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# Corporate Finance: Introduction to Capital Budgeting

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## What is capital budgeting?

- Capital budgeting is a formal process used for evaluating potential expenditures or investments that are significant in amount for the company.
- It involves the decision to invest funds for addition, disposition, modification or replacement of fixed assets.
- This type of capital expenditures include the purchase of fixed assets such as, land, new buildings and equipments, or rebuilding or replacing existing buildings and equipments, etc.
- Capital Budgeting is a tool for maximizing a company's future value. Companies are able to manage only a limited number of large projects at any one time.
- These investments are so important that ultimately they decide the future of the company
- Most capital expenditures cannot be reversed at a low cost, consequently, mistakes are very costly.

## Features of capital budgeting

- High risk
- Requires large amount of capital
- Requires a process to search and select the best projects available
- They will ensure the value creation of the company
- Usually there is a long time period between the initial investment and the cash generation (“time to cash”). Usually the longer the time to cash the riskier is the project.




## Principles of capital budgeting

- Principles of capital budgeting are based on value creation, as a consequence they have been adapted for many other decisions such as working capital, leasing, financing and refinancing, mergers and acquisitions.
- Valuation principles used in capital budgeting are similar to principles used in security analysis, portfolio management and M&A.
- Capital budgeting information is not ordinarily available to outside the company. An external financial analyst may be able to appraise the quality of the company’s capital budgeting process.

## Capital budgeting process

- Project identification and generation of opportunities and alternatives according to the corporate strategy
- Project screening and evaluation (Analysis of individual projects)
- Project selection and approval
- Implementation and monitoring
- Performance review (Post-audit)



## Categories of capital budgeting

- Replacement projects
- Expansion projects (including new geographies)
- New products and services
- New businesses (Diversification)
- Regulatory, safety and environmental projects
- Other (minor projects)

## Type of decisions in capital budgeting

- INDEPENDENT PROJECT There is only one project to be analyzed
  - Decision: Accept or reject
- MUTUALLY EXCLUSIVE PROJECTS - It refers to a set of projects out of which only one project can be selected for investment
  - Decision: Which one is the best in terms of value creation
- A SET OF INVESTMENT OPPORTUNITIES – Capital rationing
  - Considering the resources available, namely capital, only a subset of all opportunities might be selected and approved.
- PROJECT SEQUENCING
  - Investing in one project creates the option to invest in future projects

## Project Risk Management

1. Identify the risks early on in your project and make clear who is responsible for each risk.
2. Communicate about risks, focusing communication with the project sponsor
3. Consider opportunities as well as threats when assessing risks.
4. Rank the risks from most critical to less critical
5. Fully understand the reason and impact of the risks.
6. Develop responses to the risks.
7. Develop the preventative measure tasks for each risk.
8. Develop a contingency plan to mitigate each risk.
9. Record and register project risks.
10. Track risks and their associated tasks.

## The bases of capital budgeting decisions in finance

- Decisions are based on cash-flows, not on profits
- Timing of cash flows is crucial because the time value of money.
- Cash flows are valued considering the opportunity use of resources – space, equipment, people, money:
  - Incremental cash flows
  - Cost of capital
- Cash flows are analyzed net of taxes
- The separation of investment and financing decisions
- The investment must create value by itself




## Most useful capital budgeting concepts

- Sunk costs - this is a cost already incurred. You can't change a sunk cost. Today's decisions should be based on current and future cash flows
- Opportunity cost - How much the resource is worth in its next use
- Incremental cash flow - The cash flow that is realized because of the decision taken
- Externalities - Effects that can be positive or negative in terms of cash flows
- Cannibalization – When the investments takes customers and consequently cash flow away from other actual products and services of the company
- Conventional cash flow – Outflows (investment) come first. Cash inflows come after. Unconventional cash flows have unconventional patterns

## Investment decision criteria

- Average accounting rate of return
- Pay-back period
- Discounted pay-back period
- Net present value (NPV)
- Internal rate of return (IRR)
- Modified internal rate of return
- Profitability index
- Equivalent annual cost and Equivalent annual value

