Handout 1: Supply and Demand

1 Introduction

The objective of this handout is to provide a hands-on experience and applied examples using the concepts of supply, demand, market equilibrium and horizontal sum for individual demands. First, we show how to mathematically compute the market equilibrium in two examples. Second, we discuss three cases of demand/supply shifts. Third, we apply our supply and demand framework discuss the effects of a government shutdown.

2 Algebraic Supply and Demand

In this section we develop two examples of how to compute the market equilibrium when the supply and demand are given.

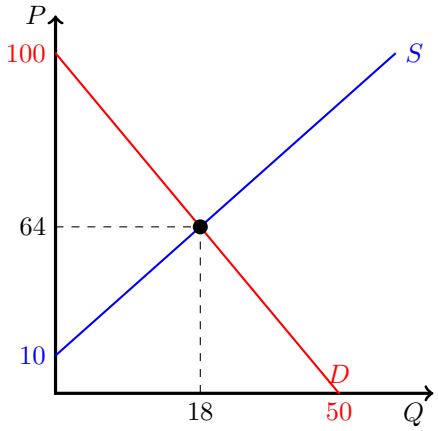
Example 1.

- Suppose supply is given by $P = 10 + 3Q_S$ and demand is given by $P = 100 - 2Q_D$, as in Figure 1 (not in scale)
- The demand intercepts the vertical axis at 100, which is the price such that quantity demanded $Q_D = 0$.
- The demand intercepts the horizontal axis at 50, which is the quantity demanded when the price is zero.
- We're interested in the rate at which demand changes when price changes. To see this, we can rewrite the demand function as:

$$Q_D = 50 - \frac{1}{2}P$$

  Therefore, for increases of \$1 dollar in the price, demand falls by 1/2 units.
- The same analysis can be done for supply.
- **Note:** *The standard in economics is to plot demand and supply curves with quantities Q in the horizontal axis and prices in the vertical axis. It is important that you follow this standard to avoid confusion in the future. Overall, you can face demands (and supplies) that are writen in the form: $P = a - bQ$ (as in this example) or as $Q = \frac{a}{b} - \frac{1}{b}P$. They both represent the same demand curve.*
- Q: How to find the equilibrium?

Figure 1: Supply and Demand



- A: In equilibrium, it must be that quantity supplied is equal to the quantity demanded, that is $Q_S = Q_D = Q$, which gives us a system of two equations and two unknowns

$$P = 10 + 3Q$$

$$P = 100 - 2Q$$

And we can solve as

$$10 + 3Q = 100 - 2Q \Rightarrow 90 = 5Q \Rightarrow Q = 18$$

- Replace the quantity back in both curves to show that prices are indeed the same: $P = 100 - 2Q = 64 = 10 + 3Q = P$, which is the point where supply and demand intersect in Figure 1.

Example 2. In Example 1, both supply and demand were linear curves. This makes the solution of the 2 equations and 2 unknown system of price and quantity in relatively easy to compute. However, in several applied situations demand and supply are not linear. One common case which will appear later on in the class is a supply (still linear) given by $Q_S = P$, and a demand given by

$$Q_D = \frac{a}{P^\sigma}$$

where $\sigma > 0$ and $a > 0$ are parameters.

- Q: How to find the equilibrium? The same way as in example 1.

- A: In equilibrium, it must be that quantity supplied is equal to the quantity demanded, that is $Q_S =$

$Q_D = Q$:

$$\frac{a}{P^\sigma} = P \Rightarrow P = a^{1/(\sigma+1)}$$

- So $P = a^{1/(\sigma+1)}$ is the equilibrium price.

3 Examples of Supply and Demand Shifts

In each of the following scenarios, we will use a supply and demand diagram to illustrate the effect of a given shock on the equilibrium price and quantity in the specified competitive market. The idea is to explain whether the shock represents a shift in the demand curve, the supply curve, both, or neither and whether it increases, decreases or has an indeterminate effect on equilibrium prices and quantities.

