# Risk Management and Derivatives 2026
# Shanghai Jiao Tong University
# Summer School 2026
# Quiz 1: Topics 1–3
# **With Solutions**

**Reading time:** 10 minutes. **Writing time:** 60 minutes.

**Total marks:** 100. **Calculators are NOT permitted.** Every calculation is designed to be done by hand.

**Instructions:** Answer **all** questions. In Section A, circle the letter of the single best answer. In Section B show your working. Section C is a short essay.

**Structure:**

- **Section A** — Multiple choice: 20 questions, 2.5 marks each (**50 marks**).
- **Section B** — One analytical problem in five parts (**30 marks**).
- **Section C** — One short essay (**20 marks**).

**Useful formulas.** Minimum-variance hedge ratio $h^* = \rho \dfrac{\sigma_S}{\sigma_F}$; number of futures contracts $N^* = h^* \dfrac{Q_A}{Q_F}$; hedge effectiveness $= \rho^2$; basis $b = S - F$.

## Section A: Multiple Choice (20 questions × 2.5 marks = 50 marks)

**1.** A *derivative* is best described as:

(A) a share of ownership in a company.

(B) a contract whose value depends on the price of some other, underlying variable.

(C) a loan made by a bank to a firm.

(D) a physical commodity, such as crude oil or gold.

**Solution. (B).** A derivative "derives" its value from an underlying variable (an asset price, an index, an interest rate). It is a contract, not the underlying asset itself (D), not equity (A), and not a loan (C). Forwards, futures, options and swaps are all derivatives.

**2.** An airline holds a *long* forward contract to buy crude oil at a delivery price $K = \$80$ per barrel. At maturity the spot price is $S_T = \$95$. The payoff to the long forward position is:

(A) $-\$15$.

(B) \$80.

(C) $+\$15$.

(D) \$95.

**Solution. (C).** The payoff to a long forward at maturity is $S_T - K = \$95 - \$80 = +\$15$ per barrel: the holder can buy at \$80 something worth \$95. (The short side has the mirror-image payoff, $-\$15$.)

**3.** A trader who takes a futures position purely to profit from an expected price move, with no underlying business exposure to offset, is acting as a:

(A) speculator.

(B) hedger.

(C) arbitrageur.

(D) clearing house.

**Solution. (A).** A speculator takes on risk in the hope of profit. A hedger uses derivatives to reduce an existing business risk; an arbitrageur locks in a riskless profit from a price discrepancy; the clearing house guarantees trades. All three types of participant are needed for a liquid market.

**4.** The holder (buyer) of a *call* option:

(A) is obliged to buy the underlying at the strike price.

(B) is obliged to sell the underlying at the strike price.

(C) has the right to sell the underlying at the strike price.

(D) has the right, but not the obligation, to buy the underlying at the strike price.

**Solution. (D).** A call gives its holder the *right* (not the obligation) to *buy* the underlying at the strike; the holder exercises only when it is worthwhile, paying a premium up front for that choice. The right to *sell* is a put (C); obligations belong to the option writer, not the holder.

**5.** Compared with a forward contract, an exchange-traded *futures* contract is:

(A) a private, customised agreement with no interim cash flows.

(B) standardised, traded on an exchange, and settled (marked to market) daily.

(C) always physically delivered and never closed out early.

(D) free of any counterparty risk because it is unregulated.

**Solution. (B).** Futures are standardised (fixed contract size, quality, delivery months), trade on an exchange, and are marked to market daily through a margin account. A forward is the private, customised, over-the-counter version (A). Most futures positions are closed before delivery, and the clearing house (not the lack of regulation) manages counterparty risk.

**6.** Suppose the quoted forward price of an asset is far *above* its no-arbitrage level (spot plus the cost of financing it to the delivery date). An arbitrageur could earn a riskless profit by:

(A) buying the asset now (borrowing to fund it) and selling it forward.

(B) selling the asset now and buying it forward.

(C) buying both the asset and the forward.

(D) doing nothing, because arbitrage is impossible.

**Solution. (A).** This is cash-and-carry arbitrage: borrow, buy the asset today, and sell it forward at the too-high price; at delivery you hand over the asset, repay the loan, and keep the difference with no risk. Such trading pushes the forward price back down until it equals the no-arbitrage level (the law of one price).

**7.** Three months ago an airline hedged its future jet-fuel purchase with futures, locking in a cost. Fuel prices then fell, so through the hedge the airline effectively paid *more* than the later spot price. The best assessment of the hedge is:

(A) it was a clear mistake and should not have been done.

(B) the risk manager should be dismissed for losing money.

