CHARTA LEARNING · LESSON NOTES

# The Evolution of Stress Testing Counterparty Exposures

FRM Part II

## 1 A story: what could my partner owe me?

- Value moves: sometimes we are owed, sometimes we owe
- We lose only if the partner fails while it owes us
- Question: how much could it owe us?
- Four measures answer it, each with its own job

IN THE LESSON

- Harbour Bank signs an interest rate swap with Northwind Energy.
- As rates move, the swap becomes worth money to Harbour on some days, and costs Harbour money on others.
- Now suppose Northwind fails.
- If the swap is worth a positive amount to Harbour, the bank is owed that amount and may recover only part of it.
- If the swap is worth a negative amount to Harbour, the bank still owes it, so the failure gives the bank no loss.
- So the question is not what the swap is worth.
- It is how much Northwind could owe us.
- Four measures answer that, and each has its own job.

## 2 Current exposure: today's replacement cost

**Current exposure = max( MTM of netting set , 0 )**

| | |
|---|---|
| **Value of the netting set** | Sum of trade values, after netting |
| **Floor at zero** | No loss when the value is negative |
| **Current exposure** | Today's replacement cost |

IN THE LESSON

- Start with the simplest measure, current exposure.
- It is today's replacement cost: what it would cost to replace the contracts if the counterparty failed right now.
- All the trades under one legally enforceable netting agreement form a netting set, and we add up their mark to market values, that is, their values at today's market prices.
- Current exposure is the larger of that total and zero.
- The zero matters.
- When the total is negative, the bank owes money and loses nothing from the failure, so the exposure is not negative, it is zero.
- Current exposure looks only at today.
- It says nothing about how the value might drift before a default.

## 3 Four measures of exposure

*Four measures, four jobs*

| Measure | What it is, and its use |
|---|---|
| Current exposure | max(MTM, 0) now: replacement cost |
| Expected exposure, EE | Average positive part at date t |
| Expected positive exposure, EPE | Time average of EE: capital, pricing |
| Peak exposure, PFE | 95th or 99th percentile: limits |

IN THE LESSON

- Now we look forward.
- Expected exposure at a future date t, written E E of t, is the average, across thousands of simulated market scenarios, of the positive part of the portfolio value at that date.
- Expected positive exposure, or E P E, is the time average of the E E profile over a horizon, usually one year.
- It is used for capital and for pricing.
- Peak exposure, also called potential future exposure, is a high percentile of the exposure distribution at a given date, such as the ninety fifth or ninety ninth.
- It looks at the tail, and it is used to set limits.
- Here is the table.

## 4 Expected exposure and peak exposure

**EE(t) = average of max( V(t) , 0 )**
**If MTM is normal, mean 0: EE = 0.399 × σ**
**95% peak = 1.645 × σ**

| | |
|---|---|
| **Value of the netting set at t** | Simulated across many scenarios |
| **Standard deviation of the MTM** | Spread of the swap's value |
| **Expected exposure, EE** | Not the expected MTM, which is 0 |
| **Peak exposure, 95%** | Tail, not the average |

IN THE LESSON

- Here is the trap that examiners love.
- Expected exposure is not the expected mark to market.
- The expected value of the swap can be zero, because gains and losses balance out, yet the expected exposure is clearly positive, because we take the average of the positive part only.
- Now suppose the mark to market is normal with mean zero and standard deviation sigma.
- Then expected exposure is zero point three nine nine times sigma.
- The ninety five per cent peak exposure is one point six four five times sigma.
- The peak is about four times larger, because it looks at the tail rather than the average.

## 5 Example 1: the four measures for Northwind

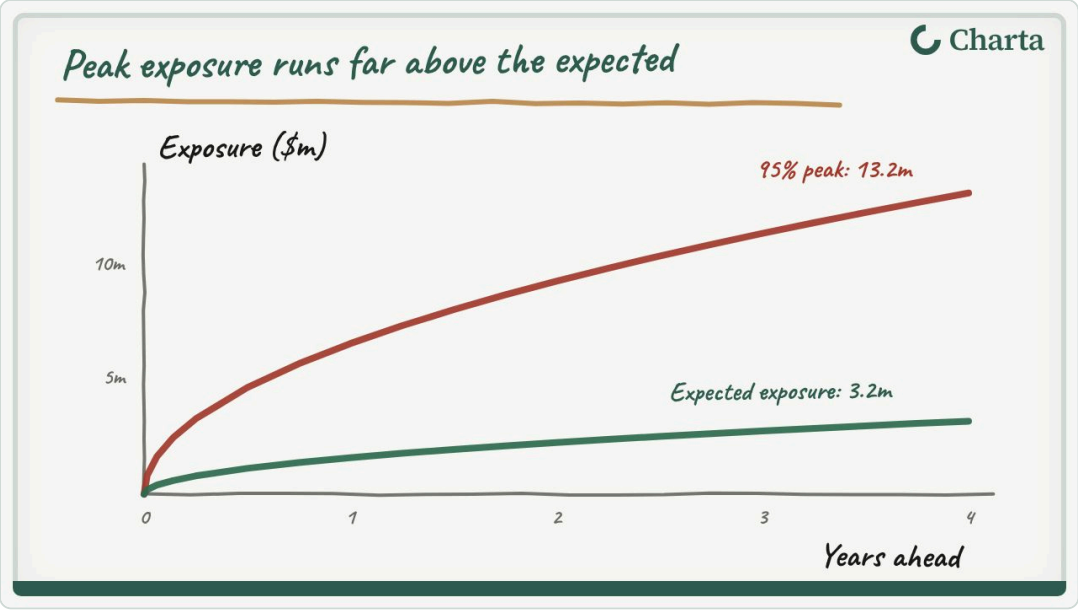
*Northwind netting set. Future MTM normal, mean 0, σ = $10m*

