Definition (Microeconomics). The study of individual choice and how the choice is influenced by economic forces.

How does economic theory apply to reality?

We introduce the institutions in society. An institution is an agency that can affect/influence economic behavior.

Definition (Economy Policy). Economic policies are actions taken by the government to influence economic behavior.

2.1 Positive and Normative Economic Statement

• Positive Economic Statement
  
  – The study of what is and how the economy works.

An positive economic statement is an economic statement can be proven by empirical evidence. It is a not a TRUE-or-FALSE statement. Economists might often disagree with each other.

• Normative Economic Statement
Study of that the goals of the economy should be.

This is not a statement can be tested.

**Example.** Two economists in response to a recession:

2. Economist B: Lower taxes

In the positive realm, economists disagree each other because they have imperfect knowledge about how economy works.

In the normative realm, economists might differ about the role of government in the economy.

(More complicated and more about different perceptions and views. Think about different schools of economic thought. It, to some extend, sounds like the religion beliefs.)

The art of economics, referred to as political economy, is the application of the knowledge learned in positive economics to the achievement of the goals we have outlined in normative economics.

### 2.2 Production Possibility Model

Every economy must solve their coordination problems:

1. Produce or not and how much
2. How to produce
3. For whom is produce

**Example.** Production Possibility Table with Application of Opportunity Cost

<table>
<thead>
<tr>
<th>Lattes</th>
<th>10</th>
<th>8</th>
<th>6</th>
<th>4</th>
<th>2</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple Juice</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

The production possibility table shows the productions able to be achieved with given resources.

The production possibility frontier/curve (PPF/PPC) illustrates the maximum combinations of Lattes and Applied Juice that can be produced if all resources are fully efficiently employed/allocated in production.

An opportunity cost of a bottle of apple juice is the number of cups of lattes we give up to produce a bottle of apple juice.

$$\frac{\Delta L}{\Delta AJ} = |-2| = 2.$$  

The negative sign implies there are 2 cups of Lattes should be given up and by using the resources allocated to that 2 cups of Lattes, we can produce a bottle of Apple Juice. Note that we take the absolute value since economists do not like negative number.
3 September 21\textsuperscript{th} 

Objectives

1. Production Possibility Model
2. Opportunity Cost
3. Comparative Advantage
4. Benefits of Trade

If the economy is operating at any point along the PPF, then every resource in this economy is fully efficiently allocated.

3.1 Production Trade-off Opportunity Cost

- The production of every good involves a trade-off.
  - For producing each additional bottle of Apple Juice, we have to forgo the production of two cups of Lattes.

- There is a limit to what can be produced given the existing resources.
  - It implies we cannot afford to produce any combination above the PPF because of the limited resources (the scarcity of resource).

- Linear PPF is somewhat unrealistic because it implies that the tradeoffs in production processes are constant. In reality the tradeoffs in production processes differ. For example, consider the case of your study, that is, you can involved in reading your book for several hours but not the whole day.

Concave PPF

<table>
<thead>
<tr>
<th>Obs</th>
<th>% Resources</th>
<th>Tons of Steels</th>
<th>% Resources</th>
<th>Yards of Textiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>4</td>
<td>80</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>7</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>9</td>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
<td>11</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- A concave PPF implies increasing opportunity cost PPF.
– From the observation (obs.) 1 to 2, the opportunity cost of steels is 0.25 yards of textiles.
  From the obs. 2 to 3, the opportunity cost of steels is 0.67 yards of textiles.
  From the obs. 3 to 4, the opportunity cost of steels is 1.5 yards of textiles.
  From the obs. 4 to 5, the opportunity cost of steels is 2 yards of textiles.
  From the obs. 5 to 6, the opportunity cost of steels is 5 yards of textiles.
– The expansion of steel output is at expense of textile output (forgoing the production of textiles).
– The increasing opportunity cost implies that some resources are suitable for production of steels at the beginning and we use them first to produce the steels. After we use up these resources we have to use other resources which are suitable for production of textiles to produce the steels and hence suffer a higher cost. In other words, some resources have a comparative advantage relative to the others and resources are not easily adaptable.

3.2 Comparative Advantage

The reason for an increasing opportunity cost PPF is that resources are better suited to the production of certain goods over other goods in economics. Terminology we would say some resources have a comparative advantage in the production of certain goods over other resources.

Efficiency implies getting as much output as possible given the level of inputs. Thus, the combinations along the PPF are efficient while any combination within PPF is inefficient. Inefficiency implies that we can increase the production of one good without forgoing the production of the other good.

Expansion of PPF

- Improvement of Technology/Resource
- Natural Resource Discovery
- Biased Technological Change

![Graph](image-url)
3.3 Benefits of Trade

- Two countries: Brazil and Germany
- Two goods: textiles and steels
- Production

<table>
<thead>
<tr>
<th>Country</th>
<th>Yards of Textiles</th>
<th>Tons of Steels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>5000</td>
<td>1</td>
</tr>
<tr>
<td>Germany</td>
<td>1000</td>
<td>4</td>
</tr>
</tbody>
</table>

- The opportunity cost of 1 yard of textile in Brazil is 0.0002 tons of steels.
- The opportunity cost of 1 yard of textile in Germany is 0.0004 tons of steels.
- Brazil has a comparative advantage over German in the production of textiles relative to steels. The claim also implies the other side: German has a comparative advantage over Brazil in the production of steels.

- Autarky: A economy is autarky is that the economy is isolated from others and only consumes self-produced goods.

- If we consider the case of specialization, the country specialized to produce textiles should be the country has a comparative advantage over the others. ¹ Then the trade consistent to the comparative advantage and help two countries achieve the combination beyond PPF.

¹The country specialized to produce textiles means the country is assigned to produce textiles only.
4 September 30th

Objectives

- Market Mechanism:
  1. Demand Analysis
  2. Supply Analysis

Example (Examine The Law of Market). Imagine you are in a market of running shoes.

1. Find a place to go/purchase your items (i.e., go to a market).
2. Find how the price is determined. Then we need to understand the two sides of this market (i.e., supply and demand).

Definition (Market). A market is any arrangement that brings buyers and sellers together. A market can be a location where buyers and sellers meet or it may not involve a physical space instead it could be online.

Note. Market is a place (not necessarily a physical place) where buyers and sellers meet. There are two sides in the market: buying side (demand) where the one wants to purchase and selling side (supply) where the one wants to sell.

4.1 Demand Analysis

Definition (Demand). The range of quantities of a commodity that a buyer is willing and able to purchase at different prices in a specific time period.

That is, buyers should have both willingness and capacity to purchase the good.

<table>
<thead>
<tr>
<th>Price of Doughnut</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>0</td>
</tr>
<tr>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>2</td>
</tr>
<tr>
<td>1.5</td>
<td>3</td>
</tr>
<tr>
<td>1.0</td>
<td>4</td>
</tr>
<tr>
<td>0.50</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 4.1: Hypothetical Demand Schedule

The demand curve is downward sloping from left to right which implies an inverse relationship between price and quantity.
**Determinants of Demand**  When we analyze one of them, we assume ceteris peribus, i.e., all the others remain/all the others hold constant.

1. Price of the good
   The change of price will cause a movement on the demand curve rather than a shift of the demand curve.

2. Income
   Consider a normal good. If your income increases (decreases), your demand curve will shift to the right (left).

3. Price of related good
   (1) Consider bagels and doughnuts are **substitute goods**. If the price of bagels increases, the demand of doughnuts will shift to the right.
   (2) Consider a pair of shoes, and the left shoe and the right shoe are **complementary goods**. If the price of the left shoe increases, the demand of the right shoe will shift to the left.

4. Taste/Preference
   If there is a favor or fashion for a good, the demand curve of that good will shift to the right.

5. Expectations
   If we expect there is a price increase (demand), the demand curve will shift to the right (left).

6. Number of Buyers/Population
   If the number of buyers increases, the demand curve will shift to the right.

7. Taxes/Subsidies
   If taxes increase, the demand curve shift to the left, or if there is no tax, it will shift the right.

8. Wealth

*Note.* A change of a good’s price, ceteris peribus, is the only determinant causes a movement along its demand curve. All other determinants might cause a shift of its demand curve.

**Definition** (The Law of Demand). There is an inverse relationship between the price of a good and the quantity demand of the good.

**Definition** (Normal Good). A good is a normal good if we purchase less (more) as our income decreases (increases).

Consider a normal good. If your income increases, your demand of that good shifts to the right.

---

Definition (Inferior Good). A good is a inferior good if we purchase less (more) as our income increases (decreases).³

Consider a inferior good. If your income increases, your demand of that good shifts to the left.

4.2 Supply Analysis

Definition (Supply). Supply is the range of quantities of a commodity that a seller is willing and able to offer for sale at different prices in a specific time period.

<table>
<thead>
<tr>
<th>Price of Pizza</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>16</td>
</tr>
<tr>
<td>3.0</td>
<td>12</td>
</tr>
<tr>
<td>2.0</td>
<td>8</td>
</tr>
</tbody>
</table>

Figure 4.2: Hypothetical Demand Schedule

The supply curve is upward sloping from left to right which implies an positive relationship between price and quantity.

5 October 5th

Objectives

1. Supply
2. Market Mechanism
3. Algebra of Supply and Demand

5.1 Supply Analysis

Recall that the supply curve is upward which implies a positive relationship between price and quantities in supply.

An increase (a decrease) in supply refers to a right (left) shift of supply curve.

Determinants of Supply

1. Prices
   
   An increase in price will cause an increase in quantity supplied. Conversely, a decrease in price will cause a decrease quantity supplied.

2. Number of sellers
   
   The supply curve will shift to the right as the number of sellers increases, vice versa.

3. Expectations

4. Production Costs

5. Technological Change

   An improvement in technology makes production more efficient which implies at the original price the supply will shift to the right.

6. Weather Conditions

7. Prices of Related Products

   (a) Supply curves of (two) substitute goods will move in the opposite directions.

