

# Advanced futures trading ...



... some useful concepts.

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# About futures:

You are already expected to have a basic knowledge of how forward and futures contracts work in this class. If you want to review the subject at the introductory level, read Chapter 10 – Futures Contracts from the Econ 104 online finance book:

Introduction to Financial Markets and Instruments: <https://www.palmislandtraders.com/books/finance/introfinbook.html>

and/or review these lectures from Economics 104:

The Futures Market – Introduction and Mechanics: <https://www.palmislandtraders.com/econ104/e104l10.pdf>

The Use of Futures Contracts in ETPs: <https://www.palmislandtraders.com/econ104/e104l10b.pdf>



# What are futures contracts?

A futures contract allows a trader to undertake a contract to **accept or make** delivery of a commodity or some kind of financial asset (a) in the future on a known date, (b) under specified conditions, (c) for a price contracted today.

The party to the contract who is agreeing to take delivery of the commodity is **long** in the position, whereas the party who is agreeing to deliver the commodity is **short** in the position. A speculator will benefit when she is long if the prices rise, short if the price falls.

Through submission of bids and asks, the exchange will match long orders with short orders, either with outside traders or with their own trades.

# Futures contract symbols ...

**NGKO**

Product    Month    Year  
Code

(natural gas April 2020)

CBOE Futures Contract  
Month Symbols

Jan	F	Jul	N
Feb	G	Aug	Q
Mar	H	Sep	U
Apr	J	Oct	V
May	K	Nov	X
Jun	M	Dec	Z

See <https://www.cmegroup.com/trading/products/> for all codes.  
 Note that there are often different codes for Globex versus floor.  
 Usually brokerage quotes Globex.

# The new roles played by the e-mini and Micro e-mini contracts

The CBOE in recent years have introduced smaller versions of their traditional popular contracts, like those shown below for SPX and CL. **E-mini** for SPX means half the size of the traditional contract and **Micro e-mini** means one-tenth the size of the E-mini. Currently Micro e-mini is only offered for four indexes, S&P 500, Nasdaq 100, Russell 2000, and DJIA. (The only super-contract index is SPX).

These contracts (especially the Micro e-mini) are popular with smaller traders. They have lower margin requirements and they are **cash-settled** (there is no commodity delivery).

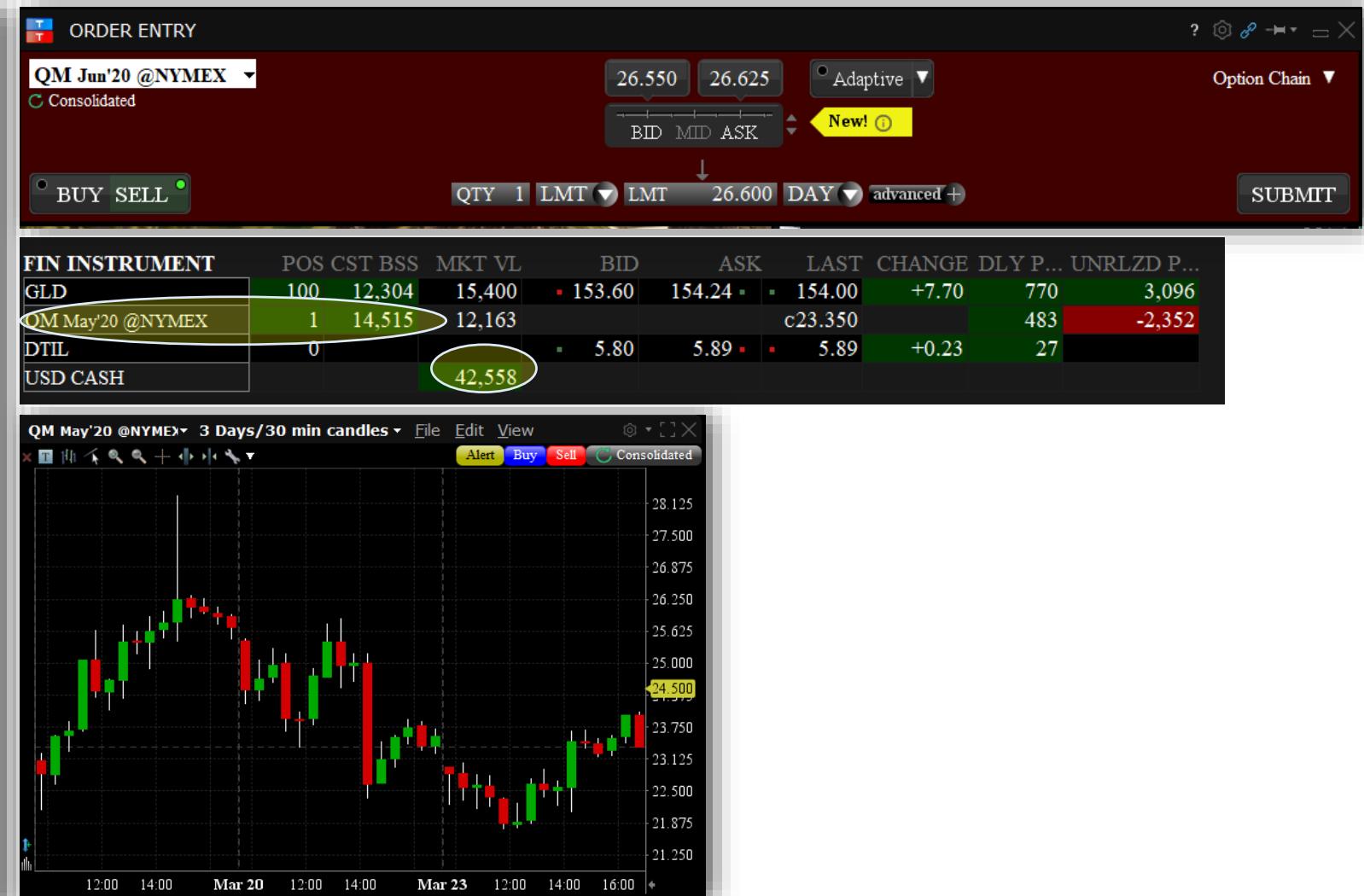
Bid/Ask spreads on the Micro e-mini indexes are a little wider than your teacher likes, but not on oil.

Contract	Symbol	Multiplier	Point or Penny impact	Delivery?
S&P 500	SPX	250	\$250	Yes
S&P 500 e-mini	ES	50	\$50	No
S&P 500 Micro e-mini	MES	5	\$5	No
WTI Crude Oil	CL	1,000	\$10	Yes
WTI Crude e-mini	QM	500	\$5	No

# What it looks like on a brokerage site ...

Interactive Brokers on March 23, 2020

	LAST	BID	ASK	BID SIZE
<b>Nat Gas</b>				
NG INDEX				
NG Apr'20 @NYMEX	1.607	1.606	1.607	5
QG Apr'20 @NYMEX	1.610	1.605	1.610	7
NG May'20 @NYMEX	1.679	1.678	1.680	5
QG May'20 @NYMEX	1.675	1.675	1.680	15
<b>Index Futures</b>				
SPX INDEX	2235.76			
MES Sep'20 @GLOBEX	2265.00	2251.50	2256.50	10
MES Dec'20 @GLOBEX	c2214.25	2230.00	2282.00	10
ES Jun'20 @GLOBEX	2261.00	2261.00	2261.50	3
ES Sep'18'20 @GLOBEX	2255.25	2253.00	2254.75	4
SPX Jun'18'20 @GLOBEX	2266.60	2260.70	2262.00	1
<b>Gold</b>				
GC INDEX	c0.00			
GC Apr'20 @NYMEX	1575.50	1575.50	1575.60	1
MGC Apr'20 @NYMEX	1575.30	1575.30	1575.60	2
GC May'20 @NYMEX	1576.00	1578.30	1578.50	1
<b>Micro e-Mini</b>				
MES Jun'20 @GLOBEX	2261.75	2261.00	2261.75	4
MYM Jun'20 @ECBOT	18856	18849	18857	1
M2K Jun'20 @GLOBEX	1017.00	1016.40	1017.20	2
<b>FX</b>				
GBP Jun'20 @GLOBEX	1.1609	1.1610	1.1613	3
EUR Jun'20 @GLOBEX	1.08055	1.08055	1.08060	1
M6B Jun'20 @GLOBEX	1.1616	1.1607	1.1617	4
M6E Jun'20 @GLOBEX	1.08060	1.08050	1.08080	4
MJY Jun'20 @GLOBEX	0.009065	0.009061	0.009065	1
<b>Oil</b>				
CL May'20 @NYMEX	24.40	24.39	24.41	5
CL Jun'20 @NYMEX	26.49	26.48	26.51	5
QM May'20 @NYMEX	24.400	24.400	24.425	1
QM Jun'20 @NYMEX	26.450	26.475	26.550	1



# Advice from your teacher ...

If you are the kind of trader who wants to experiment with (1) directional swing bets, (2) mean reversion models, or (3) technical models, especially if you want to experiment with indexes (like SPX and DJI), rather than use stocks or ETFS, you might benefit from using futures contracts instead. The markets are extremely liquid, are open more hours (essentially 23 hours a day, 6 days a week), have options available (options on futures are similar to options on ETFs), they offer leverage to practically any degree you want, and futures lend themselves well to computer-assisted trades. Unlike stocks, shorts are just as easy as longs! A bearish directional bet is trivial to make. Futures are also very useful for hedges and spreads.

A good contract on which to practice or develop mean-reversion or technical modeling is the S&P500 Micro e-mini contract (**MES**), which has notional value equal to \$5 times the index (rather than \$250 X index of the monster **SPX** parent contract) or the WTI Crude Oil e-mini (**QM**), which trades at 500 barrels, rather than the parent contract (**CL**), which trades at 1,000 barrels. Directional bets are easy to place on **SPX** or **MES**. And your option models will work just as well on futures options as on stock options.

If you are an international student, you might actually have the knowledge to trade FX futures like the e-mini Euro (**E7M**) and the e-mini Yen (**6EM**).

# Contract specs and trading hours ...

## NYMEX MINY Light Sweet Crude Oil

Security Type	FUT
Underlying	<a href="#">QM IND</a>
Contract Month	MAY20
Expiration Date	APR 20 '20
Last Trading Date	APR 20 '20 14:30 EST
Currency	USD
Multiplier	500
Exchange	NYMEX
Trading Class	QM
Symbol	QMK0
Product Type	Energy
Settlement Method	Cash

**Trading Hours:** March 23, 2020 [Calendar](#)

Regular Trading Session 09:30 EST - 17:00 EST (06:30 PST - 14:00 PST)

Total Available Hours 18:00 EST - 17:00 EST (15:00 PST - 14:00 PST)

## Current Margin Requirements

Intraday Initial	5180.00
Intraday Maintenance	4144.00
Overnight Initial	5180.00
Overnight Maintenance	4144.00

Trading 6-days a week, **no** trading (all NYT):

Sunday through Friday: One hour from 5:00 PM – 6:00 PM.

Monday - Friday trading break from 4:15 to 4:30 PM.

Trading stops on Friday, 5:00 PM, no trading on Saturday, (trading resumes on Sunday at 6:00 PM).

# NYMEX light sweet crude contracts

Month	Options	Charts	Last	Change	Prior Settle	Open	High	Low	Volume	Hi / Low Limit	Updated
MAY 2020	OPT		23.27	-0.09	23.36	23.87	25.16	23.09	544,364	No Limit / 0.01	13:08:34 CT 24 Mar 2020
JUN 2020	OPT		25.60	+0.12	25.48	25.87	27.28	25.44	145,002	No Limit / 0.01	13:08:34 CT 24 Mar 2020
JUL 2020	OPT		27.51	+0.28	27.23	27.66	29.00	27.36	89,012	No Limit / 0.01	13:08:34 CT 24 Mar 2020
AUG 2020	OPT		28.71	+0.27	28.44	28.94	30.16	28.65	36,487	No Limit / 0.01	13:08:29 CT 24 Mar 2020
SEP 2020	OPT		29.67	+0.28	29.39	29.99	31.16	29.58	36,078	No Limit / 0.01	13:08:25 CT 24 Mar 2020
OCT 2020	OPT		30.46	+0.29	30.17	30.76	31.90	30.33	10,987	No Limit / 0.01	13:08:25 CT 24 Mar 2020
NOV 2020	OPT		31.15	+0.27	30.88	31.44	32.58	31.03	5,275	No Limit / 0.01	13:08:16 CT 24 Mar 2020
DEC 2020	OPT		31.73	+0.23	31.50	32.07	33.25	31.61	52,941	No Limit / 0.01	13:08:34 CT 24 Mar 2020
JAN 2021	OPT		32.24	+0.22	32.02	32.74	33.63	32.10	2,412	No Limit / 0.01	13:06:30 CT 24 Mar 2020
FEB 2021	OPT		32.55	+0.06	32.49	33.77	33.95	32.55	1,687	No Limit / 0.01	13:04:24 CT 24 Mar 2020

This is the large contract (CL). Many more months are included, including monthly from Mar2021 to Feb2031! But, all contracts after Dec2024 are illiquid and only June and December contracts are liquid after Jan2022. The closer the expiry, the more liquid that contracts are. But contracts going out a year are generally tradeable.

