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 futures curve never changes. Do you make or lose money?
- Maybe buy contango futures and sell backwardation futures?

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 you 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.

- 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 buying contango currency futures and selling 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
- Buying contango futures means buying high interest rate or low interest rate currencies?
- Selling backwardation means selling 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 #contracts $\times$ futures price = 100 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 million x (% change in futures price + interest).

In [41]:

```python
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 [42]:

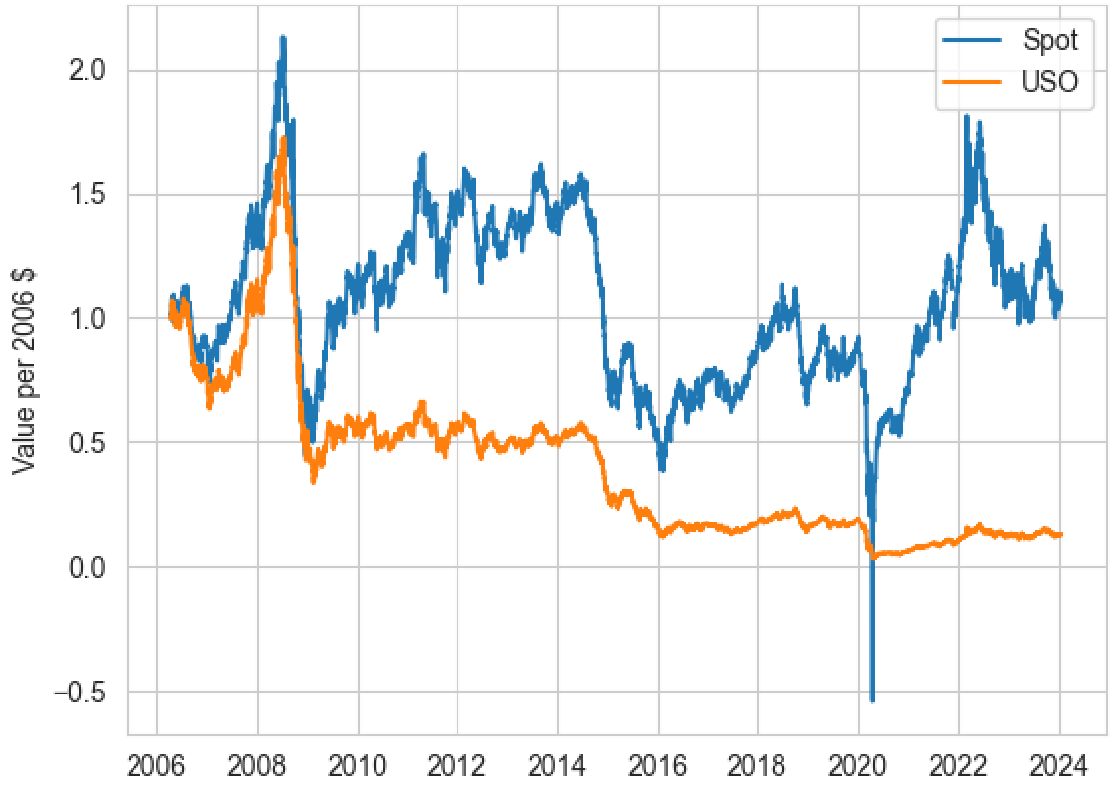
```
plt.plot(spot)
plt.show()
```

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 [43]:

```
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}
```