Unit 2. Supply and demand

Learning objectives

➢ to analyse the determinants of supply and demand and the ways in which changes in these determinants affect equilibrium price and output; in particular, to make the distinction between movements along the curves and shifts in the curves;

➢ to consider the impact of government policies, such as price floors and ceilings, excise taxes, tariffs and quotas on the free-market price and quantity exchanged;

➢ to understand the concepts of consumer surplus and producer surplus should also be introduced.

2.1. Determinants of demand and supply. Market equilibrium. Deficit and surplus

Demand curve is a schedule or graph showing the quantity of a good that buyers wish to buy at each price. One should distinguish demand and quantity demanded. Demand describes behavior of buyers at every price – the whole schedule or graph. Quantity demanded is exact quantity of a good buyers would purchase at a given price.

Supply curve is a graph or schedule showing the quantity of a good that sellers wish to sell at each price. One should distinguish between supply and quantity supplied. Supply is the correspondence between the price of the good and the quantity of the good the producers are going to supply at every price – this is the supply curve. Quantity supplied is the quantity of the good producers would sell at the given price.

Demand depicts the relationship between price and quantity demanded by consumers. Supply depicts the relationship between price and quantity supplied by producers.

Prices at competitive markets are determined by the laws of demand and supply. The law of demand says that when the market price goes up, customers are willing to buy less amount of the good. The law of supply says that if price goes up producers are going to supply larger quantity of the good to the market. So market demand is usually a downward sloping curve and market supply is an upward sloping curve.

A market is in equilibrium, when no agent in the market has an incentive to alter his or her behavior, so there is no source of change. Market is in equilibrium when the buyers and sellers are satisfied with the quantities and prices at the market. On one hand quantity demanded is equal to quantity supplied. Producers are able to sell their total output at the equilibrium price. Customers can buy the quantity of the good they need at the equilibrium price. There is neither a surplus nor a deficit, and the market is clearing at the given price. On the other hand, market is in equilibrium when the price of demand is equal to the price of supply.

The laws of demand and supply ensure stability of market equilibrium. If market price is higher than the equilibrium one, quantity of supply will be greater than quantity of demand, there will be excess supply (surplus) at the market (*CD* on the figure at the left below). A part of quantity supplied won't be sold, and the producers will have to cut the prices down to the equilibrium level. If market price is lower than the equilibrium one, there is excess demand (shortage, or deficit) at the market (*AB* on the left hand side of the graph below). Competition among buyers makes it possible for the producers to inflate the price up to equilibrium level.

The inverse considerations are valid as well. If quantity supplied is less than the equilibrium one, the price of demand will exceed the price of supply. This will be an incentive for the firms to increase production until the price of supply is equal to the price of demand. And vice versa, if there is excess supply, the price of supply will be higher than the price of demand. Competition among sellers will push the price down to the equilibrium level. The market is clearing and surplus is eliminated (see the right hand side of the graph below).

Market equilibrium (deviations)
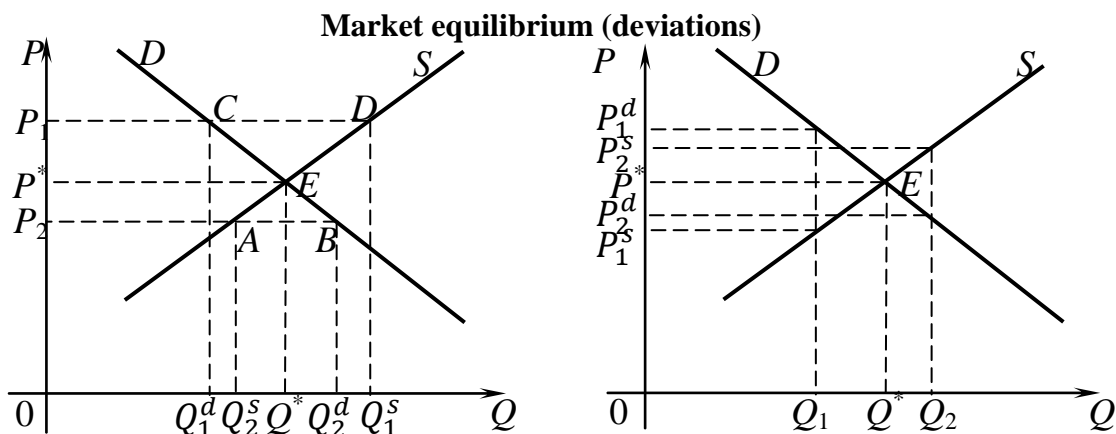
One should distinguish between a change in quantity demanded (supplied), that is a movement along the demand (supply) curve as a result of a change in price; and a change in demand (supply) – that is a shift of the entire curve.

