CHARTA LEARNING · LESSON NOTES

Fundamental Review of the Trading Book

FRM Part II

1 A story: the crisis that broke the old rules

- Halden Bank: trading capital on a 10-day 99% VaR
- Crisis losses ran far beyond the VaR figure
- Positions could not be sold within 10 days
- Assets placed in the trading book for lower capital
- Answer: the Fundamental Review of the Trading Book

IN THE LESSON

- Imagine Halden Bank, a made up bank with a large trading operation, before the crisis of two thousand seven to two thousand nine.
- Its capital for trading positions rested on a ten day V a R at ninety nine per cent.
- Then the crisis came.
- Losses ran far beyond the V a R figure, because V a R says nothing about how bad things get past its cut-off.
- Positions the model assumed could be sold within ten days could not be sold for months.
- And some assets had been placed in the trading book simply because capital there was lower.
- Regulators answered with a new framework, the Fundamental Review of the Trading Book.

2 The old rules: two books and one VaR

- Trading book: positions held to trade, valued at market
- Banking book: loans and assets held, often to maturity
- The bank chose the book by its own stated intent
- Trading book capital: 10-day 99% VaR, often lower
- So the boundary invited capital arbitrage

IN THE LESSON

- To see what went wrong, we need two terms.
- The trading book holds positions the bank holds in order to trade, valued every day at market prices.
- The banking book holds loans and other assets the bank intends to keep, often to maturity.
- Under the old rules, the bank itself decided which book a position sat in, by stating its trading intent.
- Capital for the trading book came from a ten day V a R at ninety nine per cent, and for many positions that was lower than the capital the banking book required.
- A bank could cut its capital by declaring an intent to trade.
- The boundary invited capital arbitrage, meaning a move made to save capital rather than to change risk.

3 What the crisis exposed

- 1. VaR ignores losses beyond its quantile
- 2. Many positions could not be sold in 10 days
- 3. The book boundary could be exploited
- Each made capital too small for the losses that came
- Every part of the reform answers one of them

IN THE LESSON

- The crisis exposed three weaknesses.
- First, V a R ignores losses beyond its quantile.
- A ninety nine per cent V a R is the loss exceeded in only one period in a hundred, but it says nothing about how large the losses are in that one period.
- Second, the ten day horizon assumed that every position could be sold or hedged within ten days.
- In the crisis many could not, because buyers disappeared.
- Third, the boundary between the books could be exploited.
- Each weakness meant that the capital held was too small for the losses that came.
- Keep these three in mind, because every part of the reform answers one of them.

4 Example 1: same VaR, very different tails

Two Halden desks, each with a 10-day 99% VaR of $20m

Rates desk: VaR	worst 1% starts at	**$20m**
Rates desk: average beyond	losses in the worst 1%	**$23m**
Options desk: VaR	worst 1% starts at	**$20m**
Options desk: average beyond	sold deep out-of-money options	**$69m**
Ratio of the tail averages	69 ÷ 23	**3 times**

Same VaR, same old capital; the expected shortfall differs 3 times

IN THE LESSON

- Here is the first weakness in numbers.
- Halden has two desks, each with a ten day V a R at ninety nine per cent of twenty million dollars.
- On the rates desk the worst one per cent of outcomes starts at twenty million, and the losses in that worst one per cent average about twenty three million.
- On the options desk the worst one per cent also starts at twenty million.
- But this desk has sold deep out of the money options, which pay nothing for a long time and then lose heavily, so its losses in the worst one per cent average sixty nine million.
- The ratio of the tail averages is sixty nine over twenty three, three times.
- The average loss beyond the V a R is called the expected shortfall.
- Under the old rules both desks looked identical.

5 Basel 2.5: patches on the old frame

- Stressed VaR: VaR on data from a stress period
- Incremental risk charge: default and downgrade risk
- Both added on top of the old VaR
- Still VaR at the core; boundary still set by intent
- FRTB replaces the patchwork

IN THE LESSON

- Regulators first responded with quick repairs, known as Basel two point five.
- They added stressed V a R, which is V a R computed on data from a period of severe market stress, so that capital does not shrink in calm years.
- And they added the incremental risk charge, a charge for the risk that credit positions in the trading book default or are downgraded.
- Both were added on top of the old V a R.
- But the core measure was still V a R, still blind to the size of losses in the tail, and the boundary was still decided by intent.
- The result was a patchwork of charges.
- The F R T B replaces that patchwork with one redesigned framework.

