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CHEAT SHEET

CFA® Program Level I

Derivatives Cheat Sheet

2027 curriculum · 10 readings · 41 formulas

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ABOUT THIS EDITION

CredGuild · CFA® Program Level I · Derivatives Cheat Sheet
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CFA® PROGRAM LEVEL I · CHEAT SHEET

Derivatives

Exam weight 6–9% · 10 readings · 41 formulas

70 Derivative Instrument and Derivative Market Features

- A derivative is a contract whose value is derived from an underlying, and every derivative specifies four features: its underlying, contract price, settlement date and contract size.
- The forward price is normally set so that the contract is worth zero to both parties at initiation; at settlement the long receives $S_T - F$ and the short receives $F - S_T$, so one side's gain is the other's loss.
- A deliverable contract exchanges the underlying for the contract price, a cash-settled contract exchanges only the net gain or loss, and ignoring trading costs the two are economically the same.
- Hedging uses a derivative to offset an existing risk, while speculating takes on an exposure the party did not have, so the same trade can be a hedge for one party and speculation for another.
- Compared with a cash market trade, a derivative gives highly leveraged exposure for little cash, can cost much less to trade and may move the underlying's price less.
- For exchange-traded derivatives, the central clearinghouse becomes the buyer to every seller and the seller to every buyer (novation), guaranteeing performance and collecting deposits from both sides, which keeps counterparty credit risk very low.
- Exam convention: exchange-traded derivatives are standardized, liquid, transparent and margined through the clearinghouse, while OTC derivatives are customized, less transparent, largely unregulated, carry more counterparty risk and are not subject to collateral deposit requirements; current practice: an OTC trade outside a CCP still has collateral set by the contract and the counterparties, and for many covered counterparties uncleared-swap margin rules require initial and variation margin.
- Since 2008, a central clearing mandate has required many swaps to be cleared through a central counterparty, which lowers counterparty risk but concentrates it in the CCP.

EXAM SHORTCUTS

- A hedger takes now the derivative position that matches the trade it must make later in the cash market: a party that will have to sell the underlying sells forward, and a party that will have to buy it buys forward.

FORMULAS

Long and short exposure

$$\text{Payoff to long at settlement} = S_T - F$$

$$\text{Payoff to short} = F - S_T$$

71 Forward Commitment and Contingent Claim Features and Instruments

MODULE 71.1 · FORWARDS AND FUTURES

- A forward is a private, customized agreement that obligates both parties, with nothing paid at initiation; the long profits if the underlying's price at settlement is above the forward price, and the short profits if it is below.

- A futures contract is a standardized, exchange-traded forward whose gains and losses are settled daily and whose performance the clearinghouse guarantees, which keeps counterparty credit risk minimal.
- Futures margin is collateral posted by both buyer and seller, not a loan; initial margin must be deposited before a trade, and maintenance margin is the minimum balance the account must keep.
- When a futures account falls below the maintenance margin, the margin call requires a deposit that restores it to the initial margin, or the position is closed out.
- The settlement price used for the daily mark-to-market is the average price of trades during a closing period, and price limits cap how far it may move from the previous day's settlement price.

MODULE 71.2 · SWAPS AND OPTIONS

- In a plain fixed-for-floating interest rate swap, the fixed and floating amounts on the same notional principal are netted and only the party that owes more pays; each floating rate is set at the start of its period and paid at the end.
- An interest rate swap works like a set of forwards on the floating rate, one for each settlement date with the fixed rate as the forward price, and the swap rate is chosen to give the swap zero value when it starts.
- In a credit default swap, the protection buyer makes fixed periodic payments and the protection seller pays only if a credit event occurs, covering the drop in the reference security's value.
- $c_T = \max(0,\ S_T - X)$ and $p_T = \max(0,\ X - S_T)$; the buyer's profit is the value at expiration minus the premium paid, and the writer's profit is the reverse.
- A long call and a short put have long exposure to the underlying, while a long put and a short call have short exposure.
- A forward commitment (forwards, futures, most swaps) obligates both parties and has a linear payoff, while a contingent claim (options, credit default swaps) pays off only if a particular event occurs and has a one-sided payoff; an option buyer pays a premium for the right.

