CORPORATE FINANCE FOR LONG-TERM VALUE

Chapter 6: Investment decision rules

Part 2: Discount rates and valuation methods

Chapter 6: Investment decision rules

The BIG Picture

- How to select investment projects?

Traditional solution

- Calculate the net present value (NPV) of projects -> based on FV
- Do only projects with positive NPV

New solution

- Include also SV and EV to obtain Integrated Present Value (IPV)
- Analyse the interactions between F, S and E in projects -> internalisation

Calculating financial value

- The Net Present Value (NPV) method discounts cash flows at their opportunity cost of capital
- NPV rule: investments with a positive NPV should be undertaken

$$NPV = \sum_{t=0}^{n} \frac{CF_n}{(1+r)^n} > 0$$

Year	2022	2023	2024	2025	2026	2027	2028	2029
Cash flow	-100	25	25	25	25	25	25	25
Discount factor	1.00	0.91	0.83	0.75	0.68	0.62	0.56	0.51
PV(Cash flow)	-100.0	22.7	20.7	18.8	17.1	15.5	14.1	12.8
NPV	**21.7**							

Calculating financial value

- Comparing investment projects using NPV method

Project X

Year	2022	2023	2024	2025	2026	2027	2028	2029
Cash flow	-100	25	25	25	25	25	25	25
Discount factor	1.00	0.91	0.83	0.75	0.68	0.62	0.56	0.51
PV(Cash flow)	-100.0	22.7	20.7	18.8	17.1	15.5	14.1	12.8
NPV	**21.7**							

NPV per euro invested:
21.7 / 100 = 21.7%

Project Y

Year	2022	2023	2024	2025	2026	2027	2028	2029
Cash flow	-50	20	20	20	5	5	5	5
Discount factor	1.00	0.91	0.83	0.75	0.68	0.62	0.56	0.51
PV(Cash flow)	-50.0	18.2	16.5	15.0	3.4	3.1	2.8	2.6
NPV	**11.65**							

NPV per euro invested:
11.65 / 50 = 23.3%

If project Y can be duplicated, then Y > X

Payback rule

- Payback rule: only do an investment if its cash flows pay back the initial investment within a pre-specified period
- The *payback period* is the number of years needed to earn back the initial investment
- Advantages: ease of use
- Disadvantages:
  - Payback period is usually arbitrarily determined
  - Does not account for time value of money
  - Makes cash flows after cut-off point irrelevant (reinforcing short-termism)

IRR rule

- The internal rate of return (IRR) is the discount rate at which a project's NPV equals zero
- IRR Rule: do investment if IRR > opportunity cost of capital

Year	2022	2023	2024	2025	2026	2027	2028	2029
Cash flow	-100	25	25	25	25	25	25	25
Discount factor	1.00	$\frac{1}{(1+r)^1}$	$\frac{1}{(1+r)^2}$	$\frac{1}{(1+r)^3}$	$\frac{1}{(1+r)^4}$	$\frac{1}{(1+r)^5}$	$\frac{1}{(1+r)^6}$	$\frac{1}{(1+r)^7}$
PV(Cash flow)	-100.0	?	?	?	?	?	?	?
NPV	**0**							

Using trial and error or the IRR formula in Excel: r = 0.163

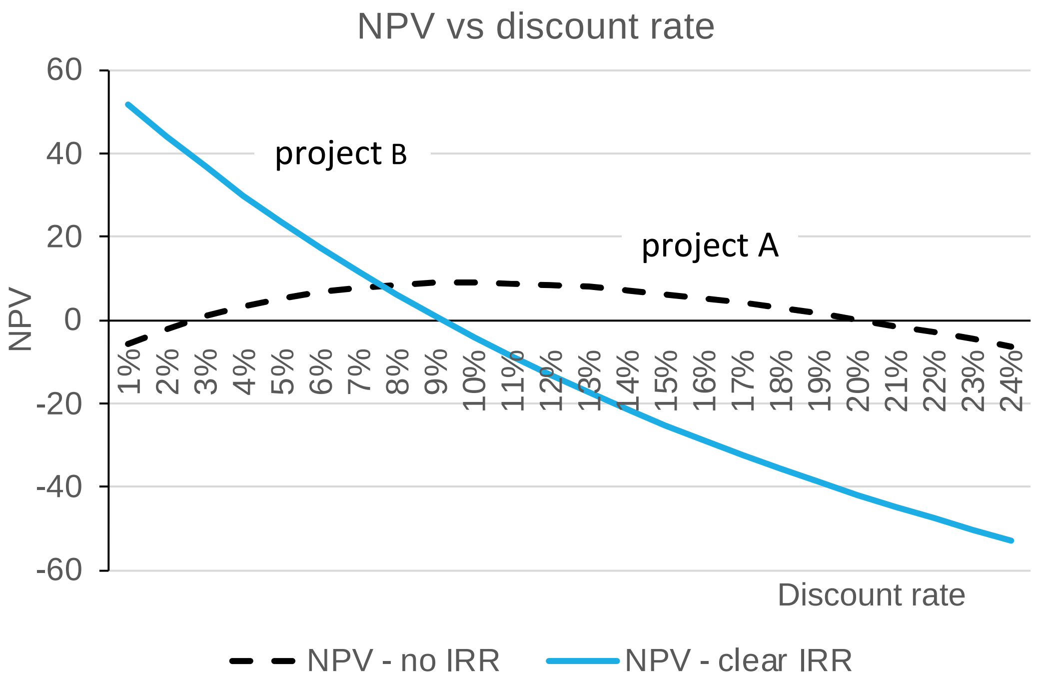
- Advantage: indicates safety
- Disadvantage: not useful in comparing projects of different sizes

