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FORMULA SHEET

FRM Part II

GARP · Financial Risk Manager · Complete formula reference

78 formulas   6 subject areas

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HOW TO USE THIS SHEET

Part II is 80 questions in four hours, and it is a different exam from Part I. The formulas matter less; the JUDGEMENT matters more. Many questions hand you a model and ask what it assumes, where it breaks, and what a risk manager should do about it.

This sheet follows GARP's six books. The formulas are here in full, but read the ▸ notes as the primary content — they carry the reasoning that Part II actually rewards.

A recurring theme runs through every book: every model is a simplification, and the exam is testing whether you know which simplification will kill you. Correlation is not dependence. VaR is not coherent. NAV is not a price. Recovery is not constant.

Current Issues changes each year and is examinable. The section here reflects the crypto capital treatment; check GARP's current reading list, because that book is rewritten annually.

MARKET RISK MEASUREMENT & MANAGEMENT · 16 formulas

Book 1. VaR beyond the normal distribution, backtesting, copulas and term-structure models.

Parametric normal VaR

$$VaR_c = -\mu + z_c \cdot \sigma$$

Where: z_c = 1.645 at 95%, 2.326 at 99%.

▸ *The baseline every other method is measured against. It fails precisely where you need it: in the tail, where returns are not normal.*

Lognormal VaR

$$VaR_c = S_0[1 - \exp(\mu - z_c \cdot \sigma)]$$

Where: S_0 = position value; μ, σ are LOG-return parameters.

▸ *Lognormal VaR is bounded by the position value — you cannot lose more than 100%. Normal VaR has no such bound, which is one reason it misprices large moves.*

Age-weighted (BRW) historical simulation weight

$$w_i = [\lambda^{(i-1)}(1 - \lambda)] / (1 - \lambda^N)$$

Where: i = days ago, $0 < \lambda < 1$ = decay factor.

▸ *Old observations are discounted geometrically, so a fresh volatility regime shows up in the VaR estimate far sooner than under equal weighting. The cost: a lower λ decays faster and responds quicker, but shrinks the effective sample you are estimating from.*

Standard error of an empirical VaR quantile

$$SE(VaR_c) \approx \sqrt{[c(1 - c)/n]} / f(VaR_c)$$

Where: f = the density at the VaR quantile.

▸ *The density in the DENOMINATOR is the whole story: in the far tail the density is tiny, so the standard error explodes. Extreme quantiles estimated from history are barely estimates at all.*

Portfolio variance via factor mapping

$$\sigma^2_p = x^T \Sigma x$$

Where: x = vector of dollar exposures to mapped risk factors, Σ = factor covariance matrix.

▸ *Mapping collapses thousands of positions onto a handful of factors. It makes VaR computable — and it hides any risk the factor set does not span.*

Regression-based hedge with beta adjustment

$$F_{hedge} = \beta \times (DV01_{pos} / DV01_{hedge}) \times F_{pos}$$

Where: β = regression slope of position yields on hedge yields.

▸ *The beta corrects for the hedge instrument moving less than one-for-one with the position. Omit it and you are systematically under-hedged — and the residual is exactly the risk you thought you had removed.*

Sklar's theorem

$$F(x_1,\dots,x_n) = C(F_1(x_1),\dots,F_n(x_n))$$

Where: C = the copula; F_i = marginal CDFs.

▸ *The foundational idea of dependence modelling: you can separate the MARGINALS from the DEPENDENCE STRUCTURE and model each independently. That separation is the whole reason copulas exist.*

Bivariate Gaussian copula joint default probability

$$P(\text{both default}) = \Phi_2(\Phi^{-1}(p_1),\ \Phi^{-1}(p_2);\ \rho)$$

Where: Φ_2 = bivariate normal CDF, ρ = asset correlation.

▸ *The Gaussian copula has ZERO tail dependence — it says extreme events are asymptotically independent. That assumption, applied to mortgage tranches, is a large part of why 2008 happened. A t-copula has tail dependence; use it and say why.*

Kolmogorov-Smirnov statistic (PIT uniformity)

$$D = \sup_x |F\_emp(x) - F\_unif(x)|$$

Where: PIT = probability integral transform.

