Chapter 1

Consumer Theory

1.1 Introduction

Consumer theory is, not surprisingly, the theory of what rational consumers do. By rational, I mean utility (happiness) maximizing consumers.

Definition 1.1.1 (Utility Maximizing) *A Utility Maximizing agent chooses the affordable bundle which makes them happiest.*

This portion of the class is designed to build this theory from scratch. The goal of this theory is to derive a demand function that we will use in our supply and demand analysis. Economists do not claim that people consciously make these maximizing decisions. Rather, we assume that the results of this model accurately represent reality. Almost all data indicates that this assumption helps our models better represent the real world. Our discussion will build the elements separately and then unify the theory. First we will discuss affordable bundles and how we represent those bundles. Second we will study what consumers like. Finally, we will mesh the two concepts to show how consumers choose the affordable bundle that makes them the happiest. Economists' fancy name for that is optimizing or maximizing behavior.

1.2 Budget Constraint

We are all constrained by our budgets'. Not even Bill Gates can buy everything he wants. We represent what an agent may afford with the Budget Constraint.

Definition 1.2.1 (Budget Constraint) *A budget constraint is a line representing affordable bundles for a fixed income and prices*

In this class, we will restrict our analysis to two goods. This is merely a simplifying assumption. The math and logic is easily extended to more dimensions. We will often call these two goods good x and good y. Given an income, I, and prices for the two goods, P_x and P_y, constructing a budget constraint is fairly simple. Simply calculate the two extreme points and connect them. The extreme points are the affordable bundles when the consumer purchases all of one or all of the other type of good. The line connecting these two points represents all affordable bundles. This line represents all information about what the consumer can afford. The slope of this line is $-\frac{P_x}{P_y}$. This can be verified by calculating the slope between the two extreme points $(0, \frac{I}{P_y})$ and $(\frac{I}{P_x}, 0)$.

1.3 Preferences

Armed with complete understanding of affordable bundles, we can begin discussing what consumers like to consume. Economists have a fancy name for 'what consumers like to consume' – preferences. We know that consumers like stuff, but we must be more specific if we intend to find the affordable bundle that makes the consumer happiest.

We assume that consumers have a Preference Ordering over all bundles.

Definition 1.3.1 (Preference Ordering) *A preference ordering is a ranking of bundles with regard to how happy they make consumers.*

That is a fancy way of saying that consumers enjoy consuming things and furthermore, know how much they enjoy it. In future classes, you will learn many fancy things about preference orderings and various ways to represent them. We will represent preferences by indifference curves in this class.

Definition 1.3.2 (Indifference Curves) *An indifference curve is a line (perhaps curved) that connects all bundles at which the consumer is equally happy.*

Indifference Curves are lines (which may be curved or straight) that go through all bundles which make a consumer equally happy. Every level of

happiness has an associated indifference curve. This means that there are usually an infinite number of indifference curves, just as there are usually infinite levels of happiness. To illustrate indifference curves, never draw more than three. In this class, we will only discuss goods (commodities for which more consumption makes the consumer more happy), so higher levels of utility are associated with higher indifference curves. Indifference curves have several interesting properties:

1. **Higher indifference curves are preferred to lower ones** As we only consider goods, more stuff makes people more happy, thus being on a higher indifference curve means more stuff and thus more happiness.

2. **Indifference curves are downward sloping** Again, the restriction to analyzing goods forces this property.

3. **Indifference curves do NOT cross** If indifference curves cross, we lose a very important mathematical property - transitivity. That means that most of the results you know in math will no longer be true.

4. **Indifference curves are bowed inwards toward the origin** This property results from the assumption that consumers have a taste for variety. Equivalently, assuming that consumers enjoy consuming mixes of goods instead of only one good gives indifference curves this shape.

5. **The slope of an indifference curve represents the consumer's willingness to exchange one good for another** This is a result of our definition of indifference curves. In future classes, you will derive this result using calculus. Intuitively, the negative slope of an indifference curve tells us how much of good y the consumer is willing to give up in order to receive one unit of good x and remain equally happy.

In future economics classes, you will learn more about the relationship between specific assumptions and the shape of the indifference curves. For this class, it is sufficient to learn the properties and not their causes.

