Quantitative Trading with Futures

L.A. QUANT CLUB

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Agenda

- What is quantitative trading
- What does the industry look like today
- What are Futures
- Introduction to our Futures Data and the Toolbox
- Develop your own trading algorithm

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```
import numpy as np

def mySettings():
    settings={}
    settings['markets']     = ['CASH', 'F_AD', 'F_BO', 'F_BP', 'F_C', 'F_CC', 'F_CD', 'F_CL',
'F_CT', 'F_DX', 'F_EC', 'F_ED', 'F_ES', 'F_FC', 'F_FV', 'F_GC', 'F_HG', 'F_HO', 'F_JY',
'F_KC', 'F_LB', 'F_LC', 'F_LN', 'F_MD', 'F_MP', 'F_NG', 'F_NQ', 'F_NR', 'F_O', 'F_OJ', 'F_PA',
'F_PL', 'F_RB', 'F_RU', 'F_S', 'F_SB', 'F_SF', 'F_SI', 'F_SM', 'F_TU', 'F_TY', 'F_US', 'F_W',
'F_XX', 'F_YM']
    settings['slippage']    = 0.05
    settings['budget']      = 1000000
    settings['lookback']    = 504
    return settings

def myTradingSystem(DATE, OPEN, HIGH, LOW, CLOSE, settings):
    rsi1 = RSI(CLOSE,100)
    rsi2 = RSI(CLOSE,500)
    p = ((rsi1 - 50) + (rsi2 - 50)) / 2
    p[p < 0] = p[p <0] / 2
    p[np.isinf(p)]=0
    return p, settings