   (b) Supply curves of (two) complementary goods will move in the same direction.

8. Taxes/Subsidies

   (a) An increase in tax will serve a reduce (a left shift) in supply since the seller will pay for this increase of production cost.
(b) Subsidy is a payment to suppliers which causes a reduction in production cost and hence leads a right shift in supply.

**Definition (The Law of Supply).** There is a positive relationship between the price of good and the quantity supplied of the good.

Like the demand, the price will only cause a movement along the supply curve rather than a (left or right) shift.

### 5.2 Market Mechanism

Examine the interaction between the buyers (demanders) and the sellers (suppliers).

In a non-restrict market (i.e., there does not exist a price/quantity control), a pair of an equilibrium price and quantity consists of a market clearing price and quantity, at which a market does not suffer a shortage or an excess of a good.

![Figure 5.1: Equilibrium Price, Price Ceiling, and Price Floor](image)

**Definition (Price Ceiling).** An instituted price set by a regulatory agency below the equilibrium price (i.e., the market clearing price) such that the price cannot rise above the instituted price.

**Note.** (i) A price ceiling is an instituted price below the equilibrium price not a shortage. However, the consequence/outcome of a price ceiling is a shortage.

(ii) If there is a shortage of a good, a market price will go up to the equilibrium price. Then a price ceiling puts a upper pressure of the market price.

**Definition (Price Floor).** An instituted price set by a regulatory agency above the equilibrium price (i.e., the market clearing price) such that the price cannot fall below the instituted price.

**Note.** If there is a excess demand, a market price will fall down to the equilibrium price. Then a price floor gives a support of the market price.
6 October 7th

6.1 Example of Tax

Question  Given the demand \( Q_{d} = 20,000 - 500P \) and the supply \( Q_{s} = 5,000 + 1,000P \), suppose an excise tax is levied on suppliers of T-Shirts and the amount of the tax is $2.

Solution: The supply with tax is \( Q_{s}^{T} = 5,000 + 1,000(P - 2) = 3,000 + 1,000P \).

By market clearing condition at the equilibrium, \( Q_{s}^{T} = Q_{d} \) which implies

\[
\begin{align*}
3000 + 1000P &= 20000 - 500P \\
1500P &= 17000 \\
P &= 11.33.
\end{align*}
\]

Shift of Supply Curve  To determine a shift of supply curve on \( x \)-axis (\( y \)-axis), we need to examine the difference between \( x \)-axis (\( y \)-axis) intercepts of \( Q_{s} \) and \( Q_{s}^{T} \).

In this example, the \( x \)-axis (\( y \)-axis) intercept of \( Q_{s} \) is 5,000 (−5), while that of \( Q_{s}^{T} \) is 3,000 (−3). Hence, the supply curve shifts along \( x \)-axis to the left by 2,000 units of quantity (shifts upward by 2 units of price).

Tax Distribution  The tax is collected from the seller. However, it does not necessarily mean the seller pays all tax. To investigate the tax distribution, we need to compare the equilibrium price with tax to the equilibrium price without tax.

In this example, the equilibrium price without tax is \( P = 10 \) (by solving \( P \) from \( Q_{d} = Q_{s} \)). Hence the tax payed by consumer is \( 11.33 - 10 = 1.33 \) and the tax payed by supplier (producer) is \( 2 - 1.33 = 0.67 \). In this scenario with tax distortion, the supplier (producer) price is \( P_{s} = 10 - 0.67 = 9.33 \).

Alternatively, the supplier (producer) price solves the problem, \( Q_{d}^{T} = Q_{s} \); that is,

\[
\begin{align*}
20,000 - 500(P_{s} + 2) &= 5,000 + 1,000P_{s} \\
19,000 - 500P_{s} &= 5,000 + 1,000P_{s} \\
14,000 &= 15,00P_{s} \\
P_{s} &= 9.33.
\end{align*}
\]

It implies the tax payed by supplier (producer) is \( 10 - 9.33 = 0.67 \) and the tax payed by consumer is \( 2 - 0.67 = 1.33 \).
7 October 19th

Objectives  Elasticity of Demand and Supply

1. Elasticity of Demand
   
   (a) Definition
   
   (b) Computation
   
   (c) Interpretation

7.1 Elasticity

Definition (Generic/General Elasticity). How a variable say, $Y$, responds/sensitive to changes in another variable say, $X$.

\[
\text{Elasticity} = \frac{\% \Delta \text{ in } Y}{\% \Delta \text{ in } X}.
\]

Beyond the Law of Demand, we can further investigate the inverse relation between price and quantity.

Definition (Elasticity of Demand). The price elasticity of demand is the responsiveness/sensitivity of quantity demanded to price changes.

Determinants of Elasticity of Demand

1. Necessity v.s. Luxuries
   
   People are not sensitive to the price change of necessity (e.g., toothpaste) but sensitive to that of luxuries (e.g., iPhone).

2. Substitutes
   
   Fish v.s. Chicken or Pork v.s. Beef

3. Price of Good Relative to Income
   
   People are sensitive to the good accounted for a big portion of your income.

4. Time

The Coefficient of Price Elasticity of Demand

\[
E_d = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}} = \frac{\% \Delta Q}{\% \Delta P} = \frac{\Delta Q}{\Delta P} \frac{Q}{P} = \frac{\Delta Q}{\Delta P} \frac{P}{Q}.
\]
We measure elasticity in percentage terms. Why? Suppose your tuition increases from $23,000 → $23,001 and price of a burger from $3 → $4. How will we respond to the same amount of change in prices for different goods? [Use demand elasticity]

Establish a rule to determine how sensitive we are to a given amount of change in price.

- The demand is elastic if $1 < |E_d| < \infty$ (responsive to price changes), i.e., $\% \triangle P < \% \triangle Q$.
- The demand is inelastic if $0 \leq |E_d| < 1$ (unresponsive to price changes), i.e., $\% \triangle P > \% \triangle Q$.
- The demand is unit elastic if $|E_d| = 1$, i.e., $\% \triangle P = \% \triangle Q$.

7.2 Computing The Coefficient of Price Elasticity

There are two ways to compute the coefficient of price elasticity of demand:

1. Point Formula/ Point Elasticity
2. Midpoint Formula

Example. (1) Suppose the initial price is $1.00 and the second price is $1.10, and the initial quantity is 5 units and the second quantity is 4 units.

Solution: $\% \triangle Q = \frac{Q_2 - Q_1}{Q_1} \times 100 = \frac{4 - 5}{5} \times 100 = -20\%$ and $\% \triangle P = \frac{p_2 - p_1}{p_1} \times 100 = \frac{1.10 - 1.00}{1.00} \times 100 = 10\%$. Hence $E_d = \% \triangle Q/\% \triangle P = -2$. It implies a 1% increase in price will lead a 2% decrease in quantity.

(2) Consider a converse scenario of part (1).

Solution: $\% \triangle Q = \frac{5 - 4}{4} \times 100 = 25\%$ and $\% \triangle P = \frac{1.00 - 1.10}{1.10} \times 100 = -9\%$. Hence $E_d = \% \triangle Q/\% \triangle P = -2.77$, which is quite different from the elasticity in part (1). Note that the change is because that we change the initial price and quantity in part (2).
8 October 21\textsuperscript{th}

**Objectives**  Elasticity of Demand and Supply

1. Computation
2. Elasticity of Demand Along A Linear Demand Curve
3. Elasticity of Demand and Total Revenue

### 8.1 Computation The Coefficient of Price Elasticity of Demand

The second method for computing the coefficient of price elasticity of demand is the midpoint or ARC method. It contrasts with the point elasticity, which is the limit of the arc elasticity as the distance between the two points approaches zero and which hence is defined at a single point rather than for a pair of points. Recall the definition of price elasticity of demand:

\[
E_d = \frac{\% \Delta \text{ in Quantity Demand}}{\% \Delta \text{ in Price}},
\]

where in the ARC method \(\% \Delta Q\) and \(\% \Delta p\) are defined as below

\[
\% \Delta Q = \frac{Q_2 - Q_1}{\frac{1}{2} (Q_1 + Q_2)} \quad \text{and} \quad \% \Delta p = \frac{p_2 - p_1}{\frac{1}{2} (p_1 + p_2)}.
\]

**Example.** Suppose \((p_1, Q_1) = (\$12, 8 \text{ units})\) and \((p_2, Q_2) = (\$20, 2 \text{ units})\).

\[
\% \Delta Q = \frac{2 - 8}{\frac{1}{2} (2 + 8)} = -1.2 \quad \text{and} \quad \% \Delta p = \frac{20 - 12}{\frac{1}{2} (20 + 12)} = 0.5. \quad \text{Hence} \quad E_d = \left| \frac{-1.2}{0.5} \right| = 2.4.
\]

**Rule of Thumb of** \(E_d\)

- \(E_d > 1\): Elastic \(\implies\) Price is more important than quantity purchased.
- \(E_d < 1\): Inelastic \(\implies\) Price is less important than quantity purchased.
- \(E_d = 1\): Unit Elastic \(\implies\) Price and Quantity are equally important.
- Extreme Cases

![Graph of Perfect Inelastic Demand](image1)

![Graph of Perfect Elastic Demand](image2)
- Perfect Inelastic: price does not matter, and $E_d = 0$.
- Perfect Elastic: price does matter, and $E_d = \infty$.

8.2 Elasticity of Demand Along A Linear Demand Curve

8.3 Elasticity of Demand and Total Revenue

Recall the definition of total revenue: $TR = p \times Q$.

<table>
<thead>
<tr>
<th>$P$</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q$</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>$TR$</td>
<td>0</td>
<td>9</td>
<td>16</td>
<td>21</td>
<td>24</td>
<td>25</td>
<td>24</td>
<td>21</td>
<td>16</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

- If demand is elastic, then a 1% decrease in price will cause an increase more than 1% in quantity; that is, the change in quantity will outweigh the change in price. Hence total revenue will increase.

