CHARTA LEARNING · LESSON NOTES

Commodity markets: sectors, cycles, value and players

Alternative Investments

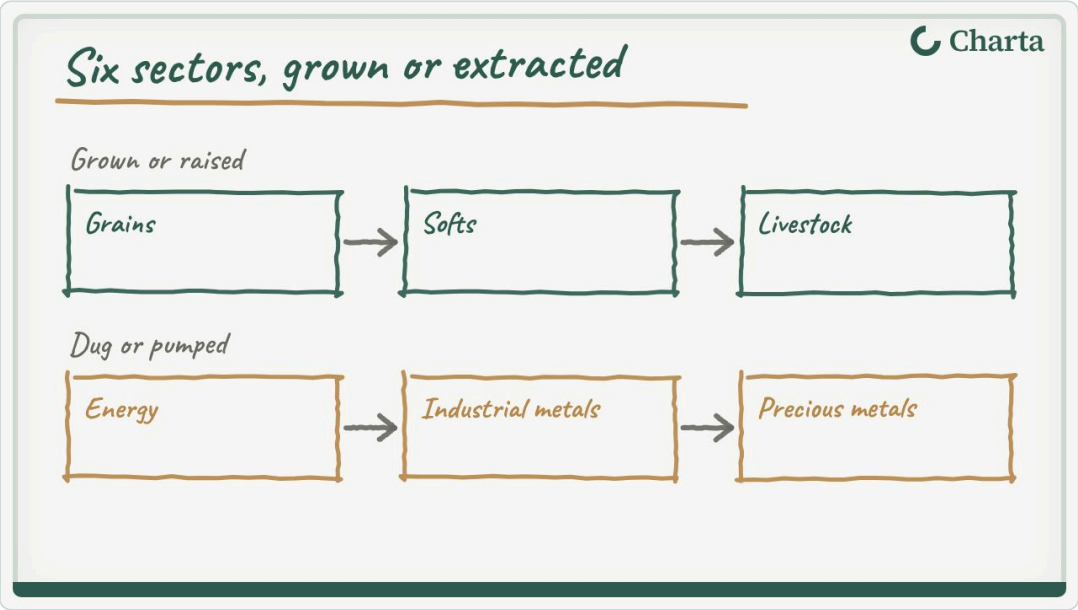
1 Commodities are not one asset

- A commodity = standard, interchangeable raw material
- Oil, copper, wheat: all commodities
- Each sector has its own supply and demand shocks
- Trap: treating them as one asset

IN THE LESSON

- Start with a story.
- Mira's committee chair says, we want some commodities, so please buy commodities.
- Mira smiles, because that sentence is like saying, buy an animal.
- Do you mean a horse or a goldfish?
- A commodity is a standard, interchangeable raw material, such as a barrel of oil, a tonne of copper or a bushel of wheat.
- But the sectors behave very differently, because each answers to its own shocks.
- A frost does nothing to a copper mine, and a building slowdown does nothing to a coffee tree.
- The trap is treating commodities as one asset.
- Sectors are only loosely related to each other, and that is exactly what makes a mix of them useful.

2 Six sectors, grown or extracted



IN THE LESSON

- Here is a map of the six sectors, drawn in two rows.
- The top row is grown or raised: grains, softs and livestock.
- Grains are crops like wheat and corn.
- Softs are crops like coffee, cocoa and sugar.
- Livestock means animals such as hogs and cattle.
- Their supply comes from nature, so weather and disease matter, and government policy matters too.
- The bottom row is dug or pumped out of the ground: energy, industrial metals and precious metals.
- Energy covers crude oil, natural gas and refined products.
- Industrial metals are things like copper and aluminium.
- Precious metals are gold, silver and their relatives.
- Their supply comes from mines and wells, which are slow to expand.

3 Energy: the biggest sector

- Largest sector by production value
- Crude oil, natural gas, refined products
- Moves with global growth and geopolitics
- Gas also moves with the weather

IN THE LESSON

- Take energy first, because it is the largest sector by the value of what is produced.
- It covers crude oil, natural gas and refined products such as petrol and heating oil.
- Energy demand follows global growth: when factories hum and people travel, it rises.
- Supply is shaped by geopolitics, since a lot of oil comes from regions where politics can interrupt it.
- Natural gas adds a twist, which is weather.
- Cold winters raise heating demand, and hot summers raise the demand for air conditioning, which burns power.
- So a weather forecast can move gas on a Monday morning.
- Because energy is so large, an index weighted by production is dominated by it and behaves much like an oil fund.

