How do firms manage financial risk?

FRM Part I

1 A story: the bakery and its flour

- Risk management = choosing a response, risk by risk
- No firm removes all risk; some risk is the business
- Four responses: avoid, transfer, mitigate, retain
- The right choice depends on the risk and on the firm

IN THE LESSON

- Imagine a bakery that buys flour every week.
- One day the owner worries.
- Flour could double in price, an oven could catch fire, a big customer might fail to pay.
- What can she do?
- She could stop making wedding cakes, which are risky.
- She could buy insurance on the oven.
- She could fit a smoke alarm and a sprinkler.
- Or she could simply shrug and accept that a few loaves burn every month.
- Those four reactions are the heart of risk management.
- A firm does not try to remove all risk.
- It chooses, risk by risk, what to do and how much to pay for it.

2 The four basic responses

- Avoid: do not undertake the activity
- Transfer: insurance or derivatives hand the risk to others
- Mitigate: cut the chance or the size of loss
- Retain: accept the loss, pay from earnings or capital

IN THE LESSON

- Here are the four responses in plain words.
- Avoid means not doing the activity at all, so the risk never arises.
- Transfer means handing the risk to someone else, by buying insurance or by using derivatives.
- Mitigate means reducing the chance of a loss or its size, through controls, diversification or limits.
- Retain means accepting the loss and paying for it out of earnings or capital.
- Notice that each answer has a price.
- Avoiding can mean giving up profit.
- Transferring costs a premium.
- Mitigating costs effort and money.
- Retaining costs you the loss itself when it comes.
- So the real question is always which response fits the risk in front of you.

3 Matching the response to the risk

Match the strategy to frequency, severity and strategic fit

Strategy	When it fits
Avoid	Large, hard to control, off-strategy
Transfer	Rare, huge, could threaten solvency
Mitigate	Firm can influence it cheaply
Retain	Small and frequent, or a core risk

IN THE LESSON

- How do we choose?
- Look at three things: how often the loss happens, how big it is, and whether the risk fits what the firm is good at.
- Avoidance suits risks that are large, hard to control and unrelated to the firm's strengths.
- Transfer suits rare but huge losses that could threaten the firm's survival, and it can be worth buying even when the premium is more than the expected loss.
- Mitigation suits risks the firm can influence cheaply.
- Retention suits small, frequent losses where cover costs more than it is worth, and also core risks, the ones the firm is paid to take.
- In questions on this, match the strategy to frequency, severity and strategic fit.

4 Transfer is not the end of the story

- Transfer swaps risks; it does not delete them
- Counterparty may fail to pay (credit risk)
- Cover may be partial: exclusions or limits
- A mismatched hedge leaves basis risk
- Cover can make the firm less careful (moral hazard)

IN THE LESSON

- A word on transfer, because it is where learners slip.
- When you buy insurance or a derivative, you do not make the risk vanish.
- You swap it for other risks.
- The insurer or the derivative counterparty might fail to pay, which is credit risk.
- The policy may have exclusions or limits, so the claim is only partly covered.
- A derivative may not match your exposure exactly, which leaves a gap called basis risk.
- And once the loss is covered, the firm may take less care, which is called moral hazard.
- So after a transfer, always ask what residual risk remains.
- The usual mistake is to assume the answer is none.

5 Example 1: why pay more than the expected loss

Illustration, $ million. Chance of fire 1% a year; firm capital 40

Expected loss	1% × 50	**0.5**
Premium asked	insurer's price	**0.8**
Extra paid	0.8 − 0.5	**0.3**
Loss if uninsured	50 against capital 40	**Firm fails**

IN THE LESSON

- Here is an illustration with made up numbers, in millions.
- A firm faces a one per cent chance each year of a fire that costs fifty.
- The expected loss is one per cent of fifty, which is half a million.
- An insurer asks a premium of eight tenths of a million.
- That is three tenths more than the expected loss.
- Should the firm still buy?
- Look at its capital: forty.
- The fire, fifty, is larger than all its capital, so it would wipe the firm out.
- The extra three tenths is the price of survival.
- Contrast that with a small leak costing a tenth, happening often: insurance would cost more than the leak, so the firm keeps that one.

