Unit 9. Factor markets

Learning objectives:

- to apply the concepts of supply and demand to markets for factors;
- to analyze the concept of derived demand;
- to understand how a factor's marginal product and the marginal revenue product affect the demand for the factor;
- to consider the role of factor prices in the allocation of scarce resources;
- to consider labour supply and wage and employment determination;
- to explain effects of deviations from perfect competition in labour market;
- to explain the determination of economic rent and price for capital;
- to consider the role of factor prices in distribution of income and the sources of income inequality in a market economy.

Questions for revision:

- ✓ Utility maximization: income and substitution effects
- ✓ Total product and cost curves;
- ✓ Profit maximization by a competitive firm;
- ✓ Equilibrium of a competitive market;
- ✓ Labour input optimization by a perfectly competitive firm;
- ✓ Profit maximization by a monopoly;
- ✓ Price discrimination;
- ✓ Government regulation of a competitive market.

9.1. Labour supply

Labour supply depends on decisions of working individuals, how many hours to work (*L*). The key issue here is a tradeoff between earning money and enjoing free time (*H*). Leisure is treated as a good now. In this sense labour is a bad because working for an hour a person gives up an hour of enjoing free time.

Decision-making of a working individual is similar to the choise of a consumer. In this case utility of an individual depends not only on consumption of commodities but on her leisure time as well: *U*(*C*,*H*), where $C = p_1^0 x_1^t + p_2^0 x_2^t$ are consumer's expenditures in fixed prices of a base period.

A worker seeks to maximize utility subject to two constraints: temporary constraint *L*+*H*=*T*, where *T*=24 is the daily temporal fund of an individual and a monetary constraint $pC = wL + \bar{M}$, where $\bar{M}$ is a non-labour income of an individual, *w* is an hourly wage rate, *p* is the consumer price index $p = \frac{p_1^t x_1^t + p_2^t x_2^t}{p_1^0 x_1^t + p_2^0 x_2^t}$. So taking into consideration the definition of *C* it is easy to see that $pC = \left(\frac{p_1^t x_1^t + p_2^t x_2^t}{p_1^0 x_1^t + p_2^0 x_2^t}\right)(p_1^0 x_1^t + p_2^0 x_2^t) = p_1^t x_1^t + p_2^t x_2^t$ are actual consumer's expenditures.

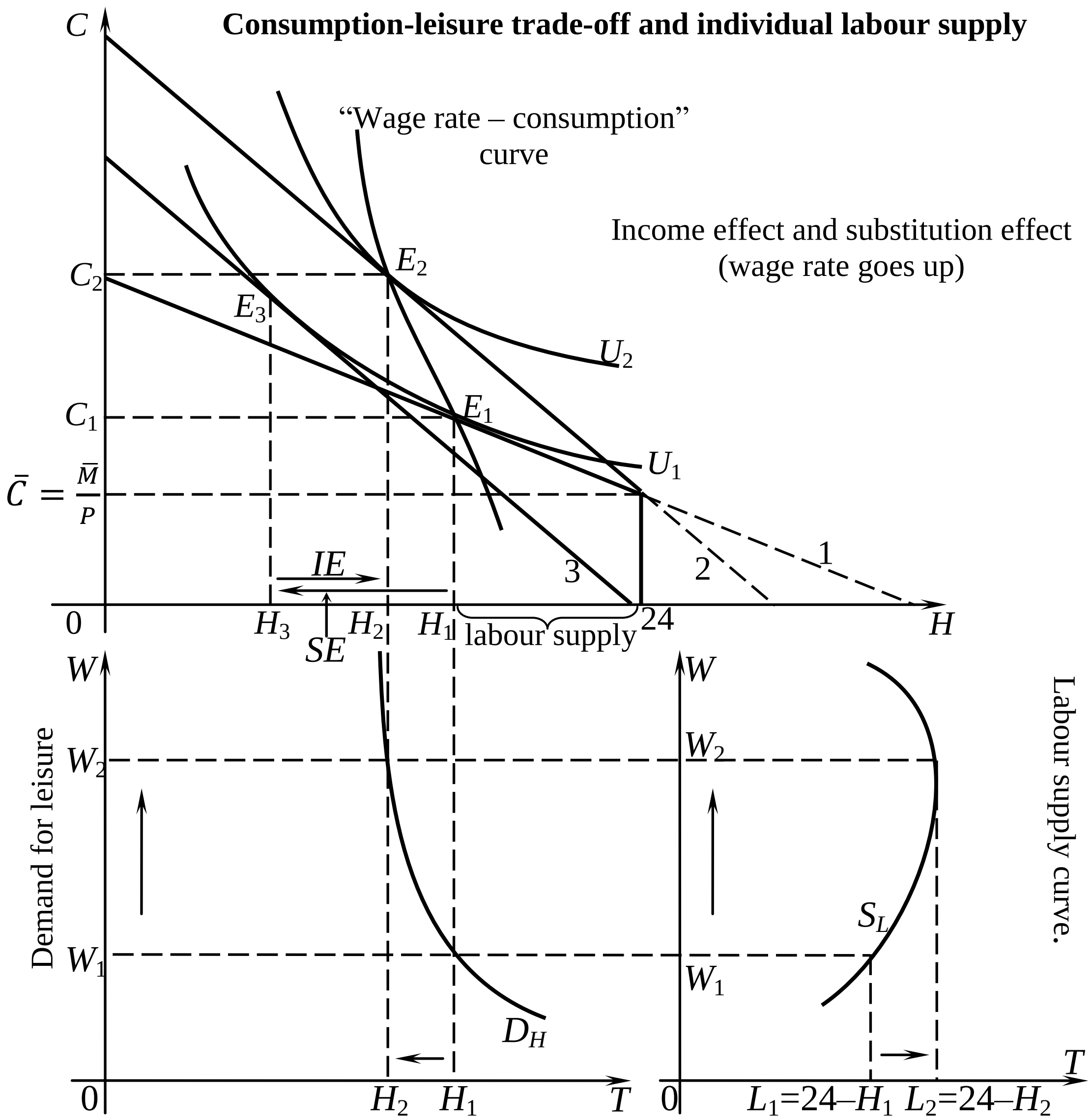
Putting the temporal and monetary constraints together one can write down a composite constraint: $pC = w(24 - H) + \bar{M} = \bar{M} + 24w - wH$, or $C = \frac{\bar{M} + 24w}{P} - \frac{w}{P}H$. The real wage rate w/P appears to be an opportunity cost of leisure.

