How to Estimate the Profitability of an Investment Project?

TU-A1300 - Introduction to Industrial Engineering and Management

Jouko Karjalainen

Aalto University
School of Science
Industrial Engineering and Management

- The previous lecture concerned financial statements, which are summaries of numerous historical financial transactions, i.e., information of past performance for stakeholders inside and outside the company.
- In decision-making, managers try to estimate what will be the financial consequences of planned actions. For both purposes, we use the same key concepts, but we must rely on estimates in planning and decision-making. Fortunately, we do not need all the concepts introduced in the context of the financial statements.
- Investment decision is the context where net present value (NPV) is applied. It is the most important measure of investment's profitability.

Learning Objectives

- Explain the generic features of models supporting decision-making
- Understand the concept of Net Present Value (NPV) and related concepts of
  - Free Cash Flow (FCF)
  - Discounted Cash Flow (DCF) and Present Value (PV)
  - Opportunity Cost of Capital
  - NPV's relation to the value of the firm's business operations
- Be able to apply NPV in a straightforward case
  - Identify the challenges in estimating FCF
  - Understand the key concepts of Cost-Volume-Profit (CVP) analysis

The pre-lecture material introduced NPV, and its role in decision-making. This lecture adds more detail to the pre-material. An important new concept is the opportunity cost of capital, which you need to understand in order to choose an appropriate discount rate (r).

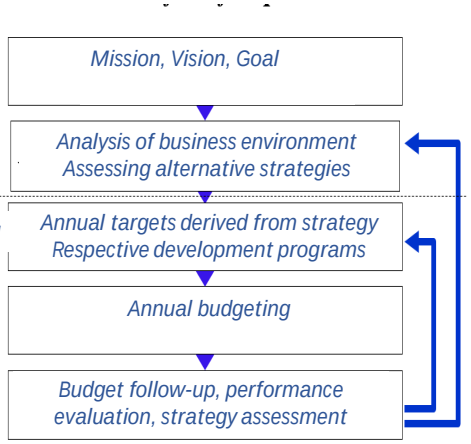
NPV connects the value of the investment and the value of the firm.

One of the course objectives is to learn how to apply NPV and closely related techniques in straightforward (non-complex) situations.

Preparing estimates is one step in calculating NPV. In the group assignment of the course, you will face this problem. Basically, one learns to estimate through experience. Fortunately, there are helpful tools and techniques.

1. Financial planning

- Based on a business and operation plan concerning a future period
  - What are the financial consequences of the planned actions
- Annual Budgeting
  - Budgeted income statement, balance sheet and cash flow
  - The most important elements to assess the achievement of the planned targets
  - Monthly figures to ease monitoring (feedback)
- The model for financial plans should
  - Describe the connection of targeted revenue and the costs (resources) required to produce the revenue
  - All models are simplifications of reality. Users must be aware of the assumptions made in the model
  - For example, Cost-Volume-Profit Analysis (CVP)



Business planning is about actions that need to be taken to reach the intended goals. Plans can be made for different time frames. Long-range planning considers the expected changes in the business environment and specifies the strategic actions for the near future. Budgeting typically concerns the next year.

Estimated financial figures are based on the action to be taken. The causes and effects are not always unambiguous, but the calculations should reflect the logic of the action plans.

In order to estimate the financial consequences of actions, we need a model that describes the relationships between benefits and costs (delivered production and required resources). All models are incomplete projections of reality. Therefore, users of a model must be aware of the simplifications and limitations of the model.

Iteration is typical for planning. The first calculations are rough estimates that become more detailed as the planning process continues. The final estimates can be used as target values, against which we compare to actual figures.

The following slides offer a simple example of planning in financial terms.

A Planning Problem

- Large shopping center
  - 1 million visitors per month
  - 200 shops, 60 000 m^2
- The Mystic Boutique
  - 100 m^2, Pays rent 7 000 €/month
  - Open 7 days a week
  - Costs of attendants 5 000 €/ month
  - Sales margin 50 % (= $1 - \frac{Purchase\ price}{Selling\ price}$)
  - Initial investment 48 000 €
    - Entrepreneur's share 50 %
    - A three-year loan for the rest, 5 % interest rate
  - Estimated net sales 540 000 €/a

Revenue	540,000	100 %
Purchase costs	-270,000	50 %
Sales margin	270,000	50 %
Personnel costs	-60,000	-11 %
Rent	-84,000	-16 %
EBITDA	126,000	23 %
Depreciation	-16,000	-3 %
EBIT	110,000	20 %
Interest	-1,200	0 %
Profit before tax	108,800	20 %
Income tax (20%)	-21,760	-4 %
Net profit	87,040	16 %

An entrepreneur plans to start The Mystic Boutique and rent premises in a large shopping center that will open soon. She will work in her boutique, but she also needs attendants to keep the store open 7 days a week.

The estimated revenue is 540 k€/year. The purchase prices of the goods to be sold are typically 50 % of sales prices (Value-added taxes are ignored). Total monthly (recurrent) costs, i.e., personnel costs and rent, will be 12 k€. Annually they make 144 k€.

Furnishing the shop before opening will cost 48 k€. This initial investment will be depreciated in three years (annual depreciation is 16 k€). For the investment, The Mystic Boutique takes a three-year loan of 48 k€ at 5 % annual interest rate. (In the income statement interest is calculated on the average loan of 24 k€.)

(Note! The personnel costs should also include a fair compensation for the work effort of the owner in running the business. In addition to that, the owner expects a return on the money she initially invests in the company.)

Which Is the Most Uncertain Element?

Can the Mystic Boutique capture enough paying customers from the huge mass of people spending time in or merely passing through the shopping center?

- How many visitors will find by The Mystic Boutique?
  - Is the location in mainstream or in shadows?
- How many visitors will visit the shop & buy something?
  - Is the product variety and pricing correct
- Sales target 540 k€/a
  - 45 k€/month or 1,5 k€/day
- Average daily sales
  - 10 paying customers, spending 150 € each
  - Or 6 spending 250 € each
- Shopping center level
  - 30 000 daily visitors per 200 shops
  - 150 potential customers per shop?

Typically, revenue is the most uncertain element in financial calculations. There are factors outside the company's control that effect the achieved level, e.g., success of the shopping center, and competition of other shops in the shopping center and other shopping centers. On the other hand, the boutique's location in the shopping center is one of the fundamental decisions that the owner must make.

Large annual figures are often difficult to grasp. Therefore, it is useful to consider, what the annual figures means in daily, weekly or monthly level on the average. The target for The Mystic Boutique could be 10 paying customer per day. The forecasted visitor volume of the shopping center seems to support the reliability of the plan. If daily visitors would be allocated evenly across all shops in the mall, less than 10 % of the potential customers need be paying customers.