6 What the FRTB changes

Each change answers a weakness the crisis exposed

Feature	Old regime	FRTB
Risk measure	VaR 99%	ES 97.5%
Calibration	Recent data + SVaR	A stress period
Horizon	10 days for all	Liquidity horizons
Credit default	Incremental risk charge	Default risk charge
Model approval	Bank as a whole	Desk by desk

IN THE LESSON

- Each change in this table answers a weakness the crisis exposed.
- The risk measure moves from V a R at ninety nine per cent to expected shortfall, E S, at ninety seven point five per cent.
- Calibration moves from recent data, with stressed V a R bolted on, to a stress period at the core of the measure.
- The horizon moves from ten days for every position to liquidity horizons, which differ by risk factor.
- The charge for credit default moves from the incremental risk charge to a default risk charge.
- And model approval, which used to be granted for the bank's model as a whole, is now granted desk by desk.

7 Two routes to capital under the FRTB

- Internal models: the bank's own ES model
- ES at 97.5%, calibrated to a stress period
- Adds liquidity horizons and a default risk charge
- Stress scenario charge for non-modellable risk factors
- Revised standardised approach: applies to every desk

IN THE LESSON

- Under the F R T B a bank has two routes to market risk capital.
- The first is the internal models approach, where the bank uses its own model.
- Its core measure is expected shortfall at ninety seven point five per cent, calibrated to a stress period.
- On top of that it adds liquidity horizons and a default risk charge.
- It also adds a stress scenario charge for non modellable risk factors, which are factors with too little reliable price data to model.
- The second route is the revised standardised approach, where capital comes from formulas set by the regulator.
- It applies to every desk, including desks that use internal models, so it is always there as the fallback.

8 Expected shortfall against VaR on a normal

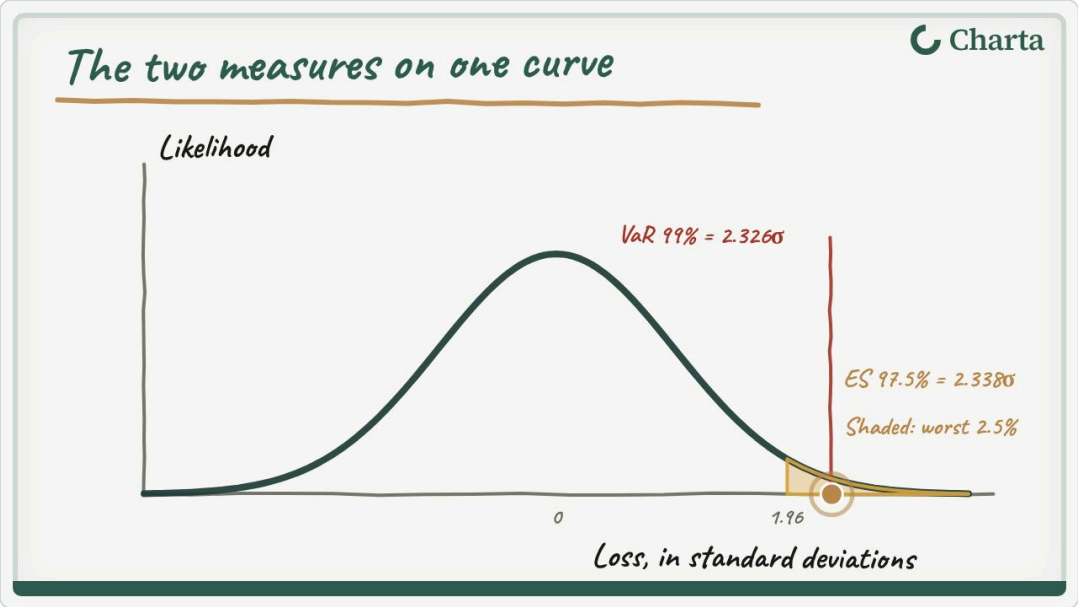
$VaR_{99} = 2.326 \times \sigma$
$ES_{97.5} = \sigma \times \varphi(1.96) \div 0.025 = 2.338 \times \sigma$

VaR at 99%	Loss exceeded on 1% of days
ES at 97.5%	Average loss in the worst 2.5%
Standard deviation, σ	Std deviation of the loss
Normal density, φ	Density at 1.96: about 0.0584

IN THE LESSON

- A natural question is whether ninety seven point five per cent is a weaker standard than ninety nine.
- Look at a normal distribution of losses with mean zero and standard deviation sigma.
- V a R at ninety nine per cent is two point three two six sigma.
- Expected shortfall at ninety seven point five per cent is sigma, times phi, the normal density, at one point nine six, divided by the tail probability, point zero two five.
- The density at one point nine six is about point zero five eight four, so the multiple is two point three three eight.
- That is almost exactly the ninety nine per cent V a R.
- So for a normal distribution the two measures are close in size.