6 Example 2: classify five cases

Match each case to the best response

Warehouse fire, once a century	rare and ruinous	**Transfer**
Bank's own lending losses	core, paid to take	**Retain**
Small weekly stock thefts	frequent, tiny	**Retain**
Payment fraud	cheap controls help	**Mitigate**
Unknown market	huge, off-strategy	**Avoid**

IN THE LESSON

- Now a classification exercise, with a strategy for each case.
- First, a warehouse fire that happens perhaps once a century and would be ruinous.
- Rare and severe: transfer, by insurance.
- Second, a bank's credit risk on the loans it chooses to make.
- Lending is what the bank is paid for.
- That is a core risk: retain it, and manage it with limits.
- Third, small thefts of stock every week.
- Frequent but tiny, and cover costs more than it saves: retain.
- Fourth, payment fraud that cheap controls can cut sharply: mitigate.
- Fifth, entering a distant market with huge unknown losses and no local strength: avoid.

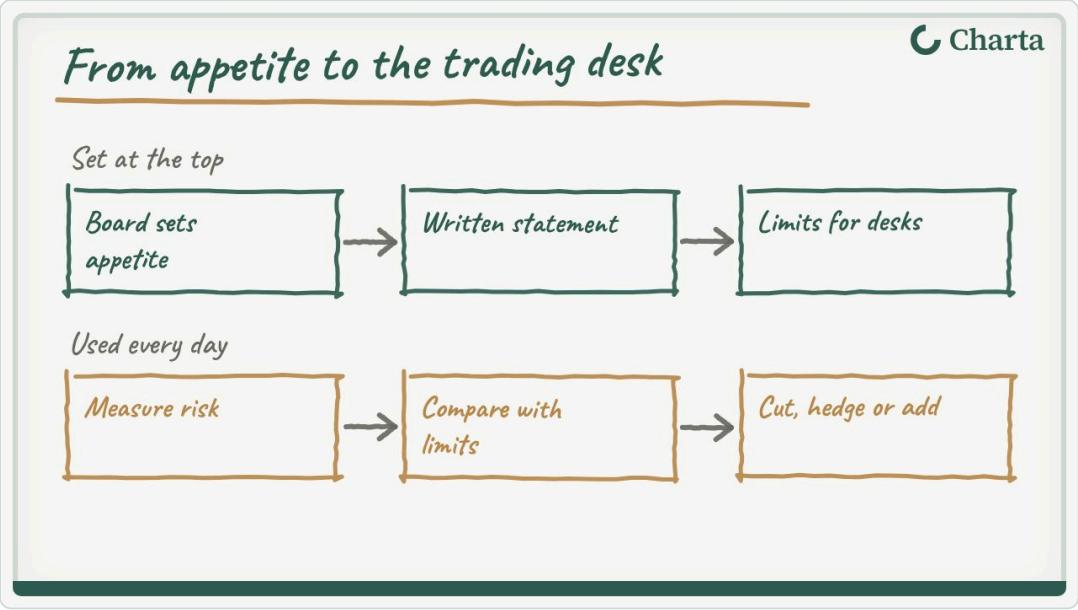
7 Risk appetite: how much risk is acceptable

- Appetite: risk the board is willing to take for its goals
- Capacity: the most it could bear before a limit breaks
- Appetite must sit below capacity, leaving a buffer
- Tolerance: acceptable variation around objectives

IN THE LESSON

- Next question: how does a firm know how much risk is too much?
- The answer starts with risk appetite.
- It is the amount and type of risk the firm is willing to take in pursuit of its objectives, and the board sets it.
- Risk capacity is different.
- It is the most risk the firm could bear before breaking a constraint, such as minimum capital or a loan covenant.
- Appetite must sit below capacity, so that a buffer remains.
- Think of a driver.
- Capacity is the top speed the car can reach before the engine fails.
- Appetite is the speed the driver chooses on this road.
- Tolerance is how far the speedometer may wander around that choice.