Break-Even Point

- How successful is the shopping center as a whole?
- After opening 20 000 visitors per day
  - 60 % of the estimated
- Experts say it will take 2-3 years to reach the expectations

Annual revenue of 320 k€
►EBIT=0, Net profit= -1,2 k€
►Total cash flow= +14,8 k€

Revenue	324,000	100 %
Purchase costs	-162,000	50 %
Sales margin	162,000	50 %
Personnel costs	-60,000	-19 %
Rent	-84,000	-26 %
EBITDA	18,000	6 %
Depreciation	-16,000	-5 %
EBIT	2,000	1 %
Interest	-1,200	0 %
Profit before tax	0,800	0 %
Income tax (20%)	-0,160	0 %
Net profit	0,640	0 %

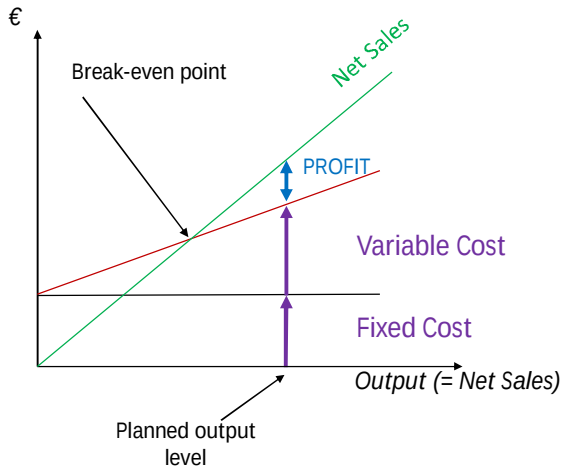
One set of number may not be enough. It is important to have a reliable (most likely to happen) base estimate. There may also be challenging target figures. To ensure the viability of the firm, it is necessary to prepare for bad times.

The visitor volume of the entire shopping center has been 20 000 visitors/day, which remains significantly lower than the original expectations of 12 million visitors annually. The owners of the shopping center say that it can take 2-3 years until the shopping center reaches the expected volumes. It would be wise to prepare alternative calculations to avoid or at least to be prepared for unpleasant surprises.

The above profit estimate is made assuming that revenue is 60% of the original estimate and the boutique can decrease its purchases respectively. Instead, all the other cost elements remain the same. In other words, purchase costs are assumed to be variable (vary with the revenue) whereas other costs are fixed (independent of revenue). EBIT and net profit fall close to zero.

Annual revenue of 320 k€ would mean that EBIT becomes zero, which is the break-even point. (Alternatively, we could define the break-even point using net profit.) Cash flow remains positive, because depreciation is not cash flow.

Cost-Volume-Profit Analysis



Net Sales	*(price*quantity)*
– Variable Cost	*(unit cost*quantity)*
= Contribution margin	
– Fixed Cost	
= Profit (e.g. EBITDA)	

$$CM_{[\%]} = \frac{Net\ Sales\ - Variable\ Cost}{Net\ Sales}$$

$$EBITDA = Net\ Sales \cdot CM_{[\%]} - Fixed\ Cost$$

Cost-volume-profit analysis (CVP) is a technique that can be used for estimating recurrent costs, which are divided into a variable and fixed portion. Variable costs change in proportion to the sales volume of the period (*cost of purchased goods in the previous example*) whereas fixed costs do not depend on the sales volume (*rent, wages*). To explain the principle of CVP, we measure sales volume in money (and use the term Net Sales). It is also possible to use a non-monetary output unit in the analysis, which would link sales volume more clearly to the capacity and output level of the production system.

Contribution margin is the difference of Net Sales and Variable costs. Contribution margin percentage ($CM_{[\%]}$) is Contribution margin divided by Net Sales (*50 % in the previous example*). Once we subtract Fixed costs from Contribution margin, we receive EBITDA (Earnings before interest, tax and depreciation). It is our first proxy of the Free Cash Flow caused by recurrent benefits and costs. (I shall discuss the connection of EBITDA and FCF later in my next lecture.) The break-even point denotes the level of output where EBITDA = 0.

You can start your numerical estimation from Net Sales and proceed towards EBITDA but for planning purposes, it is also useful to start from the targeted EBITDA and work backwards to the targeted sales volume.

Variable and Fixed Costs

- Variability depends on the time horizon and the predictability of the demand
- How fast can you acquire resources to match increasing demand?
  - The smallest amount that is economical to acquire
  - How to cope with unexpected peaks
- How fast can you adjust the costs to match decreasing demand?
  - Inventoriable goods that keep their value are variable even in the short run
  - Contracts affect how fast you can reduce costs
    - Work force
    - Rent
- In detail, variable costs do not always change linearly, and fixed costs are not completely fixed

CVP analysis divides costs unambiguously to fixed and variable, but no cost element (category in the income statement (category) is fixed or variable by definition. We have to make an assumption in our model.

In the long run, all costs should be matched according to the revenue level. In the short run, the contracts made in resource acquisition limit the possibilities to cut cost when demand decreases. Inventoriable goods tend to be the most variable element, but the value of the goods may decrease.

Work force can be hired using temporary or more permanent contracts. Some tasks can be outsourced or rental workforce may be used, which makes the costs more variable. Even long-lasting contracts can be terminated if the decrease in volume is inevitable. Because personnel with long-lasting contracts tend to accomplish complex tasks, layoffs may be avoided until absolutely necessary. It is important to attract competent workforce.

The variability of costs also depends on the economical lot size of acquiring the respective resource. It is easy to adjust the batch size of components purchased according to the output volume, but it is not possible to buy half a machine. (If you don't need the full capacity of one machine, you can consider outsourcing the capacity, naturally. Instead of a machine, you buy manufacturing services)

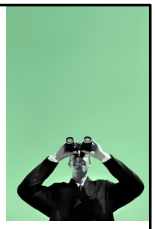
2. Calculations to support decision-making

- Comparison of alternatives for taking a business action
  - Based on a plan (last periods actual figures is the simplest case)
  - What are the future consequences if the action is taken or not taken?
  - Decision rule: If {Incremental benefits – Incremental costs > 0}, go for it
- The duration of the consequences
  - Short-term decisions – adapt the operative plan to match up the estimates of the near future
  - Long-term decisions – develop the business processes to meet the challenges/opportunities of the business environment
- Investment
  - Large negative cash-flow in the beginning and the benefits accumulate during several years
  - The timing of benefits and costs -> discounted cash flow technique
  - The concept of present value

This section starts with presenting generic features of calculations intended to support decision-making. First of all, one should only consider benefits and costs that are caused by the decision. We call them incremental benefits and costs. If these benefits exceed the costs, the calculation suggests that we accept the proposed decision.