Optimal individual choise is similar to that of a consumer in commodity markets. Marginal rate of substitution of consumption and leisure is equal to real wage rate:

$$MRS_{HC} \equiv -\frac{dC}{dH}\bigg|_{U=const} = \frac{\partial U/\partial H}{\partial U/\partial C} = \frac{MU_H}{MU_C} = \frac{w}{p}.$$

Suppose that the wage rate goes up to consider income and substitution effects. Labour supply curve (L=24-H) will be upwarg bending if substitution effect overweights income effect (see the figure below).

Consumption-leisure trade-off and individual labour supply



Here the vertical segment of a consumer’s budget constraint (see the upper segment of the figure above) is equal to real consumption if the peson is not working at all: $\bar{C} = \frac{\bar{M}}{P}$. The vertical segment will be smaller if labour force participation yields a consumer some costs, i.e. reduces her non-labour income.

A person is more likely to work if:

a) tastes are favorable to working;
b) real wage is higher;
c) fixed costs of working are lower;
d) income from not working is lower.

If income effect is greater than substitution effect labour supply curve will be backward bending. Thus, there may be two segments in an individual labour supply curve (see the figure below).

Normally, industry labour supply is upward sloping.

9.2. Derived demand for factors of production. Marginal revenue product and marginal factor cost: profit maximization

Recall that a firm is an institution that puts together factor and product markets (see the first figure in unit 5). In this sense a firm's demand for production factors – labour and capital – is a derived demand as it depends on the demand and consequently the price for the product of the firm which is sold at product markets markets.

Let's consider profit maximization in short run, when labour is the only variable production factor, so labour costs (wL) are variable, and capital costs (rK) are fixed (FC): $TC = wL + FC$. A firm is maximizing profit with respect to labour factor:

$$\max_L PR = \max_L \{pQ - (wL + rK)\} = \max_L \{pQ - wL - FC\}.$$

The first order condition of profit maximization is the zero derivative of profit function with respect to labour:

$$\frac{dPR}{dL} = p\frac{dQ}{dL} + \frac{dp}{dL}Q - \frac{dw}{dL}L - w = 0.$$

The sum of the first two terms here is the derivative of total revenue of a firm with respect to labour input:

$$\frac{dTR}{dL} = \frac{d(pQ)}{dL} = \frac{dTR}{dQ}\frac{dQ}{dL} = MR \cdot MP_L.$$

It shows an increase in revenue from selling extra output produced with an extra unit of labour and is called marginal revenue product of labor MRP_L.

The sum of the last two terms in the first order condition is the derivative of the firm's total cost with respect to labour input:

$$\frac{dTC}{dL} = \frac{d(wL + FC)}{dL} = \frac{d(wL)}{dL}.$$

It shows an increase in total cost due to an extra unit of output produced with an extra unit of labour and is called marginal factor cost of labor MFC_L.

Thus the profit maximizing rule is the equation of marginal revenue product and marginal factor cost of labour: $MRP_L = MFC_L$.

There are four possible cases:

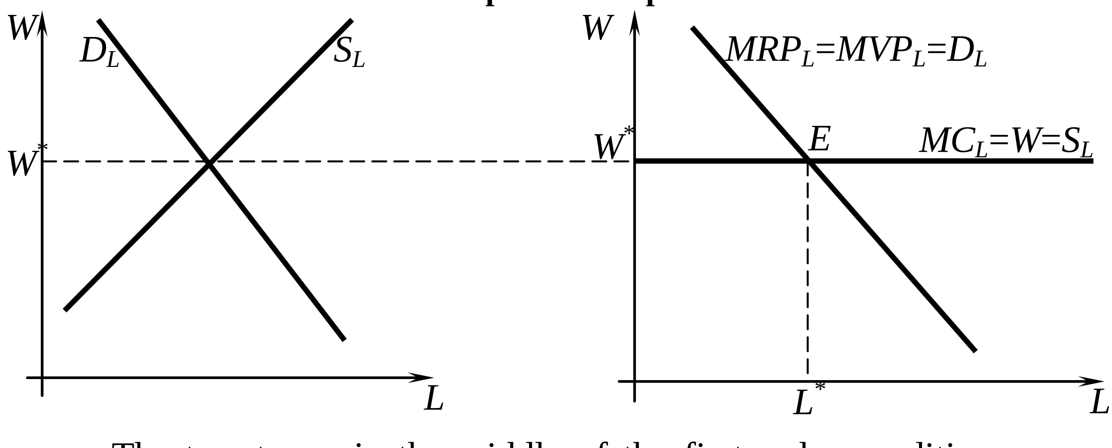
1. Perfect competition both in product and labour markets: a firm is a price (wage) taker both in the product and labour market;

2. Imperfect competition in product market and perfect competition in labour market: a firm possesses market power in a product market but is a wage taker in labour market;
3. Perfect competition in product market and monopsony in labour market: a firm is a price taker in product market but faces upward sloping labour supply curve (can get more labour only by offering higher wage);
4. Imperfect competition both in product and labour markets: a firm possesses market power both in the product and labour market.

