Recall

Last lecture we discussed foreign exchange.

- Global Currencies;
- Currency Risk;
- Interest Rate Parity;
- Purchasing Power Parity and Other Models;
- Growth Implications; and,
- Current Issues.

Today we will talk about futures (and swaps).
Forwards, Futures, and Swaps

Chapter 19, A Quantitative Primer on Investments with R
This week we will discuss forwards, futures and swaps.

In particular, we will discuss:

- Cash/Spot;
- Forwards;
- Futures and the effects;
- Swaps; and,
- Futures curves.
Spot and Cash Prices

- **Spot price**: paid for a good delivered now “on the spot.”
  - Thus location, quality, and immediacy all affect price.

- Disseminating all possible spot prices would be onerous.

  - Economies of scale, deep labor pools, ports, rail termini.
  - These spot prices more important (early standardization).
  - Leads to quoting prices “basis\(^2\)” key spot prices.

- **Cash price**: paid for a good now/ASAP in standard location.
  - People often use “spot” and “cash” interchangeably.

- **Location differential** = Spot price – Cash price.
  
  1. Q: What if demand for coal to make steel in Gary is high?
  2. A: Gary location differential for coal will be high.

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\(^2\)“Basis” refers to a price differential.
Speculators and Risk Pricing

- Standardized cash prices allow comparison, liquid markets.
- Liquid markets tend to attract speculators.
- Speculators seek profit by betting on price direction, costs.
- Successful speculators attract more speculators.
- Competition helps establish the cost of assuming borne risks.
- Thus speculators offer three major benefits:
  - *Risk Transfer*: assume risk others do not want.
  - *Liquidity*: trade when others will not; attract others.
- These three benefits are central to all derivatives markets.
Derivatives: contracts traded on *underlying* risk.

Thus they derive their value from the price of the underlier.

Contracts are negotiated b/w two individuals (*counterparties*).

May be traded on-exchange or *over-the-counter* (OTC).

OTC trading typically done over the phone.

- Allows for flexible terms, customized contracts.
- Must often call for quotes; trade rarely reported publicly.
- Thus OTC markets are less price-competitive.
Some people cannot tolerate risking where prices will be. They must make expensive business decisions in advance. They base these decisions on prices.

Thus producers who act on prices often want to lock in prices.

Consumers act likewise, also want to lock in prices.

These needs led to first forward contract:

- Agreement between two people to trade later at a set price.
- Specifies amount, quality, delivery location/method, and date.
- Money changes hands at later specified date.

First forwards traded in ancient Babylonia (1750 BCE).
Making Forwards Better

- Obvious steps to increase liquidity, convenience:
  - Standardize contracts (quality, size, expiry, delivery location).
  - Trade contracts in one location (an exchange).
  - Protect against counterparty impairment.

- With standardization, prices become comparable.
- Can require traders to deposit money in an account.
- Mark to market: regularly credit/debit account P&L.
- Net positions daily for determining proper margin.
- Comparable prices let us determine unrealized P&L.
- Structure all contracts to involve well-capitalized CCP.
Marking to Market

- Central clearing involves *marking to market*:
  - Paying/receiving payment for daily P&L change.
- What does marking to market (MTM) look like?

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Buy 10 Mar CME corn (ZCH9) @ $4.2700.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No money paid; post margin (≈ 5%).</td>
</tr>
<tr>
<td></td>
<td>Mar corn (ZCH9) closes @ $4.2625.</td>
</tr>
<tr>
<td></td>
<td>Pay MTM debit of $375.</td>
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<table>
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<tr>
<th>Day 2</th>
<th>Mar corn (ZCH9) closes @ $4.3550.</th>
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<tr>
<td></td>
<td>Receive MTM payment of $4,625.</td>
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<tr>
<th>Day 3</th>
<th>Mar corn (ZCH9) expires @ $4.3500.</th>
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<tr>
<td></td>
<td>Pay MTM debit of $250.</td>
</tr>
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- At expiry, most of P&L has been *previously* paid/debited.
- At closeout, we get our margin balance back — ± P&L
- Without MTM: realize $4,000 of P&L on day 3.
Traders on a derivatives exchange must post margin:
- Cash, letter of credit, or govt bonds in segregated account.
- Margin (collateral) ensures trader can pay mark-to-market.

Four important margin terms:
- **Initial margin**: initial deposit (max expected daily change).
- **Maintenance margin**: account level requiring more margin.
- **Margin call**: the request to post more margin.
- **Variation margin**: amount needed to satisfy (meet) margin call.
 Margin Example  

Day 1  Short 10 contracts of Mar CME corn (ZCH9) @ $4.27.  
Contract size = 5000.  
Notional = 10 \times 5000 \times $4.27 = $213,500.  
Initial margin = 10 \times $1,000 = $10,000. (\approx 5\%)  
Mar corn closes at $4.2625  
Mark-to-market credit = $375; margin balance = $10,375.  

