CHARTA LEARNING · LESSON NOTES

Derivatives and Counterparty Risk

FRM Part II

1 A story: Northgate and Corvane

- Northgate swaps interest payments with Corvane
- Derivative: value set by an asset, rate, index, event
- Forms: swaps, forwards, futures, options, CDS
- Nothing lent, yet the contract gains and loses value
- Risk: Corvane may default before the contract ends

IN THE LESSON

- Here is the story we will use all the way through.
- Northgate Bank agrees an interest rate swap with a manufacturer called Corvane Industries.
- A derivative is a contract whose value depends on an underlying asset, rate, index or event.
- The main forms are swaps, forwards, futures, options and credit default swaps.
- But as interest rates move, the contract becomes worth something to one side and costs the other.
- If it becomes valuable to Northgate, then Northgate is relying on Corvane to keep its promises, and Corvane may default before the contract ends.
- That is counterparty credit risk, and the next slide turns it into a number.

2 Exposure on a derivative

Exposure = max(V , 0)
You lose the replacement cost, not the notional

Mark-to-market value, V	Contract value to you today
Floor at zero	A negative value means no loss
Exposure	Replacement cost on default

IN THE LESSON

- Let V be the mark to market value of the contract to you, meaning what it is worth today at market prices.
- The exposure at any date is the greater of V and zero.
- If V is positive, the contract is an asset.
- The other side owes you, and if it defaults you lose the replacement cost, which is what it costs to buy the same contract from someone else.
- If V is negative, you are the one who owes.
- A defaulting counterparty does not cancel your debt, so you lose nothing on that side and the exposure is zero.
- Notice what is missing: the notional, the face amount on which payments are calculated.
- You never lose the notional.
- You lose the replacement cost.

3 Example 1: exposure at three dates

Swap, notional $200m. Value to Northgate at 3 dates. Recovery 40%

Date one: V = +4.0	max(4.0, 0)	**$4.0m**
Date two: V = −1.5	max(−1.5, 0)	**$0**
Date three: V = +7.5	max(7.5, 0)	**$7.5m**
Exposure as share of notional	7.5 ÷ 200	**3.75%**
Loss if Corvane fails, date 3	7.5 × (1 − 40%)	**$4.5m**

IN THE LESSON

- Let us try it.
- The swap has a notional of two hundred million dollars, and we look at its value to Northgate on three dates.
- On the first date it is worth plus four million, so the exposure is four million.
- On the second date interest rates have moved the other way, and the value is minus one point five million.
- The exposure is zero, because Northgate owes money and a default by Corvane would cost it nothing.
- On the third date the value is plus seven point five million, so the exposure is seven point five million.
- If Corvane fails then and creditors recover forty per cent, Northgate loses sixty per cent of seven point five, which is four point five million dollars.
- Seven point five is only three point seven five per cent of the notional.

4 Why a derivative is not a loan

- Loan: amount known. Derivative: uncertain, V moves
- Exposure can change sign: risk may run both ways
- Usually a small fraction of the notional
- Settlement risk: pay in full first; a larger exposure
- Expected loss uses positive exposure, never notional

IN THE LESSON

- Now compare this with a loan.
- On a loan, the amount at risk is known.
- It is the amount lent, and it falls as the borrower repays.
- On a derivative the exposure is uncertain, because V moves with markets, and it can change sign.
- So the risk may run both ways: Northgate may be exposed to Corvane this month, and the reverse next month.
- At any date the exposure is usually only a small fraction of the notional.
- Settlement risk is a separate and larger exposure.
- It arises when a full payment is made before the counterparty pays, so the whole amount can be lost.
- The exam point is this: expected loss is built on positive exposure, never on notional.

5 Exchange traded against over the counter

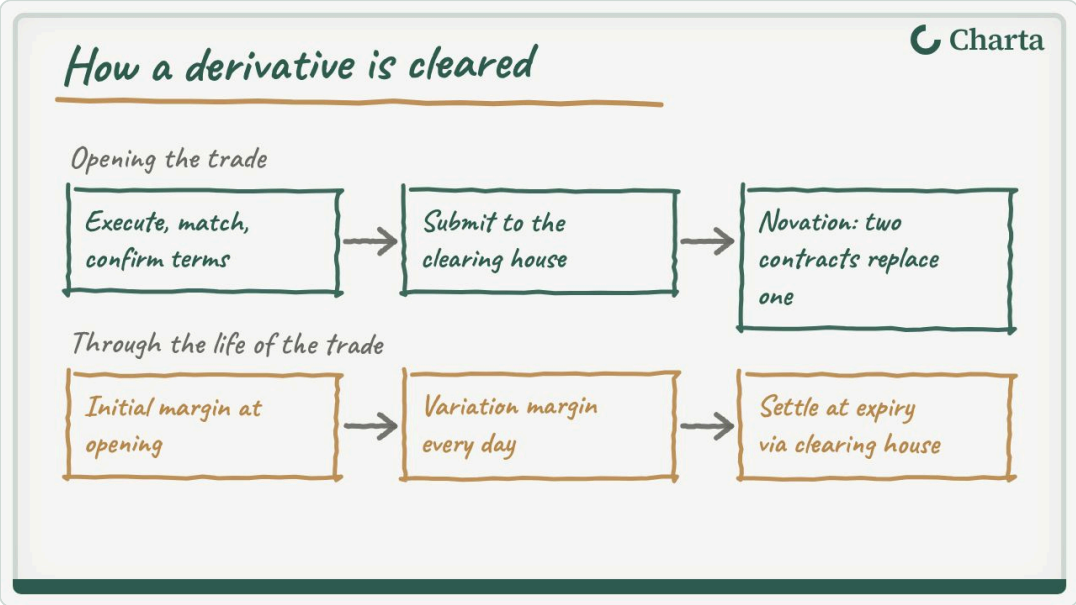
Exchange trading moves risk to the clearing house; it does not remove it