# What are margin requirements and what do you need to know about them?

When you go long or short in a futures contract, you are not buying a financial asset nor an underlying commodity like crude oil or natural gas. Effectively you are entering into a “settlement” contract that might allow you to buy an underlying commodity or similar at some time in the future at a favorable price.

Because you are not buying a financial asset, the cash in your account balance does not decline when you initiate a trade (except for the tiny transaction fee). Or, to put it in other words, no cash is debited from (nor credited to) your account.

The same holds true when you exit (offset) the contract.

For this reason, both the exchange and your broker require you to set aside a minimum amount of cash for each contract, which remains in your cash account but is earmarked and not available for use elsewhere.

The cash requirement when you enter the contract, whether long or short, is called the **initial margin**.

As the account value fluctuates over time, the minimum cash balance allowed for your account is called the **maintenance margin** or **day margin**.

# Margins and Leverage

- ✓ Initial Margin - The amount of cash per contract that you must have in your account prior to trading. (**\$5,600**)
- ✓ Maintenance Margin - If the amount of cash per contract falls below this value, you will get a margin call and must replenish cash balance. (**\$5,040**)
- ✓ Notional Value of Contract - Contract size times price
  - $\$23.27 \times 1,000 = \$23,270$
- ✓ Implicit Leverage - The notional value of the contract divided by the amount of cash dedicated to the trade.
  - $[\$23.27 \times 1000] / 10,000 = 2.33 \text{ to } 1$
- ✓ Each penny move in the price of oil affects the margin account by \$10.00 per contract. [You always want to know the “penny impact” when trading futures].

# What do we need to know about the CL Crude contract?

- Contract size
    - ✓ 1,000 bbls (42,000 gallons)
  - Pricing of quote
    - ✓ \$ per bbl
  - **Initial margin requirement**
    - ✓ \$5,600 non-member but effective brokerage margin for a small trader equals 50% of the notional value of the contract!
  - **Maintenance Margin**
    - ✓ \$5,040
  - Last trading date and moment
    - ✓ 2:30 PM NYT on 3rd business day prior to the 25th day of the month prior to the contract month (May 22 for the June 2020 contract).
- 

- Delivery date or period
  - ✓ By arrangement, anytime in the month of the contract.
- Delivery location
  - ✓ Various named locations in Cushing, Oklahoma or pipeline access to TEPPCO or Equilon Pipeline Co.

# What do we need to know about the QM e-mini Crude contract?

- Contract size
  - 1,000 bbls (42,000 gallons)
- Pricing of quote
  - \$ per bbl
- **Initial margin requirement**
  - **\$2,800** non-member **but** effective brokerage margin for a small trader equals 50% of the notional value of the contract!
- **Maintenance Margin**
  - **\$2,520**
- Last trading date and moment
  - 2:30 PM NYT on 3rd business day prior to the 25th day of the month prior to the contract month (May 22 for the June 2020 contract).
- Delivery date or period
  - **None!** Financially settled (cash contract where settlement just stops), although final price determination is complicated ... you want to offset before

# Broker initial and maintenance margins for small traders ...

## NYMEX MINY Light Sweet Crude Oil

Security Type	FUT
Underlying	<a href="#">QM IND</a>
Contract Month	MAY20
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Trading Class	QM
Symbol	QMK0
Product Type	Energy
Settlement Method	Cash

Interactive  
Brokers QM  
margin on  
3mar2020.

**Trading Hours:** March 23, 2020 [Calendar](#)

Regular Trading Session 09:30 EST - 17:00 EST (06:30 PST - 14:00 PST)

Total Available Hours 18:00 EST - 17:00 EST (15:00 PST - 14:00 PST)

### Current Margin Requirements

Intraday Initial	5180.00
Intraday Maintenance	4144.00
Overnight Initial	5180.00
Overnight Maintenance	4144.00

QM	04/2020	05/2020	2,800 USD
QM	06/2020	06/2020	2,775 USD
QM	07/2020	07/2020	2,662 USD

**CBOE for same day**

# Settlement

Unlike options, futures are not paid for (which is to say, the commodity to be delivered is not paid for) until the delivery of the commodity (**CL**) or they are cash-settled without delivery (**QM**).

The buyer of the future, however, is required to maintain funds in the *cash account* which is, at the end of each day, **adjusted to reflect the capital gain or loss**. The starting required balance for this account is called the *initial margin*.

The account balance must always be kept above the *maintenance margin*, sometimes called the *day margin*.

[Important note: Most brokerages now do dynamic settlement on your account – the change in the price is reflected frequently throughout the day].

# Dynamic Settlement ...

11:53 AM 24Mar

P&L				Margin			
DAILY		1,076	Unrealized 540.4	Net Liq		57.8K	Excess Liq 38.6K
Since prior Close ▾		1.90%	Realized -1.4K	Maintenance		3.7K SMA	--
<b>FIN INSTRUMENT</b>							
POS	CST	BSS	MKT VL	BID	ASK	LAST	CHANGE DLY P... UNRLZD P...
GLD	100	12,304	15,484	154.80	154.84	154.84	+8.54 854 3,180
QM May'20 @NYMEX	1	14,515	11,875	23.725	23.750	23.750	+0.400 195 -2,640
DTIL	0			5.82	5.89	5.82	+0.16 27
USD CASH			42,283				

Note: this is done periodically rather than continuously, so the realized gains and losses don't match the cash change in these slides. To get them to match, I would have to capture them at the exact moment of the cash update, which was not done here.

12:07 PM 24Mar

MONITOR	Portfolio	Trades	+	Filter ?
<b>P&amp;L</b>				
DAILY		1,127	Unrealized 590.9	Margin
Since prior Close ▾		1.99%	Realized -1.4K	Net Liq 57.9K Excess Liq 38.6K
<b>FIN INSTRUMENT</b>				
POS	CST	BSS	MKT VL	BID ASK LAST CHANGE DLY P... UNRLZD P...
GLD	100	12,304	15,494	154.94 155.00 154.97 +8.67 864 3,190
QM May'20 @NYMEX	1	14,515	11,913	23.825 23.850 23.825 +0.475 233 -2,602
DTIL	0			5.89 5.95 5.90 +0.24 27
USD CASH			42,346	

We have to remind ourselves that we are looking at a market that is open 23 hours a day ...



# An example of margin account adjustment

December crude oil futures contract, long 1,000 bbls

Date	Price	Position	Gain	Cash
0 - no trade				5,000
1 - mid day	56.74	56,740	0	5,000
1 - end day	56.52	56,520	-220	4,780
2 - end day	56.48	56,480	-40	4,740
3 - end day	56.22	56,220	-260	4,480
4 - end day	55.02	55,020	-1,200	3,280
5 - end day	56.34	56,340	1,320	4,600
6 - morning	57.02	57,020	680	5,280
				MC

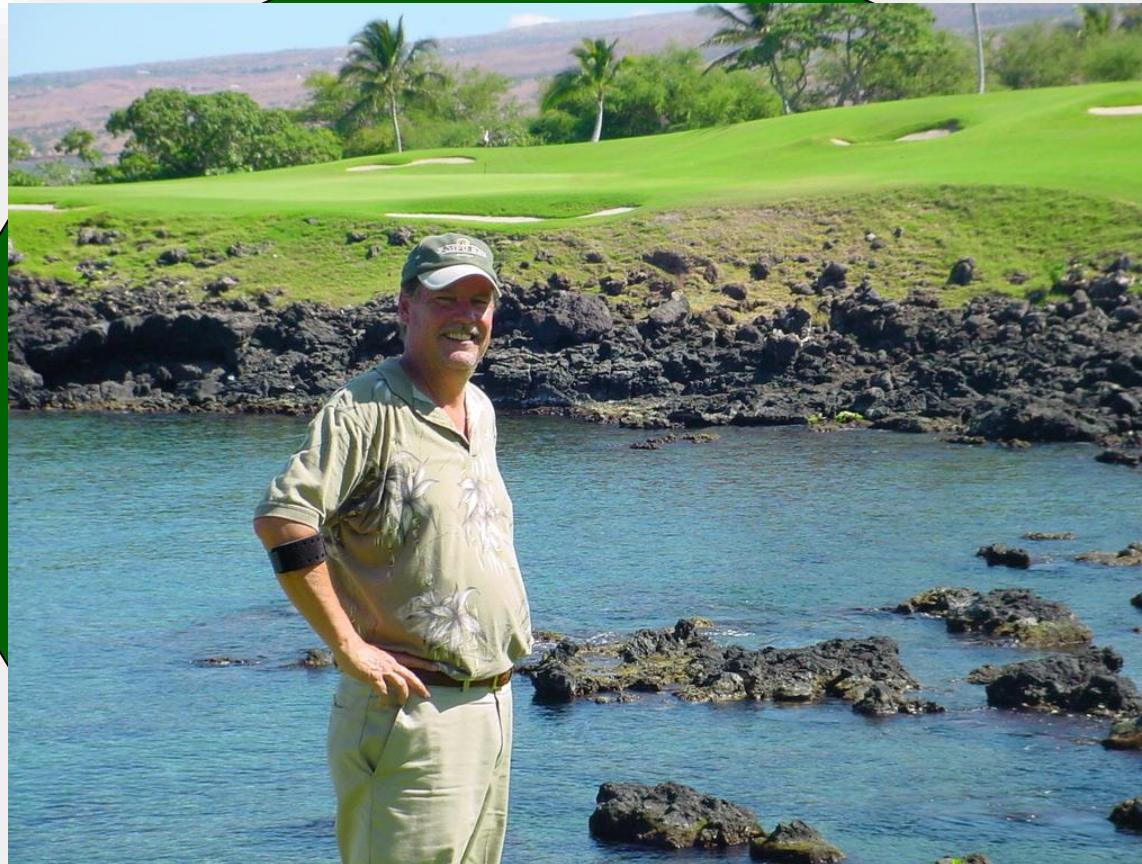
For a short contract, the signs in the Gain would simply reverse.  
 Each one cent move affects margin by \$10. Leverage here (unrealistic)  
 is about 11 to 1.

# How you pay for delivery (iff you *take* delivery)

- If you go long (buy) on a futures contract for \$57 (such as \$57 per barrel of oil), and if you take delivery, you *will* end up paying \$57 for the commodity.
- This net cost, however, will consist of two components:
  - the price you pay at delivery, *which is spot for that day*, and
  - the results of the daily adjustment to your margin account, whether a capital gain or capital loss.
- Therefore, you are effectively paying \$57 because of the adjustment in your margin account.

# Key take-aways that you *must* understand ...

1. Your margin position is determined by the free cash in your account. There is not special account for "margin."
2. When you enter a trade long or short, it does not increase nor lower the cash in your account. When you go long or short in futures contracts, you have not (yet) acquired an asset. You have initiated a contract to eventually acquire or dispose of an asset (the underlying commodity). And in a cash-settled contract, you have only agreed to start the process of settlement.
3. As the price of the underlying goes up and down, the cash in your account changes to reflect the new notional value, either at the end of the day, or dynamically.
4. When you exit a trade long or short, it does not increase nor lower the cash in your account, except for the final cash adjustment for that day, which will depend upon the price at which you exited.



Mauna Kea famous 180 yard 3rd hole over the bay, Kona. A good round of arbitrage might get you a good round here. I bogied this the first time with a routine shot, parred it the second by hitting a lava outcrop and getting a lucky bounce onto the green. Sometimes luck helps.