## The expected flows of project X

| | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Capex | 200 000 € | | | | | |
| Sales | | 100 000 € | 150 000 € | 240 000 € | 130 000 € | 130 000 € |
| Cash expenses | | 50 000 € | 70 000 € | 120 000 € | 60 000 € | 60 000 € |
| EBITDA | | 50 000 € | 80 000 € | 120 000 € | 70 000 € | 70 000 € |
| Depreciation | | 40 000 € | 40 000 € | 40 000 € | 40 000 € | 40 000 € |
| Operational profit | | 10 000 € | 40 000 € | 80 000 € | 30 000 € | 30 000 € |
| Taxes (25%) | | 2 500 € | 10 000 € | 20 000 € | 7 500 € | 7 500 € |
| Net operational profit after taxes (NOPAT) | | 7 500 € | 30 000 € | 60 000 € | 22 500 € | 22 500 € |
| Working capital requirement | | 20 000 € | 30 000 € | 48 000 € | 26 000 € | 26 000 € |
| Increase in WCR | | 20 000 € | 10 000 € | 18 000 € | -22 000 € | 0 € |
| Net operational cash flow | -200 000 € | -2 500 € | 60 000 € | 122 000 € | 74 500 € | 52 500 € |

## The average accounting rate of return of project X

$$AAR = \frac{\text{Average net income}}{\text{Average book value}}$$

| Invested capital | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Gross fixed assets | 200 000 € | 200 000 € | 200 000 € | 200 000 € | 200 000 € | 200 000 € |
| WCR | 0 € | 20 000 € | 30 000 € | 48 000 € | 26 000 € | 26 000 € |
| Gross book value of invested capital | 200 000 € | 220 000 € | 230 000 € | 248 000 € | 226 000 € | 226 000 € |
| Cumulated depreciations | 0 € | 40 000 € | 80 000 € | 120 000 € | 160 000 € | 200 000 € |
| Net book value of invested capital | 200 000 € | 180 000 € | 150 000 € | 128 000 € | 66 000 € | 26 000 € |

| Accounting rate of return: | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Annual return on invested capital | | 3,8% | 16,7% | 40,0% | 17,6% | 34,1% |
| **Average ROIC** | **22,4%** | | | | | |
| Average NOPAT | 28 500 € | | | | | |
| Average net book value of invested capital | 125 000 € | | | | | |
| **Average ROIC** | **22,8%** | | | | | |




## Advantages and disadvantages of ARR

**Advantages**

- Easy to understand
- Easy to calculate

**Disadvantages**

- Based on accounting, not cash flows
- Doesn’t account for the time value of money
- Because has no financial theory conceptual framework, it has no decision rule
- Can be calculated in different ways

NPV and IRR are preferable

# Pay back period

| Pay back period | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Net operational cash flow | -200 000 € | -2 500 € | 60 000 € | 122 000 € | 74 500 € | 52 500 € |
| Cumulated operational cash flow | -200 000 € | -202 500 € | -142 500 € | -20 500 € | 54 000 € | 106 500 € |
| Pay-back | | | | | 3,38 | |

- Advantages:
  - Easy to calculate and to explain
- Drawbacks
  - It is not a measure of profitability or value creation
  - Cash flows after the cut-off date are ignored
  - Gives equal weight to all cash flows before the cut-off date
  - Doesn't take in consideration the time value of money
  - The is no financial theory framework behind the figure: As a consequence there is no decision rule to apply




# Discounted Pay-back

| Discounted pay back period | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Net operational cash flow | -200 000 € | -2 500 € | 60 000 € | 122 000 € | 74 500 € | 52 500 € |
| Cost of capital | 10% | | | | | |
| Discounted factor | 1,000 | 1,100 | 1,210 | 1,331 | 1,464 | 1,611 |
| Net operational cash flow discounted | -200 000 € | -2 273 € | 49 587 € | 91 660 € | 50 885 € | 32 598 € |
| Cumulated operational cash flow | -200 000 € | -202 273 € | -152 686 € | -61 026 € | -10 141 € | 22 457 € |
| Discounted pay-back period | | | | | | 4,45 |

- Same draw-back as Pay-back period, except that is taking in consideration the time value of money