def RSI(CLOSE,period):
    closeMom = CLOSE[1:,:] - CLOSE[:-1,:]
    up   = closeMom >= 0
    down = closeMom < 0
    out = 100 - 100 / (1 + (np.mean(up[-(period+1):,:],axis=0) / np.mean(down[-
(period+1):,:],axis=0)))
    return out
```

21 Lines of Code

manage

$25 Million


2015
1992
successfully
(5921% over 23 years)

Quantitative Trading

Quantitative Trading is the methodical way of trading.

A quantitative trading system is a small program that seeks to find and exploit recurring patterns in equity prices. It computes positions based on those patterns and triggers trades accordingly.

Example: "*if AAPL gained 5% percent in the last 10 days buy AAPL*“

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Advantages

Trading algorithms

- are developed by application of the scientific method
- benefit from statistical inefficiencies in the markets
- react to market events faster than humanly possible
- are driven by math rather than emotions

Quantitative trading eliminates the human error from trading.

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Quantitative Finance Industry

Trading Algorithms
developed by scientists

+

High-net-worth individuals
and Institutional Investors

$300 Billion Industry

Quantitative Hedge Funds

What We Do

We connect user generated quantitative trading systems with capital from institutional investors. Our users pocket 10% of the profits without investing their own money.

How It Works For Quants

Use Quantiacs' framework and free financial data (Python, Matlab, Octave)

Develop and test your Trading Algorithm

Submit your Trading Algorithm to market it to investors

Pocket 10% of the profits your system makes without investing your own money

How It Works For Investors

Choose from a huge variety of uncorrelated trading systems

Pick the system that complements your portfolio best

Invest

Pay only the industry typical performance fee of 20% BUT NO management fees

What are Futures

Definition: A futures contract is an agreement between two parties, one to buy and the other to sell a fixed quantity and grade of a commodity, security, currency, index or other specified item at an agreed-upon price on or before a given date in the future.

- Exchange traded derivatives
- Created by an agreement between a buyer and a seller
- The buyer (long) receives delivery
- The seller (short) makes delivery
- Futures contracts can be extinguished by an offsetting transaction any time prior to the maturity
- Futures contracts can be settled by physical delivery or cash
- Standardized (quality, settlement, amounts)

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Standardization

- Definition of the underlying (a.k.a. spot) instrument
- Contract size
- Settlement mechanics (delivery location if physically delivered, cash settled)
- Delivery or maturity dates
- Specific grade or quality of the contract

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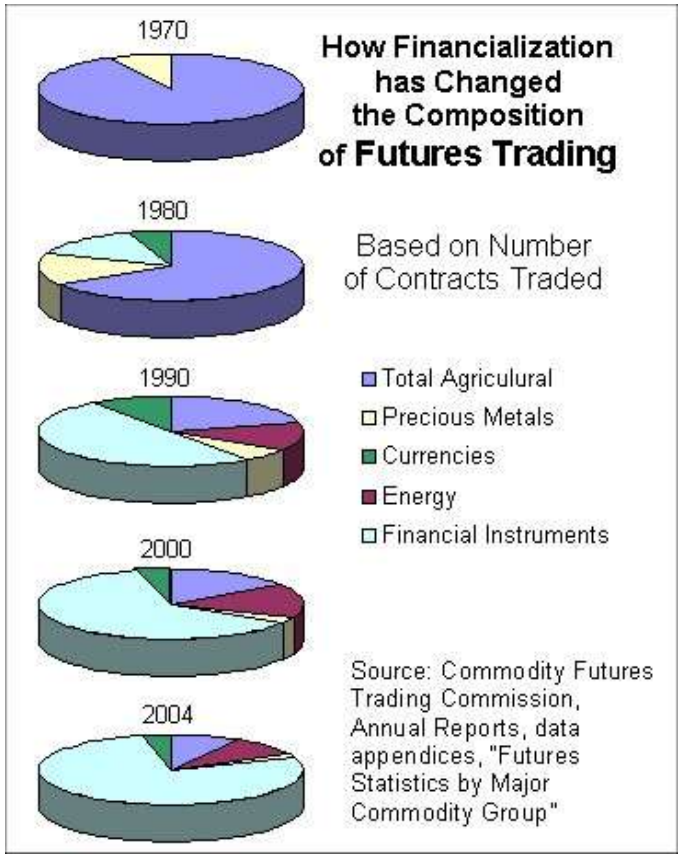
Requisites of a futures market

- Producers and users need to manage a real economic risk
- Must be based on an active underlying or cash market (a real good)
- Existence of an efficient delivery structure
- Government policy: Futures are of no use if prices are regulated (WW2)

Origin

1864: The Chicago Board of Trade (**CBOT**) listed the first-ever standardized exchange traded forward contracts in 1864, which were called futures contracts.

This contract was based on grain trading, and started a trend that saw contracts created on a number of different commodities as well as a number of futures exchanges set up in countries around the world.



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What makes Futures attractive

- Futures are among the most liquid markets in the world
- They are regulated and standardized
- Very low counterparty default risk, since the Clearinghouse substitutes itself as counterparty
- Very diverse instrument universe (uncorrelated markets)
- They can be used to reduce (hedge) unwanted business risk

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Mechanics of trading Futures

- When a future contract is opened both parties make a guaranty deposit at the exchange/clearinghouse, usually between 5 and 15 percent of the contract value, the so called **initial margin**.
- The full price is payed upon physical delivery of the commodity at the expiration of the future.