	Exchange	OTC
Contract terms	Standard	Tailored
Prices, liquidity	Open, deep	Private, thin
Your counterparty	Clearing house	Other party
Risk managed by	Margin	ISDA, collateral
Trade-off	Liquidity, safety	Fit to hedge

IN THE LESSON

- Exchange traded derivatives are standardised contracts, with fixed sizes, maturities and strikes.
- They trade on a regulated venue with transparent prices, and a clearing house stands behind them, collecting initial margin and daily variation margin.
- Over the counter derivatives, or O T C, are privately negotiated between two parties, usually with a dealer.
- The terms can be tailored to the exact hedge, but liquidity, price transparency and standardisation are lower.
- Historically O T C trades were bilateral, documented under an I S D A agreement, and each side was exposed to the other.
- Standardised O T C trades are now increasingly cleared centrally.
- The trade-off is customisation against counterparty risk and liquidity.
- A common mistake is to say exchange trading removes risk.
- It moves the risk to the clearing house and its margining system.
- Structure decides who your counterparty is.

6 How a derivative is cleared



IN THE LESSON

- First the trade is executed, and its terms are matched or confirmed.
- Then it is submitted to the clearing house.
- Next comes the key step, novation.
- The original contract is replaced by two contracts, one between the clearing house and each side.
- The clearing house becomes buyer to every seller and seller to every buyer.
- Initial margin is posted when the position opens.
- Variation margin is exchanged each day as the position is marked to market, and at expiry cash or the asset is settled through the clearing house.
- A party that is not a clearing member reaches the clearing house through a clearing member, which guarantees its performance.
- Until novation takes effect, the original counterparties are still exposed to each other.

7 Example 2: a cleared swap

Swap, notional $50m, cleared. Initial margin 3%. Amounts in $m

Initial margin posted	3% × 50	**1.5**
Day one: gain +0.8	received from the CCP	**+0.8**
Day two: loss −1.1	paid to the CCP	**−1.1**
Net variation margin so far	+0.8 − 1.1	**−0.3**
Counterparty after novation	not Corvane	**the CCP**

Non-members clear through a member that guarantees them

IN THE LESSON

- Now Northgate buys a standard swap with a notional of fifty million dollars through a clearing member.
- After novation its counterparty is the clearing house, not Corvane.
- Initial margin is set at three per cent of the notional, so Northgate posts one point five million dollars on day one.
- On the first day the swap gains eight tenths of a million, and Northgate receives that as variation margin.
- On the second day it loses one point one million, and Northgate pays that.
- After two days, net variation margin is a payment of three tenths of a million.
- Northgate now faces the clearing house, so a default by Corvane no longer hits this trade.
- The exam point is that novation swaps bilateral risk for risk against the clearing house.

8 Collateral: who takes part

- Giver posts assets when out of the money; taker holds them
- Custodian or triparty agent holds and values the collateral
- Margin agreement, such as an ISDA Credit Support Annex
- Variation margin tracks mark to market and cuts exposure
- Margin period of risk and collateral value leave some risk

IN THE LESSON

- Collateral is the main tool for cutting exposure.
- Three parties take part.
- The collateral giver posts assets when its position is out of the money.
- The collateral taker holds them when it is exposed.
- Often there is also a custodian or triparty agent, which holds and values the collateral under a margin agreement, such as an I S D A Credit Support Annex.
- The most common form is variation margin, which tracks the current mark to market and so cuts present exposure.
- But risk remains.
- After a default there is a margin period of risk of several days, during which the position keeps moving, and the eligible collateral can itself lose value.
- The exam point is that collateral reduces exposure but does not remove it.

