CHARTA LEARNING · LESSON NOTES

Index tracking and active stock picking

Portfolio Management

1 A story: the photocopied map

- An index fund is a copy of the index
- No copy is perfect: small smudges remain
- Tracking error measures size and steadiness
- Shrinking it has a price

IN THE LESSON

- Imagine photocopying a map.
- At a glance the copy is identical.
- Look closely and you find a smudge, a faint edge, a corner that is slightly off.
- An index fund is a copy of an index, and Isla Brennan holds one for Harrowgate.
- The copy is never perfect.
- At level three the question is not only what the smudges are.
- It is how large they are, how steady they are, and what it would cost to rub them out.
- The size and steadiness of the gap is called tracking error.
- First we measure it, then we find where it comes from, and then we decide how much money is worth spending to shrink it.

2 Excess return and tracking error

Excess = Rp − Ri
Tracking error = standard deviation of excess

Portfolio return	Fund's return in a year
Index return	Index's return in that year
Excess return	Fund minus index
Tracking error	Zero if the gap never moves

IN THE LESSON

- Two words from level two.
- The excess return is the fund's return minus the index's return, year by year.
- Tracking error is the standard deviation of those excess returns.
- Notice what that means.
- It is not the average gap.
- It measures how much the gap wanders.
- A fund that trails its index by the same small amount every year has a tracking error of zero, because the gap never moves.
- A fund that beats the index by a lot one year and trails it by a lot the next has a large tracking error, even if the average gap is nothing.
- For an index investor, a steady small shortfall is easier to live with than a surprise.

3 Example 1: Harrowgate's tracking error

Excess returns, fund minus index, five years (%)

Excess returns	−0.14 +0.21 −0.26 −0.06 −0.15	
Average excess return	−0.40 ÷ 5	**−0.08%**
Squared gaps from the average	added up	**0.1254**
Sample variance	0.1254 ÷ 4	**0.0314**
Tracking error	√0.0314	**0.18%**

IN THE LESSON

- Here is Harrowgate's index fund over five years.
- The excess returns, fund minus index, are minus point one four, plus point two one, minus point two six, minus point zero six and minus point one five per cent.
- The average is minus point zero eight.
- Now measure how far each gap sits from that average, square those distances and add them up, which gives point one two five four.
- Divide by four, which is five years minus one, because this is a sample, and the variance is point zero three one four.
- The square root is point one eight.
- So the tracking error is about point one eight per cent.
- The shortfall is a cost.
- The tracking error is the uncertainty around it.

4 Where the gap comes from

Four groups of causes

Source	Effect
Fees and commissions	Constant drag
Idle cash	Misses the market
Index changes	Forced trading
Sampling, thin trades	Imperfect fit

IN THE LESSON

- Where does the gap come from?
- There are four groups.
- Fees and commissions are a cost every year, so they push the fund below the index.
- Idle cash comes from dividends and new money waiting to be invested; it misses the market's moves.
- Index changes are the third.
- When the index adds or drops a company, or a takeover changes a holding, every fund tracking it has to trade, and trading costs money.
- The fourth group is sampling and thin trading.
- A fund that holds only a selection of the index, or an optimised mix, saves trading costs but will not move exactly as the index does.
- Buying an illiquid stock also pushes its price up against you.

5 Example 2: cash drag in two markets

Cash 1.5% of the fund; cash earns 2%

Up year: index +10%	1.5% × (10% − 2%)	**−0.12%**
Down year: index −8%	1.5% × (2% + 8%)	**+0.15%**
Sign of the effect	follows the market	**Not fixed**
Result for tracking	excess wanders	**More error**
Cure	make cash track the index	**Equitise**

IN THE LESSON

- Cash drag deserves a closer look, because its sign surprises people.
- Harrowgate's fund keeps one and a half per cent of its value in cash while dividends and new money wait to be invested.
- Cash earns two per cent.
- In a year when the index rises ten per cent, that cash earns eight points less than the index would have, so the drag is one and a half per cent times eight, which is point one two per cent.
- In a year when the index falls eight per cent, the cash earns ten points more than the index, and the fund gains point one five per cent.
- So cash drag is not a fixed cost.
- It follows the market, and it makes the excess returns wander.