▸ *If a model is correct, its PITs are uniform on [0,1]. KS uses the MAXIMUM gap, so it is most sensitive around the middle of the distribution — which is not where risk lives.*

Anderson-Darling statistic (PIT goodness-of-fit)

$$A^2 = -n - \Sigma\ [(2i - 1)/n] \times [\ln u_{(i)} + \ln(1 - u_{(n+1-i)})]$$

Where: $u_{(i)}$ = the i-th ordered PIT value.

▸ *Anderson-Darling weights the TAILS more heavily than KS does. For risk models, that makes it the better test — which is exactly the comparison GARP wants.*

Vasicek short-rate dynamics

$$dr = k(\theta - r)dt + \sigma \cdot dW$$

Where: k = mean-reversion speed, θ = long-run rate.

▸ *Mean-reverting with CONSTANT volatility — which means Vasicek permits negative rates. Once a curiosity, then a reality, and now a talking point.*

Vasicek conditional expected short rate

$$E[r\_T \mid r\_t] = r\_t \cdot e\text{^}(-k(T-t)) + \theta(1 - e\text{^}(-k(T-t)))$$

Where: A weighted average of today's rate and the long-run level.

▸ *As the horizon lengthens, the weight shifts entirely to ϑ. The rate forgets where it started — that is what mean reversion means, expressed as a formula.*

Half-life of a Vasicek shock

$$t_{1/2} = \ln 2 / k$$

Where: k = mean-reversion speed.

▸ *Time for a shock to decay to half its size. A quick sanity check on any calibration: k = 0.1 implies a ~7-year half-life, which is a very slow-reverting rate indeed.*

Mean-reversion regression for equity correlation

$$\Delta\rho_t = a(\bar{\rho} - \rho_{t-1}) + \varepsilon_t$$

Where: a = reversion speed, $\bar{\rho}$ = long-run correlation.

▸ *Correlations mean-revert — but they also SPIKE in crises, exactly when diversification was supposed to help. Diversification fails when you need it, and this equation does not capture that.*

Correlation swap payoff

$$\text{Payoff} = N \times (\rho\_realised - K)$$

Where: ρ_realised = average pairwise realised correlation over the swap life.

▸ *A direct trade on correlation. Buying correlation is a crisis hedge, because correlations go to 1 when everything falls together.*

Put-call parity

$$C - P = S - K \cdot e^{-rT}$$

Where: European options, same strike and expiry.

▸ *Still here, still doing the work. Any violation is a riskless arbitrage — which is why it holds to within transaction costs.*

EXAM TIPS — MARKET RISK MEASUREMENT & MANAGEMENT

- Backtesting is examinable and mechanical: count exceptions, apply the Kupiec or the Basel traffic-light test. Too many exceptions means the model understates risk; too FEW means it is over-conservative and wasting capital.
- VaR is not sub-additive and therefore not coherent. Expected shortfall is. Be able to state this in one sentence and give an example — it is the most reliably asked concept in the book.
- Copulas: the Gaussian copula has no tail dependence; the t-copula does. If a question describes assets that crash together, the Gaussian copula is the wrong model and that is the answer.

CREDIT RISK MEASUREMENT & MANAGEMENT · 18 formulas

Book 2. Structural and reduced-form models, portfolio credit risk, CVA and securitisation.

Expected loss

$$EL = PD \times LGD \times EAD$$

Where: The identity everything else builds on.

▸ *A cost, not a risk. It is priced into the spread and provisioned for. Capital covers what comes ABOVE it.*

Unexpected loss (single loan, deterministic LGD)

$$UL = EAD \times LGD \times \sqrt{PD(1 - PD)}$$

Where: Standard deviation of loss under a binomial default.

▸ *If LGD is itself stochastic, UL is larger than this. And recovery falls exactly when defaults rise, so assuming a deterministic LGD understates risk in precisely the scenario that matters.*

Merton distance to default

$$DD = \left[\ln(V/K) + (\mu - \tfrac{1}{2}\sigma_V^2)T\right] / (\sigma_V\sqrt{T})$$

Where: V = asset value, K = debt face value, σ_V = asset volatility.

▸ *How many standard deviations of asset value sit between the firm and its debt. It is a structural model: equity is a call option on the firm's assets, and default is that option expiring worthless.*

Merton default probability

$$PD = N(-DD)$$

Where: N = standard normal CDF.