9 How much collateral to call

Call = E − T − C
Made only if above the minimum transfer amount

Exposure, E	Exposure once measured
Threshold, T	Uncollateralised amount allowed
Collateral held, C	Collateral already held
Call amount	Amount to ask the other side for

IN THE LESSON

- How much collateral should Northgate ask for?
- Let E be the exposure once it is measured.
- Let T be the threshold, an amount of exposure the two sides agree to leave uncollateralised.
- Let C be the collateral already held.
- The call amount is roughly the exposure, less the threshold, less the collateral held.
- There is one more test.
- The call is made only if it exceeds the minimum transfer amount, which stops very small transfers from being made every day.

10 Example 3: a collateral call

Threshold $2.0m, collateral held $3.0m, minimum transfer $0.5m

Day one: E = 9.0, call	9.0 − 2.0 − 3.0	**$4.0m**
Minimum transfer test	4.0 is above 0.5	**Call made**
Day two: E = 5.4, call	5.4 − 2.0 − 3.0	**$0.4m**
Minimum transfer test	0.4 is below 0.5	**No call**
Left unsecured on day two	5.4 − 3.0	**$2.4m**

IN THE LESSON

- Corvane's swaps are worth nine million dollars to Northgate.
- The threshold is two million, Northgate already holds three million in collateral, and the minimum transfer amount is half a million.
- The call is nine minus two minus three, which is four million dollars.
- That is far above half a million, so the call is made.
- Now take another day.
- The exposure has fallen to five point four million, and the collateral held is still three million.
- The formula gives five point four minus two minus three, which is four tenths of a million.
- That is below half a million, so no call is made, and Northgate is left with two point four million unsecured: the two million threshold plus the four tenths not called.

11 Example 4: haircuts and what remains

Corvane posts bonds. Haircut 10%. Amounts in $m

Bond market value	posted	**$4.0m**
Value counted	4.0 × (1 − 10%)	**$3.6m**
Bonds to cover a $4.0m call	4.0 ÷ 0.9	**$4.44m**
Move in margin period of risk	assumed, after default	**+$1.5m**
Left uncovered	even with call met	**$1.5m**

IN THE LESSON

- Collateral is valued after a haircut, a cut applied to its market price to allow for the chance that its price falls.
- Corvane posts bonds with a market value of four million dollars, and the haircut is ten per cent.
- The bonds count for ninety per cent of their price, so the value counted is three point six million.
- To meet a call of four million, Northgate needs bonds worth four divided by point nine, which is about four point four four million dollars.
- Suppose Corvane defaults, and during the margin period of risk the position gains another one point five million for Northgate.
- That gain is not covered, even though the call was met in full.
- Collateral reduces exposure, but it does not remove it.

12 The ISDA Master Agreement

- ISDA Master Agreement: the standard OTC contract
- Master + Schedule + a Confirmation for each trade
- Often a Credit Support Annex for collateral
- All trades form one agreement: close-out netting
- Netting stops cherry-picking by a liquidator

IN THE LESSON

- The I S D A Master Agreement is the standard contract that governs O T C derivatives between two parties.
- I S D A is the International Swaps and Derivatives Association.
- The printed Master Agreement carries the standard terms.
- A Schedule customises it for the two parties.
- A Confirmation records each trade.
- And a Credit Support Annex, often added, sets the collateral.
- The key point is that all trades under it form a single agreement.
- That is what makes close out netting work.
- On a default, the transactions are terminated and valued, and the positive and negative values are combined into one net amount owed.
- This stops a liquidator from cherry picking, which means keeping the trades that favour the bankrupt estate and abandoning the rest.

13 Example 5: close-out netting

Trades worth +8, −5, +3 to Northgate. Recovery 40%. Amounts in $m

Gross positive claims	8 + 3	**11**
Single net amount	8 − 5 + 3	**6**
With netting: recover	40% × 6	**+2.4**
Without: recover, then pay 5	40% × 11 − 5	**−0.6**
Gap from netting	2.4 − (−0.6)	**3.0**

IN THE LESSON

- Corvane defaults.
- Under one I S D A, Northgate has three trades with it, worth plus eight, minus five and plus three million dollars to Northgate.
- Suppose recovery on unsecured claims is forty per cent.
- With close out netting, the values combine into one amount: eight minus five plus three is six million.
- Northgate recovers forty per cent of six, which is two point four million.
- Now suppose netting could not be enforced and the liquidator cherry picked.
- Corvane's estate would demand the five million Northgate owes in full, and abandon the profitable trades, leaving Northgate a claim of eleven million to recover at forty per cent.
- That is four point four million received, less five paid, a net loss of point six million.
- The gap is three million dollars.
- Netting is only as good as its legal enforceability.