- A futures position can be maintained with much less capital than its notional value. This is called **buying on margin** and gives futures traders **leverage**.
- A future is offset if the opposite transaction is made. I.e. buying a short is equivalent to selling a long position.

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Margin and leverage example

Go long 1 Ten Year Note (TY, contract value: 130k) with a margin deposit of $13k. This gives the position a leverage of 1:10.

If the TY price falls by 6,5k (a 5% move against us), we've suffered a loss of 5% based on the notional contract value, but a 50% loss based on the margin deposit.

In this case we'd get a margin call, and are asked to deposit another 6,5k (or a little less) to maintain the TY long position. Failure to provide the maintenance margin leads to a liquidation of the position.

Leverage works both ways, and can be extremely dangerous (bankruptcy risk!) if not managed properly. The risk is not limited to the margin deposit.

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Properties of a Future

Property	Value
Underlying	Corn
Unit	Bushel
Contract size	5,000 bushels
Price quotation	cents per bushel
Settlement	physical delivery
Contract months	March (H), May (K), July (N), September (U) & December (Z)
Last trading day	The business day prior to the 15th calendar day of the contract month
First notice day	The business day prior to the 15th calendar day of the contract month.

Rolling

- **Future contract expire** at some point. They are settled by physical delivery or cash.
- There is no ‘steady‘ future course like for a stock. If you buy a stock you own a percentage of the company until you sell it. Buying a future grants you the right to buy or sell a commodity for a specified price at a certain point in the future.
- If an investment in the market is desired until after the contract’s expiration traders sell their contract prior to its expiry and buy a contract with a later expiration date. This process is called rolling.

Example of a roll

A trader holds

1 TY2015Z (December) contract LONG

but wants to stay invested until February 2016. He rolls in the March 2016 contract by:

Selling 1 TY2015Z LONG

Buying 1 TY2016H LONG

Contango and Backwardation

Futures of the same underlying with different maturities have usually different prices. The reasons for that are storage costs, supply and demand at certain points in the future, and expectations of the market participants about the overall price development.

Contango is a situation where the futures price of a commodity is higher than the expected spot price. In a contango traders are willing to pay more now for a commodity at some point in the future than the actual expected price of the commodity.

Backwardation is the market condition wherein the price of a forward or futures contract is trading below the expected spot price at contract maturity.

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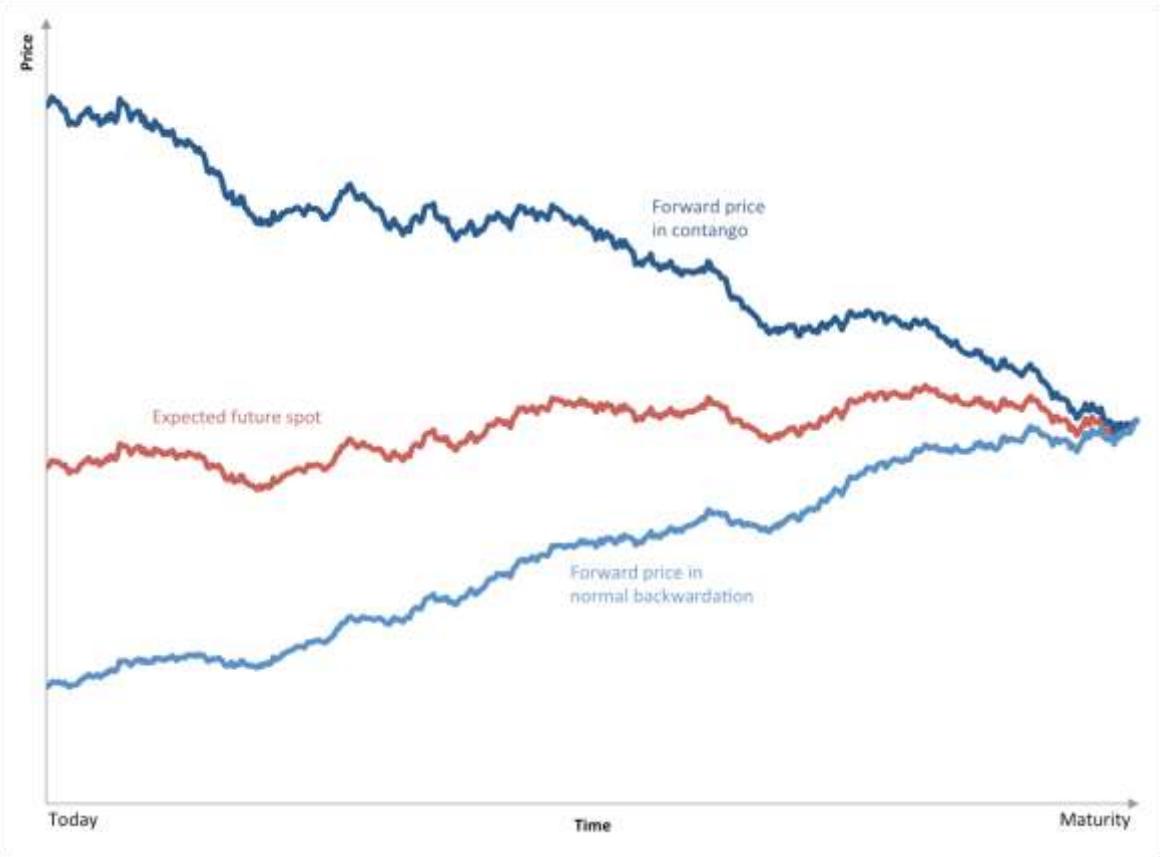
Forward price curves



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Crude Oil Contango

Month	Options	Charts	Last	Change	Prior Settle	Open	High	Low	Volume	Hi / Low Limit	Updated
JAN 2016	OPT		47.44	-1.36	48.80	48.64	49.18	47.06	96,096	58.80 / 38.80	16:00:00 CT 04 Nov 2015
FEB 2016	OPT		48.21	-1.41	49.62	49.47	50.00	47.87	29,935	59.62 / 39.62	16:00:00 CT 04 Nov 2015
MAR 2016	OPT		48.90 b	-1.44	50.34	50.10	50.67	48.58	29,877	60.34 / 40.34	16:00:00 CT 04 Nov 2015
APR 2016	OPT		49.41	-1.53	50.94	50.87	51.29 b	49.17	10,290	60.94 / 40.94	16:00:00 CT 04 Nov 2015
MAY 2016	OPT		49.75	-1.65	51.40	51.29	51.63	49.64	8,239	61.40 / 41.40	16:00:00 CT 04 Nov 2015
JUN 2016	OPT		50.21 b	-1.53	51.74	51.40	52.04	49.94	26,737	61.74 / 41.74	16:00:00 CT 04 Nov 2015
JUL 2016	OPT		50.46 a	-1.54	52.00	51.65	52.22	50.26	3,964	62.00 / 42.00	16:00:00 CT 04 Nov 2015
AUG 2016	OPT		50.70 b	-1.54	52.24	52.00	52.27	50.47	2,932	62.24 / 42.24	16:00:00 CT 04 Nov 2015
SEP 2016	OPT		50.97 a	-1.52	52.49	52.41	52.47	50.83	4,701	62.49 / 42.49	16:00:00 CT 04 Nov 2015
OCT 2016	OPT		-	-	52.75	-	-	-	1,804	62.75 / 42.75	16:00:00 CT 04 Nov 2015
NOV 2016	OPT		51.48	-1.58	53.06	52.85	53.18	51.48	1,328	63.06 / 43.06	16:00:00 CT 04 Nov 2015
DEC 2016	OPT		51.93 b	-1.45	53.38	53.05	53.58	51.69	23,103	63.38 / 43.38	16:00:00 CT 04 Nov 2015
JAN 2017	OPT		52.10 a	-1.48	53.58	53.65	53.65	52.10 a	1,117	63.58 / 43.58	16:00:00 CT 04 Nov 2015

