

More Futures

BUSI 722: Data-Driven Finance II

Kerry Back, Rice University



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, because you could buy (sell) futures now and sell (buy) spot later.
 - 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 [12]: 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 [13]: 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 [14]: 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()
```

