CHARTA LEARNING · LESSON NOTES

External and Internal Credit Ratings

FRM Part I

1 A story: lending to a stranger

- A rating is a letter grade for a borrower
- Ordinal: it ranks safest to riskiest
- It does not say by how much
- Question: how does a letter become a probability?

IN THE LESSON

- Imagine a friend asks to borrow money, and a stranger asks too.
- You would like some way to judge each one before you hand anything over.
- A reference from someone who has watched thousands of borrowers would help a lot.
- That is what a credit rating is.
- A rating agency studies a borrower, the issuer, and gives it a letter grade that sums up how likely it is to pay on time.
- The grade is ordinal, which means it ranks borrowers from safest to riskiest, but it does not say by exactly how much one beats another.
- A big question follows: how does a letter turn into a chance of default?
- We take the scales first.

2 The two main scales

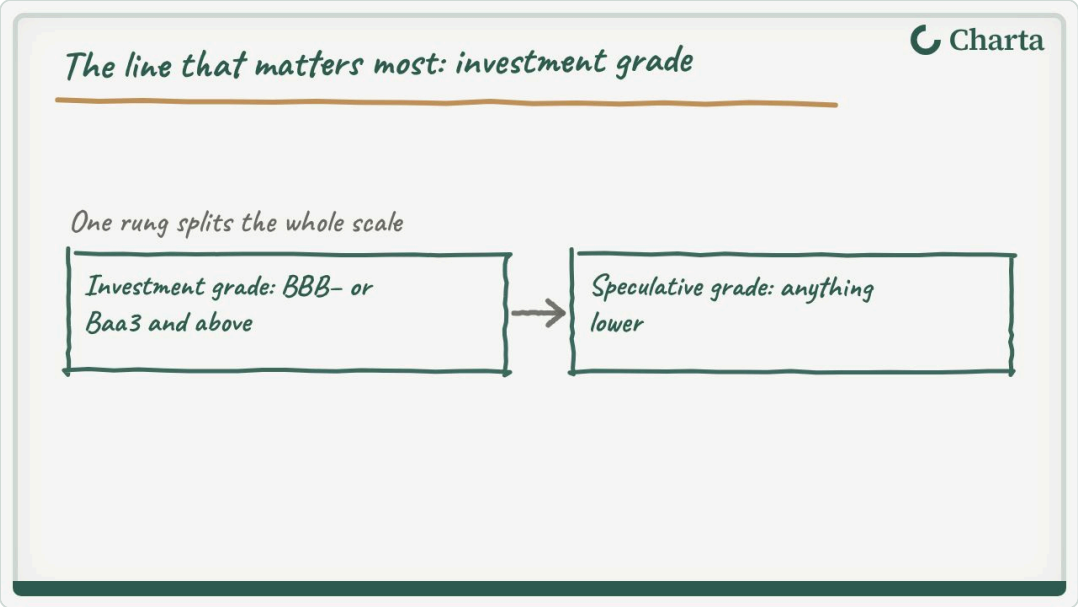
Same ladder, different spelling

Agency	Best to worst
S&P and Fitch	AAA AA A BBB BB B CCC CC C D
Moody's	Aaa Aa A Baa Ba B Caa Ca C
Modifiers	+ and − (S&P, Fitch); 1, 2, 3 (Moody's)
Same rung	BBB− equals Baa3

IN THE LESSON

- There are two main scales.
- Standard and Poor's and Fitch use the same letters, running from triple A, the safest, down through double A, single A, triple B, double B, single B, then triple C, double C, single C, and finally D, which means the borrower has defaulted.
- Within each band they add a plus or a minus.
- Moody's uses a slightly different style: A a a, A a, A, B a a, B a, B, C a a, C a and C, with the numbers one, two and three added, where one is the best in the band.
- So triple B minus at Standard and Poor's and B a a three at Moody's sit at exactly the same spot on the ladder.

3 The line that matters most: investment grade



IN THE LESSON

- One rung on that ladder matters more than any other.
- Triple B minus at Standard and Poor's and Fitch, or B a a three at Moody's, is the lowest investment grade rating.
- Anything at or above it is called investment grade.
- Anything below it is called speculative grade, sometimes called high yield or junk.
- The line matters because many pension funds, insurers and banks have rules that let them hold only investment grade debt.
- So a borrower who slips across the line suddenly loses a large part of its natural buyers and pays more to borrow.
- We will come back to this cliff at the end, because it makes ratings failures worse.