4 Grains, softs and livestock

- Grains and softs: growing-season weather
- Government policy and export rules matter
- Livestock: feed costs and disease
- A farm shock for one is not a shock for all

IN THE LESSON

- Now the grown commodities.
- Grains and softs depend on the growing season.
- A drought, a flood or a frost can shrink a harvest, and prices rise before anyone has counted the crop.
- Government policy matters as well, for example export rules or farm support.
- Livestock has its own logic.
- Animals eat feed grain, so a jump in feed prices squeezes the people who raise them.
- Disease is a danger too, since an outbreak can wipe out a herd or close export markets.
- So the three grown groups share a family trait, they live on farms, but the shocks that hit grains and softs differ from the shocks that hit livestock, and the two can pull prices in opposite directions.

5 Industrial and precious metals

- Industrial: manufacturing and construction
- Mines take years to open; strikes hit supply
- Gold: partly a store of value
- Real interest rates and inflation fears matter

IN THE LESSON

- Metals come in two kinds.
- Industrial metals, such as copper, follow manufacturing and construction.
- When building slows, demand for wire, pipe and steel slows with it.
- Supply is slow to respond, because a new mine takes years to open, and mines are exposed to strikes.
- Precious metals are different, and gold is the best example.
- Gold has some industrial uses, but it also acts partly as a store of value.
- Holding gold pays no interest, so when real interest rates, meaning rates after inflation, are low or falling, gold is cheaper to hold and tends to rise.
- Fear of inflation can lift it as well.
- So for gold, real rates and inflation fears matter as much as factories do.

6 Case: one month, four shocks

Four shocks, four different sectors

Cold winter	heating demand jumps	**Energy up**
Construction slowdown	less copper and steel	**Metals down**
Real interest rates fall	gold cheaper to hold	**Gold up**
Corn belt drought	smaller harvest expected	**Grains up**

IN THE LESSON

- Here is a month in Mira's life.
- Four pieces of news arrive.
- First, an unusually cold winter hits North America.
- Heating demand jumps, so natural gas and energy rise.
- Second, construction slows in a big economy.
- Less copper and steel are needed, so industrial metals fall.
- Third, real interest rates fall.
- Gold is cheaper to hold, so precious metals rise.
- Fourth, a drought strikes the corn belt.
- The harvest will be smaller, so grains rise.
- Notice that one month produced three rises and a fall, with four different causes.
- A buyer who thought commodities were one asset would be baffled.
- Someone who knows the sectors can read each headline and say which part of the portfolio it touches.

7 Case: what the index did

Index return = weight × sector move (illustrative)

Energy: 40% × +6%		**+2.4%**
Industrial metals: 20% × −4%		**−0.8%**
Precious metals: 10% × +3%		**+0.3%**
Agriculture: 30% × +8%		**+2.4%**
Index return	sum of the four	**+4.3%**

IN THE LESSON

- Now put numbers on it.
- These are made up.
- Harrow holds a broad index with these weights: energy forty per cent, industrial metals twenty, precious metals ten, and agriculture, meaning grains, softs and livestock together, thirty.
- After the four shocks the sector moves are: energy up six per cent, industrial metals down four, precious metals up three, and agriculture up eight.
- Multiply each weight by its move.
- Energy adds two point four.
- Industrial metals subtract point eight.
- Precious metals add point three.
- Agriculture adds two point four.
- Add them up and the index rose four point three per cent.
- Yet one sector fell, and each sector moved by a different amount, which is the whole point of knowing what drives each one.