| | | |
|---|---|---|
| **Current exposure, MTM +$6m** | max(6, 0) | **$6m** |
| **Current exposure, MTM −$4m** | max(−4, 0) | **$0** |
| **Average future MTM** | mean of the normal | **$0** |
| **Expected exposure, EE** | 0.399 × 10 | **$3.99m** |
| **95% peak exposure** | 1.645 × 10 | **$16.45m** |

IN THE LESSON

- Take Harbour Bank's netting set with Northwind.
- Today the net mark to market is plus six million dollars, so current exposure is six million.
- If it were minus four million, current exposure would be zero, not minus four.
- Now look ahead.
- Suppose the value at a future date is normal with mean zero and standard deviation ten million.
- The average value is zero, but expected exposure is zero point three nine nine times ten, which is three point nine nine million dollars.
- The ninety five per cent peak exposure is one point six four five times ten, which is sixteen point four five million.
- The peak is more than four times the expected exposure, and the mistake is quoting zero as the expected exposure.

## 6 Peak exposure runs far above the expected




IN THE LESSON

- This chart shows the two measures through time for a swap whose value is normal, with a standard deviation that grows with the square root of time.
- Along the bottom are the years ahead, up to four.
- Up the side is the exposure in millions of dollars.
- The green line is expected exposure.
- It rises slowly, reaching about three point two million dollars at four years.
- The red line is the ninety five per cent peak exposure.
- It rises from the same start but climbs much higher, to about thirteen point two million at four years.
- The average of the mark to market stays at zero throughout, which is why we never read exposure from it.

## 7 Example 2: expected positive exposure

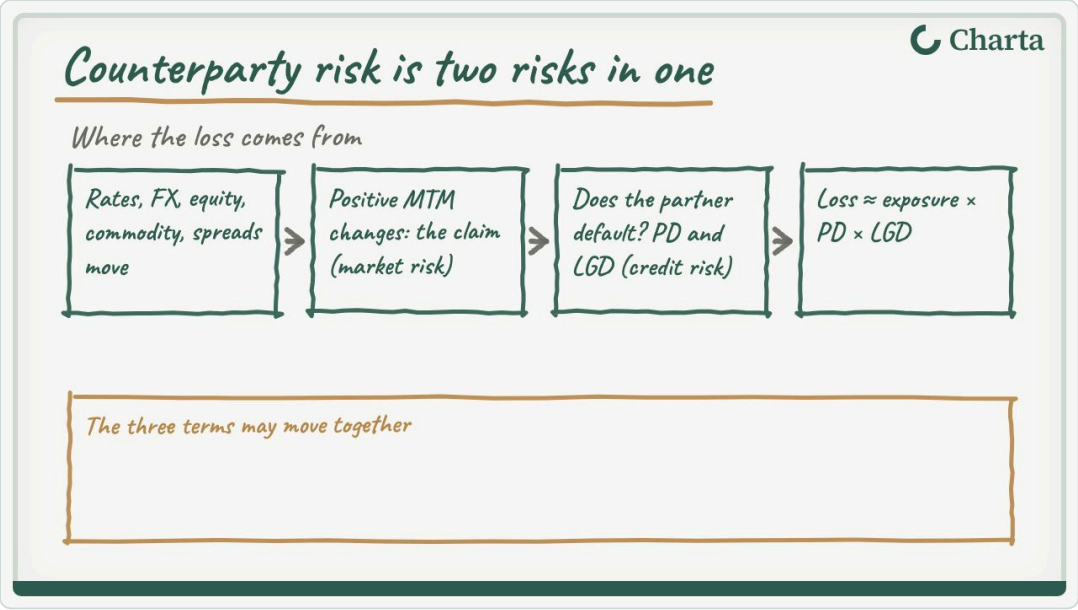
*EE at 3, 6, 9, 12 months: $2.0m, $3.0m, $3.4m, $3.6m*

| | | |
|---|---|---|
| **Sum of the EE values** | 2.0 + 3.0 + 3.4 + 3.6 | **$12.0m** |
| **Number of dates** | quarterly dates | **4** |
| **Expected positive exposure** | 12.0 ÷ 4 | **$3.0m** |
| **Wrong: last EE** | the 12-month value | **$3.6m** |
| **Used for** | EPE feeds | **capital, pricing** |

IN THE LESSON

- Now the time average.
- Harbour Bank simulates the expected exposure to Northwind at four dates in the coming year: three months, six months, nine months and twelve months.
- The values are two, three, three point four and three point six million dollars.
- Expected positive exposure is the average of the profile.
- The four values add up to twelve, and twelve divided by four is three million dollars.
- This is the figure that feeds capital and the price of the trade.
- Notice it is not the last value of three point six, and it is not the highest point either.
- Peak exposure, by contrast, would be used to set the limit.

