CHARTA LEARNING · LESSON NOTES

Forecasting risk, reweighting and the whole client

Asset Allocation

1 A story: the optimiser's other inputs

- Noor Haddad advises the Larkspur Foundation
- The optimiser needs volatilities and covariances
- Each one is an estimate, with error
- Four remedies: factors, shrinkage, ARCH, unsmoothing

IN THE LESSON

- Think of a ship's captain planning a voyage.
- She needs to know how fast the ship goes, but she also needs to know how the waves and the wind move together.
- An optimiser is the same.
- It needs expected returns, but it also needs every asset's volatility and every pair's covariance, which tells us how two assets move together.
- Meet Noor Haddad, an adviser at the made up firm Fernhill Advisers.
- Her client is the Larkspur Foundation, an endowment holding equities, bonds, credit, property and cash.
- Noor's first job is to estimate the risk inputs.
- Every one of them is only an estimate, and the errors in the estimates matter as much as the numbers themselves.

2 The plain method and its trouble

Noor's fund holds 20 assets and has 5 years of monthly data

20 assets, 5 years of data	Count
Variances and covariances needed	210
Monthly returns per asset	60
Data points in all	1,200
Numbers in a 3-factor model	86

IN THE LESSON

- Start with the plain method, the sample covariance matrix.
- You take past returns and, for each pair of assets, compute how they moved together.
- It is simple, and with plenty of data it works well.
- The trouble comes when the number of assets is large compared with the number of observations.
- Look at the board.
- Twenty assets need two hundred and ten separate variances and covariances.
- Five years of monthly data gives only sixty returns for each asset, so twelve hundred data points have to feed two hundred and ten numbers.
- Each one is noisy, and an optimiser loves noise, because it piles money into whatever the errors make look cheap.
- A three factor model needs only eighty six numbers, and that is our first remedy.

3 Remedy one: a factor model

$Cov(i, j) = \beta i \times \beta j \times \sigma^2 F$

Pair covariance	Covariance of the two assets
First exposure	How strongly asset i responds
Second exposure	How strongly asset j responds
Factor variance	Variance of the common factor

IN THE LESSON

- The first remedy is a factor model.
- Instead of estimating every pair directly, we explain each asset's return by its exposure to a few common factors, such as the equity market.
- The covariance between two assets then comes only from their exposures.
- The board shows it for a single factor.
- The covariance of asset i with asset j equals the first asset's beta, times the second asset's beta, times the variance of the factor.
- Beta is how strongly each asset responds.
- If both respond strongly to a factor that moves a lot, they move together a lot.
- The whole matrix is built from a handful of numbers, so there is far less noise.
- The cost is misspecification: if you leave out a factor that matters, the model cannot see that link.

4 Example: a one-factor covariance

Market volatility 15%; beta of A is 1.2; beta of B is 0.8

Factor variance	15 × 15	**225**
Product of betas	1.2 × 0.8	**0.96**
Covariance of A and B	0.96 × 225	**216**

Needs the right factors: a missing one hides a real link

IN THE LESSON

- Here is Noor's calculation.
- Her factor is the equity market, which has a volatility of fifteen percent.
- Squaring that gives a variance of two hundred and twenty five.
- Asset A, a global equity fund, has a beta of one point two.
- Asset B, a bond and equity blend, has a beta of zero point eight.
- Multiply the two betas and you get zero point nine six.
- Multiply that by two hundred and twenty five and the covariance is two hundred and sixteen.
- Notice what happened: Noor never had to measure the pair directly.
- She needed only two betas and one factor variance, and she could do the same for every other pair.
- The danger remains that a missing factor, such as inflation, would leave out a real link.