4 How a rating is made and what it means

- Numbers: leverage and coverage ratios
- Judgement: management, industry, funding
- A committee votes; the issuer usually pays
- Grade links to long-run historical default rates

IN THE LESSON

- How does an agency decide?
- Analysts combine numbers with judgement.
- On the numbers side they look at leverage, which is how much debt there is compared with earnings, and at coverage, which is how comfortably profits cover interest.
- On the judgement side they weigh the quality of management, the firm's position in its industry and how secure its funding is.
- A committee then votes on the grade.
- In most cases the issuer pays the agency's fee.
- Each grade links to default risk through history: agencies count how many borrowers at each grade defaulted over many years.
- Those long run averages rise steeply as the grade falls, but they are averages across cycles, not promises for next year.

5 Two ways to talk about default probability

- Weak borrowers who survive tend to improve
- Conditional: default in a year, given survival to its start
- Unconditional: default in a year, judged from today
- Year one: the two are the same

IN THE LESSON

- Here is a subtle point about low grades.
- A weak borrower may look scary in its first year, with a high chance of failing.
- But if it survives that year, it has shown it can cope, and the chance of failing in the next year, given that it is still alive, tends to be lower.
- Survivors improve.
- This means we must be careful about which probability we mean.
- The first kind is conditional: the chance of defaulting in a given year, given that the borrower has survived to the start of that year.
- The second kind is unconditional: the chance, judged today, of defaulting in that year, with no assumption that it survives until then.

6 Linking conditional and unconditional

Unconditional PD = Conditional PD × Survival to start of year
Cumulative PD = 1 − Π (1 − conditional PD)

Conditional PD	Default in a year, if alive
Survival to the year's start	Product of the earlier (1 − PD)
Unconditional PD	Default in that year, from today
Cumulative PD	Default at any time to the horizon

IN THE LESSON

- Here is the rule that links them.
- The unconditional probability for a year equals the conditional probability for that year times the probability of surviving to the start of the year.
- It makes sense: to default in year three, the borrower must first live through years one and two, and then default.
- The probabilities of surviving each year are one minus that year's conditional probability, and you multiply them.
- Add up the unconditional probabilities across the years and you get the cumulative probability of default.
- Equivalently, the cumulative probability is one minus the product of one minus each conditional probability.
- The usual mistake is to use the wrong survival probability.

7 Example 1: three years of default risk

Conditional PDs: 1%, 2%, 3% (chosen to keep the arithmetic simple)

Year 1 unconditional	survival is certain	**1%**
Year 2 unconditional	0.99 × 2%	**1.98%**
Year 3 unconditional	0.9702 × 3%	**2.9106%**
Add the three years	1% + 1.98% + 2.9106%	**5.8906%**
Check: cumulative PD	1 − 0.9702 × 0.97	**5.8906%**

IN THE LESSON

- Suppose a borrower's conditional default probabilities are one per cent in year one, two per cent in year two and three per cent in year three.
- In year one, survival is certain, so unconditional equals conditional: one per cent.
- To reach year two, the borrower survives year one, probability point nine nine.
- So year two unconditional is point nine nine times two per cent, one point nine eight per cent.
- To reach year three it must survive both years: point nine nine times point nine eight, which is point nine seven zero two.
- Times three per cent gives two point nine one zero six per cent.
- The three add to five point eight nine zero six per cent, and one minus point nine seven zero two times point nine seven gives the same cumulative figure.

8 The hazard rate: default as a flow

- Lambda: instantaneous default intensity
- Lambda times a tiny time slice = default chance in it
- Conditional on surviving until then
- Constant lambda: survivors shrink smoothly

IN THE LESSON

- So far time has come in whole years.
- Often it is smoother to think of default as something that can strike at any moment.
- The hazard rate, written with the Greek letter lambda, measures that intensity.
- Multiply lambda by a tiny slice of time and you get the probability of defaulting in that slice, given that the borrower has survived until then.
- It is like a leak in a tank: the leak rate is constant, but the tank, the pool of survivors, keeps shrinking.
- If lambda stays constant, survival decays smoothly.
- The longer the horizon, the more the survival probability shrinks, and the cumulative chance of default climbs, though never past one hundred per cent.

