CHARTA LEARNING · LESSON NOTES

Credit risk: ratings, spreads and expected loss

Fixed Income

1 A story: lending to a neighbour

- Credit risk = risk the borrower does not pay as promised
- Default = failing to pay in full and on time
- Two questions: how likely? and how much is lost?
- A bond is a loan, so every bond holder faces it

IN THE LESSON

- Imagine you lend a neighbour one hundred dollars for a month.
- Two questions decide whether you should worry.
- How likely is it that your neighbour never pays you back?
- And if that happens, how much of your money will you actually lose?
- Maybe the neighbour can repay part of it by selling a bike.
- Those two questions are credit risk.
- Credit risk is the risk that a borrower fails to pay what it owes, in full and on time.
- Failing to pay is called default.
- A bond is a loan to a company or a government, so every bond buyer faces this risk.
- The size of it is what the rest of this lesson measures.

2 Meet Calder Freight

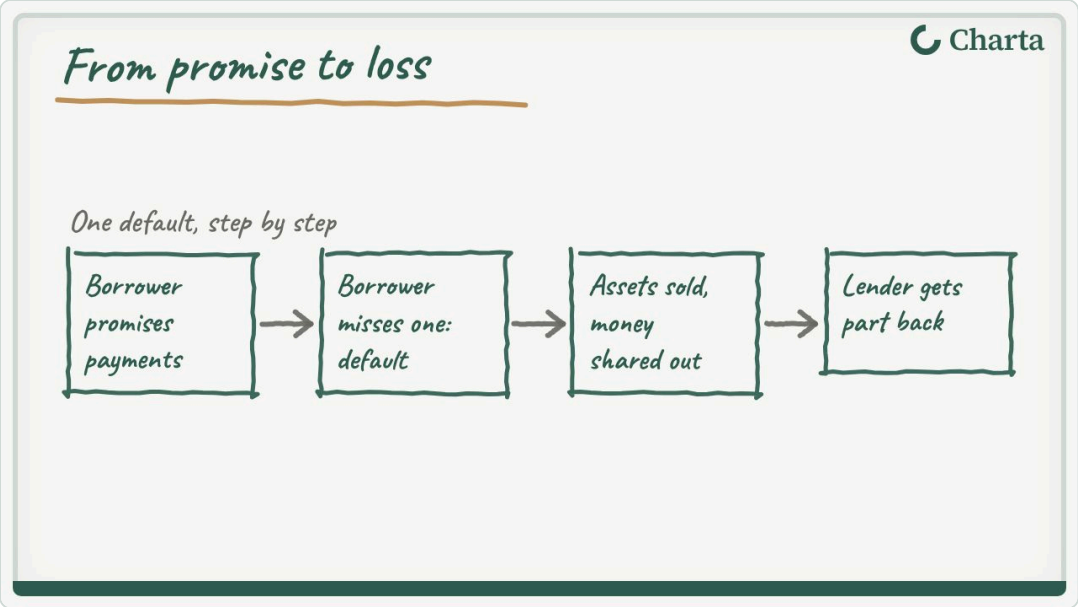
Calder Freight senior bond (made-up examples)

Bond term	Value
Face value	100
Coupon, paid twice a year	4%
Life	5 years
Government bond yield	3.00%

IN THE LESSON

- To make this concrete, we will follow one company all lesson, a trucking and warehouse business called Calder Freight.
- It has borrowed by selling bonds to investors.
- Its main bond is a senior unsecured bond, which means it is a plain promise with no particular asset pledged, and it ranks equally with the company's other ordinary debts.
- The bond pays interest twice a year, with a coupon of four per cent of face value, and it lasts five years.
- In this lesson we assume interest is counted on a thirty over three hundred and sixty day basis.
- The government bond that investors compare it with yields three per cent.
- All of these figures are made up for the example.

3 From promise to loss



IN THE LESSON

- Here is how a loss happens, drawn as a chain.
- Read the boxes from left to right.
- First, the borrower makes a promise: interest and repayment on fixed dates.
- Second, the borrower misses a payment it cannot cover, and that is default.
- Third, there is a process, often in court, where the borrower's assets are sold and the money is shared out among the lenders in order of priority.
- Fourth, each lender gets back a part of what it was owed.
- That part is the recovery.
- The gap between what you were owed and what you got back is your loss.
- Notice that default does not mean you lose everything.
- Recovery decides how bad it is.

4 Expected loss: the two questions multiplied

Expected loss = Exposure × PD × LGD
LGD = 1 − Recovery rate

Exposure	Amount lent, at risk
Default probability, PD	Chance of default in the year
Loss given default, LGD	Share of exposure lost
Recovery rate	Share of exposure got back

IN THE LESSON

- Now we turn the two questions into a formula.
- The amount you have lent is the exposure.
- The probability of default, written P D, is the chance the borrower defaults over the period, usually a year.
- The recovery rate is the share of the exposure you get back if default happens.
- Loss given default, written L G D, is the opposite: one minus the recovery rate.
- So if you recover half, your loss given default is half.
- Expected loss is the exposure times the probability of default times the loss given default.
- Think of it as the average loss per year if you made the same loan many times.
- It is not what happens in one case.