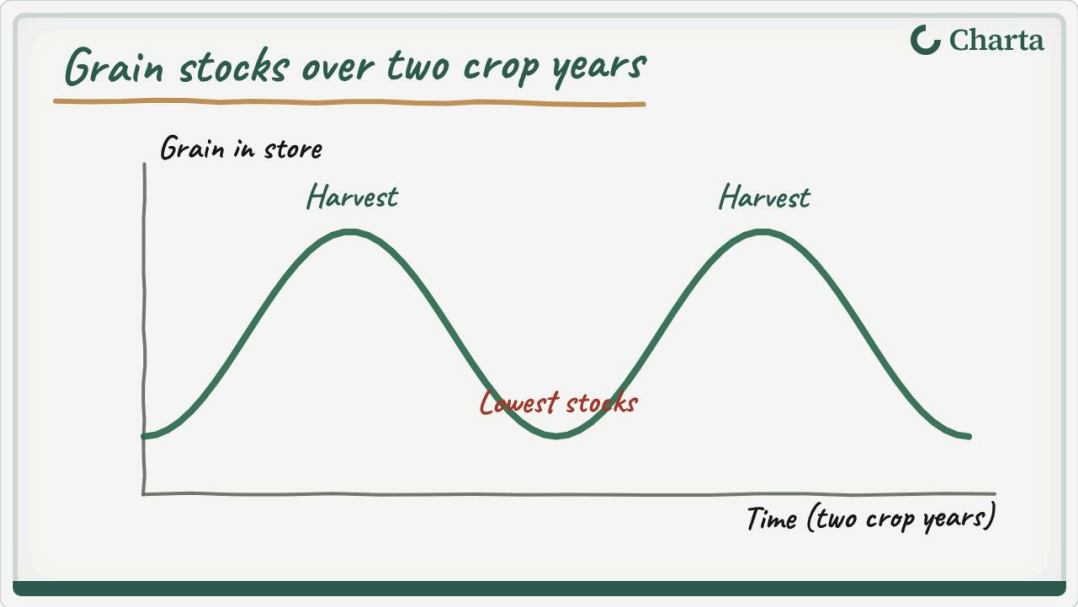
8 Every commodity has its own clock

- Production → storage and transport → use
- Each sector runs on its own timetable
- The clock sets how fast supply can respond
- A slow clock means bigger, longer price moves

IN THE LESSON

- Now the second idea.
- Every commodity travels from production to use, and each travels on its own clock.
- Think of baking bread, brewing beer and building a house.
- All three make something useful, but one takes an afternoon, one takes weeks, and one takes a year.
- Commodities are like that.
- A farmer plants in spring and harvests in autumn, and between those dates nothing she does can add to that year's crop.
- A miner may wait years between finding copper and shipping it.
- An oil well pumps every day.
- The life cycle, production, then storage and transport, then use, decides how fast supply can answer a price change, and so how violent a price move can become.

9 Grain stocks over two crop years



IN THE LESSON

- Here is the grain calendar, drawn.
- Time runs along the bottom, across two crop years, and the height of the line is grain in store.
- Follow it from the left.
- Just before a harvest, stocks are at their lowest, which is when grain is scarcest.
- Then the harvest comes in all at once, and stocks jump to the peak.
- After that they are used up a little each month, so the line falls, until the next harvest refills the barn.
- Prices tend to move the other way.
- They are firmer when stocks are low, just before a harvest, and softer when stocks are plentiful, just after it.
- This gives grains a seasonal pattern.

10 Example: a grain store running down

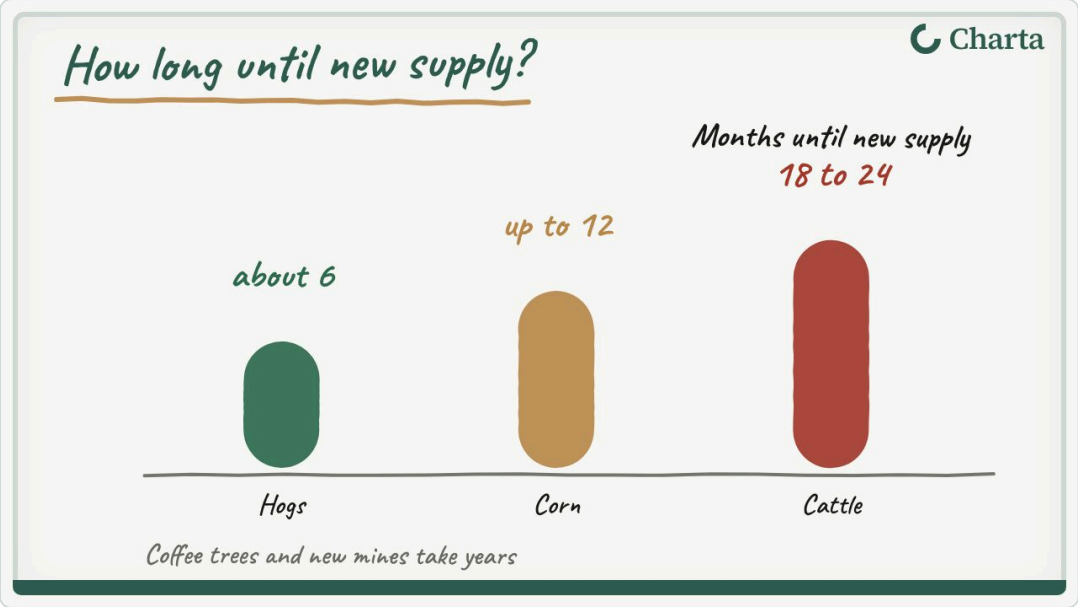
Harvest stock 100 units, use 8 units a month