9 Survival and default with a constant hazard

$S(t) = e^{-\lambda t}$ $PD(t) = 1 - e^{-\lambda t}$
$PD(t_1 \text{ to } t_2) = e^{-\lambda t_1} - e^{-\lambda t_2}$

Hazard rate, lambda	Default intensity per year
Time in years, t	Years from today
Survival probability	Chance of lasting to time t
Default probability	Chance of default by time t

IN THE LESSON

- With a constant hazard rate, the probability of surviving to time t is e to the power of minus lambda times t.
- That e is the natural exponential, around two point seven one eight.
- The cumulative default probability to time t is therefore one minus that survival.
- And the unconditional probability of defaulting between a time t one and a later time t two is survival to t one, minus survival to t two.
- If the hazard changes from period to period, you add up lambda times the length of each period inside the exponent.
- Two classic errors: using lambda times t as the default probability, which overstates it, and confusing the probability up to a date with the probability in one particular year.

10 Example 2: hazard rate from a spread

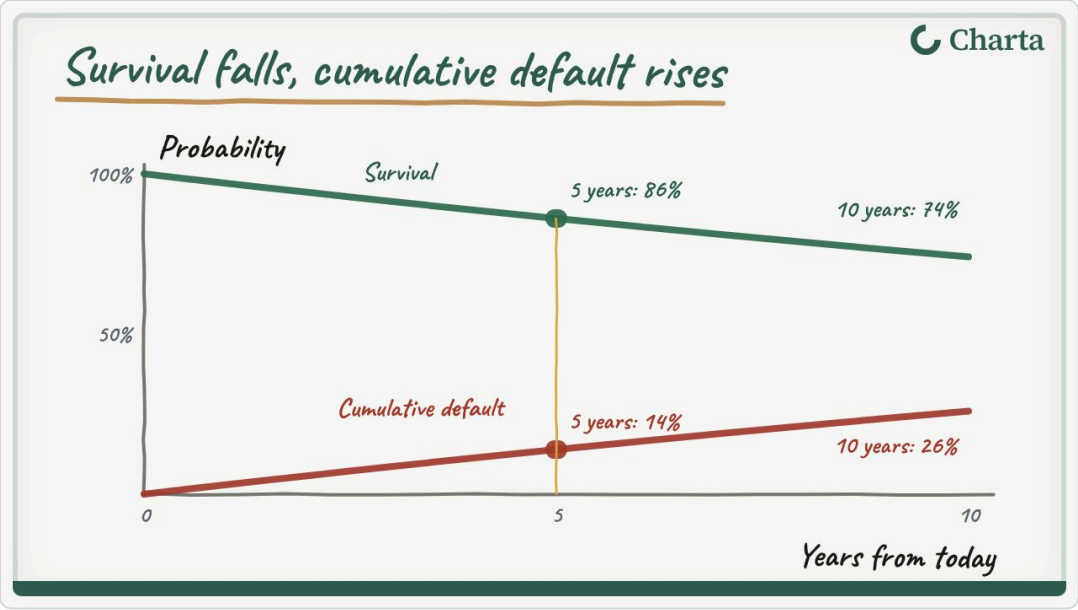
Spread 1.8%, recovery 40%. Hazard ≈ spread ÷ (1 − R)

Hazard rate	1.8% ÷ (1 − 0.40)	**3%**
Survival to 5 years	e^(−0.03 × 5)	**0.8607**
Cumulative 5-year PD	1 − 0.8607	**13.93%**
Survival to 2 years	e^(−0.03 × 2)	**0.9418**
PD between years 2 and 5	0.9418 − 0.8607	**8.11%**

IN THE LESSON

- Let us run it with market numbers.
- A market quote suggests a credit spread of one point eight per cent, and we assume recovery of forty per cent.
- A common approximation says the hazard rate equals the spread divided by one minus the recovery rate: one point eight per cent over point six gives three per cent.
- Over five years the exponent is point one five, and survival is e to the minus point one five, point eight six zero seven.
- The cumulative probability of default is therefore thirteen point nine three per cent, not the fifteen per cent you would get by wrongly using lambda times t.
- For years two to five, survival to year two is point nine four one eight, so default in that window is point nine four one eight minus point eight six zero seven, which is eight point one one per cent.