▸ *Merton's theoretical PD is far too LOW versus observed defaults, because real asset returns have fat tails. Moody's KMV replaces $N(-DD)$ with an empirical EDF mapped from actual default history — and that substitution IS the KMV model.*

Merton equity as a call on firm assets

$$E = V \cdot N(d_1) - K \cdot e^{-rT} \cdot N(d_2)$$
$$d_1 = \left[\ln(V/K) + (r + \tfrac{1}{2}\sigma_V^2)T\right] / (\sigma_V\sqrt{T}), \quad d_2 = d_1 - \sigma_V\sqrt{T}$$

Where: Black-Scholes with the firm's assets as the underlying.

▸ *Shareholders hold a call; debtholders have effectively sold a put. This explains risk-shifting: equity holders GAIN from raising asset volatility, because they own the convexity and the downside belongs to creditors.*

Cumulative default probability (constant hazard)

$$P(\text{default by } t) = 1 - e^{-\lambda t}$$

Where: λ = constant hazard rate.

▸ *The reduced-form view: default is an unpredictable jump, not the outcome of an asset process crossing a barrier. Structural models explain WHY; reduced-form models just calibrate to spreads.*

Hazard rate implied by a CDS spread

$$\lambda \approx \text{CDS spread} / (1 - R)$$

Where: R = recovery rate.

▸ *The market's view of default intensity, extracted from a price. It is a RISK-NEUTRAL hazard rate and it exceeds the real-world one — the gap is the risk premium, not a forecast.*

Single-factor model asset return

$$R_i = \sqrt{\rho} \cdot M + \sqrt{(1 - \rho)} \cdot \varepsilon_i$$

Where: M = common factor, ε_i = idiosyncratic shock, both N(0,1).

▸ *The engine of the Basel IRB formula. Higher ρ means more of the risk is systematic and cannot be diversified away — so capital requirements rise sharply with asset correlation.*

Default correlation between two obligors

$$\rho\_d = [P(D_i \cap D_j) - PD_i \cdot PD_j] / \sqrt{[PD_i(1-PD_i)PD_j(1-PD_j)]}$$

Where: Correlation of the default INDICATORS.

▸ *Default correlation is much lower than ASSET correlation — a small asset correlation produces a tiny default correlation. Confusing the two overstates diversification badly.*

Unilateral CVA

$$CVA \approx (1 - R)\ \Sigma\ EE(t_i) \cdot PD(t_{i-1}, t_i) \cdot D(t_i)$$

Where: EE = expected exposure, D = discount factor.

▸ *The market value of counterparty credit risk — a haircut on the derivative's value. Collateral, netting and central clearing all work by shrinking the EE term.*

Bilateral CVA

$$BCVA = UCVA - DVA$$

Where: DVA = debt value adjustment, the benefit of your OWN possible default.

▸ *DVA is genuinely perverse: your derivatives book GAINS value as your own credit deteriorates. Banks booked DVA profits during their own near-death moments in 2011, which is why regulators now strip it out of capital.*

CDS-bond basis

$$\text{basis} = s\_CDS - s\_bond$$

Where: Bond spread measured over Treasuries.

▸ *A NEGATIVE basis means CDS protection is cheap relative to the bond: buy the bond and buy protection for a near-riskless pickup. The trade blew up in 2008 not because it was wrong, but because funding disappeared before it converged.*

Single-month mortality from CPR

$$SMM = 1 - (1 - CPR)^{(1/12)}$$

Where: CPR = annualised constant prepayment rate.

▸ *De-annualising compounds; it does not divide by 12. Prepayment is the defining risk of MBS — homeowners refinance when rates fall, handing you cash exactly when reinvestment is worst.*

Tranche impairment from pool loss

$$\text{impairment} = \max(0, L\_pool - A) / (D - A)$$

Where: A = attachment point, D = detachment point; clip to [0, 1].

▸ *The tranche absorbs nothing until losses reach A, then loses everything by D. This makes a mezzanine tranche a LEVERAGED bet on the pool loss rate — small errors in the loss estimate become enormous errors in tranche value.*

Mezzanine tranche price via base correlation

$$V[A,D] = V[0,D] - V[0,A]$$

Where: Each equity slice priced at its own base correlation.

