I. Introduction to Taxation

Government plays an important role in most modern economies. In the United States, the role of the government extends from providing for national defense to providing social security and Medicare to the elderly. In order to provide for these programs and services, the government needs revenues. The sources of the revenues come from taxes that are paid by households. In this chapter, we'll go over a quick overview of taxes and look at how taxes affect economic decisions.

A. Sources of Federal Government Revenue

Taxes has two parts: (1) a base and (2) rate structure.

The base is the measure or value upon which a tax is levied. The base can be measures such as income, sales purchases, home value, corporate profits, etc… The tax rate structure is the percentage of the tax base that must be paid in taxes.

For example if you pay 35% of your income in taxes, then your income is the tax base, and 35% is the tax rate structure. The tax base can either be a stock measure (property, inheritance) or a flow measure (income, sales).

Table 1: Sources of Federal Government Revenue

<table>
<thead>
<tr>
<th></th>
<th>% of Total Revenues (1960)</th>
<th>% of Total Revenues (1970)</th>
<th>% of Total Revenues (1980)</th>
<th>% of Total Revenues (1990)</th>
<th>% of Total Revenues (2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Income Tax</td>
<td>44</td>
<td>46.9</td>
<td>47.2</td>
<td>45.2</td>
<td>46.8</td>
</tr>
<tr>
<td>Social Insurance Taxes</td>
<td>15.9</td>
<td>23</td>
<td>30.1</td>
<td>36.8</td>
<td>34.8</td>
</tr>
<tr>
<td>Corporate Tax</td>
<td>23.2</td>
<td>17</td>
<td>12.5</td>
<td>9.1</td>
<td>11.8</td>
</tr>
<tr>
<td>Excise, Estate, Other</td>
<td>16.9</td>
<td>13.1</td>
<td>10.2</td>
<td>8.9</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Table 1 illustrates the major sources of Federal government revenue in the United States over time. The major sources of revenue are:

(1) Individual Income Tax: This is the tax you are most familiar with. Individuals must pay this tax by April 15. During the year the government withholds a portion of each paycheck as tax payments. Table 1 shows that individual income tax has been and still is the single largest component of federal revenue over time.

(2) Social Insurance Taxes: These taxes are levied on income to pay for Social Security (retirement fund for the elderly) and Medicare (health care for the elderly). Note how these taxes has increased over time. In 1960, social insurance taxes comprised only about 16% of total revenues, by 2008 that amount had reached almost 35%
(3) **Corporate Taxes:** The corporate tax is a tax levied on the earnings of corporations. This tax was an important source of revenues in the mid-20th century, but has become less important over time. The existence of tax shelters, laws to stimulate R&D, and complex rules regarding taxing multinational corporations have all led to a decline in the importance of corporate taxes as a source of federal revenue.

(4) **Other Taxes:** The other sources of government revenue are relatively minor. Excise taxes are taxes that are levied on the sale of certain products such as gasoline, cigarettes, alcohol, etc... Estate taxes (sometimes called the “death tax”) are levied on estates of individuals when they passed away. Custom duties are taxes levied on goods imported to the United States, such as foreign cars or wines. Combined, these sources of federal revenues accounted for only 6.6% of total revenues in 2008.

**B. Types of Taxes**

A tax can either be proportional, progressive or regressive.

1. **Proportional Tax (Flat Tax):** A proportional tax is a tax whose burden is the same rate regardless of the income earned by the household. For example under a proportional tax system, if the income tax rate is 13%, then a household who earns $10,000 will pay 13% of the their income in taxes, while a household who earns $10 million will also pay 13% of their income as taxes.

2. **Progressive Tax:** A progressive tax is a tax that exacts a higher percentage of income from higher income households than from lower income households. The current income tax system in the United States is a progressive tax. For example, under a progressive tax system, a household that earns $10,000 would pay a 5% income tax while a household that earns $10 million would have to pay a 35% income tax.

3. **Regressive Tax:** A regressive tax means that higher income households pay less in taxes as a percentage of their income than lower income families. Excise taxes and retail sales taxes are examples of regressive taxes.

