Taxes

Let's first levy a per unit tax on suppliers. Suppliers will have to pay $t per unit. That is, they have to pay $t to the government for every unit they sell. I'll assume that $t = $1 in this example.

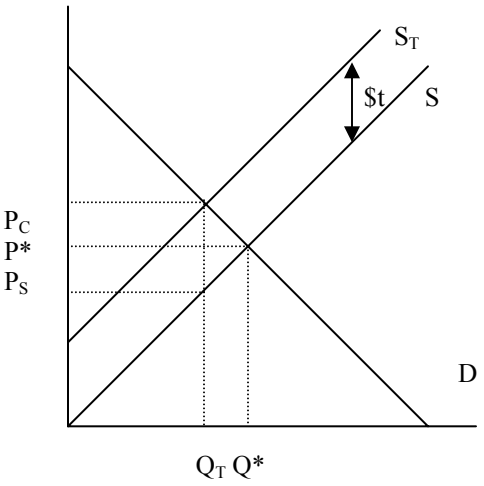
Recall that the height of a firm's supply curve at some quantity q tells us the MC of producing the qth unit. That is, to get the firm to produce the qth unit, the firm must receive a price equal (or greater) to the MC. Suppose, for instance, that MC = $32. The firm will not produce the qth unit at a price less than $32. Now, when the tax is introduced, on top of covering the firm's MC, it has to pay $t per unit to the government. In order to produce the qth unit, the firm must now receive MC + $t. Here, $32 + $1. The firm will *act as if* its MC is now $33. It is *as if* the MC curve has shifted up by $t. The story will be the same for the 4th unit, the 7th unit, and the qth unit.

At every quantity, then the firm's supply curve will shift up vertically, by the amount of the per unit tax, $t. We will shift up the supply curve, and label it S_T.

The equilibrium quantity will occur at the intersection of D and S_T, and we label this quantity Q_T. We have not altered the demand curve.

The price that consumers will pay will be given by the intersection of S_T and D, and is labeled P_C (price consumers pay). (The height of the demand curve at Q_T shows the maximum amount consumers will pay for this unit.)

The suppliers receive P_C from consumers, but must immediately pay the government $t per unit. Thus, the price they receive $P_C - \$t = P_S$ (price suppliers receive). Notice, the vertical distance between the two supply curves is the amount of the per unit tax ($t).



Results

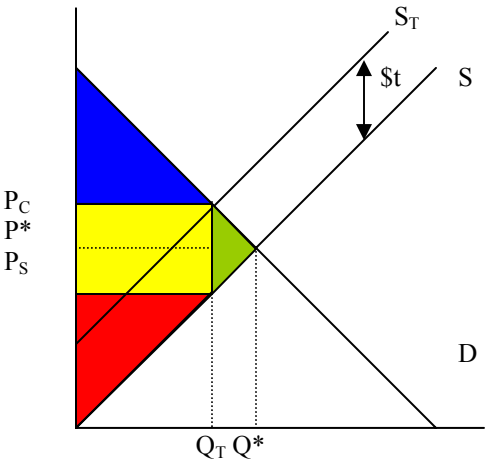
1. The price that consumers pay rises from P* to P_C, but not by the whole amount of the tax.
2. The price that suppliers receive falls form P* to P_S, but not by the whole amount of the tax.
3. There is a reduction in the equilibrium quantity from Q* to Q_T. There will be a DWL.
4. The government collects tax revenue in the amount of $t * Q_T.

We will see in one second that CS and PS fall. These follow from 1, 2, and 3 above.

Below I have shaded in all the areas after the tax is invoked.

- CS after the tax is in blue. It is the area below the demand curve, above the price **consumers** pay (P_C) and out to Q_T. (CS ↓)
- PS after the tax is in red. It is the area above the supply curve, below the price **suppliers** receive (P_S) and out to Q_T. (PS ↓)
- Tax revenue collected is shown in yellow. It is \$t * Q_T, and thus is the area between P_C and P_S out to Q_T. ($P_C - P_S$ = \$t)
- The DWL is show in green. Notice, that we have restricted output below the socially optimal level, Q*. At any quantity between Q_T and Q*, MV > MC. These are mutually beneficial trades that would take place in absence of the tax.