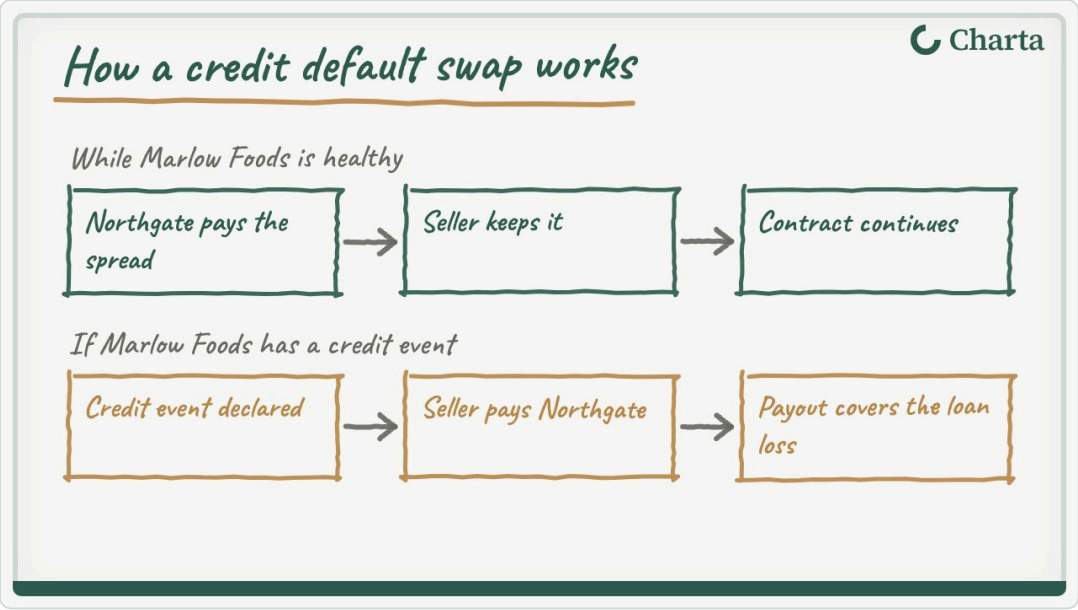
14 Events of Default and Termination Events

- Failure to pay; breach of agreement; credit support default
- Misrepresentation; default under specified transactions
- Cross-default; bankruptcy; merger without assumption
- Illegality, tax events: Termination Events, neither at fault
- On default: terminate, value, net into one amount owed

IN THE LESSON

- What counts as a default?
- The agreement lists Events of Default.
- They are failure to pay, breach of agreement, credit support default, misrepresentation, default under specified transactions, cross default, bankruptcy, and merger without assumption.
- Cross default means that a default on other borrowing triggers this one.
- Merger without assumption means a successor does not take over the obligations.
- Illegality and tax events are different.
- They are Termination Events, where neither party is at fault, for example because a change of law makes the contract illegal.
- When an Event of Default occurs, the non defaulting party can terminate the transactions, value them, and net them into one amount.

15 How a credit default swap works



IN THE LESSON

- Now credit derivatives.
- A credit derivative transfers credit risk from a protection buyer to a protection seller.
- In a credit default swap, Northgate has made a loan to a food company, Marlow Foods, and wants to keep the loan but not the risk.
- It buys protection from a seller, and pays a periodic spread.
- Marlow Foods is the reference entity.
- While it is healthy, the buyer pays, the seller keeps the spread, and the contract carries on.
- If Marlow Foods has a credit event, such as failing to pay or going bankrupt, the seller makes a contingent payment to the buyer, and the contract ends.
- The payment is meant to cover the loss on the loan.

16 The credit default swap payout

Payout = Notional × (1 − R)

Payout	Paid by seller on a credit event
Notional	Face amount of protection bought
Recovery rate, R	Share of the debt recovered

IN THE LESSON

- The payout has a simple form.
- It equals the notional, multiplied by one minus R, where R is the recovery rate on the reference entity's debt.
- The recovery rate is the share of the debt that creditors still get back after the default.
- So one minus R is the share that is lost, and the seller pays exactly that loss.
- If recovery is forty per cent, the seller pays sixty per cent of the notional.
- The payment is contingent.
- Nothing is paid unless a credit event occurs, while the buyer pays the spread every period regardless.

17 Example 6: a hedge and its weak point

Hedge a $20m loan. Spread 1.4%, recovery 35%

Spread paid each year	1.4% × 20m	**$280,000**
Payout on a credit event	20m × (1 − 35%)	**$13.0m**
Seller fails: pays 30%	30% × 13.0m	**$3.9m**
Shortfall left with Northgate	13.0 − 3.9	**$9.1m**

IN THE LESSON

- Northgate has a twenty million dollar loan to Marlow Foods and buys protection on the same amount.
- The spread is one point four per cent, so it pays two hundred and eighty thousand dollars a year.
- Marlow Foods defaults, and the debt recovers thirty five per cent.
- The payout is twenty million times sixty five per cent, which is thirteen million dollars.
- But suppose the seller is itself in trouble, and pays only thirty per cent of what it owes.
- Northgate receives three point nine million and is left with a shortfall of nine point one million dollars.
- The hedge did not remove the risk.
- It replaced the risk on Marlow Foods with risk on the seller.