▸ *Base correlation exists because compound correlation produced multiple or no solutions for mezzanine tranches. It is a pricing convention that patches a broken model, not a fix for it.*

Overcollateralisation test ratio

```
OC ratio = Pool collateral / Tranche balance
```

Where: A structural trigger.

▸ *Failing the OC test diverts cash flow AWAY from equity and mezzanine to pay down the senior notes early. It is the senior holders' protection, and it fires exactly when the equity holders most want the cash.*

Debt service coverage ratio

```
DSCR = Net operating income / Debt service
```

Where: Debt service = scheduled principal + interest.

▸ *Below 1.0 the property cannot service its own debt from its own cash flow. CRE lenders covenant on this alongside LTV.*

Damodaran country risk premium adjustment

```
ERP adj = Sovereign default spread × (σ_equity / σ_bond)
```

Where: Scales the sovereign spread up to equity volatility.

▸ *The scaling factor exists because equities are riskier than the sovereign bond. It is a rough method, and GARP wants you to know it is rough.*

> **EXAM TIPS — CREDIT RISK MEASUREMENT & MANAGEMENT**
>
> - Structural (Merton, KMV) versus reduced-form (hazard rate): structural models explain default from the balance sheet; reduced-form models calibrate default intensity from market spreads. Know which one a question is describing before you answer.
> - Securitisation questions are about the WATERFALL. Losses hit equity first and work upward; cash flows hit senior first and work downward. Draw it before you compute anything.
> - Wrong-way risk is a recurring theme: exposure rises exactly as the counterparty's credit worsens. Selling CDS protection on a bank correlated with your counterparty is the textbook case.

OPERATIONAL RISK & RESILIENCE · 10 formulas

Book 3. Loss modelling, capital frameworks and the Basel machinery. Conceptual, with a few hard formulas.

Fault tree AND-gate probability

$$P_{AND} = p_1 \times p_2$$

Where: Independent child events that must BOTH occur.

▸ *The independence assumption is the weak point. Two "independent" controls that share a common cause — one data centre, one vendor — are not independent, and the product wildly overstates their protection.*

Fault tree OR-gate probability

$$P_{OR} = p_1 + p_2 - p_1 p_2 \approx p_1 + p_2$$

Where: Either event triggers the parent.

▸ *The approximation only holds for SMALL probabilities. Add several large ones and you will happily compute a probability above 1.*

RCSA risk score

```
Score = L × I
```

Where: L = likelihood (1–5), I = impact (1–5).

▸ *Multiplicative, applied to both inherent and residual risk. The gap between the two is the measured effect of your controls — which is what the whole RCSA exercise exists to reveal.*

Basel total capital ratio

```
Total capital ratio = (T1 + T2) / RWA ≥ 8%
```

Where: T1 = Tier 1, T2 = Tier 2, RWA = risk-weighted assets.

▸ *8% is the floor before buffers. Add the conservation buffer, the countercyclical buffer and G-SIB surcharges and the real requirement is far higher. Know the components of the stack.*

Basel III SMA operational risk capital

$$K_{SMA} = BI \times ILM$$

Where: BI = Business Indicator (a size proxy from financials), ILM = Internal Loss Multiplier.

▸ *SMA replaced the AMA because internal models produced wildly inconsistent capital for identical risks. The ILM scales from 1 based on ten years of loss history — bad history means more capital, permanently.*

Basel III output floor

$$RWA_{eff} = \max(RWA_{IRB}, 0.725 \times RWA_{SA})$$

Where: IRB = internal ratings-based; SA = standardised approach.

▸ *The 72.5% floor caps how much capital a bank can save with its own models. It is the regulators' verdict on model risk, written into the rules — the "Basel IV" endgame in a single line.*

Basel 2.5 market risk capital

$$MRC = \max(VaR \cdot m_c, VaR_{prev}) + \max(sVaR \cdot m_s, sVaR_{prev}) + IRC + CRM$$

Where: IRC = incremental risk charge, CRM = comprehensive risk measure.

▸ *The whole charge is a monument to 2008: VaR calibrated on a calm period failed, so regulators bolted on stressed VaR, a default-migration charge, and a correlation-trading charge on top.*

Risk-adjusted return on capital

$$RAROC = (R - EL - E - T + K \cdot r_f) / EC$$

Where: R = revenues, EL = expected loss, E = expenses, T = taxes, $K \cdot r_f$ = the return earned on the capital held.