**Numerical Example of a Regressive Tax**

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household</td>
</tr>
<tr>
<td>Smith</td>
</tr>
<tr>
<td>Jones</td>
</tr>
</tbody>
</table>

Table 2 illustrates how a retail or consumption tax can be regressive. Suppose that tax reform eliminates the income tax and imposes a national sales retail tax of 5% on the purchase of all goods. We have two families the Smiths and the Jones'. The Jones’ have an annual household income of $100,000 while the Smiths are not so well off and earn only $10,000. Suppose that the Smiths have to spend all of their income to pay for basic necessities such as food, shelter and clothing and they have nothing left over to save (their saving rate is 0%). The Jones’, on the other hand, are able to save some of their income (their saving rate is 30%). Thus the Jones’ total spending is $70,000 while the total spending for the Smiths’ is $10,000. If the retail tax is 5%, the Smiths will pay $500 in taxes while the Jones’ will pay $3500 in taxes. As a percentage
of income, the Smith’s will pay a higher tax rate ($500/$10,000 = 5%) than the Jones’ ($3500/$100000 = 3.5%). Thus a sales tax is a regressive tax.

C. Marginal vs. Average Tax Rates

**Average tax rate** is the total amount of tax paid divided by income.

Example: Suppose that your total income is $50,000 and that you pay $10,000 in taxes. Your average tax rate is $10,000/$50,000 = 20%.

**Marginal Tax Rate** is the tax rate that you pay on any additional income you earn.

Example: Suppose that you have a part-time job that earns you an extra $1000 a year. If you have to pay an additional $250 in taxes on that extra $1000 in income, then we say that the marginal tax rate is 25%.

Marginal tax rates are important because they play a key determinant in household decisions on working extra hours and/or making contributions to charity. In order to see why marginal tax rates determines these factors we have to look at how our current tax system works.

**Table 3: Tax schedule for single taxpayer**

<table>
<thead>
<tr>
<th>Income Bracket</th>
<th>Tax Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0-$7,825</td>
<td>10%</td>
</tr>
<tr>
<td>$7,826-$31,850</td>
<td>15%</td>
</tr>
<tr>
<td>$31,851-$77,100</td>
<td>25%</td>
</tr>
<tr>
<td>$77,101-$160,850</td>
<td>28%</td>
</tr>
<tr>
<td>$160,851-$349,700</td>
<td>33%</td>
</tr>
<tr>
<td>More than $349,700</td>
<td>35%</td>
</tr>
</tbody>
</table>

Table 3 illustrates the tax rates that a single individual must pay. The taxes are **marginal taxes**. Let’s work through a numerical example to see how taxes are paid. Suppose that Stacy earned $60,000 in income last year (before paying any taxes). Taxpayers are allowed to make deductions (reductions in their income) in the form of standard deductions ($5350) and in personal exemptions ($3400). These deductions lowers the amount of taxable income.

**Numerical Example**

Step #1: Take your pre-tax income and deduct your standard deduction and personal exemption.

Before Tax Income = $60,000

Standard Deduction= -$5,350

Personal Exemption = -$3,400

Taxable Income After Deductions = $51,250
Step #2: Split your taxable income based on the tax chart. The first $7825 is taxed at the 10% tax rate. Stacey earned more than this amount, but the she pays only 10% in taxes for the first $7825 that she earns. Thus the taxes paid is $7825 x 10% = $782.50.

Step #3: We see from the chart that the next slice of income between $7826-$31,850 is taxed at a 15% rate. Stacey’s next slice of income is thus taxed at 15%. The taxes paid of this slice is $24,025 x 15% = $3,603.75.

Step #4: The next slice of income is $31,851-$77,100. This income is taxed at a 25% rate. Of Stacey’s total $51,250 salary, $19,400 would fall in this range. She would be taxed 25% on this $19,400. The taxes paid on this slice is $19,400 x 25% = $4,850.00.

The total taxes Stacey thus owes is $782.50 + $3,603.75 + $4,850 = $9,236.25.

Stacy’s average tax rate is 18.02% ($9,236.25/$51,250) while her marginal tax rate will be 25%. Her marginal tax rate is 25% because if she earns one more $1 it would be taxed at the 25% bracket.

