
I. Taxes and Economic Welfare

How do taxes affect the welfare of a society? We saw in Chapter 6, that taxes will generally hurt both consumers and producers as a result of the tax. Regardless of whether the tax is initially levied on the consumer or the producer both will eventually share in the burden of the tax. Consumers will pay a higher price than the initial equilibrium while producers will receive a lower price than initial equilibrium. From Chapter 7, we would expect that since consumers have to pay a higher price because of the tax that consumer surplus will fall. Likewise since producers receive a lower price because of the tax we would expect that producer surplus will also fall. Does this imply that total surplus will necessarily fall as well? Note that a government will impose tax to raise revenue for social programs such as education, health care, police and fire services, roads, etc... These programs have a benefit to society that need to be measured. To fully understand how taxes affect society we need to compare the loss in welfare due to the fall of consumer and producer surplus against the gain in welfare associated with the increase in government revenue for social programs.

As a result we will slightly adjust our definition of total surplus to account for the fact that government revenue from taxes has social benefits.

Total Surplus = Consumer Surplus + Producer Surplus + Government Tax Revenue

A. Review of Taxes

We saw in Chapter 6 that taxes can either be placed on producers or on consumers. Figure 1 shows graphically what would happen if the tax is levied on producers. Since producers have to pay a tax on each unit they produce their costs have essentially increased which will shift the supply curve upward (to the left) by the full amount of the tax. Equilibrium will go from Point A to Point B. Consumers will have to pay a higher equilibrium price (P_c) while producers will receive a lower price than before ($P_f = P_c - \text{tax}$). Equilibrium quantity will fall.

Figure 1: Tax levied on Producers

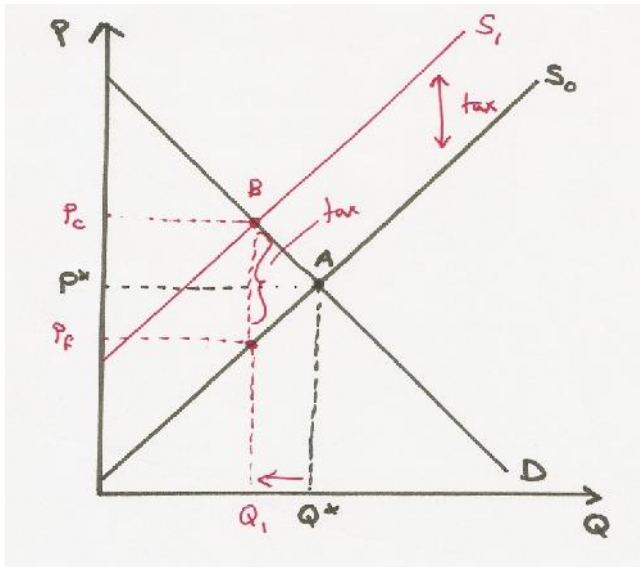
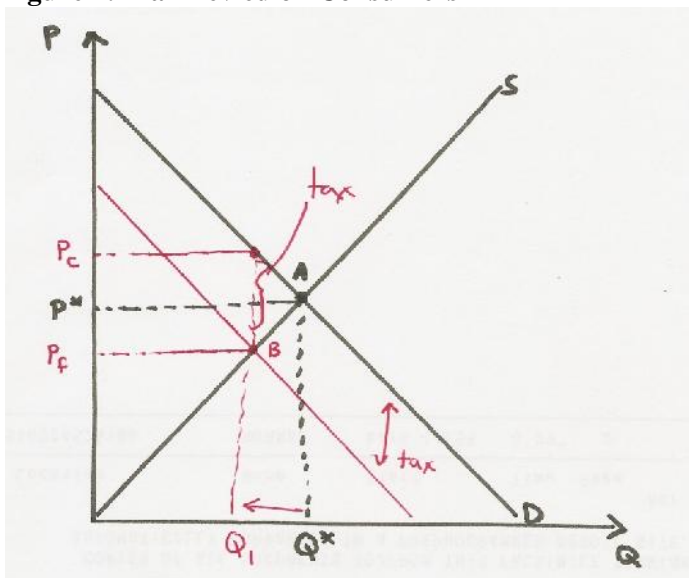


Figure 2 graphically shows the situation where the tax is levied on consumers of a good. A tax on consumers will effectively raise the price of a good for a consumer which will shift the demand curve to the left. Market equilibrium will go from Point A to Point B. Equilibrium price that producers receive will be lower (P_f), while the price that consumers have to pay will be higher than before ($P_c = P_f + \text{tax}$). Additionally, equilibrium output will be lower.