9.3. Perfect competition at output and labour markets: marginal value product of labour and a firm's demand for labour. The demand curve for labour of a perfectly competitive industry. Equilibrium in labour market

Let's consider the first case. Suppose the perfect competition both in product and labour markets. A firm is a price-taker both in product and factor markets: $\frac{dp}{dQ} = 0$, $\frac{dw}{dL} = 0$. A firms takes as given the level of wage rate which is set at the labour market. So labour supply is absolutely elastic – it is a horizontal straight line from the stand point of a firm (see the figure below).

Labour market equilibrium and labour supply for a firm under perfect competition

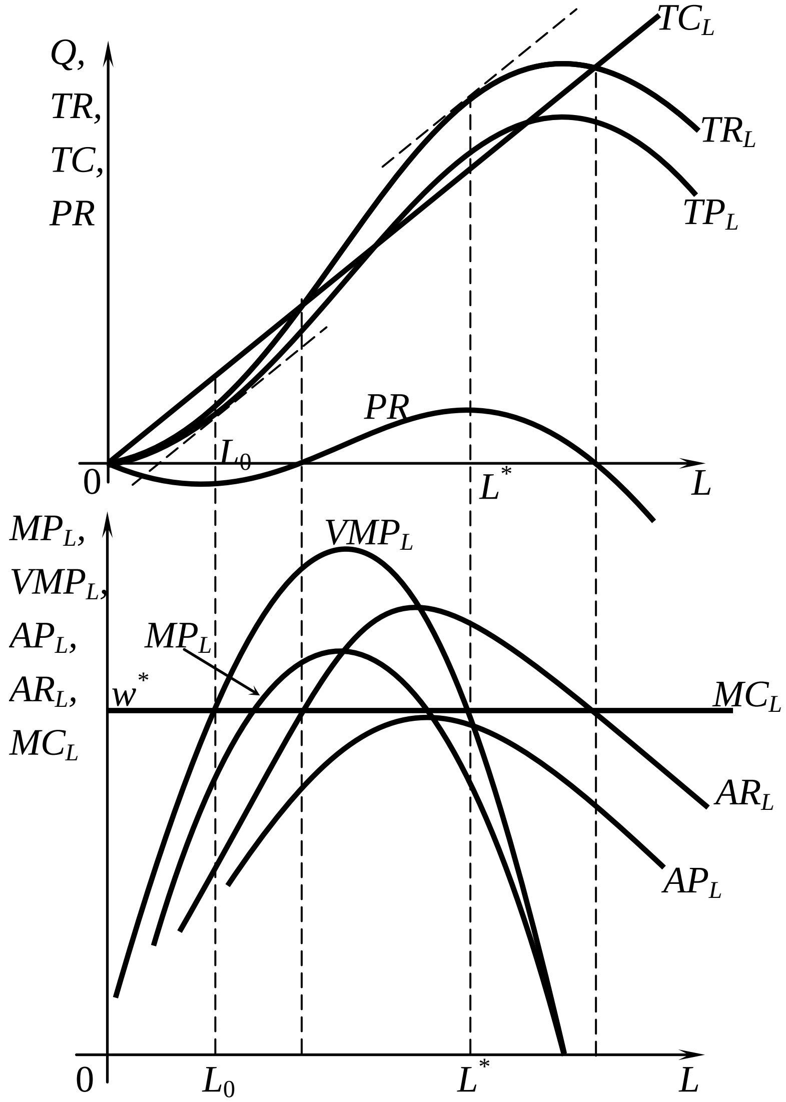


The two terms in the middle of the first order condition are zero under perfect competition in the product and factor markets. Recall that marginal revenue is equal to the market price of the product. So the first order condition in this case of combination of market structures in the product and facor markets is reduced to the equation: $\frac{dPR}{dL} = p\frac{dQ}{dL} - w = 0$, and marginal revenue product of labour turns into the product of marginal product of labour and the market price for the firm's output $\left(p\frac{dQ}{dL}\right)$ which is called marginal value product of labor ($MVP_L=p \cdot MP_L$).

So $MRP_L=VMP_L$ under perfect competition at the product market. If the labour market is perfectly competitive, $MC_L=AC_L=w$, where AC_L is a per unit labour input cost, which is equal to the market price of labour – wage rate. It follows that under perfect competition both at the product and labour market a firm will hire labour until the wage rate, which is set at the labour market, is equal to the marginal value product of labour: $w = p\frac{dQ}{dL} = p \cdot MP_L$, and a firm's demand for labour is given by the marginal value product of labour curve. Summing up: under perfect competition both at the product and labour market a firm is maximizing profit according to the rule: $w=AC_L=MC_L=MRP_L=MVP_L$.

The second order condition of profit maximization is the following: $\frac{d^2PR}{dL^2} = p\frac{d^2Q}{dL^2} < 0$. As the market price is positive ($p>0$), the derivative of the marginal product of labour is to be negative: $\frac{d^2Q}{dL^2} = MP_L' < 0$, so the law of diminishing marginal product of labour must hold (see the figure below).