At harvest	stocks peak	**100**
After six months	100 − 6 × 8	**52**
After eleven months	100 − 11 × 8	**12**
Left before next harvest	12 ÷ 100	**12%**

IN THE LESSON

- Let us put numbers on that line.
- These are made up.
- At harvest a store holds one hundred units of grain.
- The country uses eight units a month.
- After six months, the store has used forty-eight units, so fifty-two are left.
- After eleven months, just before the next harvest, eighty-eight units have been used, so only twelve are left.
- That is twelve per cent of the harvest.
- Prices are firm because a bad surprise now has almost no cushion.
- Then the new harvest arrives and refills the store.
- Notice what Mira cannot do in month eight: no farmer can make more grain that year.
- The supply is fixed until the next harvest, and only price can ration demand.

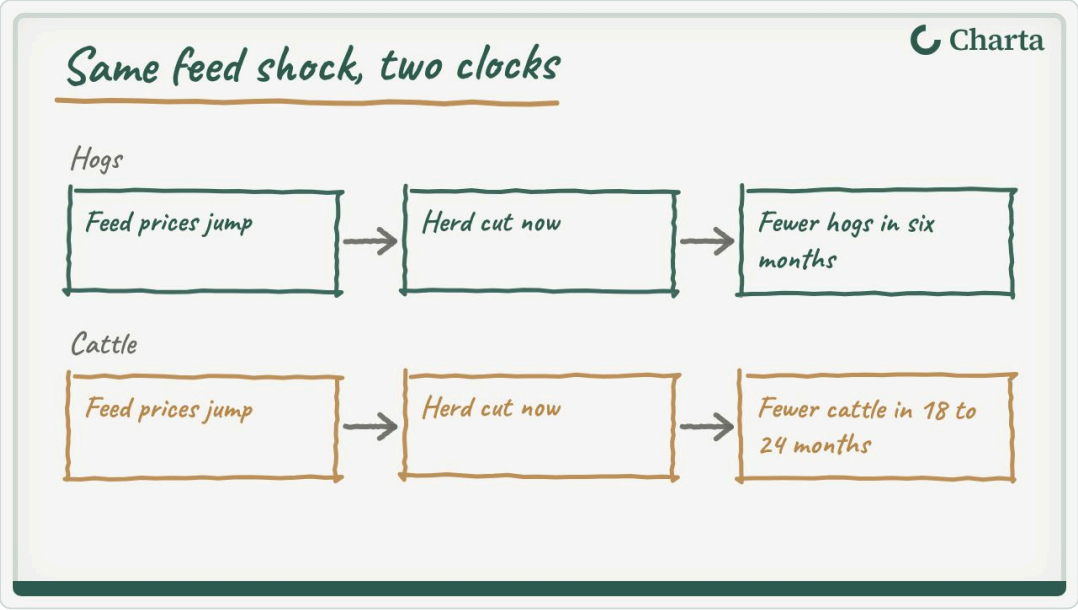
11 How long until new supply?



IN THE LESSON

- Not every sector waits for a harvest.
- Here are three livestock and grain clocks, as bars.
- The shortest is hogs.
- A hog reaches market in roughly six months, so a decision made today shows up as supply about half a year later.
- Corn is the middle bar.
- A new crop can take up to a year, because it must be planted, grown and harvested.
- Cattle are the tallest bar.
- They take eighteen months to two years to raise.
- So when feed gets dear and farmers cut their herds, the effect on supply arrives in hogs first and cattle last.
- Softs such as coffee grow on trees that need years to become productive, and metals need years from discovery to output.

12 Same feed shock, two clocks



IN THE LESSON

- Here is the livestock question from Mira's committee.
- Feed grain prices have jumped, and farmers are cutting their breeding herds.
- Which of two markets feels the lower supply first?
- Follow the top row for hogs.
- The feed price jumps, the breeding herd is cut, and about six months later there are fewer hogs coming to market.
- Now the bottom row for cattle.
- The first two boxes are the same, but cattle take eighteen months to two years to raise, so fewer animals arrive far later.
- So hog supply tightens first and cattle supply last.
- The decisions are made on today's feed prices, but they change supply much later, which is why livestock prices can swing in cycles.