6 Example 3: adding up an illustrative year

One illustrative year, basis points of return vs the index

Fees and commissions	**−5 bp**
Cash drag	**−12 bp**
Index changes, forced trades	**−8 bp**
Sampling +3, lending +4	**+7 bp**
Fund minus index	**−18 bp**

IN THE LESSON

- Now add up a whole year.
- All the figures are basis points, hundredths of a per cent, and they are made up for illustration.
- Fees and commissions cost five.
- Cash drag, from the last example, costs twelve.
- Index changes force trading that costs eight.
- Sampling happens to help by three this year, and securities lending income adds four.
- Securities lending means lending out shares the fund owns, in return for a fee.
- Add everything up and the fund finishes eighteen basis points behind its index.
- Notice that sampling could just as easily have been a cost, which is why it adds to tracking error rather than to the expected gap.

7 Keeping tracking error in check

Cut the drag

Equitise the cash → Trade at the close → Anticipate changes

Cut the cost

Replicate if affordable → Keep turnover low → Lend securities

IN THE LESSON

- How do managers keep the gap small?
- Think of two rows of tools.
- The top row cuts the drag.
- Equitising cash means using index futures or exchange traded funds to give idle cash the index's exposure until it is invested.
- Trading at the rebalancing close means buying and selling at the closing prices on the day the index changes, the same prices the index itself uses.
- Anticipating reconstitution means preparing for the index's announced changes instead of rushing.
- The bottom row cuts the cost.
- Replicate fully where affordable, keep turnover low, and lend securities to earn a fee that offsets costs.

8 Example 4: equitising the cash

Fund 2,000m; cash 1.5%; futures at 4,000, 50 per point

Idle cash to equitise	1.5% × 2,000m	**30m**
Exposure of one contract	4,000 × 50	**200,000**
Contracts to buy	30m ÷ 200,000	**150**
Check: exposure bought	150 × 200,000	**30m**
Risks left behind	futures vs index, rolling	**Basis, roll**

IN THE LESSON

- Let us equitise Harrowgate's cash.
- The fund is worth two thousand million, and one and a half per cent of it is idle, which is thirty million.
- An index futures contract on its index is quoted at four thousand, and each index point is worth fifty, so one contract covers two hundred thousand of exposure.
- Thirty million divided by two hundred thousand is one hundred and fifty contracts.
- Buying them gives the idle cash the index's moves.
- The fund has not removed all risk, though.
- The futures price can drift away from the index, which is basis risk, and the contracts must be replaced as they expire, which is roll risk.
- Those are small, but they are not zero.

9 The trade-off: fit against cost

Chart: Trading cost (bp a year) vs Tracking error (bp a year)

- Full replication
- cost 6, error 8
- Sampling: cost 2, error 22
- Limit 15

IN THE LESSON

- Here is the level three point.
- The horizontal axis is tracking error in basis points a year.
- The vertical axis is the yearly trading cost of running the portfolio, also in basis points.
- The curve slopes down.
- The closer you hold the portfolio to the index, the more it costs to trade.
- At the left sits full replication, with a cost of six and a tracking error of eight.
- At the right sits sampling, which costs two but allows a tracking error of twenty two.
- The red line is the committee's limit of fifteen.
- Sampling is cheaper, but it lies beyond the line.
- Squeezing tracking error towards zero would be dearer still, and may cost more than the error it removes.

10 Example 5: replicate or sample?

Limit: tracking error under 15 bp a year

Full replication	cost 6 bp, error 8 bp	**Within limit**
Sampling	cost 2 bp, error 22 bp	**Breaks limit**
Cost saved by sampling	6 − 2	**4 bp**
Error added by sampling	22 − 8	**14 bp**
Recommendation	client's limit decides	**Replicate**

IN THE LESSON

- Now the decision.
- Harrowgate's committee tells Isla Brennan that tracking error must stay under fifteen basis points.
- She compares two ways to run the fund.
- Full replication costs six basis points a year to trade and gives a tracking error of eight.
- Sampling costs two and gives twenty two.
- Sampling saves four basis points of cost, but it adds fourteen of tracking error and breaks the limit.
- So she recommends full replication, and she explains what could go wrong: the cost is real, and a committee that tolerated a much larger tracking error would be paying for closeness it does not need.
- The answer depends on the client's tolerance.