## 8 Counterparty risk is two risks in one




IN THE LESSON

- Now to the second outcome.
- Counterparty credit risk sits on the border of two risk types.
- Follow the boxes.
- First, the claim at default is the positive mark to market of the portfolio.
- That moves with interest rates, exchange rates, equity prices, commodity prices and credit spreads, so the size of the claim is market risk.
- Second, whether that claim is actually lost depends on the counterparty defaulting, and on how much is recovered.
- That is credit risk.
- Expected loss is roughly the product of exposure, default probability and loss given default.
- The twist is that these terms may move together.

## 9 What the double nature implies

- Priced through a CVA charge to the trading desks
- A CVA desk hedges spreads (CDS) and exposure
- Needs both credit limits and market risk limits
- Wrong-way risk must be recognised
- Basel III: a default risk charge and a separate CVA charge

IN THE LESSON

- This double nature has practical consequences for a bank's trading and risk management.
- First, the risk is priced.
- The bank charges trading desks a credit valuation adjustment, called C V A, and usually a C V A desk manages it.
- That desk hedges the spread with credit default swaps, called C D S, and the exposure with market instruments.
- Second, the bank needs both credit limits and market risk limits, because the risk lives in both worlds.
- Third, wrong-way risk must be recognised: the case where exposure rises when the counterparty weakens.
- Fourth, Basel three has a default risk charge and a separate C V A charge.
- The usual error is to treat counterparty risk as credit risk alone, with static exposure.

## 10 Example 3: exposure and default move together

*Calm 80%: $8m, PD 1.5%. Bad 20%: $20m, PD 6%. LGD 60%*

| | | |
|---|---|---|
| **Average exposure** | 0.8 × 8 + 0.2 × 20 | **$10.4m** |
| **Average PD** | 0.8 × 1.5% + 0.2 × 6% | **2.4%** |
| **Independent: product of averages** | 10.4m × 2.4% × 60% | **$149,760** |
| **Joint: scenario by scenario** | 57,600 + 144,000 | **$201,600** |

*Calm 0.8 × 8m × 1.5% × 60% = 57,600. Bad 0.2 × 20m × 6% × 60% = 144,000*

IN THE LESSON

- Here is why it matters that the terms move together.
- Harbour Bank faces Northwind in two possible worlds.
- In a calm world, with probability eighty per cent, the exposure is eight million dollars and the default probability is one point five per cent.
- In a bad world, with probability twenty per cent, the exposure is twenty million and the default probability is six per cent.
- Loss given default is sixty per cent.
- Average exposure is ten point four million, and average default probability is two point four per cent.
- Multiplying the averages gives about one hundred and fifty thousand dollars.
- Working scenario by scenario gives two hundred and one thousand six hundred, about a third more.
- Ignoring the link understates the loss.

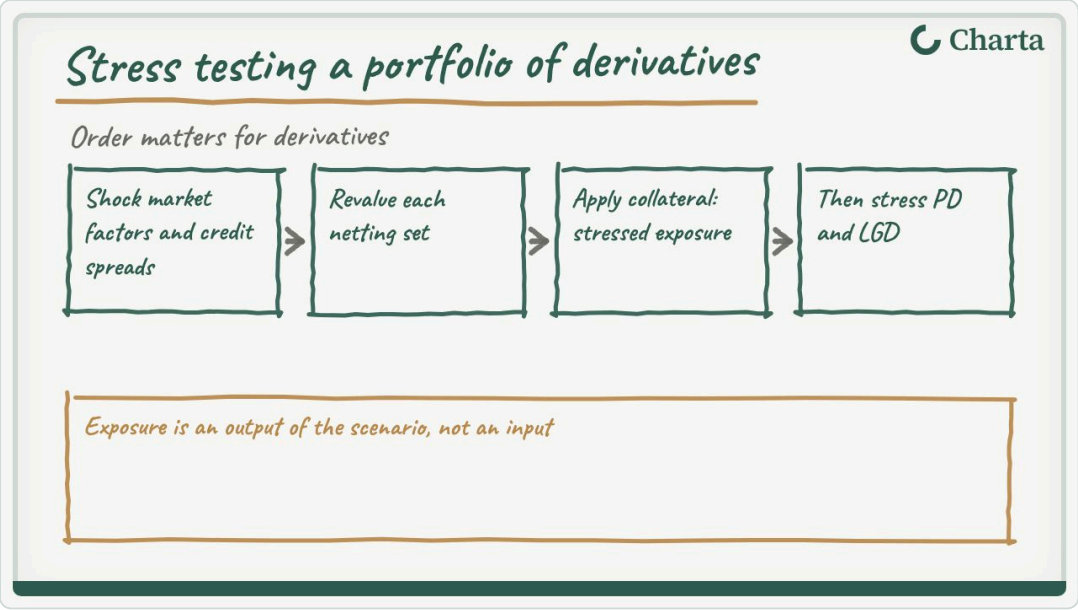
## 11 Stress testing a portfolio of loans