5 Remedy two: shrinkage

$Shrunk = \delta \times Target + (1 - \delta) \times Sample$

Shrunk estimate	The blended covariance
Weight on target	Between 0 and 1
Structured target	Calm, structured matrix
Sample estimate	Noisy, from past returns

IN THE LESSON

- The second remedy is shrinkage.
- Think of a forecaster who blends today's odd reading with the long run average for the season.
- Shrinkage does the same with the matrix.
- It blends the noisy sample matrix with a calmer, structured target.
- The board shows the shrunk estimate as delta times the target, plus one minus delta times the sample estimate.
- Delta is the weight on the target and sits between zero and one.
- Zero means trust the sample completely.
- One means trust the target completely.
- A common target assumes every pair has the same correlation.
- Shrinkage pulls extreme estimates back toward the middle, which lowers estimation error, at the price of a little bias toward the target.

6 Example: shrinking one covariance

Volatilities 10% and 6%; weight on target δ = 0.25

Sample covariance	0.6 × 10 × 6	**36**
Target covariance	0.4 × 10 × 6	**24**
Blend	0.25×24 + 0.75×36	**33**
Implied correlation	33 ÷ 60	**0.55**

IN THE LESSON

- Back to Noor.
- Two assets have volatilities of ten and six percent.
- Their sample correlation is zero point six, so the sample covariance is zero point six times ten times six, which is thirty six.
- The structured target assumes a correlation of zero point four, giving a covariance of twenty four.
- Noor chooses a weight of zero point two five on the target.
- The blend is a quarter of twenty four plus three quarters of thirty six, which is six plus twenty seven, so thirty three.
- Divide by sixty, the product of the volatilities, and the implied correlation is zero point five five.
- The extreme sample figure has been pulled part of the way back toward the target.

7 Volatility comes in clusters

Chart: Size of daily moves vs Time

- Stormy spell
- Calm spell
- Stormy again

IN THE LESSON

- Now volatility itself.
- Anyone who watches markets sees that big moves cluster together.
- A wild day is usually followed by another wild day, and quiet spells follow quiet spells.
- Look at the picture.
- Time runs along the bottom, and the size of the daily moves goes up the side.
- The line climbs into a stormy spell, falls into a calm stretch, then rises again.
- A single long run average hides all of that, and it would tell Noor the market is calm just when it is not.
- So a good forecast should let today's volatility depend on what happened recently.
- That is the idea behind the next remedy.

8 Remedy three: ARCH-type models

$\sigma^2 t = \gamma + \alpha \times \sigma^2 t{-}1 + \beta \times \eta t{-}1^2$

Variance forecast	Today's variance forecast
Constant	A floor under variance
Weight on old variance	Carries yesterday's variance
Weight on shock	Reacts to yesterday's shock²

IN THE LESSON

- The third remedy is the ARCH type model, which lets variance change over time.
- Today's variance forecast has three parts.
- First, a constant, gamma, which acts as a floor.
- Second, alpha times yesterday's variance, so a stormy yesterday carries forward.
- Third, beta times yesterday's shock squared.
- The shock is the surprise in yesterday's return, the part nobody expected, and squaring it means a big surprise in either direction raises tomorrow's variance.
- Alpha and beta are weights, and together they tell us how long a storm lasts.
- This is why volatility clusters in the model: a large shock raises the forecast, and the forecast stays high until the effect fades.

9 Example: updating a volatility forecast

Equities: $\gamma = 1$, $\alpha = 0.85$, $\beta = 0.10$; shock −9%

Last month's variance	volatility 4.0%	**16**
Latest shock squared	(−9) × (−9)	**81**
New variance	1 + 0.85×16 + 0.10×81	**22.7**
New volatility	√22.7	**4.76%**

IN THE LESSON

- Noor applies the model to the foundation's listed equities, with variance in percent squared.
- Gamma is one, alpha is zero point eight five and beta is zero point one zero.
- Last month's variance was sixteen, which is a volatility of four percent.
- Then the market fell nine percent, a big shock.
- Squaring minus nine gives eighty one.
- The new variance is one, plus zero point eight five times sixteen, plus zero point one times eighty one.
- That is one plus thirteen point six plus eight point one, which is twenty two point seven.
- Take the square root and volatility is four point seven six percent a month, up from four.
- One bad month has lifted Noor's risk estimate, as it should.

