Equilibrium
Before discussing market interventions, we should take a look at a basic market and define some important concepts.

The above is a market without any interventions – just the supply and demand curves. Equilibrium in a market is found at the intersection of the S and D curves. At this intersection, the price is such that the quantity which consumers demand at that price (Qd) equals the quantity which producers supply at that price (Qs). Here, we denote this price as \( P^* \) and the quantity as \( Q^* \).

We have also labeled two areas above – the light blue corresponds to consumer surplus, and the red to producer surplus. Here are the official definitions:

Consumer Surplus: the difference between the maximum a consumer is willing to pay to get a good and the price he must pay to get that good.

Producer Surplus: the difference between the minimum price for which a supplier is willing to sell a good and the price he actually receives.

CS and PS are measures of how much consumers and producers benefit from being able to buy and sell a good in a marketplace. A consumer benefits whenever he can buy a good for less than his maximum willingness to pay for that good, and a seller benefits whenever he can get a higher price than the minimum for which he would be willing to sell. Thus, the sum of CS and PS is often used as a measure of how much the market is benefiting society. The picture below illustrates these definitions.
Consider a consumer willing to pay \( P_1 \) for this good. This consumer is very happy, as he only has to pay \( P^* \), the equilibrium price. This consumer enjoys surplus equal to the thin light blue line, and when we sum up the surplus of all consumers, we get the entire upper triangle as shown in the first picture. Similarly, consider a producer who would be willing to sell for any price above \( P_2 \), but receives \( P^* \) in the marketplace. This seller enjoys surplus equal to the thin red line, and when we sum up the surplus of all producers, we get the entire lower triangle as shown in the first picture. Thus, we see that CS is the area under the demand curve but above the price consumers pay (\( P^* \)), while PS is the area above the supply curve but below the price sellers receive (also \( P^* \)).

Throughout our discussion of different market interventions, we will look at how each mechanism changes the market relative to the above base case – how the price, quantity, and surplus changes when we manipulate the market in various ways. To help make our examples more comparable, we will use the same supply and demand equations in each example. So we will always have demand and supply given by:
\[
D: P = 100 - Q_d \quad \text{and} \quad S: P = Q_s.
\]

**Price Ceilings and Price Floors**

*Price Ceiling:* a maximum legal price which sellers can charge for a product.

*Price Floor:* a minimum legal price which buyers must pay for a product.

Price controls are perhaps the simplest type of market intervention which a government can use. Examples of price ceilings include gas controls (during the 1970’s) and rent-controlled apartments, while examples of price floors include some agricultural markets (milk and cheese in the US, butter in Europe) and minimum wage laws. In general, price controls are imposed by the government in an effort to help either consumers or producers. For example, rent controls were imposed in New York City in the early
1940’s in an effort to keep rents down for native New Yorkers who were being outbid for housing by higher-paid workers who came to the city to work in factories as part of the war effort. If a price control has an effect on the market, it is called binding. For a price floor, this means it must be set above the market equilibrium price – and for a price ceiling, it must be below the equilibrium price.

Here is an example of a binding price floor set at a price of 75. At this price, the quantity demanded by consumers is Qd = 25, while the quantity supplied by producers is Qs = 75. This creates a surplus in the market of (Qs – Qd) = 50. Note: do not confuse this kind of surplus (quantity supplied exceeds quantity demanded) with producer and consumer surplus. We see that the price floor has reduced the quantity sold in the market from 50 to 25, and CS has also fallen. However, we must be careful when determining what has happened to PS. The red area above denotes the maximum possible PS in this market, assuming that the 25 units are all supplied by the lowest-cost producers. Because the price floor has been established at 75, we see that many producers with higher costs would still find it profitable to supply to this market, and we have no way to determine exactly which of them get to sell their products and thereby enjoy producer surplus. So the red area above is only a maximum possible PS.