18 What credit derivatives are used for

- Risk moves from protection buyer to seller
- Also total return swaps, credit-linked notes, CDOs
- Banks hedge loans without selling them
- Investors take exposure without funding it
- Traders express relative value views

IN THE LESSON

- Other forms of credit derivative include total return swaps, credit linked notes and tranches of collateralised debt obligations, or C D Os.
- Why are they used?
- Banks use them to hedge loans without selling them, which keeps the customer relationship intact.
- Investors use them to take credit exposure without funding it, because a swap needs no cash outlay for the underlying bond.
- Traders use them to express relative value views, for example that one company's credit will do better than another's.
- In every case, credit risk moves from one party to another.
- It does not disappear.

19 Risks that credit derivatives create

- Counterparty risk on the seller
- Wrong-way risk: seller and entity move together
- Basis, documentation risk: restructuring may not count
- Jump-to-default and liquidity risk
- Protection is only as strong as the seller

IN THE LESSON

- What can go wrong?
- The first risk is counterparty risk on the seller.
- The second is wrong way risk, which arises when the seller and the reference entity are highly correlated.
- Imagine buying protection on a property developer from a bank that lends heavily to property.
- When the developer fails, the bank is likely to be in trouble too.
- Third, there is basis and documentation risk.
- A restructuring may not count as a credit event, so the hedge may not pay when the loan loses value.
- Fourth, there are jump to default and liquidity risks.
- The exam point is this: protection is only as strong as the seller, especially when both fail together.

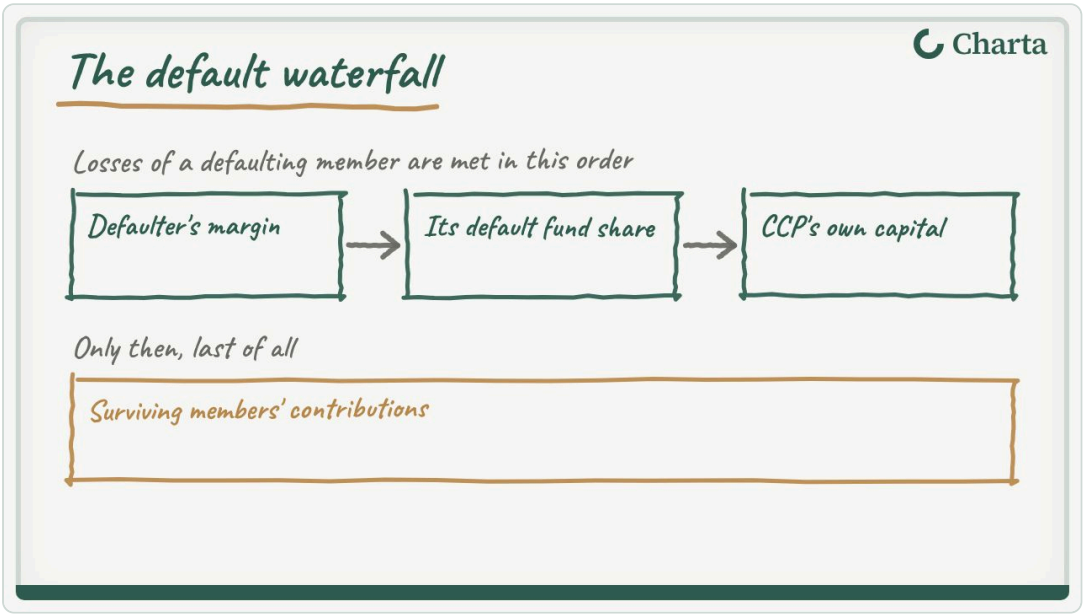
20 The central counterparty and its mandate

- CCP: buyer to every seller, seller to every buyer
- Members face the CCP, not each other
- After 2008 the G20 required clearing of standard OTC
- Also trade repositories; exchanges or platforms
- Protection: margins and a default fund

IN THE LESSON

- Now the central counterparty, or C C P, in detail.
- Its role is to step between the two sides of a trade by novation, becoming buyer to every seller and seller to every buyer, so members face the C C P instead of each other.
- Its mandate came after the two thousand eight crisis.
- The G twenty mandated that standardised O T C derivatives be cleared centrally, reported to trade repositories, and, where suitable, traded on exchanges or electronic platforms.
- A C C P protects itself with initial margin, variation margin and a default fund, a pool contributed by its members.
- Remember the exam point: the C C P concentrates risk rather than removing it.

21 The default waterfall



IN THE LESSON

- What happens when a clearing member defaults?
- Its losses are met in a fixed order, often called the default waterfall.
- First, the defaulter's own margin is used.
- Second, the defaulter's contribution to the default fund.
- Third, the C C P's own capital, which gives it a stake in good risk management.
- Only then, fourth, are the contributions of the surviving members used.
- The order matters, because the defaulter pays first and the survivors pay last.
- Details vary by C C P.