- Shock each loan's PD, LGD and EAD
- EAD rises as borrowers draw on committed lines
- Scenario comes from the economy: for example a recession
- Add sector or regional concentration shocks
- Raise default correlation

IN THE LESSON

- Now the third outcome.
- A stress test asks what a bad but plausible scenario would do to our losses.
- For a portfolio of loans, we shock the credit parameters of each exposure: the probability of default, the loss given default, and the exposure at default.
- The exposure at default can rise as borrowers draw more on their committed credit lines when times are bad.
- The shocks usually come from a macroeconomic scenario such as a recession.
- On top of that, the test can add a concentration shock to one sector or region, and a rise in default correlation.
- The key feature of a loan is that its exposure is fairly well known: it is the outstanding balance plus any further drawdowns.

## 12 Stress testing a portfolio of derivatives




IN THE LESSON

- A derivatives portfolio needs an extra step, because the exposure itself is uncertain.
- Follow the boxes in order.
- First, the scenario shocks the market risk factors: interest rates, exchange rates, equity and commodity prices, volatilities and credit spreads.
- Second, the netting sets are revalued under those shocked factors.
- Third, collateral is applied, which gives the stressed exposure of each counterparty.
- Only then, in the fourth box, do we stress the counterparty default probabilities and losses given default.
- The order matters: shocking default probabilities while leaving exposure at today's value misses the main way a derivatives book loses money.

## 13 Choices that only derivatives need

- Longer margin period of risk: collateral arrives late
- Larger collateral haircuts
- Wrong-way dependence between exposure and default
- One consistent scenario for loans and derivatives
- Aggregate by counterparty

IN THE LESSON

- There are further choices that apply only to derivatives.
- The first is a longer margin period of risk, which is the time between the last good collateral payment and the moment the position is closed out.
- In a crisis, closing out takes longer and the market moves further, so the collateral covers less.
- The second is larger collateral haircuts, since the posted collateral may lose value.
- The third is wrong-way dependence between the exposure and the default of the counterparty.
- The aim of the whole exercise is one consistent scenario, applied to loans and to derivatives, with the results added up counterparty by counterparty.

## 14 Expected loss, stressed expected loss, stress loss

**EL = EAD × PD × LGD**
**Stress loss SL = stressed EL − base EL**

| | |
|---|---|
| **Exposure at default** | Amount owed at default |
| **Probability of default** | Chance of default |
| **Loss given default** | Share not recovered |
| **Stressed expected loss** | Same sum with scenario inputs |
| **Stress loss** | What the scenario adds |

IN THE LESSON

- Now the fourth outcome.
- For any credit exposure, expected loss, written E L, is exposure at default times probability of default times loss given default.
- The portfolio figure is the sum over all exposures.
- Stressed expected loss is the same sum, recomputed with the scenario values of all three inputs.
- Stress loss, written S L, is the increase over the base case: stressed expected loss minus base expected loss.
- We subtract because the base expected loss is already priced and provisioned.
- What the scenario adds is the increment.
- So stress loss and stressed expected loss are different numbers, and mixing them up is the commonest error.

## 15 Example 4: stress loss on two loans

*A: $10m, 2%, 45% → $12m, 5%, 55%. B: $6m, 1%, 40% → $6.5m, 3%, 50%*

| | | |
|---|---|---|
| **Base EL, A + B** | 90,000 + 24,000 | **$114,000** |
| **Stressed EL, loan A** | 12m × 5% × 55% | **$330,000** |
| **Stressed EL, loan B** | 6.5m × 3% × 50% | **$97,500** |
| **Stressed EL, total** | 330,000 + 97,500 | **$427,500** |
| **Stress loss** | 427,500 − 114,000 | **$313,500** |

*Base: A 10m × 2% × 45% = 90,000. B 6m × 1% × 40% = 24,000*

IN THE LESSON

- Harbour Bank has two loans.
- Loan A has exposure ten million, default probability two per cent and loss given default forty five per cent.
- Its expected loss is ninety thousand dollars.
- Loan B has exposure six million, default probability one per cent and loss given default forty per cent, so its expected loss is twenty four thousand.
- The base total is one hundred and fourteen thousand.
- In the recession scenario, Loan A draws more and its inputs become twelve million, five per cent and fifty five per cent, giving three hundred and thirty thousand.
- Loan B becomes six and a half million, three per cent and fifty per cent, giving ninety seven thousand five hundred.
- Stressed expected loss is four hundred and twenty seven thousand five hundred.
- Stress loss is the difference, three hundred and thirteen thousand five hundred dollars.