Demand shifters are the factors that affect quantity demanded at any price. In fact, they affect the whole schedule – demand itself. These are:

1. Tastes: if a good becomes more favorable it yields outward shift of the demand curve.

2. Incomes: higher income increases demand for normal goods, and decreases it for inferior goods.

3. Prices of complements and substitutes.

An increase in the price of a good is going to reduce demand for its complement (see the figure below).

Markets for complements
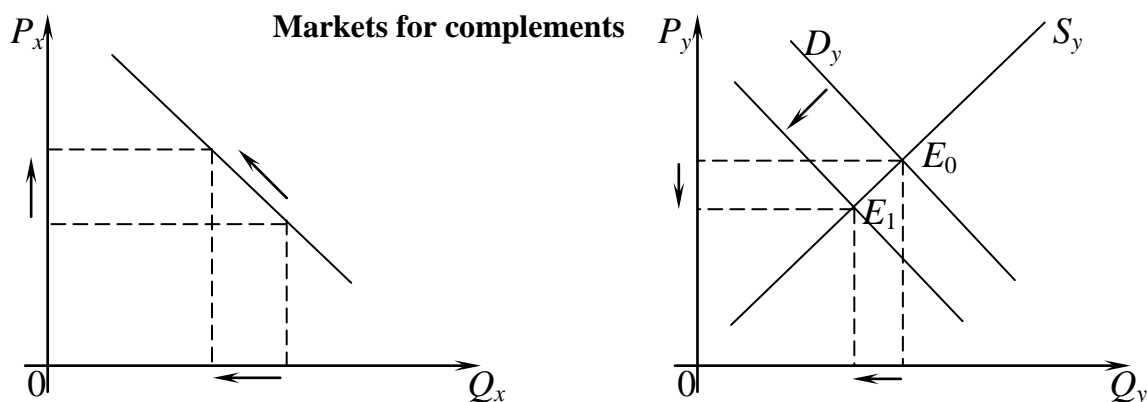
An increase in the price of a good is going to raise demand for its substitute (see the figure below)[1].

Markets for substitutes
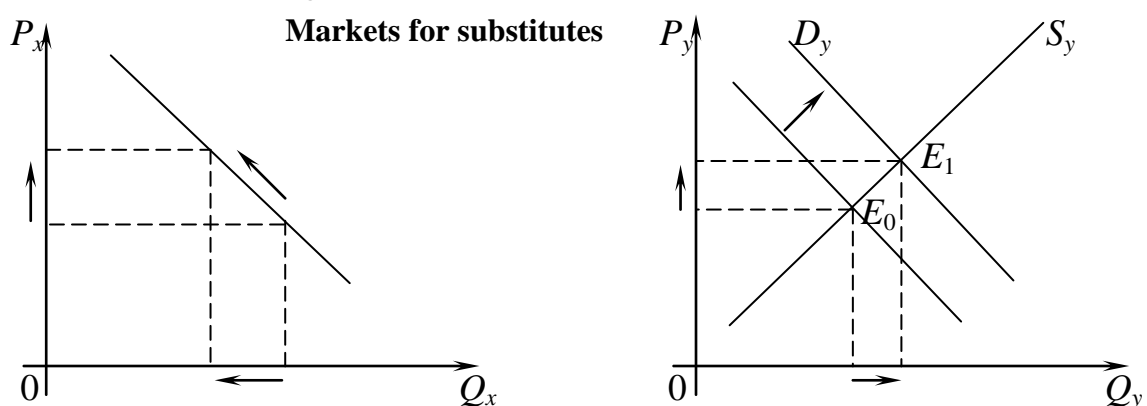
The other demand shifters are:

4. Changes in the population of potential buyers;

5. Expectations of higher/lower prices in the future.

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[1] The more precise treatment of markets for substitutes and complements is postponed until unit 4 "Consumer choice".