11 Where the return and the risk come from

Return

Index return → Residual → Lending fees

Risk

Index risk → Tracking error → Collateral, roll

IN THE LESSON

- Now the second question.
- Where do an index fund's returns and risks come from?
- Almost all of the return is simply the index's own return.
- So attribution, the analysis of what drove the result, looks at the index's own exposures: its sectors, its countries and its factor tilts.
- Beside that sits a small residual, which is how the fund differs from the index, and the lending fees the manager can add on purpose.
- The risks mirror the return.
- The index's systematic risk dominates, and holding every stock does not diversify it away.
- Tracking error is the risk that the residual turns out large.
- The last box holds the extras: collateral and counterparty risk from lending, and basis and roll risk from futures.

12 Example 6: what drives the index

Index return by sector (made-up figures)

Technology (30% of the index)	30% × 12%	**3.60%**
Financials (25% of the index)	25% × 6%	**1.50%**
Health care (20% of the index)	20% × 8%	**1.60%**
Energy (25% of the index)	25% × 4%	**1.00%**
Index return	added up	**7.70%**

IN THE LESSON

- Let us attribute the index's return.
- Suppose the index has four sectors.
- Technology is thirty per cent of the index and returned twelve per cent, so it contributed three point six.
- Financials, twenty five per cent at six per cent, contributed one and a half.
- Health care, twenty per cent at eight per cent, contributed one point six.
- Energy, twenty five per cent at four per cent, contributed one.
- The index returned seven point seven per cent.
- Technology, thirty per cent of the weight, gave nearly half the return.
- So a trustee who holds this fund is not just buying the market.
- She is buying its sector bets, whether she chose them or not.

13 Example 7: from the index to the fund

Fund return = index return plus small extras (another year)

Index return	**7.70%**
Fees and trading	**−0.04%**
Residual: cash drag and others	**−0.09%**
Securities lending	**+0.05%**
Fund return	**7.62%**

IN THE LESSON

- Now move from the index to Harrowgate's fund.
- Start with the index return of seven point seven per cent.
- Fees and trading take off point zero four.
- The residual, mostly cash drag and small differences in holdings, takes off another point zero nine.
- Securities lending adds point zero five.
- The fund returns seven point six two per cent.
- Look at the proportions.
- Everything except a few hundredths of a per cent came from the index.
- That is why, for an index fund, the sensible questions are about the index's exposures and about whether the small extras are worth their risks.
- We turn to the lending extra next.

14 Example 8: is lending free money?

Lend 10% of 2,000m; fee 0.30%; fund keeps 80%

Gross fee	200m × 0.30%	**0.60m**
Fund's share of the fee	80% × 0.60m	**0.48m**
Cash collateral reinvested	105% × 200m	**210m**
Loss if collateral falls 1%	1% × 210m	**−2.10m**
Net result	0.48m − 2.10m	**−1.62m**

IN THE LESSON

- The manager proposes lending shares to earn income and says it carries no extra risk.
- Test that.
- Harrowgate lends ten per cent of its two thousand million, so two hundred million.
- Borrowers pay a fee of point three per cent, which is point six million.
- The fund keeps eighty per cent of it, point four eight million.
- Borrowers also hand over collateral worth one hundred and five per cent of the loan, which is two hundred and ten million in cash, and the manager reinvests it.
- Suppose that reinvestment falls one per cent in a credit scare.
- The loss is two point one million.
- Net, the programme has lost one point six two million, more than three times the fee it earned.
- Lending is not free.

15 The risks of an index fund

Four risks beyond tracking error

Risk	Where it comes from
Systematic risk	The whole index
Concentration	Few big weights
Lending risk	Collateral, borrower
Futures and swaps	Basis and roll

IN THE LESSON

- So the index fund has several risks, and only one of them is the market.
- Systematic risk is the index's own movement, which no amount of diversification inside the index removes.
- Concentration is the second.
- In a cap weighted index, the biggest companies carry the biggest weights, so a handful of names can dominate the result, and the fund is a larger bet on them than it looks.
- The third is lending risk, the collateral and counterparty problems we just saw.
- The fourth belongs to futures and swaps: basis risk, where the contract drifts from the index, and roll risk, the cost of replacing contracts as they expire.
- Tracking error, already covered, ties them together.

16 Owners have duties: stewardship

- Owning the index means owning every vote
- Stewardship: vote and engage with boards
- Cannot sell a company it dislikes
- Lent shares carry no vote
- Recalling shares to vote gives up fees

IN THE LESSON

- There is one more thing an index investor gets that is not a return.
- Owning every company in the index means owning votes in every company.
- Stewardship means using those votes and holding conversations with company boards to protect the long term value of the holdings, which is called engagement.
- The index manager cannot sell a company it dislikes, so voting and engagement are its main tools.
- Here lending and stewardship collide.
- A lent share carries no vote, because the borrower holds it.
- To vote on an important resolution the manager must recall the shares, and recalling them gives up the lending fee.
- That cost is real, and a committee should know it.

