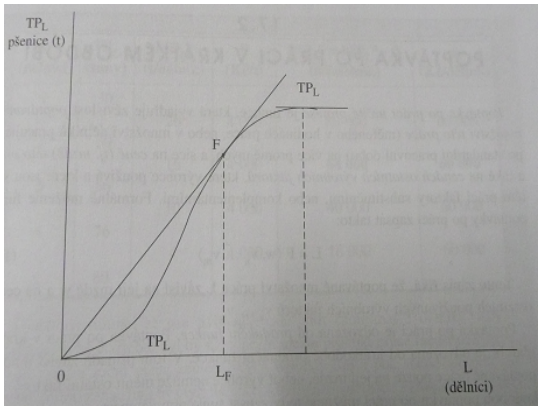
10 D/S of/for Labor

10.1 Demand for Labor

Demand for labor is determined by production function. In short run production function is function of only one variable (labor) remaining factors are fixed (capital). The productivity of a production function can be described by **Average productivity** and **Marginal productivity**. Average product is given by the ratio of total product of labor and number of units of labor used:

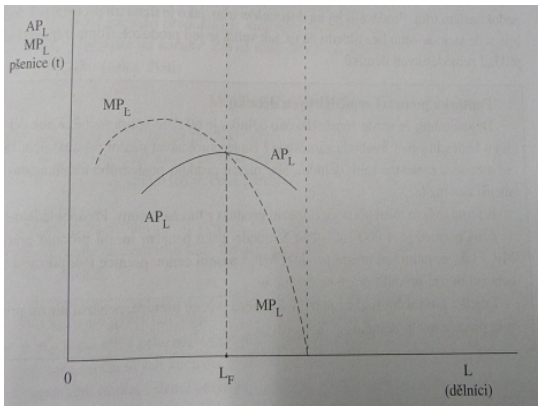
$$AP_L = \frac{TP_L}{L}$$

On the picture below we have a production function of labor. We can find an average product at a given level of labor used L_F by drawing the line between the origin and point F. Average product of labor is then the slope of this line.



Marginal product is a derivative of production function at a given level of labor used. Graphically, marginal product is the slope of a tangent to a production function at a given point.

On the picture below we have depicted both average product and marginal product curve. We see that they intercept at the the maximum of average product curve. AP curve has to be increasing while MP lies above AP and it has to decrease if MP is below AP. (Note that this situation is similar to marginal cost curve intercepting average cost curve at its minimum.)



Demand for labor depends on the price of labor, price of output and production function. In optimum a firm employs so many units of labor (number of workers) so that the value of marginal product of labor equals the wage. Look at the following example:

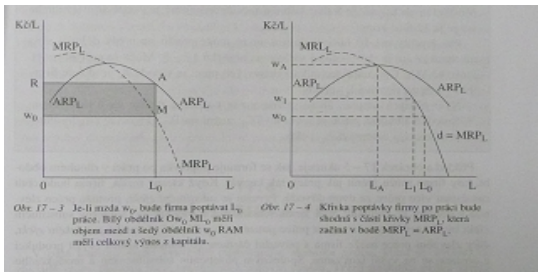
L (dělníci)	TP_L (tuny)	MP_L^n (t/dělník)	P (Kč/t)	$MP_L P = MP_L^n \cdot P$ (Kč/dělník)	w (Kč/dělník)
1	30				
		20	4 000	80 000	60 000
2	50				
		16	4 000	**64 000**	**60 000**
3	66				
		10	4 000	40 000	60 000
4	76				
		4	4 000	16 000	60 000
5	80				

From the data in the table it follows that this firm should hire three employees. It is so because hiring third employee will increase the profit by 64 000 and the wage of the worker is lower - 60 000. If the firm hires one more worker the fourth worker would bring profit of 40 000 but his wage would have to be higher - 60 000. So profit maximizing firm would hire three workers. If wage decreases below 40 000 it would be optimal to hire four workers. If the wage increases above 64 000 it would be better to hire only two workers.

In other words, the firm chooses to hire so many works that the revenue from marginal product of labor equals wage:

$$MRP_L = MP_L \times MR = w$$

This situation is illustrated on the picture below. If the wage is w_0 that the optimal choice for a firm is to employ L_0 workers. The revenue is a shaded rectangle.

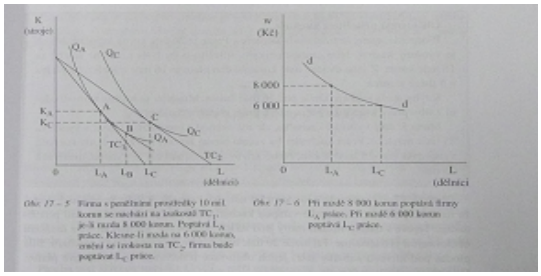


Obr. 17 – 3 Je-li mzda w_0, bude firma poptávat L_0 práce. Bílý obdélník Ow_0, ML_0, ukazuje objem mezd a šedý obdélník w_0 RAM měří celkový výnos z kapitálu.