9 The two measures on one curve



IN THE LESSON

- This chart draws the normal loss curve, with losses measured in standard deviations along the bottom.
- The shaded area on the right is the worst two and a half per cent of outcomes, everything beyond one point nine six.
- Expected shortfall at ninety seven point five per cent is the average loss inside that shaded tail.
- The vertical line marks V a R at ninety nine per cent, at two point three two six sigma.
- The label to its right gives E S at ninety seven point five per cent, two point three three eight sigma, and the dot on the axis shows where it falls, a hair to the right of the line.
- Under a normal curve the two sit almost on top of each other.

10 Example 2: Halden's rates desk on a normal

Rates desk: 10-day loss normal, mean 0, standard deviation $8.6m

VaR at 99%, as in Example 1	2.326 × 8.6	**$20.00m**
ES at 97.5%	2.338 × 8.6	**$20.11m**
Gap	0.012 × 8.6	**$0.10m**
ES at 99%: Example 1's $23m	2.665 × 8.6	**$22.92m**

Similar size on a normal; ES grows when the tail is fat

IN THE LESSON

- Now put dollars on it.
- Suppose the ten day loss of Halden's rates desk is normal, with mean zero and a standard deviation of eight point six million dollars.
- V a R at ninety nine per cent is two point three two six times eight point six, twenty point zero zero million, the twenty million we met in Example one.
- Expected shortfall at ninety seven point five per cent is two point three three eight times eight point six, twenty point one one million.
- The gap is only point zero one two times eight point six, point one zero million.
- For contrast, expected shortfall at ninety nine per cent would be two point six six five times eight point six, twenty two point nine two million, close to the twenty three million of Example one.
- So the F R T B did not simply raise the confidence level.
- On a normal the measures are similar in size, but when the tail is fat, as on the options desk, E S grows much faster.

11 Exam points on why the reform came

- ES 97.5% is close to VaR 99% on a normal
- So the reform is not a higher confidence level
- It is tail sensitivity, stress calibration and liquidity
- Basel 2.5 patched; the FRTB rebuilt
- Desk-by-desk approval; standardised for every desk

IN THE LESSON

- Here are the exam points for this first part.
- For a normal distribution, expected shortfall at ninety seven point five per cent is close to V a R at ninety nine per cent.
- So the reform is not about a higher confidence level.
- The change lies in three things: sensitivity to the tail, because E S averages the losses beyond the cut-off; calibration to a stress period, so capital reflects bad times; and liquidity, through horizons longer than ten days.
- Remember also the sequence.
- Basel two point five patched the old V a R with stressed V a R and the incremental risk charge, while the F R T B rebuilt the framework.
- Finally, models are approved desk by desk, and the standardised approach is computed for every desk.

12 Liquidity horizons: how long to get out

- Each risk factor gets its own horizon
- Time to exit or hedge a position in stressed markets
- Five buckets: 10, 20, 40, 60 and 120 days
- Liquid factors: short; illiquid factors: long
- Replaces one 10-day horizon for everything

IN THE LESSON

- Now the second weakness, liquidity.
- The F R T B gives each risk factor a liquidity horizon.
- A risk factor is a market variable that drives a position's value, such as a share price, an exchange rate or a credit spread.
- The liquidity horizon is the time needed to exit or hedge a position in stressed markets, not in calm ones.
- There are five buckets: ten, twenty, forty, sixty and one hundred and twenty days.
- Liquid factors, which can be traded quickly even in a crisis, get short horizons, and illiquid factors get long ones.
- This replaces the old assumption that every position, from a large company's shares to an exotic credit trade, could be closed in ten days.