▸ *Expected loss belongs in the numerator as a COST. Economic capital sits in the denominator. Reversing that is the error the question is built around.*

Adjusted RAROC

$$\text{Adjusted RAROC} = RAROC - \beta_E(R_M - R_F)$$

Where: β_E = the activity's equity beta.

▸ *Subtracting the systematic risk premium means the hurdle becomes the RISK-FREE RATE, not the cost of equity. Comparing against the wrong hurdle is the whole point of the adjustment — get the comparison right and you get the mark.*

Capital held under integrated risk management

$$K_{held} = \max(K_{reg}, K_{econ})$$

Where: K_{econ} typically calibrated to a 99.95–99.97% confidence level.

▸ *Economic capital targets the bank's own desired rating; regulatory capital is the legal floor. The binding constraint is whichever is higher — and which one binds tells you a lot about the bank.*

EXAM TIPS — OPERATIONAL RISK & RESILIENCE

- Operational risk loss distributions are severely fat-tailed: high-frequency/low-severity events dominate the COUNT, low-frequency/high-severity events dominate the CAPITAL. Model the two separately.
- The seven Basel event types (internal fraud, external fraud, employment practices, clients/products, physical damage, business disruption, execution/delivery) are examinable. Learn to classify a scenario quickly.
- Resilience is now its own topic: know the difference between business continuity (keep running), disaster recovery (get back up) and operational resilience (survive an outcome you never anticipated).

LIQUIDITY & TREASURY RISK · 13 formulas

Book 4. Funding, cash flow and the Basel liquidity ratios. The book that explains how solvent banks die.

Basel III Liquidity Coverage Ratio

$$LCR = HQLA / \text{Net cash outflows over 30 days} \geq 100\%$$

Where: HQLA after haircuts and caps; inflows in the denominator are capped.

▸ *Survive 30 days of severe stress on your own liquid assets. Short-horizon and acute. The inflow cap exists so a bank cannot assume its borrowers keep paying in a crisis.*

Basel III Net Stable Funding Ratio

$$\text{NSFR} = \text{Available stable funding} / \text{Required stable funding} \geq 100\%$$

Where: ASF weights liabilities by tenor and stickiness; RSF weights assets by liquidity, over a one-year horizon.

▸ *LCR is the 30-day sprint, NSFR is the one-year structure. NSFR attacks the maturity mismatch itself — funding long illiquid assets with overnight repo is exactly what it exists to stop.*

Liquidity-adjusted VaR

$$\text{LVaR} = \text{VaR} + \tfrac{1}{2}P(\bar{s} + z \cdot \sigma_s)$$

Where: P = position size, $\bar{s}$ = average proportional bid-ask spread, σ_s = spread volatility.

▸ *Standard VaR assumes you can exit at the mid. You cannot. LVaR adds the cost of crossing the spread — and spreads WIDEN in exactly the stress the VaR is modelling, which is what the $z \cdot \sigma_s$ term captures.*

Net stressed outflow

$$\text{NSO} = \Sigma\, r_i D_i + d \cdot L - I$$

Where: r_i = run-off rate by deposit category, d = drawdown rate on undrawn lines, I = reliable inflows.

▸ *Retail deposits run slowly; wholesale funding runs instantly. That difference in r_i is the single most important number in liquidity risk — and it is what Silicon Valley Bank discovered in 2023.*

Required liquid-asset buffer

$$B = \text{NSO} \times k$$

Where: k = management cushion, typically 1.10–1.25.

▸ *The cushion exists because the run-off assumptions themselves are uncertain. Regulators set a floor; prudent treasurers hold more.*

Contingent liquidity charge on committed lines

$$\text{Charge} = L \times d_{stress} \times c_{HQLA}$$

Where: L = committed line size, d_{stress} = assumed drawdown, c_{HQLA} = opportunity cost of holding HQLA.