Obr. 17 – 4 Křivka poptávky firmy po práci bude shodná s částí křivky MRP_L, která začíná v bodě $MRP_L = ARP_L$.

If the wage increases the optimal level of labor decreases as the worker are more expensive to hire. The demand for labor is actually identical with MRP_L curve. But only up to the point where wage become to high. If the wage is higher than w_A firm will stop hiring any workers because the wage is higher than average revenue from a unit of labor which means that the firm is losing money. In this case it's better to stop production.

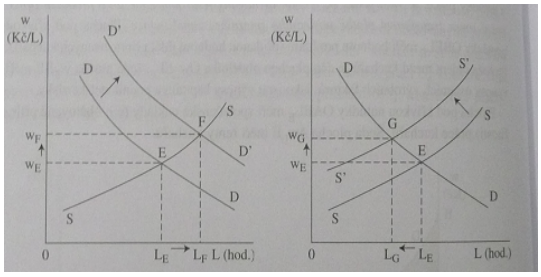
Up to now we analyzed short-run demand for labor. In short-run all factors of production apart from labor are fixed. Now we will analyze the demand for labor in long-run. In long-run all factors of production can be changed. The intuition is the same - if wage increases a firm will hire less workers. The difference between short- and long-run is the motives for this change. In short run decreasing demand for labor is caused be decreasing revenue from marginal product of labor. In long-run decreasing demand for labor is caused by substitution and production effect (similar to substitution and income effect in consumer optimization problem). This situation is depicted on the picture below.



10.2 Supply of Labor

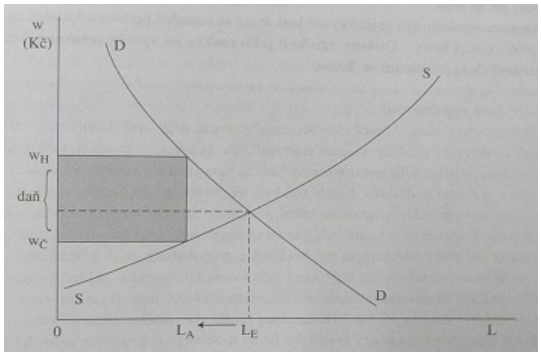
Supply of labor was discussed previously. We analyzed individual behavior when choosing between the labor (or complementary leisure) and consumption. The market supply curve is sum of individual choices and this curve is increasing.

Market equilibrium minimum wage and taxes: The equilibrium wage on the market is determined by the point where the supply and demand for labor intercept. Changes in equilibrium can be caused by changes in demand or supply. If the demand for production increases the demand for labor increases as well and as a result the equilibrium wage increases as well. Look at the left hand side of the picture.

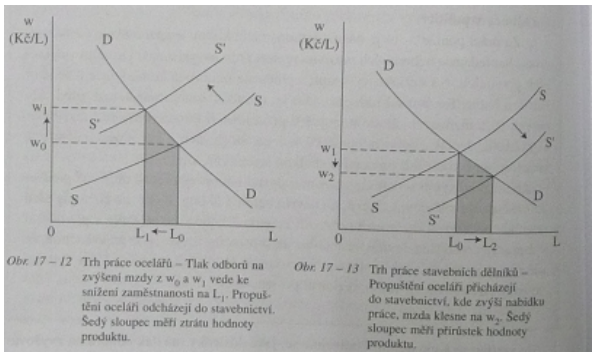


If the wages in neighbor countries increase significantly and it is simple to work abroad or if the wages in similar industries increase the supply of labor curve moves upward and as a result the equilibrium wage increases. see the right hand side picture above.

Now we will illustrate the effect of **income tax** on equilibrium wage and number of workers hired. In the Czech Republic the income tax is 15 - 32%. The situation is depicted on the picture below. With no taxes the equilibrium employment rate is L_E. After the income tax is introduced the equilibrium employment decreases to L_A.



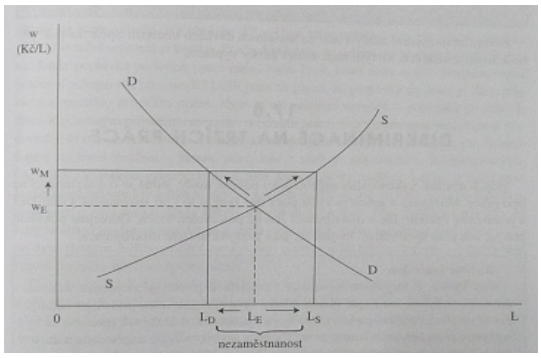
Now we analyze the effect of **unions**. Imagine that unions negotiate the wage increase in a particular industry from w_0 to w_1. Firms are forced to pay more to their workers and as a result the equilibrium employment decreases (left picture below). Those workers who no longer have a job in a given industry will go to other industries which means that the supply curve shifts to the right and as a result the equilibrium wage in the second industry goes down (right picture).



Obr. 17 – 12 Trh práce ocelářů – Tlak odborů na zvýšení mzdy z w_0 a w_1 vede ke snížení zaměstnanosti na L_1. Propuštění oceláři odcházejí do stavebnictví. Šedý sloupec měří ztrátu hodnoty produktu.