EXAM SHORTCUTS

- Both sides of a call break even at $X + c_0$ and both sides of a put at $X - p_0$, so the writer's breakeven needs no separate calculation.

FORMULAS

Value at expiration and profit for long and short option positions

$$c_T = \max(0,\ S_T - X)$$

$$p_T = \max(0,\ X - S_T)$$

$$\text{Profit to buyer} = \text{value at expiration} - \text{premium paid}$$

$$\text{Profit to writer} = \text{premium received} - \text{value at expiration}$$

72 Derivative Benefits, Risks, and Issuer and Investor Uses

- Derivatives let users change, transfer and manage risk without buying or selling cash market securities, and they create exposures, such as a floor under a sale price, that cash markets do not offer.
- Option prices reveal the market's implied volatility, and futures and forward prices indicate the expected prices of their underlyings, including expected future interest rates.
- Easier short selling, lower transaction costs, greater leverage and greater liquidity make it cheaper to exploit mispricing, which improves market efficiency.
- With margin equal to a fraction m of contract value, a price change of $\Delta P\%$ changes the margin deposit by about $\Delta P\%/m$, so leverage is $1/m$.
- Basis risk arises when the derivative's underlying or settlement date does not match the hedged position, and liquidity risk arises when the hedge's cash flows do not match those of the hedged position.
- An option buyer bears counterparty credit risk while the writer, who already holds the premium, does not, and both sides of a forward can be exposed.

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- A cash flow hedge reduces the variability of future cash flows, a fair value hedge offsets changes in the balance-sheet value of an asset or liability, and a net investment hedge reduces the volatility of the reported value of a foreign subsidiary's equity.
- A firm with floating-rate debt that pays fixed in a swap has a cash flow hedge, while a firm with fixed-rate debt carried at fair value that receives fixed and pays floating has a fair value hedge.

FORMULAS

Risks

$$\%\Delta\text{margin} = \frac{\Delta P\%}{m}$$

$$\text{leverage} = \frac{1}{m}$$

73 Arbitrage, Replication, and the Cost of Carry in Pricing Derivatives

- Arbitrage locks in a risk-free gain with no net investment, so assets with identical payoffs in every state must sell for the same price (the law of one price).
- A derivative must cost the same as the portfolio of the underlying and risk-free borrowing or lending that replicates its payoff, so it is priced with the risk-free rate and no assumption about investors' risk preferences.
- For an underlying that has neither carrying costs nor benefits, the no-arbitrage forward price is the future value of the spot price, $F_0(T) = S_0(1 + R_f)^T$.
- If $F_0(T) > S_0(1 + R_f)^T$, sell the forward, borrow S_0 and buy the underlying; if $F_0(T) < S_0(1 + R_f)^T$, buy the forward, short the underlying and invest the proceeds.
- The forward price is the cost of buying the underlying and carrying it to settlement, $F_0(T) = [S_0 + PV_0(\text{cost}) - PV_0(\text{benefit})](1 + R_f)^T$, and it is not a forecast of the expected future spot price.
- With continuously compounded annual rates for the risk-free rate r, costs c and benefits b, $F_0(T) = S_0\, e^{(r+c-b)T}$.
- For an exchange rate quoted as price currency per unit of base currency, $F = S_0[(1 + R_{\text{price}})/(1 + R_{\text{base}})]^T$, and the higher-rate currency trades at a forward discount.
- Other things equal, a higher risk-free rate or higher storage and insurance costs raise the forward price, and higher dividends, coupons or convenience yield lower it.

EXAM SHORTCUTS

- A cash benefit paid at settlement lowers the forward price by exactly its amount, so a $2 dividend paid at settlement needs no discounting or compounding.
- The currency with the higher interest rate trades at a forward discount, so the direction of the forward rate relative to spot can be read from the two interest rates before any calculation.