▸ *An undrawn credit line is a free option written to the borrower — and they draw it precisely when they are in trouble. Pricing that option back to the client is the point of the charge.*

Available funds gap

$$\text{Gap} = (\Delta L + D_{out} + S) - (\Delta D + L_{in})$$

Where: ΔL = new loan demand, D_{out} = deposit run-off, S = debt service; ΔD = new deposits, L_{in} = loan repayments.

▸ *Uses minus sources. A positive gap must be funded from somewhere — and the whole discipline is planning that "somewhere" BEFORE the gap appears.*

Historical average cost of funds

$$\bar{r} = \Sigma(B_i r_i) / \Sigma B_i$$

Where: B_i = balance of funding source i.

▸ *A backward-looking blended cost. Useless for pricing NEW business — that needs the MARGINAL cost of funds, which in a stressed market is far higher than the average.*

Duration gap with leverage adjustment

$$D_{gap} = D_A - D_L \times (L/A)$$

Where: L/A = the leverage ratio.

▸ *The leverage adjustment is essential: liabilities are smaller than assets, so their duration counts for proportionally less. Omitting L/A overstates the hedge.*

Change in equity from a rate shock

$$\Delta E \approx -D_{gap} \times [\Delta r/(1 + r)] \times A$$

Where: A = asset value, Δr = parallel rate shock.

▸ *A positive duration gap means equity FALLS when rates rise. Borrowing short and lending long — the classic bank balance sheet — is precisely a positive duration gap.*

Repo cash advance after haircut

$$\text{Cash} = V_{coll} \times (1 - h)$$

Where: h = haircut percentage.

▸ *Interest accrues on the CASH advanced, not on the collateral value. Rising haircuts in a crisis force deleveraging even when nothing about the collateral has changed — the mechanism behind the 2008 repo run.*

Repo repurchase price

$$P_{repurchase} = P_{sale} \times (1 + r_{repo} \times n/360)$$

Where: n = days to maturity, 360-day money-market count.

▸ *Money-market convention: 360 days, not 365. Using the wrong day count is a small error that GARP will still price into the answer options.*

Covered interest parity forward rate

$$F = S \times (1 + r_d)/(1 + r_f)$$

Where: Domestic per foreign.

▸ *Here it is a FUNDING tool, not an FX one. Cross-currency basis — the persistent post-2008 violation of CIP — exists because dollar funding is genuinely scarce, and that is the exam point.*

EXAM TIPS — LIQUIDITY & TREASURY RISK

- Liquidity risk kills solvent institutions. Every bank failure in the case-study readings is a funding failure first and a credit failure second. If a question asks what happened, that is usually the answer.
- LCR versus NSFR: 30 days versus one year, acute stress versus structural mismatch. Both must be at or above 100%, and they bite in different circumstances.
- Know the run-off ladder: insured retail deposits are stickiest, uninsured retail next, then corporate, then wholesale and financial-institution funding, which vanishes overnight.

RISK & INVESTMENT MANAGEMENT · 18 formulas

Book 5. Portfolio risk, factor models and the measurement problems specific to illiquid assets.

Diversified portfolio VaR

$$VaR_{div} = z \times \sqrt{w^T \Sigma w}$$

Where: w = vector of dollar positions, Σ = covariance matrix.

▸ *Below the sum of the individual VaRs whenever correlations are under 1. The difference is the diversification benefit — and it evaporates in a crisis, when correlations converge to 1.*

Component VaR

$$CVaR_i = w_i \times MVaR_i$$
$$\Sigma\, CVaR_i = VaR_{div}$$

Where: $MVaR_i$ = marginal VaR per dollar of position i.

▸ *Component VaRs SUM to the total, which is what makes them a usable risk budget. Marginal VaR tells you the effect of a small change; component VaR tells you what a position currently contributes.*

Information ratio

$$IR = (\bar{R}_p - \bar{R}_b) / \sigma(R_p - R_b)$$

Where: Active return over tracking error.

▸ *Active return per unit of active risk. Unlike Sharpe, IR is unchanged by adding leverage or cash to an unconstrained portfolio.*

Grinold's fundamental law

$$IR \approx IC \times \sqrt{BR} \times TC$$

Where: IC = skill, BR = independent bets per year, TC = transfer coefficient.

▸ *Breadth sits under a square root, so doubling your bets does not double your IR. And they must be INDEPENDENT — five hundred correlated positions are one bet. TC captures how much of your view survives the constraints.*

Sharpe ratio

$$SR = (R_p - R_f) / \sigma_p$$

Where: Excess return per unit of total risk.