5 Example 1: Calder's senior bond

Exposure 10 million, PD 0.50%, recovery 50%

Exposure		**10,000,000**
Probability of default		**0.50%**
Loss given default	1 − 0.50	**50%**
Expected loss	10,000,000 × 0.005 × 0.50	**25,000**

IN THE LESSON

- Example one.
- You hold ten million dollars of Calder's senior unsecured bond.
- Suppose the chance that Calder defaults in a year is half of one per cent, and if it does, bondholders like you would recover about half.
- So the loss given default is also half.
- Follow the steps of the calculation.
- Ten million times half of one per cent is fifty thousand dollars that you would expect to be exposed to a default.
- Recovering half of that brings back twenty-five thousand, so the loss is twenty-five thousand dollars.
- Said as a percentage of the exposure, expected loss is zero point two five per cent a year.
- Most of your money is safe in almost every year.

6 Example 2: same issuer, different claim

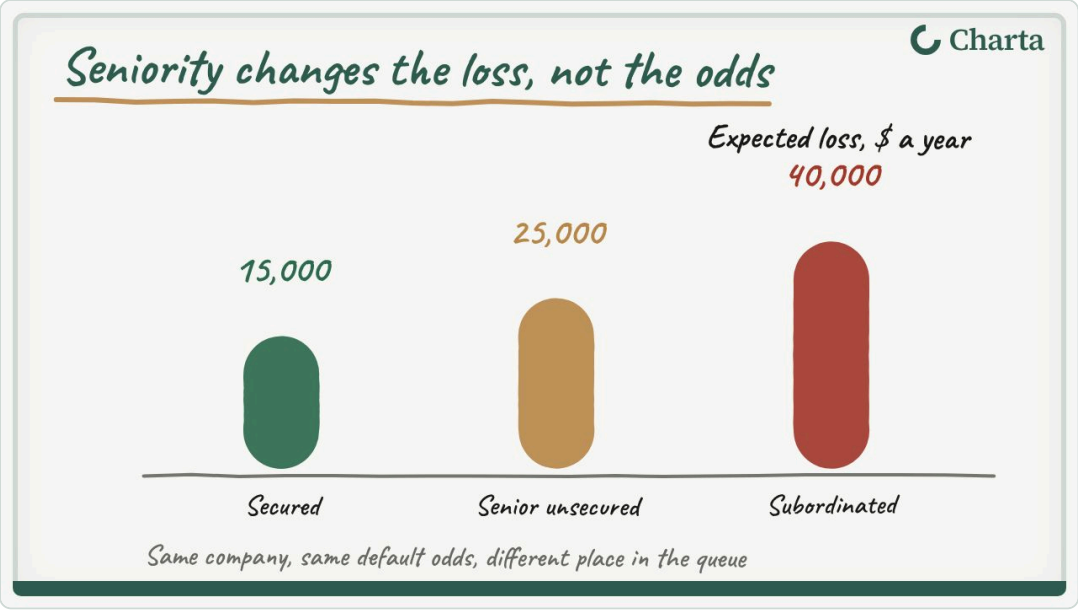
Same issuer, PD 0.50%, exposure 10 million

Secured: recovery 70%	LGD 30%	**15,000**
Senior unsecured: recovery 50%	LGD 50%	**25,000**
Subordinated: recovery 20%	LGD 80%	**40,000**

IN THE LESSON

- Example two shows why the loss part matters as much as the default part.
- Calder has two other bonds.
- One is secured, which means specific trucks are pledged to the lenders, so recovery is high, say seventy per cent.
- The other is subordinated, which means it ranks behind everyone else and is paid last, so recovery is low, say twenty per cent.
- The default chance is the same half of one per cent for all of them, because it is the same company.
- Secured: loss given default is thirty per cent, so expected loss on ten million is fifteen thousand dollars.
- Subordinated: loss given default is eighty per cent, so expected loss is forty thousand dollars.

7 Seniority changes the loss, not the odds



IN THE LESSON

- Here are those three results as bars.
- The side axis is the expected loss in dollars a year on ten million lent.
- The first bar is the secured bond, with an expected loss of fifteen thousand.
- The second is the senior unsecured bond, at twenty-five thousand.
- The third is the subordinated bond, at forty thousand, more than twice the first.
- Remember that the probability of default is identical for all three, because one company is behind them.
- Only the place in the queue is different.
- That is why two bonds from the same issuer can pay quite different yields, and why analysts always ask where in the capital structure a bond sits.
- Seniority decides who recovers first.

8 Default is not the only way to lose

- Credit migration: borrower looks riskier, price falls
- Liquidity risk: hard to sell without a loss
- Credit spread = yield minus safe government yield
- Spreads also widen when the market's fear rises

IN THE LESSON

- So far we have looked at default, but there are other ways credit risk hurts a bond owner.
- The second is credit migration risk, sometimes called downgrade risk.
- The borrower still pays, but the market decides it is riskier, so the bond price falls.
- The third is market liquidity risk, the chance that you cannot sell without accepting a worse price.
- These show up in the credit spread.
- The spread is the extra yield over a safe government bond, and it is the pay you demand for carrying the risk.
- It moves with the borrower's health, and also with the market's mood.
- In a crisis spreads widen, even for companies whose own position has not changed.