13 Which factors sit where

The less liquid a factor is under stress, the longer its horizon

Horizon	Examples
10 days	Large-cap equity prices; major FX rates
20, 40, 60 days	Middling liquidity, as prescribed
120 days	Credit spread volatility; some commodities
Rule	The prescribed table governs

IN THE LESSON

- The less liquid a factor is under stress, the longer its horizon.
- The table gives illustrations, read row by row.
- At ten days sit large company equity prices and the exchange rates of major currencies.
- These markets stay deep even under stress.
- The middle buckets, twenty, forty and sixty days, hold factors of middling liquidity, as set by the prescribed classification.
- At one hundred and twenty days sit credit spread volatility and some commodity factors, which can take months to exit in a crisis.
- The last row is the rule to remember.
- These are illustrations, and the prescribed table governs.
- In a question, always use the horizon you are given rather than one you remember for a similar factor.

14 The cascade: one base run, then reruns

- T = 10 days: the base period for every run
- ESP: base ES, all factors shocked over T
- ESj: rerun shocking only factors with horizon ≥ LHj
- Other factors held at their current values
- Every run: ES at 97.5%, one-tailed

IN THE LESSON

- How does a bank build these horizons into expected shortfall?
- It runs a cascade.
- Everything starts from a base period of ten days, written capital T.
- First it computes the base expected shortfall, written E S P, shocking all risk factors over T.
- Then, for each longer bucket j, it reruns the calculation, shocking only the factors whose horizon is at least that bucket's horizon, L H j.
- That rerun is written E S j.
- In each rerun the other factors are held at their current values.
- Every run uses expected shortfall at ninety seven point five per cent, one tailed.
- So a factor with a one hundred and twenty day horizon appears in every run, and a ten day factor appears only in the base run.

15 The liquidity-adjusted expected shortfall

Termj = ESj × √((LHj − LH(j−1)) ÷ T)
ES = √(ESP^2 + Σ Termj^2)

ESP, the base ES	All factors shocked over T
ESj, the rerun for bucket j	Only factors with LH ≥ LHj
LHj, the bucket's horizon	Bucket horizon: 20 to 120 days
T, the base period	Base period: 10 days

IN THE LESSON

- Here is how the runs combine.
- Each bucket from the twenty day one upward adds a term.
- The term is E S j, times the square root of this horizon minus the previous one, divided by T.
- Notice the difference between horizons.
- Factors in bucket j were already shocked over the previous horizon by the earlier runs, so the term scales only the extra days, using the square root of time rule.
- Then the liquidity adjusted E S is the square root of E S P squared plus the sum of the squared terms.
- The squares are added, as for independent pieces of risk, and the square root is taken at the end.
- T is always the ten day base period.

16 Example 3: one factor, one check

One risk factor, horizon 40 days; its 10-day ES is $10m

Base ES, all factors	10-day run	**$10m**
20-day term	10 × √((20 − 10) ÷ 10)	**$10.00m**
40-day term	10 × √((40 − 20) ÷ 10)	**$14.14m**
60- and 120-day terms	no factor that long	**$0**
Liquidity-adjusted ES	√(100 + 100 + 200)	**$20m**

= 10 × √(40 ÷ 10): the square-root-of-time rule out to 40 days

IN THE LESSON

- Let us check the formula on the simplest case.
- A desk holds one risk factor, with a horizon of forty days, and its ten day E S is ten million dollars.
- The base E S is ten million.
- The factor's horizon is at least twenty, so the twenty day rerun is also ten million, and its term is ten times the square root of twenty minus ten over ten, ten million.
- The factor is also in the forty day rerun, and that term is ten times the square root of forty minus twenty over ten, fourteen point one four million.
- The sixty and one hundred and twenty day terms are zero, because no factor is that long.
- Liquidity adjusted E S is the square root of one hundred plus one hundred plus two hundred, twenty million.
- That equals ten times the square root of forty over ten: the square root of time rule out to forty days.

17 Example 4: Halden's credit desk, the terms

Credit desk, $m: ESP 40; ES20 30; ES40 20; ES60 12; ES120 8; T = 10

20-day term	30 × √((20 − 10) ÷ 10)	**30.00**
40-day term	20 × √((40 − 20) ÷ 10)	**28.28**
60-day term	12 × √((60 − 40) ÷ 10)	**16.97**
120-day term	8 × √((120 − 60) ÷ 10)	**19.60**

IN THE LESSON

- Now take Halden's credit desk, a richer case, in millions of dollars.
- The base E S is forty.
- The reruns give thirty for the twenty day bucket, twenty for forty days, twelve for sixty days and eight for one hundred and twenty days.
- Each rerun is smaller because fewer factors are shocked.
- The twenty day term is thirty times the square root of twenty minus ten over ten, which is thirty.
- The forty day term is twenty times the square root of forty minus twenty over ten, twenty eight point two eight.
- The sixty day term is twelve times the square root of sixty minus forty over ten, sixteen point nine seven.
- The one hundred and twenty day term is eight times the square root of one hundred and twenty minus sixty over ten, nineteen point six zero.