Supply shifters are the major factors affecting supply. They have to do with costs of producing and selling a good:

1. Cost of inputs;
2. Technology;
3. Government regulation (safety and such);
4. Number of suppliers;
5. Expectations of future prices.

2.2. Consumers' surplus, producers' surplus and market efficiency

Competitive market is efficient, because demand and supply curves reflect all the relevant costs and benefits associated with production and consumption of the good. Any deviation fron competitive equilibrium shrinks consumers' and producers' welfare.

Demand curve shows the highest prices consumers are willing to pay for a good, or reservation prices. The reservation price (multiplied by the additional unit of the good bought) gives the increment in total consumers' benefit. The sum of these increments (shaded area on the left hand figure below) is the total consumers' benefit at the competitive market.

If demand schedule is continuous consumers' willingness to pay (total benefit) will be given by the area $0AEQ^*$. Consumers' expenditures are represented by the rectangle $0P^*EQ^*$. Consumers' surplus (net benefit) is the aggregate difference between their reservation prices and the prices that are actually paid. It is given by the triangle P^*AE (see the left hand side of the figure below).

Supply curve shows the smallest price sellers would be willing to charge for a good or sellers' reservation prices (generally equal to marginal cost). The reservation price (multiplied by the additional unit of the good sotd) gives the increment in aggregate production costs in the industry. The sum of these increments (shaded area on the right hand side of the figure below) is the aggregate production cost at the competitive market.
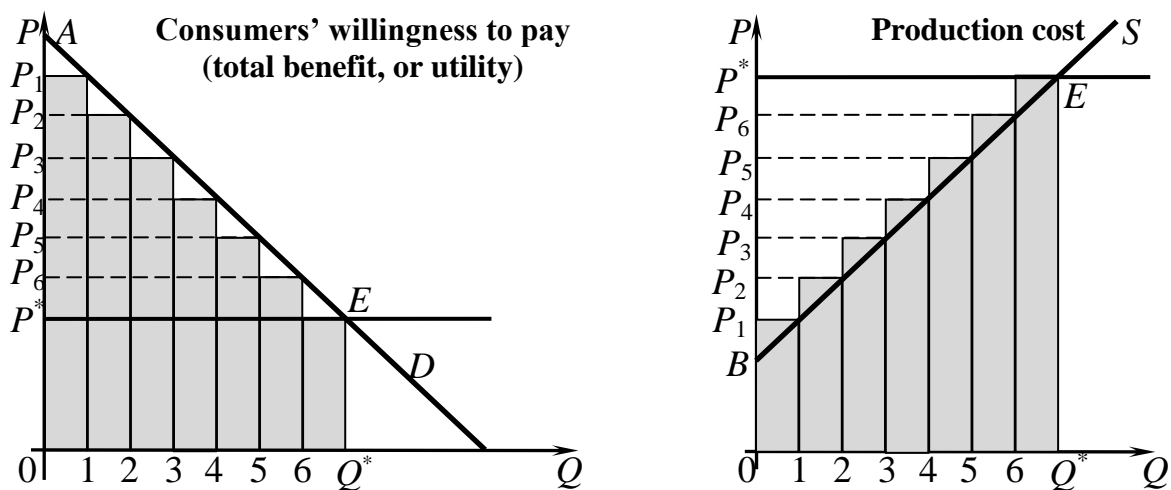
If supply schedule is continuous production costs will be given by the area $0BEQ^*$. Total revenue of producers is the rectangle $0P^*EQ^*$. Producers' surplus is the aggregate difference between the price the sellers receive and their reservation prices. It is represented by the triangle BP^*E (see the right hand side of the figure abov)[2].