▸ *Sharpe is easy to manipulate: sell deep out-of-the-money options and you post a beautiful Sharpe for years, right up until you do not. Volatility is not risk.*

Treynor ratio

$$T = (R_p - R_f) / \beta_p$$

Where: Excess return per unit of systematic risk.

▸ *Correct when the portfolio is one sleeve of a diversified whole. Sharpe is correct when it stands alone.*

Jensen's alpha

$$\alpha = (R_p - R_f) - \beta(R_b - R_f)$$

Where: Return above the beta-implied return.

▸ *Alpha is only as honest as the benchmark. Add factors — size, value, momentum — and most reported alpha turns out to be factor beta in expensive clothing.*

Modigliani-squared (M²)

$$M^2 = R_f + (\sigma_m/\sigma_p)(\bar{R}_p - R_f)$$

Where: Re-levers the portfolio to the benchmark's volatility.

▸ *Same ranking as Sharpe, but expressed in percent, so you can compare it directly against the benchmark return.*

Multifactor expected return

$$E[R_i] = R_f + \Sigma_k \beta_{i,k}\lambda_k$$

Where: λ_k = risk premium on factor k.

▸ *The engine of factor investing: returns come from EXPOSURES, and exposures can be bought cheaply. Which raises the awkward question of what the active fee is buying.*

Fama-French three-factor model

$$R_p - R_f = \alpha + \beta_{MKT}(R_m - R_f) + \beta_{SMB}\cdot SMB + \beta_{HML}\cdot HML$$

Where: SMB = size, HML = value. Carhart adds momentum.

▸ *Run this regression on a manager and watch the alpha shrink. If it survives four factors, you may have found genuine skill.*

Total value to paid-in (TVPI)

$$TVPI = (D + NAV) / PIC$$

Where: D = distributions, PIC = paid-in capital.

▸ *Includes NAV, which the GP marks themselves. Early in a fund's life, TVPI is largely an opinion — treat it as one.*

Distributions to paid-in (DPI)

$$DPI = D / PIC$$

Where: Cash actually returned to LPs.

▸ *The only multiple that cannot be flattered by a generous mark. It is the number to ask for when a GP quotes TVPI.*

IRR approximation from TVPI

$$IRR \approx TVPI^{(1/T)} - 1$$

Where: T = average duration of the net cash flows.

▸ *Shows how sensitive IRR is to TIMING. The same TVPI over a shorter T produces a far better IRR — which is why GPs like early exits and subscription lines of credit.*

Smoothed-return autoregression

$$R\_rep,t = \alpha + \rho \cdot R\_rep,t-1 + \varepsilon_t$$

Where: ρ = first-order autocorrelation of REPORTED returns.

▸ *Appraisal-based NAVs are stale, so reported returns are autocorrelated. Genuinely liquid returns are not. A high ρ is the diagnostic that returns are smoothed rather than real.*

Unsmoothed true return

$$R\_true,t = (R\_rep,t - \rho \cdot R\_rep,t-1) / (1 - \rho)$$

Where: Reverses the smoothing filter.

▸ *Unsmoothing RAISES estimated volatility and RAISES the estimated correlation with public markets. The diversification benefit of private assets is partly a reporting artefact — this is the most important single idea in the book.*

Un-smoothed private credit volatility

$$\sigma\_true \approx \sigma\_reported / 0.40$$

Where: The 0.40 smoothing-to-true ratio is attributed to an IMF Global Financial Stability Report (April 2024).

▸ *VERIFY THIS FIGURE BEFORE RELYING ON IT — the 0.40 ratio comes from one specific report and PCC has not independently confirmed it against the primary source. The MECHANISM is the examinable part and it is not in doubt: reported private-credit volatility is a fraction of the true figure, so the real volatility is materially higher than the NAV series shows. Learn the mechanism; treat the constant as provisional.*

Z-score of a risk factor

$$z\_x = (x - \mu\_x) / \sigma\_x$$

Where: Standardised distance from the historical mean.