10 Remedy four: unsmoothing private data

$r = (R - \lambda \times R_{lag}) \div (1 - \lambda)$

True return	Estimate of the real return
Reported return	What the appraisal shows
Last reported return	Last quarter's reported return
Smoothing weight	Share carried over, 0 to 1

IN THE LESSON

- The fourth remedy is for private assets such as property.
- Their values come from appraisals, and an appraiser starts from last quarter's value and moves only part of the way toward the new market value.
- That smooths the series.
- Lambda is the smoothing weight, the share of last quarter's reported return that carries into this quarter's.
- To undo it, take the reported return, subtract lambda times last quarter's reported return, and divide by one minus lambda.
- The result is the unsmoothed return, an estimate of what the market would have shown.
- If you skip this step, you feed the optimiser a series that is far too calm, and it will love property for the wrong reason.

11 Example: unsmoothing a property return

Reported returns 3.0% then 1.0%; smoothing weight $\lambda = 0.6$

Reported this quarter		**1.0%**
Remove carried part	1.0 − 0.6 × 3.0	**−0.8**
Divide by 1 − λ	−0.8 ÷ 0.4	**−2.0%**

IN THE LESSON

- Noor's property fund reported three percent last quarter and one percent this quarter.
- Lambda is zero point six.
- Look at the board.
- Take this quarter's reported one percent.
- Remove the part carried over from last quarter, which is zero point six times three.
- That leaves minus zero point eight.
- Now divide by one minus lambda, which is zero point four.
- The answer is minus two percent.
- The reported figure was a small gain, but the real quarter was a loss.
- This is why smoothed data hides bad news, and why it understates volatility and makes private assets look less correlated with listed markets.

12 How much smoothing hides

Annual volatility

True volatility	**12%**
Reported	**6%**
Unsmoothed	**12%**

Smoothing weight 0.6 halves volatility

IN THE LESSON

- Here is the cost of smoothing, in numbers.
- Suppose the property's true volatility is twelve percent a year.
- If the true returns come as independent surprises, an appraisal series with lambda of zero point six shows only half of that.
- The reported bar is six percent.
- The formula is the true volatility times the square root of one minus lambda over one plus lambda, which for these figures is exactly one half.
- After unsmoothing, the bar is back at twelve percent.
- Noor now sees property for what it is.
- It is not a smooth, low risk asset.
- It looked like one because the appraisals were slow, and the correlation with equities was understated for the same reason.

13 Which problem, which remedy

Match the problem to the technique

Problem	Remedy
Many assets, little data	Factor model
Noisy sample matrix	Shrinkage
Volatility that changes	ARCH type
Smoothed private data	Unsmoothing

IN THE LESSON

- Let us collect the four remedies, because the exam asks you to match the problem to the technique.
- When there are too many assets and too little data, use a factor model, which imposes structure and cuts the number of estimates.
- When the sample matrix is noisy, use shrinkage, which blends it with a calmer target.
- When volatility changes through time, use an ARCH type model.
- And when the data come from appraisals, unsmooth them before you estimate anything.
- Notice the trade offs.
- Structure reduces error but can be wrong about the world, and a model that is too simple may miss a real link.
- Always ask which problem you have before you pick the tool.

14 A story: from a view to a trade

- Start from named indicators, not a narrative
- Translate each into an effect on each holding
- Propose weights inside the policy ranges
- Check the whole portfolio for unintended bets

IN THE LESSON

- A client does not want an essay on the economy.
- They want to know what you would change in the portfolio, why, and what could go wrong.
- Imagine a doctor who says the patient seems unwell.
- That is useless.
- A good doctor names the test result, the likely cause and the treatment.
- Noor now has to do the same for the foundation.
- Suppose the economy is slowing, inflation is falling and the central bank has signalled cuts.
- A defensible recommendation links each of those facts to each holding, proposes specific new weights, and checks that the result stays inside policy and does not create a bet nobody intended.