There are two special cases of indifference curves. They are both rare in the real world, although most real world goods are some mixture of these two types.

Definition 1.3.3 (Perfect Complements) *Perfect Complements are goods which go so well together that they are useless unless both are present.*

Some examples of perfect complements are left and right gloves, left and right shoes, software and a computer, electricity and electrical appliances. They are characterized by right angle indifference curves.

Definition 1.3.4 (Perfect Substitutes) *Perfect substitutes are goods which are indistinguishable to the consumer in terms of utility.*

Some examples of perfect substitutes are Rainbow Sugar and Best Yet Sugar, Pillsbury flour and Gold Medal flour. Most consumers cannot distinguish between the two types of sugar or flour, therefore the goods are perfect substitutes. These special case goods are only interesting because all other goods act as a mixture of these goods.

1.4 Optimization

We know that rational consumers will choose the affordable bundle that will make that consumer the happiest. We call this utility maximization or maximizing behavior. Utility is just a fancy word for happiness. We will now put the first two concepts, budget constraints and preferences, together to graphically represent the consumer's optimal consumption bundle.

Definition 1.4.1 (Optimal Consumption Bundle) *An optimal consumption bundle is the affordable bundle of goods that makes the consumer the happiest*

The optimal consumption bundle is the answer to the consumer's maximization problem. We know that the optimal consumption bundle must lie on the budget constraint (the consumer must spend all of their money, otherwise the consumer should have bought more stuff and thus been happier). So we want to find the highest level of utility (happiness) that a consumer can obtain while still staying on the budget constraint. Since happiness levels are directly linked to indifference curves, our problem is the same as finding the highest (happiest) indifference curve that we can afford. By this I mean we must find the affordable bundle that lies on the highest indifference curve possible. Consider the indifference curve that touches the budget constraint at a single point.

Definition 1.4.2 (Tangent) *Two curves that touch at a single point are said to be tangent.*

Thus the indifference curve mentioned above is tangent to the budget constraint. That indifference curve is attainable, thus any lower indifference curves are not the highest attainable. Any higher curves do not touch the budget constraint and are thus not affordable. These two arguments show that the indifference curve that is tangent to the budget constraint represents the highest attainable level of utility. Furthermore, the affordable bundle that generates this level of utility is the point where the two curves meet. That point is the optimal consumption bundle. Thus the rational consumer will purchase the bundle of goods represented by the point where the two curves touch. As an interesting note, the slopes of tangent curves are the same. Thus at the Optimal Consumption Bundle, the slopes of the indifference curve and the budget constraints are the same. This means that the consumer's willingness to trade one good for another (slope of Indifference Curve) equals the producer's willingness to trade one good for another (slope of Budget Constraint).

Remark 1.4.1 *Many economic texts call 'a consumer's willingness to trade one good for another' the Marginal Rate of Substitution. Thus at the optimal consumption bundle,*

$$MRS = \frac{P_x}{P_y}$$

Economists often call the behavior that generates this equality 'equating the margins'. Thus at the optimal consumption bundle, the consumer equates their willingness to trade one good for another with the store's willingness to trade one good for another (ratio of prices).

1.5 Shifts

We will next study how various changes shift our optimal consumption bundle. A necessary tool for learning this is studying how various changes shift our budget constraint. Income and two prices define our budget constraint. Changes in income are the most intuitive. If we have more income, we can afford more stuff, thus our budget constraint shifts away from the origin when our income increases. The slope does not change when only income changes, as the slope represents the relative prices (ratio of the prices). Conversely, if we lower income, we can afford less stuff, and our budget constraint shifts towards the origin. The above two cases completely determine how the budget constraint shifts when only income changes. We now need to determine

how a consumer's optimal consumption bundle shifts when income changes. First we must categorize goods into two types, normal and inferior.

Definition 1.5.1 (Normal Goods) *Normal Goods are goods that a consumer demands more of when the consumer's income increases. The converse is also true, goods that a consumer demands fewer of when the consumer's income decreases.*

Most goods that people think of are normal goods. Possible examples are restaurant meals, cars, and DVD's.