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Liquidity

Liquidity of a future can be measured by Volume or Open Interest

Volume is the number of contracts traded per unit of time

Open interest refers to the total number outstanding of derivative contracts that have not been settled

The contract with the closest expiration is called the **front contract**, all other contracts are called **back contracts**.

Usually the front contract is the most liquid contract until it approaches its first notice day/expiration, and traders start to roll in the first back contract.

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Market participants

Hedgers

A Hedger's principal economic activity consists of producing, distributing, processing, storing or investing in the actual commodity or financial instrument in some form. The Hedger's activity in the futures markets would not happen were it not for the need to minimize the risks of loss inherent in these activities over a period of time.

Speculators

Futures markets provide for the orderly transfer of price risk from the Hedger to the Speculator. The speculator willingly accepts this risk in return for the prospect of dramatic gains. Speculators usually have no practical use for the commodities which they trade.

Futures markets could not function effectively without speculators, because their trading serves to provide liquidity, making possible the execution of large orders with a minimum of price disturbance.

Quantiacs' Futures Data

Ticker	Name	Type	Last
F_BO	Soybean Oil	Agriculture	16890
F_C	Corn	Agriculture	19025
F_CC	Cocoa	Agriculture	32970
F_CT	Cotton	Agriculture	31285
F_FC	Feeder Cattle	Agriculture	95325
F_KC	Coffee	Agriculture	45094
F_LB	Lumber	Agriculture	26895
F_LC	Live Cattle	Agriculture	56090
F_LN	Lean Hogs	Agriculture	23290
F_NR	Rough Rice	Agriculture	24350
F_O	Oats	Agriculture	11250
F_OJ	Orange Juice	Agriculture	20198
F_S	Soybeans	Agriculture	43950
F_SB	Sugar	Agriculture	17349
F_SM	Soybean Meal	Agriculture	30130
F_W	Wheat	Agriculture	25825
F_FV	5-year Treasury Note	Bond	119430
F_TU	2-year Treasury Note	Bond	218484
F_TY	10-year Treasury Note	Bond	127109
F_US	30-year Treasury Bond	Bond	154625
F_AD	Australian Dollar	Currency	71820
F_BP	British Pound	Currency	96456

Ticker	Name	Type	Last
F_CD	Canadian Dollar	Currency	76650
F_DX	US Dollar Index	Currency	97243
F_EC	Euro FX	Currency	137125
F_JY	Japanese Yen	Currency	103288
F_MP	Mexican Peso	Currency	30415
F_SF	Swiss Franc	Currency	126362
F_CL	WTI Crude Oil	Energy	48800
F_HO	Heating Oil	Energy	66679
F_NG	Natural Gas	Energy	24630
F_RB	Gasoline	Energy	60073
F_ES	E-mini S&P 500 Index	Index	105150
F_MD	E-mini S&P 400	Index	146470
F_NQ	E-mini Nasdaq 100 Index	Index	94240
F_RU	Russell 2000	Index	118790
F_XX	Dow Jones STOXX 50	Index	32330
F_YM	E-mini Dow Jones	Index	89205
F_ED	Eurodollars	Interest Rate	248962
F_GC	Gold	Metal	111410
F_HG	Copper	Metal	58262
F_PA	Palladium	Metal	64400
F_PL	Platinum	Metal	48110
F_SI	Silver	Metal	76195

The Toolbox

A framework to develop and test quantitative trading strategies

- In two languages with the same functionality: Matlab/Octave and Python
- It supports the full arsenal of both languages
- Free and open source
- Tweak it, adapt it to your needs and use it in any way you want
- Perform standardized backtests to make results comparable

We have built it for you, please let us know what you‘re missing

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Trading System

A trading system is a Matlab/Octave or Python function with a specific template

function [p, settings] = tradingsystem(DATE, OPEN, HIGH, LOW, CLOSE, VOL, OI, settings)

The arguments can be selected

DATE … vector of dates in the format YYYYMMDD
OPEN, HIGH, LOW, CLOSE … matrices with a column per market and a row per day.
settings … struct with the settings of the simulation

The return values need to be

p … allcoation of the available capital to the markets
settings … struct with the settings of the simulation

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Settings

Use settings to define

- What markets do you want to trade?
- How much data do you need for your trading system?
- Do you want to save some of the data for an out of sample test?
- What is your transaction cost assumption (a.ka. slippage & comission)?

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Settings – Matlab/Octave code

Code