1. During the holiday season, more people want to travel to visit friends and family. Illustrate the effect of the holiday season has in the market of airline tickets.

2. There is a possibility of a No-Deal Brexit, which would cause products from the European Union to have to go through customs to enter the UK. This process can take time and is particularly costly to perishable goods, reducing the availability of them in the UK. The UK itself has a limited ability to produce and store these goods. Illustrate the effect of a No-Deal Brexit in the market for perishable goods in the UK.

3. Starting in 1880, there was a large immigration of Italians to the United States. Between 1900 and 1910 alone, around two million Italians relocated here. Some Italian immigrants chose to open Italian restaurants when arriving in the US. Moreover, Italians also enjoy eating Italian food more than Americans. Illustrate the effect of Italian migration in the market for Italian food.

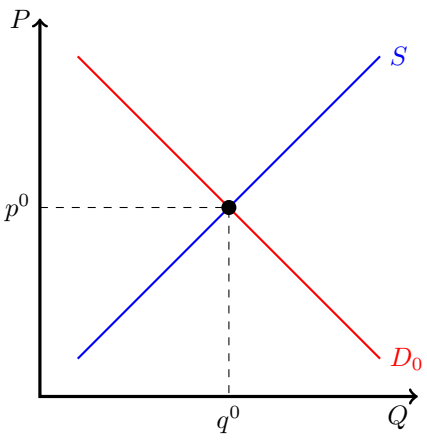
Solution.

1. The demand for airline tickets shifts right from D_0 to D_1, as in Figure 2 as more people want to buy airline tickets at any given price. This shift increases prices and quantity in equilibrium, from (q^0, p^0) to (q^1, p^1).

2. The supply of perishable goods in the UK shifts left, as in Figure 3. As the Brexit would imply larger costs to import perishable goods, importers are willing to supply a lower amount for any given price of perishable goods. This shift increases prices and reduces quantities in equilibrium, from (q^0, p^0) to (q^1, p^1).

Figure 2: Demand Shifts (Item 1)

(a) Before Shift



(b) Positive Shock

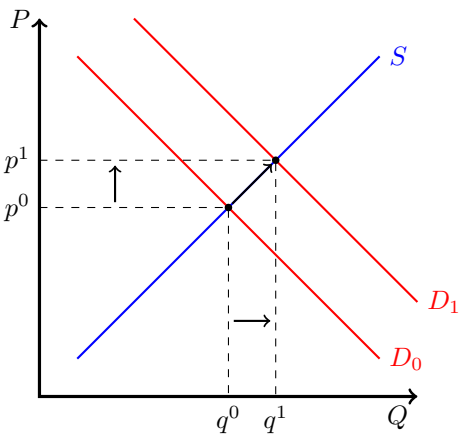
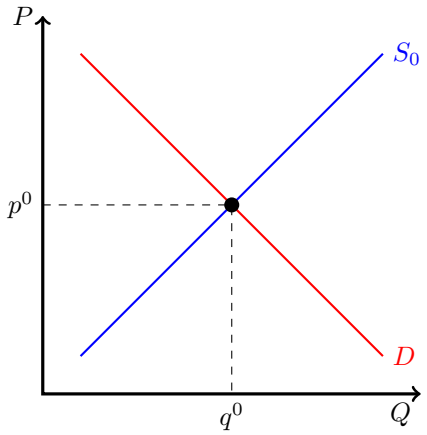
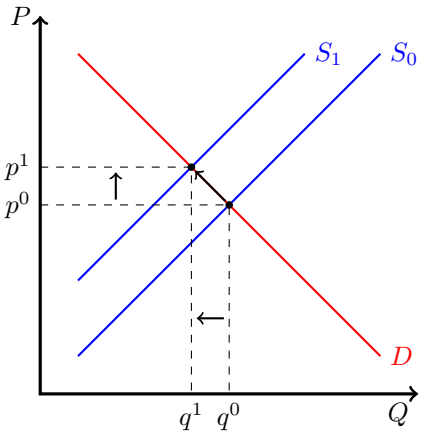


Figure 3: Supply Shifts (Item 2)

(a) Before Shift



(b) Negative Shock



3. The supply for Italian food increases (since a fraction of Italians open Italian restaurants), as does the demand (since Italians eat more Italian food than Americans). See Figure 4. These shifts increase quantities from q^0 to q^1, but the effect on prices in indeterminate, that is, we do not know if $p^0 > p^1$ or $p^1 < p^0$ - it depends on which shift is greater (the demand or the supply one), which we do not know in this exercise.