11 Survival falls, cumulative default rises



IN THE LESSON

- Here is that three per cent hazard drawn over ten years.
- Along the bottom is time in years, and up the side is probability from nought to one.
- The green line is survival.
- It starts at one hundred per cent today and slides down, fast at first in absolute terms and then more gently, because there are fewer survivors left to lose.
- The red line is the cumulative probability of default, a mirror image climbing from zero.
- At five years they stand at about eighty six and fourteen per cent.
- At ten years survival is a little under seventy five per cent.
- The two lines always add to one, and neither ever reaches a boundary.

12 Recovery: what you get back

- Recovery rate: fraction of the exposure got back
- Depends on seniority, collateral, the economy
- Loss given default = 1 − recovery
- Recoveries fall in recessions, when defaults rise

IN THE LESSON

- Default does not usually mean you lose everything.
- After a borrower fails, creditors typically get part of their money back, through selling assets or a restructuring.
- The recovery rate is that fraction of the exposure, expressed as a percentage of face value.
- It depends on how senior your claim is, whether you hold collateral, and the state of the economy.
- Analysts often estimate it from the market price of the defaulted bond about a month after default.
- The loss you suffer is called loss given default, and it equals one minus the recovery rate.
- The troubling pattern is that recoveries tend to be lower in recessions, exactly when defaults are higher, so average recovery understates stress losses.

13 Expected loss on a loan

EL = PD × (1 − R) × EAD

Probability of default	Chance the borrower defaults
Recovery rate, R	Fraction recovered after default
Exposure at default	Drawn plus expected drawdown
Expected loss	Average loss, in money

IN THE LESSON

- Now we can put the pieces together.
- The expected loss on a loan equals the probability of default, times loss given default, times the exposure at default.
- Loss given default is one minus the recovery rate.
- Exposure at default is how much you expect to be owed when the borrower fails.
- It is not just what has been drawn so far: if there is an undrawn credit line, borrowers in trouble tend to draw on it, so the expected drawdown belongs in the exposure.
- Two classic mistakes are multiplying by the recovery rate instead of one minus the recovery rate, and forgetting to include the expected drawdown on the undrawn part.

14 Example 3: a credit line

Limit 10 million, 6 million drawn, half of the rest expected drawn. PD 2%, R 40%

Exposure at default	6 + 0.5 × 4	**8 million**
Loss given default	1 − 0.40	**60%**
Expected loss	2% × 60% × 8 million	**0.096 million**
Trap: R and drawn only	2% × 40% × 6 million	**0.048 million**

IN THE LESSON

- A bank gives a company a credit line of ten million.
- Six million is drawn today, and the bank expects half of the undrawn four million to be drawn before any default.
- So exposure at default is six plus half of four, eight million.
- The chance of default is two per cent, and the recovery rate is forty per cent, so loss given default is sixty per cent.
- Expected loss is point oh two times point six times eight million, which is point oh nine six million, or ninety six thousand.
- Compare the typical error: using the recovery rate and only the drawn amount gives two per cent times forty per cent times six million, forty eight thousand, half the true figure.

15 Point in time or through the cycle

- Point in time: uses all information available today
- Through the cycle: looks past temporary conditions
- Agency ratings: usually through the cycle
- Internal ratings: more often point in time

IN THE LESSON

- A rating can be built with two different philosophies.
- A point in time rating uses all the information available now, so it reflects the borrower's condition today and the stage of the economic cycle.
- In a recession many grades fall, in a boom many rise.
- The bonus is that a given grade then carries a fairly stable default probability.
- A through the cycle rating looks past temporary swings and asks how the borrower would look across a whole cycle, often in a stressed phase.
- Those ratings are much steadier and migrate less.
- The cost is that the default rate for a given grade rises in recessions and falls in expansions.