If we add up total gains from trade (CS + PS + Tax Revenue) we can see that we are left with the DWL triangle in green. Why do we include tax revenue? Well, presumably the government will spend this money on stuff we like. Ok, that's tough to swallow, but let's run with it…



Define the consumers' burden as $P_C - P^*$. It measures how much the price that consumers pay has increased.

Define the producers' burden at $P^* - P_S$. It measures how much the price that suppliers receive has decreased.

We pointed out above, but it's worth stressing again that both consumers and producers share the burden of the tax. Suppose P* = \$12.07 and we put a \$1 per unit tax on suppliers. After the tax is imposed, suppose that P_C = \$12.50, and P_S = \$11.50. In this case, the consumers' burden is \$0.43 (\$12.50 - \$12.07), and the producers' burden in \$0.57 (\$12.07 - \$11.50). Of course, if we add up both groups' burden, it must add up to the total amount of the tax (\$0.43 + \$0.57 = \$1 = \$t)

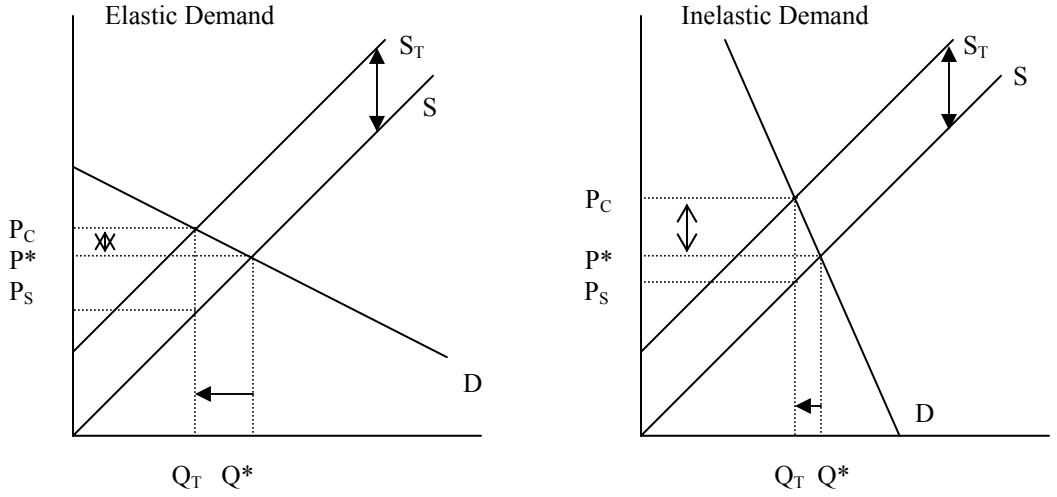
What affects the distribution of the burden between supplier and demanders?

Answer: the elasticity of demand and the elasticity of supply.

As the demand curve becomes more inelastic, the fraction of the burden that consumers will pay increases. (Thus, the fraction of the burden that producers will pay must simultaneously decrease.)

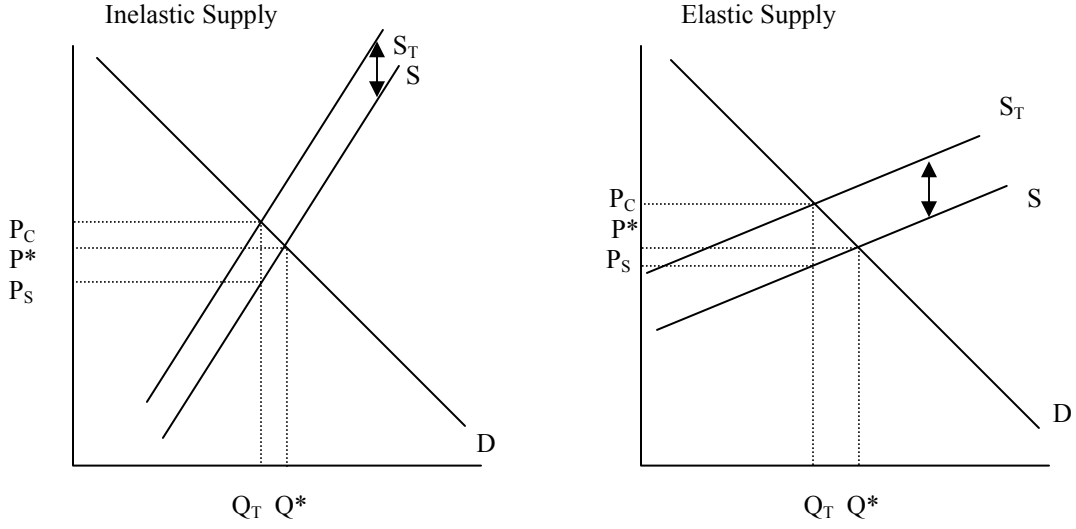
As the supply curve becomes more inelastic, the fraction of burden that suppliers will pay increases. (Thus, the fraction of the burden that consumers pay must simultaneously decrease.)