IRR rule

- Problem when CF sign flips several times (like project A)

Year	2022	2023	2024	2025	2026	2027	2028	2029
CF project A	-200	110	110	110	-60	110	110	-300
CF project B	-150	30	30	30	30	30	30	30

- For project A, there are two points at which NPV = 0, so there's no unique solution



NPV vs IRR and payback

- Preference for NPV, since:
  - NPVs can be added up
  - It is a direct measure of value created for shareholders (the manager’s primary objective)

Method	Project X	Project Y	Project Y twice	Preferred project
NPV	21.7	11.6	23.3	Project Y twice
IRR	16.3%	19.6%	19.6%	Project Y or Project Y twice
Payback rule	4	3	3	Project Y or Project Y twice

Behavioural effects on investment decisions

- People often behave irrationally in corporate investment decisions
- Internal errors are misvaluations by corporate managers
  - Overconfidence: underestimating the risk of investments, resulting in a lower discount rate
  - Excessive optimism: overestimation of cash flows
- Ways to spot internal errors: prematurely liquidating options, earnings missed and excessive press coverage
- External errors are misvaluations by participants in financial markets
- Behavioural biases, e.g., availability bias and confirmation bias

Overconfidence and excessive optimism

Problem

Suppose three managers assess the same project. The table (right) gives their individual estimates of project risk and expected cash flows, as well as an unbiased assessment of project risk and CFs.

1. What is the unbiased project value?
2. How much do managers A, B and C think the project is worth?

	Unbiased	Manager A	Manager B	Manager C
Project risk	8%	7.5%	8%	7.5%
Perpetual CF	200	200	220	220

Overconfidence and excessive optimism

Solution

1. What is the unbiased project value?

$$PV = \frac{CF}{r} = \frac{200}{0.08} = \mathbf{2500}$$

2. How much do managers A, B and C think the project is worth?

	Unbiased	Manager A	Manager B	Manager C
Project risk	8%	7.5%	8%	7.5%
Perpetual CF	200	200	220	220

Manager A: $\frac{200}{0.075} = \mathbf{2666.7}$ → Overconfidence resulting in a **lower risk assessment**

Manager B: $\frac{220}{0.08} = \mathbf{2750}$ → Excessive optimism resulting in a **higher CF projection**

Manager A: $\frac{220}{0.075} = \mathbf{2933.3}$ → Both overconfidence and excessive optimism = highest overvaluation

Integrated investment decision rules

- Three ways to prioritise investments:
  - **Constrained PV:** includes S and E in own units as budget constraint

    for example: net zero CO_2 emissions; positive health effects
  - **Expanded PV:** expresses S and E in monetary values and adds to FV

    for example: CO_2 emissions x shadow carbon price; health effects x shadow price
  - **Integrated PV:** balances FV, SV and EV in formula:

    $$IPV = FV + b * SV + c * EV \text{ with } b, c > 0$$

Constrained PV

- S and/or E function as a budget constraint to the standard NPV on F

Project	Investment, € millions	NPV F, € millions	CO_2 emitted, millions	CO_2 stored, millions	NPV≥0?	Contribution to CO_2 emissions ≤0?
A	70	-50	0	1	no	yes
B	100	200	0.2	0	yes	no
C	20	250	0.2	0	yes	no

- Project A contributes to becoming neutral but has a negative NPV, so fails on the constrained PV criterion
- Project B and C have positive NPVs but do not contribute to becoming neutral, so also fail on the constrained PV criterion

