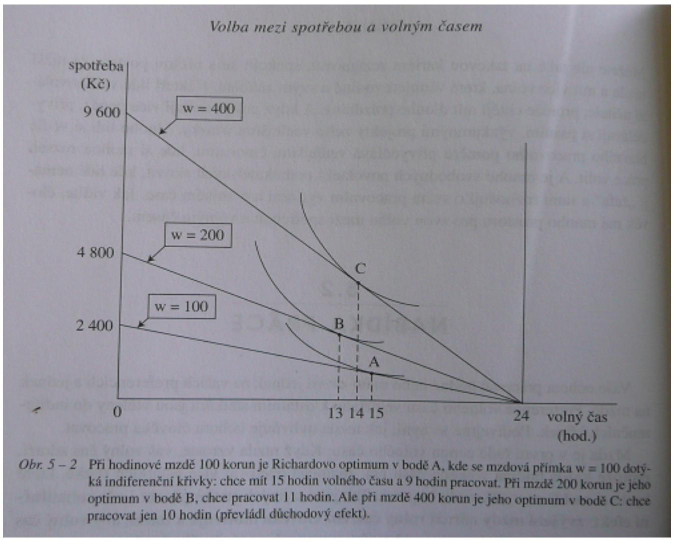
3 Intertemporal Choice, Risk, Uncertainty

3.1 Choice between leisure and consumption

We discussed the choice between two goods. Similarly, we can illustrate the choice between leisure and consumption. Leisure can be considered as a normal good. Loosely speaking the price of leisure is forgone earnings, i.e. money that consumer could earn if he spent time working instead of enjoying leisure time. The optimal choice of consumption and leisure is a combination where the indifference curve touches the budget line. This choice depends on the wage. If wage increases we can observe substitution effect (leisure becomes more expensive relative to consumption and should be substituted by working time and hence higher consumption) and income effect (we assume that both "consumption" and "leisure" are normal goods $\Rightarrow$ higher income leads to higher consumption of both goods and hence more leisure). The new optimal choice depends on which of the two effects is stronger:



Obr. 5 – 2 Při hodinové mzdě 100 korun je Richardovo optimum v bodě A, kde se mzdová přímka w = 100 dotýká indiferenční křivky: chce mít 15 hodin volného času a 9 hodin pracovat. Při mzdě 200 korun je jeho optimum v bodě B, chce pracovat 11 hodin. Ale při mzdě 400 korun je jeho optimum v bodě C: chce pracovat jen 10 hodin (převládl důchodový efekt).

3.2 Intertemporal choice (choice between current and future consumption)

So far we only studied static choices, but life is full of intertemporal choices (should I study for my test today or tomorrow; should I save or should I consume now, school, cigarettes, alcohol). When modeling intertemporal choice, economists treat one physical good consumed at two different times as two different goods.

We consider in this lecture the optimal allocation decision through time. In particular, we examine the optimal allocation of income to consumption through time. This is important as people often receive the income through time in a way that does not correspond to their preferred consumption stream through time. The individual needs to rearrange his or her income stream. This is achieved by borrowing and saving - through the use of capital markets. We assume here perfect capital markets, by which is meant that the individual can borrow and save as much as he or she wants at a constant and given rate of interest, which we shall denote by r . If the rate of interest is 10% then r = .1; if the rate of interest is 20% then r = .2; and so on. To keep our analysis simple we assume a two period world. Each individual gets current income I_a and expected future income I_b and we denote current consumption C_a and future consumption C_b. (For simplicity we assume a single consumption good and assume a price of 1 in both periods.) It may be the case that the individual is happy to currently consume his or her income I_a and to consume his or her income I_b in future. However, the individual may prefer to rearrange his or her consumption by borrowing or lending. If r is zero the possibilities are obvious: the maximum he or she could consume now is $I_a + I_b$ with zero consumption in future and the maximum he or she could consume in future is the same. More generally the choice of C_a and C_b must satisfy the budget constraint:

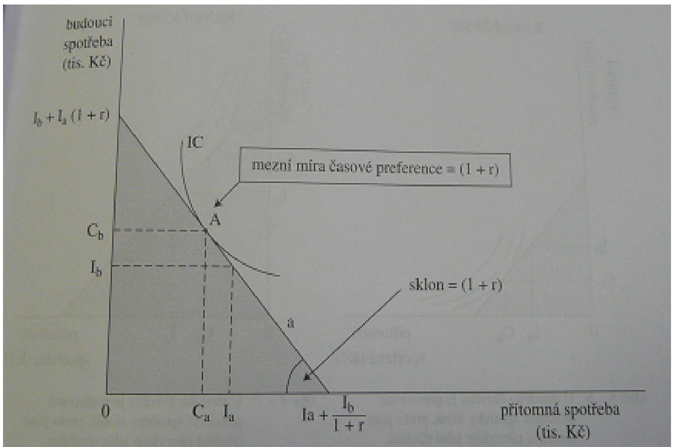
$$C_a + C_b = I_a + I_b$$

If there is a positive rate of interest things are a little more complicated. If the individual wanted to consume nothing now then he or she could save the income I_a, investing it at the rate of interest r, earning interest rI_a and thus in future having

$$I_a(1 + r) + I_b$$

Alternatively if he or she wanted to consume nothing in future, then now he or she could spend his current income plus what he or she could borrow on the strength of being able to pay back in future.

$$I_a + I_b/(1 + r)$$



Obr. 6 – 5 Přítomný důchod spotřebitele je I_a a jeho budoucí důchod je I_b. Úroková míra je r. Sklon přímky spotřebních možností je (1 + r). Optimum spotřebitele je v bodě A, spotřebovává C_a v přítomnosti a C_b v budoucnu. Mezní míra jeho časové preference v bodě optima je rovna (1 + r).

Generally, the future value of the consumption stream must equal the future value of the income stream:

$$C_a(1 + r) + C_b = I_a(1 + r) + I_b$$

Alternatively, the present value of the consumption stream must equal the present value of the income stream:

$$C_a + C_b/(1 + r) = I_a + I_b/(1 + r)$$

Change of interest rate r: changes the slope of budget constraint. Substitution effect (current consumption is more expensive) $\Rightarrow$ higher savings. Income effect (increase in future income) $\Rightarrow$ higher current consumption. The total effect depends on the shape of indifference curves, i.e. on whether substitution effect is stronger than income effect or vice versa.

3.3 Risk, Uncertainty

So far we assumed that people's choices are not uncertain - once they decide how to spend their income, they get what they want. However, very often this is not true and people makes choices that involve incomplete information (unknown quality of used car, future value of investment,...) These events have not certain outcome but *expected outcome (expected value.)*

Example: Suppose that a consumer currently has \$10 of wealth and is contemplating a gamble that gives him a 50 percent probability of winning \$5 and a 50 percent probability of losing \$5. His wealth will therefore be random: he has a 50 percent probability of ending up with \$5 and a 50 percent probability of ending up with \$15. The *expected value* of his wealth is:

$$\frac{1}{2} * \$5 + \frac{1}{2} * \$15 = \$10$$

Generally,

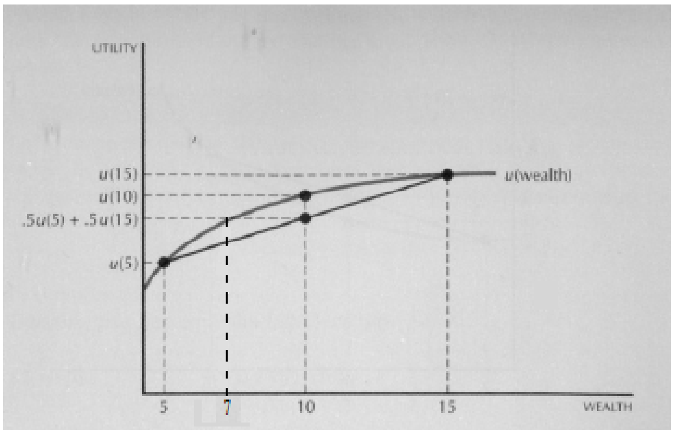
$$R_E = \sum \pi_i R_i,$$

where R_i are possible outcomes and π_i are their probabilities.

When there are several alternatives we could think that the individual should choose the alternative with the highest expected value. Is this always the case? Imagine a lottery where with 50% probability you win \$90 and with 50% probability you win \$110. The expected value is \$100. Now imagine a lottery where with 99% probability you win \$1 and with 1% probability you win \$10001. The expected value is \$101. So you should choose the second lottery. However, most of people would prefer the first lottery to the second one. The reason is that people do not compare expected values, they compare expected utilities and in general people are risk averse and the second lottery is much riskier than the first one.