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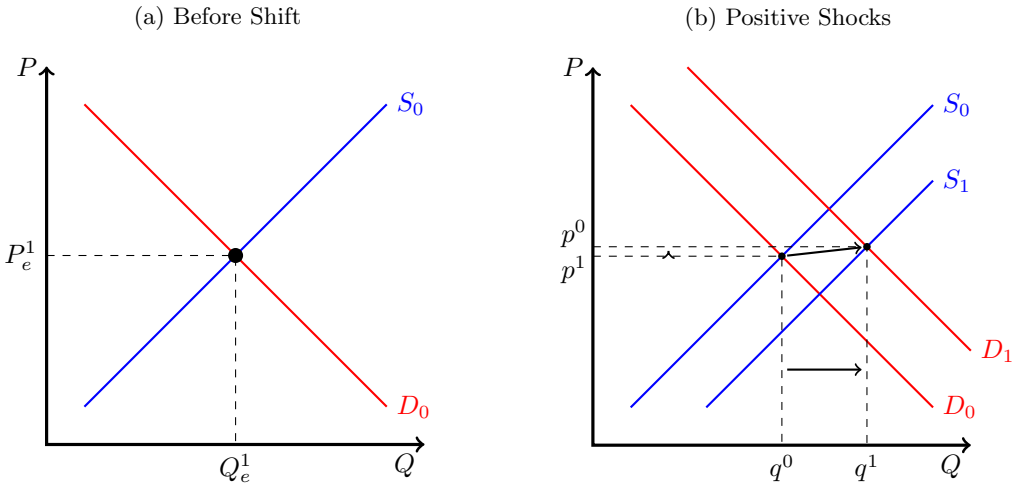
Figure 4: Supply and Demand Shifts



4 Government Shutdown

Objective. *In this example we will apply the concepts of supply and demand to understand the effects of a government shutdown in local economies. As consumers need income to demand goods, a shutdown will reduce the total demand of a market by negatively affecting the income of public employees. To construct the total demand from demand of different individuals, we will apply the concept of horizontal sum. For simplicity, we fill focus here on the demand for food. We will compute the equilibrium price and quantity without the shutdown and with the shutdown and compare them. We will further compare if regions where more employees work for the federal government are affected more or less by the shutdown.*

Suppose that the supply of food, Q_S, is given by

$$Q_S = 10000 + 10000P$$

and is not affected by the shutdown.

Suppose that the economy is composed of 1000 workers, which can work either in the private sector or the government. A worker of the private sector has a demand for food given by

$$Q_D^{Private} = 70 - 30P$$

In the absence of a shutdown, the demand of government workers is the same as those in the private sector.

With a shutdown, their demand is reduced as in Eq.(1)

$$Q_D^{Government} = \begin{cases} 40 - 30P, \text{ if there is a shutdown} \\ 70 - 30P, \text{ if otherwise} \end{cases} \tag{1}$$

1. Find the total demand for food in the absence of a shutdown.
2. Compute the price and quantity in equilibrium in the absence of a shutdown.
3. Explain why a shutdown will decrease the demand for food.
4. Suppose that 1/3 of the workers in this economy work for the federal government. Compute the shutdown equilibrium prices and quantities and compare them with those in the absence of a shutdown.
5. Suppose now that 2/3 (instead of 1/3) of the workers in this economy working for the federal government. Re-compute the shutdown equilibrium prices and quantities and compare with the answer in Item 3.