17 Mistakes to avoid so far

- Tracking error is the spread, not the average gap
- Cash drag follows the market; it is not fixed
- Zero tracking error can cost more than it saves
- Lending income is not free money
- Recalling shares to vote gives up fees

IN THE LESSON

- Let us collect the common mistakes from the first two topics.
- One: treating tracking error as the average gap, when it is the spread of the gap.
- Two: calling cash drag a fixed cost, when it follows the market and can help in a falling year.
- Three: pushing tracking error towards zero at any price, when the cost may exceed the error removed.
- Four: calling securities lending income free money, when reinvested collateral can lose more than the fee.
- Five: forgetting that recalling lent shares to vote gives up fees.
- Check these five whenever a committee reviews an index mandate.

18 A story: the detective and the survey

- Detective: weeks on one case, a written theory
- Survey team: simple questions to thousands
- Depth against breadth
- Both try to beat the same index

IN THE LESSON

- Harrowgate also wants some active management, so Isla Brennan meets two managers.
- Picture two ways to find a missing person.
- The detective spends weeks on one case: interviews, records, a theory about what happened, and a firm conclusion.
- The survey team asks a few simple questions of thousands of people and lets the statistics point to where to look.
- Neither is the purer form of detection.
- The detective trades breadth for depth.
- The survey team trades depth for breadth.
- Discretionary fundamental managers and quantitative managers face exactly the same trade, and the next few slides show what it means for a portfolio.

19 Fundamental against quantitative

Oakhaven (fundamental) against Tarn (quantitative)

Feature	Fundamental / quant
Method	Judgement / rules
Holdings	30 / 400
Risk judged	Stock / portfolio
Typical weakness	Bias / model risk

IN THE LESSON

- Meet the two shortlisted managers.
- Oakhaven Research is a discretionary fundamental manager.
- Its analysts study each company in depth, form a forward looking view of its value, and write down the reason for every holding.
- It owns about thirty stocks, and it judges risk position by position.
- Tarn Systematic is quantitative.
- It ranks thousands of stocks on factors such as value, momentum and quality, then uses an optimiser and a risk model to build a diversified portfolio of about four hundred.
- Its work is rules based, and it controls risk across the whole portfolio.
- Their weaknesses differ too.
- Fundamental managers are exposed to behavioural bias, and quants to model risk and data mining.

20 A reminder: the fundamental law

IR ≈ IC × √N

Information ratio	Active return per unit of risk
Skill per bet	Forecast vs outcome correlation
Number of bets	Independent bets a year

IN THE LESSON

- You met a tool for comparing breadth and depth in level two.
- The fundamental law of active management says the information ratio is roughly the information coefficient times the square root of the number of independent bets.
- The information ratio is active return per unit of tracking error.
- The information coefficient is the correlation between a manager's forecasts and what actually happens, a measure of skill per bet.
- The number of bets must be independent, meaning each is a separate source of insight.
- Skill and breadth trade off.
- A manager can reach the same reward per unit of risk with a lot of skill on a few bets, or a little skill on a great many bets.

21 Same reward, depth or breadth

Chart: Skill per bet vs Independent bets a year

- Every point: information ratio 0.67
- Oakhaven: 20 bets, skill 0.15
- Tarn: 500 bets, skill 0.03

IN THE LESSON

- Here is the trade drawn.
- The horizontal axis is independent bets a year, and the vertical axis is skill per bet.
- The curve joins every combination that earns the same information ratio, about point six seven.
- At the top left is Oakhaven.
- It makes about twenty independent bets a year, so each must be backed by a lot of skill, an information coefficient of point one five.
- At the bottom right is Tarn.
- It makes five hundred bets, so each needs only point zero three.
- Both points sit on the same curve.
- The picture says that neither style is better in principle.
- What matters is whether each manager's claimed skill and breadth are real.