## 16 Example 5: stress loss on a derivative netting set

*MTM +9m, collateral 3m, PD 1%, LGD 60% → MTM +20m, collateral 8m, PD 4%, LGD 70%*

| | | |
|---|---|---|
| **Base exposure** | max(9 − 3, 0) | **$6m** |
| **Stressed exposure** | max(20 − 8, 0) | **$12m** |
| **Base EL** | 6m × 1% × 60% | **$36,000** |
| **Stressed EL** | 12m × 4% × 70% | **$336,000** |
| **Stress loss** | 336,000 − 36,000 | **$300,000** |

IN THE LESSON

- Now a derivative.
- Harbour Bank's netting set with Northwind is worth nine million dollars today, and Northwind has posted three million of collateral.
- So the base exposure is six million.
- With a default probability of one per cent and loss given default of sixty per cent, base expected loss is thirty six thousand dollars.
- In the stress scenario, market factors move and the netting set is revalued at twenty million.
- Collateral rises only to eight million, because it lags the market.
- Stressed exposure is twenty minus eight, which is twelve million.
- Default probability becomes four per cent and loss given default seventy per cent, so stressed expected loss is three hundred and thirty six thousand.
- Stress loss is three hundred thousand dollars.
- Had the stressed value been negative, the floor at zero would have given no exposure.

## 17 Mistakes in stress loss

- Stressed EL reported as the stress loss
- Derivative exposure left at today's value
- Only PD shocked, not EAD and LGD
- Netting and collateral forgotten
- Use the definition in the question

IN THE LESSON

- Four mistakes appear again and again.
- First, reporting stressed expected loss as the stress loss.
- In our loan example that would be four hundred and twenty seven thousand five hundred, not three hundred and thirteen thousand five hundred.
- Second, leaving derivative exposure at its current value, so the stress touches only the credit side.
- Third, shocking only the default probability and forgetting that exposure and loss given default move as well.
- Fourth, forgetting netting and collateral.
- One last warning for the exam: use the definition given in the question.
- Some stems define stress loss differently, though the increment over base expected loss is the usual one.

## 18 CVA: a stress that needs no default

- CVA is the market value of counterparty credit risk
- It is marked to market: a stress hits P&L
- No default is needed for the loss
- Drivers: counterparty spreads, recovery rates
- And the market factors behind expected exposure

IN THE LESSON

- Now the fifth outcome, stress testing the credit valuation adjustment.
- C V A is the market value of counterparty credit risk.
- It is approximately the loss given default times a sum over time buckets of the discount factor, the expected exposure and the marginal default probability.
- The key point for stress testing is that C V A is marked to market.
- So a C V A stress test measures a profit and loss hit that happens with no default at all.
- When counterparty spreads widen, the C V A liability grows and the bank books a loss on its income statement.
- The drivers are the counterparty credit spreads, the recovery rates, and the market factors that drive expected exposure.

## 19 Two ways to run a CVA stress test

*Same stress, two methods*

| | Full revaluation | Sensitivities |
|---|---|---|
| How | Re-simulate exposure | CS01, delta, gamma |
| Speed | Slow | Fast |
| Large shocks | Accurate | Weaker |
| Cross terms | Built in | Must be added |

IN THE LESSON

- There are two approaches.
- In full revaluation, the bank re-simulates the exposure under the stressed market factors, applies the stressed spreads, and recomputes C V A from scratch.
- It is slow but accurate, even for large shocks, and it captures how spreads and exposure interact.
- The alternative is a sensitivity-based estimate.
- Here the bank uses the C S zero one, which is the change in C V A for a one basis point rise in spread, plus delta and gamma terms for the market factors, including cross terms.
- It is fast, so it can be run often.
- But it is a local approximation, so it gets weaker as the shock gets larger.

## 20 What a good CVA stress includes

- Shock spreads and market factors in one scenario
- They multiply, and may be wrong-way correlated
- No liquid CDS: use a proxy spread curve and stress it
- Include the CVA hedges in the test
- Hedges carry basis and jump-to-default risk

IN THE LESSON

- A full test has several features.
- First, it shocks both sides together, spreads and market factors, preferably in one coherent scenario.
- The reason is that CVA is a product of exposure and default probability, so the two interact multiplicatively, and they may be wrong-way correlated.
- Second, some counterparties have no liquid C D S.
- For them the bank uses a proxy spread curve, perhaps built from similar names, and the proxy must be stressed too.
- Third, the CVA hedges must be included in the test.
- A hedge reduces the loss, but it brings its own risks: basis risk, because the hedge does not move exactly with the counterparty's spread, and jump to default risk, because a default makes the market jump.