Definition 1.5.2 (Inferior Goods) *Inferior Goods are goods that a consumer demands fewer of when the consumer's income increases. The converse is also true, goods that a consumer demands more of when the consumer's income decreases.*

Examples of inferior goods are SPAM, bologna, and black label macaroni and cheese. These are the goods that you do not buy when you have enough money to buy something nicer (that's why we call them inferior). As long as we know whether the goods we are discussing are normal or inferior, we now know how a consumer's optimal consumption bundle will change when income changes. For normal goods, more income implies larger quantities bought at the store. For inferior goods, the opposite is true.

The second shift we wish to examine is changes in price. Mathematically, when the only the price of a single good rises (falls), the consumer can buy less (more) of that good and the same amount of the other good. Graphically, this means that the budget constraint rotates or pivots around the good whose price is unchanged. It is always a good idea to check your answer with your intuition on these problems. For example, if you lower the price of a good, your new budget constraint should reflect the fact that you can now afford more of that good. The above remarks completely define how to change the budget constraint when the price of one good changes. We now must discover how the consumer's optimal consumption bundle changes when the price of one good changes. Economists find it helpful to break this shift down into two effects, the income effect and the substitution effect.

Definition 1.5.3 *][Income Effect] The Income Effect is the change in consumption that results from moving from one indifference curve to another.*

When the price of one good changes, you can afford different amounts of stuff. The income effect isolates this. If price goes down, then you can buy more stuff. The income effect represents this by showing the change from a lower level of happiness to a higher level of happiness (lower indifference curve to a higher one).

Definition 1.5.4 (Substitution Effect) *The Substitution Effect is the change in consumption that results from moving along a given indifference curve.*

When you change the price of one good, the ratio of prices is different. You can now trade goods at a different rate at the store. The consumer will change their consumption bundle until the consumer's willingness to trade one good for another is equal to the store's willingness to trade one good for another (equating the margins). The substitution effect isolates this effect. Graphically constructing these effects is somewhat tedious, thus we will not cover that in this course. Table $21-2$ in the text summarizes these effects. In this class, you should find the new optimal consumption bundle by drawing the new budget constraint and drawing an indifference curve tangent to that new budget constraint. The only restriction we have on the placement of the new bundle is that if the price of a good decreases (increases), we must buy more (less) of it. We now have the tools to study how rational consumers respond to price changes. We will now use those tools to derive a relationship between price and quantity bought at the store.

1.6 Derive Demand Curve

We have developed several tools in this chapter. The **main** reason we invested time in developing these tools is justify our demand curve. I want the assumptions needed for our demand curve to be very clear. Because economics uses certain words in a very specific way that may be slightly different from the usual way you use these words, we must define a few terms before proceeding.

Definition 1.6.1 (Quantity Demanded) *The amount of a good that buyers are willing and able to purchase.*

You can think of quantity demanded as what consumers buy when they go to the store.

Definition 1.6.2 (Demand) *A relationship between price of a good and quantity demanded of that good.*

You can think of demand as something that you yell a price at and it responds with a quantity demanded. Alternatively, you could yell a quantity demanded at it and it would respond with the price at which that quantity was demanded. In this class, we will almost always work with a graphical representation of demand. This is known as the demand curve. Using the tools we developed in the preceding sections, we can derive a demand curve. Specifically, we know how to find how a consumer changes what they buy at the store (quantity demanded) when prices change. For example, say we were interested in finding the demand curve for cookies. Define the other good as a composite good.

Definition 1.6.3 (Composite Good) *A composite good is an imaginary good that results when you add many goods together.*

Economists often use composite goods as a trick to study many goods in a two good framework. For example, suppose you had data on Snickers Candy Bars, Hershey's Candy Bars, and chewing gum. You might want to represent preferences over these two goods. This might seem impossible in a two good framework, but we could simply add together the quantities of Snickers and Hershey's and call it a composite good, candy bars. Adding together prices is more like finding the average. We could then represent preferences using chewing gum and candy bars as our two goods. Taken to the extreme, we could add together all goods in the US into a composite good. Macroeconomists often do this in their research – they call it the composite good consumption. Returning to deriving the demand curve, we now have two goods, the good in which we are interested and the composite good. For any income and prices, we can construct a budget constraint and optimal consumption bundle. To derive the demand curve, simply try several (2) prices for the good in which we are interested. After finding the different optimal consumption bundles for these different prices, we have a relationship between quantity demanded and price, which is exactly demand. We represent this information in price-quantity space, usually putting price on the vertical axis. This is a recipe for deriving demand. This entire chapter was a justification for this demand curve.