## The three financial criteria based on financial theory

- Net present value (NPV)
- Internal rate of return (IRR)
- Profitability index (PI)




## The Net Present Value: Formula and rule for independent projects

Invest if NPV > 0

Do not invest if NPV < 0

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - Outlay$$

where

$CF_t$ = after-tax cash flow at time $t$

$r$ = required rate of return for the investment

Outlay = investment cash flow at time zero

## Internal Rate of Return: Formula and rule for independent projects

$$\sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - Outlay = 0$$

*Invest if IRR > Cost of capital*

*Do not invest if IRR < Cost of capital*





## Profitability index: Formula and rule for independent projects

$$PI = \frac{\text{PV of future cash flows}}{\text{Initial investment}} = 1 + \frac{NPV}{\text{Initial investment}}$$

Invest if PI > 1.0

Do not invest if PI < 1.0

## The 3 financial criteria: Application to Project X

| The 3 financial criteria for investment appraisal | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Net operational cash flow | -200 000 € | -2 500 € | 60 000 € | 122 000 € | 74 500 € | 52 500 € |
| Cost of capital | 10,0% | | | | | |
| Discounted factor | 1,000 | 1,100 | 1,210 | 1,331 | 1,464 | 1,611 |
| Discounted net operational cash flow | -200 000 € | -2 273 € | 49 587 € | 91 660 € | 50 885 € | 32 598 € |
| **NPV = SUM of discounted net operational cash flow** | **22 457 €** | | | | | |
| **NPV using Excel formula** | **22 457 €** | | | | | |
| **IRR using Excel formula** | **13,6%** | | | | | |
| Profitability index: | | | | | | |
| Gross Present Value | 222 457 € | | | | | |
| Investment | 200 000 € | | | | | |
| **Profitability index** | **1,11** | | | | | |




## Why NPV leads to better investment decisions than other criteria

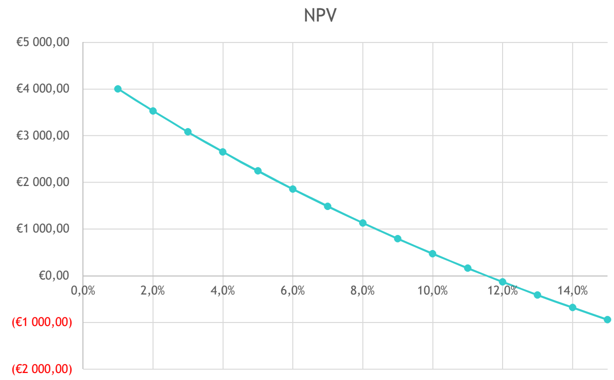
- Cash flow
  - NPV depends on cash flow not on accounting rules
- Time value of money
  - Is the most accurate measure for the timing of the cash flows
- Risk
  - It takes in consideration the risk
- Additivity
  - NPV(A+B)=NPV(A)+NPV(B)

# PITFALLS OF IRR



## The NPV profile and IRR

| Years | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Cash flow | -10 000 € | 2 000 € | 2 500 € | 1 000 € | 4 000 € | 5 000 € |
| Discount rate | 10% | | | | | |
| NPV | 472,27 € | | | | | |
| IRR | 11,6% | | | | | |



## Pitfall 1
## Not clear if you are lending or borrowing?

| Project | 0 | 1 | 2 | 3 | IRR | NPV at 10% |
|---|---|---|---|---|---|---|
| A | -1 000 € | 120 € | 120 € | 1 120 € | 12,0% | 45,22 € |
| B | 1 000 € | -120 € | -120 € | -1 120 € | 12,0% | -45,22 € |

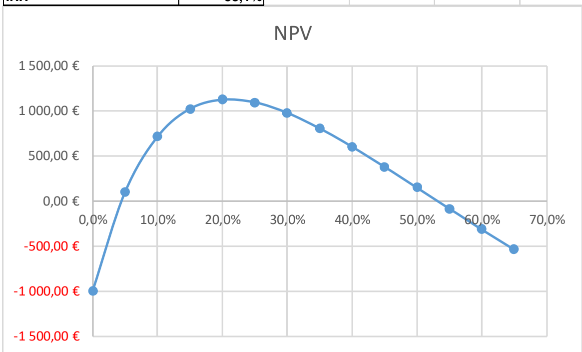
IRR is 12%. This is higher that cost of capital (10%).
This means that Projects A and B are equally attractive?
No!