8 From appetite to the trading desk



IN THE LESSON

- Appetite is useless if it stays a slogan.
- So it is written down in a risk appetite statement, for example a target credit rating, or a maximum loss at a given confidence level.
- Then it is turned into risk limits for each business line and desk, so every manager knows how much risk is theirs to use.
- Each day, risk is measured and compared with those limits.
- If measured risk exceeds appetite, the firm must cut exposure or hedge.
- If it is far below appetite, the firm may be giving up return it was willing to chase.
- And the board reviews the whole chain, because objectives and conditions change.

9 Example 3: how much to cut to fit appetite

Illustration, $ million, maximum loss at the stated confidence level

Capacity	constraint breached at	**80**
Appetite	board's max; buffer 80 − 45 = 35	**45**
Measured risk	today's risk measure	**60**
Excess over appetite	60 − 45	**15**
Cut needed	(60 − 45) ÷ 60	**25%**

IN THE LESSON

- Let's do the sums, in millions, as an illustration.
- The firm's capacity is eighty: that is the loss at which it would breach its minimum capital.
- The board sets its appetite lower, at a maximum loss of forty five at the stated confidence level.
- The buffer between capacity and appetite is therefore thirty five.
- Today the risk measure says sixty.
- That is above appetite, by fifteen.
- To fit, the firm must remove fifteen out of sixty, which is a quarter of its risk.
- It can sell positions or hedge them.
- Notice that sixty is still below capacity.
- The firm is not in danger yet, but it has broken the board's own rule.

10 Appetite, capacity, tolerance and limits

Which of the four does the statement describe?

Term	Plain meaning
Risk appetite	Willing to take; set by the board
Risk capacity	Could bear before a constraint breaks
Risk tolerance	Acceptable variation around goals
Risk limit	A number given to a desk

IN THE LESSON

- Questions often ask which of these four terms a statement describes, so let's fix them.
- Appetite is the board's chosen amount and type of risk.
- Capacity is the hard ceiling, the most the firm could bear.
- Tolerance is the acceptable variation around objectives, for example earnings that may miss target by a stated amount.
- Limits are the numbers handed to business lines and desks, which implement appetite.
- A common mistake is to confuse appetite with capacity, or with the limits that carry it out.
- Here is a quick trick.
- If the sentence says could bear, think capacity.
- If it says willing to take, think appetite.
- If it gives a number to a desk, think limit.

11 Hedging: the case for

- Lower chance and cost of financial distress
- Protects funds for good investments
- Stabilises earnings, so planning is easier
- Sometimes lowers taxes

IN THE LESSON

- Now to hedging.
- To hedge is to take a position that offsets an exposure, so that a move in price hurts one side and helps the other.
- Why would a firm bother?
- There are four classic reasons.
- First, hedging reduces the chance and expected cost of financial distress, the lawyers, lost customers and fire sales that come with near failure.
- Second, it protects funds for investment, so a bad price year does not force the firm to cancel good projects.
- Third, it stabilises earnings, which helps planning.
- Fourth, in some cases it lowers taxes, because smoother profits can mean less tax over time.
- For a firm with debt, these gains can be large.

12 Hedging: the case against

- Shareholders can diversify firm-specific risk themselves
- Transaction costs: fees and dealing spreads
- A hedge gives up gains when prices move favourably
- Can be misused for speculation

IN THE LESSON

- The other side has real force.
- Shareholders can diversify firm specific risk themselves, by holding many shares.
- So when a firm hedges, it spends money on something shareholders could do for free.
- Hedging has transaction costs, such as fees and dealing spreads.
- It gives up gains: if the price moves your way, the hedge takes the profit away.
- And hedging can drift into speculation, when staff hedge more than the exposure or take views on prices.
- Imagine an airline that locks in fuel and then watches the price crash.
- It is stuck paying above market.
- The sound approach is a net benefit comparison: weigh the gains from lower distress costs against these costs.