1.7 Conclusion

We built a theory to explain how consumers make decisions. We wanted a theory that makes testable predictions about what economic agents purchase. You may think this seemed like a lot of unnecessary mathematical modeling. You know that you do not draw budget constraints and indifference curves to decide what you want at the store. We are not trying to build a model that tells us exactly what every person does. We want a model that is usually correct in its predictions about the real world. Consumer theory as formulated in this chapter has been remarkably successful in regards to the accuracy of its predictions. I think this is because intuitively, economic agents to solve a problem when they decide how to spend their resources. This theory captures that.

Chapter 2

Demand and Supply

2.1 Introduction

In the last chapter, we derived a relationship between price and quantity and named this relationship demand. We will now study this relationship in detail. We will also assume an analogous relationship for producers (supply). After learning clear rules for what changes these relationships, we will combine them to formulate our equilibrium concept. Equilibrium is the central tenet of modern economics.

2.2 Shifts in Demand

From our derivation, it should be clear that anything that changes our optimal consumption bundle will change the quantity demanded. Changing the price of the good in which we are interested will move us along our demand curve. Moving along the demand curve means moving from one price and quantity demanded to a different price and quantity demanded. Anything else that changes our optimal consumption bundle will shift our demand curve. In this class, we will focus on the following list things that shift the demand curve. Careful thought about the pictures we used to derive demand should help clarify why these things shift demand.

1. **Income** As we change income, our demand curve shifts up or down according to our assumption of normal or inferior status for the good in question.

2. **Prices of related goods** If the price of a related good changes, demand curve will shift.

3. **Tastes and preferences** If a consumer's tastes and/or preferences change, the demand curve will shift.

4. **Expectations about future prices** If expectations about future prices change, the demand curve will shift.

5. **Number of consumers** If the number of consumers changes, then the demand curve will shift.

Remark 2.2.1 *By 'increase in demand', we mean that the consumer has a higher quantity demanded at every price. Graphically, this is a shift to the right.*

Every time you draw a demand curve, you are holding the above items constant. If you change any of these things, change your demand curve. Economists attach a fancy name to this method of analysis – ceteris paribus. Ceteris paribus means 'all other things remaining equal'.

Remark 2.2.2 *It is VERY important to note that changing the price of a good does not change demand for that good, but rather it changes the quantity demanded of that good. Thus changing price moves you ALONG the demand curve, and it does not move the entire curve.*

2.3 Supply

Just as we needed a theory of consumer behavior to derive a relationship between price and quantity demanded, we need a similar theory of producers (firms or suppliers) to derive a relationship between price and quantity supplied. Most introductory students do not appreciate this need for formalism, thus we will postpone a rigorous derivation and instead assume it. Later in the course, we will verify this relationship using producer theory.

Definition 2.3.1 (Quantity Supplied) *Quantity supplied is the amount of a good producers are willing and able to sell.*

Definition 2.3.2 (Supply) *Supply is the relationship between quantity supplied and price.*

Similar to demand, you can think of supply as something at which you yell price or quantity supplied and it responds with the other variable (quantity supplied or price).

2.4 Shifts in Supply

Analogous to demand, supply has a clear set of things that shift the supply curve.

1. **Price of inputs** If the price of inputs increases, then supply will decrease.
2. **Technology** If technology improves (usually in the form of reduced costs of production), then supply will increase.
3. **Expected future prices** If the expected future price falls, supply will increase now.
4. **Number of Suppliers** If the number of suppliers increases, then supply will increase.

Remark 2.4.1 *By 'increase in supply', we mean that at every price, suppliers will supply a higher quantity (quantity supplied is higher at every price). Graphically, this is a shift to the right.*

Every time you draw a supply curve, you are holding the above items constant. If you change any of these things, change your supply curve.

Remark 2.4.2 *It is VERY important to note that changing the price of a good does not change supply for that good, but rather it changes the quantity supplied of that good. Thus changing price moves you ALONG the supply curve, and it does not move the entire curve.*

Now we will combine our theory of supply and demand to begin making predictions about the real world.