- If demand is inelastic, then a 1% decrease in price will cause an increase less than 1% in quantity. Hence total revenue will decrease. It implies people are responsive to the price change but not so sensitive.

- If demand is unit elastic, then price and quantity are equally important. Roughly speaking, total revenue remains the same.
9 October 26th

Objectives  Elasticity of Demand and Supply

1. Elasticity, Total Revenue, and Demand
2. Income Elasticity of Demand
3. Cross-Price Elasticity of Demand
4. Elasticity of Supply

9.1 Elasticity, Total Revenue, and Demand

Consider the following example:

\[
\begin{array}{ccc}
\text{P} & \text{Q} & \text{TR} \\
10 & 0 & 0 \\
9 & 1 & 9 \\
8 & 2 & 16 \\
7 & 3 & 21 \\
6 & 4 & 24 \\
5 & 5 & 25 \\
4 & 6 & 24 \\
3 & 7 & 21 \\
2 & 8 & 16 \\
1 & 9 & 9 \\
0 & 10 & 0 \\
\end{array}
\]

Note.  (i) In the inelastic portion of our demand curve, as price increases, TR also increases. Price and TR move in the same direction.

(ii) Beyond unit elastic price (i.e., $5), TR declines as price increases. In other words, price and TR move in opposite direction.
9.2 Income Elasticity of Demand

Definition (Income Elasticity of Demand). The responsiveness quantity demanded to changes in income. The coefficient of income elasticity of demand is

\[ E_I = \frac{\% \Delta \text{ in Quantity Demanded}}{\% \Delta \text{ in Income}}. \]

Computation formulas:

- Point Formula
  \[ E_I = \frac{\Delta Q}{Q} \div \frac{\Delta I}{I} = \frac{\Delta Q}{\Delta I} \frac{I}{Q} \]
- Midpoint Formula
  \[ E_I = \frac{Q_2 - Q_1}{\frac{1}{2}(Q_1 + Q_2)} \div \frac{I_2 - I_1}{\frac{1}{2}(I_1 + I_2)} \]

Rule of Thumb for \( E_I \)

- \( E_I > 0 \): Normal Good (Quantity demanded increases as income increases.)
  - \( 0 < E_I \leq 1 \): Necessity Good
  - \( E_I > 1 \): Luxury Good
- \( E_I < 0 \): Inferior Good (Quantity demanded decreases as income increases.)

Note. Do Not take the absolute value of \( E_I \) since the sign of \( E_I \) implies it is a normal good or an inferior good, although we can take the absolute value of \( E_d \) since \( E_d \) is always negative due to the Law of Demand.

9.3 Cross-Price Elasticity of Demand

Definition (Cross-Price Elasticity of Demand). The responsiveness of quantity demanded of Good \( A \) to a change in the price of Good \( B \). The coefficient of cross-price elasticity of demand is

\[ E_{Q_A,P_B} = \frac{\% \Delta \text{ in Quantity Demanded in Good } A}{\% \Delta \text{ in price of Good } B}. \]

Computation formulas:

- Point Formula
  \[ E_{Q_A,P_B} = \frac{\Delta Q_A}{Q_A} \div \frac{\Delta P_B}{P_B} = \frac{\Delta Q_A}{\Delta P_B} \frac{P_B}{Q_A} \]
- Midpoint Formula
  \[ E_{Q_A,P_B} = \frac{Q_{A2} - Q_{A1}}{\frac{1}{2}(Q_{A1} + Q_{A2})} \div \frac{P_{B2} - P_{B1}}{\frac{1}{2}(P_{B1} + P_{B2})} \]
Rule of Thumb for $E_{QA,P_B}$

- $E_{QA,P_B} > 0$: Substitutes
- $E_{QA,P_B} < 0$: Complements

Note. Do Not take the absolute value of $E_{QA,P_B}$ since the sign of $E_{QA,P_B}$ implies the substitutes or complements.

### 9.4 Elasticity of Supply

**Definition** (Elasticity of Supply). The responsiveness of quantity supplied to changes in price. The coefficient of price elasticity of supply is

$$E_s = \frac{\% \Delta \text{ in Quantity Supplied}}{\% \Delta \text{ in Price}}$$

Computation formulas:

- Point Formula
  $$E_s = \frac{\triangle Q}{Q} \div \frac{\triangle P}{P} = \frac{\triangle Q}{\triangle P} \frac{P}{Q}$$

- Midpoint Formula
  $$E_s = \frac{Q_2 - Q_1}{\frac{1}{2}(Q_1 + Q_2)} \div \frac{P_2 - P_1}{\frac{1}{2}(P_1 + P_2)}$$

**Rule of Thumb for $E_s$**

- $E_s > 1$: Elastic
- $E_s < 1$: Inelastic
- $E_s = 1$: Unit elastic

Note. The sign of $E_s$ is always positive due to the Law of Supply.

**Determinants of Price Elasticity of Supply**

1. Time horizon (i.e., instantaneous, short-run, or long-run) in your analysis
   The longer time you have to respond to the change of price, the more flexible decision you can make on quantity.

2. Flexibility of Production
   Besides time horizon, there are also other factors affecting the production, e.g., input prices.
Objectives  Elasticity of Demand and Supply

1. Elasticity of Supply

2. In Class Exercise

10.1 Elasticity of Supply

Recall the definition, formula, and the rule of thumb for $E_s$. Consider two extreme cases:

$E_s = 0$ implies the quantity supplied does not respond to the changes in (supply) price.

$E_s = \infty$ implies there is a huge change (i.e., probably from infinity to zero, or from zero to infinity) in quantity supplied for every small change in (supply) price.

10.2 In Class Exercise

Q7 Explain why the price elasticity of demand is negative. Why do we ignore the negative sign? On the other hand the sign of the cross-price elasticity of demand is important. Explain why.

**Hint:** The price elasticity of demand is always negative because of the Law of Demand. The sign of cross-price elasticity of demand implies the substitutes and complements.

Q8 Why does the elasticity of demand for a good decline along a linear demand (straight-line demand) curve? Explain.

**Hint:** Recall the definition of the elasticity of demand, $E_d = \frac{\Delta Q}{\Delta P} \frac{P}{Q}$.

$\Delta Q/\Delta P$ is constant for a linear demand curve while $P/Q$ decreases since $P$ decreases and $Q$ increases as the movement along the demand curve.

Q9 Determine the price elasticity of demand if, in response to a price increase of 15%, quantity demanded decreases by 20%. Is the demand elastic, inelastic or unit elastic?
Hint: \(|E_d| = \left| \frac{\% \Delta Q}{\% \Delta P} \right| = \left| -\frac{20}{15} \right| = \left| -\frac{4}{3} \right| > 1\), which implies the demand is elastic.

Q10 Suppose you have the following demand curve, \(Q_d = -40P + 800\). Calculate the elasticity of demand when \(P = \$15\). At what price and quantity combination will the elasticity of demand equal 1? (Since we have a linear demand curve we can show how elasticity varies along the demand curve.)

Hint: \(E_d = \frac{\Delta Q}{\Delta P} \frac{P}{Q} = -40\times \frac{15}{-40\times 15 + 800} = -3\). Since \(\frac{\Delta Q}{\Delta P} = -40\), to obtain a unit elastic point, we need the ratio of \(P\) to \(Q\) to be \(\frac{1}{40}\), i.e., \(\frac{P}{Q} = \frac{1}{40}\).
11 November 2nd

Objectives  Theory of Consumer Choice

1. Utility Analysis
2. Marginal Utility
3. Law of Diminishing Marginal Utility

11.1 Consumer Demand

The Theory of Consumer Choice  Utility enable us to determine the value an individual places on something good.

Definition. Utility is the satisfaction derived from the consumption of a good or service.

Total utility (TU) is the total satisfaction derived from the consumption of a good or service.

Note. Utility is measured in utils.

Definition. Marginal utility (MU) is the additional or incremental satisfaction derived from consuming an additional unit of a good. That is, $MU = \Delta TU / \Delta Q$.

Example (A World of No Scarcity or Zero Price).

<table>
<thead>
<tr>
<th># of Slices of Pizza</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Utility</td>
<td>0</td>
<td>12</td>
<td>22</td>
<td>30</td>
<td>36</td>
<td>40</td>
<td>42</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>Marginal Utility</td>
<td>-</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>-2</td>
</tr>
</tbody>
</table>

Question: When should we suggest the consumer to stop consuming Pizza?

When the marginal utility is zero (i.e., the incremental utility of additional consumption is zero), we suggest this consumer to stop consuming at the 6th slice of pizza and meanwhile this consumer achieves his maximal utility at 42 utils.

11.2 Law of Diminishing Marginal Utility

Law of Diminishing Marginal Utility  As an individual consumes more units of good beyond a certain point. The marginal utility derived from each additional unit of the good decreases with each additional unit consumed.
Rational Choice and Marginal Utility (Non-Satiation)  The analysis of rational choice enable us to understand how individuals choose goods with their budget in order to maximize total utility and how maximizing total utility can be accomplished by considering marginal utility. The analysis begins with the premise that rational individuals want as much satisfaction as they can get from their available resources.

Consumers desire as much satisfaction as possible. However, they are bound by their constraint. Therefore they must choose among alternatives.

Principle of Rational Choice (Rational Choice Rule)  An individual should spend their money on goods that provide them with the most marginal utility per dollar, i.e., $MU/P$ where $MU$ is marginal utility and $P$ is unit price.

In other words, we need to compare $MU_x/P_x$ and $MU_y/P_y$. 
12 November 4th

Objectives  Theory of Consumer Choice

1. Utility Analysis
   Utility Maximization/ Consumer Equilibrium

12.1 Utility Analysis

- **Budget constraint** defines a set of consumption bundles available for a consumer with a given income; that is, \( p_x Q_x + p_y Q_y \leq I \) where \( I \) is total income.