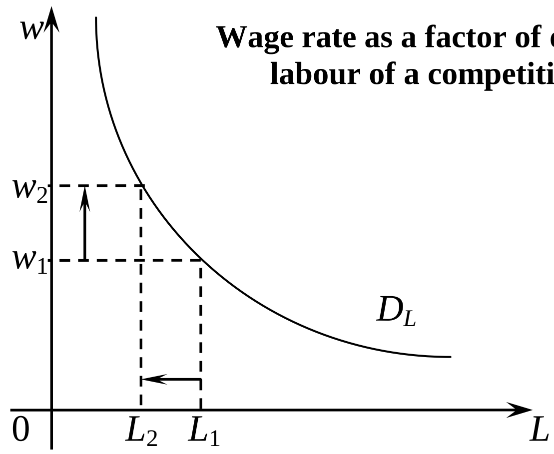
Labour input optimization by a competitive firm



Factors of a firm's demand for labour in short run are the following:

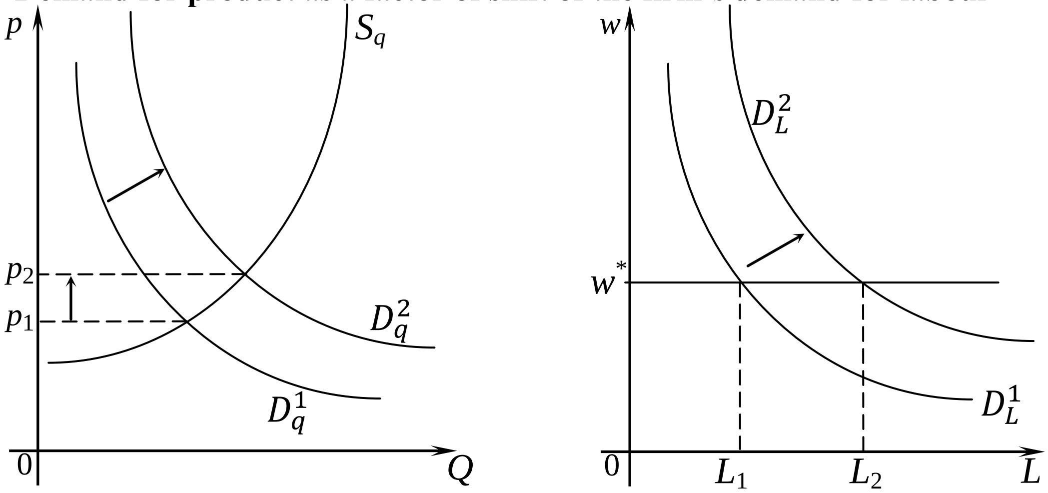
- A change in a wage rate (a shift along the demand for labour curve at the figure below);

Wage rate as a factor of demand for labour of a competitive firm



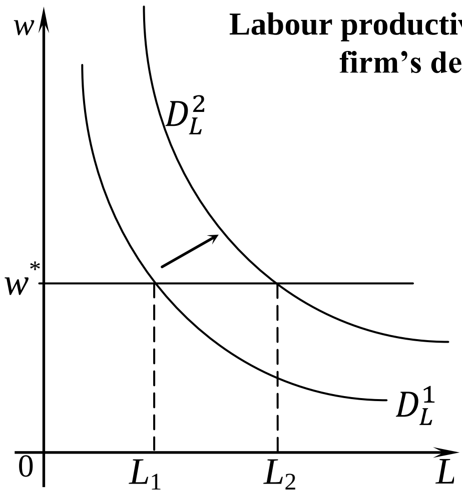
- A change in the demand for the firm's product (a shift of the demand for labour curve at the figure below);

Demand for product as a factor of shift of the firm's demand for labour



- A change in technology, i.e. marginal labour productivity (a shift of the demand for labour curve at the figure below).

Labour productivity as a factor of shift of firm's demand for labour

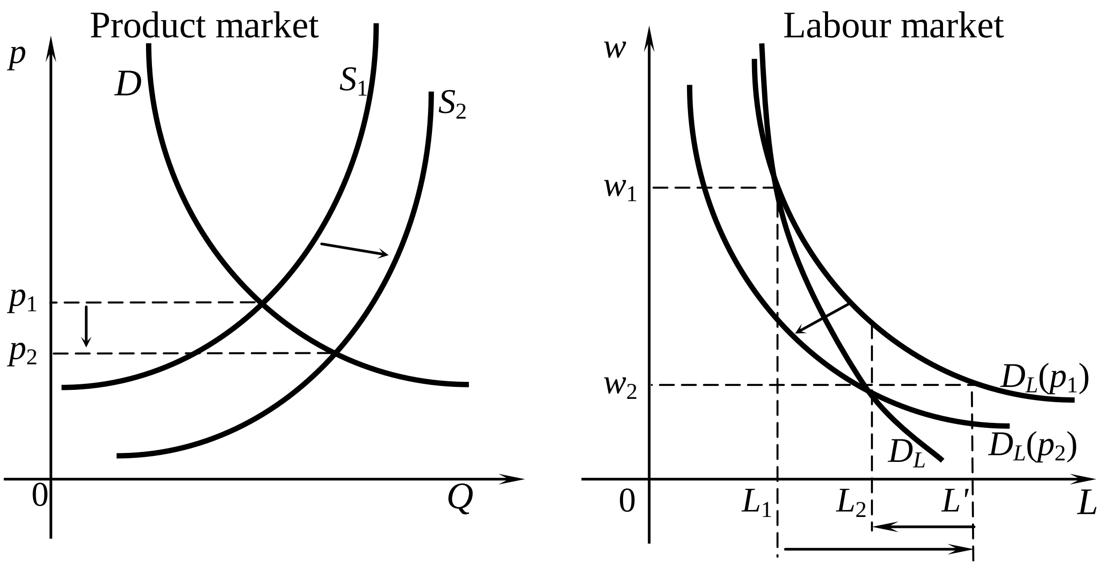


One should note that an industry demand for labour curve is not just a horizontal sum of demand curves (MVP_L) for individual firms. To obtain the industry demand for labour curve:

- Sum up demand for labour curves (MVP_Ls) of all the firms in the industry at given output price p_1 ($D_L(p_1)$ at the figure below);
- Take into consideration a change in output price at the product market (from p_1 to p_2 at the figure below) due to a change in a firm's output as a result of a fall (rise) of a wage rate, i.e. a shift of a firm's demand for labour curve;
- Sum up demand for labour curves (MVP_Ls) of all the firms in the industry at the new output price p_2 ($D_L(p_2)$ at the figure below).