FORMULAS

Replicating forwards (underlying with no costs or benefits of holding)

$$F_0(T) = S_0(1 + R_f)^T$$

Spot versus expected future price, and the cost of carry

$$F_0(T) = [S_0 + PV_0(\text{cost}) - PV_0(\text{benefit})]\,(1 + R_f)^T$$

$$F_0(T) = S_0\, e^{rT}$$

$$F_0(T) = S_0\, e^{(r+c)T}$$

$$F_0(T) = S_0\, e^{(r+c-b)T}$$

Currency forwards

$$F = S_0 \times \left(\frac{1 + R_{\text{price}}}{1 + R_{\text{base}}}\right)^T$$

$$\text{or, continuously compounded,} \quad F = S_0\, e^{(r_{\text{price}} - r_{\text{base}})T}$$

74 Pricing and Valuation of Forward Contracts and for an Underlying With Varying Maturities

- The forward price is written into the contract at initiation and does not change, while the forward's value is normally zero at initiation and then moves with the spot price.
- For an underlying with no costs or benefits of holding, a long forward is worth $V_t = S_t - F_0(T)(1+R_f)^{-(T-t)}$ during its life and $S_T - F_0(T)$ at expiration, and the short's value is the negative of the long's.
- With costs and benefits of holding, $V_t(T) = [S_t + PV_t(\text{cost}) - PV_t(\text{benefit})] - F_0(T)(1+R_f)^{-(T-t)}$.
- In AyBy notation, the first number is when the loan starts and the second is how long it lasts, so 2y3y is a 3-year loan from year 2 to year 5.
- $F_{A,B} = [(1+Z_{A+B})^{A+B}/(1+Z_A)^A]^{1/B} - 1$, the rate that makes rolling over at the forward rate earn the same as investing at the longer spot rate.
- The long in an FRA pays the fixed FRA rate and receives MRR, so it gains when MRR rises; a future borrower hedges by going long and a future lender by going short.
- The FRA payment to the long is $\text{Notional} \times (\text{MRR} - \text{FRA rate}) \times \frac{\text{days}}{360}$ discounted at $1 + \text{MRR} \times \frac{\text{days}}{360}$, because it is paid at the start of the loan period.
- A multi-period interest rate swap is a series of FRAs, so each FRA amounts to a swap with only one period.

FORMULAS

Value and price of a forward: at initiation, during its life, at expiration	$V_t(T) = [S_t + PV_t(\text{cost}) - PV_t(\text{benefit})] - F_0(T)(1+R_f)^{-(T-t)}$
Implied (no-arbitrage) forward rates	$(1+Z_{A+B})^{A+B} = (1+Z_A)^A(1+F_{A,B})^B \quad \text{so} \quad F_{A,B} = \left[\frac{(1+Z_{A+B})^{A+B}}{(1+Z_A)^A}\right]^{1/B} - 1$ $1 + Z_{\text{long}}\frac{d_{\text{long}}}{360} = \left(1 + Z_{\text{short}}\frac{d_{\text{short}}}{360}\right)\left(1 + F\frac{d_{\text{long}} - d_{\text{short}}}{360}\right)$
Forward rate agreements (FRAs)	$\text{Payment to long} = \frac{\text{Notional} \times (\text{MRR} - \text{FRA rate}) \times \frac{\text{days}}{360}}{1 + \text{MRR} \times \frac{\text{days}}{360}}$

75 Pricing and Valuation of Futures Contracts

- A forward's price stays fixed and its whole gain or loss is paid at settlement, while a futures contract is marked to market daily, so its price resets to each settlement price and its value returns to zero after each daily settlement.
- Ignoring interest, the daily futures cash flows add up to the same total as the payoff of a forward entered at the same price; what differs is the timing.
- An interest rate futures price is quoted as $100 - (100 \times \text{MRR})$, so a long futures position gains when rates fall.
- $\text{BPV} = \text{notional principal} \times \text{period (in years)} \times 0.0001$ gives the change in an interest rate futures contract's value for a 1 bp change in the rate.
- A positive correlation between rates and futures prices makes futures more attractive to a long, so the futures price is above the forward price; a negative correlation makes the forward more attractive and the futures price lower; with zero correlation or constant rates the two are equal.
- Forward–futures price differences reflect the value of the mark-to-market cash flows and do not create arbitrage opportunities, and in practice they are usually too small to observe.
- Because an FRA's settlement is discounted at the realized MRR, its payoff is nonlinear in the rate while a futures payoff is linear; this convexity bias grows with the length of the period and can make prices differ noticeably for longer-term rates.