- The **sufficient and necessary condition of utility maximization (utility maximizing principle)** is
  \[
  \frac{MU_x}{p_x} = \frac{MU_y}{p_y},
  \]
  which implies the marginal utilities per dollar for every good are equal at optimum.

  - This condition can be extended to a case of multiple goods such that
    \[
    \frac{MU_i}{p_i} = \frac{MU_j}{p_j} \text{ for all } i, j,
    \]
    where \( i \) and \( j \) are indexes for available goods. For example, in a case of three goods, say \( \{x, y, z\} \), \( \{i, j\} \) can be any pair of \( \{x, y\}, \{y, z\}, \) or \( \{x, z\} \).

- If a combination satisfies both budget constraint and the utility maximization condition, it is the **best affordable combination**.

**Example.** Consider a utility maximizing consumer is under a condition such that \( \frac{MU_x}{p_x} < \frac{MU_y}{p_y} \). How should he change his consumption decision to achieve his maximal utility?

**Hint:** In a competitive market, \( p_x \) and \( p_y \) are fixed. By the utility maximizing principle, consumer can either decrease his consumption in \( x \) to increase \( MU_x \) (i.e., \( Q_x \downarrow \implies MU_x \uparrow \)) or increase his consumption in \( y \) to decrease \( MU_y \) (i.e., \( Q_y \uparrow \implies MU_y \downarrow \)). Meanwhile, we need to check the budget constraint to guarantee the new consumption bundle is affordable for the consumer.

**Summary (Maximizing Utility).**

1. By given price, quantity, and total utility, we can calculate marginal utility and hence marginal utility per dollar.

2. By the utility maximizing principle, we need to find the consumption bundle such that the marginal utilities per dollar are equal.

3. At the end, remember to check the budget constraint.
13 November 9th

Objectives Theory of Consumer Choice

1. Indifference Curve Analysis

Consumer Choice:
(i) What are we willing to do? (Maximize utility)
(ii) What are we able to do? (Budget Constraint)
(iii) What should we do? (Maximize utility subject to budget constraint)

13.1 Indifference Curve Analysis

Assumptions

1. Goods provide the consumer with utility.

2. The consumer must state their preference: \( A \succ B \) (consumption combination \( A \) is preferred to \( B \)), \( B \succ A \), or \( A = B \).

   It is called the completeness of consumer preference.

3. Consumer preference is transitive: Suppose there are three market bracket \( A, B, C \). If \( A \succ B \) and \( B \succ C \), then \( A \succ C \).

   Note. A preference is rational if it is complete and transitive.

Suppose we consider two goods, Muffins and Coffee.

Definition (Indifference Curve). Illustrates the alternative combination of two goods that provides a consumer with the same total utility or satisfaction.

The steepness of the indifference curve implies the consumer preference between two goods.
Properties of A Typical Indifference Curve

1. **Downward sloping** From Left to Right

2. A typical indifference curve is **convex** to the origin.

3. For a given individual, his ICs cannot intersect. Otherwise it violates the transitivity of preference.
   - IC₁ and IC₃ (or IC₂ and IC₃) are not from the same family of ICs for an individual.

4. Consumer preference is monotonic: The higher the IC is, the better it implies for a consumer (or the greater utility it implies). In short words, “more” is better than “less”.
   - IC₂ implies a greater utility than IC₁ does. Hence, the consumer feels happier at IC₂.

5. The slope of (a tangent line of) an indifference curve is the marginal rate of substitution, \( MRS_{CM} = \frac{\Delta M}{\Delta C} \).
   - MRS is diminishing along the difference curve.
   - MRS implies the tradeoff between two goods or the opportunity cost of a good relative to the other.

Illustration of Consumer Equilibrium  Suppose all the following bundles are on the same IC.

<table>
<thead>
<tr>
<th>Muffins</th>
<th>Coffee</th>
<th>Bundle</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>4</td>
<td>A</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>E</td>
</tr>
</tbody>
</table>

Moving from A to B, the total loss in utility from the loss of 4 muffins, say 10 utiles. It must be offset by 10 utiles of utility gained from consuming an additional cup of coffee.

Formally in math, total change of utility in consuming muffins equals to that in consuming coffee, \( \Delta U_M = \Delta U_C \); that is, \( \Delta M \times MU_M = \Delta C \times MU_C \), and hence

\[
\frac{\Delta M}{\Delta C} = \frac{MU_C}{MU_M} = MRS_{CM}.
\]

What are we willing to do?  At the optimum, we are willing to exchange goods at MRS, if there is an exchange between two goods.

What are we able to do?  Suppose a muffin costs $1, a cup of coffee costs $0.5, and total income is $10. Then our budget constraint is \( p_M Q_M + p_C Q_C \leq I \) (i.e., \( 1Q_M + 0.5Q_C \leq 10 \)).
14 November 11th

Objectives  Theory of Consumer Choice

1. Indifference Curve Analysis

2. Consumer Equilibrium

14.1 Indifference Curve

<table>
<thead>
<tr>
<th>Muffins</th>
<th>Coffee</th>
<th>Bundle</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>4</td>
<td>A</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>E</td>
</tr>
</tbody>
</table>

Recall the definition of Marginal Rate of Substitution (MRS) is

\[
\frac{\Delta M}{\Delta C} = MRS_{CM} = \frac{MU_C}{MU_M},
\]

Note. By the law of diminishing MRS, \( MRS_{CM} \) is declining along the indifference curve from A to E.

Suppose that \( p_M = $1 \), \( p_C = $0.5 \), \( I = $10 \). Hence, the budget constraint (i.e., \( p_M Q_M + p_C Q_C \leq I \)) is \( 1M + 0.5C \leq 10 \).

Slope of Budget Constraint

\[
slop = \frac{I/p_M}{I/p_C} = -\frac{p_C}{p_M}
\]
Note. Every point along the budget line satisfies $p_M Q_M + p_C Q_C = I$, which implies we have used up all incomes in consumption.

Suppose move our consumption bundle along the budget line (i.e., the total income remains the same), we have

$$p_M \Delta Q_M + p_C \Delta Q_C = 0,$$

which implies $\Delta M / \Delta C = -p_C / p_M$. Hence, in the above example the slope of budget line is $-0.5 / 1 = -0.5$.

### 14.2 Consumer Equilibrium

At the point A (i.e., the best affordable consumption bundle), the slope of the indifference curve equals to the slope of the budget line; that is,

$$-\frac{\Delta M}{\Delta C} = -\frac{p_C}{p_M}.$$

*Note* (Implication of the Utility Maximization Condition). By the utility maximization condition, we have $\frac{MU_M}{p_M} = \frac{MU_C}{p_C}$ which implies

$$\frac{p_C}{p_M} = \frac{MU_C}{MU_M} \implies \frac{p_C}{p_M} = \frac{\Delta M}{\Delta C},$$

where the last equality follows $\frac{MU_C}{MU_M} = \Delta M / \Delta C$.

Suppose the best affordable consumption bundle is $6M + 8C$. Then the price of a cup of coffee increases from 50¢ to $1. Our new budget constraint becomes

$$1M + 1C \leq 10.$$

If the utility maximization combination is $4M + 6C$, we can drive a demand curve for coffee. (Note the price of muffins does not change.)

The demand curve for coffee is a line through two point ($1, 6$) and (50¢, 8).
Objectives  Production and Cost Analysis

1. Production Definitions

15.1 Production

Definition (Production). The process by which factors of production are transformed into goods and services. We can also define production as a process in which inputs are employed/utilized to make goods and services.

Factors of Production Every factor is received compensation/payment from the manufacture.

1. Land (Physical Space): Rents
2. Labor: Wage
3. Capital: Interest
4. Entrepreneur: Profit (denoted by $\pi$)

A firm is an economic institution in which inputs, factors of production, are transformed into goods and services. Firms can do any of the following:

1. Organize factors of production,
2. Produce goods, and
3. Sell goods to individuals, business and the government.

Motive of A Firm: Earn profits as much as possible.

Maximize Profits

- Long-Run: Time period or horizon that is sufficient enough for a firm to change the quantity of all inputs. In other words, all inputs will be variable.

- Short-Run: Time period or horizon during which at least one input is fixed. Typically, capital is considered as the fixed input.

- Production function, $Q = f (k, l)$, describes the maximum amount of output given the amount of inputs.
Shout-Run Production  Suppose we have a firm/factory in which we are producing chairs and the only variable input is labor. Capital is considered as fixed.

<table>
<thead>
<tr>
<th>No. of Workers (L)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Output (TP)</td>
<td>0</td>
<td>6</td>
<td>12</td>
<td>19</td>
<td>25</td>
<td>30</td>
<td>33</td>
<td>34</td>
<td>34</td>
<td>32</td>
<td>27</td>
</tr>
<tr>
<td>Marginal Product of Labor (MP_L)</td>
<td>-6</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>-2</td>
<td>-5</td>
<td></td>
</tr>
</tbody>
</table>

Law of Diminishing Marginal Productivity  As more units of a variable input is combined with a fixed input. Beyond a certain point the marginal productivity of the variable input begins to decline.
16 November 30th

Objectives  Costs of Production

1. Short-Run

16.1 Costs of Production in the Short-Run

Suppose that capital is a fixed input.