Total surplus (TS) = consumers' surplus (CS) + producers' surplus (PS). Market equilibrium results in largest total surplus because all mutually beneficial opportunities for exchange are exploited.

To prove allocative efficiency of competitive market more formally let's rearrange the expression of total surplus and bear in mind that total expenditures of consumers are equal to total revenue of producers: $TS = CS + PS$ = total benefit (TB) − total expenditures + total revenue − total costs (TC) = $TB - TC$.

Use marginal analysis to maximize total surplus: $\frac{dTS}{dQ} = \frac{dTB}{dQ} - \frac{dTB}{dQ} = MB - MC = 0$, i.e. $MB = MC$, when social welfare is maximized.

Market demand: price (P_d) is equal to benefit of consumption of an additional unit of good, i.e. to marginal benefit. Market supply: price (P_s) is equal to cost of production of an additional unit of good, i.e. to marginal cost. Market equilibrium: $P_d=P_s$, i.e. $MB = MC$, that proves allocative efficiency of a competitive market. Any deviations from the competitive market equilibrium, for instance price and quantity controls, lead to shrinking social welfare.

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[2] See unit 6 "Firm behavior and market structure: perfect competition" for the more precise treatment of producers' surplus.

2.3. Price and quantity controls. Tax incidence and dead weight loss

Under price controls the quantity traded is the smallest one of the quantity supplied and the quantity demanded.

Price ceiling is the maximum allowable price, specified by law. Suppose that $E(Q^*,P^*)$ is the point of market equilibrium. Note that a price ceiling which exceeds the equilibrium price would be irrelevant since the full market equilibrium at point E can still be attained. A price ceiling $P_{max}<P^*$ leads to excess demand, or deficit (AB on the left hand side of the graph below) and reduces quantity supplied from Q^* to Q_A. Consumers' surplus in an unregulated market has been equal to triangle S_{FP^*E}. Under price ceiling it turns to the area $S_{FP_{max}A}$. So the rectangle $S_{P_{max}P^*HA}$ is the gain and triangle S_{HGE} is a loss in consumers' surplus. Producers' surplus in the free market has been equal to triangle S_{CP^*E}. Under price ceiling it becomes the area $S_{P_{max}CGA}$. So the rectangle $S_{P_{max}P^*HA}$, that is a part of the reduction in producers' surplus, is compensated by the equal gain in consumers' surplus; and triangle S_{AHE} adds up to net social loss. Net losses of consumers and producers sum up to give the net social loss due to the price ceiling: $DWL = S_{AGE}$.

Price floor is a minimum allowable price, specified by law (for example, minimum wage). A price floor, that is below the equilibrium price, is irrelevant since the free market equilibrium at point E can still be attained. A price floor $P_{min}>P^*$ leads to excess supply ($AB=Q_B–Q_A$ on the right hand side of the figure below). Actual quantity of the good exchanged in the market will be equal to the quantity of demand Q_A. With the price floor consumers' surplus is $S_{P_{min}CA}$. It is less than consumers' surplus in the free market. The difference is $S_{P_{min}P^*EA}$. The quantity of the good produced will be equal to Q_B, so production cost will be given by the area S_{0FBQ_B}. Total revenue will be $S_{0P_{min}AQ_A}$. So producers' surplus under price ceiling will be equal to the difference $S_{FP_{min}AG} - S_{Q_AABQ_B}$. The substrackting term $S_{Q_AABQ_B}$ shows the losses of producers caused by overproduction in the market. Similar to the case of a price ceiling partially the rectangle $S_{P_{min}P^*HA}$ that is the gain of producers cancelles out the same consumers' loss. Net losses of consumers and producers together give the net social loss $DWL = S_{AGE} + S_{Q_AABQ_B}$.