15 Where the cycle points

Macro picture and the usual tilt

Macro picture	Tilt
Slowdown, easing bank	Longer bonds
Early expansion	Equities, credit
Unexpected inflation	Real assets

IN THE LESSON

- Here is the translation table.
- Begin by placing each economy in its cycle, then consider its inflation and policy outlook and its currency.
- An economy moving into a slowdown, with an easing central bank, argues for longer duration, because yields should fall, and for less credit and less cyclical equity, because earnings are under pressure and spreads tend to widen.
- An economy entering an early expansion argues for equities over bonds and for taking more credit risk.
- Unexpected inflation argues against long bonds, whose prices fall as yields rise, and for real assets, whose value tends to move with prices.
- These are tendencies, not laws, and the next slide shows how to defend one.

16 How to defend a reweighting

From the view to the weights

Name the indicator → Effect on each asset → Propose new weights

Before you recommend

Check policy ranges → Check unintended bets → State what could go wrong

IN THE LESSON

- A good defence follows a fixed order, and you should say it aloud in the meeting.
- First, name the indicator.
- Not growth is slowing, but leading indicators have turned down.
- Second, state the expected effect on each asset class, using its exposures: how duration, spread and earnings sensitivity respond.
- Third, propose the new weights.
- Fourth, check them against the ranges in the investment policy, because a recommendation outside the ranges is a change of policy, not a tilt.
- Fifth, test the combined portfolio for unintended bets, such as a currency or a sector tilt that crept in when you changed something else.
- Sixth, state what could go wrong, because every view can be mistaken.
- The trap is a recommendation built on a narrative, with no link to what each holding actually owns.

17 The proposal in weights

Proposed weight

Equities	**45%**
Government bonds	**37%**
Credit	**12%**
Cash	**6%**

Policy weights were 50, 30, 15 and 5

IN THE LESSON

- Now the numbers.
- The foundation's policy mix was fifty percent equities, thirty percent government bonds, fifteen percent credit and five percent cash.
- For a slowdown with easing, Noor proposes the weights on the board.
- Equities fall to forty five.
- That is below policy, at the bottom of its range, because slowing growth hurts earnings, especially in cyclical sectors.
- Government bonds rise to thirty seven.
- Credit falls to twelve, since spreads tend to widen in a slowdown.
- Cash rises to six, which keeps some flexibility.
- Every change traces back to the same two indicators, the growth outlook and the policy path.

18 Example: what the bond shift does

Government bonds: weight 30% to 37%; duration 6 to 7.5

Before: 0.30 × 6	contribution	**1.80**
After: 0.37 × 7.5	contribution	**2.78**
Yields fall 0.5, old mix	1.80 × 0.5	**0.90%**
Yields fall 0.5, new mix	2.78 × 0.5	**1.39%**

IN THE LESSON

- The bond shift is where the view becomes a measurable exposure.
- The government bonds have a duration of six today and Noor wants seven point five.
- Before the change, the bonds make up thirty percent of the portfolio, so they contribute zero point three times six, which is one point eight, to portfolio duration.
- After the change, thirty seven percent at seven point five contributes two point seven eight.
- Now apply the view.
- If yields fall by half a point, the old mix gains one point eight times a half, or point nine percent.
- The new mix gains two point seven eight times a half, about one point three nine percent.
- The change adds about half a point of return if the central bank delivers.

19 Example: what if the view is wrong

Same bonds; yields rise 0.5 instead

Old mix loses	1.80 × 0.5	**−0.90%**
New mix loses	2.78 × 0.5	**−1.39%**
Extra loss if wrong		**0.49%**
Equities: 45	range 45 to 55	**inside**
Bonds: 37	range 22 to 38	**inside**

IN THE LESSON

- A defence is not complete until it says what happens if you are wrong.
- Suppose yields rise by half a point instead.
- The old mix loses point nine percent.
- The new mix loses one point three nine percent, so the mistake costs about forty nine hundredths of a point more.
- That is the price of the view, and the client should hear it.
- Now the ranges.
- Equities at forty five percent sit exactly at the bottom of a range from forty five to fifty five.
- Government bonds at thirty seven percent sit inside a range from twenty two to thirty eight.
- Everything is inside policy, and the currency and sector mix are unchanged, so no hidden bet has crept in.
- That is a proposal Noor can defend.