<table>
<thead>
<tr>
<th>Employees (Labor)</th>
<th>Total Output (TO)</th>
<th>Total Variable Cost (TVC)</th>
<th>Total Fixed Cost (TFC)</th>
<th>Total Cost (TC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$200</td>
<td>$200</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>$350</td>
<td>$200</td>
<td>$550</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>$700</td>
<td>$200</td>
<td>$900</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>$1050</td>
<td>$200</td>
<td>$1250</td>
</tr>
<tr>
<td>4</td>
<td>23</td>
<td>$1400</td>
<td>$200</td>
<td>$1600</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>$1750</td>
<td>$200</td>
<td>$1950</td>
</tr>
<tr>
<td>6</td>
<td>31</td>
<td>$2100</td>
<td>$200</td>
<td>$2300</td>
</tr>
<tr>
<td>7</td>
<td>32</td>
<td>$2450</td>
<td>$200</td>
<td>$2650</td>
</tr>
<tr>
<td>8</td>
<td>32</td>
<td>$2800</td>
<td>$200</td>
<td>$3000</td>
</tr>
</tbody>
</table>

The cost of hiring one laborer per day is $350.00 (or the wage paid to a laborer per day for their productive service is $350.00). Fixed costs are $200. An example of a fixed cost in producing chairs is the payment for leasing the building or property where the chairs are being produced.

Definition (Total Variable Cost). The component of total cost that changes as we hire more workers.

Definition (Total Fixed Cost). The component of total cost that does not change as output changes.

Note. Total Cost = Total Variable Cost + Total Fixed Cost

<table>
<thead>
<tr>
<th>Total Output</th>
<th>TVC</th>
<th>TFC</th>
<th>TC</th>
<th>MC</th>
<th>AFC</th>
<th>AVC</th>
<th>ATC</th>
<th>MC and ATC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>$200</td>
<td>$200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>$350</td>
<td>$200</td>
<td>$550</td>
<td>$87.50</td>
<td>$50.00</td>
<td>$87.50</td>
<td>$137.50</td>
<td>$MC &lt; ATC: ATC ↓</td>
</tr>
<tr>
<td>10</td>
<td>$700</td>
<td>$200</td>
<td>$900</td>
<td>$58.33</td>
<td>$20.00</td>
<td>$70.00</td>
<td>$90.00</td>
<td>$MC &lt; ATC: ATC ↓</td>
</tr>
<tr>
<td>17</td>
<td>$1050</td>
<td>$200</td>
<td>$1250</td>
<td>$50.00</td>
<td>$11.76</td>
<td>$61.76</td>
<td>$73.53</td>
<td>$MC &lt; ATC: ATC ↓</td>
</tr>
<tr>
<td>23</td>
<td>$1400</td>
<td>$200</td>
<td>$1600</td>
<td>$58.33</td>
<td>$8.70</td>
<td>$60.87</td>
<td>$69.57</td>
<td>$MC &lt; ATC: ATC ↓</td>
</tr>
<tr>
<td>28</td>
<td>$1750</td>
<td>$200</td>
<td>$1950</td>
<td>$70.00</td>
<td>$7.14</td>
<td>$62.50</td>
<td>$69.64</td>
<td>$MC &gt; ATC: ATC ↑</td>
</tr>
<tr>
<td>31</td>
<td>$2100</td>
<td>$200</td>
<td>$2300</td>
<td>$116.67</td>
<td>$6.45</td>
<td>$67.74</td>
<td>$74.19</td>
<td>$MC &gt; ATC: ATC ↑</td>
</tr>
<tr>
<td>32</td>
<td>$2450</td>
<td>$200</td>
<td>$2650</td>
<td>$350.00</td>
<td>$6.25</td>
<td>$76.56</td>
<td>$82.81</td>
<td>$MC &gt; ATC: ATC ↑</td>
</tr>
</tbody>
</table>
Definition (Marginal Cost). Change in total cost from producing an extra unit of output.

Note. (i) $MC = \frac{\Delta TC}{\Delta Q}$ (also note in consumption $MC = \frac{\Delta TC}{\Delta Q}$ which implies the marginal cost of consuming an extra good)

(ii) Average Fixed Cost: $AFC = \frac{TFC}{Q}$

(iii) Average Variable Cost: $AVC = \frac{TVC}{Q}$

(iv) Average Total Cost (ATC or AC): $ATC = \frac{TC}{Q}$ and $ATC = AVC + AFC$

Implications of the U-Shaped MC, ATC(AC), and AVC Curves (Law of Diminishing Marginal Productivity) At the low levels of output, the firm is experiencing increasing returns to labor. At higher levels of output, the firm is experiencing diminishing returns of labor.
17 December 2nd

Objectives
1. Profit Maximization
2. Types of Profit

17.1 Profit Maximization

The motive of a typical firm is to maximize profit \( \pi = TR - TC \).

![Graph showing profit maximization]

The necessary condition for the maximization of firm’s profits is

\[
\frac{\Delta TC}{\Delta Q} = MC = MR = \frac{\Delta TR}{\Delta Q}.
\]

Note. (i) The areas below TC and TR curves are Total Cost and Total Revenue respectively.
(ii) MC is the slope of TC and MR is the slope of TR. Moreover, in the graph above, the slope of TR at \( Q^* \) is the slope of the tangent line of TR.
(iii) At \( Q^* \), the slopes of TC and TR are equal which means the firm’s profit achieves the maximum. In the graph above, the maximal profit is achieved when the dash line (i.e., the tangent line) of TR is parallel to TC.

17.2 Types of Profits

Explicit Cost and Implicit Cost

1. An explicit cost is a direct payment made to others in the course of running a business, such as wage, rent and materials, as opposed to implicit costs, which are those where no actual payment is made.
2. An implicit cost is the opportunity cost equal to what a firm must give up in order to use factor of production which it already owns (and does not pay rent for). In other words, an implicit cost is any cost that results from using an asset instead of renting it out or selling it.

We can classify the following types of profits:

1. Accounting Profit: \( TR - \) Explicit Costs.
3. Normal Profit: Accounting Profit – Economics Profit

Note. (i) Economic profit is always smaller than accounting profit but smaller because it subtracts off the total opportunity costs (not just the explicit costs, but also the implicit costs).

(ii) Normal profit is a component of (implicit) costs and not a component of business profit at all. It represents the opportunity cost, as the time that the owner spends running the firm could be spent on running a different firm.

(iii) By definition above, normal profit is “Accounting Profit – Economics Profit”, which is the implicit costs. Normal profit is a concept of economic rent. It typically equals opportunity cost.

**Example** (Selling Chairs).

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Revenue</td>
<td>$250,000</td>
</tr>
<tr>
<td>Cost of Raw Materials</td>
<td>$40,000</td>
</tr>
<tr>
<td>Wages and Salaries</td>
<td>$100,000</td>
</tr>
<tr>
<td>Utilities</td>
<td>$15,000</td>
</tr>
<tr>
<td>Advertising</td>
<td>$30,000</td>
</tr>
<tr>
<td><strong>Total Explicit Cost</strong></td>
<td><strong>$185,000</strong></td>
</tr>
<tr>
<td>Accounting Profit</td>
<td>$65,000</td>
</tr>
</tbody>
</table>

Suppose in order to start this business, you invested $90,000 which could earn interest $5,000/yr if you sold the business. You use two rooms in your home for office space. If you rented the rooms, you could earn $3,00/yr. You maintain the business full-time without earning a salary, that is you could earn $50,000/yr if you were employed.

Hence, we have

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest Forgone</td>
<td>$5,000</td>
</tr>
<tr>
<td>Rent Forgone</td>
<td>$3,000</td>
</tr>
<tr>
<td>Salary Forgone</td>
<td>$50,000</td>
</tr>
<tr>
<td><strong>Total Implicit Cost</strong></td>
<td><strong>$58,000</strong></td>
</tr>
</tbody>
</table>

Therefore, Economic profit is $65,000-$58,000=$7,000.
Zero Economic Profit  Normal profit refers to zero economic profit. Markets where producers are making normal profits will neither expand nor shrink and will, therefore, be in a state of long-term equilibrium.

In a perfect competitive market, even though a firm earns zero economic profit, the firm will still keep running, since it makes a normal profit and the owner/entrepreneur will not deviate to another option (i.e., running another business).
Objectives Selling Environment or Market Structure

1. Pure Competition
2. Short-Run Output

Market Structure

1. Pure Competition
2. Pure Monopoly
3. Monopolistic Competition
4. Oligopoly

18.1 Pure or Perfect Competition

Characteristics

1. Large number of buyers and sellers (Implication: Neither side has market power to manipulate market equilibrium.)
2. Standardized or Homogeneous Product
3. Symmetry of Information (Perfect Knowledge)
4. Free Mobility (No Restriction for Firm Entry and Exit)
5. All Agents (Buyers or Sellers) are price takers (i.e., prices are given by the market)
6. Profit maximizing motive of each firm

Demand Curve Facing and Typical Firm
18.2 Short-Run Output/Behavior

- A firm possibly earns a positive economic profit in the short-run.

- If \( p = ATC \), then a firm earns a normal profit (i.e., zero economic profit) which is the opportunity cost of running this firm. Hence the entrepreneur will stay and the perfect competitive market achieves the equilibrium (i.e., there is no firm entry or exit in the market).

- In sum, there are possible cases for a firm in the short-run operation (e.g., normal profit, economic profit, and economic loss).

**Shut-Down Price**  A firm has to pay for fixed rent albeit it is shut down. For example, consider the heat factory in Minnesota. We have to pay for the facility fees even in summer, though the heat factory only runs in winter.

There are two critical points below: Break-even Point at \( P = ATC \) and Shut Down Point at \( P = AVC \). Thus a firm should cease production or shut down temporarily as long as \( P < AVC \). By doing so the firm can minimize its economic loss.

*Note.* It is a criteria for the short-run operation NOT for the long-run.
Objectives  Pure Competition

1. Shut-Down Price

2. Long-Run Equilibrium/Adjustment

19.1 Shut-Down Price

Criteria: \( p \leq AVC_{\text{min}} \Rightarrow \) Shut Down or Cease the production temporally

The SR supply curve of a purely competitive firm is the portion of the \( MC \) curve above the shut down price. (For example, the red lines in the following graphs are SR supply curves.)

19.2 Long-Run Equilibrium/Adjustment

If \( TR - \text{Explicit Cost} - \text{Implicit Cost} > 0 \), it signals that this industry earns positive economic profit. Now new firms enter and compete for profits. The force of competition drives costs down. The entry of new firms will cease until the market has a zero economic profit.