Luck is not an issue in arbitrage

**The theoretical connection between pure arbitrage of storable commodities and upper and lower price limits ...**

# Corrections:

## Trading hours for (most) futures:

Sunday through Friday: 6:00 PM (NYT) to 5:00 PM

~~Mon-Fri trading break from 3:15 to 3:30 PM.~~

Trading 6-days a week, **no** trading (all NYT):

Sunday through Friday: One hour from 5:00 PM – 6:00 PM.

Monday - Friday trading break from 4:15 to 4:30 PM.

Trading stops on Friday, 5:00 PM, no trading on Saturday,  
(trading resumes on Sunday at 6:00 PM).

Also, **SPX** usually refers to the actual S&P 500 index, although many traders, including me, are in the habit of calling the big futures contract **SPX**.

At CBOE, **ES** is the actual symbol of the **SPX** futures contract.

# Pure (true) Arbitrage

Arbitrage takes advantage of the fact that two or more commodities or financial assets are mispriced relative to each other. With true arbitrage, an automatic profit will be realized.

*Usually arbitrage involves taking a long or short position in the primary asset and taking an opposite position in its derivative.*

Suppose the spot price of gold is \$1200 per ounce.

Suppose the one-year future price of gold is \$1800 per ounce.

The interest rate for borrowed money is 5% (\$60 per ounce).

The storage cost of gold is \$40 per ounce.

The insurance cost for gold is \$20.

The initial margin is 10% of the price of gold (\$120) and the interest charge on that is \$6.

Note: We are not learning this because this presents itself as a frequent opportunity. We are doing it to support a theory.

# What do you do?

1. Borrow \$1200 and pay \$60 interest.
2. Buy, store, and insure one ounce of gold.
3. Sell (short) a futures contract for \$1800.
4. Pay interest on the initial margin (implicitly)

Your “**carry cost**” on this contract is  $\$126 = \$60 + \$40 + \$20 + \$6$ .

No matter what happens to the price of gold, you are  
guaranteed an arbitrage profit of \$474 per ounce.

Why?

**Carry cost:** the cost of being in a futures contract, sometimes expressed as a percentage of the value of the contract. Consists of financing costs (direct or implied), plus storage, transportation, and insurance costs for relevant (storable) commodities.

# Results from possible future gold prices

In one year you sell the gold that you bought for \$1200 at the new spot price (5 possibilities are shown below). You add the gain or loss on the margin account (you were short at 400, so the margin account grows when the price of gold falls).

Spot at end of year	Spot gain/loss	Margin gain/loss	less carry	Profit
1000	-200	800	-126	474
1200	0	600	-126	474
1400	200	400	-126	474
1600	400	200	-126	474
1800	600	0	-126	474
2000	800	-200	-126	474

# Future price upper limit (continuous)

Because the arbitrage possibility in the previous example would result in heavy purchases of gold at spot, raising the spot price, and heavy sales of gold futures, lowering the futures price, the spread in prices would narrow.

This implies that, given borrowing, storage, insurance, and other costs, there is an upper limit on futures prices for gold and similar commodities:

$$FPUL = Se^{[r+s+i+r(m)]t}$$

FPUL = Future price upper limit t = days in contract/365

r = interest rate for borrowing S = Spot price

s = storage cost as a percent

i = insurance as a percent

m = initial margin

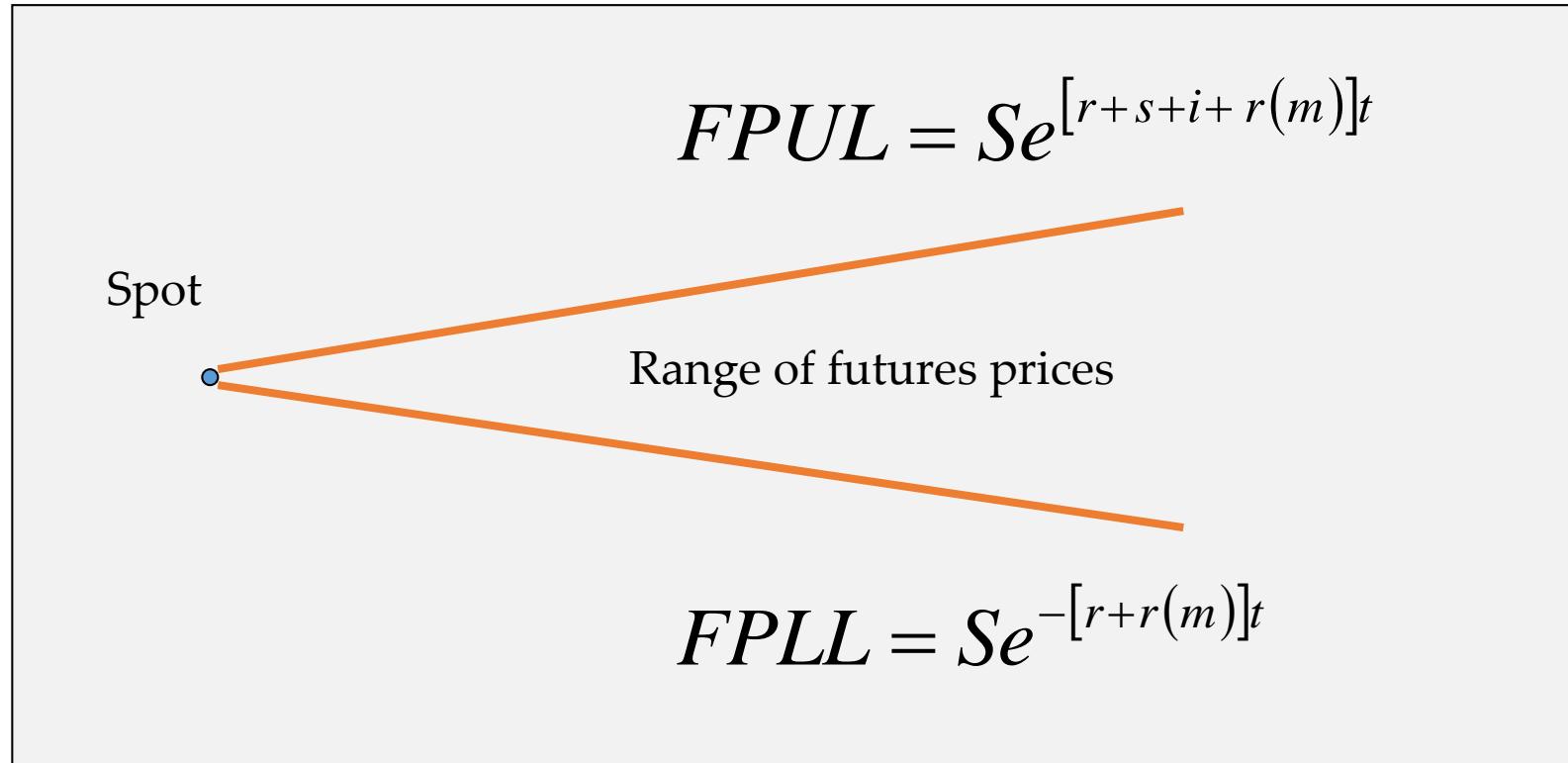
Discrete:

$$FPUL = S[1 + r + s + i + r(m)]^t$$

Note: This limit exists for storable commodities only if storage is truly available! Sometimes natural gas and crude oil have no available storage!

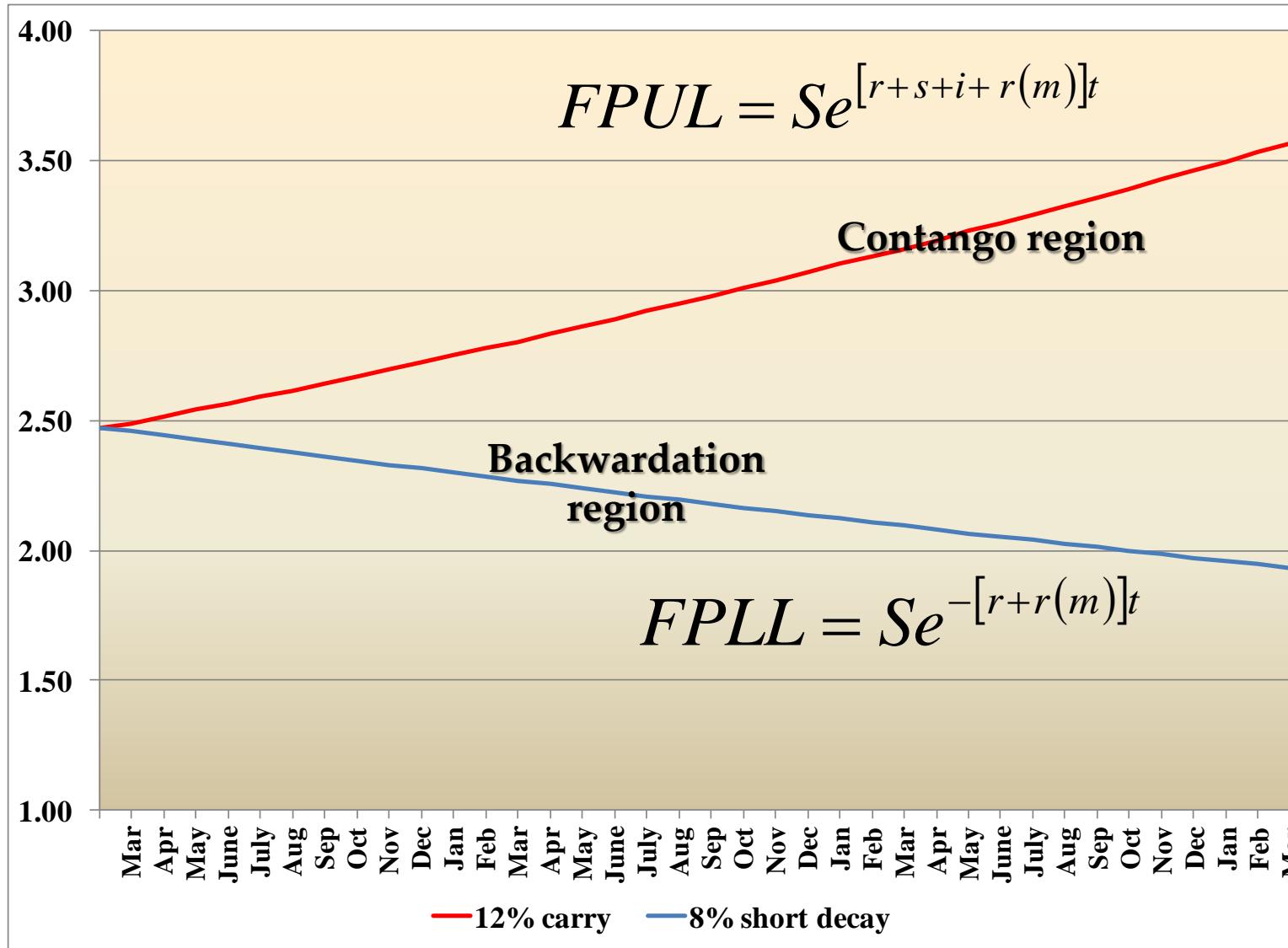
# Arbitrage restricts futures price ranges

Why sometimes this is not possible in natural gas nor oil!



Note: This is true only if arbitrage is possible, which in the case of physical commodities, requires the means and possibility of storage.

# The continuous case for Nat Gas



# Arbitrage and directional betting with the SPX, S&P 500 portfolios, SPY, options on SPX, and other indexes

Arbitrage with the S&P 500 index (SPX) futures contract is the historical basis of what is now called *Program Trading*. Generally, this kind of arbitrage is done by buying a portfolio of the S&P 500 stocks (or an index mutual fund) and at the same time shorting one of the SPX futures. This is a closed contract.

Generally you are buying the stocks with the intention of delivering them (or the equivalent) when the futures contract expires. (This can also be done with SPY).

Why would you do this?