Day 2  Mar corn closes at $4.3550  
Mark-to-market debit = $4,625; margin balance = $5,750.  
Below maintenance margin (75\% of $10,000 = $7,500).  
Margin call: variation margin of $4,250.  
After meeting margin call, margin balance = $10,000.
B sells A 10 contracts of Mar CME corn\(^3\) at $4.27.
- A’s position = +10; B’s position = -10.

ZCH9 goes up $0.10: A makes $0.10 \times 10 \times 5000 = $5000.
- B loses $5000.
- Derivatives markets are *zero-sum games*.

*Open interest* = 10 contracts; *volume* = 10 contracts.

A closes out position by selling 10 contracts back to B.
- Open interest = 0; volume = 20.
- Had A sold to C instead, open interest would be 10.
- When B made money, C would lose money (still zero-sum).

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\(^3\)Mar CME corn contract (ZCH9) is for 5000 bushels.
Forward to Futures

- These features change a forward into a *futures contract*.
  - Standardized contracts (quality, size, expiry, delivery location).
  - Trading contracts on an exchange.
  - Require trader to post collateral in a margin account.
  - Mark to market to reduce counterparty risk.
  - Net positions daily for determining proper margin.
  - Make well-capitalized *clearinghouse* all contracts’ counterparty.
    (aka *central counterparty*, CCP)

- First futures in 1730 in Osaka at Dōjima Rice Market.
- Re-emerged in 1848 at Chicago Board of Trade.
- Term “futures” coined in 1865 at CBOT.
Futures are traded on a number of underliers:

- **Equity Indices**: Domestic/foreign, large-/small-cap.
- **Interest Rates**: LIBOR/short-term, sovereign bonds.
- **Foreign Exchange**: Cross-rates with “Big 5,” others.
- **Ags**: Grains, oilseeds/crush, fibers, livestock, softs.
- **Metals**: Base, minor, strategic \(U_3O_8\), precious, steel.
- **Energy**: Crude+products, LPGs+natural gas, coal, power, ethanol.
- **Other**: Plastics, emissions, shipping, real estate, volatility, storage.

*N.B.* LME contracts are often called futures; technically forwards.

This allows easy and cheap trading of many risk factors.

Thus futures may be used to hedge or invest.
Hedging with Futures

- Hedge usually does not replace supply chain or investments.
- Rather: put hedge on; P&L roughly compensates for price changes.
- Exit contract before actual purchase/sale via supply chain.
- e.g. buy copper futures; exit before delivery of copper wire.
- Can exit a contract in a few ways:
  - Usually trade out of (“offset”) position before expiry.
  - Rare delivery: 1% (metals, energy) to 0.25% (grains, oilseeds).
  - Can exchange contracts for physical goods (“EFP”) before expiry.
- To keep hedge, must *roll* (transition) to new contract at expiry.
Benefits of Futures: Market-wide

- Futures lower cash market volatility.
  - What about onions...?
- Futures increase cash market liquidity, depth.
- Futures have also increased trade, allocative efficiency.
- That lowers prices; consumer benefit exceeds producer burden.
- Futures also allow investors to further diversify portfolios
Benefits of Futures: Specific

- Can use 10Y Treasury note futures to hedge, e.g. $10,000 DV01.
  - Modified duration $D^* = 8.7$ for bond futures trading at 90;
  - Contract multiplier is $1000$;
  - Futures DV01: $8.7 \times 0.0001 \times 1000 \times 90 = 78.3$.
  - Sell $10k/78.3 \approx 128$ futures contracts to hedge.

- **Index arbitrage**: trade futures vs index members, syncs prices.
  - Trade all 500 S&P 500 stocks, most/all of Topix/Russell 2000.

- We can also use the futures to synthetically short stocks:
  - Go long 1 contract; do an EFP.\(^4\) Now have stocks long.
  - Go short 1 contract. Now flat: stocks net out futures.
  - Selling stock long gives us a synthetic short position.

\(^4\)EFP turns futures long into portfolio of index stocks.
A swap is an agreement to exchange cashflows.

Thus a swap is very similar to a futures contract.

Futures: Post collateral (ceding interest), get MTM flows.

Swap: Pay financing flows, receive desired cashflows.

For swaps, cashflows based on some notional amount.
  - The notional amount never changes hands.

Cashflows referred to as legs: pay leg, receive leg.
  - Usually, one leg is a floating rate = financing leg.
  - Occasionally resets: net payment; change floating-rate.

Interest Rate Swaps

- Interest rate swaps are the most “plain vanilla” of swaps.
- “Fixed-for-float:” swap fixed- for floating-rate (or vice versa).
- Example: pay USD 6M LIBOR + 50, receive 3% fixed.

Swap on $100 MM notional; resets semi-annually.
- 50 bp floating-rate offset is a credit spread.

