

# More Futures

BUSI 722: Data-Driven Finance II

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## Some cash-settled contracts

- [S&P 500](#)
- [Fed Funds](#)
- [Crack Spread](#)



## Slopes of Forward Curves



- Forward curve (or futures curve) = futures price as a function of maturity
- Sometimes upward sloping (prices are higher at later maturities)
- Sometimes downward sloping (prices are lower at later maturities)
- Why?
- [Histories of forward curves](#)



## Gold futures

- Can create "synthetic" gold futures:
  - borrow money, buy gold spot and store it
  - later pay today's spot price + interest and have gold
- Futures price should equal today's spot price + interest
  - Anyone can create synthetic futures and sell actual futures if synthetic futures is cheaper
  - People storing gold can "sell" synthetic futures and buy actual if synthetic is more expensive
- [Gold futures prices](#)



## Cost of carry and convenience yield

- Cost of carry = cost of owning physical = foregone interest + storage costs
- Convenience yield = benefit of owning physical = dividends and/or profits from temporary product shortages



## Contango and backwardation

- Contango = upward sloping forward curve (futures > spot)
- Cost of carry > convenience yield  $\Rightarrow$  contango (like gold)
- Backwardation = downward sloping (spot > futures)
- Convenience yield > cost of carry  $\Rightarrow$  backwardation (like peso)



## Currencies

- Cost of carry for currency = U.S. interest rate
- Convenience yield for currency = foreign interest rate
- Foreign rate  $>$  U.S. rate  $\Rightarrow$  backwardation. See [peso futures](#).
- Foreign rate  $<$  U.S. rate  $\Rightarrow$  contango. See [euro futures](#).





## Financials

- Cost of carry for financials = U.S. interest rate
- Convenience yield = dividends (for stock index futures), coupons (for T-bond futures), ...
- Dividends/coupons > interest rates  $\Rightarrow$  backwardation
- Dividends/coupons < interest rates  $\Rightarrow$  contango
- [S&P 500 futures prices](#)



## Commodities (agriculture, energy)

- Commodities can have high cost of carry (storage) and sometimes high convenience yields
- Sometimes in contango and sometimes in backwardation
- Seasonal commodities can be in neither (cyclical)
  - [Natural gas](#) prices high in winters
  - Gasoline prices high in summers
  - Agricultural high before harvest and low after harvest



Futures roll and expectations hypothesis



## Futures roll

- Think of the forward curve as in terms of time to maturity
  - Futures price for 1 month to maturity, 2 months, ...
- Suppose you buy a futures that is in contango, and the forward curve never changes. Do you make or lose money?
- Maybe sell contango futures and buy backwardation futures?



## Illustration

- Contract that is 12 months out
- Follow the price of the contract as time passes
- If the forward curve doesn't change, the futures price will
  - fall in a contango market and
  - rise in a backwardation market



Futures roll in a contango market

Futures roll in a backwardation market



But maybe the forward curve tends to rise over time in contango markets and fall over time in backwardation markets?



## Expectations hypothesis

- Today's futures price should be related to the spot price people expect the asset to trade at in the future.
  - Example: suppose we can buy December corn now at 5.00 per bushel
  - If we expect corn to sell for 4.00 per bushel in December, then maybe we should all be selling 5.00 corn now. Spot-futures convergence implies 1.00 profit if corn is 4.00 in December.
  - If there are no expected profits of this sort, then we must expect corn to sell for 5.00 in December.
- The expectations hypothesis is that the futures price represents today's expectation of the future spot price.





Expectations hypothesis in a contango market

Expectations hypothesis in a backwardation market



- But there could be risk premia.
- Example: more corn hedging by farmers than by grain processors
  - Speculators are needed to buy corn futures from farmers
  - Expect compensation for risk
  - Implies futures price < expected future spot

## Currencies

- The data indicate that selling contango currency futures and buying backwardation currency futures is profitable on average.
  - Long futures  $\sim$  long synthetic futures = borrowing dollars and buying currency
  - Short futures  $\sim$  short synthetic futures = borrowing foreign currency and buying dollars
- Selling contango futures means selling (borrowing) high interest rate or low interest rate currencies?
- Buying backwardation means buying (investing in) high interest rate or low interest rate currencies?