Now we can see how marginal tax rate can affect decisions to work and to contribute to charity.

(1) Incentive to work: If Stacy’s decides to take a second job, her income from that second job will be taxed at the 25% bracket. At that rate, Stacy may decide it might not be worth it to work that second job. If the marginal tax rate is very high, it might provide a disincentive for workers to work overtime hours or work the second job.

(2) Incentive to contribute to charity: One of the features of charitable giving is that the donations are tax-deductable. That is if you give $1000 to your local church, you may deduct that contribution from your income and thus lower your taxable income. For example, suppose that Stacy also contributed $2000 to the Red Cross last year. We would add that contribution to her standard deduction and thus lower her income after deductions to $49,250. Stacey has to pay less in taxes due to the charitable donation. She pays 25% on now $17,400 (instead of $19,400) at 25%. The taxes she must pay on her last slice of her income is now $4,350. Stacey has saved $500 in taxes owed. High marginal tax rate would increase the incentive for individuals to contribute to charity so they can take a higher deduction.

II. Tax Incidence: Who Pays?

When the government passes tax laws, the laws clearly indicates who has the responsibility to pay the tax. For example, an excise tax on cigarettes might impose a tax that cigarette manufacturers must pay per pack of cigarettes sold. However, as we will soon see, the burden of a tax might not always be borne by those who the law saws have a responsibility to pay for it. For most taxes, the burden of payments is often shifted, either directly or indirectly to others.
A. Tax-Shifting: Tax on Producers (Graphical Analysis)

Let us use our supply and demand framework to look at how taxes affect economic behavior and how the burden of taxes can shift from one party to another. Figure 1 below looks at the market for 12 pack of Cokes. Initially, the market supply and market demand curves intersected at Point A. Thus the market equilibrium price is at $3 while the market equilibrium quantity was at 900 packs of sodas.

Figure 1

Suppose the government wants to impose a $1 “Health Tax” on each case of Coca-Cola sold. The government will collect the tax directly from Coca-Cola and use the proceeds to fund childhood obesity programs. On the surface you would expect that since Coca-Cola has to mail the tax revenue directly to the government they would bear the sole brunt of this tax, but this thinking would be incorrect.

Consider what happens when the government imposes the tax.
Step #1: Coca-Cola was perfectly willing to supply 900 cases of soda when the price of sodas were $3 each. However, with this new tax, if Coke kept the price at $3, it would only receive $2 and have to pay $1 to the government. Thus Coke would not be able to supply 900 units anymore. In order to continue to supply 900 units of sodas, Coca Cola must charge $4 per case. They will receive $3 (which was their pre-tax price receive) and also will have $1 to pay the government. **The end result is that the supply curve shifts upward by the amount of the tax.**
At any given level of output, the firm must increase price by the amount of the tax. In this case, Coca-Cola will move to Point C and start charging $4.

Step #2: **Find the new equilibrium.** Find the new equilibrium where the demand curve intersects the new supply curve. This will be at Point B. Looking at the graph we see that Point B results in an equilibrium price of $3.60 and an equilibrium quantity of 750 units.

Step #3: **Find the following prices** (Price consumers pay = $P_C$) and (Price firm receives = $P_f$) Looking at Figure 1 we see that at the new equilibrium the households must pay $3.60 for each case of Coke. What is the price that Coca-Cola receives? Although Coca-Cola receives $3.60 from the consumer, the firm must pay $1 of that to the government. Thus Coca-Cola only receives $2.60 net.

Step #4: **Calculate Government Tax Revenue:** How much does the government collect from this health tax? After the tax the number of cases sold is 750 cases. Since the tax is $1, the government will generate $750 in revenue.

Step #5: **Calculate the tax incidence:** Who ultimately pays this $1 health tax? Compare the prices that consumers pay and firms receive in Step #3 to the initial equilibrium situation. Before the tax, the consumer paid $3 for the soda, while Coca-Cola received $3 for each case sold. Now after the tax, consumers have to pay $0.60 more than before, while Coca-Cola receives $0.40 less than before. Notice that the majority of the $1 tax burden was shifted to consumers who pay $0.60 out of the $1.00 tax. Although Coca-Cola pays the entire $1.00 tax in a legal sense, they get some of the money to pay the tax by charging consumers higher price for their product.