22 Example 9: choosing between the managers

IR = skill × √bets

Oakhaven	0.15 × 4.47 (√20)	**0.67**
Tarn	0.03 × 22.4 (√500)	**0.67**
Tarn if skill falls to 0.02	0.02 × √500	**0.45**
Oakhaven with 16 true bets	0.15 × √16	**0.60**
Verdict	equal on paper	**Both fragile**

IN THE LESSON

- Run the numbers for Harrowgate.
- Oakhaven has skill of point one five and twenty bets.
- The square root of twenty is about four point four seven, so its information ratio is point six seven.
- Tarn has skill of point zero three and five hundred bets.
- The square root of five hundred is about twenty two point four, and its ratio is also point six seven.
- On paper they tie.
- Now test what could go wrong.
- If crowded signals cut Tarn's skill to point zero two, its ratio falls to point four five.
- If five of Oakhaven's twenty bets are really one view about the economy, it has only sixteen independent bets, and its ratio falls to point six.
- Both claims are fragile.

23 Where they overlap, and what to ask

- Quants use economic reasoning to pick factors
- Fundamental managers screen with numbers
- Fundamental risk: behavioural bias
- Quant risk: model error and data mining
- Ask each: how would you know you are wrong?

IN THE LESSON

- The trap is to think the two styles never meet.
- They do.
- A good quant picks its factors for economic reasons, such as the belief that cheap companies are mispriced, not because a back test happened to look good.
- A good fundamental manager screens thousands of stocks with numbers before spending weeks on any one.
- The real difference is where judgement sits.
- For the fundamental manager it sits in each stock decision, and the risk is behavioural bias.
- For the quant it sits in designing the model, and the risk is model error and data mining.
- So Isla Brennan asks each of them what goes wrong, and how they would know.

24 A story: the house hunter

- Start with the house, not the neighbourhood
- Study business, competition, management, price
- Believe careful work finds mispriced stocks
- Sector weights are a by-product

IN THE LESSON

- Harrowgate chooses Oakhaven, and Isla Brennan asks how it finds ideas.
- Think of a house hunter.
- One buyer starts with a city, picks the best neighbourhood, and then looks at whichever house is for sale.
- Another starts with the house itself: the roof, the foundations, the price compared with similar houses.
- The second buyer is a bottom up investor.
- Bottom up managers start with individual companies and believe that careful study of a firm's business, its competitive position, its management and its valuation will reveal stocks the market has priced wrongly.
- Everything else about the portfolio, including its sector weights, follows from those choices.

25 How a bottom-up process runs

Find and understand

Screen the universe → Study the industry → Study the company

Value and decide

Forecast the numbers → Value the shares → Buy, size, monitor

IN THE LESSON

- This is how Oakhaven runs its process.
- The top row finds and understands.
- A screen narrows thousands of stocks to a few dozen worth the time.
- Then the analyst studies the industry, including its growth, competition and risks, and then the company itself, its business model, its management and its finances.
- The bottom row decides.
- Forecasts of sales, margins and cash flow come next.
- Then valuation, using discounted cash flow, which converts forecast cash into a value today, or multiples, which compare the price with earnings or sales.
- Last come buying, sizing the position by conviction, and monitoring whether the thesis still holds.

26 Value styles: five ways to buy cheap

- Relative value: cheap against peers or history
- Contrarian: out of favour, pessimism overdone
- High-quality value: sound firm at a discount
- Income: high, sustainable dividends
- Deep value: far below what it is worth

IN THE LESSON

- Value managers buy stocks trading below estimated intrinsic value, but they do it in different ways.
- Relative value buys the cheapest stocks compared with their peers or their own history.
- Contrarian buys what everyone else has given up on, betting that pessimism has gone too far.
- High quality value looks for a sound, profitable business that has been marked down.
- Income value buys shares with a high and sustainable dividend.
- Deep value looks for stocks priced far below what the whole business, or even its assets, should be worth.
- Which style fits depends on what the client wants and what risks it can bear.
- All five share one danger, which we meet next.

27 Example 10: the value trap

Lowmoor Stores: price 12.00, earnings per share 2.00

Price to earnings today	12.00 ÷ 2.00	**6.0**
Value at the sector multiple	11 × 2.00	**22.00 (+83%)**
Earnings after 3 years	2.00 × 0.8 × 0.8 × 0.8	**1.024**
Price at 6 times earnings	6.0 × 1.024	**6.14**
Change from today	6.14 ÷ 12.00 − 1	**−49%**

IN THE LESSON

- Oakhaven's analyst finds Lowmoor Stores, a fictional retailer.
- The price is twelve and earnings per share are two, so it trades at six times earnings.
- Its sector trades at eleven times.
- At the sector multiple, the shares would be worth twenty two, a gain of eighty three per cent.
- Looks cheap.
- But the analyst's forecast says earnings fall twenty per cent a year for three years, as customers move online.
- After three years earnings per share are one point zero two four.
- If the shares still trade at six times earnings, the price is six point one four, a fall of forty nine per cent.
- The stock was cheap because the business was getting worse.
- That is a value trap.