1. Aggregate demand decreases \( \Rightarrow p \downarrow \)
2. Since \( p \) decreases to \( p' \) and \( p' < ATC \) at \( q'^* \), \( TR = p' \times q'^* < TC = ATC \times q'^* \), that is, firm incurs a economic loss.

3. The existence of loss causes some existing firms to exit the market (because in the pure competitive market firms are free to enter or exit). As a result, the aggregate supply decreases (\( S \) shifts to the left, i.e., \( S' \)) and price increases until firms in the markets can earn a zero profit.

4. This process is an example of the long-run equilibrium/adjustment, where \( p = ATC_{\min} \) for all firms.

**Question:** Can firms earn a negative economic profit in a long-run? [NO. Note: It can happen in a short-run.]

**Question:** Can firms earn a zero economic profit in both a short-run and a long-run. [Yes]

*Note.* In the competitive market, positive economic profit is always a signal for new firms entering.
Part II

Appendix (Discussion Session)

A September 18th (TA)

Objectives  My Spanish Name: Jhon Jairo

1. Cost-Benefit Principle
2. Positive/Normative Economics
3. Course Project: Mock Trail 1

A.1 The Cost-Benefit Principle:

An individual (or a firm or a society) should take an action if, and only if, the extra benefits from taking the action are at least as great as the extra costs.

The cost-benefit principle is a fundamental tool for the study of how rational people make choices.

Example (Purchase A Computer Game). Assume you live on campus and you friend tells you following information:

- $25 from a nearby campus store
- $15 from a downtown store (30-minute walking away from campus)

Where should you buy the game?

- The benefit of buying downtown is exactly $10 which is the amount you will save.
- The cost of buying downtown is the dollar value you assign to the time and trouble it takes to make the trip. (The cost of taking any action is the dollar value of everything you give up by taking it.)
- How do we estimate that dollar value?

One way is to perform the following hypothetical auction.

- If she offered you a payment of, say, $1,000, would you accept? If so, we know that your cost of walking downtown and back must be less than $1,000.
- Now imagine her offer being reduced in small increments until you refuse the last offer. For example, if you would agree to walk downtown and back for $9.00 but not for $8.99, then your cost of making the trip is $9.00. In this case, you should buy the game
downtown because the $10 you’ll save (your benefit) is greater than your $9.00 cost of making the trip.

Alternatively, if your cost of making the trip had been greater than $10, your best bet is to buy the game from the nearby campus store.

A.2 Positive/Normative Economics

- Positive analysis is a fact based analysis. It is testable and excludes any personal judgment. It can be proved or disproved.
  
  – For example, I claim that the outside temperature is 20 Celsius. (You can check it.)

- Normative analysis is an opinion based analysis. It is about what should be or ought to be and include personal judgment and ideas. It cannot be verified and proved or disproved.
  
  – For example, I claim that the color orange is better than red. (You cannot prove it. What will people do? Take a vote!)

*Note.* The Cost-Benefit Principle is an example of a normative economic principle, one that provides guidance about how we should behave. For example, according to the Cost-Benefit Principle, we should ignore sunk costs when making decisions about the future. (What we should do in applying the Cost-Benefit Principle.)

However, the Cost-Benefit Principle is not always a positive, or descriptive, economic principle, one that describes how we actually will behave. Since the Cost-Benefit Principle can be tricky to implement, people sometimes fail to heed its prescriptions. (Should we buy the computer game or not.)

Mock Trail

- Two court sessions: Oct 23 and Dec 11.
- 10% total in grade (5% each)
- Randomly divided into three groups: (different roles in the two court sessions)
  
  – Judge Panel (one chief judge)
  – Complainant and Respondent
    * Research group (one chief researcher)
    * Oral group (one chief counsel and five roles)

- Specific preparation plan and schedule are written in the document available on Moodle.
B  September 25th (TA)

Objectives

1. Opportunity cost

2. Production Possibility Frontier

3. Quiz 1

B.1 Opportunity Cost

The value of the next best alternative that I have to give up in order to satisfy a present desire.

Example. (1) You are thinking about going to a concert. But you have other options of looking for baby-sitting that pays you $35 or working for a restaurant that pays you $25. What is the opportunity cost of going to a concert?

(2) Suppose you already bought a concert ticket by $30. After you bought it, you got a call from your sister and she asks you if you can dog-sit her dog and she’ll pay you $20. You cannot refund your ticket. What is the opportunity cost of going to a concert? ($30 is a sunk cost.)

(3) Suppose you work at a coffee shop that pays you $8 per hour. You are thinking about going to a concert which lasts 2 hours and ticket is $20. It takes 1 hour to get to the concert from your home. What is the opportunity cost of going to a concert? (4h × $8/h = $32.)

B.2 Production Possibility Frontier (PPF)

PPF illustrates the alternative combinations of two goods that an economy can produce if it fully and efficiently employs the available resources.

Q: Explain the reason why the slope of the PPF is downward (can be linear in some parts).

A: The principle of scarcity. Specifically, the resources are constrained. When you want to produce more of one good, you have to give up producing another. Thus, there is a trade-off.

Note. The slope of PPF measures the opportunity cost of producing one more unit of good X in terms of good Y.

Example. Consider a county can only produce car and rice.
<table>
<thead>
<tr>
<th>Car</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
</tr>
</tbody>
</table>

• What is the opportunity cost of the third car?
  – That is from point C to point D:
    \[
    \frac{\Delta rice}{\Delta car} = \frac{55 - 75}{3 - 2} = -20 \Rightarrow 20 \text{ unit of rice}
    \]

• What is the opportunity cost of the forth car?
  – That is from point D to point E:
    \[
    \frac{\Delta rice}{\Delta car} = \frac{30 - 55}{4 - 3} = -25 \Rightarrow 25 \text{ unit of rice}
    \]

• There is an increasing opportunity cost: 10→15→20→25→30
  – This makes the PPF concave. It implies that some resources are better at producing one type of good than at producing the other.
  – For example, some land is suited to growing rice while other land is suited to build a factory.
C  September 25th (TA)

Objectives

1. Review Quiz 1
2. Opportunity Cost
3. Consumer Demand

C.1 Quiz 1

- Median: 20(002) and 21(007)
- Highest: 29
- Question 3

<table>
<thead>
<tr>
<th></th>
<th>Pizza</th>
<th>Ice-cream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economy A</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>Economy B</td>
<td>75</td>
<td>125</td>
</tr>
</tbody>
</table>

- Opportunity cost of ice-cream in Economy A: 60/120 = 1/2 pizza
  Opportunity cost of pizza in Economy A: 120/60 = 2 ice-cream
- Opportunity cost of ice-cream in Economy B: 75/125 = 3/5 pizza
  Opportunity cost of pizza in Economy B: 125/75 = 5/3 ice-cream
- Comparative advantage: A produces ice-cream while B produces pizza.
- PPF and slopes

C.2 Opportunity Cost

Example. Suppose you have already brought a $30 concert ticket. One of your friends asks you to watch a hockey game. The ticket of this hockey game is $25 and you can get $20 of enjoyment out of this game. What is the opportunity cost of watching this hockey game?

<table>
<thead>
<tr>
<th></th>
<th>Watching Hockey</th>
<th>Not Watching Hockey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$30</td>
<td>$20</td>
</tr>
<tr>
<td>Benefit</td>
<td>$20</td>
<td>$25</td>
</tr>
</tbody>
</table>

Note: $30 is a cost if you decide to watch hockey, while it is not your benefit if you does not watch hockey since it is a sunk cost.

Thus, the opportunity cost of watching the hockey game is $30 + $25 = $55.
C.3 Consumer Demand

**Definition.** The range of quantities of a commodity that a buyer is willing and able to purchase at different prices in a specific time period.

**Example.** Suppose the market demand and supply curves for mead are given by the equations $Q_D = 38 - 3P$ and $Q_S = P - 2$.

1. Solve for the equilibrium price and quantity. Graph your results.
   
   $38 - 3P = P - 2 \implies 4P = 40$; that is, $P^* = 10$ and $Q^* = 8$.

2. Consider that government imposes an excise tax of $2 on the producers of mead. Calculate the new equilibrium prices and quantity. Plot the new equilibrium on your graph.
   
   $P_S = P_D - 2$ and hence $38 - 3P = P - 2 - 2 \implies 4P = 42$; that is, $P^* = 10.5$ and $Q^* = 6.5$.

   Note: consumer pays 1/4 of tax and producer pays 3/4.

**Example.** Consider the market for potatoes with inverse demand given by $P = 30 - 2Q_D$ and inverse supply given by $P = 10 + 2Q_S$. Now suppose the government implements a price subsidy program instead of the price support program. Let the government target price be $24.

1. Calculate the equilibrium price and quantity. Draw a graph and label the equilibrium price and quantity.
   
   $30 - 2Q = 10 + 2Q \implies 4Q = 20$; that is, $Q^* = 5$ and $P^* = 20$.

2. Consider the government implements a price support policy by setting a price floor of $24 in the market for potatoes and the government will purchase and destroy the surplus potatoes at a price of $24.
   
   Calculate the price of exchange, quantity exchanged in the marketplace, and the amount of potatoes purchased and destroyed by the government.
   
   $P_1 = 24$. New demand for potato is $Q_{D1} = 15 - P/2 = 3$ and new supply for potato is $Q_{S1} = P/2 - 5 = 7$.

   So the farmer will supply 7 potatoes and consumer will buy 3 potatoes. The government will purchased $7 - 3 = 4$ potatoes and destroyed them. The total government expenditure is $4 \times 24 = 96$. 

46
D October 8th (TA)

Announcement

1. Two weeks before the court date. The oral argument group is to write a two-page court brief as a written summary of the team’s arguments.