# Futures-based ETFs



- You can buy or sell futures through a stock broker by buying ETFs.
- Example: USO holds oil futures
- To set up a 100 million dollar ETF:
  - Raise 100 million cash.
  - Buy (or sell) enough futures contracts so that  $\text{\#contracts} \times \text{futures price} = 100 \text{ million}$
  - Deposit 10 million as T-bills for margin
  - Buy other higher yielding liquid safe assets with other 90 million
  - Gain/loss each day =  $100 \text{ million} \times (\% \text{ change in futures price} + \text{interest})$ .



```
In [18]: import pandas as pd
from pandas_datareader import DataReader as pdr
import yfinance as yf
import matplotlib.pyplot as plt
import seaborn as sns
sns.set_style("whitegrid")

spot = pdr("DCOILWTICO", "fred", start=1990)
uso = yf.download("USO", start=1970, progress=False)["Adj Close"]
spot = spot.reindex(uso.index)
```

Spot (front month futures) price of oil



```
In [19]: plt.plot(spot)  
plt.show()
```



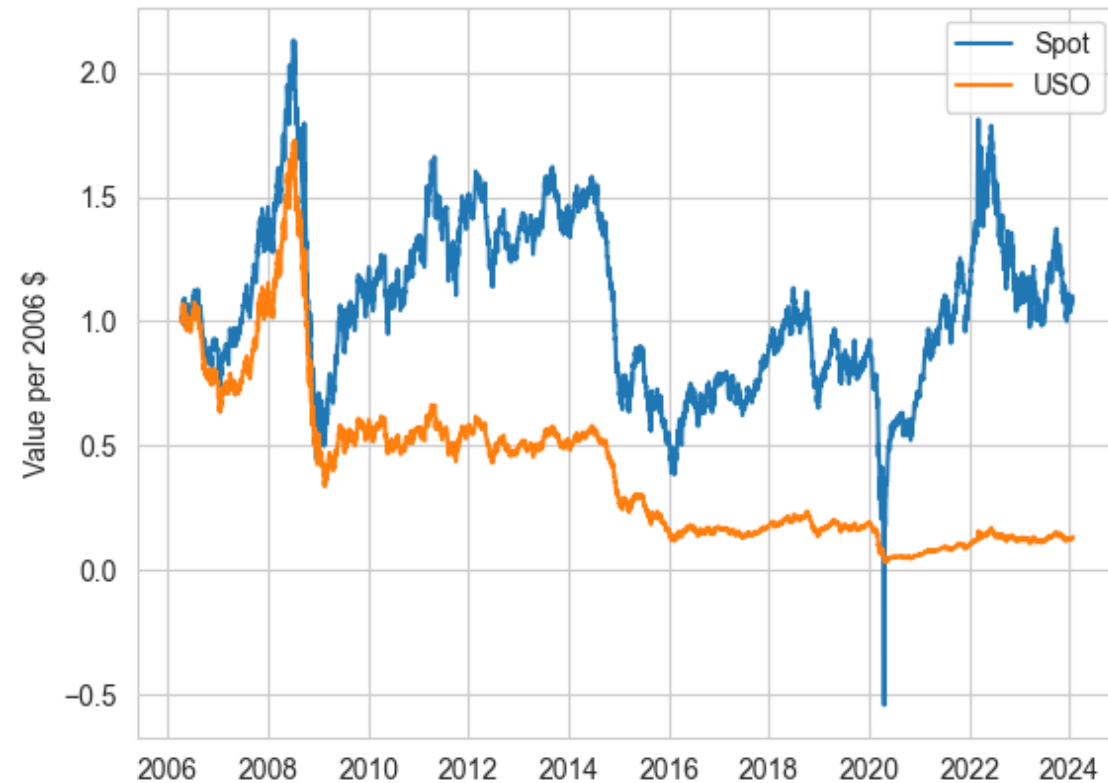


## Comparing oil prices to USO returns

- Calculate what 1 dollar of oil in 2006 is worth now
- Calculate what 1 dollar in USO in 2006 would have grown to



```
In [20]: spot = spot/spot.iloc[0]
         uso = uso/uso.iloc[0]
         plt.plot(spot, label="Spot")
         plt.plot(uso, label="USO")
         plt.ylabel("Value per 2006 $")
         plt.legend()
         plt.show()
```



# Futures returns vs spot prices

Spot price of crude from EIA

...

```
{python}  
import pandas as pd  
import plotly.graph_objects as go  
import plotly.express as px  
import yfinance as yf  
import numpy as np
```

```
{python}  
df = pd.read_excel(  
    "files/PET_PRI_SPT_S1_D.xls",  
    sheet_name="Data 1",  
    skiprows=9,  
    header=None,  
    parse_dates=[0])  
df.columns=['date', 'wti', 'brent']
```

```
{python}
```