FORMULAS

Interest rate futures	$\text{futures price} = 100 - (100 \times \text{MRR}_{A,\,B-A})$ $\text{BPV} = \text{notional principal} \times \text{period (in years)} \times 0.0001$

76 Pricing and Valuation of Interest Rates and Other Swaps

- An interest rate swap is equivalent to a series of FRAs in which the fixed-rate payer is long at the swap fixed rate, and its first net payment is already known at initiation.
- Market FRAs each carry their own no-arbitrage rate and start at zero value, while the FRAs embedded in a swap all use the swap fixed rate, so their individual values are generally not zero but sum to zero.
- A fixed-rate payer's position replicates borrowing at a fixed rate and investing the money at the floating rate, and a floating-rate payer's position replicates borrowing at a floating rate and putting the money into a fixed-rate bond.
- A swap's price is its fixed par swap rate, which is set at initiation and does not change, while its value is zero at initiation and then changes as expected future MRRs change.
- $F = \left[1 - 1/(1+S_N)^N\right] \Big/ \sum_{n=1}^{N} 1/(1+S_n)^n$, the fixed rate per period that makes the fixed leg and the expected floating leg equal in present value.
- Value to the fixed-rate payer = PV(expected floating payments) − PV(remaining fixed payments), so a rise in expected MRRs after initiation gives the fixed-rate payer a gain and the floating-rate payer an equal loss.

EXAM SHORTCUTS

- The par swap rate needs only the spot-rate discount factors, $F = (1 - \text{last discount factor}) / \text{sum of the discount factors}$, so the implied floating rates do not have to be computed first.

FORMULAS

Solving for the par swap rate	$\sum_{n=1}^{N} \frac{\text{MRR}_n}{(1+S_n)^n} = \sum_{n=1}^{N} \frac{F}{(1+S_n)^n}$ $F = \frac{1 - \frac{1}{(1+S_N)^N}}{\sum_{n=1}^{N} \frac{1}{(1+S_n)^n}}$
Value during the life	$\text{Value to fixed-rate payer} = PV(\text{expected floating payments}) - PV(\text{remaining fixed payments})$

77 Pricing and Valuation of Options

- A call is in the money when $S > X$ and a put when $S < X$; either is at the money when $S = X$.
- Exercise value is $\max(0,\ S - X)$ for a call and $\max(0,\ X - S)$ for a put, and time value is the premium minus the exercise value, so the whole premium of an option with zero exercise value is time value.
- Time value generally shrinks as expiration approaches and is zero at expiration; it is typically positive but can be negative for a deep in-the-money European put.
- European option bounds: $\max[0,\ S_t - X(1+R_f)^{-(T-t)}] \le c_t \le S_t$ and $\max[0,\ X(1+R_f)^{-(T-t)} - S_t] \le p_t \le X(1+R_f)^{-(T-t)}$.
- Other things equal, a higher underlying price or a lower exercise price raises a call's value and lowers a put's, a higher risk-free rate raises calls and lowers puts, and higher volatility raises both.
- A longer time to expiration raises a call's value and usually a put's, but a deep in-the-money European put can be worth less with a longer life, more likely when it is deeper in the money, the risk-free rate is higher and the time to expiration is longer.

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- Benefits of holding the underlying, such as dividends, lower call values and raise put values, while storage costs do the opposite.
- At expiration only the underlying price and the exercise price matter, because time value is zero; interest rates and volatility affect only time value.