13 Basis risk and the variance a hedge removes

Variance removed = ρ² × Variance of the exposure
Variance left = (1 − ρ²) × Variance

Correlation, ρ	Correlation of hedge and exposure
Variance removed	Share of variance the hedge cuts
Variance of the exposure	Risk before any hedge

IN THE LESSON

- Now the main practical problem: basis risk.
- It arises when the hedge instrument does not move one for one with the exposure.
- A firm hedging jet fuel with crude oil futures is a good example.
- The two prices are related, but not identical.
- In the standard minimum variance result, the correlation between the exposure and the hedge is called rho.
- When the hedge is set at the best size, it removes a fraction of the exposure's variance equal to rho squared.
- What remains is one minus rho squared.
- This assumes a linear hedge, set at the optimal ratio, with a correlation that stays stable.
- If the correlation moves, so does the protection.

14 Example 4: how much a hedge really removes

Illustration. Exposure variance = 100 (any unit)

ρ = 1.0	ρ² = 1.00	**100 removed**
ρ = 0.8	ρ² = 0.64	**64 cut, 36 left**
ρ = 0.5	ρ² = 0.25	**25 cut, 75 left**

IN THE LESSON

- A made up illustration.
- Suppose the exposure has a variance of one hundred, in some unit.
- If the hedge is perfectly correlated, rho equals one, rho squared is one, and all the variance goes.
- Now take a more realistic correlation of eight tenths.
- Rho squared is sixty four hundredths, so the hedge removes sixty four per cent of the variance, and thirty six per cent remains.
- In units, that is sixty four removed and thirty six left.
- Now a weaker hedge, with rho of one half.
- Rho squared is a quarter, so only twenty five per cent is removed.
- Notice that a correlation that sounds high, eight tenths, still leaves over a third of the variance in place.

15 More hedging difficulties in practice

- Maturity mismatch forces rolling hedges
- Daily cash settlement: the hedge loses cash now
- The offsetting gain may be unrealised for months
- Hedging a bid that may be lost creates speculation

IN THE LESSON

- Basis risk is not the only trouble.
- Maturity mismatch is another.
- If the exposure lasts longer than the available contracts, the firm must roll the hedge, closing the old contract and opening a new one, and the cost of that roll is uncertain.
- Funding liquidity risk is a third difficulty.
- Futures are settled daily in cash, so when the hedge loses, the firm must pay now, while the gain on the thing it is hedging may be unrealised for months.
- A sound hedge can still cause a cash crisis.
- And a fourth: hedging an exposure that may never materialise, such as a bid for a contract that is not won, leaves a speculative position behind.

16 Example 5: the cash drain from a good hedge

Illustration. Long futures; price falls $8 a barrel

Barrels hedged	200 contracts × 1,000	**200,000**
Price move	fall in the oil price	**−$8 a barrel**
Loss on futures	8 × 200,000	**$1,600,000**
Cash needed now	paid through margin	**$1.6m**

IN THE LESSON

- An illustration.
- An airline expects to buy fuel in six months.
- To lock in the price it buys futures: two hundred contracts of one thousand barrels each, so two hundred thousand barrels.
- Then the oil price falls by eight dollars a barrel.
- The loss on the futures is eight dollars times two hundred thousand, which is one million six hundred thousand dollars.
- Futures are settled daily, so the airline must pay that in cash through margin calls.
- Yet the gain, cheaper fuel, will not arrive until it buys the fuel.
- The hedge worked as designed, but the airline needs one point six million of cash now.
- That is funding liquidity risk.

17 Hedging by type of price risk

Pick the hedge that offsets the worry

Exposure and worry	Typical hedge
Producer fears a price fall	Sell futures or buy puts
Consumer fears a price rise	Buy futures, pay fixed, buy calls
Foreign currency receivable	Sell forward or money market
Floating-rate borrower	Pay fixed on a swap
Bond portfolio, rates rise	Sell futures until DV01 fits

IN THE LESSON

- Now to choosing a hedge.
- Take commodity price risk first.
- A producer fears a fall in price, so it sells futures or forwards, or buys puts.
- A consumer fears a rise, so it buys futures, pays fixed on a swap, or buys calls.
- For currency risk, use forwards priced by covered interest parity, or a money market hedge.
- For interest rate risk, a borrower with floating debt pays fixed on a swap, and a portfolio is hedged by selling futures until its D V zero one matches the target.
- Operational hedges come first.
- Matching the currency of costs and revenues reduces the net exposure before any contract is signed, and it is often cheaper.