### B. Tax-Shifting: Tax on Consumers (Graphical Analysis)

So far we have focused on a tax paid directly by a firm. What difference would it make graphically if the law said that the tax had to be paid by consumers directly? Figure 2 shows the market for beer. The initial market supply and demand curves resulted in an equilibrium at Point A. At point A, beer is sold at $P_o$ and $Q_o$ bottles of beer are sold.

$P_o$ = Initial equilibrium price  
$Q_o$ = Initial equilibrium quantity

Step #1: Suppose the government imposes a tax $= St$ per bottle of beer on the consumer. For each bottle of beer consumed, the consumer has to pay $St$. Consumers initially were willing to purchase $Q_o$ bottles of beer at the price of $P_o$ per bottle. But now that a tax has been imposed, consumers would be willing to purchase $Q_o$ only if the price of beer falls to ($P_o$ - $t$). This will hold true at every quantity, thus the effect of a tax imposed on the consumer is that the demand curve will shift down (shift to the left) by the amount of the tax.

Step #2: Find the new equilibrium. The new equilibrium would be where the new demand curve intersects the supply curve. In Figure 2 this is at Point B. At Point B, the new equilibrium quantity is $Q_1$, while the new equilibrium price is equal to $P^*$. 
Step #3: **Find the following prices (Price consumers pay = \( P_C \)) and (Price firm receives = \( P_f \))**

Looking at Figure 2 we see that at the new equilibrium the firm receives the equilibrium price \( P_f \), while the household must pay \( P_C = (P_f + t) \) for each bottle of beer.

Price consumers must ultimately pay = \( P_C = P_f + t \)

Price producers receive = \( P_f = P* \)

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Step #4: **Calculate Government Tax Revenue:** How much does the government collect from this tax? After the tax the number of cases sold is \( Q_1 \). Since the tax is \( t \), the government will generate \( t \times Q_1 \) in revenue.

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Step #5: **Calculate the tax incidence.** Although this example is more abstract, we can see that (1) producers receive less under the tax than the price they initially received (\( P* < P_0 \)), so producers bear some of the tax burden. Clearly, consumers will also bear some of the tax burden as they have to pay the tax directly (\( P_C > P_0 \)). The same general result occurs as our first example, in that the ultimate burden of the tax is shared between consumers and producers.

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**Figure 2**
C. Example of Tax-Shifting: (Using Algebra)

Let us work out a problem using Algebra to see how tax shifting works.

Suppose the market demand function for corn is $Q_d = 15 - 2P$
Suppose the market supply function for corn is $Q_s = 5P - 2.5$

Suppose the government imposes a $0.70 tax per bushel on the corn producers.
(a) Calculate the equilibrium price and quantity of corn before the tax.
(b) After the tax, what will be the equilibrium price and quantity of corn?
(c) Calculate the government revenue.
(d) Calculate the tax incidence (i.e. Will consumers or producers bear the brunt of this corn tax?)

(a) Initial equilibrium is where $Q_d = Q_s$, so $15 - 2P = 5P - 2.5$
17.5 = 7P
P = 2.50 ; Q = 10. Before the tax, equilibrium quantity was equal to 10, and price was equal to $2.50.

(b) Since by law the tax is imposed on producers, this will affect the supply curve but leave the demand curve unchanged.
What is the new supply curve?
$Q_s = 5P* - 2.5$
Let $P* = price (amount) that firms actually receive$
Now with the tax firms no longer receive the price of the good sold. They receive the price of the good minus the tax. Algebraically we can write this as follows
$P* = P - t$
Or
$P* = P - 0.70$
The new supply curve is thus:
$Q_s = 5[P-0.70] - 2.5$
$Q_s = 5P - 3.5-2.5 = 5P - 6$

Set the $Q_d = Q_s$ and solve.