Solution.

1. To compute the total demand, we must do what is called the *horizontal sum*. In the supply-demand framework, we represent quantities in the horizontal axis and prices in the vertical axis. When summing the demand or supply of multiple market participants, we must sum the quantities given prices - that is, sum on the horizontal axis. Therefore, to recover market demand, we sum on the horizontal axis (quantities). For this example, we sum the demand of 1000 workers - so we multiply the demand of 1 worker by 1000.

$$Q_D = 1000\,[70 - 30P] = 70000 - 30000P$$

2. The equilibrium price is the one that equates demand and supply. At this price, the quantity demanded is equal to the quantity supplied, and the market is in equilibrium. To have $Q_S = Q_D$, we need to have that

$$10000 + 10000P = 70000 - 30000P$$

This implies that $40,000P = 60,000 \Rightarrow P = 1.5$. We can replace this price at either the supply or the demand to recover the equilibrium quantities. In the supply:

$$Q = 10000 + 10000 \times 1.5 = 25000$$

Therefore, the equilibrium is given by $P = 1.5, Q = 25000$

3. The demand function represents the quantity the market is willing to buy at a given price. Movements in price are movements *along* the demand curve. Other factors however affect how much consumers are willing to pay for a product: their income, the price of substitutes etc.. For instance, if we are considering the demand for soda, if the price of Pepsi falls, the demand for Coke should be expected to fall *for any given price of Coke*, which is a downward shift in demand. The shutdown decreases the demand through the loss of *income* of workers, that is: for any given level of food prices, consumers demand less food because on aggregate they have less income.

4. We must recompute the total demand. For that, we must again sum on the quantities that each person demands. We have that $1000 \times 2/3$ are demanding $70 - 30P$, while the rest - $1000 \times 1/3$ are demanding $40 - 30P$. Therefore, total demand is given by[1]

$$Q_D = 1000\left[(70 - 30P) * 2/3 + (40 - 30P) * 1/3\right]$$

. The new equilibrium price is the one that equates supply and demand during a shutdown, that is, that equates supply with the demand above. We can re-write the demand above as

$$Q_D = 70000 \times 2/3 + 40000 \times 1/3 - 30000(2/3 + 1/3)P = 60000 - 30000P$$

Equating the demand with the supply:

$$10000 + 10000P = 60000 - 30000P$$

Solving the equation above gives $40000P = 50000$. Therefore, equilibrium prices after the shutdown are $P = 1.25$. Replacing this price in either the supply or demand, we have that the equilibrium quantity post-shutdown is given by $Q = 22500$. With the shutdown, the price and quantity of food sold falls in equilibrium.

5. We must recompute the total demand. Following the same logic from item 3, the demand is now given by

$$Q_D = 1000\left[(70 - 30P) * 1/3 + (40 - 30P) * 2/3\right]$$

[1] In this problem, it is assumed individuals can have negative demands. Consider the case when $P = 1.5$: while total demand is $Q_D = 1000 * ((7030 * (1.5)) * \frac{2}{3} + (4030 * (1.5)) * \frac{1}{3}) = 15,000$, the demand of government workers with shutdown is $1000 * \frac{1}{3} * (4030 * (1.5)) = -1666.7$. A better expression for total demand would be a kinked demand defined as $Q_D = 1000[(7030P)\frac{2}{3}]$ if $P > \frac{4}{3}$ and $Q_D = 1000[(7030P)\frac{2}{3} + (4030P)\frac{1}{3}]$ if $P < \frac{4}{3}$. However, to simplify things, in this case, it is assumed individuals can have negative demands.

. The new equilibrium price is such that

$$10000 + 10000P = 50000 - 30000P \Rightarrow P = 1$$

which implies an equilibrium quantity of $Q = 20000$. The effect of a shutdown is larger if a larger share of workers is employed by the federal government. As more workers lose their income and reduce their individual demand, the market demand reacts more when more workers lose their income.

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