22 Example 7: the waterfall in numbers

Close-out loss $120m. Margin $70m, fund share $20m, CCP capital $10m

Defaulter's margin	first 70 of 120	**$70m**
Its default fund share	next 20; 30 left	**$20m**
CCP's own capital	next 10; 20 left	**$10m**
Surviving members	the last 20	**$20m**
Total losses met	70 + 20 + 10 + 20	**$120m**

IN THE LESSON

- Let us run it with numbers.
- A member defaults, leaving a close out loss of one hundred and twenty million dollars.
- The member had posted seventy million of margin, its default fund share is twenty million, and the C C P holds ten million of its own capital.
- The margin takes the first seventy million, and fifty is left.
- The default fund share takes twenty, leaving thirty.
- The C C P's own capital takes ten, leaving twenty.
- The last twenty million is met by the surviving members.
- That last step is why surviving members care who else is in the C C P.

23 Central clearing: benefits and drawbacks

The CCP concentrates risk rather than removing it

	Benefit	Drawback
Netting	Multilateral	Fragmented
Visibility and risk	Transparent	Concentrated
Default process, incentives	Standardised	Moral hazard
Margin	Daily cover	Procyclical

IN THE LESSON

- Weigh the benefits and drawbacks.
- The benefits are multilateral netting, because all of a member's trades are netted against one C C P; transparency, since the C C P sees positions and prices; and standardised default handling.
- The drawbacks are concentration of risk in a few C C Ps, so that one failure would be felt everywhere; procyclical margin, which rises in stress, just when firms are short of cash; moral hazard from mutualisation, since members share losses and may police each other less; and fragmented netting, because trades cleared at different C C Ps cannot be netted against each other.
- The exam point once more: the C C P concentrates risk, it does not remove it.

24 Margin rules: cleared and not cleared

Initial margin covers future moves; variation margin, moves made

	Cleared	Not cleared
Initial margin	~5 days	99%, 10 days
Posting	To CCP	Both ways, gross
Holding	At CCP	Segregated
Diversification	CCP model	None across
Variation margin	Daily	At least daily

IN THE LESSON

- Margin rules differ by clearing status.
- For centrally cleared derivatives, the C C P sets its own rules.
- Initial margin is sized to cover close out losses over a period typically around five days for O T C products, and variation margin is paid daily.
- For derivatives that are not centrally cleared, the Basel Committee and I O S C O framework requires covered entities to exchange both variation margin and initial margin, in both directions.
- The bilateral initial margin is based on a ninety nine per cent, one tailed loss over ten days.
- It is collected gross, not netted between the parties, segregated from the collecting party's own assets and generally not reused, and sized without diversification benefits across asset classes.
- Variation margin is exchanged at least daily.
- Initial margin covers future moves.
- Variation margin covers moves already made.

25 Example 8: sizing initial margin

Position $100m, daily vol 0.8%, normal losses, z(99%) = 2.326

10-day SD	100m × 0.8% × √10	**$2.53m**
Bilateral initial margin	2.326 × 2.53	**$5.88m**
5-day SD	100m × 0.8% × √5	**$1.79m**
Cleared margin, 99% assumed	2.326 × 1.79	**$4.16m**
Bilateral: each side posts	gross, not netted	**$5.88m**

IN THE LESSON

- Northgate holds a position of one hundred million dollars with daily volatility of point eight per cent.
- For the bilateral rule, scale the daily figure to ten days by multiplying by the square root of ten.
- The ten day standard deviation is two point five three million.
- A ninety nine per cent one tailed loss is two point three two six standard deviations, so initial margin is about five point eight eight million dollars.
- Each side posts it, gross.
- Now a cleared trade, using a five day period and the same ninety nine per cent for comparison.
- The standard deviation is one point seven nine million, and the margin about four point one six million.
- A shorter period means less initial margin.

26 SPVs, DPCs, monolines and CDPCs

- SPV: separate legal entity that holds assets or risk, isolated
- DPC: highly rated, ring-fenced dealer subsidiary
- DPC hedges back to its parent; clients get a better rating
- Monoline: insurer guaranteeing bond principal and interest
- CDPC: sells protection on a leveraged portfolio, thin capital

IN THE LESSON

- A special purpose vehicle, or S P V, is a separate legal entity created to hold assets or take risk and isolate it from a sponsor.
- A derivatives product company, or D P C, is a highly rated, ring fenced subsidiary of a dealer.
- It faces clients and hedges back to its parent, so clients can trade with a counterparty better rated than the parent.
- A monoline is an insurer that guarantees the payment of bond principal and interest, notably on structured credit.
- A credit derivatives product company, or C D P C, sells credit protection against a leveraged portfolio, funded with thin capital.