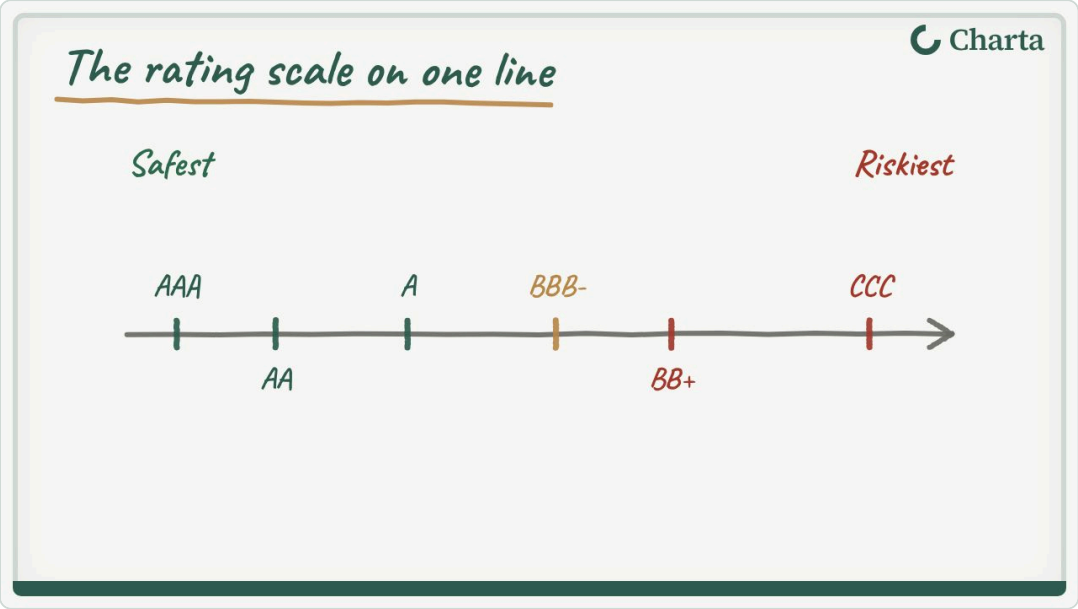
9 A story: the report card

- Agencies grade borrowers on likely default risk
- Triple A is safest; lower letters mean more risk
- A rating is an opinion about relative risk
- It is not advice to buy, and it is not a price

IN THE LESSON

- When you pick a restaurant in a new town, you might check its star rating.
- You trust it a bit because someone has looked more carefully than you could.
- A credit rating works the same way for borrowers.
- Rating agencies, such as S and P, Moody's and Fitch, study a borrower and publish a grade for how likely it is to default, compared with other borrowers.
- The grade is a letter code, with triple A at the top.
- Remember three things.
- A rating is an opinion, not a fact.
- It is about relative default risk, which means who is safer than whom.
- And the borrower usually pays the agency for it, so the agency has to guard its independence.

10 The rating scale on one line



IN THE LESSON

- Here is the scale, drawn as a line.
- On the left is the safest end and on the right the riskiest.
- At the far left sits triple A, the strongest.
- Next comes double A, then single A, and then triple B.
- The line between triple B minus and double B plus is the key line in the market.
- Everything from triple B minus upward is called investment grade.
- Everything below is called high yield, or speculative grade, and sometimes junk.
- Many investors, such as pension funds, are only allowed to hold investment grade, so the line matters a great deal.
- I am using the S and P style of letters here.
- Moody's uses a slightly different style, such as Baa three for triple B minus.