18 Covered interest parity

F = S × (1 + r_d × T) ÷ (1 + r_f × T)

Forward, F	Price fixed now, paid at delivery
Spot, S	Price today, home per foreign
Home interest rate	Rate on the home currency
Foreign interest rate	Rate on the foreign currency
Time in years, T	Years until delivery

IN THE LESSON

- Currency forwards are priced by covered interest parity.
- Here the spot price S and the forward price F are quoted as the domestic currency price of one unit of foreign currency.
- The formula says the forward equals the spot times one plus the home interest rate times time, divided by one plus the foreign interest rate times time.
- Why?
- If the forward were different, someone could borrow in one currency, convert, lend in the other and lock in a riskless profit.
- Competition removes that.
- So the currency with the lower interest rate trades at a forward premium, and the higher rate currency at a forward discount.
- Here the home rate is above the foreign rate, so the forward is above the spot.
- Be careful to keep home and foreign the right way round, because it is easy to swap them.

19 Example 6: pricing a currency forward

Illustration. Spot $1.25 per €; $ rate 5%; € rate 3%; T = 1 year

Top: 1 + r_d × T	1 + 0.05 × 1	**1.05**
Bottom: 1 + r_f × T	1 + 0.03 × 1	**1.03**
Forward price F	1.25 × 1.05 ÷ 1.03	**$1.2743 per €**
Locked-in dollars	2,000,000 × 1.274272	**$2,548,544**

IN THE LESSON

- Let's price one, as an illustration.
- A firm based in dollars will receive two million euros in one year.
- The spot price is one dollar twenty five per euro.
- The dollar interest rate is five per cent a year and the euro rate is three per cent.
- Time is one year.
- Top line: one plus five per cent is one point zero five.
- Bottom line: one plus three per cent is one point zero three.
- The ratio is about one point zero one nine four, and multiplying by one point two five gives a forward price of about one point two seven four three dollars per euro.
- Selling the euros forward locks in about two million five hundred forty eight thousand five hundred forty four dollars.

20 Example 7: the money market hedge agrees

Illustration. Same inputs as Example 6

Borrow € today	2,000,000 ÷ 1.03	**€1,941,748**
Convert at spot	× 1.25	**$2,427,184**
Invest at 5% for a year	× 1.05	**$2,548,544**
Forward answer	2,000,000 × 1.274272	**$2,548,544**

IN THE LESSON

- There is a second way to lock in the same result, the money market hedge.
- Instead of a forward contract, the firm uses borrowing and lending.
- Step one: borrow euros today, an amount that grows to exactly two million euros in a year at three per cent.
- That is two million divided by one point zero three, about one million nine hundred forty one thousand seven hundred forty eight euros.
- Step two: sell those euros at spot one point two five, giving about two million four hundred twenty seven thousand one hundred eighty four dollars today.
- Step three: invest those dollars at five per cent.
- After a year they grow to about two million five hundred forty eight thousand five hundred forty four.
- The same answer as the forward, up to rounding.

21 The minimum variance hedge ratio

h = ρ × σ_S ÷ σ_F
Contracts = h × exposure ÷ contract size

Hedge ratio, h	Units of futures per unit exposed
Correlation, ρ	Correlation of price changes
Spot volatility, σ_S	Spot price change volatility
Futures volatility, σ_F	Futures price change volatility

IN THE LESSON

- When the hedge instrument is imperfect, how many contracts should the firm use?
- The minimum variance hedge ratio is h equals rho times sigma S divided by sigma F.
- Here rho is the correlation between the spot price changes and the futures price changes.
- Sigma S is the volatility of spot price changes, and sigma F is the volatility of futures price changes.
- The number of contracts is then h times the exposure, divided by the contract size.
- Read the formula sensibly.
- If the futures are more volatile than the spot, you need fewer than a one for one hedge.
- If the correlation is low, the ratio shrinks.
- A common mistake is inverting the sigma ratio.