20 Common mistakes so far

- Using smoothed property returns as if they were true
- Trusting a raw sample matrix when data are thin
- Reweighting on a story, not on each holding's exposures
- Skipping the range check and the check for hidden bets

IN THE LESSON

- Before we move on, here are the traps from the first half of the lesson.
- First, using smoothed property returns as if they were true.
- They understate both volatility and correlation, so the optimiser overweights property.
- Second, trusting a raw sample matrix when there are many assets and little data, instead of imposing structure or shrinking it.
- Third, reweighting on a story, such as the economy feels weak, without tying it to the exposures of each holding: its duration, its spread risk, its earnings sensitivity.
- Fourth, skipping the range check and the check for hidden bets.
- A tilt that breaks the policy ranges is not a tilt at all, and a currency bet you did not intend is still a bet.

21 A story: who holds the wheel

- Clear objectives, long and short term
- Decision rights go to those with the expertise
- Written process, reporting and periodic review
- Continuity when committee members change

IN THE LESSON

- Picture a ship with a good chart, but nobody sure who may turn the wheel.
- The crew argue in every storm.
- Governance is the answer to that problem in investing.
- It decides who makes which decisions and how they are held to account.
- Good governance sets clear long and short term objectives.
- It gives decision rights to those with the expertise to use them.
- It writes down how policy is developed, approved and carried out, reports on progress, and reviews the whole structure from time to time.
- It also builds continuity, so the process survives when committee members change.
- The Larkspur Foundation's board meets only a few times a year, and that fact will shape the example.

22 Decisions nested by expertise

Set by the governing body

Clear objectives → Policy statement (IPS) → Strategic mix and ranges

Run and checked

Staff implement in ranges → Report on progress → Review, such as an audit

IN THE LESSON

- Read the picture in two rows.
- On top is what the governing body sets.
- It owns the objectives.
- It approves the investment policy statement, or I P S, which records the foundation's goals, risk tolerance and constraints.
- And it approves the strategic mix and its ranges.
- Because it meets rarely, it sets limits rather than trading.
- The second row is how the work runs.
- Staff, or an outsourced manager, implement the policy inside the ranges, because they have the time and expertise.
- They report progress back to the board.
- And the whole structure is reviewed from time to time, for example in a governance audit, so it keeps working after the people change.

23 Example: a trustee's tactical idea

Policy 60% equities, 40% bonds; range 55% to 65%

Equities after a 15% fall	60 × 0.85	**51**
Bonds, unchanged	40 × 1.00	**40**
New equity weight	51 ÷ 91	**56.0%**
Trustee's proposal	outside 55 to 65	**70%**
Staff response	rebalance toward 60	**in authority**

IN THE LESSON

- Here is the test.
- The foundation's policy is sixty percent equities and forty percent bonds, with an equity range of fifty five to sixty five.
- Equities fall fifteen percent in a quarter and bonds are flat.
- Starting from sixty and forty, equities are now sixty times zero point eight five, which is fifty one, and bonds are still forty, so the total is ninety one.
- The equity weight is fifty one over ninety one, about fifty six percent, still inside the range.
- At the next meeting a trustee proposes seventy percent equities to catch the rebound.
- That is outside the range, so it is a policy change, not an implementation choice.
- Staff already have authority to rebalance toward sixty, so the policy answers the question.

24 Who decides what

Matching the decision to the people equipped for it

Decision	Who decides
Policy and strategic mix	Governing body
Rebalance inside ranges	Staff
Choose securities	Managers
Tactical bets	Only if delegated

IN THE LESSON

- This table is the answer to the example.
- The governing body decides the policy statement and the strategic mix.
- Staff or the outsourced manager rebalance inside the ranges.
- The underlying managers choose securities inside their mandates.
- Tactical bets are the awkward case.
- They need someone watching markets every day who can reverse a position quickly, and a part time committee cannot do that.
- If the foundation wants tactical flexibility, the board should delegate it explicitly, with limits.
- The second trap is documentation.
- If the reasons for the sixty forty policy are not written down, the next committee will reopen the allocation after every fall in the market, and the process will not survive turnover.