## 21 The CVA formula

**CVA = LGD × Σ DF(t) × EE(t) × marginal PD(t)**

| | |
|---|---|
| **Loss given default** | Share not recovered |
| **Discount factor, DF(t)** | Brings the amount to today |
| **Expected exposure, EE** | Average positive exposure at t |
| **Marginal default probability** | Default between t − 1 and t |

IN THE LESSON

- Now the sixth outcome, computing stressed C V A.
- Rebuild the formula with scenario inputs.
- Split the life of the trades into time buckets.
- For each bucket we need three things.
- The discount factor, written D F of t, brings the future amount to today.
- The expected exposure, E E of t, says how much we expect to be owed.
- The marginal default probability is the chance that the counterparty defaults between the previous date and date t.
- Multiply the three, add up over the buckets, and multiply by the loss given default.
- The result is the market price of the credit risk.
- Note the word marginal: it is the probability of defaulting in that bucket, not the cumulative probability of defaulting by then.

## 22 From a spread to a default probability

**Hazard = spread ÷ LGD**
**Survival(t) = e^( −Hazard × t )**
**Marginal PD(t) = Survival(t − 1) − Survival(t)**

| | |
|---|---|
| **Credit spread** | Quoted for the counterparty |
| **Hazard rate** | Instantaneous chance of default |
| **Survival to t** | Chance of no default by t |
| **Marginal default probability** | Default within the bucket |

IN THE LESSON

- Where does the marginal default probability come from?
- From the counterparty's credit spread, through the credit triangle.
- The spread is roughly the hazard rate times the loss given default, so the hazard rate is the spread divided by the loss given default.
- The hazard rate is the instantaneous chance of default, and it gives the survival probability: e raised to the power of minus the hazard rate times t.
- The marginal default probability for a bucket is the survival to the start of the bucket minus the survival to its end.
- Three errors to avoid.
- Using the spread directly as a probability.
- Leaving the loss given default out of the triangle.
- And, when recovery is stressed, forgetting that the hazard rate changes too.

## 23 Example 6: base CVA for Northwind

*LGD 60%, spread 120bp → hazard 2%. DF 0.97, 0.94, 0.91. EE $4m, $6m, $5m*

| | | |
|---|---|---|
| **Year 1: DF × EE × mPD** | 0.97 × 4m × 1.980% | **$76,829** |
| **Year 2: DF × EE × mPD** | 0.94 × 6m × 1.941% | **$109,468** |
| **Year 3: DF × EE × mPD** | 0.91 × 5m × 1.902% | **$86,563** |
| **Sum of the three buckets** | | **$272,861** |
| **Base CVA** | 60% × sum | **$163,716** |

*Survival 98.02%, 96.08%, 94.18% → mPD 1.980%, 1.941%, 1.902%*

IN THE LESSON

- Let us compute base C V A with three yearly buckets.
- The loss given default is sixty per cent and the spread is one hundred and twenty basis points, which is one point two per cent.
- The hazard rate is point zero one two over point six, or two per cent.
- The marginal default probabilities are about one point nine eight per cent, one point nine four per cent and one point nine zero per cent.
- The discount factors are point nine seven, point nine four and point nine one.
- Expected exposures are four, six and five million dollars.
- Multiplying in each bucket and adding gives about two hundred and seventy three thousand, and sixty per cent of it is a C V A of about one hundred and sixty four thousand dollars.

## 24 Example 7: stressed CVA and the stress loss

*Spread 300bp: hazard 3% ÷ 0.6 = 5%. EE +25%. Hedge gains $90,000*

| | | |
|---|---|---|
| **Buckets: DF × EE × mPD** | 236,537 + 327,064 + 250,986 | **$814,587** |
| **Stressed CVA** | 60% × sum | **$488,752** |
| **Stress loss on CVA, gross** | stressed − base | **$325,036** |
| **Hedge gain** | CDS hedge | **− $90,000** |
| **Stress loss on CVA, net** | gross − hedge gain | **$235,036** |

*mPD 4.877%, 4.639%, 4.413%. DF 0.97, 0.94, 0.91 as before*

IN THE LESSON

- Now the stress.
- The scenario widens Northwind's spread from one hundred and twenty to three hundred basis points, and raises every expected exposure by a quarter, to five, seven and a half and six and a quarter million dollars.
- Loss given default stays at sixty per cent.
- The hazard rate becomes three per cent over point six, which is five per cent, and the marginal default probabilities rise to about four point nine, four point six and four point four per cent.
- The buckets are about two hundred and thirty seven, three hundred and twenty seven and two hundred and fifty one thousand dollars.
- Recomputing gives a stressed C V A of about four hundred and eighty nine thousand dollars.
- The stress loss on C V A is the stressed level minus the base level, about three hundred and twenty five thousand.
- A credit default swap hedge that gains ninety thousand dollars reduces the net loss to about two hundred and thirty five thousand.