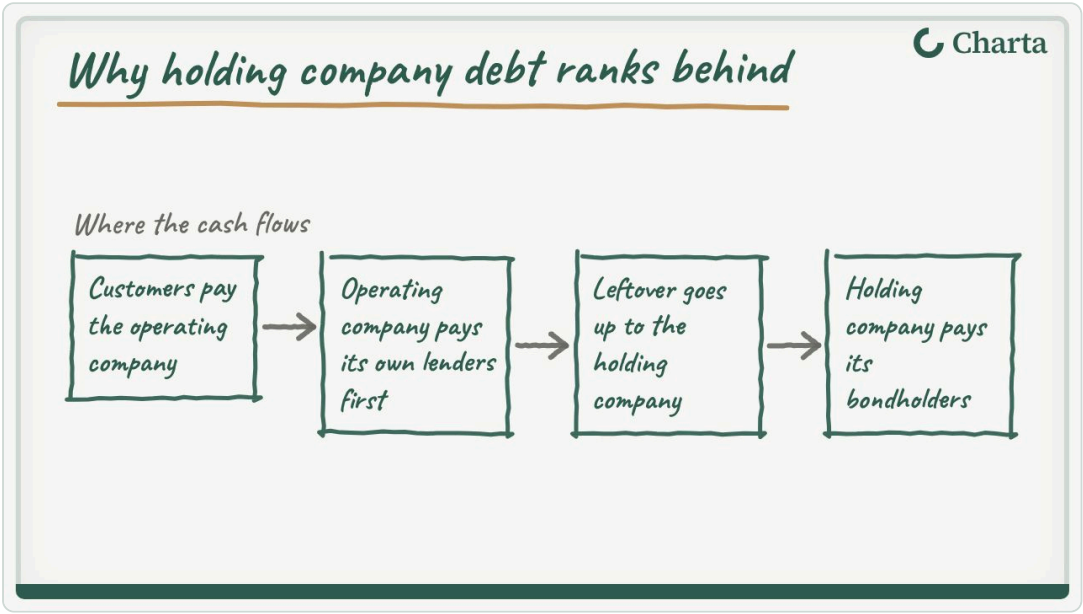
11 Issuer rating and issue rating

- Issuer rating = the borrower, on senior unsecured debt
- Issue rating = one particular bond
- They can differ, because claims rank differently
- Notching = steps up or down from the issuer rating

IN THE LESSON

- There are two kinds of rating, and they are easy to mix up.
- The issuer credit rating is a grade for the borrower as a whole.
- By convention it describes how likely the borrower is to default on its senior unsecured debt, the plain kind of debt.
- An issue rating is a grade for one particular bond.
- It can be the same as the issuer rating or different.
- Think of a person's overall credit score against the risk of one specific loan, where that loan may be secured by a house or may come last in the line.
- Because the same company can have bonds ranking in different places, each bond may get its own grade.
- Moving from the issuer grade to the bond's grade is called notching.

12 Why holding company debt ranks behind



IN THE LESSON

- Here is the most testable case of notching, drawn as a flow.
- Imagine Calder Freight is run as a group.
- The trucks and warehouses are owned by an operating company, which earns the cash.
- Above it sits a holding company, whose only asset is the shares of the operating company.
- Follow the money from left to right.
- Customers pay the operating company.
- The operating company must pay its own lenders and suppliers first.
- Only what is left over can go up to the holding company.
- Then the holding company pays its bondholders.
- So holding company lenders are paid after the operating company's lenders.
- This is called structural subordination, and it means holding company debt is worth less in a default.

13 Example 3: notching Calder's bonds

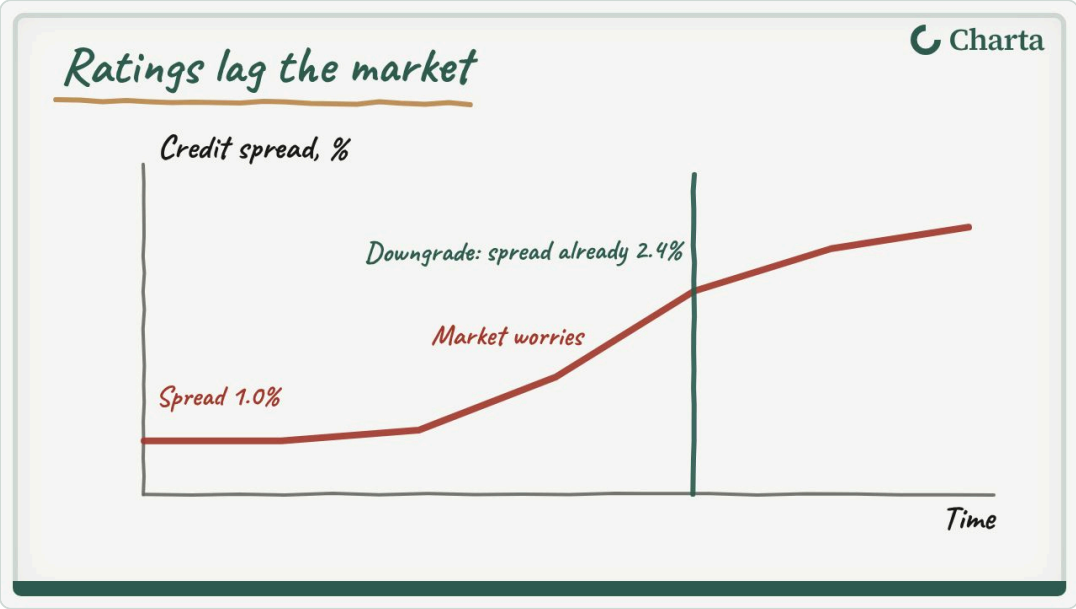
Issuer rating (senior unsecured): BBB

Secured bond, up one notch	BBB → BBB+	**BBB+**
Subordinated bond, down two	BBB → BB+	**BB+**
Holding company bond, down one	BBB → BBB-	**BBB-**
Still investment grade?	BB+ is high yield	**No**

IN THE LESSON

- Example three.
- Say the agency gives the Calder group an issuer rating of triple B.
- A notch is one step on the scale.
- The secured bond is safer than the issuer's senior unsecured debt, so it moves up one notch to triple B plus.
- The subordinated bond comes last in the line, so the agency moves it down two notches, first to triple B minus and then to double B plus.
- Then the holding company bond, notched down one for structure, lands on triple B minus.
- Now see the effect.
- The subordinated bond has slipped below the investment grade line, so many investors can no longer hold it, even though the group is the same.