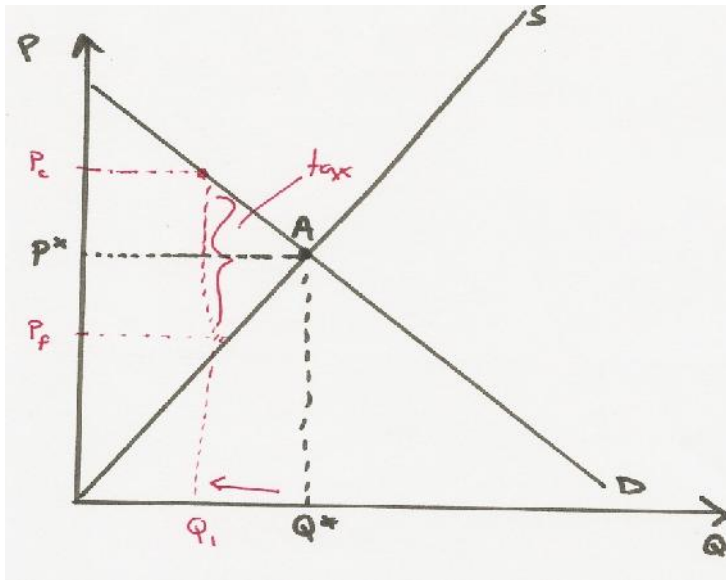
Figure 2: Tax Levied on Consumers



Note that regardless on whether or not the tax is levied on producers or consumers, a tax will cause consumers to pay a higher price than before ($P_c > P^*$) and firms will receive a lower price than before ($P_f < P^*$).

To simplify our analysis in the rest of the chapter, we can draw the effect of a tax without worrying whether the demand or the supply curve will shift. Figure 3 illustrates this general graphical analysis. We know that a tax will cause prices that consumers pay to increase to P_c , while the price that firms receive will fall to P_f . The difference between P_c and P_f will be the amount of the tax.

Figure 3: Graphical Analysis of a Tax (General Case)



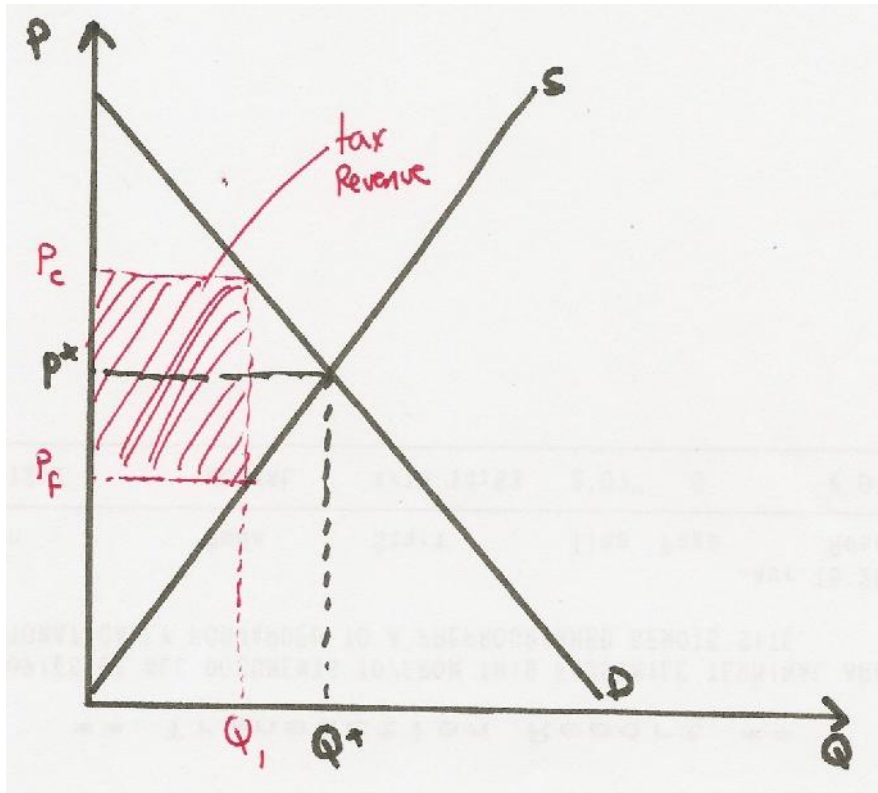
The imposition of taxes will have an effect on three groups:

(1) Consumers will be affected by taxes. We see from Figure 3 that consumers have to pay a higher price after a tax than before a tax (regardless on whether or not the tax was imposed on firms or consumers). We would expect that consumers would be negatively affected by taxes (Consumer Surplus will fall).