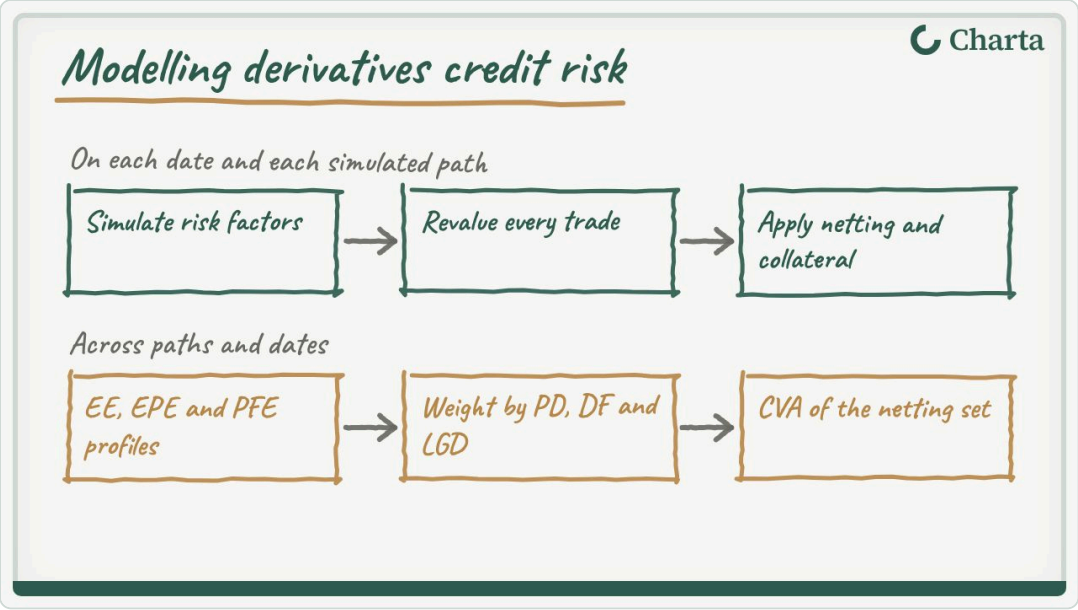
27 Why they fall short as risk protection

- Capital small next to the notional protected
- Risk is concentrated in one sector
- Losses come with the downgrades that remove value
- Collateral is often not posted
- $0.8bn ÷ $40bn = 2%: a 2% loss ends it

IN THE LESSON

- Why are these weak ways to reduce risk?
- First, capital is small compared with the notional protected.
- Take a C D P C with eight tenths of a billion dollars of capital, protecting a portfolio of forty billion.
- Capital is only two per cent of the notional, so a two per cent portfolio loss wipes it out.
- Second, risk is concentrated in one sector.
- Third, losses arrive together with the downgrades that remove their value, so the protection loses credibility just when it is needed.
- Fourth, collateral is often not posted, so nothing stands behind the promise.
- The exam point is this: such protection fails exactly when it is needed.

28 Modelling derivatives credit risk



IN THE LESSON

- Last, how is derivatives credit risk modelled?
- The method is simulation.
- On each of many dates, risk factors such as interest rates and exchange rates are simulated with Monte Carlo.
- Each simulated future is called a path.
- On each path every trade is revalued, and then the netting and collateral terms are applied, path by path, to the whole netting set, the group of trades under one netting agreement.
- From the results come exposure profiles.
- Expected exposure, or E E, is the average exposure at each date.
- Expected positive exposure, or E P E, is its average over time.
- Potential future exposure, or P F E, is a high percentile of exposure at each date.
- Weighting these by default probability, discounting and loss given default gives C V A, covered next.

29 Example 9: netting path by path

Trade A: 6, 1, −3. Trade B: −2, −4, 5. Three paths, $m

Net value on paths 1, 2, 3	6−2, 1−4, −3+5	**4, −3, 2**
Exposure on each path	max(net, 0)	**4, 0, 2**
EE, netting set	(4 + 0 + 2) ÷ 3	**2.0**
EE, trade by trade, added	(6+1+0)÷3 + (0+0+5)÷3	**4.0**
Overstatement	4.0 − 2.0	**2.0**

Positive parts alone: A = 6, 1, 0 (sum 7); B = 0, 0, 5 (sum 5)

IN THE LESSON

- Why must netting be applied on each path?
- Take a netting set of two trades, and three simulated paths at one date.
- Trade A is worth plus six, plus one and minus three million dollars.
- Trade B is worth minus two, minus four and plus five.
- Net the trades on each path, and you get four, minus three, and two.
- Exposure is the positive part, so four, zero and two.
- The average, the expected exposure, is two million.
- If instead we measured each trade alone and added the results, A has positive parts six, one and zero, so seven thirds, B has zero, zero and five, so five thirds, and the sum is four million, double the true figure.
- Exposure must be aggregated per netting set on each path, not trade by trade.