14 Ratings lag the market



IN THE LESSON

- Now to a weakness of ratings, drawn as a picture.
- These numbers are made up to show the idea.
- The bottom axis is time, and the side axis is the credit spread the market demands from Calder.
- The line starts low, with a spread of one per cent.
- Then investors start to worry, and the spread climbs.
- The straight vertical line marks the day the agency announces a downgrade.
- By then, the spread has already risen to two point four per cent.
- Investors who waited for the rating to change had already lost money.
- Agencies move slowly on purpose, because they aim for ratings that do not flip around, and so the market gets there first.

15 Where ratings fall short

- Ratings lag: markets often move first
- Opinions on default risk only, not on price
- Silent on liquidity and spread widening
- Agencies can differ; issuer-paid fees can bias them

IN THE LESSON

- Ratings are useful, but they have limits, and questions ask about them.
- First, they lag the market, as the picture showed.
- Second, they are opinions about default risk only.
- They say nothing about whether the price is fair, so a bond can be rated well and still be a poor buy at that price.
- Third, they ignore liquidity, and they ignore the risk of a spread widening short of default.
- Fourth, agencies can disagree with each other, and they can be slow, which creates cliff effects when a downgrade happens suddenly.
- A final point: the issuer usually pays for the rating, which can create a conflict of interest.
- So a rating is a starting point, not the whole analysis.

16 Mistakes to avoid so far

- LGD = 1 − recovery, never the recovery itself
- Credit risk is default and also downgrade and liquidity
- A rating is an opinion on relative risk, not a price
- Issuer rating covers senior unsecured only: notch the rest

IN THE LESSON

- Time to pause and look at the traps in what we have covered.
- Mistake one: mixing up the recovery rate with loss given default.
- They add to one, so loss is one minus recovery.
- Mistake two: thinking the probability of default is the whole of credit risk.
- The loss, the downgrade and the liquidity all matter too.
- Mistake three: thinking a rating is a price signal or a guarantee.
- It is an opinion about relative default risk.
- Mistake four: forgetting to notch.
- The issuer rating describes senior unsecured debt, so a subordinated or holding company bond usually sits lower, and it may fall out of investment grade.
- Say these four traps aloud once.

17 A story: why a loaf costs more than the wheat

- Spread = corporate yield − government yield
- It pays for more than expected default loss
- Pieces: loss, uncertainty, hard to sell, spread risk
- Tax can add a piece in some markets

IN THE LESSON

- Think of the price of a loaf of bread.
- The wheat is only part of it.
- There is also the baker's work, the delivery and the shop's margin.
- The extra yield on a risky bond is like that.
- The yield spread is the extra yield on a corporate bond over a government bond of the same life.
- People often say the spread pays for default, and it does, but only in part.
- Other pieces pay for the bother of holding a bond that is hard to sell, for the uncertainty about the loss, and for the risk that the spread itself gets wider.
- Splitting the spread into its pieces tells you what you are really being paid for.

18 The pieces of a spread

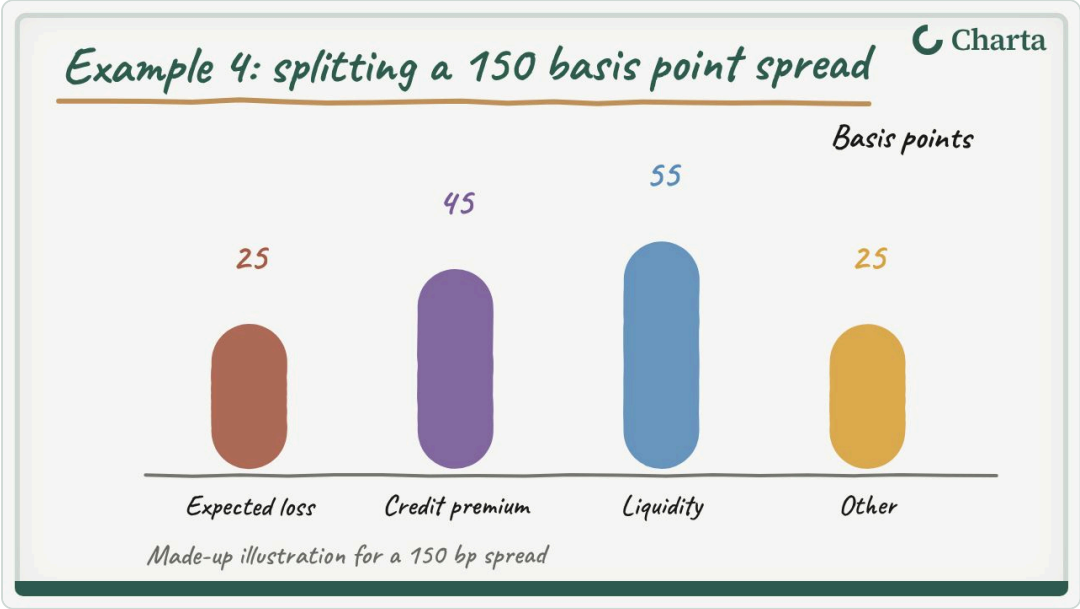
Spread = Expected loss + Credit risk premium + Liquidity premium + Other