## 25 Example 8: sensitivity estimate against full revaluation

*Same stress as Example 7, before the hedge*

| | | |
|---|---|---|
| **CS01: CVA change per +1bp** | bump 120bp to 121bp | **$1,322** |
| **Sensitivity estimate** | 180bp × CS01 | **$237,979** |
| **Full revaluation, spread only** | 391,002 − 163,716, rounded | **$227,285** |
| **Exposure +25%, at base spread** | 25% × base CVA | **$40,929** |
| **Cross term** | 325,036 − 227,285 − 40,929 | **about $56,800** |

IN THE LESSON

- Finally, compare the two approaches on the same stress.
- Bumping the spread by one basis point raises C V A by about one thousand three hundred and twenty two dollars: that is the C S zero one.
- Multiplied by the one hundred and eighty basis point widening, the sensitivity estimate is about two hundred and thirty eight thousand dollars.
- Full revaluation of the spread change alone gives about two hundred and twenty seven thousand, so the straight line overstates by roughly eleven thousand.
- Now add the exposure shock.
- On its own, a quarter rise in exposure at the base spread adds about forty one thousand.
- The two pieces sum to about two hundred and sixty eight thousand, but the joint stress gave three hundred and twenty five.
- The difference, about fifty seven thousand, is the cross term.

## 26 DVA: the mirror image of CVA

**DVA = own LGD × Σ DF(t) × ENE(t) × own marginal PD(t)**
**Bilateral adjustment = CVA − DVA**

| | |
|---|---|
| **Expected negative exposure, ENE** | What we expect to owe, at t |
| **Debit valuation adjustment** | Value of our own option to default |
| **Bilateral adjustment** | Net charge for the trade |

IN THE LESSON

- Now the seventh outcome.
- D V A, the debit valuation adjustment, is the mirror image of C V A.
- It is the value of the institution's own option to default.
- Where C V A looks at what the counterparty may owe us, D V A looks at what we may owe the counterparty.
- The average of what the institution itself owes is the expected negative exposure, E N E.
- The formula is the same as for C V A, using the institution's own loss given default, the discounted expected negative exposure, and the institution's own marginal default probability.
- The bilateral adjustment is C V A minus D V A.
- It is smaller than C V A alone, because the counterparty also bears the risk that we default.

## 27 Example 9: DVA in the combined stress

*Own spread 80 → 200bp, LGD 60%, ENE $2m, $3m, $2.5m, DF as before*

| | | |
|---|---|---|
| **Base DVA** | 1.333% hazard; 60% × 91,890 | **$55,134** |
| **Stressed DVA** | 3.333% hazard; 60% × 222,794 | **$133,676** |
| **Increase in DVA** | stressed − base | **$78,542** |
| **Increase in CVA (gross loss)** | from Example 7 | **$325,036** |
| **Net stress loss** | CVA rise − DVA rise | **$246,494** |

IN THE LESSON

- Harbour Bank's own spread is eighty basis points, with its own loss given default of sixty per cent.
- Its expected negative exposure to Northwind is two, three and two and a half million dollars over the three buckets.
- Base D V A is about fifty five thousand dollars.
- In the stress, Harbour's own spread widens to two hundred basis points, so its hazard rate rises from one point three three to three point three three per cent and D V A grows to about one hundred and thirty four thousand.
- That is a rise of about seventy eight and a half thousand dollars, an accounting gain.
- The net stress loss is the rise in C V A, about three hundred and twenty five thousand, minus the rise in D V A, about seventy eight and a half thousand.
- That leaves about two hundred and forty six and a half thousand dollars.
- Adding the D V A instead would give a wrong answer of about four hundred and four thousand.

## 28 DVA is weak support in a stress

- Own spread widens, so DVA rises: an accounting gain
- Realised only by default, and hard to hedge
- Basel III removes DVA gains from CET1 capital
- Show the CVA loss gross and the DVA offset apart
- Errors: netting all of it, or adding instead of subtracting

IN THE LESSON

- Why not simply net the D V A gain against the C V A loss and report a small number?
- Because the gain is weak support.
- It is an accounting gain that can only be realised by defaulting, which is hardly a plan.
- It is also hard to hedge, because the bank cannot easily trade protection on itself.
- And Basel three removes D V A gains from common equity tier one capital, so the regulator does not count it.
- For this reason combined counterparty risk stress results should show the C V A loss gross, and the D V A offset as a separate line.
- The usual errors are netting the whole D V A gain against the C V A loss and presenting only the small net number, or adding D V A instead of subtracting it.

## 29 Mistakes in designing the test

*Design errors and why they fail*

| Mistake | Why it fails |
|---|---|
| Only PD stressed, exposure static | Understates joint effect |
| Only markets shocked, credit constant | Misses the default side |
| 99% PFE called a stress test | Normal-times statistic |
| Exposure independent of default | Misses wrong-way risk |
| Mild or purely historical scenarios | Test never bites |

IN THE LESSON

- Now the last outcome, the usual mistakes in stress testing counterparty credit risk.
- Most of them come from forgetting that the risk is both credit and market.
- Stressing counterparty default probabilities while holding exposure at today's level, or shocking market factors while holding credit quality constant, understates the joint effect.
- Treating the ninety ninth percentile potential future exposure as a stress test is another.
- It is a statistical measure calibrated to normal conditions, not a scenario with stressed correlations and spreads.
- Assuming exposure and default are independent misses wrong-way risk.
- And relying on mild or purely historical scenarios means the test never bites.