Below is an example of a binding price ceiling, with the price set at P = 15. At this price, the quantity demanded by consumers is Qd = 85, while the quantity supplied by producers is Qs = 15. This creates a shortage in the market of (Qd – Qs) = 70. So just as in the case of a price floor, we have reduced the quantity sold in the market (this time to 15), but note how the effects on surplus have changed. Now we have an exact area for PS, but we have only a maximum possible CS, assuming that the 15 goods sold end up in the hands of the consumers with the highest valuations. This is for the same reason as above: we do not know exactly which of the consumers get to buy the 15 units offered for sale, so CS may be smaller than the area pictured below.
Price Supports
Price Support: a price set by the government which it guarantees by offering to purchase an unlimited quantity of the good at that price.

Price supports are chiefly used in agricultural markets to support farmers by guaranteeing them a minimum price for which they can sell their output. In the above picture, we have a price support at $P = 70$. This means that farmers always have the option of selling their output to the government at this price, so they will never sell it to private consumers at
any price below 70. Thus we have the situation pictured above – at $P = 70$, consumers demand 30 units, but producers supply 70 units, so the government must purchase the remaining $(Q_s - Q_d) = 40$ units. Thus, the total expense to the government of this price support program is the guaranteed price per unit times the number of units it must buy, or $(P_{supp}) \times (Q_s - Q_d) = 70 \times 40 = 2800$. Typically, these are the three main pieces of information you’ll most likely be asked to find in price support questions – the quantity bought by consumers, the quantity bought by the government, and the total cost to the government of running the program.

Price Subsidies
Price Subsidy: a price set by the government which it guarantees by paying the difference between the market price and the guaranteed price to producers for every unit sold.

The price subsidy mechanism is quite different from the price support. Under a price subsidy, the government again guarantees a price – in this case, $P = 80$. However, producers can no longer simply sell directly to the government. Now they must find consumers willing to purchase their product, and the government will give them the difference between the price which prevails in the market and the guaranteed price. In this example, we see that at $P = 80$, producers wish to sell 80 units of the good. In order to sell 80 units, the price must be low enough to make $Q_d = 80$. From our demand equation, we see that $Q_d = 80$ if $P_{market} = 20$. So consumers will buy 80 units of this good for $20 per unit, and the government will bear a total expense of the difference between the market price and the guaranteed price times the number of units sold in the market, or $(P_{subsidy} - P_{market}) \times Q_{subsidiy} = 60 \times 80 = 4800$. Again, these are the three pieces of information you’ll most likely have to find in the price subsidy problem – the quantity which consumers buy, the price consumers must pay for the good, and the total cost to the government of running the program.
**Excise Taxes**

**Excise Tax:** a tax charged per unit consumed or purchased.

Most taxes that we deal with every day are not excise taxes. Most notably, a sales tax is not an excise tax, as a sales tax is charged based on the price of the good purchased. Cigarettes have an excise tax placed on them in most states, as the tax is charged per pack. Gasoline also has an excise tax in most states, with the tax charged per gallon pumped. We talk about excise taxes in economics because they are easier to deal with analytically. When dealing with an excise tax, we are interested in the tax revenue raised by the government as well as the welfare effects on society (that is, the amount of CS and PS lost when the tax is imposed). This is illustrated in the picture below:

![Diagram](image)

We show the effects of the tax by shifting either the supply or demand curve, depending on whether the tax is put on producers or consumers, respectively. Recall that our examples are all using the equations D: \( P = 100 – Q_d \) and S: \( P = Q_s \). In this case, we will impose a tax of $10 per unit bought on consumers. With a tax on consumers, they find the product less desirable and demand shifts down. As we have imposed a $10 tax, our new demand curve is given by \( D_{tax} \): \( P = 90 – Q_d \) and is pictured in purple above.