Expected loss	PD × LGD, the average loss
Credit risk premium	Pay for uncertainty of loss
Liquidity premium	Pay for hard to sell
Other: spread risk, tax	Spread widening, tax

IN THE LESSON

- Here are the pieces.
- The first is the expected loss from default, which we just learned: probability of default times loss given default.
- The second is the credit risk premium, extra pay for the uncertainty.
- Expected loss is an average, but a real default is a lump, and investors want paying for the chance that the loss is bigger than the average.
- The third is the liquidity premium, extra pay for the cost and difficulty of selling the bond quickly.
- The fourth bucket holds other items.
- One is a premium for the risk that the spread itself widens before maturity.
- In some markets, a tax difference between the bond and the government bond also sits here.

19 Example 4: splitting a 150 basis point spread



IN THE LESSON

- Example four, with made-up numbers.
- A basis point is one hundredth of one per cent.
- Suppose Calder's senior bond pays a spread of one hundred and fifty basis points over the government bond.
- The side axis shows basis points.
- The first bar is expected loss.
- We already know it: half of one per cent times half, which is twenty-five basis points.
- The credit risk premium takes forty-five, liquidity takes fifty-five, and the other pieces take twenty-five.
- Add the four bars up and you get one hundred and fifty, the whole spread.
- Expected loss is about one sixth of the total.
- The rest pays for risks that are real, even if no default ever happens.

20 Example 5: from spread to price

Calder 4% semiannual coupon, 5 years, per 100 of face

Government yield + spread	3.00% + 1.50%	**4.50%**
Price at 3.00% yield	no spread	**104.61**
Price at 4.50% yield	with spread	**97.78**
Price lost to the spread	104.61 − 97.78	**6.83**

IN THE LESSON

- Example five.
- How does a spread turn into a price?
- The government bond yields three per cent.
- Add Calder's spread of one and a half per cent and the required yield is four and a half per cent.
- Discount the cash flows at that yield, with ten half-year periods and a coupon of two per period, and the price per hundred of face value is ninety-seven point seven eight.
- Check it the other way: if the market price is ninety-seven point seven eight, solving for the yield gives four and a half per cent, so the spread is one and a half.
- Now compare with a bond that had no spread.
- At three per cent it would cost one hundred and four point six one.
- So the spread takes six point eight three off the price.

21 Spread moves change the price

Price change (%) ≈ − Duration × Change in spread

Price change	Percent change in price
Duration	Sensitivity to the yield
Change in spread	New spread minus old

IN THE LESSON

- A spread also moves after you buy the bond, and that changes its price even if the company never misses a payment.
- The quick estimate uses duration.
- Duration measures how sensitive a bond's price is to a change in its yield.
- If the government yield stays put and the spread widens, the bond's yield rises by the same amount.
- The price falls by about the duration times the change in spread, as a percentage.
- A wider spread means a lower price and a tighter spread means a higher one.
- The estimate is rough for big moves, because the real price curve bends.
- It slightly overstates the fall, which a question may hint at with the word convexity.

22 Example 6: a loss with no default

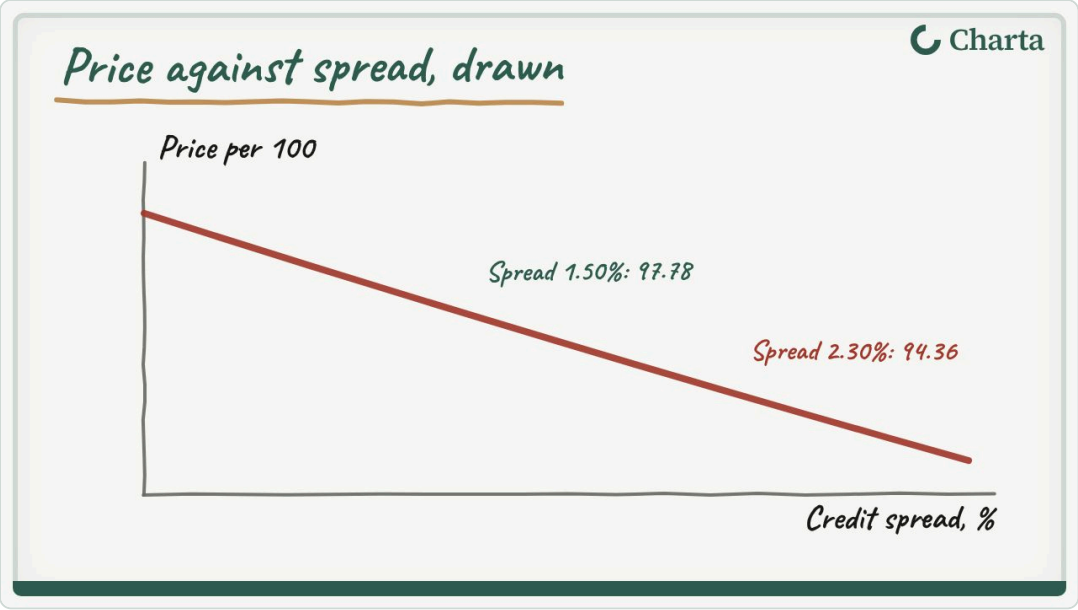
Spread 1.50% to 2.30%, government yield unchanged at 3.00%