13 Why spikes last: supply cannot hurry

- Grain resets every harvest; metals do not
- New mines and coffee trees take years
- Energy flows daily but needs refining and storage
- Trap: assuming supply responds quickly

IN THE LESSON

- Now the trap, and it appears in questions again and again.
- A board member says copper has doubled, so new supply will arrive within a year and push the price back down, just as grain does after a big harvest.
- It sounds sensible, but it confuses two clocks.
- Grain resets every year, and the next harvest can swamp a shortage.
- A new copper mine takes years from discovery to output, and new coffee trees take years too.
- After a frost, planting more trees does not bring coffee prices down quickly.
- Energy is produced continuously, but it still has to be refined, shipped and stored.
- So never assume supply can answer a price change quickly.
- For most commodities it cannot.

14 A machine versus a barrel

- Shares and bonds: value = discounted cash flows
- A barrel pays no dividend and no coupon
- Holding it costs storage, insurance, transport
- Its price comes from supply and demand

IN THE LESSON

- Time for the third idea: value.
- Imagine two things.
- One is a small shop that earns profit every year and pays you a share of it.
- The other is a barrel of oil sitting in a tank.
- The shop is a machine that produces cash, and you can value it by adding up the cash it will pay, after shrinking each payment for waiting.
- That is discounting, which you know from Level One.
- Shares and bonds work that way.
- The barrel produces nothing.
- It pays no dividend and no coupon.
- Worse, it costs you money to keep, for the tank, the insurance and the trucks.
- So there is no cash stream to discount.
- A physical commodity is worth what the market will pay for it.

15 What each asset pays you to hold it

Cash from holding the asset

Asset	Cash it pays
Share	Dividends
Bond	Coupons, principal
Physical commodity	Nothing
Cost of holding it	Storage, insurance

IN THE LESSON

- Here is the comparison laid out.
- A share pays dividends, and you value it from the dividends it is expected to pay.
- A bond pays coupons and the principal at the end, and you value it by discounting those promised payments.
- A physical commodity pays nothing at all.
- And the last line is the sting: it charges you, for storage and insurance.
- So the first thing to say about commodity valuation is that the usual tool, a model of discounted cash flows, has nothing to work on.
- News about weather, harvests or mine output moves prices directly, through what it says about expected supply, rather than through a change in anyone's expected cash flow.
- A frost report is a supply report.

16 Futures price from spot: the cost of carry

F = S × (1 + r) + C − CY

Futures price, F	Price agreed today for later
Spot price, S	Price for delivery now
Financing rate, r	Interest on money tied up
Storage cost, C	Tank, insurance, transport
Convenience yield, CY	Benefit of having it on hand

IN THE LESSON

- So how is a commodity futures contract priced?
- Not from cash flows, but from the cost of carrying the physical good.
- The idea is simple.
- You could buy the futures contract.
- Or you could buy the barrel today, borrow to pay for it, and store it until the date.
- The futures price should make the two routes cost about the same.
- The formula is: futures price equals spot price times one plus the financing rate, plus the storage cost, minus the convenience yield.
- Spot price is the price for immediate delivery.
- The financing rate is the interest on the money tied up.
- Storage cost covers tank and insurance.
- The convenience yield is the benefit of having the physical good on hand, such as a refinery that can never run dry.

17 Example: crude oil, spot to futures

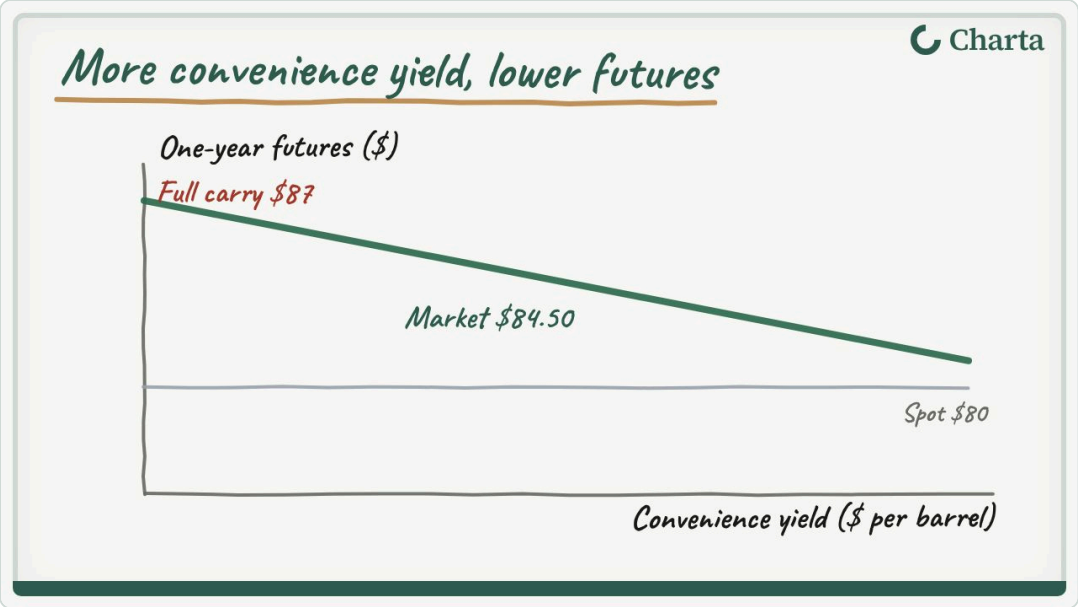
Spot $80, financing 5%, storage $3, one year