Chapter 3

Equilibrium

3.1 Introduction

We have built up several tools so far. Now we will combine these tools to form an equilibrium.

Definition 3.1.1 (Equilibrium) *An equilibrium is a situation in which* $Q_s = Q_d$ *(Quantity supplied = quantity demanded)*

By 'situation', we will usually mean simply a price at which $Q_s = Q_d$. In more advanced economics classes, you will spend a considerable amount of time studying various ways to define and solve for various equilibria. This is because economists believe that the real world is usually accurately represented as an equilibrium outcome. Thus economists build models that have equilibria. Economists then shock their models to see they change. The purpose of this is to determine how the real world will respond to various shocks. Examples of shocks can be taxes, government purchases, natural disasters, or monetary policy. In this class, we will use our tools of supply and demand to determine how equilibria change when various things happen to our model economy. For example, how would our equilibrium in the market for cokes change if the government began taxing cokes? Most data indicates that our simple model of supply and demand produces accurate results.

3.2 Why this equilibrium?

A big question here is why do economists believe that the real world arrives at the equilibrium described by our theory. The quick answer is that the equilibrium described by our theory is the best description of the real world that economists have formulated. A more serious answer involves considering various 'out of equilibrium' or 'disequilibrium' mechanics. Specifically, imagine that we are at a price higher than the equilibrium price. Then quantity supplied exceeds quantity demanded. In real world terms, this means stores are trying to sell more stuff than people are willing to purchase. This means that store inventories are increasing. How do stores usually deal with this situation? They hold a sale. Thus if we are at a price higher than the equilibrium price, profit maximizing firms will lower prices. On the other hand, what if we are at a price below the equilibrium price? Then quantity supplied will be less than quantity demanded. In real world terms, this means that people want to buy more stuff than the store has. This means lines. When stores see lines outside of their store, they usually raise prices. Thus we have argued that in the real world, market forces (stores wanting to make money) move us towards the equilibrium price.

3.3 How to solve problems

For the next few weeks, we will be using the tools of supply and demand to answer questions about the real world. We will usually do this by considering an initial equilibrium and then introducing some shock into the system. The following set of steps will facilitate solving these problems.

1. Draw initial equilibrium.
2. Decide what shifts (Supply or Demand) and how.
3. Draw shifts in your picture from step 1.
4. Find new equilibrium.
5. Answer ALL questions about changes in the equilibrium (usually price and quantity).

Work some examples.

Chapter 4

Elasticity

4.1 Introduction

In the previous chapter,we developed the tools of supply and demand to answer questions about the real world. The tools are crude but effective. Now we will work on refining those tools into a more accurate description of the real world. We know qualitatively (general direction) how consumers respond to changes in price, but we do not have quantitative (how much) answers yet. Elasticity is a measure of how much consumers respond to various changes. In other words, elasticity is a measure of how flexible consumers are. This chapter will develop the tools necessary to answer a wide range of quantitative questions.

4.2 Elasticities

4.2.1 Price Elasticity of Demand

The most common form of elasticity in this class is Price Elasticity of Demand.

Definition 4.2.1 (Price Elasticity of Demand (PED)) *Price Elasticity of Demand is a measure of how much consumers respond to changes in price.*

Consumers respond to price changes by changing the quantity they demand. PED tells us how much the consumers respond to changes in price. PED is

calculated as follows (dropping any negative sign in the answer).

$$PED = \frac{\%\Delta Q_d}{\%\Delta P} = \frac{\frac{Q_2 - Q_1}{.5(Q_2+Q_1)}}{\frac{P_2 - P_1}{.5(P_2+P_1)}}$$

The above formula uses the midpoint approximation method to calculate elasticity (that's why there is that .5 in the formula). The numerical value of PED tells us how responsive consumers are to price changes. Specifically, PED¿1 means that consumers are elastic, while PED¡1 means that they are inelastic. You may think of elastic and inelastic as flexible and inflexible respectively. In this class, we will associate elastic(flexible) consumers with a flat demand curve. While this is technically not true, it will suffice for this class. Similarly, we will associate inelastic(inflexible) consumers with a steep demand curve. You will often have to incorporate this into the answers to homeworks and exams.