Most floating rates reset every 6M, based on LIBOR.
- Fixed rate set by market to equalize NPVs of expected cashflows.
- For same maturity, swap DV01 < bond: no principal repaid.
Other swaps: equity index or baskets; variance; assets; credit.
Instead of fixed rate, might swap equity-related returns.
- Pay USD 3M LIBOR + 35 bp; receive S&P 500 index return; or
- Pay USD 1M LIBOR + 20 bp; receive returns on portfolio \( P \).
- Often reset quarterly (index) or monthly (baskets).
- Basket swaps: like transactional prime brokerage agreements.

Credit default and asset swaps let you hedge default risk.
Basket and asset swaps may also substitute for repo transactions.
Worry: will counterparty be able to pay cashflow owed?
How do swaps differ from futures? A few key ways:

- Not standardized;
- Traded OTC, mostly out of London (for now?);
- No margin is posted (although some swaps use margin);
- If not centrally-cleared, incur counterparty risk;
- Not designed for ease of exit.

Difficulty of exit means swaps often accrete:

- Historically: enter into another swap to “exit” a trade.
- Thus outstanding notionals are nearly meaningless.
- In bankruptcy, this may allow selective contract enforcement

To alleviate that, some services now offer compression:

- Net out swaps which cancel risk factors; leave only net exposure.
Recent regulations encourage central clearing of common derivatives. What is the difference from futures then? Not much.

Central clearing has handled many crises smoothly:
- 1987 stock market crash;
- 1991 Persian Gulf War;
- Refco bankruptcy (failure of #1 CME futures broker);
- Amaranth bankruptcy (large commodities hedge fund failure);
- Bear Stearns near-bankruptcy ($700 bn of exposure at CME alone);
- Lehman Brothers bankruptcy ($1.3 tn exposure at CME alone!).
I claim $F_{t,T} = S_t e^{r_t(T-t)}$; w/div. yield $d$: $F_{t,T} = S_t e^{(r_t-d)(T-t)}$.

Can do likewise for convenience yield with commodity futures.

This implies futures equals forward price $F_{t,T} = f_{t,T}$.

What if changes in $S_t$ are correlated with changes in $r_t$?

- e.g. Rate cuts correlated with changes in oil prices? bond prices? 
- Then mark-to-market in-/out-flows have asymmetric effect

Let $\rho_{S,r} = \text{Corr}(dS_t/S_t, dr_t/r_t)$.

- $\rho_{S,r} > 0 \implies F_{t,T} > f_{t,T}$ (futures above forwards).
- $\rho_{S,r} < 0 \implies F_{t,T} < f_{t,T}$ (futures below forwards).

If $\rho_{S,r} > 0$, longs get MTM money when rates high.
**Futures Curves**

- **Near contract**: contract nearest to expiry; usu. most active.
- **Next contract**: contract next-closest to expiry.
- **Futures/forward curve**: plot of contract prices vs. maturities.
  - Indicates relative supply and demand, including cost of carry.

If futures curve increases (A), market is in *contango*.
If futures curve decreases (B), market is in *backwardation*.
Contracts drift along curve, converge to cash \((T = 0)\) price.
Basis = Cash price - Futures price.
Futures Curves: Beautiful Theories

- Keynes (1930) claims producers hedge (sell) aggressively.
  - Thus futures underestimate later spot prices.
  - Futures curve is normally decreasing (backwardated).

  - Arbitrage argument: Equilibrium price grows with risk-free rate.
  - However, unique resources may be worth more (e.g. catalysts).

- Beautiful theories...yet again, slain by ugly facts:
  - The data just do not agree with these hypotheses.
Research suggests commodity prices mean-revert, suggests:

\[ r_{F,t,T} = \alpha + \beta(\bar{X} - X_t)e^{-\gamma(T-t)} + \epsilon_{t,T}, \]  
\[ \epsilon_{t,T} \sim (0, \sigma_t e^{-\gamma_2(T-t)}/\text{inventory}), \]  
\[ X_t = \frac{\sum_{i=1}^{n} \phi_i X_{t-i}}{\sum_{i=1}^{n} \phi_i}. \]

But if cash prices revert, they are stationary; can work w/prices.

Can then modify first (dynamics) equation to be:

\[ F_{t,T} = \alpha + \beta(\bar{X}_t - X_t)e^{-\gamma_1(T-t)} + \beta_2 X_t e^{r_{t,T} + \kappa c_t - d_{t,T} - \nu_{t,T}} + \epsilon_{t,T}. \]

w/cost-of-carry coefficient \( \kappa \), convenience yield \( \nu_{t,T} \).

Then must decide how long averaging window \( n \) should be.
The Road Ahead

We covered Futures and Swaps; on to Options Basics next!

- Risk Alleviation: Options (Basics, Valuation), Credit, Structured Products; and,
- All Together Now: Active Portfolios, Investment Firms, Crises.