# Traditional, mini, and micro e-mini ...

SPX, ES, and MES Futures Contracts			
Date:	Mid-March 2020	Contract months:	Jun, Sep, Dec, Mar
Index:	2600	Leaps:	3 additional Dec
	S&P 500 futures	E-mini S&P 500	Micro E-mini S&P 500
Multiplier size:	250	50	5
Notional value (1):	\$650,000	\$130,000	\$13,000
One point settlement:	\$250	\$50	\$5
Maintenance:	\$60,000	\$12,000	\$2,380 br

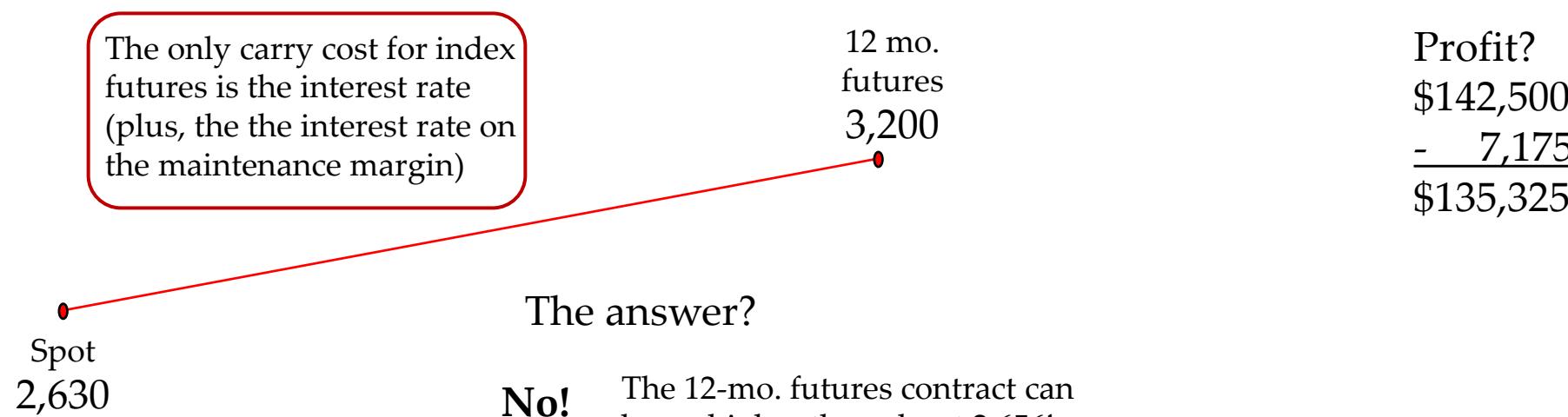
Margin for Micro e-mini is the broker's (IB) much higher maintenance margin on this contract.

See the same for Dow Jones Industrial Average, Nasdaq-100, and Russell 2000. None of these have the large contract. They only have an E-mini and Micro E-mini contracts.

# Anomaly arbitrage with SPX:

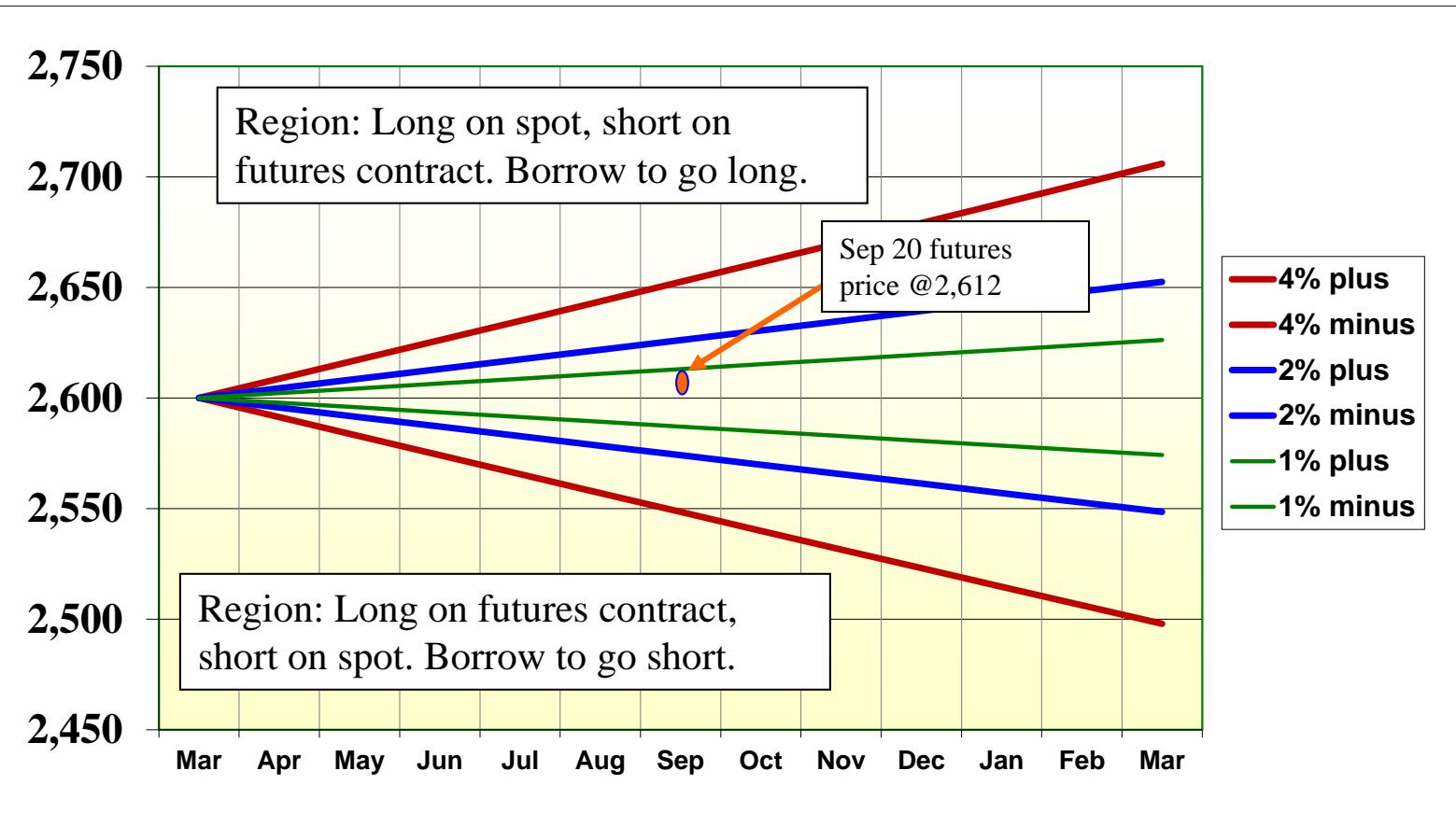
Right now short-term interest rates are very low ... less than 1%, and the FRS is insuring that large, institutional borrowers can borrow at these low rates. So let's assume that the carry interest rate is 1% ann.

On this day, March 26, the S&P 500 closed at 2,630.07. The recent market peak, seen only weeks ago, was above 3,200. What if we all were highly confident that the S&P 500 would return to 3,200 within one year? Would the ES futures contract 12 months be at this expected price?



1. Short one 12-month futures ES contract, notional value \$800,000.
2. Borrow \$657,500 + \$60,000(mm) at 1%. Interest cost will be \$7,175.
3. Buy (long) the equivalent of 250 positions in a market basket of SPX stocks, or SPY, which will cost \$657,500.
4. In one year deliver the SPX selection or SPY to satisfy the deliverable on your futures contract.

# Upper/lower arbitrage ranges for SPX futures contracts



Spot on 26 Mar 20: 2,630

Because SPX futures stays tight on the current price, SPX futures are good for direction bets, including spreads (which in this case are long directional bets). Shorts are just as easy as longs!

What is the carry cost on index futures? The short-term interest rate (currently near zero).

# Key take-aways that you *must* understand ...

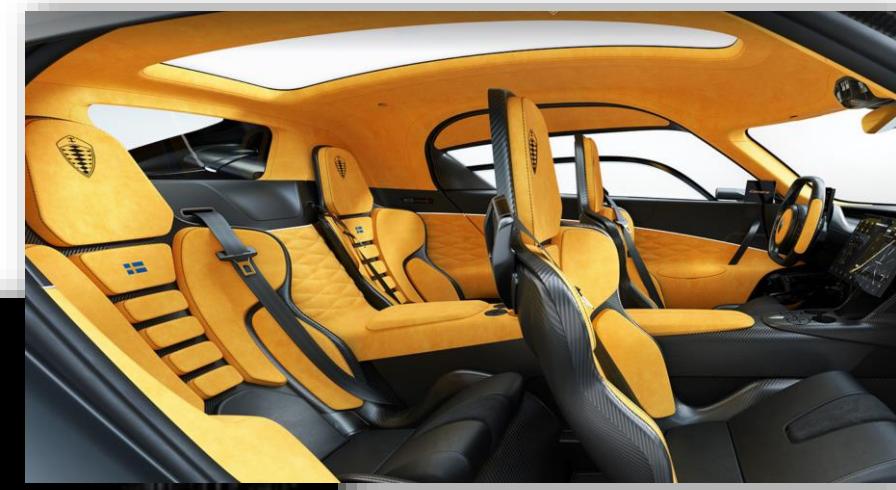
1. The possibility of arbitrage will put an **upper** and **lower limit** on futures prices for **storable commodities, indexes, and currencies**.
2. That limit is determined by the **carry cost** for that contract, which always includes interest and can include storage, insurance, transportation and other costs.
3. Because index futures and fx (currency) have only interest rates as carry costs, futures prices going out will always be relatively flat, constrained only interest compounding or discounting.  
Therefore these futures prices *do not reflect the future expected spot prices of the indexes* (except directionally within the index).

# Let's raise our standards ...

**... and start talking about contangos!**

(and backwardation, which isn't as cool-sounding).

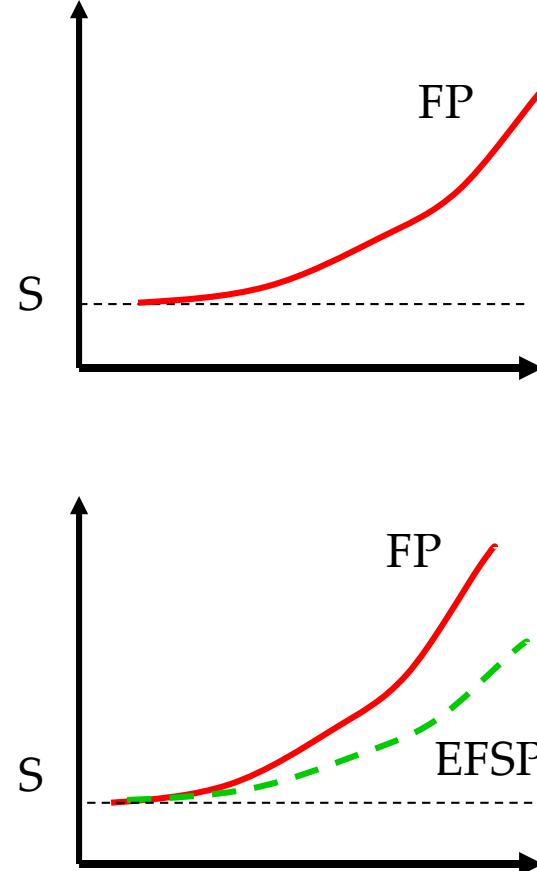
Koenigsegg Gemera Electric Hybrid



<https://www.koenigsegg.com/gemera/>

Powertrain:  
3 cylinder 2 liter twin turbo freevalve  
producing 600 bhp.  
Three electric motors producing 500  
bhp each, total output 1,700 bhp.

# Definition of contango ...



Most of the literature refers to any schedule of futures prices that is above the spot price and rising as the maturity extends, such as the graph on the left, as a **contango**. Because that is so common, that is the definition that we will use.

In some literature, a contango is defined as a pricing situation only where the futures prices is above the **expected spot price**, as shown in the bottom graph.

The latter definition gives rise to the possibility of a rising futures chain that is nonetheless not in contango.

This is relevant because in arbitrage we will consider the **Contango Spread**.