The abovementioned logic applies to both short-term and long-term decisions. Investments refer to long-term decisions. There is a large initial cost and payback is received by future revenue (less the recurrent costs to create the revenue). Because of the significant difference in timing of benefits and costs, discounted cash flow technique should be used. Any future payment should be converted to its present value.

Identifying Future Benefits and Costs



- Incremental benefits caused by the decision
  - Customer segments, Revenue streams
  - How much channels take from the price-to-customer
- Incremental costs caused by the decision
  - Investment costs (Initial investment)
  - Recurrent costs (Variable or Fixed)
- Sunk costs must be ignored!
  - Past costs or costs caused by past decisions
  - Unavoidable because they cannot be changed no matter what action is taken now
- Consider indirect effects (project externalities)
  - Is there a cost for using existing resources
  - Does launching the new product affect the sales of old products

Calculating NPV is simple – the real challenge is getting the numbers. The first stage in preparing the FCF-estimates is to identify the relevant benefits and costs. One should consider only the future incremental revenues and costs caused by the investment. Sunk costs are past costs that may be logically connected to the investment but the decision at hand does not affect them anymore. Therefore, sunk costs are not relevant.

Eventually, one needs numerical estimates connected to sales volumes and prices. But estimates remain wild guesses without considering the customer segments that are the source of revenue streams and the portion of these streams that is captured by the delivery channels.

There are two broad classes of incremental costs. Investment costs are non-current cost that occur before the recurrent production and deliveries can begin (initial investment). Recurrent costs occur more or less periodically, thereafter.

If the investment affects the existing operations of the company, it is necessary to identify the indirect costs. Using equipment that the firm has already obtained for previous purposes is not without cash-flow consequences: Is the capacity sufficient for both the previous purposes and the current investment?

Short-term decisions

- If the daily sales are 60 % of the forecasted, The Mystic Boutique has plenty of products in inventory
- How fast will the products become obsolete?
  - Fashion products
  - Food
- Outmoded inventory
  - The best achievable sales price
  - The lowest possible sales price

- Space needed for the products of the forthcoming season
- The actual sales price is probably lower than the planned/estimated price
- The average sales margin is probably below 50 %
- The value of the residual inventory is likely to decrease with time
  - Eventually, selling below the original purchase price may be the best alternative

Let's return to the example of The Mystic Boutique. It seems that the entrepreneur's estimates were optimistic. How fast will the shopping center's visitor volumes grow? Is the boutique's site in the center attractive to lure visitors inside the shop? Is the variety of goods appealing? Are people just browsing or actually buying, and how much will they spend?

Garments are typically sold in seasons (winter, spring, summer, autumn). If purchases were based on higher sales volumes, the boutique will have significant inventory that is becoming obsolete. On the other hand, space Is needed for the articles of the next season. The owner must make pricing decisions concerning the inventory. In such a case, articles are sold at discount. The sales margin remains below the targeted 50 %, but it is necessary to get rid of the outmoding inventory.

In the extreme case, the boutique may sell articles below the original purchase price, which could be the best choice. In accounting terms, this means accepting losses. Nevertheless, storing the obsolete articles would cause extra cost and their value would not increase. In accounting, the obsolete inventory should be valued at its true value – not at the purchase cost. It is not possible to avoid reporting losses; one can only delay accepting the fact.

Diverse Investment Decisions

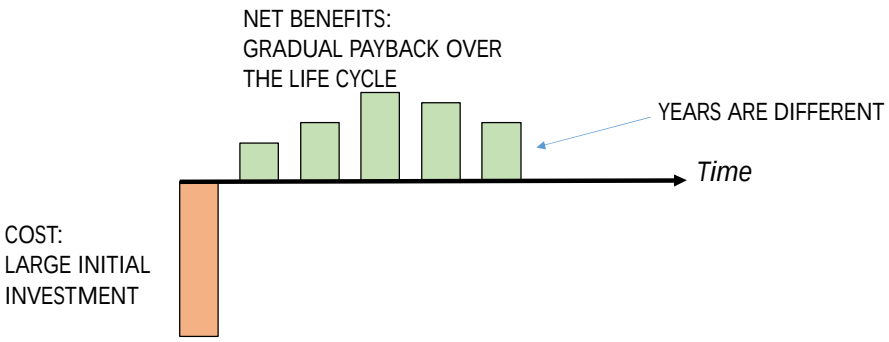
- Bioproduct factory
  - Investment cost billions, very long useful life (life cycle)
  - Significant environmental and societal impacts
- Increasing the capacity of existing production facilities
- Development or renewal of the production process
  - New technology, existing products
  - One process step... the entire process
- Development and market-launch of a new product
  - The life-cycle phases affect the price, volume and production efficiency
- Management information system, automation of office activities
  - Implementation and training; software and hardware

The above examples illustrate the diversity of investment decisions made in companies. In principle, the same basic techniques apply to all types. Naturally, the size and scope of the investment affect the resources allocated to planning the project.

Increasing capacity and renewing of process steps may benefit more from past experience, whereas applying new product or process technology or launching products in new markets are more apt to forecasting errors.

The benefits of management information systems are difficult to estimate, because this systems affect revenue and operating costs indirectly. Better information and supporting systems are expected to lead to better decision, but the relationship is not easy to model.