2. Homework 1 due in class. Please turn in your HW1 before leaving.

Objectives

1. Review Terms
2. Practice Questions
3. Group Meeting (last 10 minutes)

D.1 Review Terms

- Normal good: \( I \uparrow \implies Q \uparrow \) demand curve shifts to the right.
- Inferior good: \( I \uparrow \implies Q \downarrow \) demand curve shifts to the left.
- Price ceiling: It is a instituted price which causes a shortage.
- Price floor: It is a instituted price which causes a surplus.

D.2 Practice Questions

Example (Market for Coffee). Let’s examine how some events affect the market equilibrium.

1. The price of tea decreases:
   \( P_{\text{tea}} \downarrow \implies Q_{\text{tea}} \uparrow \)
   (a) Tea and coffee are substitute goods.
   (b) There will be less buyer for coffee.
   (d) Demand curve for coffee shifts to the left.

   Conclusion. \( \downarrow \) in price of substitutes \( \implies \downarrow \) in demand for coffee \( \implies \) at the equilibrium, \( Q_{E} \downarrow \) and \( P_{E} \downarrow \).

2. Consumer’s income increases:
   (a) Assume coffee is a normal good
   (b) Demand curve shifts to the right.
Conclusion. At the equilibrium, $Q_E \uparrow$ and $P_E \uparrow$.

3. The price of sugar increases:
   
   (a) $P_{sugar} \uparrow \implies Q_{sugar}^d \downarrow$
   
   (b) Sugar and coffee are complementary goods.
   
   (c) Thus, there will be fewer buyers for coffee.
   
   (d) Demand curve for coffee shifts to the left.

Conclusion. At the equilibrium, $Q_E \downarrow$ and $P_E \downarrow$.

4. Technological improvement in the production of coffee
   
   (a) Sellers can produce more at existing price
   
   (b) $S$ shifts to the right.

Conclusion. At the equilibrium, $Q_E \uparrow$ and $P_E \downarrow$.

5. Bad weather affects the area where coffee tree grown and the price of tea increases.

   (a) Bad weather $\implies$ Supply curve for coffee shifts to the left.
   
   $P_{tea} \uparrow \implies Q_{tea}^d \downarrow$ (tea and coffee are substitute goods) which implies the demand curve for coffee shifts to the right.
   
   i. Supply curve shifts more in quantity than demand curve does, then $P_E \uparrow$ and $Q_E \downarrow$.
   
   ii. Supply curve shifts as same in quantity as demand curve does, then $P_E \uparrow$ and $Q_E$ constant.
   
   iii. Supply curve shifts less in quantity than demand curve does, then $P_E \uparrow$ and $Q_E \uparrow$.

Conclusion. At the equilibrium, $P_E \uparrow$ but $Q_E$ is undetermined.

Note. (i) The fact that supply curve for coffee shifts to the left will cause $Q_E \downarrow$ and a support/push for the price of coffee (i.e., $P_E \uparrow$).

(ii) The fact that the demand curve for coffee shifts to the right will cause $Q_E \uparrow$ and an increase in price (i.e., $P_E \uparrow$).

Hence, both facts lead an increase in $P_E$ but the change for quantity at the equilibrium, $Q_E$, is undetermined.
E  October 15th (TA)

Announcement

1. Mock Trial: Next Friday! In this room, same time as class. We have a tight schedule so will start the court on time. So please come to class on time.

2. Oral Argument Group: Court brief is due today at 6pm. After that, please prepare oral presentations.

3. Judge: After receiving court briefs from each team, I will forward the court briefs and synopses to you. Please read them, have a meeting among judge panel, prepare two sets of questions (one for Complainant and one for Respondent). Email the questions to me before the start of the court session on Friday). Team score will be given to the set of questions.

Objectives

1. Review for HW1

2. Price elasticity of demand

3. Group Meeting (last 10 minutes)

E.1 Review for HW1

Q1 In December, the price of Christmas trees sold rises and the quantity of trees sold rises. Does this violate the Law of Demand?

Recall: The Law of Demand implies the inverse relationship between price and quantity.

In this question, the supply of Christmas trees remains but the demand shifts to the right, which causes $P^* \uparrow$ and $Q^* \uparrow$.

Q5 What will happen, if consumers expect the price of pizza to decline immediate future?

Consumer will wait for the lower price. Thus, the demand curve of pizza will shift to the left, which causes decreases in equilibrium price and equilibrium quantity.

Note. It is a self-fulfilling prophecy. e.g., In 2007/8, loss of confidence could trigger a run on banks that would threaten the entire financial system.

E.2 Price Elasticity of Demand

• Suppose you run your own business in the future, you wanna especially know the answer to this question. How do your consumers will respond when you change a price of your product?
Consider the consumption of milk in Cub Food. If the price of milk increases 1%, what will the quantity change in percent?

**Definition 1** (Price Elasticity of Demand). Price elasticity of demand is a ratio of percentage change (\(\Delta \%\)) in quantity demanded of a good to the percentage change (\(\Delta \%\)) in its price. That is,

\[
\varepsilon_x = \frac{\Delta Q_x \%}{\Delta P_x \%} = \frac{\Delta Q_x / Q_x}{\Delta P_x / P_x} = \frac{(Q_1^x - Q_0^x) / Q_0^x}{(P_1^x - P_0^x) / P_0^x}
\]

**Example.** Suppose that a price of coffee increased by 2%. Will the quantity demanded increase? Or decrease?

Suppose at the same time the quantity demanded decreased by 4%. Then what is price elasticity of demand? \([-4\%/2\% = -2]\)

What does it mean? **Interpretation:** It means that when the price increases by 1%, the quantity demanded will decrease by 2%.

- If the percentage change is given, you can just plug the numbers into the formula, i.e., \(\Delta Q_x \%/\Delta P_x \%\).
- What if we do not know the percentage change? Then we need to calculate the value of the change divided by the initial value, i.e., \(\Delta Q_x / Q_x / \Delta P_x / P_x\).

Price elasticity of demand is always negative. (why? Because price and quantity demanded is negatively correlated according to the Law of Demand.) So we can ignore the minus sign and use the absolute value for elasticity.

- For example, let’s say elasticity of good X is \(-1\) and that of Y is \(-2\); that is, \(\varepsilon_x = -1\) and \(\varepsilon_y = -2\).

Mathematically, -1 is bigger than -2 (i.e., \(-1 > -2\)). But in terms of elasticity, good Y has a greater elasticity than good X does. (Why? Because given a certain change of its price, the percentage change of demand quantity of good Y is bigger than that of good X.) So we can simply drop the minus sign and use the absolute value for elasticity.

- Note that using the original value as a reference point for calculating % change might cause some problems. Hence we will learn another way to calculating the elasticity, called the **Midpoints Approach**, next week. For now, we will stick to this formula.

**Implication**

- Demand is elastic, if \(|\varepsilon| > 1\). It implies that a \% change in price results in a larger \% change in quantity demanded.
  - Luxury: LV and Gucci.
Demand is inelastic, if $|\varepsilon| < 1$. It implies that a % change in price results in a smaller % change in quantity demanded.

* Necessity: Milk and eggs.

Demand is unit elastic, if $|\varepsilon| = 1$. It implies that a % change in price results is same as a % change in quantity demanded.

** Determinants

- Necessity v.s. Luxury: Luxury tends to have higher price elasticity of demand.
- Substitutes Availability: If a good has a lot of substitutes, this good should have a lower price elasticity.
- Time + Adjustment Process: The longer time you have to adjust for the price change, the higher price elasticity of demand it might be.
  * For example, organic milk may be a luxury good for the poor.
November 5th (TA)

**Objectives**

1. Quiz 2 (002: 23; 007: 25)
2. Consumer Theory
3. Mock Trail

**F.1 Quiz 2**

**Q2d** If the coefficient of price elasticity of demand is zero, it implies price is fixed.

It implies the demand is perfectly inelastic; that is, price does not matter. It does not say price is fixed.

**Q3b** Why is the coefficient of elasticity of demand declining along the linear demand curve?

By definition, we have \( |E_d| = \frac{\triangle Q}{\triangle P} \frac{P}{Q} \), where (i) \( \triangle Q / \triangle P \) is constant along the linear demand curve but (ii) \( P/Q \) is declining due to the law of demand.

**Q4a** Price of gasoline is $2 and the price elasticity of demand is 0.5. How much will a 10% reduction in \( Q \) increase \( P \)? Will total spending on gasoline increase? by what percentage?

\[
|E_d| = \frac{\% \triangle Q}{\% \triangle P} \implies \% \triangle P = \frac{\% \triangle Q}{|E_d|} = \frac{10\%}{0.5} = 20%.
\]

\[
TS = (1 + 20\%) P \times (1 - 10\%) Q = 1.08 \times TS \implies TS \uparrow \text{by } 8%.
\]

**Q4b** A cafe store has 1,000 patrons with price $2 per cup. Suppose when price goes up to $2.1, the store loses all of these patrons. Compute the elasticity of coffee demand?

\[
E_d = \frac{\% \triangle Q}{\% \triangle P} = \frac{(0 - 1000)}{1000} \frac{1000}{(2.1 - 2)} = \frac{-1}{0.172} = -20.
\]

**Note** (Elasticity of Demand, Supply, Income, and Cross price Elasticity).

1. \( E_d < 0 \) (law of demand) and \( |E_d| < 1 \) if inelastic
   \( = 1 \) if unit elastic
   \( > 1 \) if elastic

2. \( E_s > 0 \) (law of supply) and \( E_s < 1 \) if inelastic
   \( = 1 \) if unit elastic
   \( > 1 \) if elastic

3. \( E_I < 0 \) if inferior good and \( E_{Q,A,P_B} < 0 \) if complement
   \( > 0 \) if normal good
   \( > 0 \) if substitute
F.2 Consumer Theory

- Utility: Satisfaction (Level of bliss)
- Total Utility: Total satisfaction
- Marginal Utility: Incremental satisfaction if consume an additional unit of good
- Law of Diminishing MU: At the lunch time, the happiness you eat the first piece of bread is greater than that you eat the last piece of bread (say 10th).
  - Draw a concave utility curve (y-axis: utiles; x-axis: quantity).
  - Formal definition in math: \( MU = \frac{\Delta TU}{\Delta Q} \). Show the MU in graph.
- Rational Choice Principle (Utility Maximization Condition):
  \[
  \frac{MU_x}{p_x} = \frac{MU_y}{p_y}
  \]
  - This condition can be extended to a case of multiple goods such that
    \[
    \frac{MU_i}{p_i} = \frac{MU_j}{p_j} \text{ for all } i, j,
    \]
    where \( i \) and \( j \) are indexes for available goods. For example, in a case of three goods, say \( \{x, y, z\}, \{i, j\} \) can be any pair of \( \{x, y\}, \{y, z\}, \) or \( \{x, z\} \).