# Calendar spread possibility – oil was in severe contango in late 2008:

[New York Mercantile Exchange \(NYMEX\)](#)

[Energy](#)

**CRUDE OIL (CL)**

Market		Oil in late 2008						Time
		Open	High	Low	Last	Change	Pct	
<a href="#">CL.F09</a>	<a href="#">Jan 2009</a>	43.40	44.20	43.15	43.15	-0.56	-1.28%	14:33
<a href="#">CL.G09</a>	<a href="#">Feb 2009</a>	46.10	46.40	44.60	44.60	-1.76	-3.78%	14:28
<a href="#">CL.H09</a>	<a href="#">Mar 2009</a>	46.80	46.80	46.80	46.80	-1.82	-4.07%	14:29
<a href="#">CL.J09</a>	<a href="#">Apr 2009</a>	50.25	50.25	50.25	50.25	-0.04	-0.08%	10:32
<a href="#">CL.K09</a>	<a href="#">May 2009</a>	77.15	77.15	77.15	51.64	+4.03	+7.80%	set 15:25
<a href="#">CL.M09</a>	<a href="#">Jun 2009</a>	54.20	54.20	54.15	52.78	+3.94	+7.46%	set 15:25
<a href="#">CL.N09</a>	<a href="#">Jul 2009</a>	59.58	59.58	59.58	53.76	+3.84	+7.14%	set 15:25
<a href="#">CL.Q09</a>	<a href="#">Aug 2009</a>	54.63	54.63	54.63	54.63	0.00	0.00%	09:42
<a href="#">CL.U09</a>	<a href="#">Sep 2009</a>	64.15	64.15	64.15	55.48	+3.59	+6.47%	set 15:25
<a href="#">CL.V09</a>	<a href="#">Oct 2009</a>	117.80	118.00	117.80	56.32	+3.50	+6.21%	set 15:25
<a href="#">CL.X09</a>	<a href="#">Nov 2009</a>	100.70	100.70	100.70	57.15	+3.41	+5.97%	set 15:25
<a href="#">CL.Z09</a>	<a href="#">Dec 2009</a>	60.25	60.25	60.00	57.98	+3.33	+5.74%	set 15:25
<a href="#">CL.F10</a>	<a href="#">Jan 2010</a>	61.35	61.35	60.80	58.78	+3.27	+5.56%	set 15:25

Source: ino.com

This was described as a “six-sigma move.”



... very late in the cycle (December) !!

# Contango theory: Why the futures price is not necessarily the expected future spot price

Key slide!!

Assumes that

- In any market, hedgers are on one side net (say net long) and speculators are on the other (net short).
- Speculators as a group are able to estimate the **future spot price** of a commodity, and they might agree.
- Speculators will go short in a future only if the futures price is **above** the estimated future spot price of a commodity, otherwise for them it is a zero sum game with risk.
- Therefore, hedgers must be willing to buy long at a price above the estimated future spot price, or the market won't clear – they are paying an **insurance rate** if they do this.
- Therefore, when the market clears, the futures price will be different than the expected future spot price.

# Example of “true” contango where $FP > EFSP$

Suppose the **spot price** of wheat is currently **\$4.20** per bushel. Suppose that both millers and speculators think that the future spot price of wheat in six months will be **\$4.60**.

Millers will want to “lock in” the price that is paid for their wheat by going long in the wheat futures market at **\$4.60**, given that is still an acceptable value.

However, speculators will not agree to going short unless the price is above **\$4.60**. [Why not?]

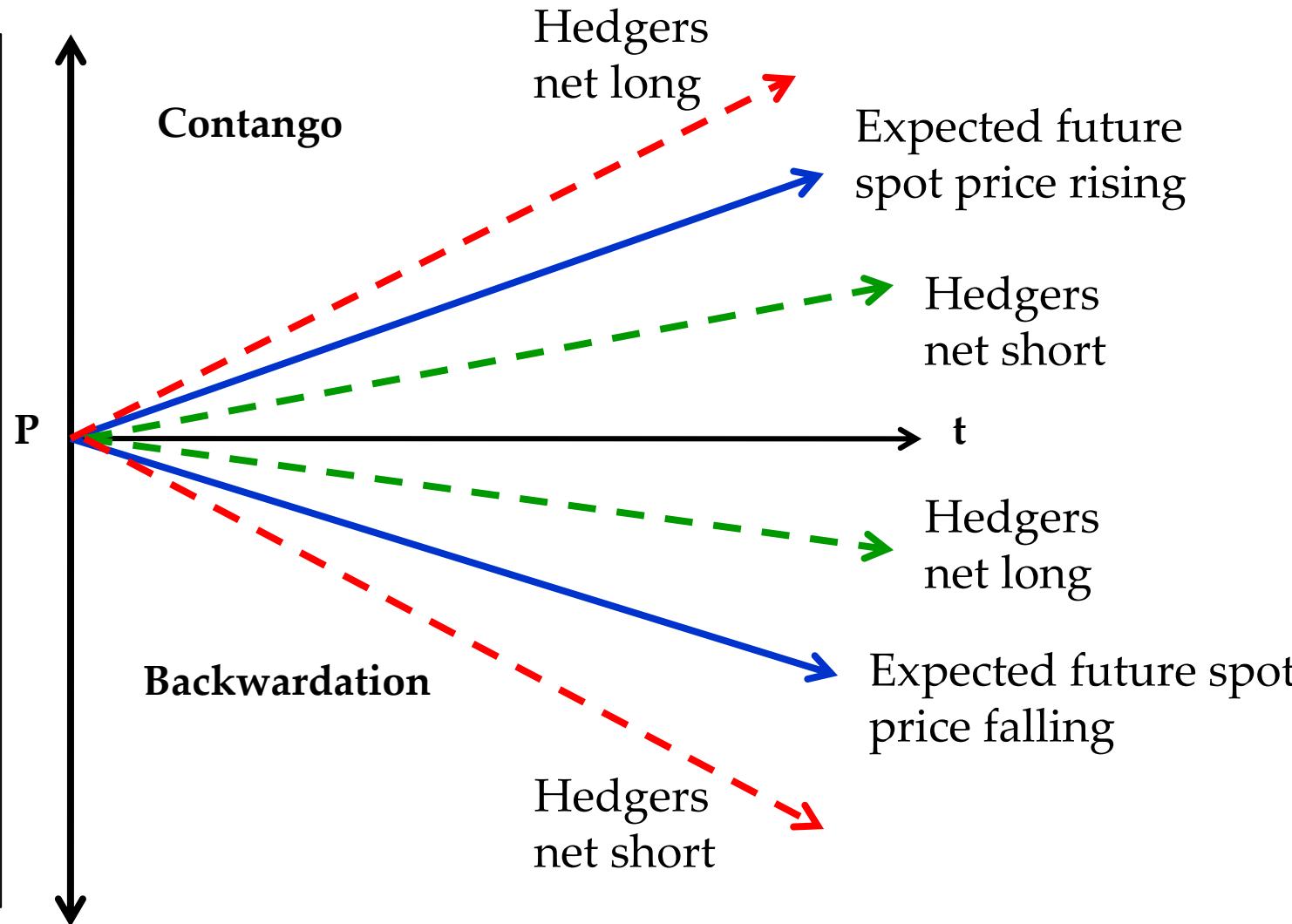
Therefore, if the millers want to hedge, they must agree to go long at a price above **\$4.60**, or the market won’t clear, even though they estimate the future spot price to be **\$4.60**. Therefore the market might clear at **\$4.80**.

Also use the example of where we both (seller short [us] and buyer long [hedger]) both agree that the spot price of oil in one year will be **\$32**, even though it is only **\$21** now.

Think about this. As sellers, what price would be acceptable for us to make this trade?

# Contango/Backwardation possible scenarios

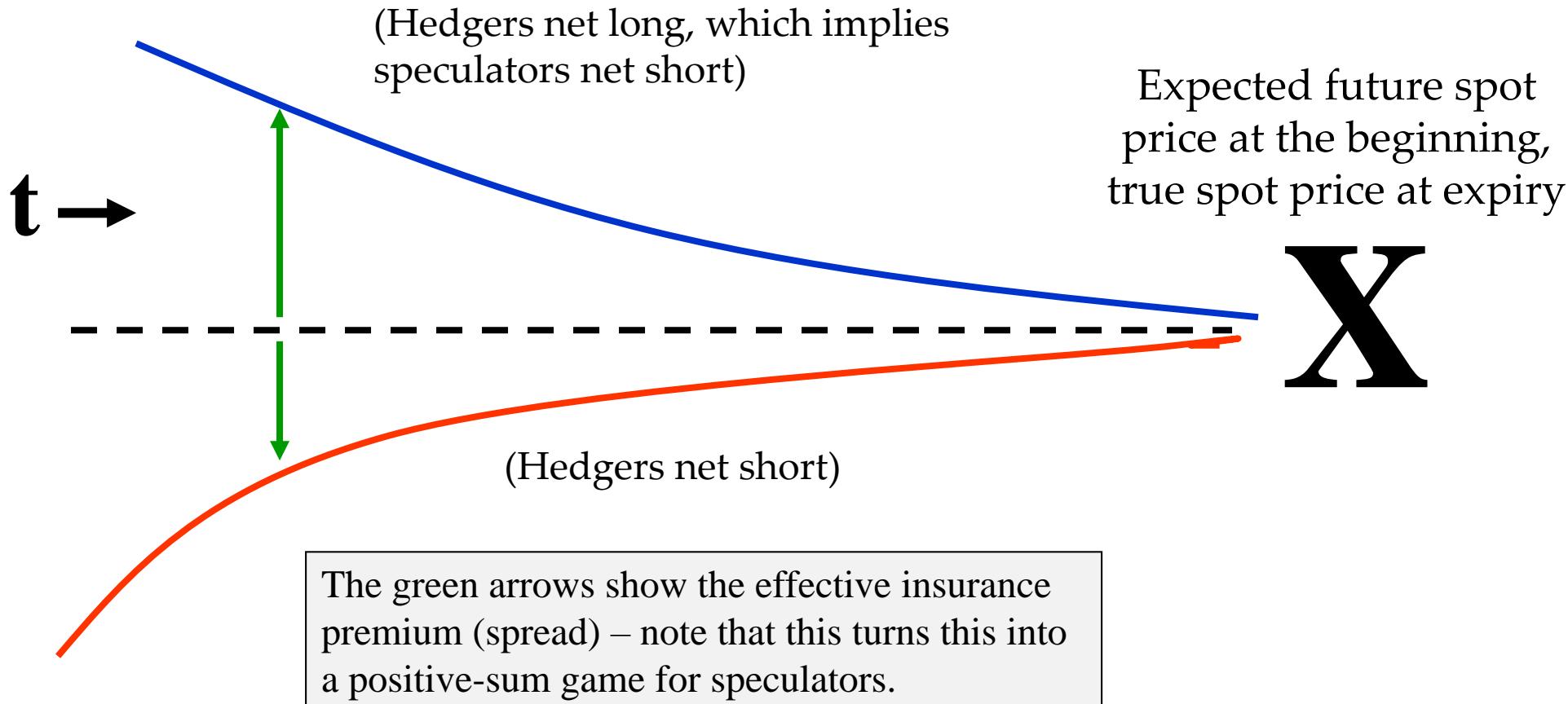
Red and Green lines show the actual futures prices relative to expected future spot prices (blue) depending upon whether hedgers are net long or net short in the futures contract in question.



**Note:** This scenario is not possible for index or FX futures, and for storable, only of all lines are FPUL and FPLL or there are constraints on storage, making pure arbitrage impossible.

# Convergence of futures prices to spot prices expected by hedgers and speculators

This does not require that the contract is in pure contango or pure backwardation.