22 Example 8: counting contracts, and the inversion trap

Illustration. 500,000 barrels; contract = 1,000 barrels

Inputs	ρ 0.8, σS 6%, σF 5%	**given**
Hedge ratio h	0.8 × 6 ÷ 5	**0.96**
Contracts	0.96 × 500,000 ÷ 1,000	**480**
Wrong (inverted) answer	0.8 × 5 ÷ 6 → about	**333**

IN THE LESSON

- An illustration.
- A refiner must buy five hundred thousand barrels.
- The only futures available are on a related grade.
- The correlation is eight tenths.
- Volatility of spot changes is six per cent, and of futures changes is five per cent.
- The ratio h is eight tenths times six over five, which is ninety six hundredths.
- Contracts equal ninety six hundredths times five hundred thousand, divided by a contract size of one thousand barrels: four hundred eighty contracts.
- Now see the trap.
- If you invert the sigmas, you compute eight tenths times five over six, about sixty seven hundredths, giving only about three hundred thirty three contracts.
- That leaves the firm badly under hedged.

23 Net exposure and interest rate hedges

- Hedge the net exposure, not the gross
- Matching costs and revenues is an operational hedge
- Floating-rate borrower: pay fixed on a swap
- Portfolio: sell futures until DV01 matches the target

IN THE LESSON

- Two more points.
- First, hedge the net exposure, not the gross.
- A firm with revenues of ten million euros and costs of seven million euros in the same currency is naturally hedged on most of it.
- Only the net three million is exposed.
- Hedging the gross ten million would create a new, opposite exposure.
- That is why operational hedges come first.
- Second, interest rate risk.
- A borrower with floating rate debt fears a rise in rates, so it pays fixed on a swap and turns the debt into fixed rate.
- For a bond portfolio, the firm sells futures until the portfolio's D V zero one, the money change per basis point, matches its target.

24 Example 9: hedging a portfolio's DV01

Illustration. Portfolio DV01 = $42,000; futures DV01 = $70 per contract

Portfolio DV01	loss per +1 basis point	**$42,000**
Futures DV01	per contract sold	**$70**
Contracts to sell	42,000 ÷ 70	**600**
Check	600 × 70	**$42,000 offset**

IN THE LESSON

- A final hedging illustration.
- A bond portfolio has a D V zero one of forty two thousand dollars: if yields rise one basis point, it loses forty two thousand.
- The firm wants it near zero.
- Each interest rate futures contract has a D V zero one of seventy dollars per contract.
- Selling a futures contract gains when rates rise, so it offsets the portfolio.
- The number needed is forty two thousand divided by seventy, which is six hundred contracts.
- Check: six hundred contracts times seventy gives forty two thousand of D V zero one on the short side, cancelling the long side.
- If the target were half the portfolio's D V zero one, we would sell three hundred.

25 Risk limits: how they constrain a position

- Position or notional limits cap the size of holdings
- Sensitivity limits, like DV01, cap loss per small move
- VaR and concentration limits cap loss and clustering
- Stop-loss limits trigger a review after cumulative losses

IN THE LESSON

- Now the last outcome: gauging how far limits and instruments change a risk position.
- Limits constrain.
- They come in several types.
- Position or notional limits cap the size of holdings.
- Sensitivity limits, such as D V zero one, cap the loss for a small market move.
- Value at risk, or V a R, limits cap a statistical loss measure.
- Concentration limits stop too much money going to one name or sector.
- Stop loss limits trigger a review after cumulative losses.
- Each has a blind spot.
- A notional limit on its own does not control risk, because a trader can stay within the same notional while shifting from short to long maturity bonds, which hugely raises the sensitivity.