Cash Flows in Long-Term Decisions

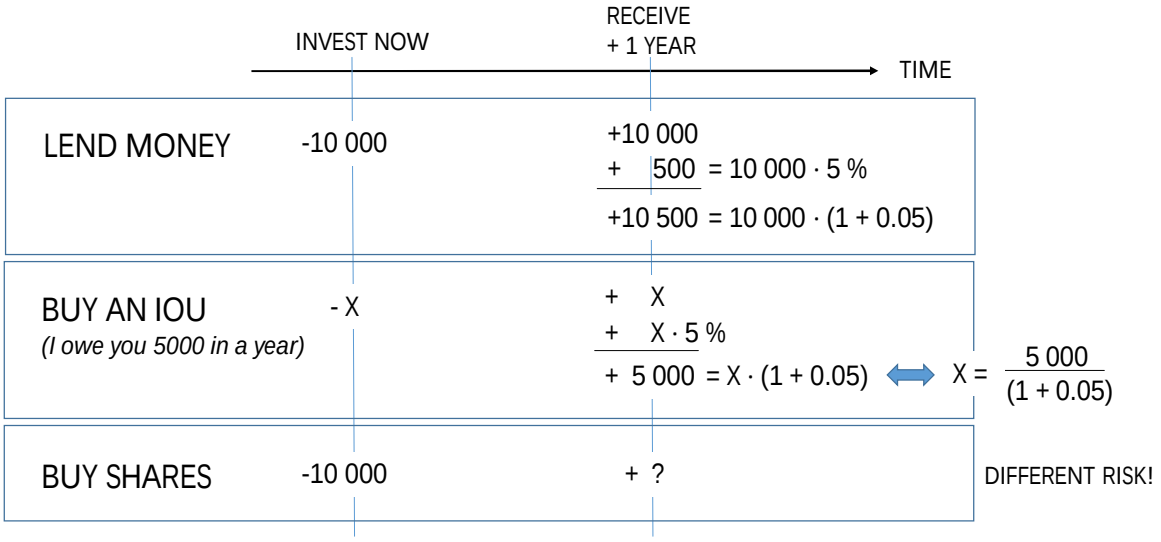


COUNTING SIMPLY (SUM OF NET BENEFITS – INVESTMENT COST) OR THE AVERAGE ANNUAL PROFIT MISSES THE TIME-VALUE OF MONEY
i.e., THE REQUIRED RETURN OF THE INVESTMENT
►DISCOUNTED CASH FLOW (DCF) TECHNIQUE

As stated earlier, it is typical to the cash flows caused by an investment decision that gradual net benefits (green bars) follow the large initial investment (red bar).

The basic idea concerning the time-value of money says that a euro earned to day is more than a euro earned after a couple of years. Discounting is the technique that considers time-value of money

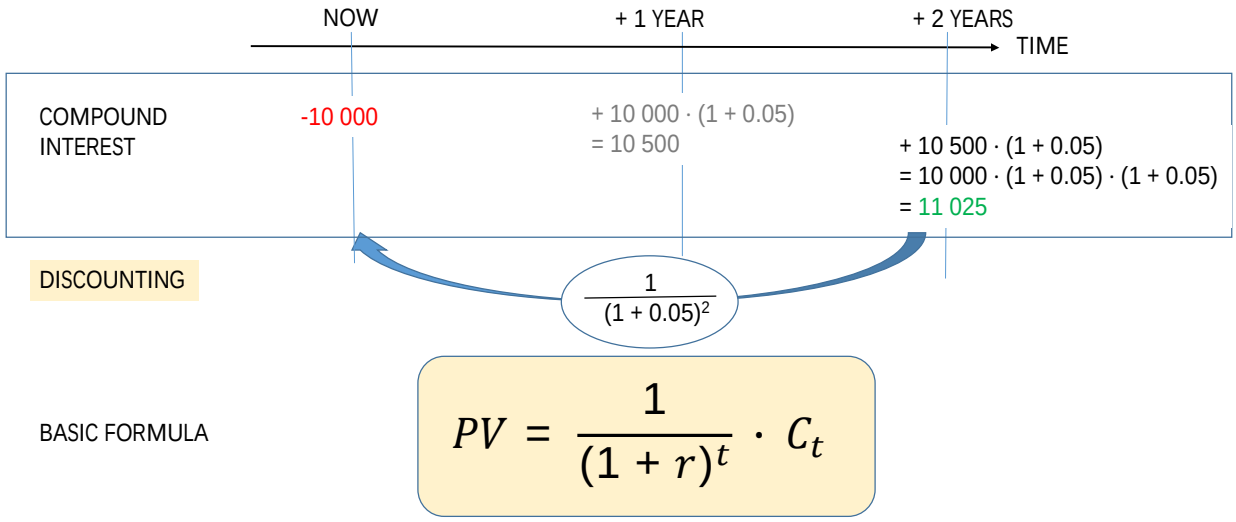
Compare Alternatives for Investing Money



We shall demonstrate the basic principle of discounting by comparing the following alternatives of investing your money.

- You can lend 10 000 euros to a reliable person who promises to pay the loan back in a year plus an interest of 5 %.
- Another equally reliable person promises to pay you 5 thousand euros in a year if you lend him money today. Now the risk is equal to the first case, and you can expect equal return (5 %). The maximum amount of money you would loan to him is unknown (X) but you should earn a return of 5 % on this sum in a year? So, you have an equation to solve X. In other words, you discount the sum that you expect to receive in a year to its present value using an appropriate discount rate.
- Your can fund the firm of your friends by becoming a shareholder. You purchase shares of their firm worth 10 000 today. Your friends say that they will sell their company in a year, and you will receive a fair price for your shares. You are likely to be dissatisfied, if you will be able to sell your shares at less than 10 500 € because the return on your investment is less than 5 %. Furthermore, the risk of losing money is higher when investing in a startup than when lending money to a reliable person. Higher risk means that you should expect higher return than 5 %.

Present Value (PV)



Assume, you lend 10 000 euros to a reliable person who promises to pay the loan with interest in two years and the annual interest rate is 5 %, as before. In other words, you will eventually get one payment of 11 025 €. You are entitled to an interest of 500 € in one year but you don't receive the payment. Instead, the interest is added to the loan sum. This is called compound interest.

If you reverse the calculation of compound interest (the same way we did in the case of one-year loan), you get the discounting factor for two years and discount rate of 5 %. The procedure of discounting gives us a way to compare payments that occur in different time periods. Given an appropriate discount rate, receiving 10 000 today is equally valuable as receiving 11 025 in two years. In other words, the present value of the single payment (11 025) is 10 000.

Now we can generalize the formula of the present value (PV) for different time frames:

- C_t denotes a positive or negative cash flow that happens after t year from the present time.
- r denotes the appropriate discount rate.

Compare Streams of Cash Flow

Compound interest r = 2 %	now	+ 1 year	+ 2 years	+ 3 years	+ 4 years
	1 000,00	1 020,00	1 040,40	1 061,21	1 082,43

Plan 1 — Single payment

now	+ 1 year	+ 2 years	+ 3 years	+ 4 years
				1 082,43

$PV_{r=2\%} = 1000{,}00$

Plan 2

	now	+ 1 year	+ 2 years	+ 3 years	+ 4 years
Loan balance	1 000,00	750,00	500,00	250,00	0,00
Interest (2%)		20,00	15,00	10,00	5,00
Repayment		250,00	250,00	250,00	250,00
Total payments		270,00	265,00	260,00	255,00

$PV_{r=2\%} = ?$

Let us look another example. The four-year compound interest at 2 % for 1 000 is 82,43. So if you plan to borrow 1000 today at 2 % annual interest and settle the loan after four years with a single payment, you will pay 1082,43.