(C) hedging is pointless, because it can lose money.

(D) it did its job: it removed the cost uncertainty in advance, and a hedge is judged by the risk it removed at inception, not by whether it beats the spot outcome afterwards.

**Solution. (D).** A hedge is assessed *ex ante*, against its purpose of fixing an uncertain cost, not *ex post* against the spot price that happened to occur. Had fuel risen, the hedge would have "won," but that was never the objective. Judging hedges by their after-the-fact profit would push the firm toward speculation, which is the opposite of risk management. (This is the theme of Section C.)

**8.** When a futures trade is registered with the exchange's clearing house (central counterparty), the clearing house:

(A) matches the two traders and then steps away.

(B) guarantees only the buyer, not the seller.

(C) becomes the buyer to every seller and the seller to every buyer, so neither trader is exposed to the other's default.

(D) lends money to both traders.

**Solution. (C).** This is *novation*: the clearing house interposes itself as counterparty to both sides, so each trader faces the clearing house rather than the other party. Backed by margin and a default "waterfall," this is what removes bilateral counterparty risk from exchange-traded futures.

**9.** A futures trader must add cash to the margin account (a margin call) when the account balance falls:

(A) below the maintenance margin level.

(B) below the initial margin level.

(C) below the notional value of the contract.

(D) below zero, and never before.

**Solution. (A).** The trader posts an *initial* margin to open the position; a call is triggered only once losses pull the balance below the lower *maintenance* margin, at which point the account must be topped back up to the initial level. This buffer between the two levels avoids a call on every small adverse move.

**10.** "Marking to market" (daily settlement) of a futures position means that:

(A) the contract is repriced only at maturity.

(B) the day's gain or loss is credited to or debited from the margin account every day.

(C) the trader must take physical delivery each day.

(D) the futures price is fixed for the life of the contract.

**Solution. (B).** Each day the position is revalued at the new settlement price and the change is settled in cash through the margin account, so profits and losses are realised daily rather than all at maturity. This daily flow (variation margin) is what keeps counterparty exposure small and is the key mechanical difference from a forward.

**11.** As a futures contract approaches its delivery date, the futures price:

(A) rises far above the spot price.

(B) stays completely disconnected from the spot price.

(C) converges toward the spot price of the underlying.

(D) is fixed by the clearing house.

**Solution. (C).** At delivery a futures contract is essentially a claim on the asset now, so the futures price must converge to the spot price; otherwise an arbitrage between the two would exist. Before delivery the two can differ (the basis), but that gap shrinks toward zero as expiry nears.

**12.** In a hedge, the *basis* is defined as:

(A) the initial margin divided by the notional value.

(B) the futures price minus the option strike price.

(C) the profit on the futures position.

(D) the spot price of the asset being hedged minus the futures price used.

**Solution. (D).** The basis is $b = S - F$, the spot price of the hedged asset minus the futures price. Because the two need not move exactly together, the basis fluctuates, and the risk it leaves in a hedge is called basis risk.

**13.** A futures market is said to be in *contango* when:

(A) the futures price is below the current spot price.

(B) the futures price is above the current spot price.

(C) the spot price equals the futures price.

(D) there is no basis risk.

**Solution. (B).** Contango is a futures price above the spot price (an upward-sloping curve across delivery months); the reverse, futures below spot, is backwardation. In contango a hedger who keeps rolling a long position tends to pay a "roll cost" each time.

**14.** Because a futures position requires posting only a small margin relative to the contract's large notional value, futures give the trader:

(A) leverage: small price moves produce large percentage gains or losses on the cash posted.

(B) no exposure to price movements at all.

(C) a guaranteed profit.

(D) protection from all possible losses.

**Solution. (A).** A small margin controls a large notional, so the percentage gain or loss on the cash actually posted is magnified: this is leverage. It cuts both ways, which is why futures used without a matching exposure (speculation) can produce very large losses, as the Barings collapse showed.

**15.** A company knows it will *buy* a commodity in the future and wants to protect against a price *rise*. It should take a:

(A) written (short) put position only.

(B) short futures hedge.

(C) no position, since buyers are never at risk.

(D) long futures hedge.

**Solution. (D).** A future buyer fears higher prices, so it takes a *long* futures hedge: if the price rises, the gain on the futures offsets the higher purchase cost. (A future *seller* of a commodity fears a price fall and uses a short hedge.)

**16.** The *minimum-variance hedge ratio*, the size of the futures position that minimises the variance of the hedged position, equals:

(A) $\sigma_F/\sigma_S$.

(B) $\rho \times \sigma_F/\sigma_S$.

(C) $\rho \times \sigma_S/\sigma_F$.

