Topic 09

University Business

What this course is, and how to use it

This is the ninth course in University Business: **corporate finance** – the discipline of deciding which cash to take, which projects to fund, and what that cash costs. Accounting (course 2) recorded the past; finance prices the future.

The running case is **Nimbus Kitchen's second-site raise**: £60,000 of new capital, one five-year project, and every number machine-verified. The course's one habit: **a pound today is not a pound tomorrow – so every comparison happens at one point in time.**

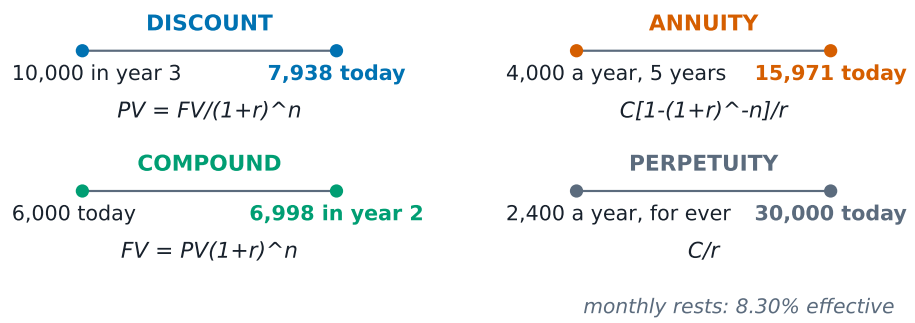
- Units 9.1–9.3 build the machine: time value, incremental cash flows, and the appraisal rules (NPV, IRR, payback).
- Units 9.4–9.5 price the risk and the capital: expected return, diversification, WACC.
- Unit 9.6 closes the loop: financing choices and working capital as the cash the growth eats.

How to read each unit: the question first, then the machinery, then two escalating worked examples on the raise, the mistakes people actually make, and a three-line summary.

Time value of money

Why it matters. The second site costs £60,000 now and pays back over five years. Until those pounds are moved to one common date, "it pays back more than it costs" is not even a sentence.

The idea, with a picture. At 8%, a pound today grows to £1.08 in a year; a pound next year is worth 1/1.08 today. Everything in the course is one of four movements: **compounding** forward, **discounting** back, an **annuity** (equal payments), or a **perpetuity** (equal payments for ever).



Every comparison happens at one point in time - usually today

The definitions. $PV = FV/(1+r)^n$; $FV = PV(1+r)^n$. Annuity of C for n years: $C[1-(1+r)^{-n}]/r$. Perpetuity: C/r. An APR of 8% compounded monthly is $\frac{8\%}{12}$ a month – an effective annual $(1+0.08/12)^{12}-1 = 8.30\%$ ✓.

The derivation. The four checks: £10,000 in 3 years at 8% → $10\,000/1.08^3 = £7\,938$ ✓; £6,000 today in 2 years → $6\,000 \times 1.08^2 = £6\,998$ ✓; £4,000 a year for 5 years → $4\,000 \times [1-1.08^{-5}]/0.08 = £15\,971$ ✓; £2,400 for ever → $2\,400/0.08 = £30\,000$ ✓. Four formulas, one idea.

> **Worked example 1 – which is worth more?** £10,000 in year 3 or £6,000 today plus £4,000 in year 2? Move everything to today: £7,938 against $6\,000 + 4\,000/1.166 = 6\,000 + 3\,430 = £9\,430$. The second wins by £1,492 – and the comparison took one line because both sides sit at the same date. Never compare a future pound with a present pound; move one of them.

> **Worked example 2 – escalate to the mortgage.** The site's fit-out is financed at 8% nominal, monthly rests: the monthly rate is 0.667%, and the effective annual rate is 8.30% – not 8%. On £60,000 over 10 years, quoting 8% flat understates the true rate's cost by roughly £180 of extra interest a year. The convention (nominal ÷ rests) is law in some markets and a trap in all of them: always ask "how many rests, and which rate did you quote?"