Spot financed	80 × 1.05	**$84.00**
Plus storage	84.00 + 3.00	**$87.00**
Futures seen in the market	below full carry	**$84.50**
Implied convenience yield	87.00 − 84.50	**$2.50**

IN THE LESSON

- Let us build one.
- Crude oil is eighty dollars a barrel today.
- The financing rate is five per cent for the year, and storage and insurance cost three dollars a barrel for the year.
- Step one: financing.
- Eighty times one point zero five is eighty-four.
- Step two: add storage, three dollars, and the full cost of carrying a barrel for a year is eighty-seven.
- That is the price if the physical good gave no benefit at all.
- But the market shows the one year futures at eighty-four fifty.
- That is below eighty-seven, so holders must value having the oil on hand.
- The gap, two dollars fifty, is the convenience yield the market is implying.
- Notice that none of these steps is a cash flow from the oil.

18 More convenience yield, lower futures



IN THE LESSON

- Here is the same idea as a picture.
- Along the bottom is the convenience yield, in dollars a barrel, and up the side is the one year futures price.
- The flat grey line marks the spot price of eighty.
- Now the sloping line.
- At the far left the convenience yield is zero, and the futures sits at the full carry price of eighty-seven.
- As the convenience yield grows, the futures price slides down, one dollar for each dollar.
- At two dollars fifty, it reaches the price the market shows, eighty-four fifty.
- The scarcer the physical oil, the more holders value having it now, the larger the convenience yield, and the lower the futures price relative to spot.
- Large inventories shrink it towards zero.

19 Example: gold with large inventories

Gold $2,000, financing 4%, storage 0.5% of spot, CY = 0

Financing cost	2,000 × 0.04	**$80**
Storage and insurance	2,000 × 0.005	**$10**
Convenience yield	inventories are large	**$0**
Futures price	2,000 + 80 + 10 − 0	**$2,090**

IN THE LESSON

- Now a case where the convenience yield is negligible.
- Gold is two thousand dollars an ounce.
- The financing rate is four per cent for the year.
- Storage and insurance cost a half of one per cent of the spot price, which is ten dollars.
- Stocks of gold above ground are large, so nobody pays extra to have an ounce on hand and the convenience yield is zero.
- Financing costs eighty dollars: two thousand times point zero four.
- Add storage of ten, and the futures price is two thousand and ninety dollars.
- Because the cost of carry is all that is left, the curve slopes up from spot.
- Compare that with crude oil above, where scarce stocks pulled the futures price below full carry.

20 Mistakes to avoid so far

- 1. One asset: sectors react to different shocks
- 2. Supply can respond fast: for most, it cannot
- 3. Discounting the commodity's own cash flows
- 4. Storage as income: it is a cost

IN THE LESSON

- Before we move on, a pause for the traps from the first three ideas.
- One.
- Treating commodities as one asset.
- Energy, metals and crops respond to different shocks, and a slowdown does not push every sector down together.
- Two.
- Assuming supply responds quickly.
- A harvest resets grain each year, but mines, trees and herds take far longer.
- Three.
- Building a model of discounted cash flows for the commodity itself.
- There are none to discount.
- Four.
- Treating storage as though it earned income.
- Storage costs money, so it is added to the futures price, while the convenience yield is the item that comes off.
- Keep the sign of each piece clear and the formula will not trip you up.