New yield	3.00% + 2.30%	**5.30%**
Price now		**94.36**
Exact change in price	94.36 ÷ 97.78 − 1	**-3.51%**
Estimate: −4.5 × 0.80	duration approach	**-3.6%**

IN THE LESSON

- Example six.
- Suppose Calder keeps paying every coupon, but nervous markets push its spread from one and a half per cent to two point three per cent, a widening of eighty basis points.
- The new yield is five point three per cent and the price falls from ninety-seven point seven eight to ninety-four point three six.
- That is a fall of three point five one per cent.
- The quick estimate, with a duration of about four and a half, gives four and a half times zero point eight, about three point six per cent.
- Close enough.
- An investor who must sell now, perhaps because a fund has redemptions, takes that loss.
- An investor who can hold to maturity and get paid in full does not, as long as Calder survives.

23 Price against spread, drawn



IN THE LESSON

- Here is the same story as a picture.
- The bottom axis is the credit spread, from half a per cent on the left to three per cent on the right.
- The side axis is the bond's price per hundred.
- Follow the curve from the left.
- It slopes downward, because a wider spread means a higher yield and a lower price.
- At a spread of one and a half per cent the price is ninety-seven point seven eight.
- At two point three per cent it is ninety-four point three six.
- The curve bends slightly, flatter on the right, which is why the duration estimate overstates the loss a little.
- The lesson of the picture is that spread risk is price risk, and it exists even when the borrower never defaults.

24 The trap: spread is not all default

- Expected loss is only part of the spread
- The rest pays for uncertainty, liquidity, spread risk
- Spread minus expected loss is NOT free profit
- Holding to maturity avoids spread risk only if you can hold

IN THE LESSON

- Here is the trap that matters most here.
- A naive investor sees a spread of one hundred and fifty basis points and an expected loss of only twenty-five, and thinks, there is free money here.
- A hundred and twenty-five basis points of profit!
- But the other pieces are not free money.
- They are pay for real risks: the risk of a bigger loss than average, of being unable to sell, and of the spread widening.
- Real studies find that expected default losses explain only a fraction of investment grade spreads.
- So never say that the whole spread is the expected loss, and never say that the rest is pure profit.

25 A story: the umbrella and the average year

- Expected loss = exposure × PD × LGD
- PD and LGD respond to different things
- In a recession both get worse together
- So the average understates the bad year

IN THE LESSON

- Think of a company that sells umbrellas.
- In an average year it rains on a hundred days, and the company plans for that.
- A lender plans in the same way, using expected loss, the average loss across many years.
- The formula is simple: exposure times the probability of default times the loss given default.
- But the two inputs respond to different things.
- A secured lender may see the default chance rise while recovery stays steady, because the trucks are still worth the same.
- A subordinated lender to the same company sees both get worse together.
- And in a recession, defaults rise and recoveries fall at the same time, so the average year hides the bad one.

26 Example 7: Calder in a rough patch

Exposure 10 million, PD 3%, recovery 35%

Loss given default	1 − 0.35	**65%**
Expected loss	10,000,000 × 0.03 × 0.65	**195,000**
As a share of exposure	3% × 65%	**1.95%**
The trap: use recovery	3% × 35%	**1.05%**

IN THE LESSON

- Example seven.
- Calder hits a rough patch.
- Its default probability rises to three per cent, and the recovery on its senior bonds drops to thirty-five per cent because trucks sell for less.
- You hold ten million.
- Loss given default is one minus thirty-five per cent, which is sixty-five per cent.
- Expected loss is ten million times three per cent times sixty-five per cent, which is one hundred and ninety-five thousand dollars, or one point nine five per cent of the exposure.
- Now see the common trap.
- If you multiply by the recovery rate instead of the loss, you get one hundred and five thousand dollars, only one point zero five per cent.
- It looks reasonable, and it is wrong.
- Always ask: of every hundred owed, how much is lost?