The bank that lends you the money receives the sum after four years. The basic formula of present value tells that from the bank's point of view, the present value of your debt is 1000.

You can negotiate alternative payment plans with the bank. In plan 2, you amortize the loan in four years with equal payments and pay the interest of 2 % respectively. The first interest payment is based on 1000, the second on 750 and so on.

What is the present value of these four annual payments (270, 265, 260, 255).

Naturally, you apply the basic formula to each payment and add up the results.

$$\frac{270}{(1+0{,}02)^1} + \frac{265}{(1+0{,}02)^2} + \frac{260}{(1+0{,}02)^3} + \frac{255}{(1+0{,}02)^4} = 1000$$

From the bank's point of view, the present value of your debt is again 1000. By lending you money on these terms, the bank expects to earn 2 % on their investment.

Loan vs. Part Payment

Plan 3

	now	+ 1 year	+ 2 years	+ 3 years	+ 4 years
Loan balance	1 000,00	1 000,00	1 000,00	500,00	0,00
Interest (2%)		20,00	20,00	20,00	10,00
Repayment		0,00	0,00	500,00	500,00
Total payments		20,00	20,00	520,00	510,00

$PV_{r=2\%} = ?$

Plan 4

now	+ 1 year	+ 2 years	+ 3 years	+ 4 years
	200	100	400	400

$PV_{r=2\%} = ?$

Someone lends you money (invests 1000 in you) and expects to receive the positive cash flows that equal your payments (your negative cash flows)

The example continues. In plan 3, your first amortization is after three years. In years 1 and 2, you only pay the interest. The stream of cash flows to be discounted is (20, 20, 520, 510). Again, the present value of this stream of payments is 1000.

Let us assume you need the money to buy a new smart device. Instead of borrowing the money (plan 4), you can agree to pay the phone in several batches during four years (i.e., 200, 100, 400, 400).

Now, the present value of your future payments at 2 % is more than 1000 (1039 to be precise). This means that your phone dealer earns more than 2 %. To find out how much, you can formulate the following equation that describes the cash flows of the dealer.

$$-1000 + \frac{200}{(1+X)^1} + \frac{100}{(1+X)^2} + \frac{400}{(1+X)^3} + \frac{400}{(1+X)^4} = 0$$

You can solve the equation by iteration or applying the IRR function in Excel to the cash flow stream (-1000,+200,+100,+400,+400). In this case X is 3,35 %. It is also the Internal Rate of Return (IRR) of the investment.

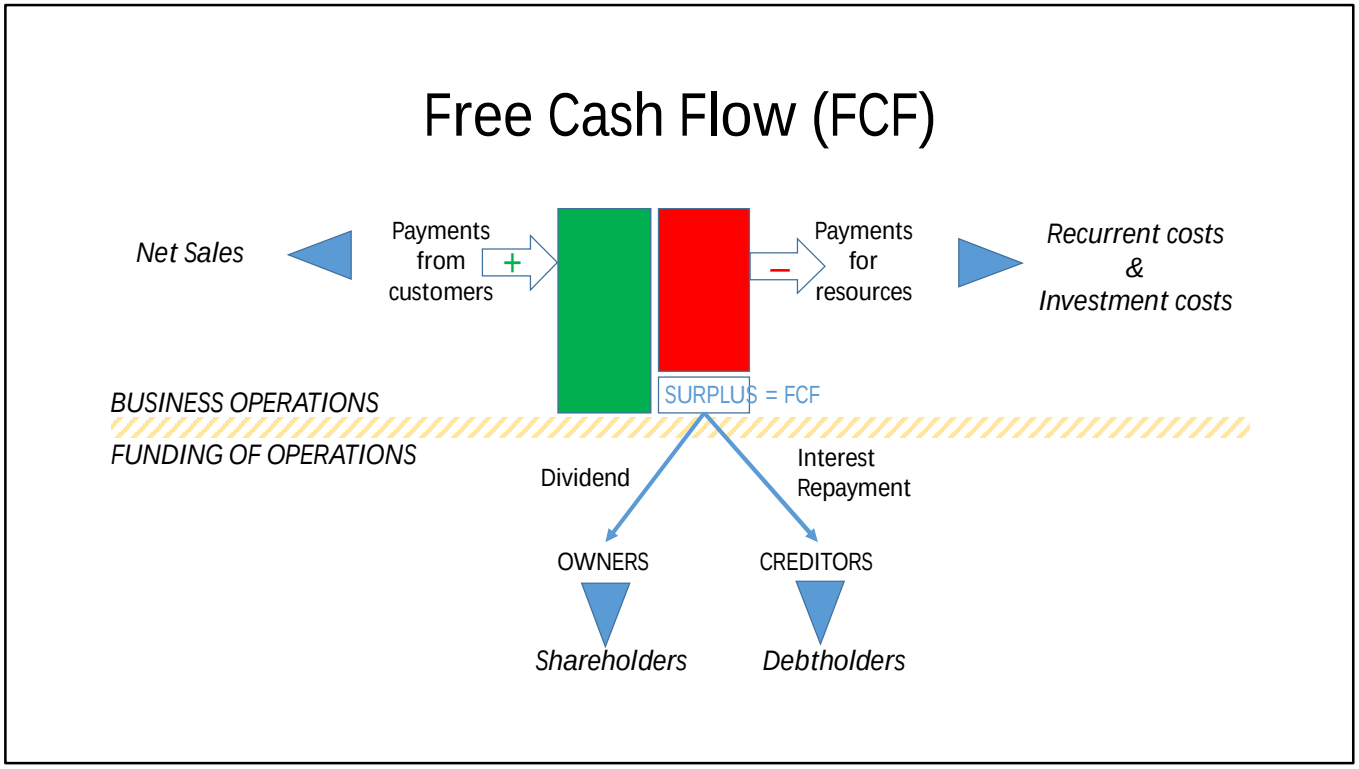
Various streams of cash flow result into the same summative present value only if the annual payments are based on 2 % annual interest on the remaining loan balance.

3. Measuring Profitability of Investments

- Investment's estimated impact on the company's earnings before interest and taxes (EBIT), and free cashflow (FCF)
- Net Present Value, NPV
  - Discounted free cash flows
- Other commonly used measures
  - Internal Rate of Return, IRR
  - Payback period
- Companies tend to use 2-3 measures when assessing an investment
  - Primary and complementing
- The calculations are based on uncertain estimates

In literature, NPV (Net Present Value) is regarded as the best indicator of an investment's profitability. To calculate NPV, one needs to estimate the incremental free cash flows (FCF) caused by the investment. The FCF estimates are based on the estimated EBIT (an accrual accounting concept), which is then converted closer to cash flow. This is reflected in the formula of FCF.