## 30 Mistakes in treating protection and prices

*Protection and price errors*

| Mistake | Why it fails |
|---|---|
| Collateral fully effective | Ignores MPOR, haircuts |
| CVA hedges seen as perfect | Basis, jump to default |
| DVA gain counted as offset | Weak support |
| Risk-neutral and real-world PDs mixed | Different measures |
| Separate tests per risk type | Need one coherent scenario |

IN THE LESSON

- A second group of mistakes is about protection and prices.
- Treating collateral as fully effective ignores the margin period of risk, the haircuts and disputes over what is owed.
- Treating C V A hedges as perfect forgets basis risk, jump to default risk, and changes in exposure that leave the hedge too big or too small.
- Counting the D V A gain as an offset is another.
- Another mistake is mixing risk-neutral default probabilities, implied from spreads, with real-world default probabilities when estimating default losses.
- The two are different measures, and each belongs in its own calculation.
- The last mistake is running separate tests for each risk type.
- A sound test uses one coherent scenario across the whole book.

## 31 Example 10: why partial stresses understate

*Example 5 netting set: base EL 6m × 1% × 60% = 36,000*

| | | |
|---|---|---|
| **Credit only: stress loss** | 168,000 − 36,000 | **$132,000** |
| **Markets only: stress loss** | 72,000 − 36,000 | **$36,000** |
| **Joint scenario, EL** | 12m × 4% × 70% | **$336,000** |
| **Joint stress loss** | 336,000 − 36,000 | **$300,000** |
| **Sum of partial stress losses** | 132,000 + 36,000 | **$168,000** |

*Credit only EL 6m × 4% × 70% = 168,000. Markets only EL 12m × 1% × 60% = 72,000*

**IN THE LESSON**

- Let us see the first mistake in numbers, using the derivative from Example five.
- Base expected loss is thirty six thousand dollars.
- Suppose the bank stresses only the credit side, with exposure left at six million, default probability four per cent and loss given default seventy per cent.
- The expected loss is one hundred and sixty eight thousand, a stress loss of one hundred and thirty two thousand.
- Suppose instead it shocks only the markets, keeping credit quality as it was: exposure twelve million, default probability one per cent and loss given default sixty per cent.
- The expected loss is seventy two thousand, a stress loss of only thirty six thousand.
- The joint scenario gives three hundred and thirty six thousand, a stress loss of three hundred thousand, far above the one hundred and sixty eight thousand the two partial stress losses add to.

## 32 Recap: the main ideas

- Four exposures: current, EE, EPE, peak
- CCR = market risk (exposure) plus credit risk (PD, LGD)
- SL = stressed EL − base EL; markets first
- Stressed CVA: credit triangle, marginal PD, discounting
- DVA: weak support, show gross; one scenario

**IN THE LESSON**

- Let us pull it together.
- There are four exposure measures: current exposure is today's replacement cost, expected exposure is the average positive part at a date, expected positive exposure is its time average, and peak exposure is a high percentile used for limits.
- Counterparty credit risk is market risk through the exposure and credit risk through default and recovery, and the two can move together.
- Stress loss is stressed expected loss minus base expected loss, and for derivatives we shock markets first.
- Stressed C V A uses the credit triangle and marginal default probabilities, and the loss is the increase.
- D V A offsets only part of it.
- And one coherent scenario beats partial tests.

## 33 Try three quick questions

1. MTM normal, mean 0, σ = $20m. EE and 95% peak?
   **Answer:** EE 0.399 × 20 = $7.98m. Peak 1.645 × 20 = $32.9m.
2. Loan $5m, 2%, 50% → $6m, 6%, 60%. Stress loss?
   **Answer:** Base 5m × 2% × 50% = 50,000. Stressed 6m × 6% × 60% = 216,000. SL = $166,000.
3. CVA up $1.7m, DVA up $0.4m. Net loss? Report?
   **Answer:** $1.3m net. Show CVA loss $1.7m gross, DVA apart.

**IN THE LESSON**

- Now try three quick questions.
- Pause the video, think, then listen.
- Question one.
- A mark to market is normal with mean zero and a standard deviation of twenty million dollars.
- What are expected exposure and ninety five per cent peak exposure?
- Zero point three nine nine times twenty is seven point nine eight million.
- One point six four five times twenty is thirty two point nine million.
- Question two.
- A loan of five million dollars has a default probability of two per cent and a loss given default of fifty per cent.
- In a stress it becomes six million, six per cent and sixty per cent.
- What is the stress loss?
- Base expected loss is fifty thousand dollars, stressed is two hundred and sixteen thousand, so the stress loss is one hundred and sixty six thousand.
- Question three.
- A stress raises C V A by one point seven million and D V A by point four million.
- What is the net loss?
- One point three million, but report the C V A loss gross.