Constrained PV

- Combining projects might lead to value creation

Project	Investment, € millions	NPV F, € millions	CO_2 emitted, millions	CO_2 stored, millions	NPV≥0?	Contribution to CO_2 emissions ≤0?
A	70	-50	0	1	no	yes
B	100	200	0.2	0	yes	no
C	20	250	0.2	0	yes	no
A+B	170	150	0.2	1	yes	yes
A+C	90	200	0.2	1	yes	yes

- Combing both A with B and A with C contribute to becoming carbon neutral and have a positive NPV, so can both be accepted
- A with C has a higher NPV compared to A with B, so A with C is preferred
- Potential issues: netting pros and cons & including other E and S issues

Expanded PV

- Expresses S and E in monetary values to arrive at SV and EV and then shows these in addition to the standard NPV

Project	Investment, € millions	NPV F, € millions	E in own units net CO_2 reduction	EV (€ millions) net CO_2 reduction at 200 Euro/ton	S in own units quality life years added	SV (€ millions) quality life years added at 110k Euro/life
A	70	-50	1.0	200	-	0
B	100	200	-0.2	-40	2,500	275
C	20	250	-0.2	-40	4,000	440
A+C	90	200	0.8	160	4,000	440

- Project A and C combined looks much better than any individual project, being strongly positive on all three value dimensions

Integrated PV = IPV

- SV and EV are not only separately calculated but also added and weighted, along with the NPV to arrive at an integrated value creation number
- Simple integrated present value decision model: $IPV = FV + SV + EV > 0$

Project	FV	SV	EV	IPV=FV+SV+EV
A	-50	0	200	150
B	200	275	-40	435
C	250	440	-40	650
A+C	200	440	160	800

IPV

- A company should avoid conducting projects whereby a positive FV outweighs negative SV and EV
- Applying different regimes, with *b* denoting the weighting of SV and *c* denoting the weighting of EV

$$IPV = FV + b \cdot SV + c \cdot EV > 0 \qquad with\ b, c > 0$$

- The IPV model acknowledges the interrelationships between the different types of values and allows a structured balancing of stakeholder interests
- Current corporate governance regime: $b = c = 0.1$

IPV

- Intermediate case: $b = c = 0.5$
- Full case: $b = c = 1$

Project	FV	SV	EV	IPV = FV+0.5*SV+0.5*EV	IPV=FV+SV+EV
K	50	-50	-20	15	-20
L	30	30	-40	25	20
M	10	60	-40	20	30

- Which project to choose?
  - Intermediate case: choose project L
  - Full case: choose project M

Internalisation

- The three value dimensions (FV, SV and EV) are created jointly, and with similar drivers, and therefore interact and affect each other

- Taking a dynamic perspective is very important: do not assume the current conditions will last forever, but acknowledge that they can change
  - Current loss-making entities may become profitable as their positive externalities get priced
  - Profitable entities with large negative externalities face the risk of those externalities being (partly) internalised

Internalisation

Project	FV	SV	EV	IPV = FV+0.5*SV+0.5*EV
X	80	-20	-50	45
Y	-20	-30	40	-15
Z	-40	-50	60	-35

Internalisation due to carbon tax, so FV absorbs 75% of EV

Project	FV (old)	SV	EV	FV (new) = FV (old) + 0.75*EV	IPV with internalisation	IPV without internalisation
X	80	-20	-50	42.5	7.5	45
Y	-20	-30	40	10	15	-15
Z	-40	-50	60	5	10	-35

With internalisation, project Y becomes more attractive

Internalisation

- The probability of internalisation estimates to what extent externalities are likely to be translated into FV effects, driven by transition processes

Expected IPV of project Y under varying probabilities of internalisation

IPV with internalisation	Probability of internalisation	IPV without internalisation	Probability of no internalisation	Expected IPV
15	0%	-15	100%	-15
15	10%	-15	90%	-12
15	20%	-15	80%	-9
15	30%	-15	70%	-6
15	40%	-15	60%	-3
15	50%	-15	50%	0
15	60%	-15	40%	3
15	70%	-15	30%	6
15	80%	-15	20%	9
15	90%	-15	10%	12
15	100%	-15	0%	15

Conclusions

- When making investment decisions, companies need to be able to compare various investment opportunities - NPV, payback period and IRR

- Combining NPV with E and S: constrained PV, expanded PV and integrated PV

- F, S and E all weigh in and can be prioritised – ideally informed by the company’s purpose and value creation profile

- Internalisation can happen, thereby shifting EV or SV to FV in positive or negative ways