# Real numbers for a real problem ...

end of trading day, March 31, 2020

	LAST	BID	ASK	BID SIZE
<b>Nat Gas</b>				
NG INDEX				
NG Apr'20 @NYMEX	c1.634			
NG May'20 @NYMEX	1.652	1.652	1.653	36
QG May'20 @NYMEX	1.650	1.650	1.655	56
<b>Index Futures</b>				
SPX INDEX	2592.06			
MES Sep18'20 @GLOBEX	2577.50	2576.25	2578.50	1
MES Dec18'20 @GLOBEX	2556.25	2556.75	2586.75	9
ES Jun19'20 @GLOBEX	2580.75	2580.75	2581.00	2
ES Sep18'20 @GLOBEX	2576.50	2577.00	2578.50	2
SPX Jun18'20 @GLOBEX	2588.60	2593.90	2595.30	1
<b>Gold</b>				
GC INDEX	c0.00			
GC Apr28'20 @NYMEX	1580.50	1579.80	1581.20	2
GC Jun26'20 @NYMEX	1593.70	1593.60	1593.80	3
MGC Apr28'20 @NYMEX	1588.60	1579.50	1581.60	10
MGC Jun26'20 @NYMEX	1593.80	1593.60	1593.90	3
GC May27'20 @NYMEX	1587.00	1586.40	1587.10	1
<b>Micro e-Mini</b>				
MES Jun19'20 @GLOBEX	2581.00	2580.75	2581.00	9
MYM Jun19'20 @ECBOT	21896	21895	21897	1
M2K Jun19'20 @GLOBEX	1133.80	1133.80	1134.00	1
<b>FX</b>				
GBP Jun15'20 @GLOBEX	1.2432	1.2431	1.2433	5
EUR Jun15'20 @GLOBEX	1.10440	1.10435	1.10445	7
M6B Jun15'20 @GLOBEX	1.2430	1.2430	1.2435	5
M6E Jun15'20 @GLOBEX	1.10450	1.10440	1.10450	4
MJY Jun15'20 @GLOBEX	0.009316	0.009318	0.009320	1
<b>Oil</b>				
CL May'20 @NYMEX	20.43	20.43	20.44	7
CL Jun'20 @NYMEX	24.36	24.35	24.37	10
QM May'20 @NYMEX	20.450	20.425	20.450	7
QM Jun'20 @NYMEX	24.325	24.350	24.375	1



FIN INSTRUMENT	POS	CST	BSS	MKT VL	BID	ASK	LAST	CHANGE	DLY P...	UNRLZD P...
GLD	100	12,304	14,945		149.42	149.51	149.45	+1.40	140	2,641
QM May'20 @NYMEX	1	14,515	10,650		21.275	21.300	21.300	+0.825	410	-3,865

# A current example of where we are close to the dividing line between contango and pure contango, by any reasonable standard.

March 31, 2020

FINANCIAL INSTRUMENT	LAST	BID	ASK
<b>Oil</b>			
CL May'20 @NYMEX	20.38	20.38	20.39
CL Jun'20 @NYMEX	24.32	24.31	24.33
CL Jul'20 @NYMEX	27.43	27.41	27.44
CL Aug'20 @NYMEX	29.50	29.48	29.51
CL Sep'20 @NYMEX	30.85	30.80	30.83

How should we play this?

Should we go long in May and short June?

Should we go long in May and short September?

Should I short June or September?

What kind

CL futures pri	FIN INSTRUMENT	POS	CST	BSS	MKT VL	BID	ASK	LAST	CHANGE	DLY P...	UNRLZD P...
						100	12,304	14,945	149.42	149.51	149.45
CL futures pri	QM May'20 @NYMEX	1	14.515	10,650	21.275	21.300	21.300	21.300	+0.825	410	-3,865
March 31, 2020											
CL Month	Futures Price	Spread	Carry at 10% annual								
May 20	20.38										
Jun 20	24.31	3.93	20.55								
Jul 20	27.41	3.10	20.72								
Aug 20	29.48	2.07	20.90								
Sep 20	30.80	1.32	21.07								

carry cost, so what does that imply?

Is it possible that these futures are close the expected spot? Why would that matter?

All carry values are based upon only the 20.38.

# What model might we have used to allow us to consider this?

Perhaps a mean reversion model, possibly a Bollinger Band model, any technical model, but also a **statistical arbitrage model**, so let's talk about that briefly ...

1. Convert all data to the log spread, for example  $\ln(\text{June}/\text{May})^*(1/\text{days\_to\_expiry})$
2. Figure out a way to smooth for the rolls as contracts expire, because it will cause problems (it does for all of the futures ETPs like USO).
3. Either regress/test or use our simpler methods to calculate mean spreads and standard deviations of the same.
4. Run a sigma algo with a daemon (15 seconds) to check against current sigma estimates.
5. (Make sure another algo is keeping current sigma up to date).
6. When we spot a 2-Sigma or greater anomoly we consider a spread trade, which in this example, would be long May and short June.
7. BUT we always have to ask, has there been a change of state???
  - A **Black Swan** is a change of state.



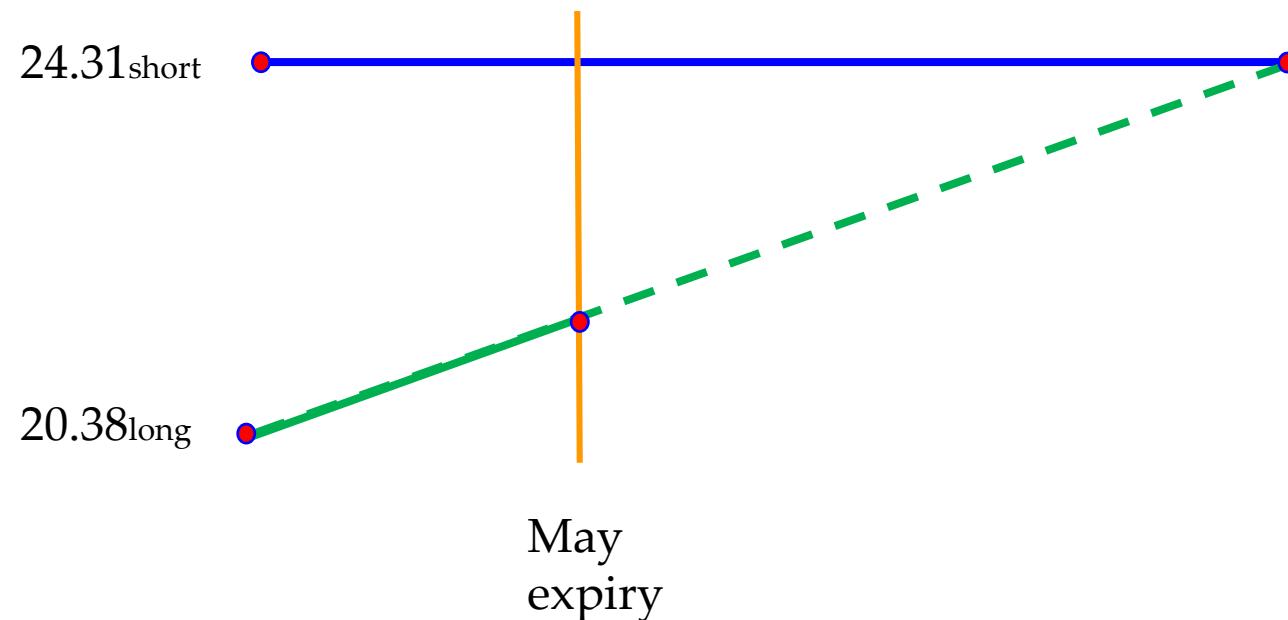
# Do we still do this??

March 31, 2020

FINANCIAL INSTRUMENT	LAST	BID	ASK
<b>Oil</b>			
CL May'20 @NYMEX	20.38	20.38	20.39
CL Jun'20 @NYMEX	24.32	24.31	24.33
CL Jul'20 @NYMEX	27.43	27.41	27.44
CL Aug'20 @NYMEX	29.50	29.48	29.51
CL Sep'20 @NYMEX	30.85	30.80	30.83

CL futures prices, spreads and 10% carry			
March 31, 2020			
CL Month	Futures Price	Spread	Carry at 10% annual
May 20	20.38		
Jun 20	24.31	3.93	20.55
Jul 20	27.41	3.10	20.72
Aug 20	29.48	2.07	20.90
Sep 20	30.80	1.32	21.07

What if it is a good proxy for [expected] future spot [which implies neutral hedging]?



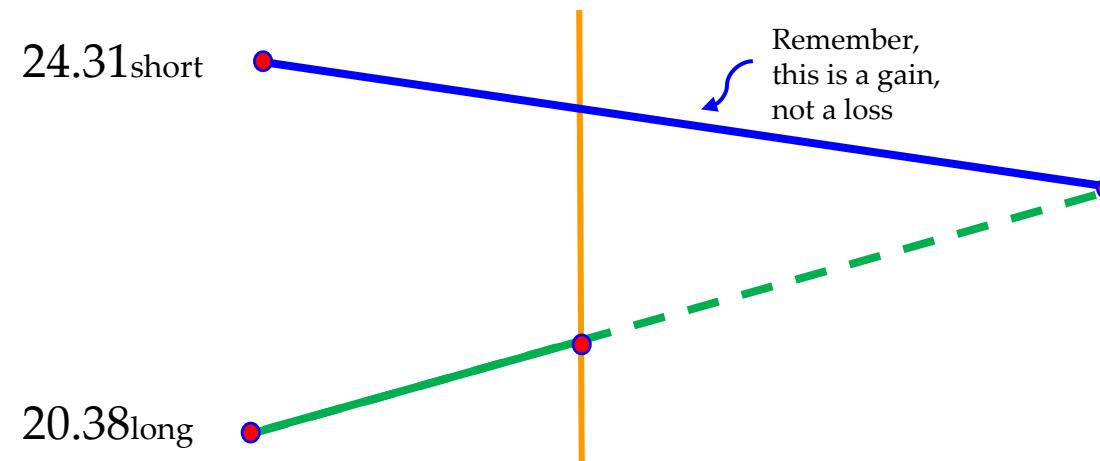
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March 31, 2020

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Aug 20	29.48	2.07	20.90
Sep 20	30.80	1.32	21.07

What if they converge to a central point (spread narrows)?



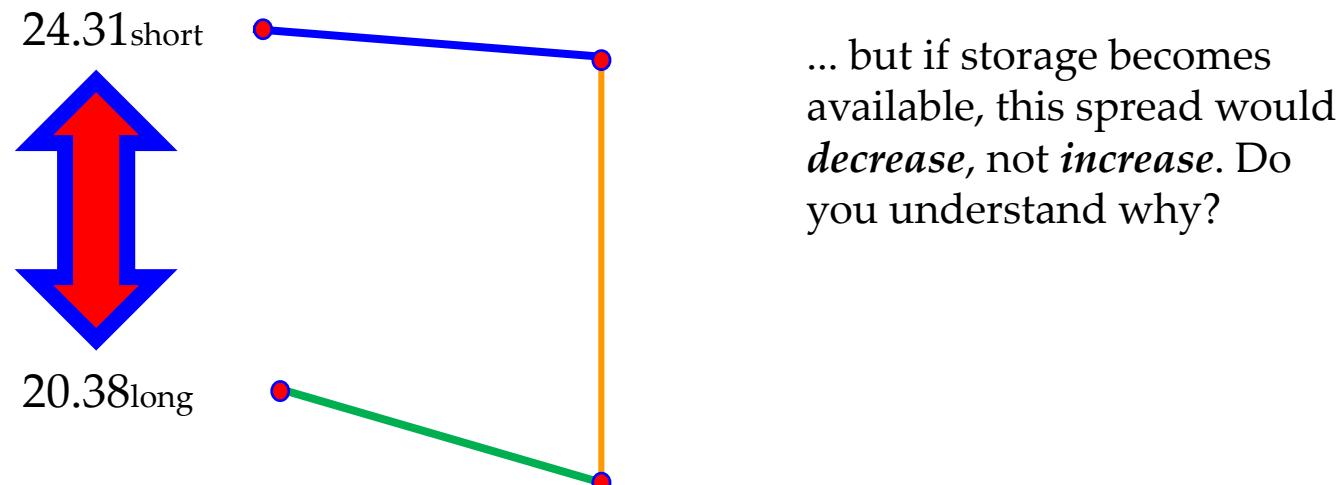
# Do we still do this??

March 31, 2020

FINANCIAL INSTRUMENT	LAST	BID	ASK
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CL futures prices, spreads and 10% carry			
CL Month	Futures Price	Spread	Carry at 10% annual
May 20	20.38		
Jun 20	24.31	3.93	20.55
Jul 20	27.41	3.10	20.72
Aug 20	29.48	2.07	20.90
Sep 20	30.80	1.32	21.07

What if the spread increases before the May expiry (3<sup>rd</sup> week in April)?