▸ *Standardising lets you compare shocks across factors on different scales. It is the building block of the Mahalanobis distance below.*

Mahalanobis distance

$$D^2 = (x - \mu)^T \Sigma^{-1} (x - \mu)$$

Where: x = observation vector, Σ = covariance matrix.

▸ *A multivariate z-score that ACCOUNTS FOR CORRELATION. A scenario where every factor moves 2σ in its historical direction is unremarkable; one where they move 2σ in opposite directions is extreme. Univariate stress testing cannot see the difference.*

EXAM TIPS — RISK & INVESTMENT MANAGEMENT

- The organising theme of this book is that illiquid-asset returns are measured badly. Smoothing understates volatility, understates correlation, and overstates Sharpe. Every one of those errors flatters the asset class.
- IRR can be engineered (early exits, subscription lines); multiples ignore time; NAV is an appraisal. Know what each metric hides — that is the exam question, not the arithmetic.
- Risk budgeting runs on component VaR because it sums to the total. Marginal VaR answers "what if I add a little more?" — a different question.

CURRENT ISSUES IN FINANCIAL MARKETS · 3 formulas

Book 6. Rewritten every year. This section reflects the crypto capital treatment — verify against GARP's current reading list.

BCBS Group 2 crypto risk-weighted assets

$$RWA = Exposure \times 1{,}250\% = Exposure \times 12.5$$

Where: Group 2 = unbacked crypto and non-qualifying stablecoins.

▸ *A 1,250% risk weight is punitive by design. Group 1 assets (tokenised traditional securities, qualifying stablecoins) get treated like their underlying; Group 2 is treated as though it may go to zero.*

Minimum CET1 against Group 2 crypto

$$Required\ CET1 = RWA \times 4.5\% = Exposure \times 12.5 \times 4.5\% = 56.25\%\ of\ exposure$$

Where: 4.5% = the Basel III CET1 minimum ratio.

▸ *Do the arithmetic rather than trusting a summary: 12.5 × 4.5% is 56.25%, not 100%. The CET1 minimum alone does not consume the whole exposure.*

Effective dollar-for-dollar capital charge

```
Required TOTAL capital = Exposure × 12.5 × 8% = 100% of exposure
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Where: 8% = the Basel III minimum TOTAL capital ratio.

▸ *The 1,250% weight is reverse-engineered from the 8% total capital minimum: 1/0.08 = 12.5. So the full capital stack must equal the position, dollar for dollar. Regulators are treating the asset as already written off — which is why bank balance sheets hold almost no unbacked crypto.*

EXAM TIPS — CURRENT ISSUES IN FINANCIAL MARKETS

- Current Issues is rewritten annually and IS examinable. Read the actual GARP papers — no summary substitutes, because the questions come straight from them.
- Recent themes have clustered around post-2023 banking stress (deposit run-off, interest-rate risk in the banking book, held-to-maturity accounting), private credit growth, AI in risk management, and climate risk. Expect the framing to change year to year.
- These questions are usually conceptual, not computational. Understand the mechanism and the policy debate, not the arithmetic.

PASSING FRM PART II

What Part II is really testing

- Not whether you can compute, but whether you know when the model lies. Every book is built around a failure mode.
- Correlation is not dependence (copulas). VaR is not coherent (expected shortfall). NAV is not a price (smoothing). Recovery is not constant (LGD). Learn the four and you have the spine of the exam.
- The case studies are examinable and they are cheap marks. One lesson each: LTCM (liquidity and leverage), 2008 (correlation and the Gaussian copula), the London Whale (model governance), SVB (duration gap and deposit run-off).

Formulas worth knowing cold

- EL, UL, and the Basel IRB Vasicek machinery underneath them.
- CVA, DVA, and why DVA is perverse.
- LCR and NSFR — what each covers, and over what horizon.
- Component VaR versus marginal VaR.
- The unsmoothing formula, and what it does to volatility and correlation.
- The hazard rate implied by a CDS spread.

Exam mechanics

- 80 questions in four hours — three minutes each, and more of them are conceptual than in Part I.
- Part II is scored against the cohort. Broad competence across all six books beats mastery of three.
- Do not neglect Current Issues because it is short and unfamiliar. It is roughly 10% of the exam and it is the section everyone skips.
- Practise explaining each model's ASSUMPTION out loud. If you cannot say what breaks it, you do not know it well enough for this exam.