21 Who trades commodity futures, and why

- Hedgers, speculators, arbitrageurs
- Exchanges, analysts and regulators support them
- Sort by WHY they trade
- Not by what kind of firm they are

IN THE LESSON

- Now the fourth idea: the people in the market.
- Picture a farmers market with a small crowd.
- A farmer wants to lock in a price for the wheat that is still growing.
- A bakery wants to lock in what flour will cost.
- A few people have no wheat and no bakery, but they have an opinion about the harvest.
- Someone else is simply ready to buy or sell whenever asked, and charges a small fee for doing so.
- An exchange runs the venue and clears the trades, analysts publish research, and regulators watch conduct.
- Mira's rule for sorting this crowd is to ask why each person trades, rather than what kind of firm they are.

22 The four traders, sorted by motive

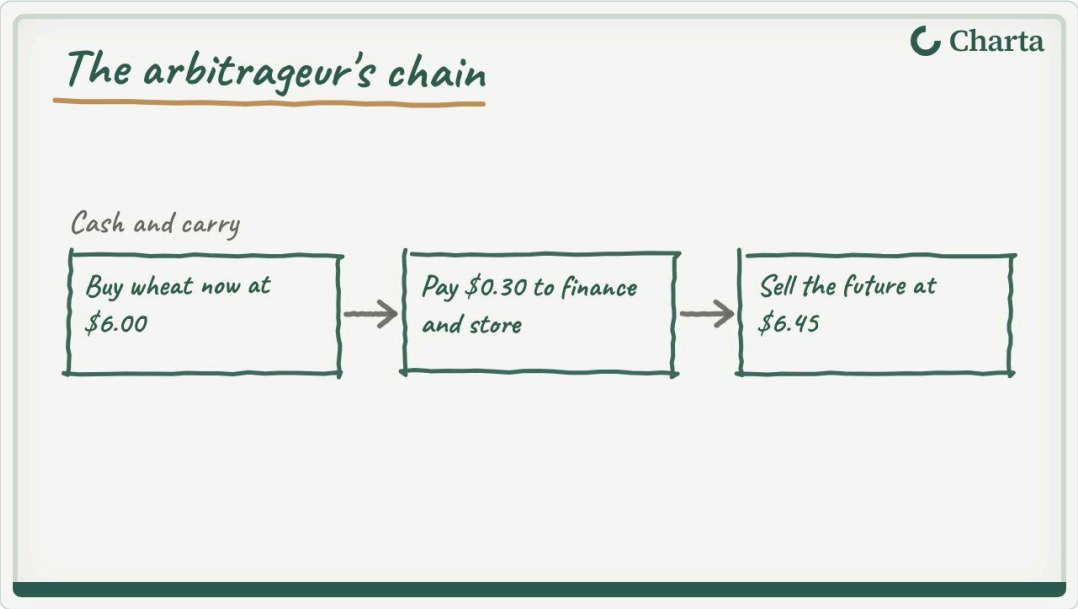
Each one trades for a different reason

Hedger	offsets a physical risk	**Lays off risk**
Informed investor	a better view of supply, demand	**Takes risk**
Liquidity provider	paid to absorb hedgers' flow	**Takes risk**
Arbitrageur	earns the gap over carry	**Little net risk**

IN THE LESSON

- Here are the four main traders, by motive.
- The hedger already has a price risk in the physical business, and trades futures to offset it.
- A farmer selling futures, or an airline buying fuel futures, are examples.
- The informed investor and the liquidity provider are speculators in a broad sense, and the arbitrageur is a separate type.
- The informed investor trades on a better view of supply and demand, perhaps from satellite pictures of crops.
- The liquidity provider has no view, and stands ready to take the other side of hedgers' orders, earning a small premium for absorbing them.
- The arbitrageur takes a gap between the physical and the futures price, often owning storage, so that it can buy the physical good and sell futures when carry is rich.

23 The arbitrageur's chain



IN THE LESSON

- Let us see the arbitrageur at work, in a chain of boxes.
- Wheat costs six dollars a bushel today, and the six month futures price is six forty-five.
- Reading left to right, the merchant first buys the wheat now at six dollars.
- Second, it pays thirty cents to finance and store the bushel for six months.
- Third, it sells the six month future at six forty-five.
- At the date it delivers the stored wheat against that future and collects the price.
- Notice that the merchant does not need a view on wheat prices.
- Whatever wheat is worth in six months, the sale price was fixed on day one.
- All that matters is whether the gap pays for carrying the wheat.