Effect of a price ceiling / **Effect of a price floor**
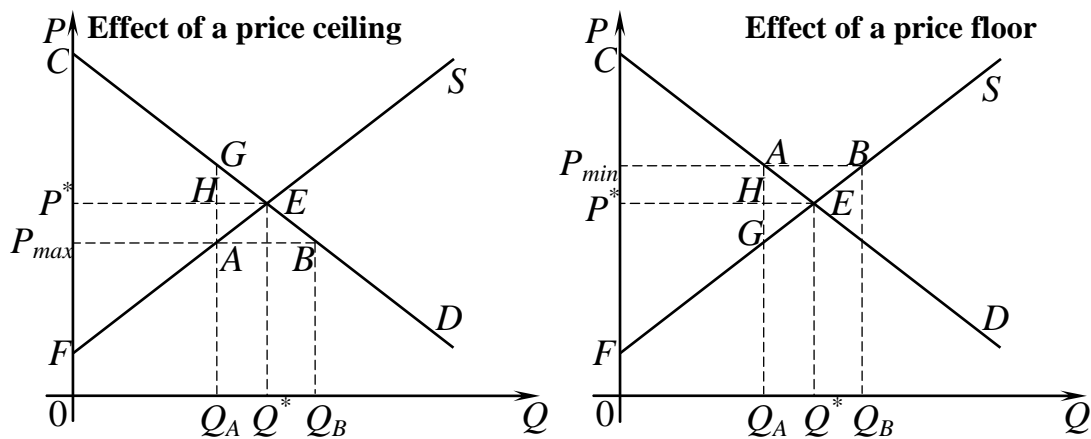
Let's consider welfare effects of a unit tax and of an ad valorem tax. In case of a unit tax a fixed amount of money is to be transferred from producers to budget per every unit of good sold. The imposition of a unit tax per each unit of a good produced is consistent with leftward shift of the supply curve. The price that is actually received by producers for each unit of the good is lower as compared to the situation without regulation. In order to cover production costs producers are going to increase price of supply for each unit of the good produced. The increase in the price of supply for each output will be equal to the tax rate. This will shift the supply curve to the left.
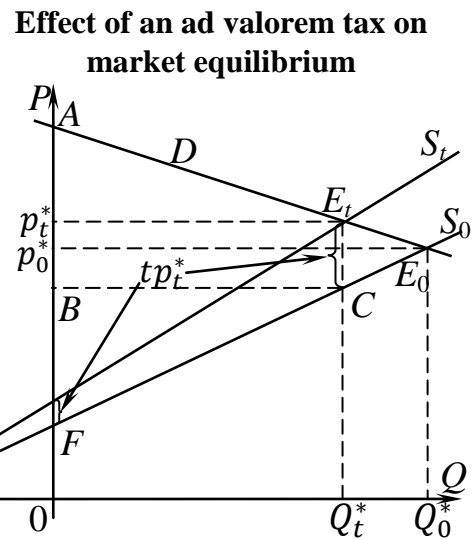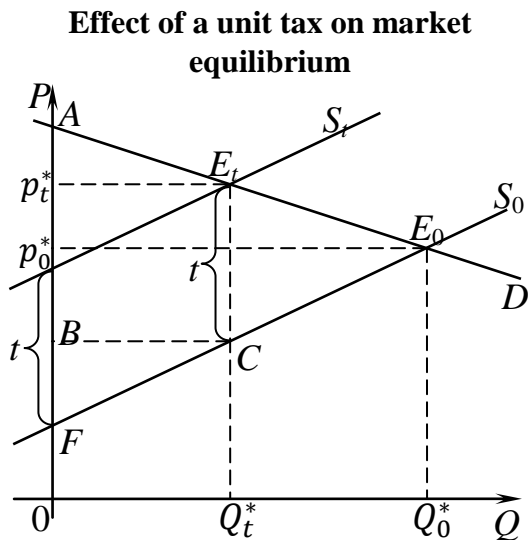
The amount of ad valorem tax is proportional to the revenues of producers, i.e. the amount of tax per unit sold is proportional to the price (see the figure below). The imposition of ad valorem tax is consistent with counter clockwise rotation of the supply curve. The price that is actually received by producers for each unit of the good is lower $(1-t)$ times lower as compared to the situation without regulation, where t is the tax rate. In order to cover production costs producers are going to increase price of supply by the factor $(1-t)$ for each unit of the good produced. This will rotate the supply curve in the counter clockwise direction around the intercept with the horizontal axis.