I have started with identical supply curves in both graphs below. I put the same per unit tax on both goods (still levied on suppliers). The picture on the left has a (relatively) elastic demand curve, and the picture on the right a more inelastic demand curve. Also, the initial equilibrium price and quantity in both graphs is identical (P*, Q* are the same in both pictures).



The consumers' share of the tax burden is larger for the more inelastic case (right) compared to the more elastic case (left). Or, as the demand curve became more inelastic, the portion of the tax that consumer pay has increased. Why does this make sense? For the inelastic case, consumer are less sensitive to price. Producers will be able to pass a larger portion of the tax onto consumers because they are less sensitive to price.

Below, I start with identical demand curves. An (relatively) inelastic supply curve is on the left, with a more elastic supply curve on the right. Again, the initial equilibrium is identical in each picture.



For the inelastic supply case (left) you can see that the producer's share of the burden is larger. Or, as supply curves become more inelastic, the portion of the tax that is paid by producers becomes larger. Again, in this case, suppliers are less sensitive to price. They will end up paying a larger share.

Does the elasticity of demand and elasticity of supply have anything to do with the size of the DWL?

The answer is yes. Look at the two sets of pictures drawn above. If you were to shade in the DWL for each of these two cases, you will see that the DWL is larger for the elastic cases than for the inelastic cases. The reason is that the elastic cases result in a large reduction in the equilibrium quantity (from Q* to Q_T), while the inelastic cases result in a smaller reduction in equilibrium quantity (from Q* to Q_T).

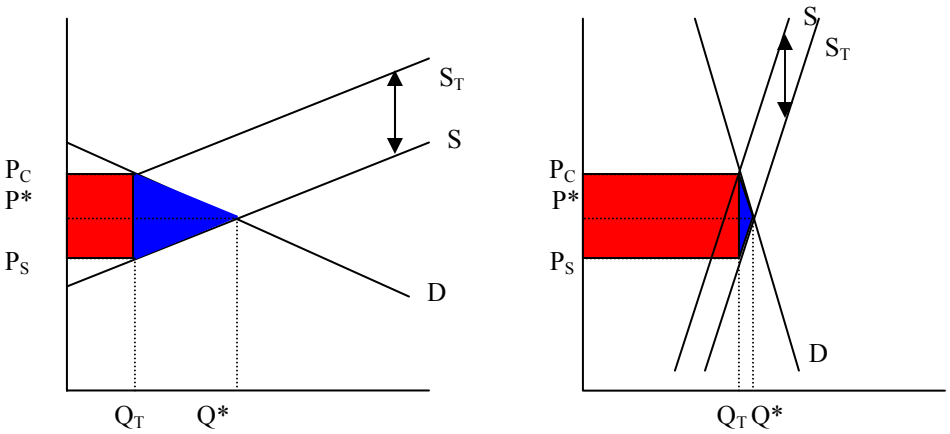
The dead weight loss comes about because we restrict the amount of trade below that optimal level (Q*). The elastic cases restrict trade more than the inelastic cases, because for elastic demand (or supply), quantity is more sensitive to price changes.

Thus, given that we must have taxes (because we want the government to have some money to spend on some stuff), should we try to put taxes on those goods that will have the lowest DWL? (Notice, also, that the tax with the smaller DWL also generates more revenue). So, given a choice between taxing elastically demanded goods and inelastically demanded goods, we should tax inelastically demanded goods. This is presumably why we see (relatively large) taxes on cigarettes, gasoline, alcohol and not Dr. Pepper and Fruit Loops.