The value of PED tells us something about the relationship between total revenue and price. We know that if a firm raises price, two things affect total revenue. Higher price means more total revenue. On the other hand, higher price means fewer customers, which means less total revenue. The value of PED tells us which effect is larger. Specifically, elastic consumers are very flexible, so an increase in price means that they will decrease consumption by a lot, thus total revenues would decrease. Inelastic consumers are exactly opposite. They are inflexible, so an increase in price will not cause a large drop in consumption, thus total revenues would increase. We will use this fact more in the course.

Several things affect PED.

1. Necessities vs. Luxuries
2. Availability of close substitutes
3. Time horizon
4. Fraction of income spent on item

4.2.2 Other Consumer Elasticities

There are two other elasticities that we will use in this class to describe consumers.

Definition 4.2.2 (Income Elasticity of Demand (IED)) *The IED measures how a consumer's quantity demanded responds to changes in income.*

IED can be calculated using the following formula.

$$IED = \frac{\%\Delta Q_d}{\%\Delta I} = \frac{\frac{Q_2 - Q_1}{.5(Q_2+Q_1)}}{\frac{I_2 - I_1}{.5(I_2+I_1)}}$$

The sign of IED tells us if a good is normal ($IED > 0$)or inferior ($IED < 0$).

Definition 4.2.3 (Cross Price Elasticity of Demand (CPE)) *The CPE is a measure of how a consumer's quantity demanded of a good changes when the price of a different good changes.*

CPE can be calculated using the following formula.

$$CPE = \frac{\%\Delta Q_d}{\%\Delta P} = \frac{\frac{Q_2 - Q_1}{.5(Q_2+Q_1)}}{\frac{P_2 - P_1}{.5(P_2+P_1)}}$$

The only difference between PED and CPE is that in the calculation of CPE, you use the price of one good and the quantities for a DIFFERENT good. The value of CPE tells us if goods are complements ($CPE < 0$) or substitutes ($CPE > 0$). That is the only reason to be interested in CPE. If $CPE = 0$, then we say that the goods are unrelated.

4.2.3 Price Elasticity of Supply

Just as consumers respond to price changes, so do profit-maximizing firms.

Definition 4.2.4 (Price Elasticity of Supply) *The price elasticity of supply is a measure of how much firms change their quantities supplied when price changes.*

PES can be calculated using the following formula.

$$PES = \frac{\%\Delta Q_s}{\%\Delta P} = \frac{\frac{Q_2 - Q_1}{.5(Q_2+Q_1)}}{\frac{P_2 - P_1}{.5(P_2+P_1)}}$$

We use PES to determine if the supply curve is steep or flat (similar to PED). If $PES < 1$, then we say that supply is inelastic and represent it as

a relatively steep curve. If $PES > 1$, then we say that supply is elastic and represent it as a relatively flat curve. Just as with PED, the above statements are not entirely true, but for this class they are sufficiently accurate.

4.2.4 Examples

1. Farming increase in Supply.
2. OPEC decrease in supply. (time horizon and PED)

4.2.5 Calculus and Elasticity

Elasticity is a dimensionless (no units) measure of how much a variable changes with respect to another. We want a dimensionless measure so that we can compare across various data sets. The usual measure of how one variable changes with respect to another is slope, but slope has units (y axis/x axis). Calculating the percentage change in things eliminates these units. So we define elasticity, ϵ to be the ratio of percentage changes in two variables. If we define our demand curve as a function relating price P and quantity demanded Q_d, we can use calculus to help calculate these elasticities.

$$\epsilon_{PED} = \frac{\%\Delta Q_d}{\%\Delta P} = \lim_{\Delta P \to 0} \frac{\Delta Q_d}{\Delta P} \frac{P}{Q} = \frac{P}{Q} \left(\lim_{\Delta P \to 0} \frac{\Delta Q_d}{\Delta P} \right)$$

The final term in parenthesis is merely the derivative of our demand function with respect to P.

Chapter 5

Welfare Economics

5.1 Introduction

Economists use models to make positive statements about reality. In order to make stronger statements, we need to develop a concept of efficiency. In order to develop a concept of efficiency, we need to rank outcomes in some way. By outcomes, I mean who gets what and who makes it. This chapter will develop these tools.

5.2 Consumer Surplus

The first of these tools will tell us how happy consumers are with the way goods are allocated.