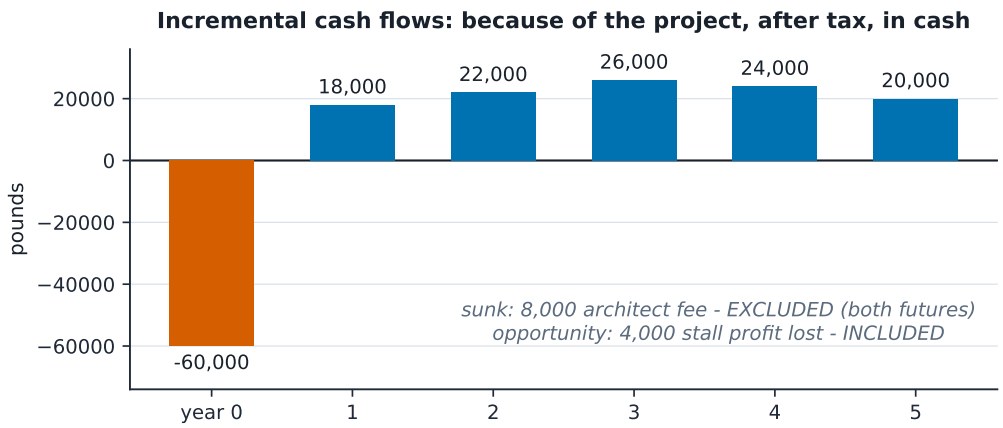
Common mistakes. Comparing cash at different dates. Using the nominal rate as if it were effective. And discounting at a rate that does not match the payment frequency (monthly cash needs the monthly rate).

Summary. $PV = FV/(1+r)^n$; annuities and perpetuities are discounting pre-assembled. Nominal ≠ effective. One date, then compare.

Cash flows and valuation basics

Why it matters. NPV is arithmetic on a list; the craft is the LIST. Most valuation errors are cash-flow errors: sunk costs included, opportunity costs missed, cannibalisation ignored.

The idea, with a picture. The second site's INCREMENTAL cash flows exclude the £8,000 already spent on the architect (sunk), include the £4,000 a year the market stall loses (opportunity), and add back depreciation's tax shield after tax.



Incremental means: because of the project, after tax, in cash

The definitions. Incremental cash flow : the difference the project makes. **Sunk cost** : already spent, never enters. **Opportunity cost** : the best alternative forgone, always enters. **Cannibalisation**: sales stolen from your own products, entered net. Financing costs are in the DISCOUNT rate (unit 9.5), never in the flows.

The derivation. The raise's flows: −60,000; then +18,000, +22,000, +26,000, +24,000, +20,000 – constructed by: revenue 78,000 rising to 92,000; cash costs 54,000 rising to 62,000; depreciation 12,000 a year (non-cash) with tax at 25% on (revenue − costs − depreciation), then depreciation added back; plus the working-capital injection of 4,000 in year 0 recovered in year 5. Every line differences to zero against "do nothing".

> **Worked example 1 – the architect's 8,000.** The founder argues "we've spent 8,000 on drawings, so the project must go ahead". The 8,000 is in BOTH futures – with and without the site – so it differences to zero. Include it and the NPV falls by exactly 0. The rule is not heartless; it is bookkeeping: the money is gone at the decision, and grief is not a cash flow.

> **Worked example 2 – escalate to the stolen Saturday crew.** The second site will use the existing Saturday crew on festival days: £3,000 of contribution that would otherwise be earned ANYWAY is not incremental – but the £1,200 of lost festival orders (capacity genuinely diverted) is. Net entry: −1,200. The test for every line: does the cash change BECAUSE of the project? If yes, in it goes at the moment it moves.