(D) $\rho^2 \times \sigma_S/\sigma_F$.

**Solution. (C).** $h^* = \rho\,\sigma_S/\sigma_F$: the ratio of the volatilities scales the position (how much the futures moves relative to the exposure), and the correlation $\rho$ discounts it (only the part of the futures move that tracks the exposure is useful). It is exactly the slope of a regression of the spot change on the futures change.

**17.** An airline cross-hedges jet fuel with crude-oil futures and finds a minimum-variance hedge ratio of 0.6, not 1.0. The main reason it is below 1.0 is that:

(A) the airline is using the wrong contract entirely.

(B) jet fuel and crude oil are related but do not move one-for-one: they have different volatilities and less-than-perfect correlation.

(C) the hedge ratio must always equal the number of contracts.

(D) futures cannot be used to hedge commodities.

**Solution. (B).** A ratio below one says that matching barrel-for-barrel would over-hedge: crude futures and jet fuel differ in volatility and are imperfectly correlated, so each futures barrel does not remove a full barrel of fuel-price risk. Cross-hedging with a related-but-not-identical instrument is exactly what leaves basis risk.

**18.** For a minimum-variance hedge, the fraction of the variance of the exposure that the hedge removes (its effectiveness) is:

(A) $\rho^2$, the square of the correlation between the spot and futures price changes.

(B) $\rho$, the correlation itself.

(C) $1 - \rho$.

(D) the hedge ratio $h^*$.

**Solution. (A).** The optimally hedged variance is $\sigma_S^2(1-\rho^2)$, so the fraction removed is $\rho^2$ (the regression $R^2$). With $\rho = 0.8$, for example, the hedge removes 0.64, or 64%, of the variance, leaving 36% as basis risk.

**19.** The holder (buyer) of a *put* option:

(A) is obliged to buy the underlying at the strike price.

(B) is obliged to sell the underlying at the strike price.

(C) has the right, but not the obligation, to buy the underlying at the strike price.

(D) has the right, but not the obligation, to sell the underlying at the strike price.

**Solution. (D).** A put gives its holder the *right* (not the obligation) to *sell* the underlying at the strike price; a firm that will sell an asset later and wants a price floor can buy a put for protection. The right to *buy* is a call (C); the obligations fall on the option writer, not the holder.

**20.** Even a well-designed futures hedge usually leaves some residual risk, called *basis risk*, because:

(A) the clearing house adds risk to every trade.

(B) futures always expire worthless.

(C) the futures contract does not track the hedged exposure perfectly (a different asset, delivery timing, or location).

(D) hedging is prohibited for most firms.

**Solution. (C).** A hedge replaces a large price risk with a smaller basis risk; it changes the form of risk rather than removing it. The residual arises whenever the futures used is not identical to the exposure, for example crude futures against jet fuel, a standard delivery month against the actual purchase date, or an exchange delivery point against the firm's own location.

# Section B: Analytical Problem (30 marks)

An airline will buy **600,000 barrels** of jet fuel in three months. There is no liquid jet-fuel futures contract, so it **cross-hedges** using crude-oil futures, each contract covering **1,000 barrels** and currently priced at **\$80 per barrel**. From monthly price-change data:

$$\sigma_S = 3 \text{ (jet-fuel spot changes)}, \qquad \sigma_F = 4 \text{ (crude-futures changes)}, \qquad \rho = 0.8.$$

*No calculator is needed anywhere in this question.*

(a) **[6 marks]** Compute the minimum-variance hedge ratio $h^* = \rho\,\sigma_S/\sigma_F$. In one sentence, explain the roles of the two factors (the volatility ratio and the correlation).

(b) **[6 marks]** Compute the optimal number of futures contracts $N^* = h^*\,Q_A/Q_F$. Should the airline go **long** or **short** the futures, and why?

(c) **[6 marks]** What fraction of the variance of the airline's fuel cost does this hedge remove (its effectiveness), and what fraction remains? What is the name for the risk that remains?

(d) **[6 marks]** Three months later the airline buys its fuel and closes the hedge. The crude-futures price has risen from \$80 to \$90 per barrel. Using the number of contracts from part (b), compute the total profit or loss on the futures position.

(e) **[6 marks]** Over the same period the airline's actual jet-fuel bill turns out to be \$6 million higher than it had budgeted at inception. Taking the futures result into account, find the airline's **net** additional fuel cost, and explain in one or two sentences what this outcome shows about what a hedge does.