**Question** What does the best affordable combination imply?

It implies (i) budget constraint and (ii) the utility maximization condition.

**Summary** (Maximizing Utility).

1. By given price, quantity, and total utility, we can calculate marginal utility and hence marginal utility per dollar.
2. By the utility maximizing principle, we need to find the consumption bundle such that the marginal utilities per dollar are equal.
3. At the end, remember to check the budget constraint.

**Question** How to evaluate the total utility of consuming a pair of goods?

Contour Map. (Think about a mountain).

Three Dimensional graph of total utility over any pair of goods.
November 13th (TA)

Announcement

- Research synopsis due at 6pm today.
  - Please email it to your chief researchers
  - Then chief researchers email to all synopses to me and your peers in oral group
  - Next week, 10 min meeting for all members in oral and research group

Objectives

1. Review Some HW Questions
2. Budget Constraint
3. Utility Maximization

G.1 Review Some HW Questions

3a. Use the concept of elasticity to explain why people on vacation tend to spend more money on food and necessities than the local residents in the area.

Hint: \( T'S = p \times Q \). The demands of food and necessities for local residents are inelastic (they have many substitutes in local) but elastic for visitors (they knew little about local substitutes). Thus, if there is a price promotion (i.e., price reduction), visitors will spend more.

3b. Suppose you are an analyst at a major airline that is considering raising the airfare between two major cities in the United States in an attempt to raise revenues. What would you recommend?

Hint: Depends on the price elasticity of demand of tickets.

4. The demand for education at “prestigious” colleges is generally considered to be very inelastic. What does this suggest about tuition increases at prestigious schools in the future? A student who is more eager to attend a prestigious college will receive less financial aid. Use the concept of elasticity to explain this phenomenon.

Hint: (i) If the demand of education is inelastic, \( P \uparrow \implies Q \downarrow \implies TR \uparrow \); (ii) Willingness to pay: Given a quantity \( Q \), the demand curve shows the maximal price for which a consumer would like to pay.
G.2 Budget Constraint

- General form: \( p_x x + p_y y \leq I \).
- How to draw a budget line? (Two intercepts)
- Slope of budget line:
  - Algebraic definition: \( p_y y = I - p_x x \implies y = \frac{I}{p_y} - \frac{p_x}{p_y} x \), where the slope is \(-\frac{p_x}{p_y}\) (e.g., \( y = ax + b \), where the slope is \(a\)).
  - Geometrical definition: 
    \[-\frac{I}{p_y} / \frac{I}{p_x} = -\frac{p_x}{p_y}.\]
- Price changes
  - Case 1 \( p_x \) changes
  - Case 2 \( p_y \) changes
  - Case 3 \( I \) changes

G.3 Utility Maximization

Consider a 3-D utility graph and its projection on the \( xy \)-coordinate. Graphically, to find a maximal utility level, we need to move the IC back and forth until IC has a tangent point on the budget line.

Suppose we achieve the maximal level of the utility, how can we find the corresponding bundle for the tangent point?

(i) Then we need to know how to characterize every point along the IC. For every point along the IC, we have

\[ MU_x \times \Delta x + MU_y \times \Delta y = 0 \implies \frac{MU_x}{MU_y} = -\frac{\Delta y}{\Delta x} = MRS_{xy}. \quad (G.1) \]

(ii) After we have characterized the point on IC, we also need to characterize every point on budget line:

\[ p_x \times \Delta x + p_y \times \Delta y = 0 \implies \frac{p_x}{p_y} = -\frac{\Delta y}{\Delta x} = MRS_{xy}. \quad (G.2) \]

Since the tangent point is a point on both IC and budget line, it should satisfy both Equations G.1 and G.2. By (i) and (ii), we have the utility maximization condition (the rational choice principle):

\[ MRS_{xy} = \frac{p_x}{p_y} \implies \frac{MU_x}{MU_y} = \frac{p_x}{p_y} \implies \frac{MU_x}{p_x} = \frac{MU_y}{p_y}. \]

Note. Alternatively, the slope of budget line equal to the slope of tangent line of IC.

The slope of budget line: 
\[-\frac{I}{p_y} / \frac{I}{p_x} = -\frac{p_x}{p_y}.\]
The slope of tangent line of IC: $\frac{\Delta y}{\Delta x}$

Hence, $-\frac{p_x}{p_y} = \frac{\Delta y}{\Delta x}$. Since $MRS_{xy} = -\frac{\Delta y}{\Delta x} = \frac{MU_x}{MU_y}$, $\frac{MU_x}{p_x} = \frac{MU_y}{p_y}$.

Example (HW2 Q2).

<table>
<thead>
<tr>
<th>Cookies ($2)</th>
<th>Smoothies ($4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q</td>
<td>TU</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>38</td>
</tr>
</tbody>
</table>

c. What is the marginal rate of substitution of smoothies for cookies? What is the market trade-off?

\[ MRS_{SC} = \frac{MU_s}{MU_c} = \frac{20}{10} = 2 = \frac{\Delta y}{\Delta x}. \] The best consumption bundle can be (2, 2) for cookies and smoothies. It satisfies the budget constraint: $2 \times 2 + 2 \times 4 \leq 12$. Then, (2, 2) is the best affordable consumption bundle.

d. Suppose the price of a smoothie decreases to $2.00 ceteris paribus, determine the best affordable combination.

\[ MRS_{SC} = \frac{MU_s}{MU_c} = \frac{p_s}{p_c} = \frac{2}{2} = 1. \] The best consumption bundle can be either (1, 3) or (2, 4). Both satisfy the budget constraint: $1 \times 2 + 3 \times 2 = 8 < 12$ and $2 \times 2 + 4 \times 2 = 12$. However, $TU (2, 4) > TU (1, 3)$. Thus, (2, 4) is the best affordable consumption bundle.

Note. Usually the budget constraint is binding, if the consumption bundle is the best affordable one. Why? Hint: Local Non-satiation of consumer preference (i.e., more is better than less).
December 4th (TA)

Objectives  Production

1. Short-Run V.S. Long-Run
2. Profit Maximization
3. Firms under Perfect Competition
4. Consumer and Producer Surplus

H.1 Short-Run V.S. Long-Run

- Short-Run: At least one input (usually capital) is fixed.
- Long-Run: Everything is variable.
- Law of Diminishing Returns governs the production in the short-run.
  - As we add extra units of a variable factor to a fixed factor, beyond some point, the marginal productivity of the variable factor will begin to decline.

- Total Production and Marginal Production
– Efficient Production: $MP > 0$
– Inefficient Production: $MP < 0$

**H.2 Profit Maximization**

The goal of producers is maximizing their profits:

$$\max_{q} \pi (q) = TR - TC = p \times q - (TVC + TFC) = p \times q - ATC \times q.$$  

The necessary optimal condition is $MR = MC$.

**Question**

(i) In the profit maximization graph, explain why the tangent line of $TC$ is parallel to $TR$ at the optimum (i.e., at the maximum of profit)?

(ii) Does $MC$ intersect with $ATC$ at its minimum? Why?

**H.3 Firms under Perfect Competition**

- Accounting Profit: $TR$—explicit costs
- Economic Profit: $TR$—explicit costs—implicit costs
- Normal Profit: Accounting Profit—Economic Profit

**Question**

(i) What does “a firm is earning a normal profit”? [zero economic profit]

(ii) Suppose there is a SR demand decline. Is there a entry or exit for firms? [NO]

**Example.** Suppose in a perfect competitive market, the equilibrium price is $10 and the equilibrium quantity is 10,000. Every firm earns a normal profit (zero economic profit).

(i) If demand goes down and the price decreases to $8, will a firm with $ATC = $11 and $AVC = $7 remain in operation? [Firm remain in operation when $p > AVC$.]

(ii) If the price decreases to $6, will a firm with $ATC = $12 and $AVC = $7 remain in operation? [Firm should shut down when $p \leq AVC$.]

(iii) What is the LR adjustment of the market, if the demand decreases?

**H.4 Consumer and Producer Surplus**

- Consumer Surplus: The difference between the maximum price a consumer is willing to pay for a good and the price they actually pay for it, that is, a measure of net benefit received by the consumer.

- Producer Surplus: The difference between the minimum price for which a seller is willing to sell their product and the price they actually receive.
Suppose Lisa wants 3 slices of pizza.

For the 1st unit, willing to pay $9, but eq. price is $5 \Rightarrow \$4

2nd unit, $7, $5 \Rightarrow \$2

3rd unit, $5, $5 \Rightarrow \$0

Consumer surplus = $4 + $2 + $0 = $6

* She was willing to pay $21, but actually paid $15

\( \Rightarrow \$21 - \$15 = \boxed{\$6} \) CS

Market price $6

If they sell 3 units......

For the 1st unit, willing to sell at $12, but received $6 \Rightarrow \text{net benefit} \$4

2nd unit $14, $6 \Rightarrow \$8

3rd unit $6, $6 \Rightarrow \$0

Producer surplus = $14 + $8 + $0 = $26

For 3 units, they were willing to sell for $18, but received $18, PS = $18 - $18 = $0