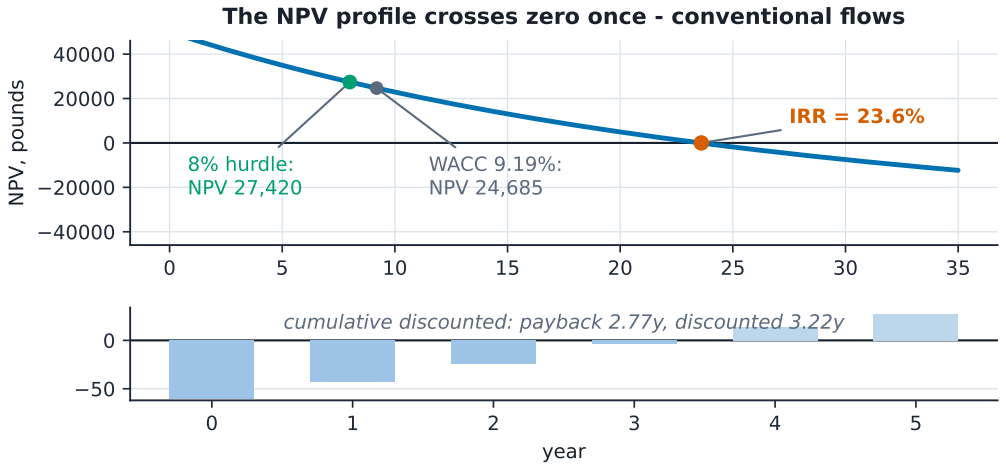
Common mistakes. Including sunk or financing flows (double count). Missing opportunity costs (the stall). And using accounting profit where cash moves: depreciation shelters tax but is not a cash out.

Summary. Incremental = because-of, after-tax, in-cash. Sunk never; opportunity always; financing in the rate. Depreciation's only entry is its tax shield.

Investment appraisal

Why it matters. The five flows are on the table; the decision needs a rule. Three are on the table in every boardroom – NPV, IRR, payback – and they do not always agree. Finance's answer: NPV is the referee.

The idea, with a picture. NPV at 8% = **£27,420** ✓ (positive – create value). IRR = **23.6 per cent** ✓ (above the 8% hurdle → same verdict). Payback = **2.77 years** ✓; discounted payback 3.22 years.



The profile crosses zero once (conventional flows) - where IRR is honest

The definitions. NPV $= \Sigma\ \mathrm{CF}_t/(1+\mathrm{r})^t - \mathrm{I}$: pounds of value created today. **IRR** : the rate where NPV = 0. **The hurdle rate** is the opportunity cost of capital (unit 9.5's WACC). Payback: years to recover the outlay – a liquidity measure, not a value measure.

The derivation. Year by year at 8 per cent: 18,000/1.08 = 16,667; 22,000/1.166 =

18,858; 26,000/1.260 = 20,635; 24,000/1.360 = 17,647; 20,000/1.469 = 13,612. The inflows sum to 87,420, so NPV = 87,420 − 60,000 = 27,420. The IRR solves the same sum for zero: at 23.6 per cent the discounted inflows equal 60,000. Payback: after year 2 the cumulative inflow is 40,000, and year 3 delivers 26,000, so payback is 2 + 20,000/26,000 = 2.77 years (discounted: 3.22).

Worked example 1 – the three rules on one project. NPV says +27,420: do it. IRR says 23.6% > 8%: do it. Payback says 2.77 years: comfortable. All three agree here because the flows are conventional (one sign change) and the project is independent. The discipline: quote NPV as the decision (pounds of value), IRR as a summary (a rate – useful for comparing scale-free), payback as a risk note (how long the money is exposed). Each answers a different question; only NPV answers "how much richer?".

Worked example 2 – escalate to where IRR lies. Alongside site A, a quick refit project C needs only £5,000 (flows −5,000; +4,200; +2,700 over two years): its IRR is 26.6% – HIGHER than A's 23.6% – yet its NPV is £1,204, a twenty-third of A's £27,420. Ranking by IRR prefers C; NPV prefers A, and NPV is right: the company gets 27,420 richer with A. IRR ignores SCALE – the higher rate on £5,000 adds £1,204 of value; the slightly lower rate on £60,000 adds £27,420. With non-conventional flows (a later outflow), IRR can exist twice or not at all – the profile crosses zero twice. The referee stays NPV; the others are commentary.