There are also other measures of profitability, such as Internal Rate of Return and Payback period. Surveys show that companies use 2-3 measures to assess investments. All measures need estimated FCFs. Therefore attention must be paid to the uncertainty of the estimates.



By defining the concept of the free cash flow, we separate the positive and negative cash flows that the business operations generate, and the cash flows that relate to the funding of the business operations.

Because profit has a specific meaning in accounting, we use the term surplus to denote the sum of the payments generated by the business operations. From now on, we shall call this surplus the free cash flow (FCF).

The firm can use a positive free cash flow in three basic ways:

- The firm must repay loans it has taken form creditors (=debtholders) and related interest. This is an obligation.
- The firm may pay dividend to the owners (=shareholders). While it is possible that firms sometimes repurchase shares from the owners, owners usually trade their shares with other individuals or companies via the capital markets (e.g., selling or buying shares in the stock market).
- The firm can save the free cash flow for further investments, which are needed to grow or maintain the current level.

In case of a negative free cash flow, the firm must raise new loans or get more funding from existing or new shareholders.

The Statement of Cash Flows

- Cash from operating activities (CF_{ops})
  - Includes income taxes and interest paid
- Cash from investing activities (CF_{inv})
  - Capital expenditures

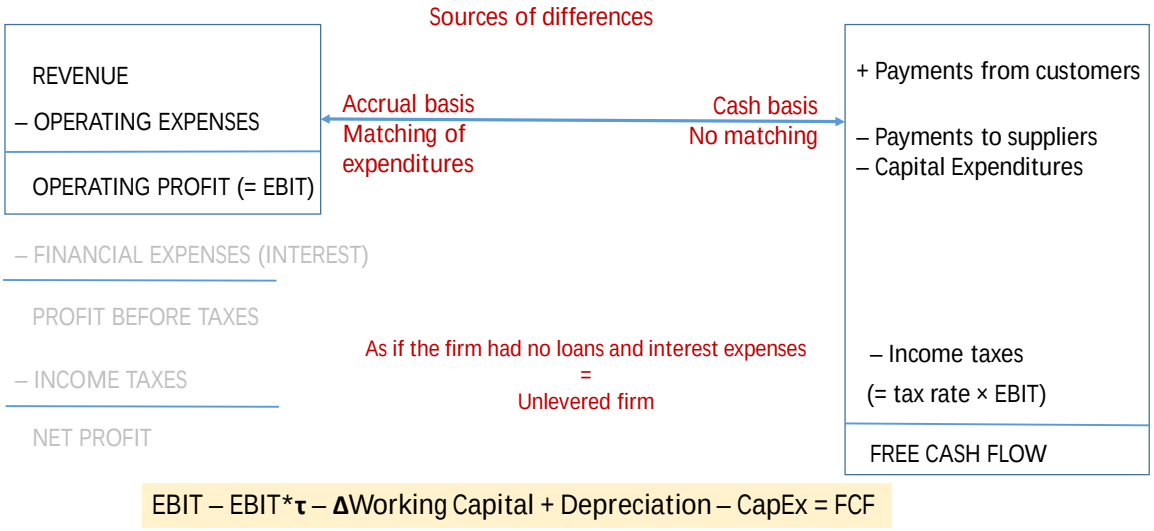
≈ FCF

- Cash from financing activities (CF_{fin})
  - Dividend paid (Div)
  - Increase in shareholders' capital (ΔShares)
  - Increase in borrowing (ΔDebt)
- Change in cash ($\Delta Cash = CF_{ops} + CF_{inv} + CF_{fin}$)
  - ΔCash = Increase in cash = Cash in the end – Cash in the beginning

The statement of cash flow has three sections: operating activities, investing activities, and financing activities. Operating activities and investing activities do not exactly equal the Free Cash Flow. There are two key differences by definition.

- First, cash from operating activities includes interest (whereas FCF unambiguously separates cash flows from business operations and cash flow needed to finance those operations.
- Second, it includes the income taxes actually paid during the period (whereas FCF used taxes estimated through EBIT and tax rate).

Operating Profit versus Free Cash Flow



EBIT – EBIT*τ – ΔWorking Capital + Depreciation – CapEx = FCF

Operating profit is closely linked to the free cash flow because it considers only the revenues and expenses due to the business operations of the firm – and excludes funding transactions. The increase in working capital is not the only issue we need include in an equation that connects EBIT and FCF. Remember that operating expenses include depreciation, which is not cash flow. Instead, the capital expenditures are cash flow caused by investments. Therefore, we add depreciation and subtract capital expenditures from EBIT.

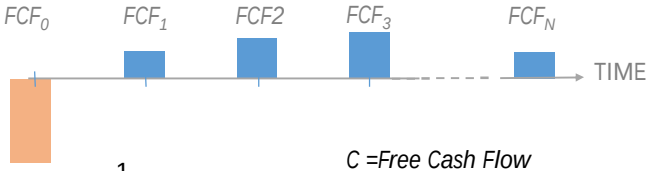
The last source of disparity concerns how we handle income taxes.

Because tax payments do not belong to those who have funded the company (shareholders & debtholders), income taxes are not free cash flow. We should deduct them.

On the other hand, Firms may deduct interest in taxation. The amount of income taxes depends on the taxable income of the company (profit before taxes). The complication is that interest represent cash flow to those who have funded the company by loans. Only if we assume that the firm has no loans and pays no interest, we can calculate income taxes directly using EBIT and income tax rate (τ). Remember, that this is the principal assumption, when we calculate the free cash flow. This weakness will be eliminated by using the weighted average cost of capital as the discount rate.