**Solution. (a)** $h^* = \rho\,\dfrac{\sigma_S}{\sigma_F} = 0.8 \times \dfrac{3}{4} = 0.8 \times 0.75 = \mathbf{0.6}$. The volatility ratio $\sigma_S/\sigma_F = 0.75$ scales the position (crude futures are more volatile than jet fuel, so each futures barrel does more than a barrel of work), and the correlation 0.8 discounts it (only the part of the futures move that tracks fuel is useful). Because $h^* < 1$, matching barrel-for-barrel would over-hedge.

**(b)** $N^* = h^*\dfrac{Q_A}{Q_F} = 0.6 \times \dfrac{600{,}000}{1{,}000} = 0.6 \times 600 = \mathbf{360}$ contracts. The airline goes **long**: it will *buy* fuel and fears a price rise, so it needs a position that *gains* when prices rise, which is a long futures position.

**(c)** Effectiveness $= \rho^2 = 0.8^2 = \mathbf{0.64}$, so the hedge removes about **64**% of the variance and **36**% remains. The residual is **basis risk**: jet fuel and crude are related but not identical, so the futures cannot track the exposure perfectly.

**(d)** The airline is long 360 contracts of 1,000 barrels each, and the futures price rose \$10 (from \$80 to \$90). The gain is

$$360 \times 1{,}000 \times (\$90 - \$80) = 360{,}000 \times \$10 = +\$\mathbf{3.6} \text{ million}.$$

**(e)** The fuel bill rose \$6 million and the futures gained \$3.6 million, so the **net** extra cost is \$6M − \$3.6M = \$**2.4** million. The hedge absorbed most of the price rise but not all of it: because it is a partial cross-hedge (crude used for jet fuel, and sized below one-for-one), some basis risk remains. The lesson is that a hedge *reduces* the impact of price moves and cushions the outcome; it does not remove all risk, and its purpose is not to make a profit.

## Section C: Essay (20 marks)

Read the scenario and write a short essay of **about half a page** (roughly 5 to 8 sentences). Marks are for clear economic reasoning, not length.

*An airline runs a hedging programme: each year it fixes the cost of most of its jet fuel in advance, using futures. This year, fuel prices fell sharply after the hedges were put on, so the airline's annual report shows a large loss on its fuel-hedging positions. At the board meeting, a director attacks the treasurer: "You gambled on oil and lost us a fortune. Next year, stop hedging and just buy fuel when we need it."*

**Question [20 marks].** Is the director's criticism fair? In your essay, explain **what the objective of the airline's hedging programme actually is**, why "losing money" on the hedge this year is **not** evidence that it failed, and why an airline (whose core business is flying, not trading oil) should hedge its fuel at all.

**Solution. Model answer (the objective is certainty, not profit).** The criticism is not fair, because it confuses two different goals. The purpose of the hedging programme is **risk management**: to turn an uncertain future fuel cost into a known one, so the airline can price tickets, plan routes and budget with confidence. **Making the cost certain is itself the benefit and the objective; making a profit on the hedge is not.** A hedge locks in a cost in advance, so it must be judged *ex ante*, by the uncertainty it removed at inception, not *ex post* by whether it beat the spot price that happened to occur. This year fuel fell and the hedge "lost," but had fuel risen the hedge would have "won" and saved the airline; either way the airline received exactly what it wanted, a fixed cost, and to judge the programme by this year's outcome would be to reward luck and push the firm toward speculation. The airline should hedge because (i) a stable fuel cost lets it **plan and budget**; (ii) an unhedged fuel spike could threaten the firm itself (cancelled orders, forced sales, nervous lenders), so removing that **tail risk** has value; and (iii) the airline's **comparative advantage** is in flying, not in forecasting oil, so carrying an unhedged fuel bill is itself an active bet in a market where it has no edge. The right response is therefore to keep hedging as a stated, board-level *policy*, not to abandon it after one adverse outcome.

**Marking guide (20 marks).**

- **8 marks** — states clearly that the **objective is to reduce or remove uncertainty / fix the future cost**, and that **certainty itself is the benefit, not profit on the transaction**.
- **6 marks** — explains that "losing money" is **not failure**: a hedge is judged ex ante against its purpose, not ex post against the spot outcome; judging by realised profit invites speculation (and had prices risen, the hedge would have paid off).
- **4 marks** — gives at least one sound reason **why the airline should hedge** de-

spite oil not being its business: planning/budgeting, financial-distress / tail risk, or comparative advantage (no edge in oil; not hedging is itself a bet).

- **2 marks** — notes that hedging should be a pre-agreed **policy**, not a discretionary trade to make money, and writes clearly.

A strong answer may add that a real "loss" would be a *speculative* position with no underlying exposure (as at Barings), which is the opposite of what this programme is.