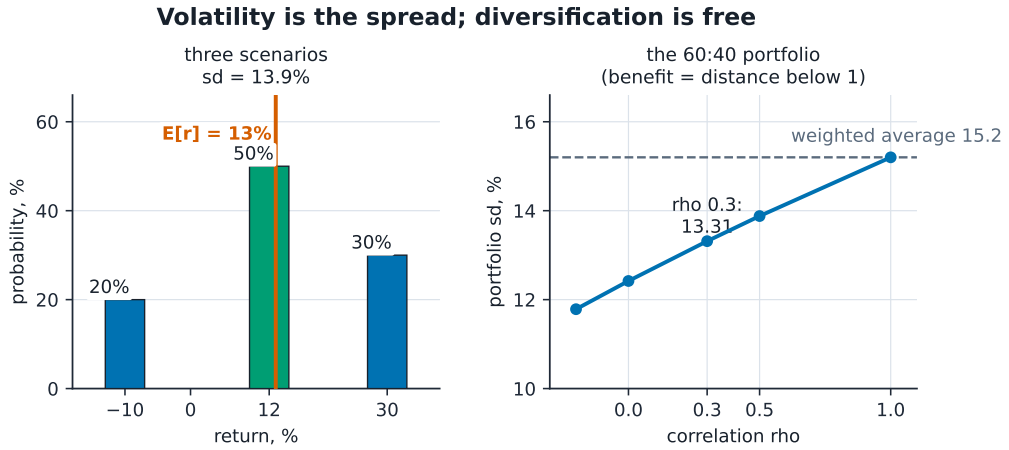
Common mistakes. Ranking mutually exclusive projects by IRR. Accepting on payback alone (it ignores everything after recovery). And quoting IRR without the profile when flows change sign more than once.

Summary. NPV = value in pounds – the decision rule. IRR = where the profile crosses zero; misleads on scale and multiple crossings. Payback = exposure time. Quote all three; decide on NPV.

Risk and return

Why it matters. The 8% hurdle is not given by nature – it is the return investors demand for the risk they carry. This unit builds the demand curve: expected return, volatility, and the one free lunch in finance.

The idea, with a picture. The second site's return distribution: boom 30% (p = 0.3), base 12% (p = 0.5), bust −10% (p = 0.2). **Expected return** = 0.3×30 + 0.5×12 + 0.2×(−10) = **13.0%** ✓; **volatility** (sd) = **13.9%** ✓ – the spread around the mean.



Volatility is the spread; diversification is the only free lunch

The definitions. $E[r] = \sum p_i r_i$; $\sigma^2 = \sum p_i (r_i - E[r])^2$. **Risk premium** : the excess over the 4% risk-free rate. **Diversification** : combining imperfectly correlated assets lowers portfolio volatility below the weighted average – nothing else in finance is free.

The derivation. Variance: $0.3(0.30-0.13)^2+0.5(0.12-0.13)^2+0.2(-0.10-0.13)^2 = 0.0193 \rightarrow \sigma = 13.89\%$ ✓. A 60:40 portfolio of a stock ($\sigma = 20\%$) and a bond ($\sigma = 8\%$) at correlation 0.3: $\sigma_p^2 = 0.36(0.04) + 0.16(0.0064) + 2(0.6)(0.4)(0.3)(0.2)(0.08) = 0.01771 \rightarrow \sigma_p = 13.31\%$ ✓ – below the 15.2% weighted average, because the third term shrinks with ρ. Risk that diversification cannot remove is **systematic** ; risk it can is **specific** . Only the systematic kind is priced.

Worked example 1 – price the site's risk. The site's 13% expected return against a 4% risk-free rate is a 9-point premium. If the site's volatility is mostly specific (a single location), investors holding many sites bear little of it – and should not demand much premium. The finance answer: the 8% hurdle was never about this site alone; it is the WACC of unit 9.5, where only systematic risk survives the portfolio. A single-site founder FEELS idiosyncratic risk; a diversified investor does not price it.

Worked example 2 – escalate to the correlation knife. The same 60:40 portfolio at $\rho = 1.0$: $\sigma_p = 15.2\%$ (no benefit); at $\rho = 0$: 12.4%; at $\rho = -0.2$: 11.8%. Diversification's power is exactly the distance of ρ below 1 – which is why "add another bakery" ($\rho \approx 0.9$ with the first) barely helps, while "add the bond fund" ($\rho \approx 0.3$) does. In the 2008 crisis correlations rose toward 1 and the free lunch briefly vanished; the honest course says so.