Considerations are similar in both cases. At the graphs below P_0^* and Q_0^* is correspondingly the free market price and free market quantity exchanged. B is the price received by producers, P_t^* is the price paid by consumers and Q_t^* is the quantity demanded and supplied when tax is imposed.

Consumer surplus in the free market is $CS_0 = S_{Ap_0^* E_0}$. Consumer surplus with tax is $CS_t = S_{Ap_t^* E_t}$. So the loss of consumers is $\Delta CS = S_{p_0^* p_t^* E_t E_0}$.

Now let's consider the supply side of the market. In the free market (variable) production costs are $C_0 = S_{0FE_0Q_0^*}$, total revenue of producers is $TR_0 = S_{0p_0^* E_0 Q_0^*}$, producer surplus is the difference between total revenue and (variable) production costs: $PS_0 = TR_0 - C_0 = S_{Fp_0^* E_0}$. When either a unit or an ad valorem tax is imposed, (variable) production costs are $C_t = S_{0FCQ_t^*}$, total revenue of producers is $TR_t = S_{0p_t^* E_t Q_t^*}$. Tax expences of producers are $T = S_{Bp_t^* E_t C}$, they are equal to tax revenue of the government. Producer surplus is the difference between total revenue net of tax paid and (variable) production costs: $PS_t = TR_t - C_t - T = S_{FBC}$. So the loss of producers caused by taxation is $\Delta PS = S_{Bp_0^* E_0 C}$.

Summing up, both a unit and an ad valorem tax result in dead weigh loss: $DWL = \Delta CS + \Delta PS - T = S_{CE_t E_0}$.

Effect of a unit tax on market equilibrium   **Effect of an ad valorem tax on market equilibrium**

Let's give examples of government fiscal policies and their effect on market equilibrium. Suppose that initially market demand and supply curves are: Qd = 100 – P and Qs = 3P – 20 correspondingly. Equilibrium market price and the quantity exchanged are: P_0=30 and Q_0=70. Social welfare is the sum of consumers' and producers' surpluses: CS_0=0,5(100-30)70=2450 and PS_0=0,5(30-6^2/$_3$)70=816,66.

If the government imposes tax at the rate 8 (dollars) per unit sold by producers the new supply curve will be P_{s1}=14^2/$_3$+^{1}/$_3$Q. So the new equilibrium is: P_1=36, Q_1=64. The new consumers' surplus is CS_1=0,5(100-

36)64=2048; the new producers' surplus is $PS_1=0,5(28-6^2/_3)64=682,66$. So the changes in consumers' and producers' surpluses are: $\Delta CS=-402$; $\Delta PS=-134$. Budget tax revenues are: $T=8 \cdot 64=512$. Summing up, there emerges dead weight loss: $DWL=0,5 \cdot 8(70-64)=24$ (see the left hand side of the figure below).

      If the government imposes ad valorem tax equal to 15% of producers' revenues the new supply curve will be $Q_{s2}=3 \cdot 0,85 \cdot P-20=2,55P-20$, or $P_{s2}=7,84+0,39Q$. So the new equilibrium is: $P=33,8$; $Q=66,2$. The new consumers' surplus is $CS_2=0,5(100-33,8)66,2=2191,22$; the new producers' surplus is $PS_2=0,5(28,73-6^2/_3)66,2=730,5$. So the changes in consumers' and producers' surpluses are: $\Delta CS=-258,78$. $\Delta PS=-86,16$. Budget tax revenues are: $T=0,15 \cdot 66,2 \cdot 33,8=335,634$. Summing up, there emerges dead weight loss: $DWL=0,5 \cdot (33,8-28,73)(70-66,2)=9,76$ (see the right hand side of the figure below).