FORMULAS

Moneyness, exercise value and time value	$\text{Call exercise value} = \max(0,\ S - X)$ $\text{Put exercise value} = \max(0,\ X - S)$ $\text{Option premium} = \text{exercise value} + \text{time value}, \quad \text{so} \quad \text{time value} = \text{premium} - \text{exercise value}$

78 Option Replication Using Put-Call Parity

- A fiduciary call (long call plus a bond paying X) and a protective put (share plus long put) both pay $\max(S_T, X)$, so $c + X(1+R_f)^{-T} = S + p$.
- Put–call parity in this form holds for European options with the same exercise price and expiration on an underlying with no income and no holding costs during the option's life.
- Rearranging parity gives synthetic positions: a synthetic call is long the stock, long the put and short the bond (borrowing $PV(X)$), and a synthetic put is long the call, short the stock and long the bond (lending $PV(X)$).
- When one side of parity is cheap relative to the other, buying the cheap side and selling the expensive side earns the price difference today as an arbitrage profit.
- Put–call forward parity replaces the spot price with the present value of the forward price, $F_0(T)(1+R_f)^{-T} + p_0 = c_0 + X(1+R_f)^{-T}$, so $p_0 - c_0 = [X - F_0(T)](1+R_f)^{-T}$.
- For a firm financed by equity and zero-coupon debt with face value D, shareholders hold a call on the firm's assets with exercise price D, or equivalently the assets plus a long put.
- Debtholders hold a risk-free claim to D plus a short put written to the shareholders; that put is the firm's credit risk, and $V_0 = c_0 + PV(D) - p_0$.

FORMULAS

Put–call parity	$c + X(1+R_f)^{-T} = S + p$
Put–call forward parity and options in corporate finance	$F_0(T)(1+R_f)^{-T} + p_0 = c_0 + X(1+R_f)^{-T}$ $p_0 - c_0 = [X - F_0(T)]\,(1+R_f)^{-T}$
Option view of a firm (equity and debt)	$V_0 = c_0 + PV(D) - p_0$ $\text{Equity}_T = \max(0,\ V_T - D)$ $\text{Debt}_T = \min(V_T,\ D) = D - \max(0,\ D - V_T)$

79 Valuing a Derivative Using a One-Period Binomial Model

- A one-period binomial model values an option from the current underlying price, the exercise price, the up-move and down-move factors and the risk-free rate; it needs neither real-world probabilities nor a risk-adjusted discount rate.
- For a call, the hedge portfolio is long h shares and short one call, with $h = (c_1^u - c_1^d)/(S_1^u - S_1^d)$; its certain end value is discounted at the risk-free rate and $c_0 = hS_0 - V_0$.
- For a put, the hedge portfolio is long h shares and long one put, with $h = (p_1^d - p_1^u)/(S_1^u - S_1^d)$ and $p_0 = V_0 - hS_0$.

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- $\pi_U = (1 + R_f - R^d)/(R^u - R^d)$ and $\pi_D = 1 - \pi_U$, and an option's value is its payoffs weighted by π_U and π_D and discounted one period at the risk-free rate.
- Risk-neutral probabilities are pseudo-probabilities derived from the no-arbitrage hedge, under which the underlying's expected return equals the risk-free rate; they are not the actual probabilities of the moves.
- The hedge approach and risk-neutral valuation both discount at the risk-free rate and give the same option value.

EXAM SHORTCUTS

- For European options with the same exercise price and expiration on an underlying with no income or holding costs, once the call is valued the put follows from put–call parity, $p_0 = c_0 - S_0 + X/(1 + R_f)$, with no second hedge calculation.

FORMULAS

Call: long h shares, short one call	$h\,S_1^u - c_1^u = h\,S_1^d - c_1^d \quad \Rightarrow \quad h = \dfrac{c_1^u - c_1^d}{S_1^u - S_1^d}$ $c_0 = hS_0 - V_0$
Put: long h shares, long one put	$h = \dfrac{p_1^d - p_1^u}{S_1^u - S_1^d}$ $V_0 = hS_0 + p_0 \;\Rightarrow\; p_0 = V_0 - hS_0$
Risk neutrality	$\pi_U = \dfrac{1 + R_f - R^d}{R^u - R^d}$ $\pi_D = 1 - \pi_U$ $c_0 = \dfrac{\pi_U\,c_1^u + \pi_D\,c_1^d}{1 + R_f}$ $p_0 = \dfrac{\pi_U\,p_1^u + \pi_D\,p_1^d}{1 + R_f}$

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