In A we are lending money at 12%, which is good for value creation
In B we are borrowing money at 12%, which is not good for value creation




## Pitfall 2
## You may find projects with multiple IRR

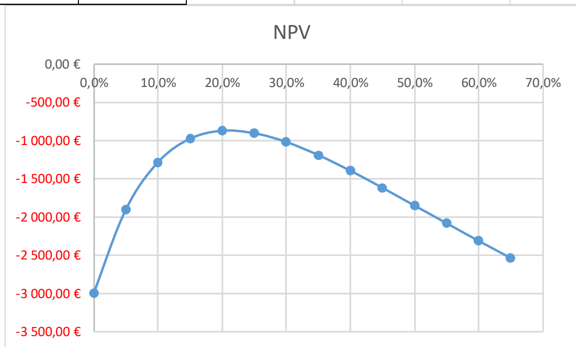
| Years: | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Cash flows | -7 000 € | 8 000 € | 2 000 € | 4 000 € | 12 000 € | -20 000 € |
| Cost of capital | 10% | | | | | |
| NPV | 708,6 € | | | | | |
| IRR | 4,5% | | | | | |
| IRR | 53,1% | | | | | |




There can be as many solutions to the IRR definition as there are changes of sign in the time ordered cash flow series.

## Pitfall 3
## You may find projects without an IRR

| Years: | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Cash flows | -9 000 € | 8 000 € | 2 000 € | 4 000 € | 12 000 € | -20 000 € |
| Cost of capital | 10% | | | | | |
| **NPV** | **-1 291,4 €** | | | | | |
| **IRR** | **#NUM!** | | | | | |
| **IRR** | **#NUM!** | | | | | |






## Pitfall 4 - Different timing of cash flows in mutually exclusive projects

| Years | Project A | Project B | A-B |
|---|---|---|---|
| 0 | -1 000 € | -1 000 € | 0 € |
| 1 | 0 € | 400 € | -400 € |
| 2 | 200 € | 400 € | -200 € |
| 3 | 300 € | 300 € | 0 € |
| 4 | 500 € | 300 € | 200 € |
| 5 | 900 € | 200 € | 700 € |
| Cost of capital | 10% | | |
| **NPV** | **291 €** | **249 €** | 42 € |
| **IRR** | **17,3%** | **20,5%** | 12,5% |
| **PI** | **1,29** | **1,25** | N/D |

# Pitfall 5 - Different sizes of mutually exclusive projects

| Years | Project A | Project B | A-B |
|---|---|---|---|
| 0 | -10 000 | -2 000 | -8 000 |
| 1 | 4 000 | 800 | 3 200 |
| 2 | 4 000 | 800 | 3 200 |
| 3 | 3 000 | 600 | 2 400 |
| 4 | 3 000 | 600 | 2 400 |
| 5 | 2 000 | 600 | 1 400 |
| Cost of capital | 10% | | |
| **NPV** | 2 487 | 622 | 1 865 |
| **IRR** | 20,5% | 22,4% | 20,0% |
| **PI** | 1,25 | 1,31 | 1,23 |




# Pitfall 6 - Unequal life spans

| Years | Project A | Project B | A-B |
|---|---|---|---|
| 0 | -10 000 € | -10 000 € | 0 € |
| 1 | 3 000 € | 6 400 € | -3 400 € |
| 2 | 3 000 € | 6 400 € | -3 400 € |
| 3 | 3 000 € | | 3 000 € |
| 4 | 3 000 € | | 3 000 € |
| 5 | 3 000 € | | 3 000 € |
| Cost of capital | 10% | 10% | 10% |
| **NPV** | 1 372 € | 1 107 € | 265 € |
| **IRR** | 15,2% | 18,2% | 12,0% |
| **PI** | 1,14 | 1,11 | N/D |

The NPV shows the present value of two investments that have uneven cash flows. When comparing two different investments using the NPV method, the length of the investment (n) is not taken into consideration

In this case, is better to use the Equivalent Annual Value

## Equivalent annual value

The equivalent annual value formula is used in capital budgeting to show the NPV of an investment as a series of equal cash flows for the length of the investment.