The story is the same for elasticity of supply. The more inelastic the supply, the lower will be the DWL.

Just to drive this point home even further, I have drawn one more picture.

Case 1: Elastic demand and elastic supply (both should tend have relatively larger DWL)
Case 2: Inelastic demand and inelastic supply (both should tend to have relatively small DWL)



So here, I have exaggerated the situation by putting elastic supply and elastic demand together, resulting in a big DWL, and inelastic supply and inelastic demand together, resulting in a small DWL. Though it doesn't look like, I have shifted up (vertically), in each case, by the same amount, $t. (See the double arrows – they are the same size)

Obviously, the case on the left has a larger DWL than the case on the right. On the left we see a large reduction in quantity, on the right a smaller reduction in quantity due to the tax.

Here, again, you can see difference in tax revenue generated by these two taxes. I have shaded the tax revenue in red. Recollect that algebraically, tax revenue is $t * Q_T. So, for the picture on the left, with a big reduction in equilibrium quantity, there are fewer units sold (smaller Q_T), and hence less tax revenue. For the case on the right, there is a small reduction in Q, thus a small DWL, and hence a larger amount of tax revenue generated.

Summary, thus far

- The more inelastic the demand curve, the larger will be the portion of the burden consumers pay.
- The more inelastic the supply curve, the larger will be the portion of the burden that suppliers pay
- The more inelastic supply (or demand), the smaller will be the DWL for a given sized tax.
- So long as the elasticity of demand or supply is not 0 or ∞, consumer and producers will share the burden of the tax. That is, so long as the supply or demand curves are not horizontal or vertical, both consumers and producers will share the burden of the tax.

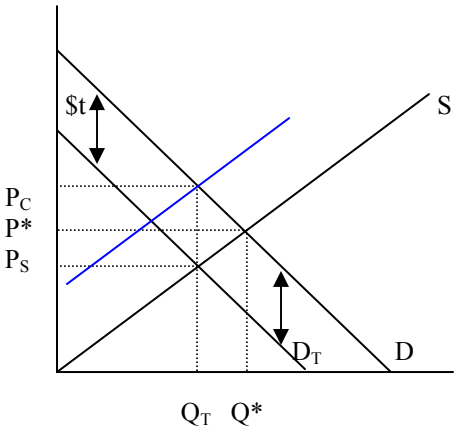
Variations on taxes (Read this for the big picture, but don't sweat the details)

Variation #1 – Who is the tax levied upon? Notice that even though we levied the tax on suppliers, both producers and consumer paid a portion of the tax burden. If you think about this for a second, it might seem like that fact that suppliers collect the tax is irrelevant, and it is.

If we levied the same per unit tax ($t) on demanders instead of supplier, absolutely none (zero, zilch, zippo, nada) of the results discussed above will change. The only difference would be who sends the check to Washington. I have drawn you the picture below. Don't worry about this for the test. I include it only for the benefit of the skeptics. (Ignore the blue line for the time being.)

The main difference is that now we fiddle around with the demand curve. The demand curve tells us the MV of consuming a unit. So, if at q, MV = $8, the most we'll pay to consume that good is $8. Now, with a $1 tax that we have to pay to government when we purchase the good, the most we'll be willing to give suppliers is $7. Consumers *act as if* their MV schedule shifts down $1, or more generally, by the amount $t.

The price consumers pay will be P_S + $t. They hand over P_S to the guy at the cash register, and immediately have to send off $t to the government. Suppliers receive P_S.



The price supplier receive is given at P_S. Consumers pay a price that is P_S + $t. P_S goes to suppliers, and the $t goes to pay the tax bill.

If you squint your eyes hard enough, and imagine erasing D_T, and adding in S_T (in blue) as we did before, you'll see that it's the same prices and quantities you get as before.