26 Example 10: why a notional limit is not enough

Illustration. Notional $100m; 1 basis point = 0.0001

2-year bonds	duration 2	**DV01 $20,000**
10-year bonds	duration 9	**DV01 $90,000**
Notional used	100m in both cases	**No change**
Risk multiplied by	90,000 ÷ 20,000	**4.5**

IN THE LESSON

- An illustration.
- A desk has a notional limit of one hundred million dollars.
- First it holds two year bonds with a modified duration of two.
- D V zero one is notional times duration times one basis point, which is one hundred million times two times zero point zero zero zero one: twenty thousand dollars.
- Now the desk switches into ten year bonds, still one hundred million of notional, within the limit.
- With a duration of nine the D V zero one is ninety thousand dollars.
- Notional is unchanged, but the risk has multiplied by four and a half.
- A D V zero one limit would have caught it.
- This is why firms combine limit types.

27 Example 11: derivatives change exposure

Illustration. Pay-fixed swap shortens duration; sign matters

Call: delta 0.6 × 10,000 shares	acts like	**6,000 shares**
Equivalent value at $50	6,000 × 50	**$300,000**
Swap change in duration	(5 − 0.5) × 100 ÷ 200	**−2.25 years**
New portfolio duration	6 − 2.25	**3.75 years**

IN THE LESSON

- Derivatives change a position by their delta or duration equivalents.
- First, options.
- A call with a delta of six tenths on ten thousand shares acts like six thousand shares: ten thousand times point six.
- At a share price of fifty dollars, that is an exposure equal to three hundred thousand dollars.
- Second, swaps.
- A pay fixed swap shortens a bond portfolio's duration by the fixed leg duration less the floating leg duration, scaled by the swap notional as a fraction of portfolio value.
- Take a portfolio of two hundred million with duration six, and a swap on one hundred million with fixed leg duration five and floating leg duration a half.
- The change is four and a half times a half, so two and a quarter years.
- New duration: three and three quarters.

28 Diversified VaR for two positions

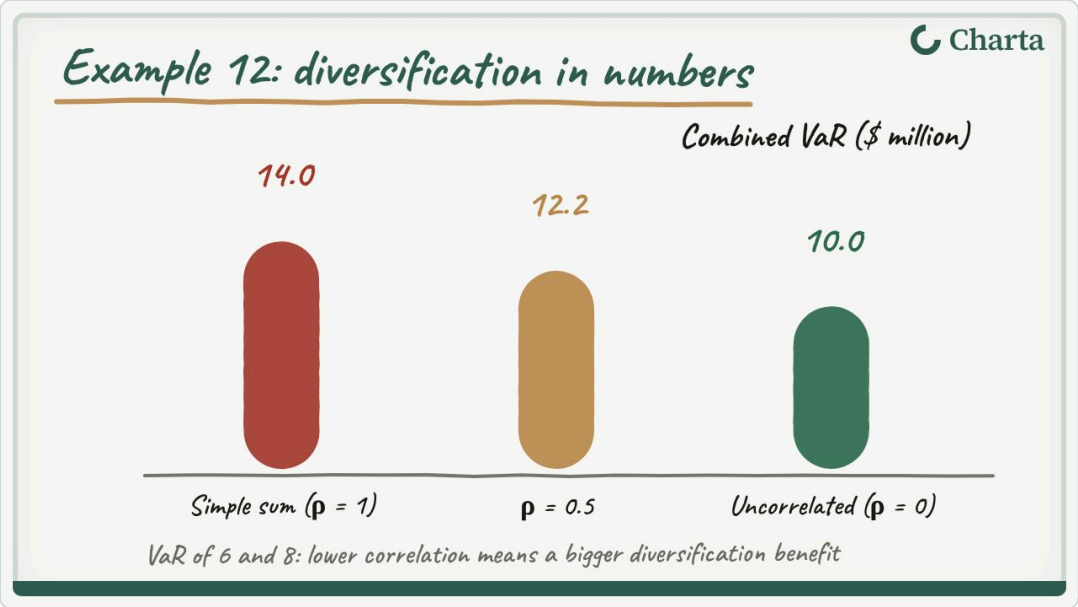
$VaRp = \sqrt{(VaR_1^2 + VaR_2^2 + 2 \times \rho \times VaR_1 \times VaR_2)}$

Combined VaR	VaR of the two positions together
VaR of position 1	VaR of the first position
VaR of position 2	VaR of the second position
Correlation, ρ	Correlation of their returns

IN THE LESSON

- Finally, how do risks combine?
- You cannot just add value at risk figures.
- For two positions, combined V a R is the square root of the first V a R squared, plus the second squared, plus two times rho times the first times the second.
- Rho is the correlation between the two positions' returns.
- If rho equals one, the formula collapses to the simple sum, and there is no diversification benefit.
- If rho is below one, the combined figure is smaller than the sum.
- The formula assumes normally distributed returns.
- A common mistake is to ignore the sign of a position or the offsetting leg of a hedge, which would make the correlation sign wrong.

