Tax incidence on supply and demand

Many studies conducted with rats and mice have shown that charcoal-grilled meat is carcinogenic. Since the authorities cannot easily regulate the methods used for cooking at home, they have proposed another solution to reduce the consumption of grilled meat. The proposal is to impose a 100 percent tax on the retail sale of charcoal. Suppose the daily demand for charcoal is given by $P = 120 - 2Q$ and the supply by $P = 30 + Q$, where P is expressed in dollars and Q is the number of 20-kilogram sacks of charcoal sold per week.

- What is the price of charcoal before and after the tax?

- What is the quantity of charcoal before and after the tax?

- How is the tax divided between sellers and buyers?

Solutions

We calculate the equilibrium price and quantity before the tax by equating supply and demand:

$$30 + Q = 120 - 2Q$$
$$Q = 30$$

With this, we substitute into either of the two functions and obtain the equilibrium price:

$$P = 30 + 30 = 60$$

Now we add the tax, which is 100%, meaning that consumers now have to pay 120 for each quantity consumed of the good. This creates two prices: one is the price received by the producer, and the other is the price paid by the consumer. The difference between these prices is the tax and generates government revenue.

$$P_O = 30 + Q$$
$$P_D = 120 - 2Q$$
$$P_D - P_O = T = 60$$

With these three equations, we will solve the problem. First, we isolate the price of supply or demand from the third equation:

$$P_D = 60 + P_O$$

We substitute this into the demand function:

$$60 + P_O = 120 - 2Q$$

We solve for P_O and equate it to the supply function:

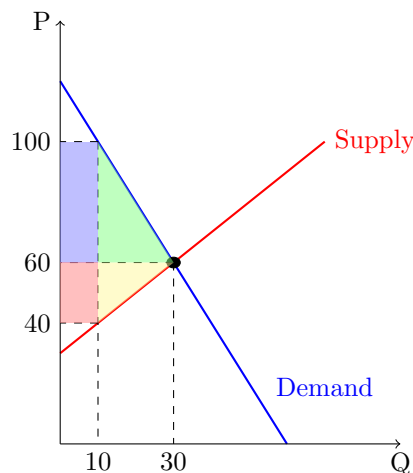$$P_O = 60 - 2Q$$
$$60 - 2Q = 30 + Q$$

Solving for Q:

$$Q = 10$$

Now we obtain the producer's and consumer's prices:

$$P_O = 60 - 2 \cdot 10 = 40$$

$$P_D = 120 - 2 \cdot 10 = 100$$

Therefore, we can see that the quantity has decreased, the consumer pays more, and the producer earns less. To see how the tax is distributed, we graph this situation:

The calculation of these four areas shows how consumer and producer surplus is reduced, partly due to deadweight loss (green and yellow triangles) and partly due to government revenue (red and blue rectangles). The total government revenue is $10 \cdot 60 = 600$. This is divided into: Blue rectangle: $40 \cdot 10 = 400$. And Red rectangle: $20 \cdot 10 = 200$. Additionally, the consumer deadweight loss is the green triangle: $\dfrac{20 \cdot 40}{2} = 400$, and the producer deadweight loss is the yellow triangle: $\dfrac{20 \cdot 20}{10} = 200$.