In the example above the *expected utility* is:

$$\frac{1}{2}u(\$5) + \frac{1}{2}u(\$15)$$



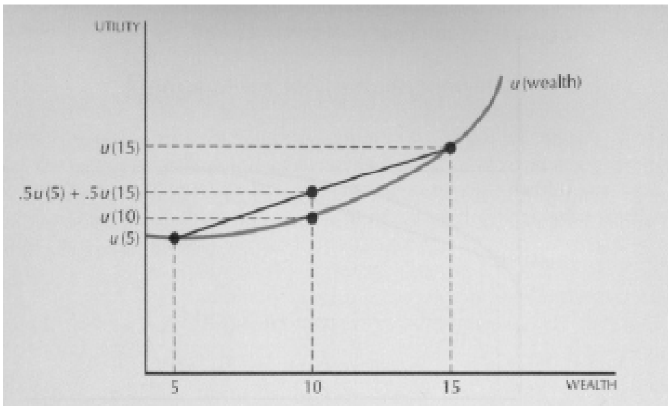
Risk aversion. For a risk-averse consumer the utility of the expected value of wealth, $u(10)$, is greater than the expected utility of wealth, $.5u(5) + .5u(15)$.

Note that in this diagram the expected utility of wealth is less than the utility of the expected wealth:

$$u\left(\frac{1}{2} * \$5 + \frac{1}{2} * \$15\right) = u(\$10) > \frac{1}{2}u(\$5) + \frac{1}{2}u(\$15)$$

In this case, consumer is **risk averse** since expected value is preferred to gamble.

It could happen that the consumer prefers a a random distribution of wealth to its expected value, in which case we say that the consumer is a **risk lover**.



Risk loving. For a risk-loving consumer the expected utility of wealth, $.5u(5) + .5u(15)$, is greater than the utility of the expected value of wealth, $u(10)$.

The intermediate case is that of a linear utility function. Here the consumer is **risk neutral**: the expected utility of wealth is the utility of its expected value. In this case the consumer doesn't care about the riskiness of his wealth at all-only about its expected value.

3.4 Insurance against risk

Risk premium: maximum amount of money that an individual is willing to pay in order to avoid the gamble. Risk-averse individual in example above is willing to pay up to \$3 to avoid the gamble, therefore the risk premium is \$3. If someone offers this individual insurance against the uncertainty; i.e. insurance company offers to keep individual's wealth constant and the price of this insurance is at most \$3 the individual buys this insurance.

The expected utility is the same whether the individual gets the insurance or not. Then why is the individual willing to buy it in the first place? Because when there is no insurance, marginal utility in the event of loss is higher than if no loss occurs (because of diminishing marginal utility of risk-averse individual). Hence, the transfer from no-loss to the loss situation must increase total utility.

3.5 Diversification

Suppose, for example, that shares of the raincoat company and the sunglasses company currently sell for \$10 a piece. If it is a rainy summer, the raincoat company will be worth \$20 and the sunglasses company will be worth \$5. If it is a sunny summer, the payoffs are reversed: the sunglasses company will be worth \$20 and the raincoat company will be worth \$5. If you invest your entire \$100 in the sunglasses company, you are taking a gamble that has a 50 percent chance of giving you \$200 and a 50 percent chance of giving you \$50. The same magnitude of payoffs results if you invest all your money in the sunglasses company: ill either case you have an expected payoff of \$125. But look what happens if you put half of your money in each. Then, if it is sunny you get \$100 from the sunglasses investment and \$25 hom the raincoat investment. But if it is rainy, you get \$100 from the raincoat investment and \$25 hom the sunglasses investment. Either way, you end up with \$125 for sure. By diversifying your investment in the two companies, you have managed to reduce the overall risk of your investment, while keeping the expected payoff the same.

Diversification was quite easy in this example: the two assets were perfectly negatively correlated- when one went up, the other went down. Pairs of assets like this can be extremely valuable because they call reduce risk so dramatically. But, alas, they are also very hard to find. Most asset values move together: when GM stock is high, so is Ford stock, and so is Goodrich stock. But as long as asset price movements are not perfectly positively correlated, there will be some gains from diversification.