29 Example 12: diversification in numbers



IN THE LESSON

- Take two positions with V a R of six million and eight million.
- If the correlation is one, the combined figure is the plain sum: fourteen million.
- If the correlation is one half, we get the square root of thirty six plus sixty four plus forty eight, which is the square root of one hundred forty eight, about twelve point two million.
- If the positions are uncorrelated, rho zero, it is the square root of one hundred, exactly ten million.
- So the lower the correlation, the bigger the saving, from nothing at fourteen to four million at ten.
- The bars show it.
- This is why a firm's total risk is below the sum of its desks' limits, and why limits must be set with correlation in mind.

30 Four groups of mistakes to avoid

- Transfer does not leave zero residual risk
- Appetite is not capacity, and not the limits
- Hedge the net exposure; get the sigma ratio right
- One limit type is not enough; watch signs and offsets

IN THE LESSON

- Four groups of mistakes to avoid.
- One: assuming that transfer leaves no residual risk.
- Counterparty failure, exclusions and basis risk all remain.
- Two: confusing appetite with capacity or with limits.
- Appetite is what the board is willing to take, capacity is the ceiling, and limits are the numbers given to desks.
- Three: hedging the gross exposure instead of the net, or inverting the sigma ratio in the hedge ratio.
- Four: trusting one kind of limit alone, or ignoring the sign and the offsetting leg.
- A notional limit says nothing about D V zero one, and a long and a short position do not add.
- Keep those four in mind and many questions become easy.

31 Recap: the main ideas

- Avoid, transfer, mitigate, retain: match to the risk
- Appetite below capacity; limits carry it to the desks
- Hedge removes ρ^2 of variance; $h = \rho \times \sigma S \div \sigma F$
- Limits constrain; derivatives add delta; VaR diversifies

IN THE LESSON

- Let's pull it together.
- A firm can avoid, transfer, mitigate or retain a risk, and matches the choice to frequency, severity and fit with its strategy.
- The board sets appetite below capacity, then turns it into limits.
- Hedging can cut distress costs and stabilise earnings, but shareholders can diversify, and basis risk means a hedge removes only rho squared of the variance.
- Currency forwards follow covered interest parity, and the hedge ratio is rho times the spot over futures volatility.
- Limits constrain, derivatives change exposure by delta or duration equivalents, and diversified V a R is below the sum unless correlation is one.

32 Try three quick questions

1. A hedge has $\rho = 0.6$. What share of variance does the best hedge remove?
   Answer: 36%, because $\rho^2 = 0.36$.
2. $\rho = 0.9$, $\sigma S = 10\%$, $\sigma F = 8\%$. What is the hedge ratio h?
   Answer: $h = 0.9 \times 10 \div 8 = 1.125$.
3. Uncorrelated positions with VaR of 3 and 4. What is the combined VaR?
   Answer: $\sqrt{(9 + 16)} = 5$.

IN THE LESSON

- Now try three quick questions yourself.
- Pause after each one.
- Question one.
- A hedge has a correlation of six tenths with the exposure.
- What share of the exposure's variance does the best sized hedge remove?
- Thirty six per cent, since rho squared is point three six.
- Question two.
- Spot volatility is ten per cent, futures volatility is eight per cent, and the correlation is nine tenths.
- What is the hedge ratio?
- Nine tenths times ten over eight: one point one two five.
- Question three.
- Value at risk figures of three and four million are uncorrelated.
- What is the combined figure?
- The square root of nine plus sixteen: five million.