Common mistakes. Using past average return as the expectation without a scenario or a model. Adding volatilities (variances add, with the covariance term). And treating

specific risk as priced – the market pays for systematic risk only.

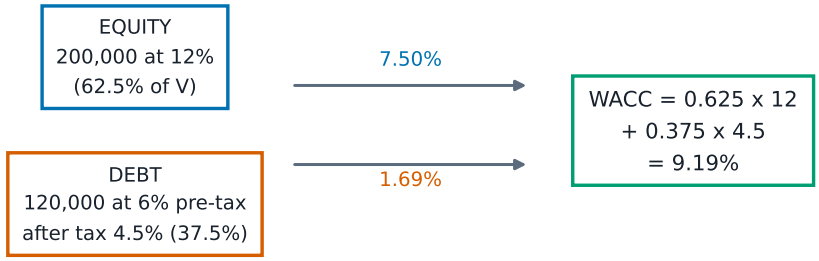
Summary. $E[r] = \sum p_i r_i$; σ = the spread. Portfolio σ falls with the covariance term; only systematic risk earns a premium.

Cost of capital

Why it matters. Every appraisal rule needs the hurdle rate, and the hurdle rate is the blended cost of the money actually raised: £200,000 of equity and £120,000 of debt. Get the blend wrong and every NPV the company ever computes is wrong in the same direction.

The idea, with a picture. WACC with market-value weights: equity £200,000 at 12%, debt £120,000 at 6% pre-tax with tax at 25% → **9.19%** ✓. The weights are what the capital is worth NOW, not the letterhead.

The hurdle is a blend of market values



previously assumed 8%: every NPV was 2,735 too fat;
the proxy working: k_e = 4 + 1.1 x 6 + 1.4 private

The hurdle rate is a blend of market values - and debt is cheaper only because the taxman pays part of it

The definitions. $WACC = \frac{E}{V}k_e + \frac{D}{V}k_d(1-t)$. Cost of equity k_e: what equity investors require (CAPM's $k_e = r_f + \beta(E[r_m] - r_f)$ when a beta exists). The **tax shield**: interest is deductible, so debt's effective cost is $k_d(1-t)$. **Book vs market weights**: the market values, always.

The derivation. E = 80 000 shares × £2.50 = £200,000; D = £120 000; V = 320 000. Weights 62.5% / 37.5%. $WACC = 0.625(12\%) + 0.375(6\% \times 0.75) = 7.5\% + 1.69\% = 9.19\%$ ✓. Recompute the site's NPV at 9.19%: the inflows discount to £84,685 → NPV £24,685 – still comfortably positive, but £2,735 thinner than the 8% guess. The hurdle is not a rounding detail.

> **Worked example 1 – the beta-less private firm.** Nimbus is private: no beta, no quoted price. Proxy: a listed food company with $\beta = 1.1$, $E[r_m] = 10\%$, $r_f = 4\%$ → $k_e = 4 + 1.1 \times 6 = 10.6\%$; add a private-risk premium of 1.4 points → 12% (the number above). Every step is written down because each is a judgement: the proxy, the premium, the market estimate. A WACC with no working shown is a number wearing a lab coat.

> **Worked example 2 – escalate to the debt illusion.** Borrow more at 6% (after tax 4.5%) and WACC falls: at D = £240,000 the blend is 7.91%. Cheaper for ever? No – each tranche of debt raises the equity's risk (β rises toward 1.5, k_e toward 13%+) and eventually the 6% becomes 8% for the riskier borrower. The curve is U-shaped: the bottom is the right amount of debt, not the most the bank will lend. WACC is a snapshot of a balance sheet, not a dial to minimise by borrowing.

Common mistakes. Book-value weights (equity at par when the market says 2.50). Forgetting the tax shield (using k_d pre-tax) – or claiming it while forgetting interest must actually be paid. And recomputing WACC per project with project-level debt: the hurdle moves with the COMPANY's blend, adjusted for the project's RISK.

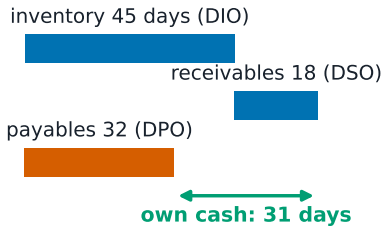
Summary. $WACC = \frac{E}{V}k_e + \frac{D}{V}k_d(1-t)$ at market weights; private k_e by proxy with the judgements written down. Debt helps to a point; the U-curve finds the point.