18 Example 4, continued: combine the squares

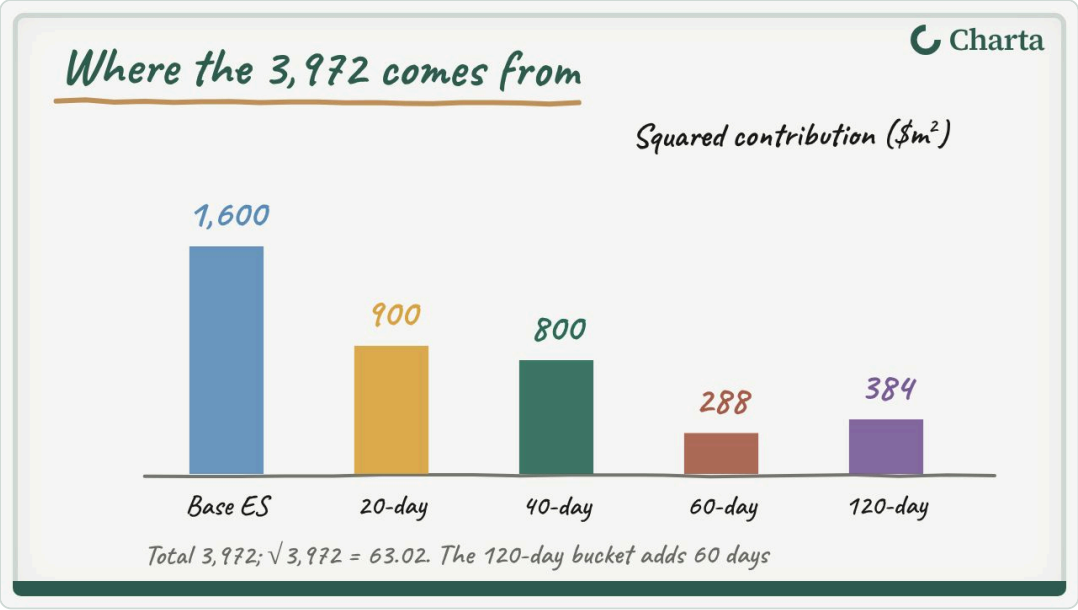
Base ES 40; terms 30.00, 28.28, 16.97, 19.60 ($m)

Base ES squared	40^2	**1,600**
Terms squared	900 + 800 + 288 + 384	**2,372**
Sum of squares	1,600 + 2,372	**3,972**
Liquidity-adjusted ES	√3,972	**$63.02m**
Against the base	63.02 ÷ 40	**1.58 times**

IN THE LESSON

- Now combine, keeping the credit desk's figures in millions of dollars.
- The base E S squared is forty squared, one thousand six hundred.
- The terms squared are nine hundred, eight hundred, two hundred and eighty eight and three hundred and eighty four, which add up to two thousand three hundred and seventy two.
- The sum of squares is one thousand six hundred plus two thousand three hundred and seventy two, three thousand nine hundred and seventy two.
- The liquidity adjusted E S is the square root of that, sixty three point zero two million dollars.
- Against the base of forty, that is one point five eight times.
- The longer horizons have added more than half again to the desk's risk measure.

19 Where the 3,972 comes from



IN THE LESSON

- The bars show each piece of the sum of squares for the credit desk.
- The base E S contributes one thousand six hundred.
- The twenty day term contributes nine hundred, and the forty day term eight hundred.
- The sixty day term contributes two hundred and eighty eight.
- Now look at the last bar.
- The one hundred and twenty day term contributes three hundred and eighty four, more than the sixty day term, even though its rerun E S of eight is smaller than twelve.
- The reason is the gap between horizons.
- The last bucket covers sixty extra days, against twenty for the bucket before it.
- Long horizons matter even when the rerun E S is small.
- The five bars total three thousand nine hundred and seventy two, and its square root is sixty three point zero two.