The resulting industry demand for labour curve (D_L at the figure below) will go through initial (w_1,L_1) and final (w_2,L_2) equilibrium points at the industry labour market.

Industry demand for labour curve



Market demand for labour curve is the horizontal sum of demand for labou curves of all the industries that hire the given type of labour. Labour market equilibrium is the point where the market supply of labour of the given quality and type is equal to market demand for labour.

9.4. Monopoly in product market and perfect competition in labour market

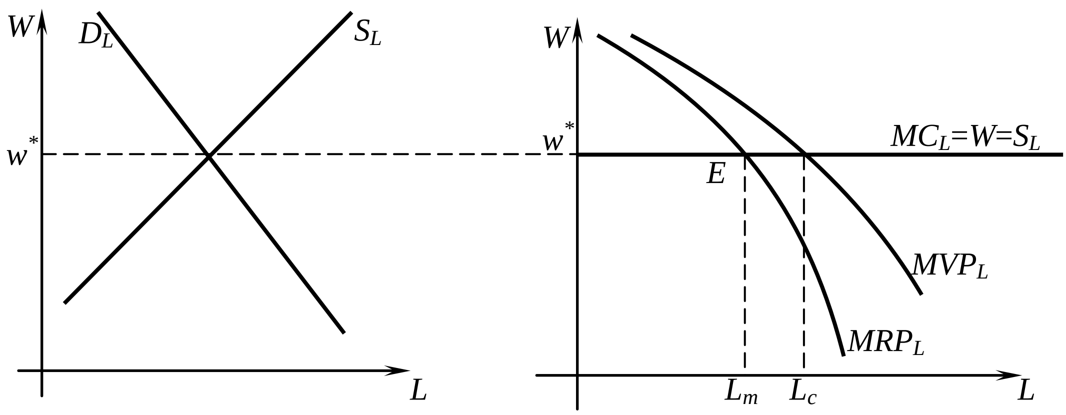
Let's now consider the second case: imperfect competition in product market and perfect competition in labour market. Suppose for simplicity that the firm is sole producer at the market, i.e. there is a monopoly. It has market power to influence the price for its product: $\frac{dp}{dq} < 0$.

In this case the first order condition of maximum of profits takes the form:

$$\frac{dPR}{dL} = \frac{dTR}{dQ}\frac{dQ}{dL} - w = MR \cdot MP_L - w = 0.$$

So to maximize profits the firm follows labour input optimization rule: $MRP_L = MR \cdot MP_L = MC_L = AC_L = w$ (see the figure below).

Monopoly in the product market which is a perfect competitor in labour market



A monopoly at a product market will hire less labour (L_m) as compared to a firm under perfect competition at a product market (L_c).

Demand for the product and its elasticity of market demand, which affect marginal revenue and limit market power, are the new factors that influences demand for labour of a monopoly in addition to the factors of labour demand mentioned above.

9.5. Perfect competition in product market and monopsony in labour market

Suppose for simplicity that there is only one employer at a labour market, i.e. there is a monopsony, which sells its product at a perfectly competitive market. The choice of this sole buyer at the labour market how much workers to hire influences the factor's price – wage rate. So a monopsony possesses market power at the labour market. The firm faces upward sloping labour supply: $\frac{dw}{dL} > 0$.

The first order condition of profit maximization in this case looks like the following:

$$\frac{dPR}{dL} = \frac{dTR}{dL} - \frac{dTC}{dL} = p\frac{dQ}{dL} - \frac{d(w(L) \cdot L)}{dL} = p \cdot MP_L - w - \frac{dw}{dL}L$$

$$= p \cdot MP_L - w\left(1 + \frac{1}{\frac{dL}{dw} \cdot \frac{w}{L}}\right) = 0.$$