$15 - 2P = 5P - 6$
$21 = 7P$
P = 3, Q = 9
After the tax, the new equilibrium quantity is 9 while the equilibrium price is $3.

(c) The government revenue will be $0.70 x 9 units sold = $6.30

(d) Compare the price paid by consumers and the price received by firms after the tax is imposed to the initial equilibrium. After the tax, consumers must pay $3, which is $0.50 greater than what they had to pay before the tax. Firms receive $3-$0.70 = $2.30 for each unit sold,
which is $0.20 lower than what they had received before. Therefore it is the consumer who bears the brunt of the tax.

C. Tax Incidence and Elasticity

As we have seen both graphically and algebraically, an increase in taxes will result in the tax burden being shared by consumers and producers. If a tax is placed on producers, how much of the tax can be shifted forward on to the consumers? The answer depends on the price elasticity of demand for the taxed good. If the demand for the taxed good is very inelastic (in other words consumers are not very responsive to price changes) then consumers will pay the large bulk of the tax.

Consider the example of the extreme case of a good with perfectly inelastic demand. Recall that if a good has perfectly inelastic demand, consumers will not alter the amount purchased no matter what the price of the good. In other words the demand curve is vertical. Figure 3 illustrates this case.

In Figure 3, the equilibrium price is at Point A where the initial price is equal to $5 and the equilibrium quantity is at 500. Note that the demand curve is vertical which represents a good that has perfectly inelastic demand. Suppose now that the government imposes a tax on produces of $1 per unit produced. As with our earlier examples, the supply curve will shift upwards (to the left) by the tax of $1. Note that the new equilibrium is at Point B. At Point B, the quantity stays the same at 500 while the equilibrium price increases to $6. Firms still receive $5 for their product (they are able to charge $6, keep $5 and pay $1 in taxes). Firms are not affected at all by the tax. Consumers on the other hand have to pay $6 instead of $5. Under the case with perfectly inelastic demand, the firms will be able to pass the entire tax to consumers.

Figure 3
In general: **The more inelastic the demand, the greater the ability for a firm to shift some of the tax burden to consumers.**

Conversely, if a good has relatively elastic demand (consumers are very responsive) then the firms will find it difficult to pass the tax burden onto consumers. Consider the extreme example of a perfectly elastic demand. Recall that perfectly elastic demand occurs when the demand is so responsive that even if the firm tries to raise its price by 1 cent, demand will drop to 0. A good that has perfectly elastic demand will face a horizontal demand curve.

Figure 4 shows a firm with perfectly elastic demand. We see that initial equilibrium is at Point A, where price is equal to $5 and quantity is equal to 500. Suppose that the government imposes a tax of $1 on this producer which shifts upward its supply curve. The new equilibrium will be at Point B. Since the firm faces perfectly elastic demand, the firm cannot charge more than its current price of $5. Indeed in the new equilibrium the equilibrium price remains at $5. The only difference is that the quantity is now lower. Note that the price consumers pay for the good is unaffected. They are still paying $5 for the good. The producer on the other hand, only receives $4 from selling the good. Of the $5 he receives from the consumers, the producer must send $1 to the government so the net is only $4. In this case of perfectly elastic demand the producer must bear the entire cost of the tax.

**Figure 4**

In general, the more elastic the demand for a good, the tax incidence will be with the producer.
III. Taxes and Inefficiency

A. Calculating Deadweight Loss with Taxes

In our two examples where we looked at tax shifting, the one thing both had in common was that the equilibrium quantity decreases after a tax is imposed. There is an underproduction of the good compared to the original socially optimal level. We know from Chapter 4 that when there is underproduction, economic inefficiency will result in the form of deadweight losses. Let’s calculate the deadweight loss that would result from a tax.

Figure 5 looks at a situation where a tax will be imposed on firms. Without a tax, the equilibrium price will equal $10 and the equilibrium quantity will be 30,000. Given this initial equilibrium, let us calculate (a) consumer surplus, (b) producer surplus, and (c) total surplus.