This is one year in financial terms= $\frac{1}{(1+k)^1}$

This is *n* years in financial terms = $A_{k;n} = \sum_{i=1}^{n} \frac{1}{(1+k)^i}$

$$A_{k;n} = \frac{1}{k}\left[1 - \frac{1}{(1+k)^n}\right]$$

So, equivalent annual value is:

$$AEV = \frac{NPV}{\sum_{i=1}^{n} \frac{1}{(1+k)^i}}$$





## The calculation for projects A and B Annual Equivalent Value

$$AEV = \frac{NPV}{\sum_{i=1}^{n} \frac{1}{(1+k)^i}}$$

**PROJECT A**

$$A_{10\%;5} = \frac{1}{(1,1)^1} + \frac{1}{(1,1)^2} + \frac{1}{(1,1)^3} + \frac{1}{(1,1)^4} + \frac{1}{(1,1)^5} = 3,79$$

$$A_{k;n} = \sum_{i=1}^{n} \frac{1}{(1+k)^i} \qquad A_{10\%;5} = \frac{1}{10\%}\left[1 - \frac{1}{(1+10\%)^5}\right] = 3,79$$

$$AEV_A = \frac{1372€}{3,79} = 362€/year$$

**PROJECT B**

$$A_{10\%;2} = \frac{1}{(1,1)^1} + \frac{1}{(1,1)^2} = 1,74$$

$$A_{10\%;2} = \frac{1}{10\%}\left[1 - \frac{1}{(1+10\%)^2}\right] = 1,74 \qquad AEV_B = \frac{1107€}{1,74} = 638€/year$$

$$Factor\ in\ Excel = \frac{1}{PMT(rate; n; -1€)} \qquad AEV\ in\ Excel = NPV \times PMT(rate; n; -1€)$$

## Explaining why IRR is misleading in comparison to NPV

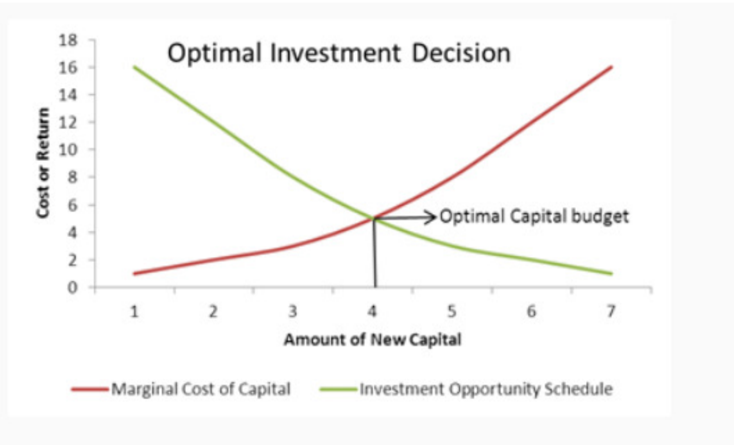
| | Cash Flow | At IRR |
|---|---|---|
| **Reinvestment rate** | | 22,6% |
| 0 | -65 000 | |
| 1 | 15 000 | 33 904 |
| 2 | 20 000 | 36 868 |
| 3 | 25 000 | 37 586 |
| 4 | 30 000 | 36 784 |
| 5 | 35 000 | 35 000 |
| IRR | 22,6% | |
| Future value | | 180 142 |
| Geometric average rate of return | | 22,6% |

IRR formula assumes that cash flow generated is reinvested at the same rate as IRR.