25 A story: the biggest asset nobody lists

- Joel Larkspur: commission based salesperson
- Assets add human capital and pension income
- Liabilities add consumption, education, bequests
- Then choose financial assets to complement the rest

IN THE LESSON

- Now meet Joel Larkspur, the founder, who also wants advice on his own savings.
- Joel is a commission based salesperson.
- An ordinary balance sheet would list his savings and his mortgage and stop.
- But the biggest thing Joel owns is not on it: the present value of all the pay he has yet to earn, called human capital.
- And the biggest thing he owes is not on it either: the spending he plans to fund.
- The economic balance sheet adds both.
- On the asset side it adds human capital, expected pension income and other future inflows.
- On the liability side it adds future consumption, education costs, bequests and philanthropic goals.

26 Example: valuing human capital

Earnings 144 a year for 20 years; discount rate 5%; in thousands

Annuity factor	(1 − 1/1.05^20) ÷ 0.05	**12.462**
Present value	144 × 12.462	**1,795**
Rounded for the sheet		**1,800**

IN THE LESSON

- How big is Joel's human capital?
- Treat it like a bond.
- He expects to earn one hundred and forty four thousand a year for twenty years, and we discount at five percent.
- The annuity factor is one, minus one over one point zero five to the twentieth, all divided by zero point zero five, which comes to about twelve point four six.
- Multiply by one hundred and forty four and the present value is about one thousand seven hundred and ninety five thousand.
- We round that to one thousand eight hundred, in thousands, to keep the later numbers clean.
- The point is the scale.
- It is almost twice his financial savings, and it behaves like an asset with its own risk.

27 Joel's economic assets

Joel's economic assets, in thousands

Asset	Value
Human capital	1,800
Financial portfolio	1,000
Expected pension income	300
Total economic assets	3,100

IN THE LESSON

- Now the asset side.
- In thousands, Joel's human capital is one thousand eight hundred.
- His financial portfolio, the part an adviser usually looks at, is one thousand.
- His expected pension income, valued today, is three hundred.
- Add them up and his total economic assets are three thousand one hundred.
- Look at the proportions.
- The financial portfolio is less than a third of the total, and human capital is more than half.
- If Noor optimised the financial portfolio alone, she would be steering a third of the ship and ignoring the rest.
- This is the trap for a client with a long career ahead, whose largest asset is usually the career still ahead.

28 Example: liabilities and net worth

Joel's liabilities and economic net worth, in thousands

Future consumption		**2,200**
Education		**300**
Bequest		**200**
Total liabilities	2,200 + 300 + 200	**2,700**
Economic net worth	3,100 − 2,700	**400**

IN THE LESSON

- Now the liability side, again in thousands.
- Joel plans to fund a lifestyle worth two thousand two hundred in present value, which is future consumption.
- He wants three hundred set aside for his children's education and two hundred as a bequest.
- These add up to two thousand seven hundred.
- Subtract that from the three thousand one hundred of assets and Joel's economic net worth is four hundred.
- That is the cushion left after every goal is funded.
- Notice that this picture says nothing about risk yet.
- Risk comes next, because each asset has a character.
- Human capital may behave like a bond or like equities, depending on the job.

29 Complementing the whole balance sheet

Equity weight = (T × Total − e × HC) ÷ Financial

Equity weight	Share of the financial portfolio
Amount wanted	Target share × total assets
Career supplies	Equity-like share × career value
Financial assets	Divide by the portfolio

IN THE LESSON

- Here is the rule that links the balance sheet to the portfolio.
- Decide how much equity like exposure the whole balance sheet should have, as a share of total economic assets.
- Multiply that share by the total.
- Then subtract the equity like exposure the client already has in the career, which is the equity like share of human capital times its value.
- Pension income is treated as bond like here.
- What remains is the equity needed in the financial portfolio.
- Divide by the financial assets for the weight.
- A tenured civil servant's pay is stable and bond like, so the portfolio can hold more equities.
- A commission based salesperson's pay moves with the economy, so the portfolio should hold fewer.