20 Example 5: two classic mistakes

Same credit desk. Correct liquidity-adjusted ES: $63.02m

Wrong 1: LHj ÷ T in the root	30√2, 20√4, 12√6, 8√12	**terms**
Wrong 1: the terms	42.43, 40.00, 29.39, 27.71	**squares 5,032**
Wrong 1: the result	√(1,600 + 5,032)	**$81.44m**
Wrong 2: add, no squaring	40 + 30 + 28.28 + 16.97 + 19.60	**$134.85m**
Correct, from Example 4	√3,972	**$63.02m**

IN THE LESSON

- For the same credit desk, the correct liquidity adjusted E S is sixty three point zero two million.
- Two mistakes are common.
- The first puts L H j over T inside the root, not the difference between horizons.
- The terms become thirty times root two, twenty times root four, twelve times root six and eight times root twelve.
- Those are forty two point four three, forty, twenty nine point three nine and twenty seven point seven one, whose squares add up to five thousand and thirty two.
- The result is the square root of one thousand six hundred plus five thousand and thirty two, eighty one point four four million.
- The second mistake is to add the base and the terms without squaring: forty plus thirty plus twenty eight point two eight plus sixteen point nine seven plus nineteen point six zero, one hundred and thirty four point eight five million.
- Both errors overstate the risk.
- The correct figure, from Example four, is the square root of three thousand nine hundred and seventy two.

21 Calibrating to a stress period

- Full set of factors often lacks stress-period data
- Reduced set: factors with a long enough history
- ES R,S: reduced set over the stress period
- Ratio: ES F,C ÷ ES R,C (current), floored at 1
- Stress-calibrated ES = ES R,S × ES F,C ÷ ES R,C

IN THE LESSON

- The last ingredient is stress calibration.
- The expected shortfall should reflect a period of severe stress.
- But the full set of risk factors a desk uses today often lacks price data going back to such a period.
- So the bank picks a reduced set of factors with a long enough history.
- It computes E S on the reduced set over the stress period, written E S R S.
- Then it scales that up by a ratio, the full set E S in the current period, E S F C, divided by the reduced set E S in the current period, E S R C.
- The ratio says how much risk the missing factors add today, and under the Basel standard it is floored at one, so the scaling never reduces the stressed E S.
- So the stress calibrated E S is E S R S times E S F C over E S R C.

22 Example 6: stress-calibrating the equity desk

Equity desk, $m. Three ES runs, each at 97.5%

Reduced set, stress period	ES R,S	**$48m**
Full set, current period	ES F,C	**$36m**
Reduced set, current period	ES R,C	**$30m**
Scaling ratio	36 ÷ 30	**1.20**
Stress-calibrated ES	48 × 1.20	**$57.6m**

The ratio grosses up for the factors the reduced set leaves out

IN THE LESSON

- Here are numbers for Halden's equity desk, in millions of dollars, from three E S runs, each at ninety seven point five per cent.
- On the reduced set of factors over the stress period, E S is forty eight.
- On the full set of factors in the current period, E S is thirty six.
- On the reduced set in the current period, E S is thirty.
- The scaling ratio is thirty six over thirty, one point two.
- Today the full set shows twenty per cent more risk than the reduced set, and the method assumes the same holds in the stress period.
- The stress calibrated E S is forty eight times one point two, fifty seven point six million dollars.
- The ratio grosses up for the factors the reduced set leaves out.

23 The trading book boundary, tightened

- Old rule: the bank's own stated trading intent
- FRTB: a presumptive list of trading book instruments
- Switching books: only in extraordinary circumstances
- Switching needs supervisory approval
- And a switch gives no capital relief

IN THE LESSON

- Now the third weakness, the boundary.
- Under the old rule a position's book followed the bank's own stated trading intent.
- The F R T B replaces intent with a presumptive list, a list of instruments that are presumed to belong in the trading book.
- Moving a position from one book to the other, called switching, is allowed only in extraordinary circumstances.
- It needs supervisory approval, meaning the regulator must agree.
- And even when a switch is approved, it gives no capital relief.
- The bank cannot end up holding less capital because it moved the position.
- Together these rules close the door that let banks pick the book with the lower charge.