Remark 5.2.1 *The use of surplus here is different than the use of surplus when* $Q_s > Q_d$.

Definition 5.2.1 (Consumer Surplus) *Consumer surplus is a measure of how happy consumers are with outcomes. It is the difference between the price a consumer is willing to pay for an item and the price a consumer ends up paying.*

In order to construct this measure, we must decide how to value outcomes. Because we assume our agents are rational, we can use each consumer's preferences to see how happy they are with outcomes and sum over consumers.

If we define the height of our demand curve at a quantity Q as $D(Q)$, then consumer surplus (CS) can be calculated as follows:

$$CS = \sum_{Q}(D(Q) - P)$$

Graphically, consumer surplus is the area above price paid by consumers and below the demand curve shaded up to the quantity traded. If the demand curve is below the price paid by consumers (the consumers would not willingly purchase items at that price, but the government could mandate that they purchase them), then that region is negative consumer surplus and represents unhappiness that the consumers receive. Analogous to consumer surplus is producer surplus.

Definition 5.2.2 (Produer Surplus) *Producer surplus is a measure of how happy producers are with outcomes. It is the difference between the price sellers receive and the price they are willing to receive.*

If we define the height of our supply curve at a quantity Q as $S(Q)$, then producer surplus (PS) can be calculated as follows:

$$PS = \sum_{Q}(P - S(Q)$$

Graphically, producer surplus is the area below price received by producers and above the supply curve shaded up to the quantity traded.

Chapter 6

Government Policies

6.1 Price Controls

The government sometimes regulates the allowable market prices. These fall into two categories, price ceilings and price floors. Collectively, we call these restrictions on legal prices - price controls. A price ceiling is a legal maximum on the price that firms can charge. Intuitively, you cannot move above the ceiling, thus price ceilings are prices that you cannot go above. Tracing across from a binding price ceiling shows that quantity demanded is larger than quantity supplied.

Definition 6.1.1 (Shortage) *A shortage is a situation where* $Q_D > Q_S$.

Similarly, a price floor is a legal minimum price that a firm can charge. Intuitively, you cannot move below the floor, thus you cannot charge prices below the price floor. Tracing across from a binding price floor shows you that quantity demanded is less than quantity supplied.

Definition 6.1.2 (Surplus) *A surplus is a situation where* $Q_S > Q_D$.

Remark 6.1.1 *This surplus is different than the surplus's we discussed in the Welfare Economics chapter. This surplus is a quantity, represented by a horizontal distance in our supply and demand diagrams.*

An examples of a price ceiling is rent control. Examples of price floors are minimum wage and farm price supports.

6.2 Taxes

More often, the government intervenes in markets by taxing goods. Taxes always drive a wedge between the price buyers pay and the price sellers receive. This is a way of discouraging trades because the government is 'taking away' from the trades, which prevents some trades from occurring.

Definition 6.2.1 (Per Unit Tax) *A tax paid on each unit of a good is called a Per Unit Tax.*

We will focus on per unit taxes in this class. It is sometimes called the marginal tax. A government tax means that we can no longer describe an equilibrium with a simple price and quantity. There is no longer a single price. There is a price sellers receive and a price buyers pay. Thus we must include both of these prices in our equilibrium.

Definition 6.2.2 (Equilibrium with taxes) *An equilibrium with taxes includes the price buyers pay, the price sellers receive, and the quantity traded.*

The government sometimes levies taxes on buyers, sometimes on sellers, and sometimes divides the tax. In our model, it does not matter who the government levies the tax upon. This is an important result. We say 'does not matter' because the price paid by buyers, the price received by sellers, and the quantity traded are the same regardless of how the government distributes who pays the tax. Thus policy makers do NOT determine who bears the burden of a tax, despite their common claims to the contrary. To clarify the above statement, define the change in price paid or received as the tax burden. Thus the consumers' tax burden is the difference between the price paid after the tax and the original equilibrium price. The producers' tax burden is the difference between the price received before the tax (the original equilibrium price) and the price received after the tax is imposed. Intuitively, the change in price due to the tax is the burden you bear.

Definition 6.2.3 (Subsidy) *A subsidy is a negative tax.*

Intuitively, a subsidy encourages trades because the government is 'chipping in' for a consumer.