CHARTA LEARNING · LESSON NOTES

Capital investments: NPV, IRR and allocating capital

CFA Level I · Corporate Issuers

You will learn: How a firm chooses long-term projects: sort and allocate capital, calculate net present value (NPV) and internal rate of return (IRR), choose between them when they conflict, avoid the classic mistakes, value real options, and check results with return on invested capital (ROIC).

Running example: Examples use made-up figures in $ millions: a project costing 600 now with inflows of 250, 300 and 350 over three years at a 10% hurdle rate, and a budget of 1,000.

1. Allocating capital

- A capital investment is spending on long-lived assets (buildings, machines, software) that earn for years. Capital allocation is deciding which projects get funded.
- Kinds of project: replacement or maintenance (light scrutiny); expansion (moderate); new product or market (the most uncertain, so the deepest analysis); regulatory or compliance (must be done whatever the return, so find the cheapest way); strategic, such as buying a rival (judged case by case).
- Process: generate ideas, analyse the extra cash flows, authorise at the right level, monitor, then post-audit by comparing actual results with the forecast and feeding lessons back. The post-audit is most often skipped and matters most, because it shows whether forecasts are always too rosy.
- Capital rationing is a fixed budget: pick the mix that adds the most value in total. The profitability index is NPV ÷ outlay, value per dollar of scarce money.
- The hurdle rate is the minimum return a project must clear; it starts from the cost of capital and is higher for riskier projects.

RATIONING A $1,000M BUDGET (VALUE ADDED = NPV)

Project X	cost 600, adds 120	**index 0.20**
Project Y	cost 400, adds 100	**index 0.25**
Project Z	cost 500, adds 90	**index 0.18**
X + Z	cost 1,100	**over budget**
Y + Z	cost 900	**adds 190**
X + Y (best fit)	cost 1,000	**adds 220**

2. Net present value

- Money later is worth less than money now, so each future payment is shrunk to today's value (discounted) at the hurdle rate. NPV is the sum of the discounted cash flows minus the outlay: the extra wealth created, in today's money.
- Only the extra, after-tax cash the project causes counts: not accounting profit, and not financing costs, which the hurdle rate already covers.
- Rule: NPV above zero, accept; below zero, reject; exactly zero, the project earns just its hurdle rate and it makes no difference. NPVs are in dollars and add up. Discounting assumes cash paid out early can be reinvested at the hurdle rate, which is realistic.

$$NPV = CF_1/(1+r) + CF_2/(1+r)^2 + \ldots + CF_n/(1+r)^n - \text{Outlay}$$

OUTLAY 600 AT YEAR 0; INFLOWS 250, 300, 350; R = 10%

Year 1	250 ÷ 1.10	**227.3**
Year 2	300 ÷ 1.21	**247.9**
Year 3	350 ÷ 1.331	**263.0**
Present value of inflows	add the three	**738.2**
NPV	738.2 − 600.0	**+138.2 (accept)**

3. Internal rate of return, and when NPV and IRR conflict

- IRR is the discount rate at which NPV is zero: the rate the project itself pays on the money tied up. Accept if IRR is above the hurdle rate, reject if below. There is no neat formula, so find it by trial and error or a calculator.
- For one stand-alone project with conventional flows (money out first, then in) NPV and IRR always agree. Trouble comes with mutually exclusive projects (choosing one rules out the other) and unconventional flows, which can have several IRRs or none. NPV always gives one clear answer.
- When they conflict, follow NPV. Owners want more dollars, not a nicer percentage. IRR ignores size and assumes cash is reinvested at the IRR itself, which is far-fetched for a 40% project; NPV assumes the hurdle rate.
- On an NPV profile (NPV against the discount rate) the IRR is where the line crosses zero. Where two profiles cross (the crossover rate, about 16%), below it the bigger, slower project has the higher NPV.