16 Point in time versus through the cycle

The trap: attaching stability to the wrong thing

	Stable thing
Point in time	Default probability per grade
Through the cycle	The grades themselves
Typical user	PIT: banks; TTC: agencies
Capital effect	PIT is more procyclical

IN THE LESSON

- Here is the comparison, with the exam trap marked.
- A point in time system has unstable grades, because they follow the cycle, but a stable default probability for each grade.
- A through the cycle system has stable grades, but a default rate for each grade that changes from year to year.
- Remember it as stability attached to the wrong thing: point in time is stable in probability, through the cycle is stable in grade.
- Agency ratings are generally described as through the cycle, internal ones more often as point in time.
- There is also a policy consequence.
- Capital rules that depend on point in time ratings make capital requirements more procyclical, rising in recessions when banks can least afford it.

17 Alternatives to agency ratings

- Internal ratings and scorecards: the bank's own data
- Market-implied: from CDS and bond spreads
- Merton model: equity as an option, distance to default
- Accounting scores such as Altman Z

IN THE LESSON

- What if there is no agency rating, or it is too slow?
- A risk manager has several substitutes.
- The first is the bank's own internal rating or scorecard, built from borrower data.
- The second is a market implied measure, backing default probabilities out of credit default swap spreads, or C D S spreads, or out of bond spreads.
- The third is a structural model in the Merton tradition: equity is treated as a call option on the firm's assets, and equity value, equity volatility and debt give a distance to default.
- The fourth is an accounting score, such as the Altman Z score, which weights financial ratios.
- One warning: market implied probabilities are risk neutral and include liquidity premiums, so they tend to overstate real world default frequencies.

18 Market-implied hazard rate

$\lambda \approx \text{Spread} \div (1 - R)$

Credit spread	Yearly price of default cover
Recovery rate, R	Fraction recovered after default
Loss given default	One minus recovery
Hazard rate	Implied default intensity

IN THE LESSON

- The market-implied route uses a handy rule of thumb.
- A credit default swap, or C D S, is insurance against default, and its spread is the yearly price of that insurance.
- If the spread is high, the market sees danger.
- The hazard rate is roughly the spread divided by one minus the recovery rate.
- The logic is that the insurer pays only the loss given default, so the spread has to compensate for the default intensity times that loss.
- If recovery is higher, the loss is smaller, so a given spread implies a higher chance of default.
- Bond spreads over a risk free rate work the same way.
- Remember that this gives a risk neutral number, which is usually above the real world probability.

19 The Altman Z score

Z = 1.2·WC/A + 1.4·RE/A + 3.3·EBIT/A + 0.6·MktEquity/Liabilities + 1.0·Sales/A

Working capital ratio	Weight 1.2 on the ratio
Retained earnings ratio	Weight 1.4 on the ratio
Earnings ratio	Weight 3.3, the heaviest
Market equity to liabilities	Weight 0.6 on the ratio
Sales ratio	Weight 1.0 on the ratio

IN THE LESSON

- The accounting route is the Altman Z score.
- It takes five ratios, multiplies each by a weight, and adds them.
- Working capital over assets gets one point two.
- Retained earnings over assets gets one point four.
- Earnings before interest and tax, E B I T, over assets gets three point three, the heaviest weight, because profitability matters most.
- The market value of equity over liabilities gets point six, and sales over assets gets one.
- A score above two point nine nine is considered safe.
- Below one point eight one signals distress, and anything in between is a grey zone.
- It is a cheap summary of financial health, not a model of the exact default probability.

20 Example 4: scoring a firm

WC 15%, RE 20%, EBIT 8% of assets; equity 0.9 of liabilities; sales 1.1 of assets

First two terms	0.18 + 0.28	**0.46**
Earnings term	3.3 × 0.08	**0.264**
Equity term	0.6 × 0.9	**0.54**
Sales term	1.0 × 1.1	**1.10**
Z score: grey zone	0.46 + 0.264 + 0.54 + 1.10	**2.364**

IN THE LESSON

- Let us score a firm.
- Working capital is fifteen per cent of assets, retained earnings twenty per cent, and earnings before interest and tax eight per cent.
- The market value of equity is point nine of liabilities, and sales are one point one times assets.
- Now multiply by the weights.
- One point two times point one five is point one eight, and one point four times point two is point two eight, together point four six.
- Three point three times point oh eight is point two six four.
- Point six times point nine is point five four.
- And one times one point one is one point one.
- The total is two point three six four.
- That is below two point nine nine but above one point eight one, so the firm sits in the grey zone.