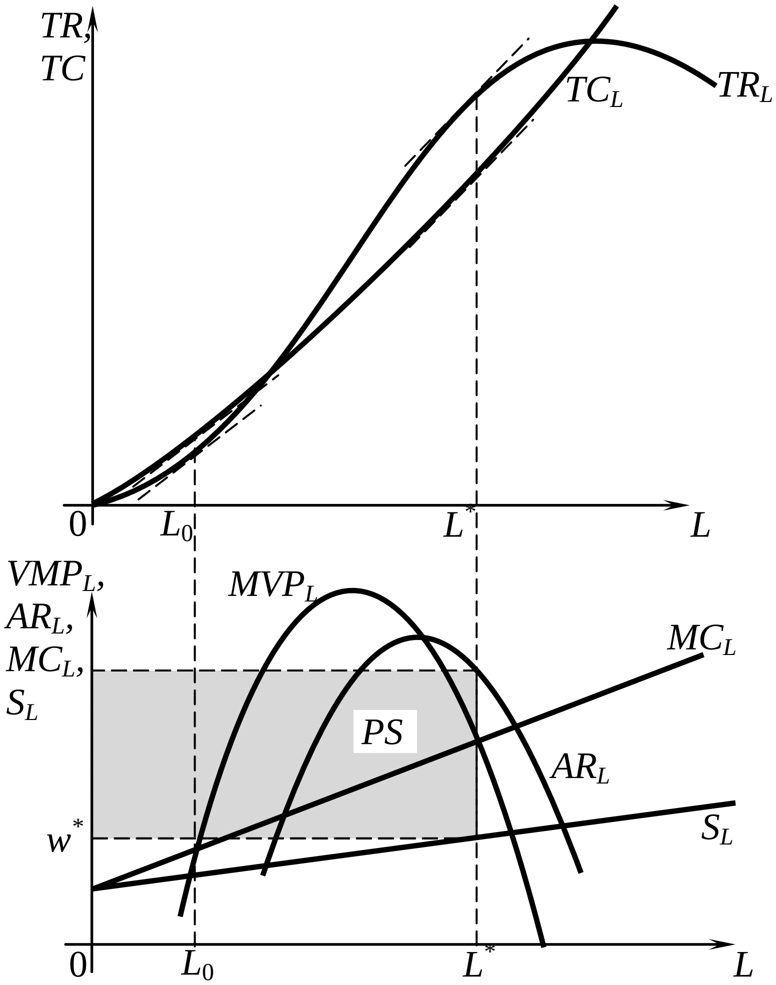
Here $w\left(1 + \frac{1}{\frac{dL}{dw} \cdot \frac{w}{L}}\right) = \frac{dTC}{dL}$ is the marginal cost of labour (MC_L), and $\frac{dL}{dw} \cdot \frac{w}{L}$ is the elasticity of labour supply (E_w^s).

So a monopsony follows the profit maximization rule (see the figure below):

$$MVP_L = p \cdot MP_L = w\left(1 + \frac{1}{E_w^{L_s}}\right) = MC_L.$$

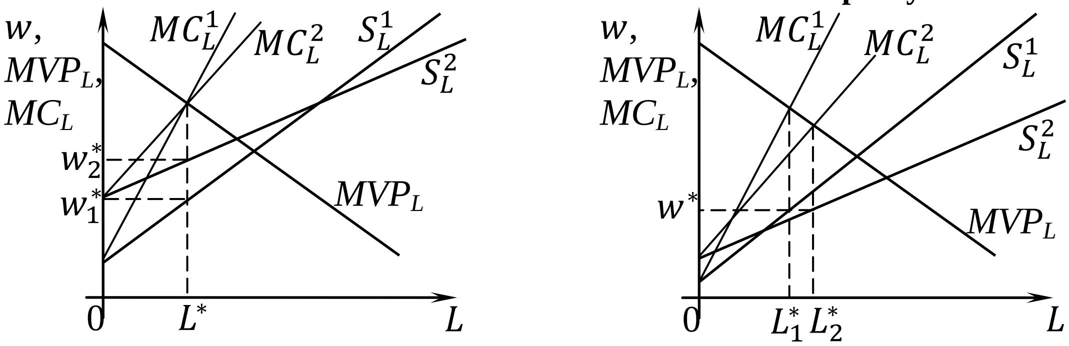
One can see that elasticity of labour supply, which is the limitation of market power, is a new factor that influences demand for labour of a monopsony. It takes the place of the wage rate among the factors of a firm's demand for labour. The other factors are the demand (price) for the product and technological shifts (changes in marginal productivity of labour).

Monopsony in labour market which is a perfect competitor at the product market



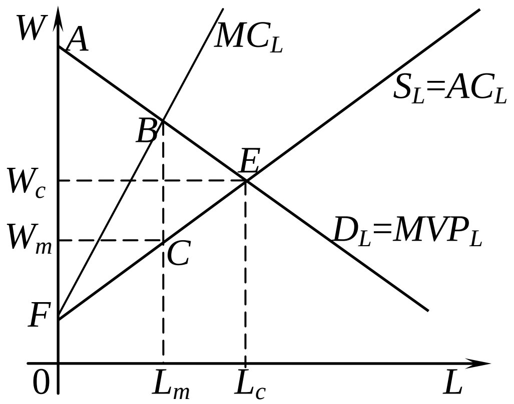
Similar to the situation of a monopoly at a product market, which lacks a supply curve (see unit 7), a monopsony has no demand for labour curve (see the two figures below).

There is no demand for labour curve with monopsony



To show relative inefficiency of monopsony as a market structure suppose that all the empoyers at a labour market have decided to collude and to form a monopsony. Suppose that initially all these firms have been perfect competitors both in the product and the labour market. Suppose that the newly born monopsony is still a perfect competitor at the product market. It follows that initially a change in aggregate output of all the firms that have colluded in the monopsony had no impact on the market price of the product. It means that in this case the industry demand for labour curve had been a horizontal sum of individual MVP_L curves. After collusion of the firms this industry demand for labour curve turns into MVP_L curve of the monopsony.

It can be easily seen from the graph below that under perfect competition at a product market the monopsony hires less labour (L_M) and pays lower wages (W_M) as compared to a perfectly competitive labour market (L_C and W_C correspondingly): $W_M<W_C$, $L_M<L_C$.



Social costs of monopsony

Let's consider welfare effects of monopsony as compared to the perfect competition in labour market.