24 Example 7: a switch that saves nothing

Bonds of $200m. Charge: $16m in the trading book, $10m in the banking book

Old rules: relabel the intent	16 − 10	**saves $6m**
FRTB: when is a switch allowed?	extraordinary, with approval	**rarely**
FRTB: charge after a switch	no capital relief	**$16m**
Saving from the switch	16 − 16	**$0**

IN THE LESSON

- Halden holds a two hundred million dollar bond position.
- Suppose its capital charge would be sixteen million in the trading book and ten million in the banking book.
- Under the old rules Halden could simply relabel its intent and move the bonds, saving sixteen minus ten, six million dollars of capital.
- Under the F R T B, when is a switch allowed?
- Only in extraordinary circumstances and with the supervisor's approval, so rarely.
- And after a switch, there is no capital relief, so the charge stays at sixteen million.
- The saving from the switch is sixteen minus sixteen, zero.
- With nothing to gain, the motive for capital arbitrage disappears.

25 Everything is tested desk by desk

- A desk: traders with one strategy and its own limits
- Model approval is granted desk by desk
- Backtesting and P&L attribution run for each desk
- A failing desk must use the standardised approach
- Exam point: tested desk by desk, not just bank-wide

IN THE LESSON

- The F R T B moves the tests of a model down to the trading desk.
- A desk is a group of traders working to one business strategy, with its own risk limits.
- Model approval is granted desk by desk, not for the bank as a whole.
- Backtesting, which compares the model's risk figures with actual outcomes, and profit and loss attribution, which we meet shortly, are both run for each desk separately.
- A desk that fails must use the standardised approach for its capital.
- This is a favourite exam point.
- Approval, backtesting and attribution are tested desk by desk, not only for the bank as a whole, so one weak desk cannot hide inside a strong bank.

26 Backtesting limits for a desk

Latest 250 trading days, compared with the desk's VaR

Expected exceptions at 99%	250 × 1%	**2.5**
Fail at 99% if more than	12 ÷ 250 = 4.8% of days	**12**
Expected exceptions at 97.5%	250 × 2.5%	**6.25**
Fail at 97.5% if more than	30 ÷ 250 = 12% of days	**30**
Fails if either limit is broken		**standardised**

IN THE LESSON

- Here are the backtesting rules.
- An exception is a day when the desk's loss, actual or hypothetical, is larger than its V a R.
- The test looks at the latest two hundred and fifty trading days, and it is run at two V a R levels.
- At ninety nine per cent you expect two hundred and fifty times one per cent, two and a half exceptions.
- A desk fails if it has more than twelve, which is twelve over two hundred and fifty, four point eight per cent of days.
- At ninety seven point five per cent you expect two hundred and fifty times two point five per cent, six point two five exceptions.
- A desk fails if it has more than thirty, twelve per cent of days.
- Breaking either limit is a failure, and the desk moves to the standardised approach.

27 Example 8: backtesting Halden's four desks

Fail if more than 12 at 99% or more than 30 at 97.5%

Desk	At 99%	At 97.5%	Result
Rates	12	25	Pass (12 is not > 12)
Credit	14	29	Fail at 99%
Equity	9	33	Fail at 97.5%
FX	5	14	Pass

IN THE LESSON

- Remember the rule: a desk fails with more than twelve exceptions at ninety nine per cent or more than thirty at ninety seven point five.
- Here are Halden's four desks over the latest two hundred and fifty days.
- The rates desk has twelve exceptions at ninety nine per cent and twenty five at ninety seven point five.
- Twelve is not more than twelve, so it passes, though only just.
- The credit desk has fourteen and twenty nine.
- Fourteen is more than twelve, so it fails at the ninety nine per cent level.
- The equity desk has nine and thirty three.
- It passes at ninety nine, but thirty three is more than thirty, so it fails at ninety seven point five.
- The F X desk has five and fourteen, and passes.
- So two desks move to the standardised approach, and two keep their models.

28 P&L attribution: does the risk model see the risk?

- Hypothetical P&L: front-office revaluation, positions fixed
- Risk-theoretical P&L: the same day, from the risk model
- Close match: the model captures the desk's risks
- Large, repeated gaps: the model misses risk factors
- Failing desk: standardised approach

IN THE LESSON

- Backtesting asks whether losses exceed V a R.
- Profit and loss attribution asks a different question: does the risk model capture what actually drives the desk's profit and loss?
- It compares two daily figures.
- Hypothetical P and L is the day's profit or loss on the desk's positions, held fixed, as valued by the front office pricing models.
- Risk theoretical P and L is the same day's figure as produced by the risk model, using only its own risk factors.
- A close match means the model sees the desk's risks.
- Large and repeated gaps mean the model misses risk factors that matter.
- A desk that fails the attribution test, like one that fails backtesting, must use the standardised approach.