(2) Firms will be affected by taxes. We see from Figure 3 that producers will receive a lower price after a tax than before the tax. We would also expect that producers would be negatively affected by taxes (Producer Surplus will fall).

(3) Government (or broadly speaking society) will be affected by taxes. Taxes will generate revenue for the government which they can use to fund programs such as education, roads, hospitals, etc... Government revenue will increase as a result of taxes. How much tax revenue is generated? We can see this from Figure 4.

Figure 4: Tax Revenue



After the tax Q_1 units will be produced. Each of these units will be taxed an amount T . Since we know that the amount of the tax is the difference between what consumers actually pay (P_c) and what firms actually receive (P_f) the total tax revenue generated will be $T \times Q_1$ (shaded rectangle in Figure 4).

We've seen that taxes will adversely affect consumer and producer surplus while it will increase government revenue. Recall that with taxes, total surplus will equal:
 Total Surplus = Consumer Surplus + Producer Surplus + Government Revenue.

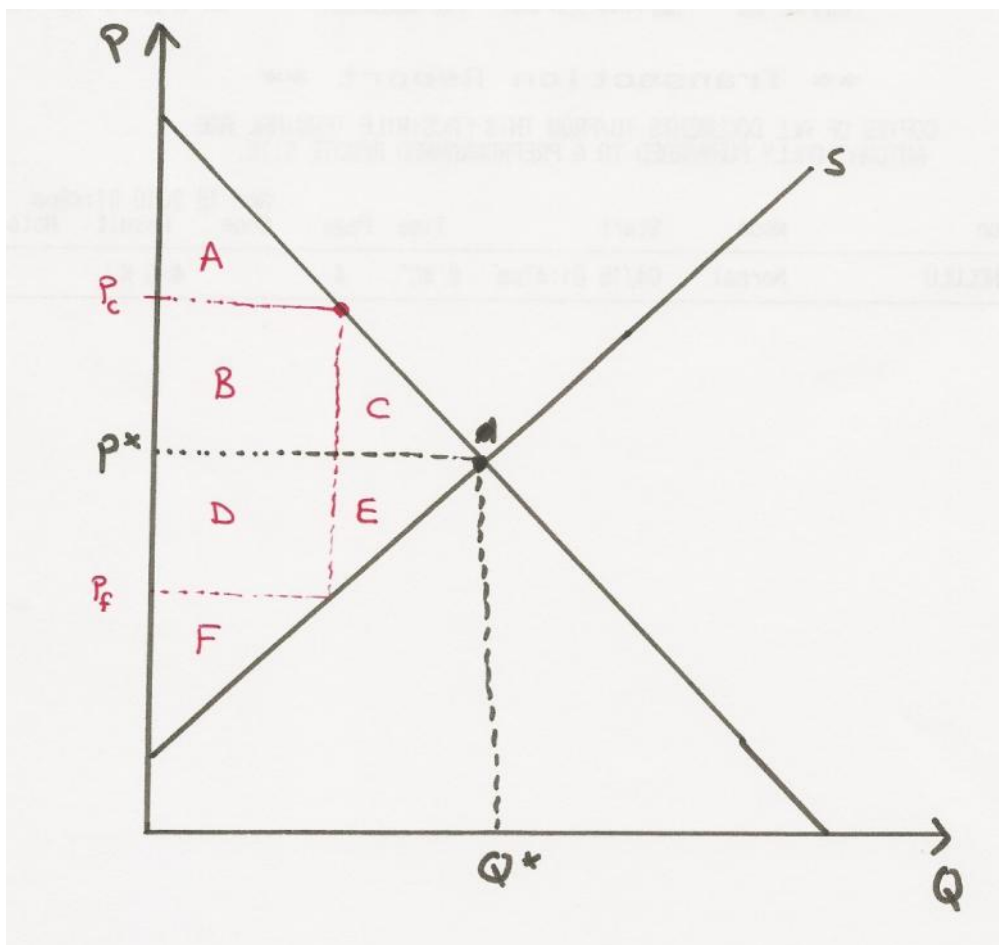
What will happen to total surplus as a result of a tax? We turn to that question in the next section.

B. Taxes and Economic Welfare

What effect will an imposition of taxes have on total surplus which measures the well being of society as a whole? To see the effect of taxes we first have to calculate the total surplus that will result when there is no taxes.