Under perfect competition in labour market: S_{0AEL_c} is total revenue of the firms; $S_{0W_cEL_c}$ are aggregate variable production costs, and S_{W_cAE} is the producers' surplus. As concerns labour, $S_{0W_cEL_c}$ are actual wage earnings of workers, S_{0FEL_c} represents transfer earnings, and S_{FW_cE} is workers' rent. The transfer earnings of a factor of production are minimum payments required to induce that factor to work in that job. Economic rent is the extra payment a factor receives over and above the transfer earnings. So S_{FAE} shows social welfare under perfect competition in labour market.

Under monopsony: S_{0ABL_m} is total revenue of the firm; $S_{0W_mCL_m}$ are variable production costs; S_{W_mABC} is the producer's surplus; $S_{0W_mCL_m}$ shows actual wage earnings of workers; S_{0FCL_m} – transfer earnings; S_{FW_mC} – workers' rent. S_{FABC} is the social welfare.

S_{BCE} is the difference between social welfare under perfect competition and under monopsony. This is welfare loss of a monopsony.

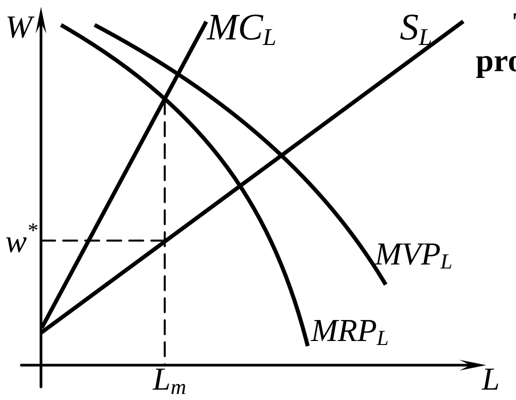
9.6. Imperfect competition both in product and labour market

Labour input optimization rule is a kind of mix of that under monopoly and monopsony:

$$\frac{dPR}{dL} = \frac{dTR}{dL} - \frac{dTC}{dL} = \frac{dTR}{dQ} \cdot \frac{dQ}{dL} - \frac{d}{dL}(w(L) \cdot L)$$
$$= \frac{dTR}{dQ} \cdot \frac{dQ}{dL} - \left(w + L\frac{dw}{dL}\right) = MR \cdot MP_L - w \cdot \left(1 + \frac{L}{w}\frac{dw}{dL}\right)$$
$$= p \cdot MP_L \cdot \left(1 + \frac{1}{E_p^d}\right) - w \cdot \left(1 + \frac{1}{E_w^{L_s}}\right) = 0,$$

i.e.:

$$MRP_L = MR \cdot MP_L = p \cdot MP_L \cdot \left(1 + \frac{1}{E_p^d}\right) = w\left(1 + \frac{1}{E_w^{L_s}}\right) = MC_L.$$



The firm is both a monopoly at the product market and a monopsony at the labour market

A monopsony at a labour market which is the sole producer of the good will hire less labour (L^M_M) and pay lower wages (W^M_M) as compared to monopsony under perfect competition at a product market (L^C_M and W^C_M correspondingly, see the figure above).

9.7. Demand and supply of capital. Equilibrium in capital market. Net present value and discounting. Interest rate

Capital markets consist of financial markets and markets for real assets.

Interest rate is determined at financial markets, where supply of loanable funds is provided by households (savers) and demand for loanable funds is required by investors (borrowers).

It is obvious that there is a difference between nominal interest rate (i) and real interest rate (r): $r = i - \pi$, where π is inflation rate. This is the so called Fisher's law. Still from now on we shall neglect the differerence between nominal and real interest rates, i.e. we are going to suppose that there is no inflation.

Temporal aspect of decision making is one of the most important factor at the markets for real assets. Value of an asset next year is equal to (1+r)*PV, where PV is the present value of the asset. It follows that $\text{Present value} = \frac{\text{Value next year}}{1+r}$. Denote by FV the future value of the asset t years from now and apply the above consideration t times to get: $FV=PV(1+r)^t$. Consequently,

$$PV = \frac{FV}{(1+r)^t}.$$

Net present value of an asset is given by the following expression:

$$NPV = R_0 - C_0 + \frac{R_1 - C_1}{1+r} + \frac{R_2 - C_2}{(1+r)^2} + \cdots + \frac{R_T - C_T}{(1+r)^T},$$

i.e.

$$NPV = \sum_{t=0}^{T} \frac{R_t - C_t}{(1+r)^t},$$

where R_t is rental in year t, C_t are costs in year t (investment and maintenance).

It pays to invest money in an asset if the asset price is greater than the present discounted value of its net income stream.

Consider value of a perpetuity to have an example of NPV of an asset. Suppose R_t =R=const is the annual rental, C_t=0, and T=∞ to get:

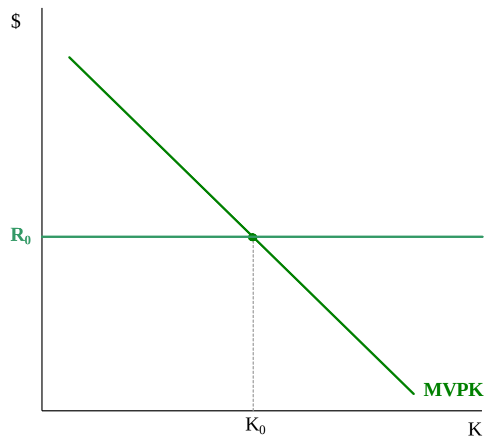
$$NPV = \frac{R}{1+r} + \frac{R}{(1+r)^2} + \cdots + \frac{R}{(1+r)^t} = \frac{R}{r}.$$

Let's now consider the relationship between asset prices, rental payments and interest rates taking into consideration depreciation of assets. Let P_A be price of an asset, R – annual rental, C – annual maintenance costs, r – real interest rate, δ –depreciation rate. Required rental on capital is rental payment that would just cover the costs.