```
settings.markets = {'CASH', 'F_ES', 'F_SI', 'F_YM'};
settings.slippage = 0.05;
settings.budget = 1000000;
settings.samplebegin = 19900101;
settings.sampleend = 20161231;
settings.lookback = 504;
```

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Settings – Python code

Code

```
def mySettings():
    settings[markets] = ['CASH', 'F_ES', 'F_SI', 'F_YM’
    ]
    settings[‘slippage’] = 0.05
    settings[‘budget’] = 1000000
    settings[‘samplebegin’] = ‘19900101’
    settings[‘sampleend’] = ‘20161231’
    settings[‘lookback’] = 504
```

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Backtest mechanics

Your TS is called for each (trading) day of the specified backtesting period with the most recent market data as input, and it computes a percent allocation p for the next trading day as output.

The arguments are data matrices of size [nMarkets x settings.lookback] with the most recent market data availalbe at time t. The oldest market data is in row 1, the most recent in the last row of the data matrix.

You can use the full arsenal of Matlab/Octave and Python to compute the positions for the next period.

p > 0 … a long position

p < 0 … a short position

p = 0 … no position

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Run a backtest and submit

Matlab/Octave

```
runts('somets')
submit('somets','mySystemName')
```

Python

```
import quantiacsToolbox
returnDict = quantiacsToolbox.runts('somets.py')
quantiacsToolbox.submit('somets.py','mySystemName')
```

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Developing a TS

Live development of a Futures trading system in Python…

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How good is a trading system?

There is no universal number that tells you everything about a trading system

There are a lot of things to consider like

- Performance
- Volatility
- Alpha
- Drawdowns
- Correlations

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Sharpe Ratio

The Sharpe Ratio is a popular performance to volatility ratio. The Formula:

$$returns_i = \frac{e_i - e_{i-1}}{e_{i-1}}$$

$$\mathrm{i} = \{2,3,\ldots,\mathrm{t}\}, \qquad t = \text{number of tradingdays}$$

$$e \text{ is the } portfolio \text{ equity curve of the } Tradingsystem$$

$$volaYearly = \sqrt{252} * std(returns);$$

$$index_i = \prod_{i=2}^{t}(1 + returns_i)$$

$$returnDaily = e^{\frac{\ln(index_t)}{t}}$$

$$returnYearly = returnDaily^{252} - 1$$

$$SharpeRatio = \frac{\mathrm{returnYearly}}{\mathrm{volaYearly}}$$

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Good practice and pitfalls

Overfitting is the natural enemy of quantitative trading

- It’s easy to fit the known past with enough parameters. Limit the number of your parameters.
- Stability. How does your model react when you change some of the Parameters by 10%
- Save some of the data for an out of sample test

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Q&A

Put your skills into practice join our Q5 competition!

The best three futures trading systems submitted to our platform before March 31, 2016 get guaranteed investments of

$ 1,000,000

$ 750,000

$ 500,000

and you get to pocket 10% of the profits.

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