Figure 5 shows a hypothetical market for some good.

Figure 5: Total Surplus



Absent any taxes, equilibrium will be where the market supply intersects market demand. At this point equilibrium price will be at P^* while equilibrium quantity will be a Q^* .

From Chapter 7 we know that consumer surplus will be the area below the demand curve but above the price that consumers pay. From Figure 5 we see that this would include Areas A, B and C.

Consumer surplus will be therefore be equal to $A + B + C$.

Producer surplus is defined as the area above the supply curve but below the price that sellers receive. From Figure 5 this will be the areas D, E and F.

Producer Surplus will therefore be equal to $D + E + F$.

Since there are no taxes initially, there is no government revenue. Government revenue is equal to 0.

Total Surplus = Consumer Surplus + Producer Surplus + Government Revenue

Total Surplus (without taxes) = $A + B + C + D + E + F$

Now suppose a tax is imposed in this market. We know that the price that consumers pay (P_c) will increase while the price that firms receive will fall (P_f). What is the total surplus after the tax?

Consumer Surplus will be the area below the demand curve but above the price that consumers pay (P_c). We can see from Figure 5 that this will just be Area A.

Consumer Surplus = Area A

Producer Surplus will be the area above the supply curve but below the price that firms receive (P_f). We can see from Figure 5 that this will just be Area F.

Producer Surplus = Area F.

Government Revenue will be the amount of the tax (the difference between the price consumers pay and the price that firms receive) multiplied by the quantity produced after the tax. From Figure 5 this will be Areas B + D.

Total Surplus (with taxes) = A + B + D + F

Note that society after taxes are imposed is actually worse off than before. We can state this because total surplus with taxes is less than total surplus after taxes. Society has lost Areas C and E. **Deadweight loss** measures the loss in total surplus as a result of a tax (or some other policy). In this example, the deadweight loss will equal C + E.

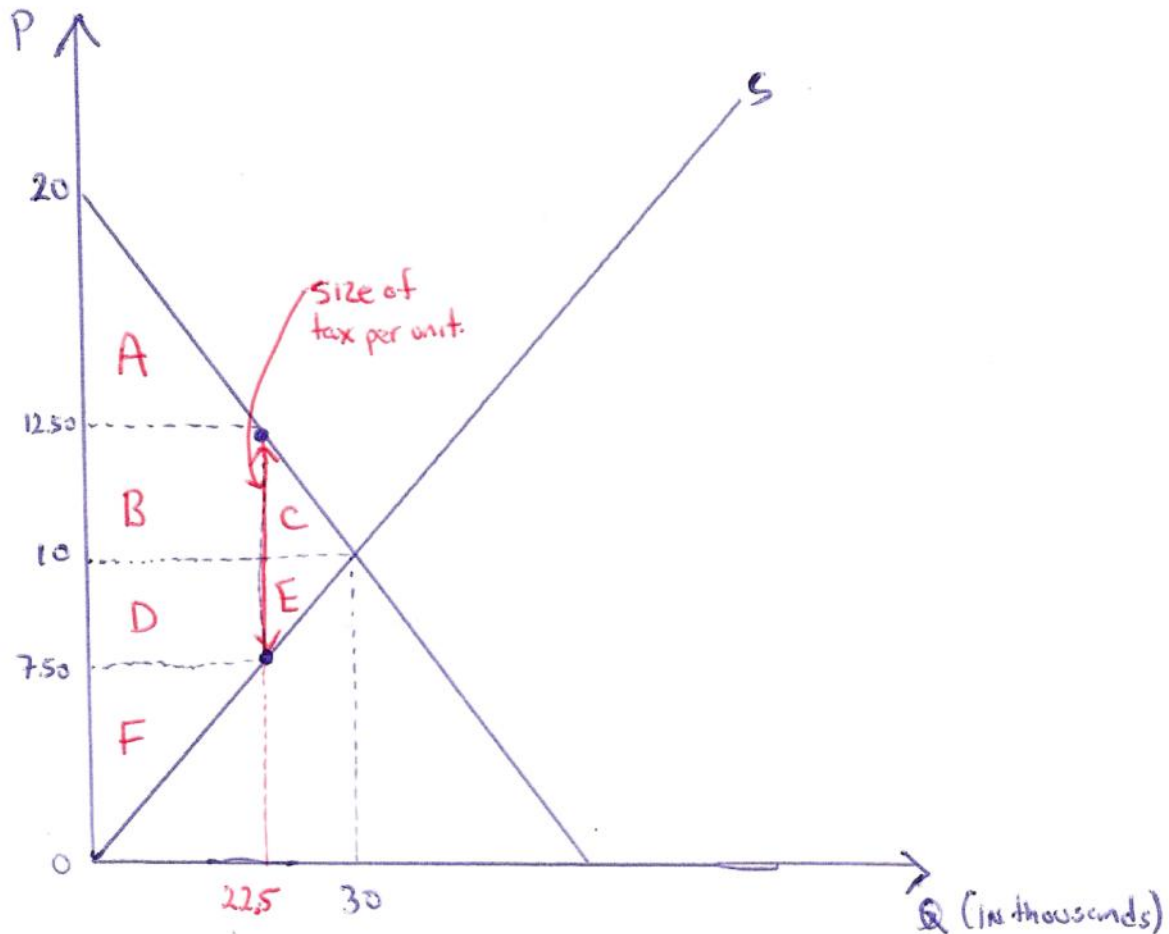
Key Point: The loss in consumer and producer surplus as a result of a tax will exceed that of the gain in revenue to the government as a result of the tax.