Let's suppose that an entrepreneur borrows to invest in projects that would yield return in future. In this case interest rate is the price of borrowing for investors. Investment in real and financial assets should yield at least the same return: $R - C + (1 - \delta)P_A \geqslant P_A(1 + r)$. This gives the equilibrium price of an asset:

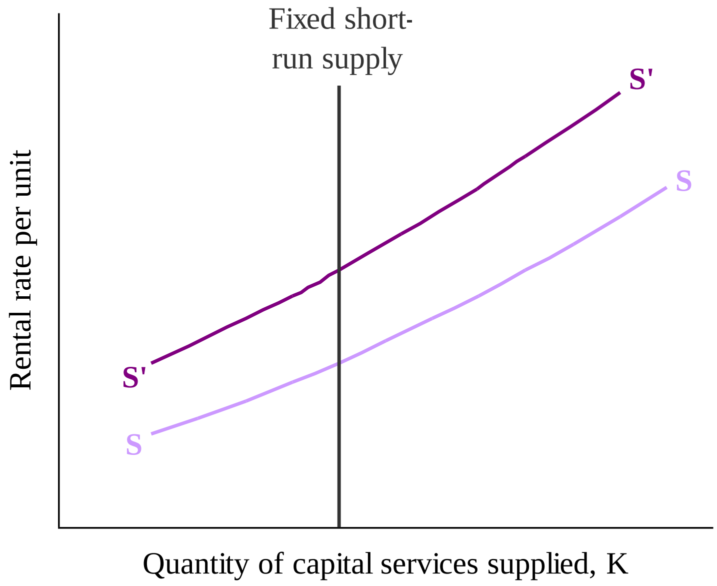
$$P_A = \frac{R - C}{\delta + r}.$$

The laws that are similar to those that govern demand for labour can be applied to demand for capital services. Let's consider perfectly competitive output market and perfectly competitive capital market. Capital input optimization rule is: $MVP_K = R$., where $MVP_K = MP_K * P$ is the marginal value product of capital (see the figure below).

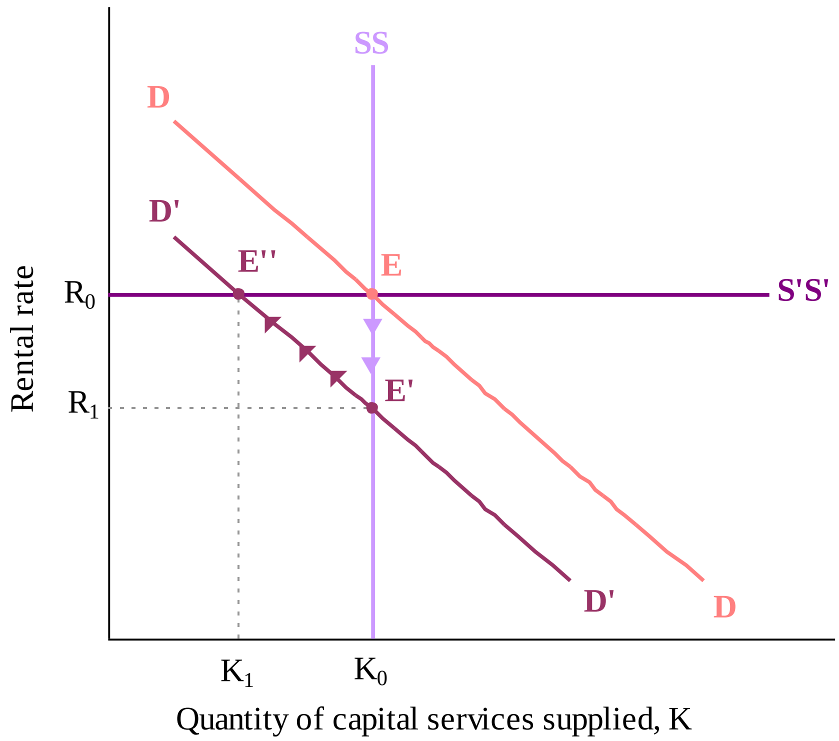


So MVP_K curve gives the demand for capital services by individual firm. As with demand for labour, elasticity of demand for capital services depends on the elasticity of demand for industry's output (derived demand). The industry demand for capital services can be derived from demands of individual firms as we derived the market demand for labour.

Supply of capital services to the economy is fixed in the short run but can be varied in the long run. Long-run supply curve to a large industry is upward-sloping. An increase in the real interest rate yields a shift of long run supply of capital services (from S to S' curve at the figure below).



The slope of the supply curve depends on size of the industry: long-run supply curve to a small industry is horizontal. Market for capital services puts together supply provided by owners of capital and demand of firms renting capital. Market for Capital Services determines rental rate for capital services and hours rented. Short-run and long-run equilibrium in the market for capital services in case of a small industry is presented on the figure below.



9.8. Wage differentials: discrimination and human capital

Compensating wage differentials is the difference in the wage rate that reflects attractiveness of a job's working conditions. Discrimination means different treatment of people whose relevant characteristics are identical.

Investment in human capital is another source of wage differentials. Human capital is the stock of knowledge and skills accumulated by a worker to enhance future productivity. Investment in human capital may take the form of:

- education;
- training and on-the-job training;
- experience.

The investment decision is taken it means that benefits of getting more education outweight the corresponding costs (see the figure below). The benefits are:

- higher future earnings (discounted for present value),
- fun going to school.

The corresponding costs include:

- direct costs: tuition, books,… (minus grants and subsidies)
- opportunity costs: forgone income