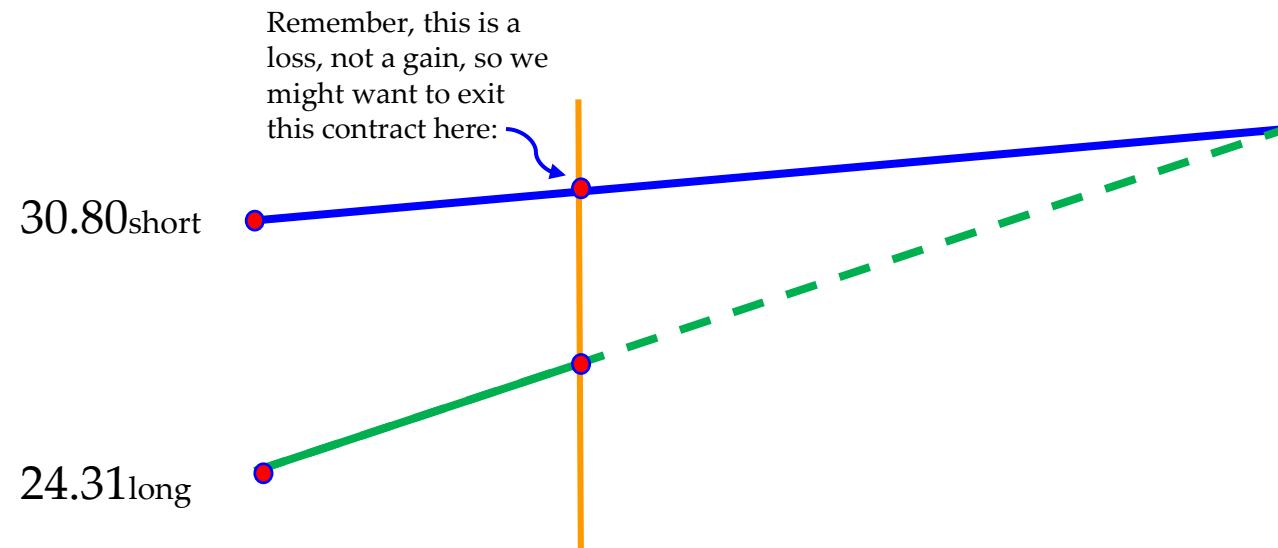
# Do we still do this??

March 31, 2020

FINANCIAL INSTRUMENT	LAST	BID	ASK
<b>Oil</b>			
CL May'20 @NYMEX	20.38	20.38	20.39
CL Jun'20 @NYMEX	24.32	24.31	24.33
CL Jul'20 @NYMEX	27.43	27.41	27.44
CL Aug'20 @NYMEX	29.50	29.48	29.51
CL Sep'20 @NYMEX	30.85	30.80	30.83

CL futures prices, spreads and 10% carry			
CL Month	Futures Price	Spread	Carry at 10% annual
May 20	20.38		
Jun 20	24.31	3.93	20.55
Jul 20	27.41	3.10	20.72
Aug 20	29.48	2.07	20.90
Sep 20	30.80	1.32	21.07

What if we are in the Jun<sub>long</sub> and Sep<sub>short</sub> and bin Salmon and Alexander Novack reach a deal before 3<sup>rd</sup> week in May ? [Or what if it appears they won't?]



# Taking a final look at the index futures ..

April 1, 2020 3:47 PM NYT

Index Futures			
SPX INDEX	▪ 2460.26		
MES Jun19'20 @GLOBEX	▪ 2447.00	▪ 2447.00	2447.25 ▪
MES Sep18'20 @GLOBEX	▪ 2435.00	▪ 2442.75	2446.00 ▪
MES Dec18'20 @GLOBEX	▪ 2460.00	▪ 2427.50	2460.00 ▪
ES Jun19'20 @GLOBEX	▪ 2447.25	▪ 2447.00	2447.25 ▪
ES Sep18'20 @GLOBEX	▪ 2446.00	▪ 2443.50	2445.00 ▪

... and this was on a day that the DOW plunged 973 points!  
Yet this is pretty flat. A little backwardation in Dec Micro E-mini contract.

2 questions:

1. Why is this so flat?
2. Are these futures good estimators for future spot SPX?

**Note:** I tried to get this trade in today at 4:15 NYT butg could not use my trading algos (not set up for futures trades)



# Key take-aways that you *must* understand ...

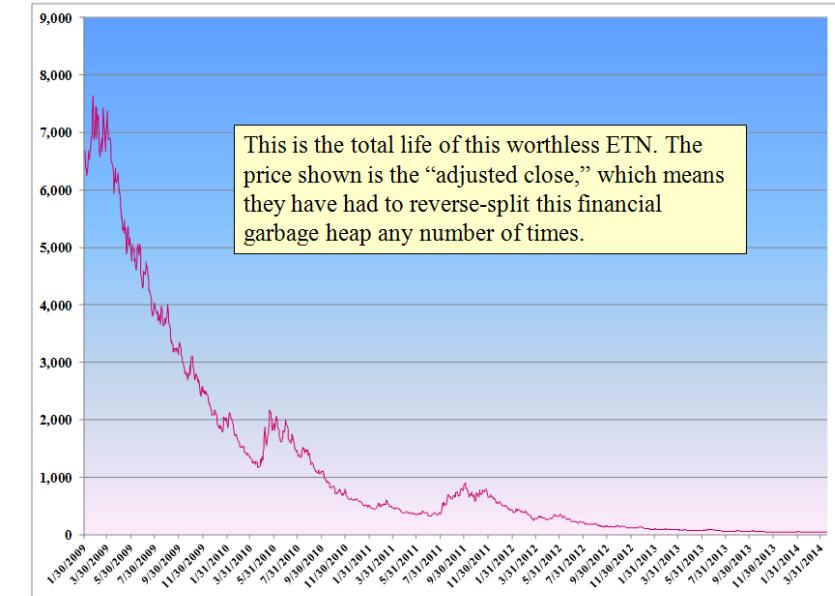
1. There is an important difference between what the industry generally calls a contango and what we are calling a pure contango. Know that difference.
2. Understand why futures prices are not good proxies for expected future spot price.
  - Because of arbitrage, low-carry contracts like the indexes and FX are always more or less flat
  - Even for storable commodities, that net hedgers must find speculators to take their bets insures the same ...
3. Whether futures prices are above or below expected future spot prices depends upon which side is net hedging whether in contango or backwardation.
4. Futures must converge to spot, and that convergence will be automatic.
5. A standard Gaussian statistical arbitrage model can be used to trade spreads that emerge from contango or backwardation, but these are dangerous if there is a change of state.
6. Spread trading logic involves mostly considering multiple scenarios.

# A contango (on the left) always generates ETP decay (on the right)!!

## 5. VIX futures contracts (strange behavior) Mudd Finance



## The VXX ETN (total crap) Mudd Finance



If you don't remember, go back and read appendix A2 of the Chapter 10 futures contracts for Econ 104: <http://palmislandtraders.com/econ104/ch10futures.pdf>



2020 Bently Bentayga Speed

# Futures Hedging

## Risk reduction with futures

# Revisiting the QM e-Mini Crude Contract ...

Mudd (Palm Island Traders) finance



Stock Description	
<b>NYMEX MINY Light Sweet Crude Oil</b>	
Security Type	FUT
Underlying	QM IND
Contract Month	MAY20
Expiration Date	APR 20 '20
Last Trading Date	APR 20 '20 14:30 EST
Currency	USD
Multiplier	500
Exchange	NYMEX
Trading Class	QM
Symbol	QMK0
Product Type	Energy
Settlement Method	Cash
Trading Hours: April 7, 2020 <a href="#">Calendar</a>	
Regular Trading Session	09:30 EST - 17:00 EST (06:30 PST - 14:00 PST)
Total Available Hours	18:00 EST - 17:00 EST (15:00 PST - 14:00 PST)
Note: times in <i>italics</i> are on the calendar date preceding trade date	
Current Margin Requirements	
Intraday Initial	4428.13
Intraday Maintenance	3542.50
Overnight Initial	4428.13
Overnight Maintenance	3542.50

	LAST ...	HIGH	LOW	CHANGE
SPX INDEX	♦ 2657.81	2756.89	2659.19	-5.87 -0.22%
RUT INDEX	♦ 1138.42	1190.98	1133.55	-0.36 -0.03%
VIX INDEX	■ 46.66	47.51	43.51	+1.42 3.14%
INDU INDEX	■ 22653.90	23617.20	22634.40	-26.10 -0.12%
COMP INDEX	♦ 7919.79			+6.55 0.08%

Notional value CL:  
500 X \$25.00 = \$12,500  
\$12,500/4,428 = 35%  
Multiplier = 2.82 to 1

Penny move or penny change in spread: \$5.00

\$ move or \$ change in spread: \$500

# Spreads on April 7, 2020

12:44 AM PDT

**Oil**

CL May'20 @NYMEX	24.32	24.31	24.32
CL Jun'20 @NYMEX	29.14	29.14	29.16
CL Jul'20 @NYMEX	31.96	31.94	31.96
CL Aug'20 @NYMEX	33.05	33.00	33.03
CL Sep'20 @NYMEX	33.59	33.60	33.62

Notional value CL:

$$500 \times \$25.00 = \$12,500$$

$$\$12,500 / 4,428 = 35\%$$

Multiplier = 2.82 to 1

**CL futures prices, spreads and 10% carry**

April 7, 2020

CL Month	Futures Price	Spread	Carry at 10% annual
May 20	24.32		
Jun 20	29.14	4.82	24.52
Jul 20	31.96	2.82	24.73
Aug 20	33.05	1.09	24.94
Sep 20	33.59	0.54	25.14

**CL futures prices, spreads and 10% carry**

March 31, 2020

CL Month	Futures Price	Spread	Carry at 10% annual
May 20	20.38		
Jun 20	24.31	3.93	20.55
Jul 20	27.41	3.10	20.72
Aug 20	29.48	2.07	20.90
Sep 20	30.80	1.32	21.07

+/-	Time ▾	Fin Instrument	Action	Price	Exch.	Quantity	Commission
	05:06:46	QM Jun'20 @NYMEX	SLD	30.725	NYMEX	1	2.07
	05:05:59	QM May'20 @NYMEX	BOT	26.400	NYMEX	1	2.07

Spread = 30.725 – 26.400 = 4.325, max profit about \$2,000, realistically, \$1,250

# CMEGroup S&P 500 E-mini and Micro E-mini contract

## Contract Specs:

1. 50 X S&P 500
2. Symbol: **ES**
3. Current notional value: \$133,000 (@2660)
4. Maint margin (CBOE): \$12,000
5. ON initial margin (IB): \$23,275
6. Mar, Jun, Sep, Dec
7. Point: \$50

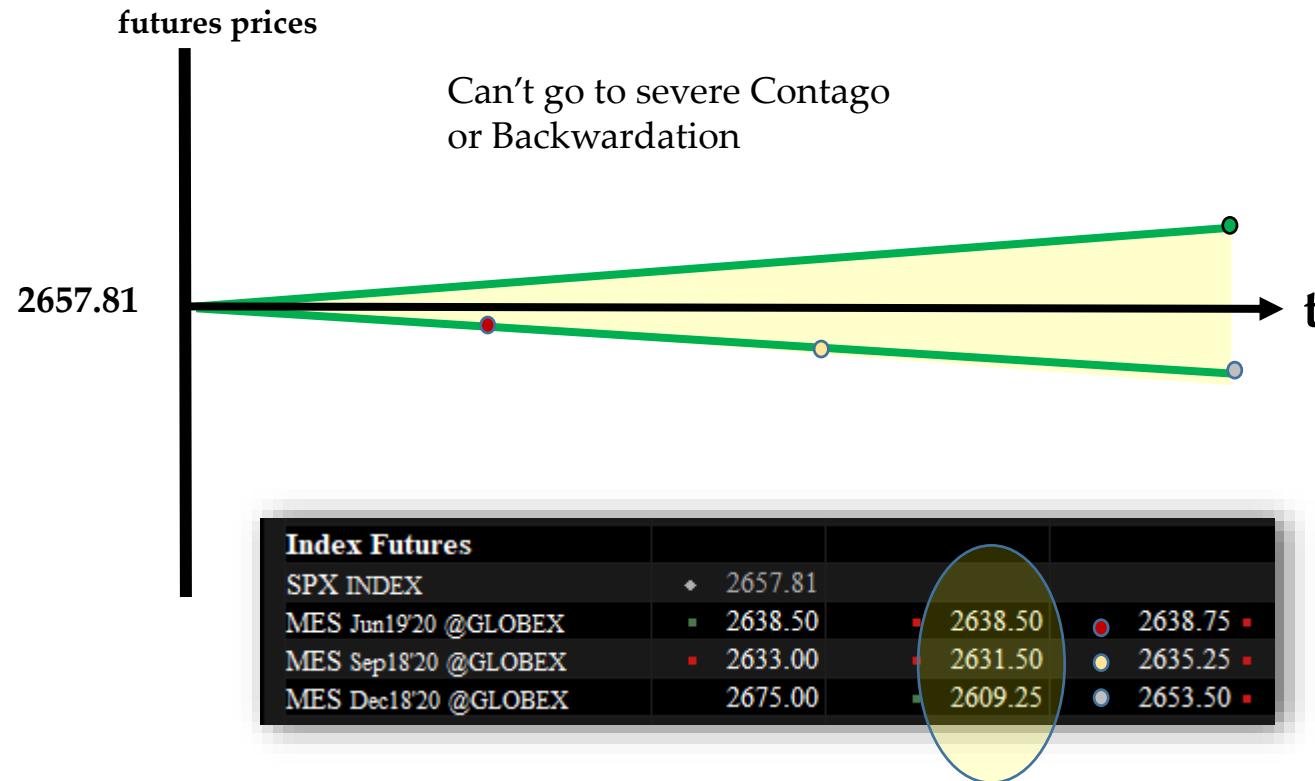
## Contract Specs:

1. 5 X S&P 500
2. Symbol: **MES**
3. Current notional value: \$13,300 (@2660)
4. Maint margin (CBOE): \$1,200
5. ON initial margin (IB): \$2,327
6. Mar, Jun, Sep, Dec
7. Point: \$5



Specs on this provide the correlation coefficient and the denominator for our *Beta* formula, and options on the large (**SPX**) contract provide the basis for calculating the VIX.