21 External against internal ratings

Each strength of one is a weakness of the other

	Main points
External	Independent, comparable, long history
External weakness	Large issuers only, slow, lagging
Internal	Private data, frequent, tailored
Internal weakness	Subjective, short history, hard to validate

IN THE LESSON

- Which is better, an agency's grade or the bank's own?
- Each has strengths, and they are mirror images.
- External ratings are independent of the lender, comparable across institutions, backed by long default histories and widely understood.
- Their weaknesses are that they cover mainly large rated issuers, change infrequently, follow a through the cycle philosophy, and lag market information.
- Internal ratings can cover private firms and small businesses that agencies ignore, use private information from the relationship such as covenants and account behaviour, and can be updated often.
- They can also be tailored to the bank's own portfolio and cover loss given default as well as default probability.
- Their weaknesses are subjectivity, pressure from relationship managers, short data histories and difficulty of validating them.

22 Complements, joined by a map

- Banks map internal grades to agency grades
- That borrows long default histories
- Internal view adds speed and private detail
- Use both: each covers the other's gap

IN THE LESSON

- The exam point is that internal and external ratings are complements.
- A bank rarely picks one.
- Because its own history of defaults is short, it maps its internal grades onto the agency scale, so that it can borrow the agencies' long default statistics.
- A bank grade four might be treated like a double B, and from then on it uses the historical default rate for double B as a starting point.
- The bank then adds its own information on top: how the firm uses its accounts, whether it meets its covenants, how the relationship manager sees the business.
- The external rating gives the independent anchor and the comparison.
- The internal rating gives the speed, the coverage and the detail.

23 A rating transition matrix

A small illustrative matrix with three states

Start	End of one year
From A	A 90%, B 8%, default 2%
From B	A 10%, B 80%, default 10%
From default	default 100% (absorbing)
Each row adds to	100%

IN THE LESSON

- Ratings change over time, and a rating transition matrix records how.
- Each row is a starting rating.
- Each column is the rating at the end of the horizon, usually one year.
- The entries are probabilities, so each row adds to one hundred per cent.
- The diagonal shows the chance of keeping the same rating.
- Here is a small made up example with three states.
- A borrower rated A has a ninety per cent chance of staying A, eight per cent of falling to B and two per cent of defaulting.
- A B borrower has ten per cent of moving up, eighty of staying and ten of defaulting.
- Default is an absorbing state: once there, you stay there.

24 Looking two years ahead

$P_2(i \to j) = \Sigma$ over k of $P(i \to k) \times P(k \to j)$

Two-year move, i to j	Chance of i to j in two years
First year, i to k	One-year move into a middle rating
Second year, k to j	One-year move out of it

IN THE LESSON

- To get the two year matrix, multiply the one year matrix by itself.
- For the chance of moving from rating i to rating j in two years, consider every middle rating k the borrower might be in after the first year.
- For each one, multiply the chance of going from i to k, by the chance of going from k to j, then add all those paths together.
- Include default among the middle states, because a path through default counts, and from there the borrower stays.
- This assumes the Markov property: next year's move does not depend on the earlier path.
- That is only approximate in reality, because ratings show momentum, a downgrade being more likely to be followed by another.

25 Example 5: A to default in two years

From A: 90% stay, 8% to B, 2% default. From B: 10% to A, 80% stay, 10% default

A to A in two years	0.81 + 0.008 + 0	**81.8%**
A to B in two years	0.072 + 0.064 + 0	**13.6%**
A to default in two years	0.018 + 0.008 + 0.02	**4.6%**
Check: the row adds to	81.8 + 13.6 + 4.6	**100%**

IN THE LESSON

- Take a borrower rated A today.
- To find where it stands in two years, go through the three middle states.
- Staying A in both years: point nine times point nine is point eight one.
- Falling to B and then climbing back to A: point oh eight times point one is point oh oh eight.
- A default in the first year cannot lead back to A.
- So A to A is eighty one point eight per cent.
- A to B works out at thirteen point six per cent.
- For default: point nine times point oh two is point oh one eight, point oh eight times point one is point oh oh eight, and an early default stays defaulted, point oh two.
- That adds to point oh four six, four point six per cent.
- The row adds to one hundred, a good check.