28 Example 11: growth that fades

Brightwell: price 60.00 at 30 times earnings of 2.00

If growth is 20%: earnings	2.00 × 1.2^3	**3.456**
Price at 30 times	30 × 3.456	**103.68 (+73%)**
If growth fades to 8%: earnings	2.00 × 1.08^3	**2.519**
Price at 18 times	18 × 2.519	**45.35**
Change from today	45.35 ÷ 60.00 − 1	**−24%**

IN THE LESSON

- Growth managers look for companies with sustainable, above average earnings growth, and many insist on growth at a reasonable price.
- Take a fictional software firm, Brightwell.
- Earnings per share are two and the shares trade at thirty times earnings, a price of sixty.
- If earnings grow twenty per cent a year for three years, they reach three point four five six, and at the same multiple the price is one hundred and three point six eight, a gain of seventy three per cent.
- But suppose growth fades to eight per cent.
- Earnings reach two point five one nine, and the multiple falls to eighteen.
- The price is forty five point three five, a loss of twenty four per cent.
- The pitfall is paying for growth that does not last.

29 Sector bets are a by-product

Oakhaven's active sector weights, made-up figures

Sector	Active weight
Financials	+8%
Energy	+5%
Technology	−9%
Utilities	−4%

IN THE LESSON

- One last feature of bottom up investing.
- Oakhaven never decided to overweight banks or underweight utilities.
- Those positions simply appeared as the analysts found the stocks they liked.
- Look at the active weights, the differences from the index.
- Financials are eight per cent overweight and energy five.
- Technology is nine per cent underweight and utilities four.
- Together they sum to zero, as active weights must.
- Sector and macro exposures are a by-product, not a deliberate view.
- But a by-product can still hurt.
- Isla Brennan asks Oakhaven to report these weights, because eight points in financials is quietly a view on interest rates, whether anyone meant it or not.

30 Recap: the lesson in five lines

- Tracking error: spread of excess returns
- Index fund: index return plus small extras and risks
- Fundamental is deep, quantitative is broad
- Bottom-up: screen, study, forecast, value, size
- Pitfalls: value traps and fading growth

IN THE LESSON

- Let us pull the lesson together.
- First, tracking error is the standard deviation of excess returns.
- Its sources are fees, idle cash, index changes, sampling and thin trading, and managers control it by equitising cash, trading at the close and replicating fully where affordable, while weighing cost against fit.
- Second, an index fund's return is the index's, with small extras, and its risks include concentration, lending and futures.
- Third, fundamental managers go deep and quants go broad, both obeying the fundamental law.
- Fourth, bottom up value and growth styles follow a process from screen to position.
- Fifth, value traps and fading growth are their classic pitfalls.

31 Try three quick questions

1. Excess returns 0.1, 0.3, 0.2 (%). Tracking error?
   Answer: Mean 0.2; (0.01 + 0.01 + 0) ÷ 2 = 0.01; √0.01 = 0.10%.
2. Cash 2% earns 1%; index rises 9%. Cash drag?
   Answer: 2% × (9% − 1%) = 0.16%.
3. Skill 0.05, 100 independent bets. Information ratio?
   Answer: 0.05 × √100 = 0.05 × 10 = 0.50.

IN THE LESSON

- Now try three quick questions yourself.
- Pause after each one.
- Question one.
- A fund's excess returns over three years are point one, point three and point two per cent.
- What is its tracking error?
- The average is point two.
- The squared gaps are point zero one, point zero one and zero, which add to point zero two.
- Divide by two to get point zero one, and the square root is point one per cent.
- Question two.
- A fund holds two per cent in cash earning one per cent, and the index rises nine per cent.
- What is the cash drag?
- Two per cent times eight is point one six per cent.
- Question three.
- A manager has skill of point zero five and one hundred independent bets.
- The square root of one hundred is ten, so the information ratio is point five, which is a respectable result.