*And this is not true, according to classical economics theory (see next slide)*




## Marginal cost of capital and investment schedule based on classical economics theory



## The Modified IRR

We may decide the level of reinvestment rate

$$MIRR = \sqrt[n]{\frac{\sum_{i=1}^{n} FC_i \times (1+r)^{(n-i)}}{I_0}}$$

MIRR – Modified IRR
$CF_i$ – Cash Flow at year i
r – Reinvestment rate
$I_0$ – Initial Investiment

| | Cash Flow | At another rate |
|---|---|---|
| **Reinvestment rate** | | 12% |
| 0 | -65 000 | |
| 1 | 15 000 | 23 603 |
| 2 | 20 000 | 28 099 |
| 3 | 25 000 | 31 360 |
| 4 | 30 000 | 33 600 |
| 5 | 35 000 | 35 000 |
| IRR | 22,6% | |
| Future value | | 151 661 |
| Geometric average rate of return | | 18,5% |
| Excel Formula: MIRR(range;kfinance;kreinv) | | 18,5% |

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## CAPITAL RATIONING

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## Profitability Index may perform better than NPV or IRR under capital rationing

Capital constraint = 100M€

| Project | Investment | NPV | PI |
|---|---|---|---|
| A | 40 € | 20 € | 1,50 |
| B | 100 € | 35 € | 1,35 |
| C | 50 € | 24 € | 1,48 |
| D | 60 € | 18 € | 1,30 |
| E | 50 € | 10 € | 1,20 |
| Capital Constraint | 100 € | | |

| Ranking by NPV | Investment | NPV | PI |
|---|---|---|---|
| B | 100 € | 35 € | 1,35 |

Is there a better solution?

| Rank by PI | Investment | NPV | PI |
|---|---|---|---|
| A | 40 € | 20 € | 1,50 |
| C | 50 € | 24 € | 1,48 |
| Liquidity | 10 € | | |
| Total NPV | | 44 € | 1,49 |

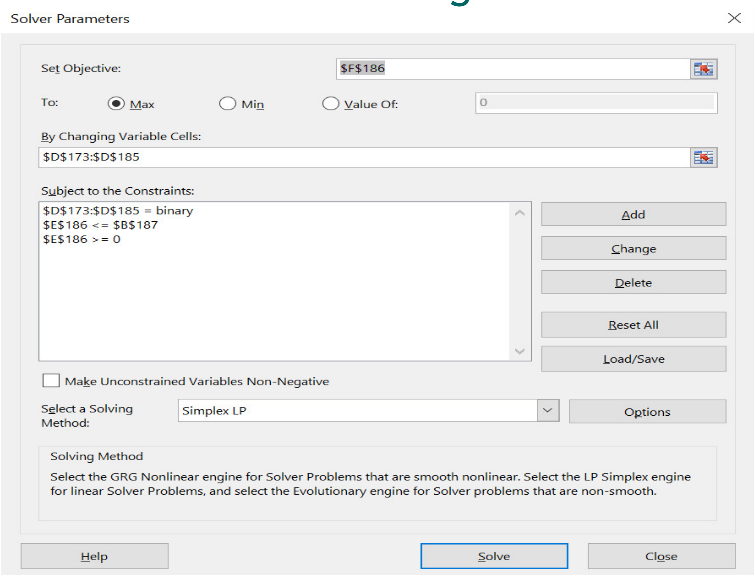
We cannot choose on the basis of the NPV.
When funds are limited we need to find how to maximize the NPV.
We must pick the projects that offer the highest NPV per euro of investment outlay.




## Under capital rationing linear programming maximizing NPV is a better approach

| Project | Investment | NPV | Include | Selected Projects Investement | Selected Projects NPV |
|---|---|---|---|---|---|
| A | 237 000 | 84 300 | 1 | 237 000 | 84 300 |
| B | 765 000 | 26 900 | 1 | 765 000 | 26 900 |
| C | 304 000 | 23 200 | 1 | 304 000 | 23 200 |
| D | 565 000 | 82 600 | 1 | 565 000 | 82 600 |
| E | 109 000 | 20 500 | 1 | 109 000 | 20 500 |
| F | 89 000 | 90 400 | 1 | 89 000 | 90 400 |
| G | 796 000 | 18 200 | 1 | 796 000 | 18 200 |
| H | 814 000 | 97 600 | 1 | 814 000 | 97 600 |
| I | 480 000 | 52 000 | 1 | 480 000 | 52 000 |
| J | 827 000 | 54 000 | 1 | 827 000 | 54 000 |
| K | 734 000 | 56 300 | 1 | 734 000 | 56 300 |
| L | 911 000 | 88 300 | 1 | 911 000 | 88 300 |
| M | 978 000 | 69 400 | 1 | 978 000 | 69 400 |
| **Total** | **7 609 000** | **763 700** | **13** | **7 609 000** | **763 700** |
| **Constraint** | **3 000 000** | | | | |