27 Example 8: does the spread cover the loss?

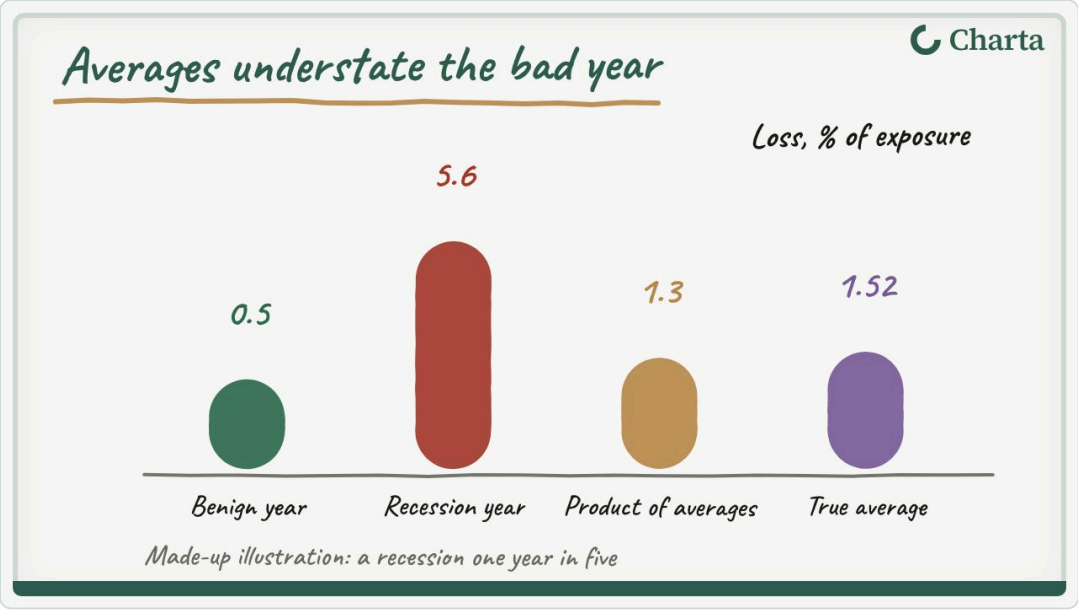
Spread 4.00% versus expected loss 1.95%

Spread, in basis points	4.00% × 100	**400**
Expected loss, in basis points	3% × 65%	**195**
Left for other premiums	400 − 195	**205**
Expected loss share	195 ÷ 400	**49%**

IN THE LESSON

- Example eight connects expected loss back to the spread.
- In the rough patch Calder's bond pays a spread of four per cent, which is four hundred basis points.
- The expected loss is one point nine five per cent, which is one hundred and ninety-five basis points.
- Divide one by the other and expected loss is a little under half of the spread.
- A short rule of thumb says that if investors cared only about the average loss, the spread would roughly equal the probability of default times the loss given default.
- Real spreads are higher than that rule, because investors also want pay for uncertainty, for liquidity and for spread risk, exactly as we saw.
- So the rule gives a floor, not the whole answer.

28 Averages understate the bad year



IN THE LESSON

- The last picture shows why expected loss can mislead.
- These are made-up numbers for a lender's portfolio, with a recession one year in five.
- The side axis is the loss as a per cent of exposure.
- In a benign year the default probability is one per cent and the loss given default is half, so the loss is zero point five per cent.
- In a recession the default probability is eight per cent and the loss given default is seventy per cent, so the loss is five point six per cent.
- Multiplying the average default probability by the average loss gives one point three.
- But the true average, weighing the two kinds of year, is one point five two.
- The inputs are linked, so multiplying averages understates the loss.

29 Recap: the whole lesson in three lines

Expected loss = Exposure × PD × LGD
Spread = Expected loss + premiums

Exposure	Amount lent
Default probability, PD	Chance of default
Loss given default, LGD	1 − recovery rate
Credit spread	Expected loss plus premiums

IN THE LESSON

- Let us pull it together.
- Credit risk has two parts: how likely default is, and how much is lost if it happens.
- Expected loss is the exposure times the probability of default times the loss given default, and the loss given default is one minus the recovery rate.
- A rating is an opinion about relative default risk, and notching moves it up or down for seniority and structure.
- The credit spread is the extra yield over a government bond.
- It contains the expected loss, a premium for uncertainty, a premium for liquidity, and other items such as the risk of the spread widening.
- Expected loss is only part of it, and it understates the tail.

30 Try three quick questions

1. Exposure 5m, PD 2%, recovery 40%. Expected loss?
   Answer: LGD 60%. 5m × 0.02 × 0.60 = 60,000.
2. Issuer BBB; subordinated notched down two. Rating? Investment grade?
   Answer: BB+. No, it is high yield.
3. Spread 120 bp, expected loss 30 bp. What pays for the rest?
   Answer: 90 bp: risk premium, liquidity, other.

IN THE LESSON

- Now try three quick questions yourself.
- Pause after each one.
- Question one.
- You hold five million dollars of a bond.
- The probability of default is two per cent and the recovery rate is forty per cent.
- What is the expected loss?
- Loss given default is sixty per cent, so five million times two per cent times sixty per cent is sixty thousand dollars.
- Question two.
- An issuer is rated triple B and a subordinated bond is notched down two.
- What is its rating, and is it investment grade?
- It is double B plus, which is not investment grade.
- Question three.
- A spread is one hundred and twenty basis points and expected loss is thirty.
- What pays for the other basis points?
- The answer is ninety basis points, which cover the credit risk premium, liquidity and other premiums.