26 What transition matrices are for

- Default probability term structure
- Simulating migration for credit VaR
- Pricing credit risk, including downgrade losses
- Caveat: Markov assumption is approximate

IN THE LESSON

- Why build these matrices?
- Three main uses.
- First, they give a term structure of default probability.
- Multiply the matrix by itself again and again, and the default column traces out the chance of default by one year, two years, three years and so on, for each starting grade.
- Second, they allow simulation of migration, which is the engine of credit V a R: you simulate where each borrower's rating will be next year and revalue the portfolio.
- Third, they help price credit risk, since a downgrade lowers value even without default.
- Keep the Markov caveat in mind: the numbers are only approximate when ratings have momentum, and the matrices are averages over history.

27 When ratings change, markets move

- Downgrade: CDS spread up, bond yield up, bond price down
- Stock price tends to fall too
- Upgrades: weaker, often not significant
- Markets anticipate, especially downgrades

IN THE LESSON

- Now the market side.
- A downgrade raises the return the market demands from the issuer's debt.
- So the credit default swap spread widens, the bond's yield rises, its price falls, and the stock tends to fall too.
- An upgrade does the reverse.
- Two features matter on the exam.
- First, the reaction is asymmetric: downgrades bring clear and significant negative reactions, while upgrades bring weaker responses, often not statistically significant.
- Second, markets anticipate.
- Agencies move slowly, so spreads and equity prices often move before the announcement, especially for downgrades.
- If the downgrade was expected, the surprise on the day is smaller.
- So remember direction, asymmetry and anticipation.

28 How far does a bond price move?

$\Delta P \div P \approx -D \times \Delta y$

Price change	Percentage change in price
Modified duration, D	Price sensitivity to yield
Yield change	Change in the bond's yield

IN THE LESSON

- To size the bond move, use modified duration, which measures how sensitive a bond's price is to its yield.
- The approximate percentage change in price, as a fraction of the bond's price, is minus duration times the change in yield.
- The minus sign is the reminder that yields and prices move in opposite directions: a downgrade pushes the yield up, so the price goes down.
- A duration of six means that for each one per cent rise in yield, the price falls about six per cent.
- It is an approximation that works well for small yield changes.
- For large ones, the true price curve bends, and the estimate drifts away from the truth.

29 Example 6: a downgrade hits a bond

Price 100, modified duration 6, yield up 0.5% after a downgrade

Yield change	+0.50% = 0.005	**0.005**
Percentage price change	−6 × 0.005	**−3%**
New price, about	100 × (1 − 0.03)	**97.00**

IN THE LESSON

- A bond is priced at one hundred, with a modified duration of six.
- A downgrade widens its spread, and its yield rises by half a per cent, point oh oh five.
- The approximate change in price is minus six times point oh oh five, minus point oh three, or minus three per cent.
- A drop of three per cent takes the price from one hundred to about ninety seven.
- Now think about who suffers.
- If the downgrade was well anticipated, much of this fall already happened before the announcement, because spreads moved earlier.
- The holder who watched the market, not just the agency, was not surprised.
- An upgrade of the same size would give a smaller and less reliable reaction.