IRR BY TRIAL FOR THE 600 PROJECT, AND TWO MUTUALLY EXCLUSIVE PROJECTS AT 10%

NPV at 10% / 20% / 25%		**+138.2 / +19.2 / −28.8**
NPV at 22% / 21.9%	just below zero / about zero	**−0.8 / ≈ 0, so IRR ≈ 21.9%**
Project A: −500 now, +700 in year 1	700 ÷ 1.1 − 500	**NPV 136.4, IRR 40.0%**
Project B: −1,000 now, +300 a year for 6 years	PV 1,306.6 − 1,000	**NPV 306.6, IRR 19.9%**
Choice	choose the higher NPV	**B**

4. Mistakes in capital allocation

- Sunk costs: money already spent cannot be recovered whatever you decide, so leave it out. Opportunity costs: if the project uses an asset the firm owns, the income it could have earned is a real cost.
- Side effects: a new product that takes sales from an existing one cannibalises it, and only the net gain counts. Politics: the most persuasive manager should not win over the best project.
- Overstated forecasts: managers who want approval are optimistic, and forecasts are rarely checked, which is why the post-audit matters. Taxes: use after-tax cash flows, allowing for the tax effect of depreciation, a non-cash expense that cuts the tax bill.
- Working capital: extra stock and receivables are an outflow early and recovered at the end.
- Financing costs such as interest do not belong in the cash flows: the hurdle rate already charges for financing, so including interest counts the cost twice.

NEW PRODUCT, PRESENT VALUES; THE 3 SPENT ON A MARKET STUDY IS SUNK

Present value of its cash flows		**14**
Outlay still to be spent		**−10**
Lost profit on the old line	cannibalisation	**−2**
Warehouse rent given up	opportunity cost	**−1**
NPV (study cost left out)	14 − 10 − 2 − 1	**+1**
If the sunk study cost were counted		**−2, rejecting a good project**

5. Real options

- A standard NPV picks one path. But managers can change course as they learn, and that flexibility has value. A real option is the right, not the obligation, to do something later, attached to a real project.
- Four common ones: delay (wait for more news before committing); expand (grow the project if it goes well); abandon (sell the assets and stop if it goes badly, a floor under the loss); switch (for example, changing a plant's inputs).
- A single-scenario NPV leaves them all out, so a project that looks like a reject can be worth taking.

OPTION TO EXPAND (CHANCE OF STRONG MARKET 40%, WEAK 60%)

Plain NPV of the project		**−4.0**
Strong market: expand	0.40 × 25	**10.0**
Weak market: do not expand	0.60 × 0	**0.0**
NPV including the option	−4.0 + 10.0	**+6.0**

6. Return on invested capital

- ROIC asks how much profit the firm earns per dollar of capital put in. The top line is NOPAT (net operating profit after tax), taken before interest because interest is the lenders' reward.
- Invested capital is debt plus equity put to work (analysts use the average over the year), so ROIC measures what the business earns on money from both lenders and owners.
- Compare ROIC with the weighted average cost of capital (WACC), not the cost of equity alone. Above it, value is created; below it, value is destroyed, even with an accounting profit, and growth makes it worse. The spread is ROIC minus WACC; economic profit is the spread times capital.
- Because it is measured before financing, ROIC is not distorted by how much debt a firm uses, unlike return on equity. It splits into after-tax margin times capital turnover.

> **ROIC = NOPAT ÷ Invested capital; NOPAT = EBIT × (1 − tax rate)**

EBIT 240, TAX 25%, DEBT 700, EQUITY 800; WACC 9%, CAPITAL 1,500

NOPAT	240 × (1 − 0.25)	**180**
ROIC	180 ÷ (700 + 800) = 180 ÷ 1,500	**12%**
Firm A: spread; economic profit	12% − 9%; 3% × 1,500	**+3%; +45**
Firm B (ROIC 7%): spread; economic profit	7% − 9%; −2% × 1,500	**−2%; −30**

Key takeaways

- Allocate capital through ideas, analysis, authorisation, monitoring and a post-audit; under rationing choose the mix that adds the most value.
- NPV is the discounted after-tax extra cash flows minus the outlay: accept if positive.
- IRR is the rate that makes NPV zero: accept if above the hurdle rate; when it conflicts with NPV, follow NPV.
- Leave out sunk costs and financing costs; count opportunity costs, side effects, tax and working capital.
- Real options (delay, expand, abandon, switch) add value that a single-scenario NPV misses.
- Value is created when ROIC is above WACC.

Quick check

1. Study cost 2 is already spent. Outlay still to come is 10; PV of inflows is 11. Go ahead?
   Answer: Yes. The study is sunk. NPV = 11 − 10 = +1.
2. Mutually exclusive projects: A has the higher IRR, B the higher NPV. Which to choose?
   Answer: B. Choose the higher NPV.
3. NOPAT 90, invested capital 1,000, WACC 11%. Does it create value?
   Answer: No. ROIC = 9%, below the WACC of 11%.