Obr. 17 – 13 Trh práce stavebních dělníků – Propuštění oceláři přicházejí do stavebnictví, kde zvýší nabídku práce, mzda klesne na w_2. Šedý sloupec měří přírůstek hodnoty produktu.

The **minimum wage** also has an impact on the level of employment. If the minimum wage is introduced and it is higher than the equilibrium wage than as a result supply of labor is higher than demand and the unemployment is present.



11 D/S of/for Capital

Similarly to decision about the demand for labor a firm will use the level of capital such that the revenue from marginal product of capital equals its price.

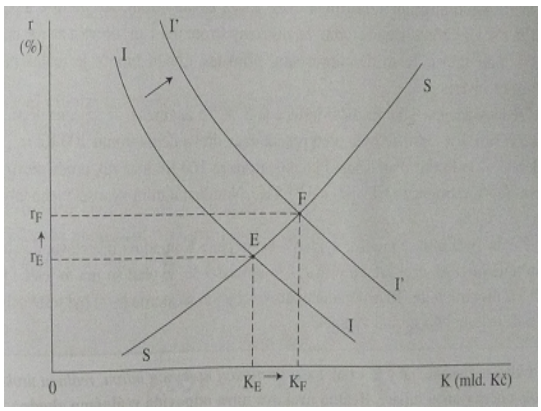
$$MRP_K = v$$

where $v = R + D$, R is the forgone interest and D is depreciation or

$$v = rP + dP$$

where P is the price of the capital (machine), r is interest rate, and d is depreciation rate.for labor.

As the interest rate increases the demand function for capital decreases and supply increases. The equilibrium interest rate is given by their intercept.



The picture above illustrates the situation when the investment environment improves, i.e. there are better investment opportunities. This means that firms want to rent more capital and as a result the the demand curve shifts upwards. The new equilibrium interest rate is higher.

Nominal vs Real interest rate: we have to distinguish between nominal interest rate which measures change in monetary value of capital and real interest rate which measure change in real value of capital.

In other words, the nominal interest rate is the amount, in money terms, of interest payable. For example, suppose a household deposits \$100 with a bank for 1 year and they receive interest of \$10. At the end of the year their balance is \$110. In this case, the nominal interest rate is 10% per annum.

The real interest rate, which measures the purchasing power of interest receipts, is calculated by adjusting the nominal rate charged to take inflation into account. If inflation in the economy has been 10% in the year, then the \$110 in the account at the end of the year buys the same amount as the \$100 did a year ago. The real interest rate, in this case, is zero.

The relationship between nominal and real interest rate is:

$$r_N = r_R + i_e$$

where r_N is nominal interest rate, r_R is real interest rate, and i_e is expected inflation.

Choice of Investment Projects: there are usually several investment possibilities available. How do we decide where to invest free capital? We choose the project with the highest value. The value of project is the present value of all future returns where future returns are discounted to the present date.

Net present value, NPV, is an indicator of how much value an investment or project adds to the value of the firm. In financial theory, if there is a choice between two mutually exclusive alternatives, the one yielding the higher NPV should be selected.

Example: A corporation must decide whether to introduce a new product line. The new product will have startup costs, operational costs, and incoming cash flows over six years. This project will have an immediate (t=0) cash outflow of \$100,000 (which might include machinery, and employee training costs). Other cash outflows for years 1-6 are expected to be \$5,000 per year. Cash inflows are expected to be \$30,000 per year for years 1-6. All cash flows are after-tax, and there are no

cash flows expected after year 6. The required rate of return is 10%. The present value (PV) can be calculated for each year:

Year	Cashflow	Present Value
T=0	$\frac{-100,000}{(1+0.10)^0}$	-$100,000
T=1	$\frac{30,000-5,000}{(1+0.10)^1}$	$22,727
T=2	$\frac{30,000-5,000}{(1+0.10)^2}$	$20,661
T=3	$\frac{30,000-5,000}{(1+0.10)^3}$	$18,783
T=4	$\frac{30,000-5,000}{(1+0.10)^4}$	$17,075
T=5	$\frac{30,000-5,000}{(1+0.10)^5}$	$15,523
T=6	$\frac{30,000-5,000}{(1+0.10)^6}$	$14,112

The sum of all these present values is the net present value, which equals $8,881.52. Since the NPV is greater than zero, it would be better to invest in the project than to do nothing, and the corporation should invest in this project if there is no alternative with a higher NPV.

Return vs Risk Investment opportunities bring different returns at different level of risk. More risky opportunities yield higher return.

Example: An individual can invest into stocks or bonds. Stocks are supposed to bring 20% return but the investment is risky and this happens only with 50% probability. On the other hand investment into bonds is safe and yields 8% return with 95% probability. The expected return is as follows:

$$ER_B = 0.08 \times 0.95 = 0.076, \quad \text{i.e.} \quad 7.6\%$$
$$ER_S = 0.2 \times 0.5 = 0.1, \quad \text{i.e.} \quad 10\%$$

We see that expected return of investment into stocks is higher. However, this investment is risky and some investors would prefer bonds to stocks.