Net Present Value (NPV)

ESTIMATE ANNUAL FCFs



APPLY THE BASIC FORMULA

$$PV = \frac{1}{(1+r)^t} \cdot C_t$$

C =Free Cash Flow
t = Time
r = Discount rate → risk of the business

TO CALCULATE THE SUM OF DISCRETE PRESENT VALUES

$$FCF_0 + \frac{FCF_1}{(1+r)^1} + \frac{FCF_2}{(1+r)^2} + \frac{FCF_3}{(1+r)^3} + \ldots + \frac{FCF_N}{(1+r)^N}$$

GENERIC FORMULA & INTERPRETATION

$$NPV = FCF_0 + \sum_{n=1}^{N} \frac{FCF_n}{(1+r)^n}$$

Invest if NPV ≥ 0

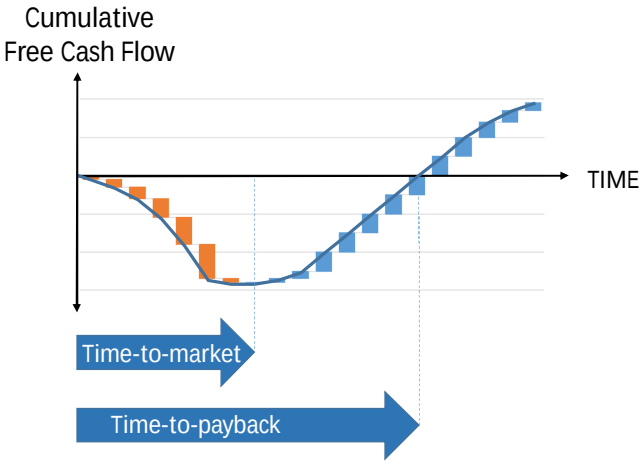
The DCF technique is useful in different contexts. The basic PV formula gives us a means to compare cash flows that occur at different points in time. It is possible to adjust the formula and the discount rate for other time intervals than a year, but to keep things plain, we shall measure time in years.

Now we return to valuing investments to be made in a firm. In this case, the cash flow means the free cash flow (FCF). An investment causes a stream of FCFs during its life time *(=N)*. Different kinds of FCF streams are possible but we shall follow a straightforward approach used in text books: First, we must estimate annual FCFs from the initial investment made "today" (FCF_0) till the end of the useful life (FCF_1, ... FCF_N). The initial investment means negative FCF but the following FCFs are mainly positive. Then we apply the basic PV formula to these estimates and, finally, add up the discrete present values. The result is called the Net Present Value (NPV).

NPV is the most important indicator for an investment's profitability. Positive NPV means that the return on investment is higher than the return required to compensate for the riskiness of the investment. In theory, decision-makers should accept investment proposals where NPV ≥ 0.

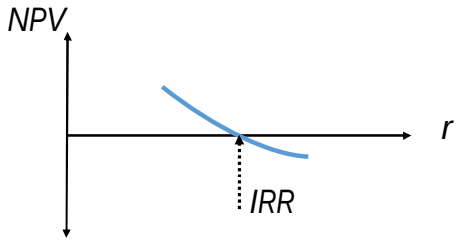
Other Indicators

The Payback Period



The Internal Rate of Return (IRR)

$$NPV = 0 = FCF_0 + \sum_{n=1}^{N} \frac{FCF_n}{(1 + IRR)^n}$$



Cumulative free cash flow illustrates how the business generates free cash flow over time. In a case of a start-up, the entrepreneurs must first develop their product and build the production system. The firm uses money to pay for the various resources it needs but there are not any payments from customers. So, the periodic free cash flow is negative. The cumulative free cash flow curve dives until the firm starts deliveries to the paying customers (Time-to-market or time to first sale). After this point, the periodic free cash flow turns positive.

The firm must pay the costs of running the business but the received payments from customers offset the operating costs. Eventually, the cumulative free cash flow reaches the zero-level (Time-to-payback). The same logic applies to discrete investment projects.

The internal rate of return (IRR) is a variation of the NPV formula. Now we solve the discount rate that make NPV equal zero. It is not possible to solve this equation in a closed form. Instead iteration must be used. Spreadsheet software have a standard function to solve IRR. Basically, iteration means that we guess values for r and then interpolate towards the value that leads to zero-NPV. In manual iteration, we need one r producing positive NPV and one producing negative. The we draw a straight line to find a rough estimate for IRR.

Consider the Reliability of Numerical Estimates

- Initial rough estimates
  - Experience (qualitative, subjective), available past data (quantitative, subjective)
- Critical values (NPV=0 if ...)
  - IRR & others
- Reasonable range
  - Best case, worst case
- Internal logic / compatible estimates
  - Volume and available capacity, market share and marketing costs.

Numerical estimates of FCF or cost of capital are not accurate forecasts of the future. They are prone to several sources of error. Experts can naturally make more reliable estimates than beginners but analyzing past data can help beginners to improve their estimates. However, future can seldom be extrapolated from history. Even experts can ignore changes in the business environment. It is wise to test and refine estimates during the planning process. There are some simple numerical techniques for testing estimates.

We can search the critical value for each of the input parameters in our NPV model. Critical input value leads to zero-NPV.

We can also consider the reasonable range of input parameter values. We may describe different scenarios of the future and use parameter values that fit our scenario. These scenarios might describe different developments in the competitive markets.

We should check the internal logic of our estimates, too. Is the estimated sales volume in line with our capacity (on the average and in cases of growing or fluctuating demand)? What kind of market share does our sales volume suggest? Is it a reasonable figure considering the competition?

4. The Weighted Average Cost of Capital

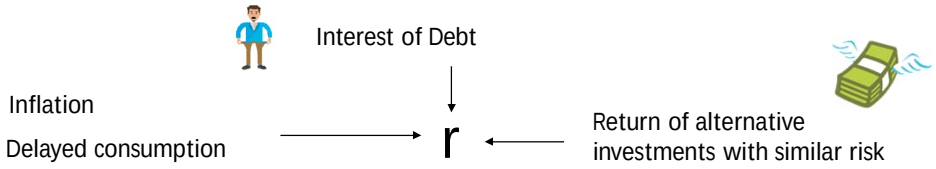
- Weighted average cost of capital (WACC)
- The discount rate
  - Considers the return expected by shareholders and debtholders of the company as well as the fact that interests are tax-deductible (FCF does not include interest)
- Describes the systematic risk related to the business
  - Investors want compensation (return) for the risk they take
  - Investors cannot diversify (invest in diverse companies) systematic risk
  - Because unsystematic risk can be eliminated by diversifying, investor do not expect return on it

In order to understand the formula of the net present value, one must know the concepts of free cash flow, discounting and the opportunity cost of capital. The last concepts explains the origin of the WACC.

WACC represents the return that a company or its investment should create to those who have funded the company. The appropriate discount rate is related to the risk of the investment (or lending money): the higher the risk, the higher the discount rate, i.e. expected return on money invested.

On the other hand players in capital markets can invest in many diverse companies, i.e., diversify their personal investment portfolio. This means that they can and should eliminate firm-specific (unsystematic) risks. Therefore, they expect return only on systematic risk (a.k.a. market risk) that they can not eliminate by diversifying. This issue is not explained in detail in this course, but it is important to remember that there is a specific definition of risk in this context.