There aren't too many taxes I can think of that involve transactions between suppliers and demanders that have taxes levied on demanders. This is likely because of the fact that it is more efficient for suppliers to collect the revenue. Think about groceries. Suppose 1000 people a day walk into Bi-Lo. If the sales tax was collected (paid) by consumers, we'd have 1000 consumers sending checks to the government. If the sales tax was collected by Bi-Lo, we'd have only 1 check written from Bi-Lo to the government. Since suppliers are involved with more transactions that the average consumer, it is probably easier for them to collect the revenue.

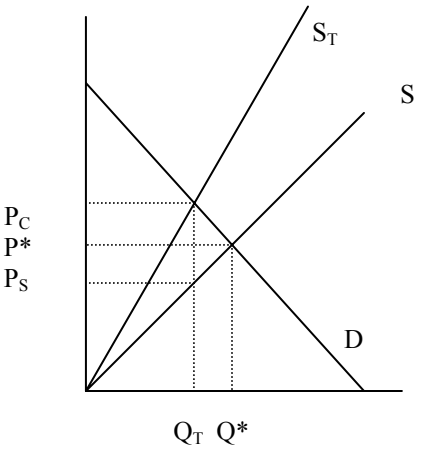
Variation #2 – Per unit vs. ad-valorem (percentage taxes)

Many taxes you see out there in the real world aren't per unit taxes, put rather percentage taxes. For example, a sales tax is a percentage tax levied on suppliers. Instead of paying a tax of $0.25 per box of fruit loops, you pay a tax equal to 7% of the value of the fruit loops.

There is one slight complication that can confuse you a bit – storeowners don't put the full price on the price tag. If you see a price tag at the grocery store of $1.00, what is implied is that the price consumers will pay is $1 * (1 + τ), where τ denotes the sales tax percentage, e.g. 7%.

Thus, the price consumers will pay is $1 * (1 + .07) = $1 * 1.07 = $1.07 ($P_C$)

After taking care of that issue, the only slight difference is the shape of S_T.



A percentage tax, levied on suppliers.
The point is that it doesn't look much different from the per unit tax. You could do this is you wanted with no trouble.
Instead of shifting the supply curve up by $t Vertically (everywhere), you shift it up vertically by say 7%. Doesn't change much.

Again, what's the point? It's easier to draw and do the algebra on per-unit taxes than ad-valorem taxes, but you could easily analyze ad-valorem taxes if you wanted to. Sometimes I have nightmares that go something like this. One of my students, comes to my office, holding a large handgun saying something like… "Chad, you evil bastard. You only taught us how to do per-unit taxes. I went to the grocery store trying to figure out the tax on my preparation-H. I stood they for a long time trying to figure out who was going to pay the tax, I couldn't do it, and it really burned me. One of my friends saw me in the aisle. I had to cover it up by picking up some corn remover. Now, I will get sweet cooling relief by shooting you….".

Having written this last ditty about ad-valorem taxes, I will now sleep better, and only have the nightmare showing up to class wearing only my Superman Underoos.

<u>What should I be reading?</u>

Some textbooks give you an alternative (and I think inferior) way to think about taxes by using a "wedge". The idea is that a tax of $2 per unit puts a $2 wedge between the price that consumers pay and the price suppliers receive. To find the equilibrium quantity, you imagine some $2 tall line, and move it around until it just hits the supply and demand curve simultaneously. This will be Q_T. See the picture on the next page.

It's good in that is helps explain why there is a DWL. Normally, we wind that anytime MV > MC, there will be GFT and a transaction will occur. Of course, for the trade to occur with a $2 per unit tax, the GFT have to be larger than the $2 tax for the transaction to occur. If MV = $8.50 and MC = $7.25, there are $1.25 worth of GFT (this transaction is mutually beneficial), but there are not enough to pay the tax and have GFT left over, so it doesn't happen. This is why taxes are inefficient, that is, they lead to a DWL.

You miss part of the boat if you do the wedge deal, so do it my way.

In the book, you can read a bit about taxes on p. 137, and more for the adventurous starting on p. 317. Don't worry about forward shifting and backward shifting. If you really want to know, come talk to me. On p. 317 the author has already assumed a perfectly competitive industry, an assumption we have not made and will probably not make in 211. It's not hard, but if you really want to know, again, come talk to me.

Move around the $2 wedge until it just hits the S and D curve.