Why does demand shift “down” instead of “left”? Well, one way to think about this is in terms of the units on the axes. If we impose a tax in terms of dollars, then the demand curve should shift with respect to the axis measured in terms of dollars – the vertical axis. This also gives us our technique for getting the \( D_{tax} \) equation: if we write the demand equation in “P=” form, then we can simply subtract the amount of the tax from the D equation to get \( D_{tax} \). From our above example, we see that D: \( P = 100 – Q_d \) and our tax is $10, so \( D_{tax} \): \( P = (100 – Q_d) – 10 = 90 – Q_d \).
Now that we have $D_{\text{tax}}$, we can find the intersection of $D_{\text{tax}}$ and $S$ to find out the quantity which will be bought and sold in this market ($Q_T$). We see that sellers are willing to provide 45 units if they receive $45 per unit, while consumers are willing to buy 45 units if they pay no more than $55 per unit. Fortunately, this is exactly what happens — consumers pay $55 (P_{CT}$, for price consumers face under the tax), of which $10 goes to the government (tax), and sellers receive $45 (P_{ST}$, for price sellers receive under the tax). This “wedge” between the price consumers pay and the price sellers receive must always exactly equal the amount of the tax.

Our last concept pictured above to discuss is DWL — deadweight loss.

**Deadweight Loss:** a loss to consumers and producers which is not offset by a gain to another party

In this case, we can also think of DWL as the amount by which the loss of surplus caused by the imposition of the tax exceeds the amount of tax revenue raised by the government. The idea is that without a tax, there were 50 units bought and sold in the market, but the imposition of the tax reduces this to 45 units, so now too little of the good is being traded. This loss of beneficial trades imposes a cost on society, and the DWL is our measure of this cost.

So now, let’s work through the numbers of this example to see just how costly this tax is to society. We will compare the total surplus (CS + PS + Tax Revenue, if applicable) before the imposition of the tax to the total surplus afterwards. Recall that the pre-tax case is shown in the very first picture on page 1.

**Pre-tax:**

\[
CS = \frac{[(100 - 50) \times (50 - 0)]}{2} = 1250 \\
PS = \frac{[(50 - 0) \times (50 - 0)]}{2} = 1250 \\
\text{Total Surplus} = 1250 + 1250 = 2500
\]

**Post-tax:**

\[
CS = \frac{[(100 - 55) \times (45 - 0)]}{2} = 1012.5 \\
PS = \frac{[(45 - 0) \times (45 - 0)]}{2} = 1012.5 \\
\text{Tax Revenue} = (55 - 45) \times 45 = 450 \\
\text{Total Surplus} = 1012.5 + 1012.5 + 450 = 2475
\]

Thus, we expect DWL = 25, which we can check by finding the area of the grey triangle.

\[
\text{DWL} = \frac{[(55 - 45) \times (50 - 45)]}{2} = 25
\]

so our calculations are correct.

These are the basic mechanics of working through a tax problem. First, we find the new supply or demand curve created by the tax. Then we find the new intersection, which gives us $Q_T$, the quantity bought and sold under the tax. Once we have $Q_T$, we can find $P_{CT}$ and $P_{ST}$, and from there find CS, PS, Tax Revenue, and DWL. In tax problems, you might reasonably be asked to solve for any of these quantities, so it is best to be comfortable working through tax problems from beginning to end.
A final word about taxes: it might seem that there is a natural trade-off to be achieved when setting taxes – as revenue is good and DWL is bad, why not set taxes by finding a way to maximize revenue while keeping DWL as low as possible? Indeed, there is more than a little merit to this approach, but this is not always the goal of the politicians who propose tax bills. Former Sen. Daniel Patrick Moynihan (D-NY; he held the seat now occupied by Hillary Clinton) used to regularly propose a bill which would have imposed a 10,000% tax on sales of hollow-tipped bullets. Assuming that this tax was imposed as an excise tax on consumers, the picture might look something like this:

The tax revenue generated is very small – while every bullet sale generates plenty of tax income, very few bullets are actually sold. Really, the only thing such a tax would generate is DWL. But of course, that’s exactly the point. The Senator was trying to use economic forces to destroy the market for hollow-tipped bullets. So while we might think that generating the most tax revenue with minimum loss of surplus for society is a reasonable goal to keep in mind when setting taxes, we must remember that, sometimes, raising revenue is not the reason the tax is being imposed. Certainly, this was not the goal for Sen. Moynihan.¹

¹ No, the tax never passed. As you might imagine, some lobbying groups worked very hard to defeat it.