Financing and working capital

Why it matters. The raise succeeded; now the cash has to survive contact with growth. Fast-growing kitchens die of one thing: the cash cycle eating the working capital before the profit arrives.

The idea, with a picture. The **cash conversion cycle**: inventory 45 days + receivables 18 − payables 32 = **31 days** ✓ of the business's own cash tied up. Growth multiplies it.

The 31-day bridge of own cash



CCC = 45 + 18 - 32 = 31 days of sales tied up

Overtrading, one table

sales	100	**160**
NWC/sales	20%	**25%**
NWC	24,000	**48,000**

NWC DOUBLES
(1.6 x 1.25)

sales +60%, not +60% cash

Growth multiplies the cycle - and overtrading is the multiplier turning profit into a cash crisis

The definitions. $CCC = DIO + DSO - DPO$. **Overtrading**: sales grow faster than the working capital funding them – ratios worsen as the cycle is financed by stress (overdraft, late payments). **Debt vs equity financing**: debt is cheaper and tax-shielded but rigid; equity is permanent but dilutive. **Matching**: fund long assets with long money.

The derivation. Second site opens: sales rise 60%; with the same terms the NWC need rises 60% – but new-supplier terms are worse (NWC/sales 20% → 25%), so working capital must rise $1.6 \times 1.25 = 2.0\times$ ✓: DOUBLE, not 60%. At the old scale NWC was £24,000; the new need is £48,000 – £24,000 of extra cash the profit-and-loss will never show as a cost, and exactly the trap the overtrading table names.

> **Worked example 1 – choose the funding.** The £60,000 raise: option A, all equity at 12%; option B, £24,000 debt at 6% (after tax 4.5%)

- £36,000 equity. Blended cost: A = 12.0%; B = 0.4×4.5 + 0.6×12 = 9.0% – cheaper, and the WACC curve (unit 9.5) said this much debt is left of the U's bottom. The matching principle checks the term: the fit-out is a 10-year asset, the debt is 5-year – mismatched; either lengthen the debt or accept the refinancing risk, in writing.

> **Worked example 2 – escalate to the rescue package.** Six months in: sales +60% as planned, but the cash cycle stretched to 38 days and the overdraft is at its limit. The diagnosis in the overtrading table: NWC/sales has hit 26% – the business is profitable and insolvent at the same time. The levers, in order of speed: collect faster (DSO 18 → 12 releases six days of sales, about £3,200 on the new £192,000 a year), stretch suppliers honestly (DPO 32 → 35 releases three days of purchases), and only then the slow lever – permanent capital. The lesson of the whole course in one sentence: profit is an opinion; cash is a fact, and the cycle decides which fact.

Common mistakes. Reading profit as liquidity (the overtrading trap). Funding long assets with overdrafts. And comparing debt's 6% with equity's 12% without the shield and the risk difference.

Summary. $CCC = DIO + DSO - DPO$; growth multiplies it, and ratio-worsening doubles it. Match term to life. Profit is an opinion; cash is a fact.

The project sheet (reproducible)

Second-site raise, five years:

- Flows: −60,000; +18,000; +22,000; +26,000; +24,000; +20,000.
- NPV at 8% = 27,420; at 9.19% (WACC) = 24,685. IRR = 23.6%. Payback 2.77 years; discounted 3.22.
- Risk: E[r] = 13.0%, σ = 13.9% (boom 30%/0.3, base 12%/0.5, bust −10%/0.2). 60:40 portfolio σ 13.31% at $\rho = 0.3$.
- WACC: E 200,000 (80,000 × 2.50) at 12%; D 120,000 at 6% pre-tax, tax 25% → 9.19%. CAPM proxy: 4 + 1.1×6 = 10.6% + 1.4 private.
- Working capital: CCC = 45 + 18 − 32 = 31 days; sales +60% with NWC/sales 20% → 25% means NWC doubles (24,000 → 48,000).

Every figure in this handout recomputes from these values.