30 Credit valuation adjustment

CVA = LGD × Σ (EE × PD × DF)

Loss given default	Share lost if default happens
Expected exposure, EE	Average exposure at each date
Marginal default probability, PD	Chance of default in that period
Discount factor, DF	Brings the loss to today

IN THE LESSON

- Credit valuation adjustment, or C V A, is the price of counterparty default risk on the netting set.
- It is roughly the loss given default, times the sum over the dates of three things: the expected exposure at the date, the marginal default probability for that period, and the discount factor.
- Marginal default probability is the chance that the counterparty defaults during that particular period.
- The discount factor converts the loss into today's money.
- Adding them up gives an expected loss in present value terms, and it is what Northgate would charge Corvane for the risk.

31 Example 10: a small CVA

EE 2.0, 3.5, 4.0, 3.0 ($m); PD 1.0, 1.2, 1.5, 1.8%; LGD 60%

Date one	2.0m × 1.0% × 0.98	**$19,600**
Date two	3.5m × 1.2% × 0.96	**$40,320**
Date three	4.0m × 1.5% × 0.94	**$56,400**
Date four	3.0m × 1.8% × 0.92	**$49,680**
CVA	60% × 166,000	**$99,600**

DF 0.98, 0.96, 0.94, 0.92. Sum: 19,600+40,320+56,400+49,680 = $166,000

IN THE LESSON

- Here are four dates for the Corvane netting set.
- Expected exposure is two, three point five, four and three million dollars.
- Marginal default probabilities are one, one point two, one point five and one point eight per cent.
- Discount factors are point nine eight, point nine six, point nine four and point nine two.
- Loss given default is sixty per cent.
- Date one gives two million times one per cent times point nine eight, which is nineteen thousand six hundred dollars.
- Date two gives forty thousand three hundred and twenty.
- Date three gives fifty six thousand four hundred.
- Date four gives forty nine thousand six hundred and eighty.
- The sum is one hundred and sixty six thousand dollars.
- Times sixty per cent, C V A is ninety nine thousand six hundred dollars.

32 Why modelling is hard

- Heavy computation: big portfolios, long horizons
- CVA uses risk-neutral inputs; limits use real-world ones
- Wrong-way risk, collateral and close-out assumptions
- Model risk adds to all of this
- Aggregate per netting set on each path, not trade by trade

IN THE LESSON

- The difficulties are real.
- First, computation.
- A large portfolio, over a long horizon, with many paths, is heavy work.
- Second, calibration.
- C V A is priced under risk neutral parameters, the ones implied by market prices, while exposure limits use real world parameters, estimated from history.
- Third, wrong way risk, where exposure rises as the counterparty weakens, breaks the simple product of expected exposure and default probability.
- Fourth, collateral and close out assumptions, such as the margin period of risk, change the answer a lot.
- And model risk adds to all of these.
- Never forget the exam point: aggregate per netting set on each path.

33 Recap and mistakes to avoid

- Exposure = max(V, 0): replacement cost, not notional
- Novation: bilateral risk becomes risk on the CCP
- Collateral cuts risk; netting needs legal force
- CDS only as strong as seller; CCPs concentrate risk
- IM = future moves, VM = past; net per path

IN THE LESSON

- Let us pull it together, with the traps.
- Exposure is the greater of V and zero.
- It is a replacement cost, never the notional.
- Exchange trading moves risk to the clearing house, it does not remove it, and novation is the step that swaps bilateral risk for risk against the clearing house.
- Collateral reduces exposure, but a margin period of risk and haircuts leave some.
- I S D A netting is only as good as its legal enforceability.
- Protection from a credit default swap is only as strong as the seller.
- A C C P concentrates risk.
- Initial margin covers future moves, and variation margin covers moves already made.
- Vehicles with thin capital fail when needed.
- And exposure is aggregated per netting set on each path.

34 Try three quick questions

1. Notional $80m, V = +$2.4m. Exposure? Share of notional?
   Answer: max(2.4, 0) = $2.4m, which is 3% of notional.
2. E = $6.0m, T = $1.5m, C = $2.0m, minimum transfer $0.5m. Call?
   Answer: 6.0 − 1.5 − 2.0 = $2.5m, above 0.5, so call $2.5m.
3. CDS notional $30m, recovery 25%. Payout on a credit event?
   Answer: 30m × (1 − 25%) = $22.5m.

IN THE LESSON

- Now try three quick questions.
- Pause the video, think, then listen to the answers.
- Question one.
- A swap has a notional of eighty million dollars and is worth plus two point four million to you.
- What is the exposure, and what share of the notional is it?
- The exposure is the greater of two point four and zero, so two point four million dollars, which is three per cent of the notional.
- Question two.
- Exposure is six million dollars, the threshold is one point five million, collateral held is two million, and the minimum transfer amount is half a million.
- What is the call?
- Six minus one point five minus two is two point five million, above the minimum, so the call is two point five million dollars.
- Question three.
- Protection is bought on thirty million dollars of notional, and recovery is twenty five per cent.
- What does the seller pay on a credit event?
- Thirty million times seventy five per cent is twenty two point five million dollars.