# Solver Parameters using Excel

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# The solution using Solver of Excel

| Project | Investment | NPV | Include | Selected Projects | |
|---|---|---|---|---|---|
| | | | | Investement | NPV |
| A | 237 000 | 84 300 | 1 | 237 000 | 84 300 |
| B | 765 000 | 26 900 | 0 | 0 | 0 |
| C | 304 000 | 23 200 | 1 | 304 000 | 23 200 |
| D | 565 000 | 82 600 | 1 | 565 000 | 82 600 |
| E | 109 000 | 20 500 | 0 | 0 | 0 |
| F | 89 000 | 90 400 | 1 | 89 000 | 90 400 |
| G | 796 000 | 18 200 | 0 | 0 | 0 |
| H | 814 000 | 97 600 | 1 | 814 000 | 97 600 |
| I | 480 000 | 52 000 | 0 | 0 | 0 |
| J | 827 000 | 54 000 | 0 | 0 | 0 |
| K | 734 000 | 56 300 | 0 | 0 | 0 |
| L | 911 000 | 88 300 | 1 | 911 000 | 88 300 |
| M | 978 000 | 69 400 | 0 | 0 | 0 |
| **Total** | **7 609 000** | **763 700** | 6 | **2 920 000** | **466 400** |
| **Constraint** | **3 000 000** | | | | |



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# But life can be more complex than that

**Multi-period analysis**

| Projects | Cash flows 0 | 1 | 2 | NPV | PI |
|---|---|---|---|---|---|
| A | -10,0 € | 30,0 € | 5,0 € | 21,4 € | 3,14 |
| B | -5,0 € | 5,0 € | 20,0 € | 16,1 € | 4,21 |
| C | -5,0 € | 5,0 € | 15,0 € | 11,9 € | 3,39 |
| D | | -40,0 € | 60,0 € | 13,2 € | 1,33 |

According to PI you must should B and C = 16,1€+11,9€= 28,0€

But if you choose A in year 0, you may choose D in year 1
A+B=21,4€+13,2€=34,6€




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# FINAL COMMENTS

## Basic rules for financial decision

- QUANTIFY the relevant cash flow for each year;
- Identify the level of RISK of cash flows and decide the appropriate discount rate considering the level of risk;
- Discount the cash flows of each project with the relevant discount rate;
- Compare the NPV of each project at the same time value of money.




## Investment decision is not a black box?

- Net operating cash flow (cash flow to the firm) or net cash flow (cash flow to the equity)?
- Incremental cash flows
    - Do not confuse average with incremental cash flows
    - Include all incidental effects
    - Do not forget working capital requirements
    - Include opportunity costs
    - Forget the sunk costs
    - Beware of allocated overhead costs
- Treat inflation consistently
- Separate investment from financing decisions
- Depreciation is a non-cash expense. It is important only because it is tax deductible

# Treat inflation consistently

| **Cash flows in real terms** | | | | |
|---|---|---|---|---|
| | **0** | **1** | **2** | **3** |
| Cash flows (real terms) | -1 000 € | 300 € | 500 € | 400 € |
| Cost of capital (real terms) | 6% | | | |
| **NPV** | **63,86 €** | | | |
| **IRR** | **9,3%** | | | |
| **Cash flows in nominal terms** | | | | |
| | **0** | **1** | **2** | **3** |
| Inflation rate | 2,50% | | | |
| Cash flows (nominal terms) | -1 000 € | 308 € | 525 € | 431 € |
| Cost of capital (nominal terms) | 9% | | | |
| **NPV** | **63,86 €** | | | |
| **IRR** | **12,0%** | | | |
| **IRR (real terms)** | **9,3%** | | | |

$r_n$ – nominal rate
$r_r$ – rate in real terms
$r_i$ = inflation rate

Fisher Formula:

$$(1+r_n) = (1 + r_r) \times (1 + r_i)$$



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