30 Example: two clients, one balance sheet

Target: 40% equity-like across 3,100 (in thousands)

Equity-like amount wanted	0.40 × 3,100	**1,240**
Joel's career supplies	0.50 × 1,800	**900**
Joel's equities	1,240 − 900 = 340	**34%**
Kim's career supplies	0.20 × 1,800	**360**
Kim's equities	1,240 − 360 = 880	**88%**

IN THE LESSON

- Both Joel and a tenured civil servant, Kim, have the same balance sheet and the same wish for forty percent equity like exposure across everything.
- Forty percent of three thousand one hundred is twelve hundred and forty.
- Joel's career is judged fifty percent equity like, so it already supplies nine hundred.
- The portfolio needs only three hundred and forty more, which is thirty four percent of his one thousand.
- Kim's career is judged only twenty percent equity like, so it supplies three hundred and sixty.
- The portfolio must supply eight hundred and eighty, which is eighty eight percent.
- Same wealth, same goals, very different portfolios, because the careers differ.

31 The same wealth, different portfolios

Equities in financial portfolio

Joel	**34%**
Flat default	**60%**
Kim	**88%**

Same 3,100 balance sheet, same 40% target

IN THE LESSON

- Look at the three bars.
- Joel, whose pay rises and falls with the economy, should hold thirty four percent equities in his financial portfolio.
- Kim, with a secure and bond like job, should hold eighty eight percent.
- The middle bar is a flat default of sixty percent, the kind of rule of thumb that ignores the client's career.
- It would be too much risk for Joel and too little for Kim.
- There is one more point for Joel.
- His income depends on one industry, so he should avoid assets that move with his employer or industry, such as its shares.
- That would pile the same risk on top of the risk he already carries.

32 Recap: the whole lesson

- Factors and shrinkage tame a noisy matrix
- ARCH tracks clusters; unsmooth appraisal data
- Defend a reweighting: indicators, ranges, downside
- Governance: right decision, right people, written down
- Economic balance sheet: complement human capital

IN THE LESSON

- Let us pull it together.
- For risk inputs, the sample covariance matrix is noisy when assets are many and data are thin, so impose structure with a factor model or blend with a target through shrinkage.
- Use an ARCH type model when volatility clusters, and unsmooth appraisal data before you estimate anything.
- For reweighting, name the indicator, state the effect on each holding, keep inside the ranges, check for hidden bets and say what happens if you are wrong.
- For governance, give each decision to those equipped to make it, and write the reasons down.
- For the client, build the economic balance sheet and let the career shape the portfolio.

33 Check yourself

1. γ 2, α 0.5, β 0.2; old variance 10, shock 5. New variance?
   Answer: 2 + 0.5×10 + 0.2×25 = 12.
2. Reported 4%, last quarter 2%, λ 0.5. Unsmoothed return?
   Answer: (4 − 0.5×2) ÷ 0.5 = 6%.
3. Total 2,000; career 1,000, 60% equity-like; target 50%; financial 800. Equity weight?
   Answer: (0.5×2,000 − 0.6×1,000) ÷ 800 = 50%.

IN THE LESSON

- Three questions.
- Question one.
- An equity model has gamma two, alpha zero point five and beta zero point two.
- Last variance was ten and the shock was five.
- What is the new variance?
- The answer is two plus five plus five, which is twelve.
- Question two.
- A property fund reported four percent this quarter and two percent last quarter, with lambda of zero point five.
- What is the unsmoothed return?
- Four minus one, divided by zero point five, gives six percent.
- Question three.
- Total economic assets are two thousand, with career capital of one thousand that is sixty percent equity like.
- The target is fifty percent, and the financial portfolio is eight hundred.
- What equity weight?
- One thousand minus six hundred, over eight hundred, is fifty percent, and that is the answer to practise.