In Summary:

Prior to the Tax		After the Tax	
Consumer Surplus	Areas A + B + C	Consumer Surplus	Area A
Producer Surplus	Areas D + E + F	Producer Surplus	Area F
Government Revenue	0	Government Revenue	Areas B + D
Total Surplus	Areas A+B+C+D+E+F	Total Surplus	Areas A+B+D+F
Deadweight Loss	N/A	Deadweight Loss	Areas C + E

C. Taxes and Economic Welfare: Numerical Example

Figure 6



Suppose initially for this market, equilibrium is at $P = \$10$ and quantity is $Q = 30,000$.
Given this initial equilibrium find

- (i) Consumer Surplus
- (ii) Producer Surplus
- (iii) Total Surplus

Assume that the government imposes a tax of \$5 per unit sold. Given this information calculate

- (i) Consumer Surplus
- (ii) Producer Surplus
- (iii) Government Revenue
- (iv) Total Surplus
- (v) Deadweight Loss

(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 $(1/2)(\$10)(30,000) = \$150,000$

(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 = $(1/2)(22,500)(\$7.50) = \$84,375$.

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 = $(1/2)(22,500)(\$7.50) = \$84,375$

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
 (\$84,375) (\$84,375) (\$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.

D. Deadweight Losses and Elasticity

As we saw in Ch. 6, the price elasticity of demand is critical 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

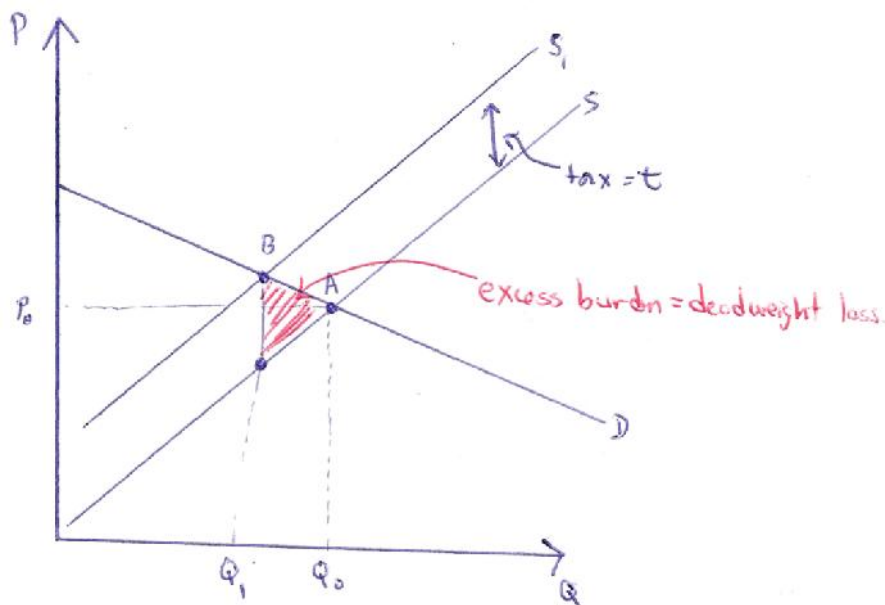
elastic, the firm will not have the ability to shift much of the tax to consumers. It turns out that price elasticity of demand can also be used to determine the size of the excess burden or deadweight loss that will occur if a tax is imposed. To see why, let us recall why deadweight loss exist in the 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**. Figure 7 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 7



(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 8 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 8, 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.**

Figure 8