24 Example: the gap that pays

Spot $6.00; six-month future $6.45; carry cost $0.30

Cost of holding the wheat	6.00 + 0.30	**$6.30**
Sale price fixed by future		**$6.45**
Locked-in gap per bushel	6.45 − 6.30	**$0.15**
Contract of 5,000 bushels	0.15 × 5,000	**$750**

IN THE LESSON

- Now the numbers.
- Buying the wheat costs six dollars.
- Financing and storing it for six months costs another thirty cents, so the total cost of holding it is six thirty.
- The future sells it for six forty-five.
- The difference, fifteen cents a bushel, is locked in, whatever wheat does meanwhile.
- A futures contract here covers five thousand bushels, so fifteen cents on five thousand bushels is seven hundred and fifty dollars a contract.
- Now see what happens if the future were only six thirty.
- The gap would be zero, and nobody would bother.
- As arbitrageurs buy wheat now and sell futures, they push spot up and futures down, which closes the gap.
- Their trading keeps the two prices tied together.

25 Four firms, one contract: sort them

Same wheat contract, four motives

Bakery buys the future	fixes next year's flour cost	**Hedger**
Merchant buys wheat, sells future	locks the gap over carry	**Arbitrageur**
Fund buys on a crop survey	its own view of the harvest	**Informed investor**
Bank desk takes other side	paid to absorb hedgers' flow	**Liquidity provider**

IN THE LESSON

- Now a test of the rule.
- Four different firms trade the same six month wheat contract.
- A bakery buys the future to fix next year's flour cost.
- It already has the risk in its business, so it is a hedger.
- A grain merchant with its own silos buys wheat now and sells the future, to lock in the gap over its carrying cost, so it is an arbitrageur.
- A fund buys the future because its crop survey points to a poor harvest.
- It trades on a better view, so it is an informed investor.
- A bank desk takes the other side of large hedging orders for a small premium and has no view on wheat.
- It is a liquidity provider.
- Same contract, four motives, four labels.

26 The support cast, and the trap

- Exchange: venue, standard contracts, clearing
- Analysts: research. Regulators: conduct
- The same firm can play different roles
- Trap: labelling by firm, not by motive

IN THE LESSON

- Three more groups complete the picture.
- The exchange provides the venue, the standard contracts, and the clearing that guarantees performance, so that you do not need to trust the person on the other side.
- Analysts supply research on crops, mines and inventories, which helps prices reflect the facts.
- Regulators police conduct and guard against abuse.
- Now the trap.
- Labelling a participant by what kind of firm it is.
- A bank might hedge its own inventory in one trade and provide liquidity in another.
- An airline buying fuel futures to fix its costs is a hedger, but the same airline taking a bet on oil is a speculator.
- Ask why this trade was done, then label it.

27 Recap: sectors, clocks, value and players

F = S × (1 + r) + C − CY

Sectors	Different shocks, loose link
Life cycles	Supply responds slowly
Valuation	Spot plus carry, no DCF
Participants	Label by motive

IN THE LESSON

- Let us recap.
- First, sectors.
- Energy, grains and softs, livestock, industrial metals and precious metals answer to different shocks, so commodities are not one asset.
- Second, life cycles.
- Grain follows the harvest year, hogs take about six months, cattle eighteen months to two years, and trees and mines take years, so supply responds slowly.
- Third, value.
- A physical commodity has no cash flow to discount.
- The futures price is spot times one plus the financing rate, plus storage, minus the convenience yield.
- Fourth, participants.
- Hedgers lay off risk, informed investors and liquidity providers take it, and arbitrageurs earn the gap over carry.
- Label by motive, never by the type of firm.

28 Try three quick questions

1. Spot $50, financing 4%, storage $1, convenience yield $0.50. One-year futures?
   Answer: 50 × 1.04 + 1 − 0.50 = $52.50
2. Feed prices jump. Which supply tightens first, hogs or cattle?
   Answer: Hogs: about 6 months vs 18 to 24
3. Merchant buys wheat, sells a future above the carry cost. Who is it?
   Answer: An arbitrageur: earns the gap

IN THE LESSON

- Now three quick questions.
- Pause after each.
- Question one.
- Crude oil is fifty dollars, the financing rate is four per cent for the year, storage costs one dollar, and the convenience yield is fifty cents.
- What is the one year futures price?
- Fifty times one point zero four is fifty-two.
- Add one, subtract fifty cents, and you get fifty-two fifty.
- Question two.
- Feed prices jump.
- Which supply tightens first, hogs or cattle?
- Hogs, in about six months.
- Cattle take eighteen months to two years.
- Question three.
- A merchant buys wheat now and sells a future whose price exceeds the cost of carry.
- Which participant is it?
- An arbitrageur.
- It earns the gap, with no view on wheat.
- Well done.