# Index funds are great leveraged directional bets and good hedges (but so much at these margins)



# Cross-hedging: The minimum-variance hedge ratio (the *Beta*)

One of the most common uses of cross-hedging and related trades is to hedge a stock portfolio that you have constructed with a commonly-traded index futures contract, like the e-Mini S&P500 futures contract. Another application might be to hedge a fuel not represented in a futures contract with one that is, like jet fuel (JA-1) with crude oil or gasoline. In such an application, a minimum variance hedge ratio can be calculated (sometimes using spot and futures as below, or using both spot):

$\sigma_s$  = standard deviation of delta/ln spot

$\sigma_f$  = standard deviation of delta/ln future

$\rho$  = correlation coefficient of the two

$h$  = hedge ratio

$$h = \rho \frac{\sigma_s}{\sigma_f}$$

See section 3.3 and Table 3.3 of Hull.

## Hedging a stock portfolio with the S&P500 futures index

Suppose (for whatever reason) you wanted to completely hedge a stock portfolio. To do this, you would first have to calculate the *Beta* of the portfolio relative to the S&P 500 index (in the example below, think of a *Beta* like 1.5). Then, you would **short** an S&P500 futures contract using the formula below:

$$N = \beta \frac{S}{F}$$

where

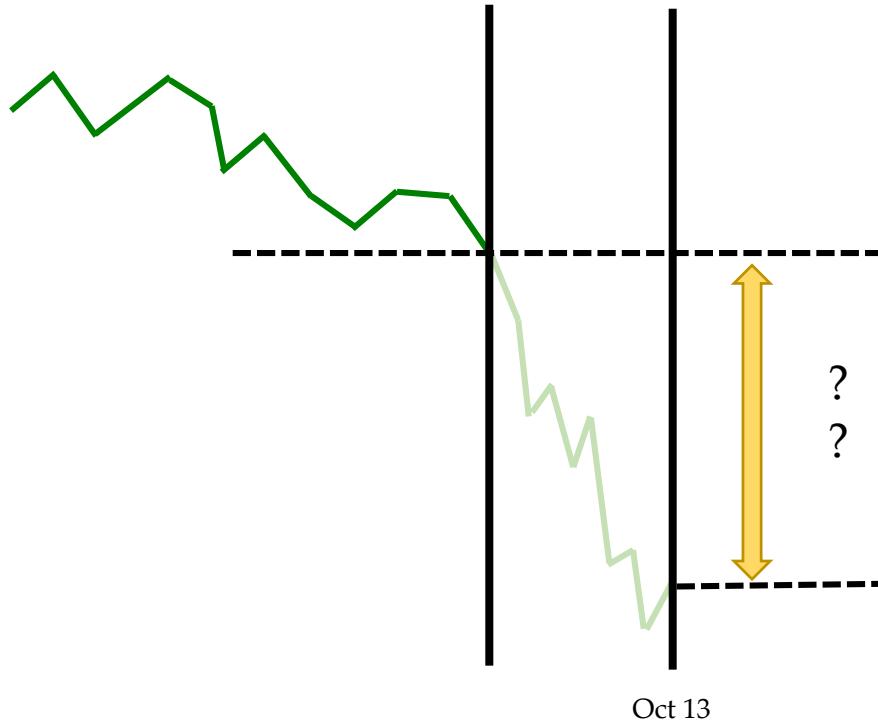
N = number of S&P500 contracts

$\beta$  = the *Beta*

S = the value of the portfolio

F = the size of an S&P500 futures contract

# The discontinuities in the overnight markets and program trading ...

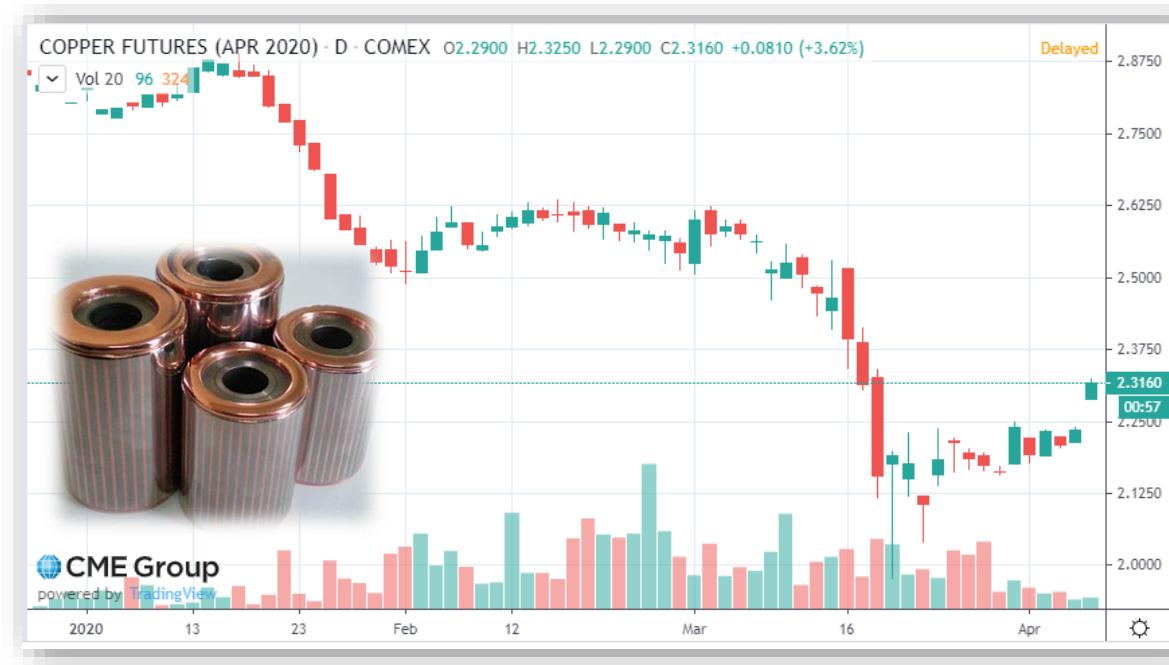


Program trading is supposed to bring these back into alignment (and note, there is a morning auction process at all exchanges that sets the morning open)

# Reasons to hedge – the example of copper

## Contract Specs:

1. 25,000 pounds
2. \$ and cents per lb.
3. Monthly til 4/2022
4. Current notional value: \$57,900.
5. Maint margin: \$3,750
6. (also a 12,500 pound e-Mini)



Suppose you manufacture copper rotor induction motors, currently popular because they use no rare earth elements, and you use 23,000 tons of copper per year. You are in a competitive industry and a large price increase could bankrupt you if not hedged. You would have to be long about 150 contracts per month in the futures chain.

# Is hedging always possible?

Of course not. If you need to hedge long and prices are at the top of their range, making it obvious that you *should have hedged a year ago*, it's too late. What good is it to hedge long on crude oil if the current spot and futures are above \$120?

Also, if the contract is in *contango* we probably can't hedge.

Rule of thumb: Probably the best time to hedge is when the current market makes it seem like you don't need to do it (i.e. when spot prices are very favorable).

From the perspective of most CFOs, the hedge buys certainty:

"You're basically buying a level of certainty," said John Heimlich, vice president and chief economist for the Air Transport Assn. "The market price may be higher, it may be lower, but I know what I'm going to pay, and I can set my business plan accordingly."

*Airlines Again Consider Locking In Jet Fuel Prices, Los Angeles Times September 5, 2006*

# The downside of hedging

We know that if, for example, you take a long hedge to avoid the cost of rising prices, if the price of the commodity declines after the hedge, then you will have to deal with the cash requirements of settlement, which can be considerable with a large hedge like jet fuel. This presents a potential *interim* cashflow problem even though the hedge is locking you into a known price.

Likewise not all executives understand the hedge all that well under these circumstances. As Hull points out, "It is easy to see why treasurers are reluctant to hedge. Hedging reduces risk for the company. However, it may increase risk for the treasurer if others do not fully understand what is being done." (page 52)

# Cross-Hedging: Calculating the optimal number of contracts

Problem: How many contracts should you purchase when you are trying to hedge a position?

For example: Suppose you want to hedge (because you are buying) 1 million gallons (24 thousand barrels) of JA-1 in June. What sized long June contract should you buy?

Answer: Use this formula

$$N = h \frac{S}{Q_f}$$

where

N = optimal number of contracts

h = MV hedge ratio

S = size of position

Q<sub>f</sub> = size of one contract

# Estimation of MVHR by researchers

EXHIBIT 1 Hedge Ratio Calculation				
<i>1 year of historical data</i>	Regression Coefficient (H)	Correlation of Returns with Jet Fuel	Volatility of Returns	Calculated H
Jet Fuel	n/a	n/a	54.85%	n/a
Crude Oil	1.06	77.00%	39.75%	1.06
Heating Oil	1.15	90.35%	43.22%	1.15
<i>2 years of historical data</i>				
Jet Fuel	n/a	n/a	44.91%	n/a
Crude Oil	0.98	80.41%	36.78%	0.98
Heating Oil	1.07	91.18%	38.33%	1.07

Source: Historical commodity prices from Datastream and U.S. Energy Information Administration

Note: This article points out that some airlines prefer to use options on futures rather than futures.  
 From

*Jet Fuel Hedging Strategies: Options Available for Airlines and a Survey of Industry Practices* by Richard Cobbs and Alex Wolf, Finance 467 . Spring 2004, Kellogg (Northwestern University)

# The connection between the MVHR, the *Beta*, and Correlation: The difficult side of cross hedging

The formulas for the MVHR and the *Beta* are the same, and frequent references to market “correlations” also refer to the same, so the application depends upon context.

Actually using the data introduces problems too. Do you use daily data, which reduces correlation, or weekly? Do you use CGRs (our approach) or deltas (Hull approach)?

And sometimes it just doesn't come out the way you would think! Look at the *Betas* for JA-1 versus RBOB Gasoline and WTI, 2 years weekly data (found when setting up a HW for you):

Correl:	0.622584
SDJA-1	0.016241
SDGas	0.024107
Beta	0.419438

Daily n=252

Jet Fuel	SD:	0.0273
RBOB Gas	SD:	0.0393
	Correl:	0.6530
	Beta:	0.4524

Weekly n=104

Jet Fuel	SD:	0.0273
WTI Crude	SD:	0.0357
	Correl:	0.8116
	Beta:	0.6204

Weekly n=104

Spot prices, jet fuel and gasoline, strangely low beta, high SD for gasoline!

Highest beta is with a crude product rather than a distillate!

# Key take-aways that you *must* understand ...

1. Again, index futures can't go into contango...
  - ... which makes them ideal for hedges
2. If hedging any non-SPX portfolio with SPX, then you should calculate the MVHR
  - ... which is the *Beta*, and you should know the formula for that.
3. Cross-hedging is used when you have to hedge one commodity or instrument with another that is merely correlated ...
  - ... and the coefficient of adjustment is, once again, the *Beta* (minimum variance hedge ratio)
4. ... and you should by now understand the basis of spread strategy.

# That's it ...

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