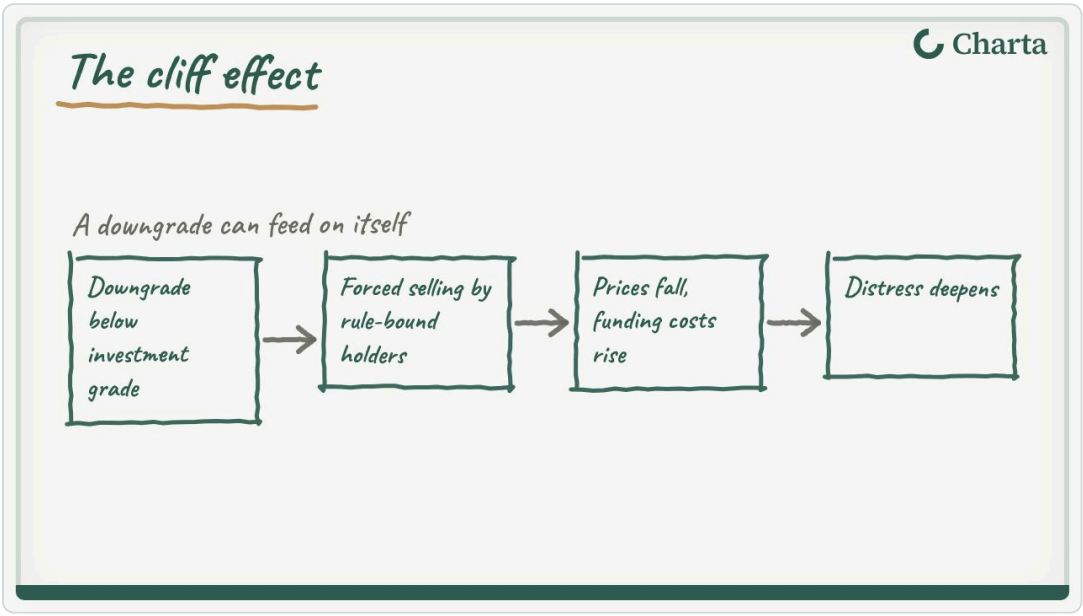
30 Where ratings have failed

- Structured products rated AAA before 2007 lost heavily
- Same letter, very different risk from a corporate AAA
- Enron: investment grade until shortly before failing
- Lag, conflicts of interest, rating shopping

IN THE LESSON

- Ratings have failed in several well known ways.
- Before two thousand seven, structured finance products were rated triple A, yet suffered huge losses when house prices fell, because the ratings did not capture correlation and systematic risk.
- The same letter therefore meant very different risk from a triple A corporate bond.
- Some firms, Enron being the usual example, held investment grade ratings until shortly before failing.
- Ratings also lag market prices.
- And the issuer pays model creates conflicts of interest, and the chance of rating shopping, where an issuer picks the agency giving the best grade.

31 The cliff effect



IN THE LESSON

- A further difficulty comes from rules that tie decisions to ratings.
- Many mandates and capital rules refer to ratings: this fund may hold only investment grade, that bank must hold more capital against lower grades.
- That creates cliff effects.
- When a borrower is downgraded below investment grade, holders are forced to sell.
- The forced selling pushes prices down, which raises the borrower's funding cost, which can deepen the very distress that the downgrade described.
- The rating then stops being just an opinion and becomes a trigger.
- This is why a sensible investor uses ratings as one input beside market signals and independent analysis, never as the only credit work.

32 Recap: the main ideas

- Unconditional = conditional × survival
- Survival = e^(−λt); EL = PD × (1 − R) × EAD
- PIT: stable PD per grade; TTC: stable grades
- Downgrades hit harder; ratings are one input only

IN THE LESSON

- Let us pull it together.
- Agencies rank borrowers on letter scales, with triple B minus or B a a three the border of investment grade, and link grades to long run default rates.
- Conditional default probability assumes survival to the start of the year, while unconditional is judged from today, and they multiply with survival.
- The hazard rate gives survival as e to the minus lambda t.
- Expected loss is probability times one minus recovery times exposure at default.
- Agency ratings are through the cycle; internal ones, more often point in time.
- Substitutes include internal scores, spreads, Merton models and Altman Z.
- Matrices multiply to look ahead.
- Downgrades hurt prices more than upgrades help.
- Ratings fail, so use them as one input.

33 Try three quick questions

1. Conditional PD 4% in year 2, survival to its start 95%. Unconditional?
   Answer: 0.95 × 4% = 3.8%.
2. EAD 5 million, PD 3%, R 30%. Expected loss?
   Answer: 3% × 70% × 5 million = 0.105 million.
3. Duration 7, yield up 0.4%. Price change?
   Answer: −7 × 0.004 = −2.8%, about.

IN THE LESSON

- Now try three quick questions.
- Pause the video, think, then listen.
- Question one.
- A borrower has a conditional default probability of four per cent in year two, and a ninety five per cent chance of surviving to the start of that year.
- What is the unconditional probability?
- Zero point nine five times four per cent, which is three point eight per cent.
- Question two.
- Exposure at default is five million, default probability is three per cent and recovery is thirty per cent.
- What is expected loss?
- Three per cent times seventy per cent times five million, which is zero point one zero five million.
- Question three.
- Duration is seven and the yield rises by point four per cent.
- What is the price change?
- Minus seven times zero point zero zero four, which is about minus two point eight per cent.