**Figure 5**

(a) Consumer Surplus is the area above the price paid by consumers ($10) but below the demand curve. It will be the sum of Areas A + B + C. We can calculate this area based on the information given as (1/2)(30000)($10) = $150,000.
(b) Producer Surplus is the area below the price received by firms ($10) but above the supply curve. In Figure 5, it is represented by Areas D + E + F. The area is 
\[
\frac{1}{2}(10)(30,000) = 150,000
\]

(c) Total Surplus is the summation of producer and consumer surplus which is equal to 
A+B+C+D+E+F or $300,000.

The presence of a tax directed at producers will shift the supply curve upward to the left. Let us assume the government imposes a tax of $5 per unit sold. Suppose that as a result of the tax, the new equilibrium will be at a point where price will increase to $12.50, while equilibrium quantity will be 22,500 units. What has happened to consumer surplus, producer surplus and total surplus?

To calculate consumer and producer surplus note that the price paid by consumers and the price received by firms are no longer equal. The price paid by consumers is $12.50. Therefore the consumer surplus will be the area above $12.50, below the demand curve up to the new equilibrium quantity of 22,500. In this case the consumer surplus is equal to Area A
\[
\frac{1}{2}(22,500)(7.50) = 84,375
\]

Producer surplus will be the area below the price received by firms ($7.50) but above the old supply curve. In Figure 5 this would be Area F = \( \frac{1}{2}(22,500)(7.50) = 84,375 \)

Now that we have taxes, there is a third actor in our surplus calculation and this is the government. We can redefine Total Surplus = Consumer Surplus + Producer Surplus + Government Tax Revenue.

Let’s calculate the Government Revenue. Revenue from the government is simply the quantity produced in the market multiplied by the tax rate. We know that after the taxes, 22,500 units of the good will be produced, and each unit will be taxed at $5 each. Total tax revenue will be equal to Areas B + D or $112,500.

Total Surplus is therefore = A + B + D + F 
Total Surplus = Consumer Surplus + Producer Surplus + Government Revenue 
\[
\frac{84,375}{84,375} \frac{(112,500)}{112,500}
\]

Total Surplus = $281,250

Note that this is smaller than the initial total surplus of $300,000 that existed prior to the tax. Thus the economy is worse off due to the tax. This is captured by the deadweight loss which is shown graphically in Figure 5 as Areas C + E. The amount of the deadweight loss is equal to $18,750.
In Summary:

<table>
<thead>
<tr>
<th>Prior to the Tax</th>
<th>Consumer Surplus</th>
<th>Areas A + B + C</th>
<th>Consumer Surplus</th>
<th>Area A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer Surplus</td>
<td>Areas D + E + F</td>
<td>Producer Surplus</td>
<td>Area F</td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>0</td>
<td>Government</td>
<td>Areas B + D</td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td></td>
<td>Revenue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Surplus</td>
<td>Areas A+B+C+D+E+F</td>
<td>Total Surplus</td>
<td>Areas A+B+D+F</td>
<td></td>
</tr>
<tr>
<td>Deadweight Loss</td>
<td>N/A</td>
<td>Deadweight Loss</td>
<td>Areas C + E</td>
<td></td>
</tr>
</tbody>
</table>

As seen in the above example in Figure 5, the imposition of a tax causes both consumers and producers to experience lower surpluses. Part of the “lost” surpluses are transferred to the government in the form of government tax revenue, while the remainder is simply lost completely. This is known as the deadweight loss or excess burden of a tax increase. The excess burden is the amount of the tax burden that exceeds the total revenue that is collected by the government.

B. Deadweight Losses and Elasticity

As we saw earlier, the price elasticity of demand is important in determining the ability of the firm to shift the tax burden to consumers. If demand for a good is relatively inelastic, the firm is able to shift a majority of the tax burden to consumers, while if the demand for a good is relatively elastic, the firm will not have the ability to shift much of the tax to consumers. It turns out that price elasticity of demand can also be used to determine the size of the excess burden or deadweight loss that will occur if a tax is imposed. To see why, let us recall why deadweight loss exist in the first place.

The presence of a deadweight loss means that society is either under-producing or over-producing the socially optimal level of output. In the case of a tax, fewer output will be produced than otherwise would have been in the absence of a tax. The loss to society is the loss in consumer and producer surplus from units of good that should have been produced but was not due to the tax.