29 Example 9: one day on the FX desk

FX desk, one day: hypothetical P&L −$4.0m; risk-theoretical P&L −$2.5m

Hypothetical P&L	front-office pricing	**−$4.0m**
Risk-theoretical P&L	risk model	**−$2.5m**
Unexplained gap	−4.0 − (−2.5)	**−$1.5m**
Gap as a share of the loss	1.5 ÷ 4.0	**37.5%**

One day proves little; a persistent gap fails the test

IN THE LESSON

- Here is one day on Halden's F X desk.
- Hypothetical P and L, from the front office pricing models, is a loss of four million dollars.
- Risk theoretical P and L, from the risk model, is a loss of only two and a half million.
- The unexplained gap is minus four minus minus two point five, a loss of one point five million that the risk model did not see.
- As a share of the loss, that is one point five over four, thirty seven point five per cent.
- One day proves little.
- But if gaps like this keep appearing, the risk model is missing a factor, perhaps a currency the model does not include.
- The attribution test is run on many days, and the rules set how close is close enough.

30 Credit risk and securitisations

- Incremental risk charge becomes a default risk charge
- DRC: 99.9% VaR over a one-year horizon
- Credit spread risk sits in the ES model
- Securitisations: no internal models allowed
- They go to the standardised approach

IN THE LESSON

- The F R T B also changes how credit risk in the trading book is treated.
- The incremental risk charge of Basel two point five becomes a default risk charge.
- It is a V a R at ninety nine point nine per cent over a one year horizon.
- It is the default loss that would be exceeded in only one year out of a thousand.
- The other part of credit risk, the day to day movement of credit spreads, sits in the expected shortfall model alongside every other market factor.
- Securitisations, which are bonds backed by pools of loans, cannot use internal models at all.
- They go to the standardised approach.

31 Mistakes to avoid

- Thinking the FRTB just raised the confidence level
- Using LHj ÷ T instead of the gap between horizons
- Adding the terms without squaring them
- Treating approval and the tests as bank-wide
- Switching books for capital relief

IN THE LESSON

- Before the questions, here are the mistakes to avoid.
- First, thinking the F R T B simply raised the confidence level.
- On a normal distribution expected shortfall at ninety seven point five per cent is close to V a R at ninety nine; the change is tail sensitivity, stress and liquidity.
- Second, using L H j over T instead of the gap between horizons.
- Third, adding the terms without squaring them.
- Fourth, treating approval, backtesting and attribution as bank wide, when each is done desk by desk.
- Fifth, believing a bank can switch books for capital relief.
- Switching is rare, needs approval and brings no relief.

32 Try three quick questions

1. Base ES $12m; 20-day rerun $9m; nothing longer. Liquidity-adjusted ES?
   Answer: Term 9 × √(10 ÷ 10) = 9. √(144 + 81) = $15m.
2. 250 days: 11 exceptions at 99%, 31 at 97.5%. Does the desk pass?
   Answer: No: 31 > 30. Standardised approach.
3. Normal loss, σ = $4m. VaR 99% against ES 97.5%?
   Answer: 2.326 × 4 = $9.30m; 2.338 × 4 = $9.35m.

IN THE LESSON

- Now try three quick questions.
- Pause the video, think, then listen to the answers.
- Question one.
- A desk has a base E S of twelve million dollars, and the twenty day rerun gives nine million.
- No factor has a horizon longer than twenty days.
- What is the liquidity adjusted E S?
- The term is nine times the square root of ten over ten, nine, so the answer is the square root of one hundred and forty four plus eighty one, fifteen million dollars.
- Question two.
- Over two hundred and fifty days a desk has eleven exceptions at ninety nine per cent and thirty one at ninety seven point five.
- Does it pass?
- No.
- Thirty one is more than thirty, so it moves to the standardised approach.
- Question three.
- A desk's loss is normal with a standard deviation of four million.
- Compare V a R at ninety nine and E S at ninety seven point five.
- They are nine point three zero and nine point three five million, almost equal.