Opportunity Cost of Capital



- Interest rate of debt and the return of alternative investments affect your opportunity cost of capital
- The expected return depends on the risk of the investment. Risk means variation of return.
- Internal Rate of Return (IRR) should be compared to the opportunity cost of capital

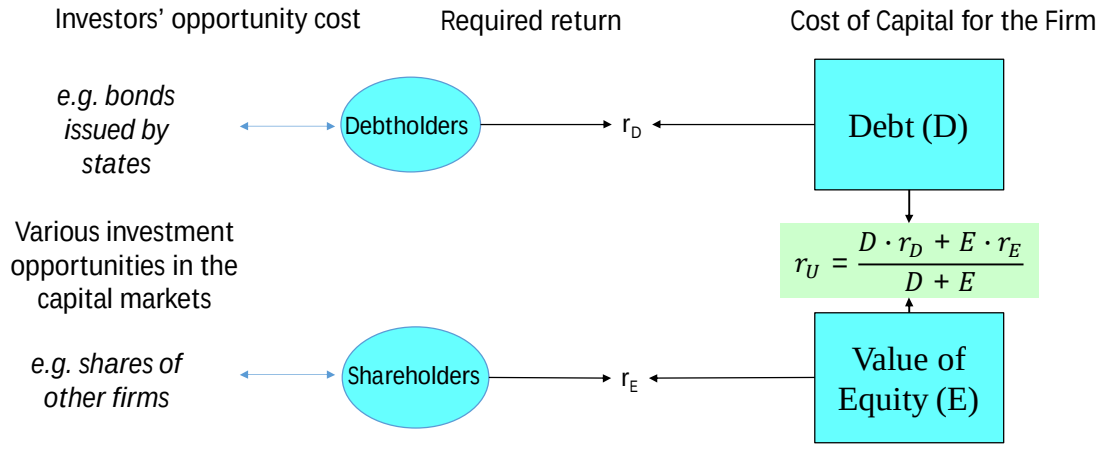
When we estimate the discount rate (*r*), we should consider the decision-maker's opportunity cost of capital. Generally, opportunity cost is the benefit that is missed when someone chooses one alternative over another. Opportunity cost of capital refers to different investment opportunities that individuals or organizations have.

For example, if you have excess money, you may consider investing (or saving) it. If you also have loans, the return on your investment should be higher than the interest rate you pay for the loan.

Economic actors may set more implicit expected return for their investments. Because of inflation, the purchase power of money declines over time. Alternative use of money may give pleasure instead of tangible financial benefits. Investing means delaying consumption. Economic actors set a price tag for this in their mind.

The required return should always be in line with the risks of the investment. In this context, risk is the potential variation of return. Two investment opportunities may have the same expected return, i.e., the most likely return, but they differ in potential variation. One will result in an actual result that is very close to the most likely return, while the other can clearly exceed the expectations or fail to meet them. The latter opportunity is riskier and, respectively, the required return should be higher than for the former opportunity.

Cost of Capital for a Firm



A firm's appropriate discount rate combines debtholders' and shareholders' opportunity costs of capital. Both have invested money in the firm instead of other alternatives in the capital markets. They do not share the risk of the business evenly because of different privileges. Debtholders receive steady repayments and interest. In case of bankruptcy, their position is stronger compared to shareholders. Thus, the debtholders' required return (r_D) is lower than the shareholders' required return (r_E). Cost of capital and required return describe the same issue from different angles. Cost of capital is "the purchase price" of funding for the firm, whereas the required return is "the sales price" of the investors.

Given the required returns as well as the values of equity and interest-bearing debt, we can calculate the weighted average cost of capital (r_U). Since shareholders expect return on the sum they have paid for their shares, one should use the market value of equity instead of the book value. Note that r_E depends on the proportion of debt. Increasing debt will increase r_E (the risk taken by the shareholders) but r_U (the underlying risk of the business) remains the same.

Because firms can deduct interest when calculating taxable income, the effective after-tax interest rate = r_D*(1 – tax rate) in the WACC formula. WACC can be used for investments with the same risk and same financing as the firm itself. (To fully understand this issue, you should take TU-C1030, for example)

Debt Increases Your Risk

- You consider investing 10 000 € in a company (buy shares)
- In a year, the value of your shares can increase 30 % or decrease 20 %
- If you have cash to invest, you don't have to sell in a year (but you may)
  - In the best case, your wealth increases from 10 000 to 13 000
  - In the worst case, your wealth decreases from 10 000 to 8 000
- What happens if you need borrow the money to invest (one-year loan, 5 % interest)?
  - In the best case, your wealth increases from 0 to 2 500. You must sell 10,5/13 =81 % of the shares to repay the loan + interest.
  - In the worst case, you must sell all the shares to cover part of the debt. Your wealth decreases from 0 to -2 500.

The following example illustrated how debt increases risk. An individual can have savings to invest in shares of a listed company, or he can use debt to finance the investment. The value of the share may go up or down, but the variance of possible outcomes is larger when debt is used.

If the individual uses savings, he will earn either 30 % or lose 20 %. He does not have to sell the shares in a year (unless he wants to invest in another company).

If the share purchase was funded with loan, the individual must have enough money in a year to repay the loan plus interest. When the share price goes up, he needs sell 81 % of his holding. On the other hand, the return on the original "individual equity" is unbelievable high (i.e., higher than 30 %). In case of falling share price, selling all the holdings is not enough to cover the liabilities. In the beginning, he had no money but in the end, he has 2 500 € debt.

WACC

- A firm invests in risky business assets with required return of r_U. Leverage (proportion of debt) increases risk of the shareholders. Consequently, shareholders require higher return
  - Financial leverage $$r_E = r_U + \frac{D}{E}(r_U - r_D)$$
- Use the weighted average cost of capital (WACC) to discount free cash flows $$r_{WACC} = r_U - \frac{D \cdot r_D \cdot (1 - tax\ rate)}{D + E}$$

A typical misunderstanding is to assume that r_E does not depend on the amount of debt. The equation of financial leverage shows how the expected return on equity rises as the proportion of debt to equity increases.

Actually, one should regard r_U as a factor independent on leverage (D/E). It describes the systematic risk of the business operations. Shareholders and debtholders divide this risk with each other.

In the above WACC formula, we adjust r_U to consider the right to deduct interest expenses in taxation. Therefore, $r_D \cdot (1 - tax\ rate)$ is called the effective interest rate.

The WACC formula can also be written in the following way, which highlights the proportions of equity and debt as weights.

$$r_{WACC} = \frac{E}{D + E} \cdot r_E + \frac{D}{D + E} \cdot r_D \cdot (1 - rate)$$