With that in mind, let us consider what price elasticity of demand can tell us about deadweight loss. Let us consider two cases: (1) relatively elastic demand and (2) relatively inelastic demand

(1) Relatively Elastic Demand: By definition, if a good has elastic demand, that means that consumers are very responsive to changes in price. An increase in taxes will cause an increase in price that consumers have to pay (unless demand is perfectly elastic). Consumers will respond to this increase in price by cutting back their consumption of the good and the quantity will fall drastically. As a result, equilibrium quantity after the tax will be significantly lower than the quantity that was consumed prior to the tax. Since there is significantly less goods being consumed than what is socially optimal, there will be a greater loss to society. The loss to society will be all the units of good that would have been produced and consumed in the absence of the tax. In short, the more responsive the consumer behavior to a change in price (the more elastic the demand), the greater the deadweight loss (or excess burden). Figure 6
illustrates the case with elastic demand. Note that a good that has relatively elastic demand will have a demand curve that is relatively flat. The area shaded in red will be the deadweight loss or excess burden.

**Figure 6**

(2) Relatively Inelastic Demand: Consider the opposite case where consumers are generally irresponsive to changes in price. An increase in price that consumers pay due to a tax will lower the quantity demanded, but not very much. Since the quantity demanded will be very close to the initial pre-tax level of quantity demanded, the “lost production” will be small. Since the new equilibrium quantity is close to the initial socially optimal level of output, the deadweight loss or excess burden will be small (especially compared to the case of elastic demand). Figure 7 illustrates the case of inelastic demand. A good that has inelastic demand will have a demand curve that is relatively steep. As we can see in Figure 7, new equilibrium quantity that results from the tax increase is lower than initial equilibrium, but it’s not far from the initial level. As a direct result the area of the deadweight loss is small. If the demand for the good has inelastic demand, then the deadweight loss or excess burden will be relatively small.
C. Deadweight Losses: Numerical Example

Let us work out the problem we did earlier in this handout to see how deadweight losses are calculated.

Suppose the market demand function for corn is \( Q^d = 15 - 2P \)
Suppose the market supply function for corn is \( Q^s = 5P - 2.5 \)

Suppose the government imposes a $0.70 tax per bushel on the corn producers.

(a) Calculate the producer surplus, consumer surplus, government revenue and total surplus before the tax was imposed.
(b) Calculate the producer surplus, consumer surplus, government revenue and total surplus after the tax was imposed.
(c) Calculate the deadweight loss (excess tax burden) that results from the tax.

The easiest way to derive the deadweight loss is to draw the demand and supply curves. From Ch. 3 simply find the intercepts and we get the following diagram in Figure 8. We know from earlier that equilibrium quantity = 10, equilibrium price = $2.50

(a) Consumer surplus will be equal to \( \frac{1}{2} \times 5 \times 10 = $25.00 \)
Producer surplus will be equal to \( \frac{1}{2} \times 2.00 \times 10 = $10.00 \)
Government revenue = $0
Total surplus = $35.00
(b) We already solved earlier the new equilibrium that would result from the tax of 70 cents per unit that is imposed on the firm. Such a tax would raise the price paid by consumers to $3 (and hence lower the price received by firms to $2.30), while equilibrium quantity would fall to 9 units. Figure 9 illustrates graphically how this would look like. As a result we have the following:

Consumer surplus = \( \frac{1}{2}(9)(4.50) = 20.25 \)

Producer surplus = \( \frac{1}{2}(9)(1.80) = 8.10 \)

Government revenue = \( 0.70 \times 9 = 6.30 \)

Total surplus = $34.65
(c) Compare the total surplus in Part (b) to the total surplus calculated in Part (a), and we’ll notice that it has fallen by $35.50 - $34.65 = $0.35. This is the excess burden or deadweight loss that result from producing 9 units instead of the socially optimal 10 units. We could have found the same answer if we had calculate the red shaded region in Figure 9.

Area = $\frac{1}{2}(1)(0.70) = 0.35$