THE BASIS

Basis Basics

- Remember: Basis is the difference between the cash (spot) price of a commodity and a futures price
- Cash price rises relative to futures=strengthening basis
- Basis is driven by differences (law of one price)
- Two basic differences drive the basis
- Time (difference between delivery dates)
- Location (or quality) (difference in location/quality)

Basis Is Hard: The Space-Time Continuum

- For deliverables, the calendar spread is the basis: only time matters
- For non-deliverables, space (or quality) and time matter
- Understanding the economics of transformation in both space & time necessary to understanding the basis
- Bottlenecks, transformation costs, etc., are extremely important

Simple Case

- Simplest case, constant cost of transportation *t* between market 2 and the delivery location (market 1)
- Commodity in abundant supply: full carry

$$B = P_2 - F = P_1 - t - (1 + RT)P_1 = -t - RTP$$

Basis Behavior in Simple Case

- Demand increase in the delivery market raises P_1
- Basis weakens
- Basis strengthens due to passage of time (convergence)

The Simple Case is Boring

- Now for something more interesting: more complex (but still pretty simple) spatial structure of the commodity market
- Market 1 and Market 2 are at the endpoints of a line segment
- Commodity produced/stored along the segment
- Some of the commodity flows to Market 1, some flows to Market 2

Some Basic Features of the Model

- The two markets compete for shipments of the commodity
- Demand in Market 1 goes up, it draws supplies from a larger fraction of the line segment
- This causes P_1 to rise relative to P_2: cash basis weakens
- What happens to the futures basis is more complicated: depends on market conditions

Futures Basis When Supplies Abundant

- When supplies are abundant, delivery market in full carry

$$B = P_2 - F = P_2 - (1 + RT)P_1 = P_2 - P_1 - RTP_1$$

- Rise in demand in Market 1 causes the basis to weaken because the cash basis weakens and because of the time (carrying-cost) effect: costlier to carry more expensive inventory

Futures Basis in Less Than Fully Carry Markets

- Analysis more complicated when market is at less than full carry
- Again consider a positive demand shock in Market 1
- Cash basis weakens, but P_2 rises because supplies fall there (more of the commodity flows to Market 1)
- Futures price rises, but by less than spot price: Contango falls/backwardation increases

Indeterminate Effect of the Demand Shock

- Since both P_2 and F go up as a result of the demand increase, we don't know what will happen to the basis: don't know how much F will rise, relative to P_2 because can't use full-carry equation
- Basis strengthens if the impact of the demand shock on P_2 is bigger than the effect on F, and this is possible
- Basis weakens if the reverse is true

An Edge Case

- Supplies extremely short: stockout almost certain before expiration of future
- Demand shock is temporary: expected to go away by futures expiry
- Example, Market 1 is an export point for a processed commodity (e.g., soybean oil) and there is a temporary shutdown of a processor in a location Market 1 exports to

Basis Movements in the Edge Case

- Due to near certainty of stockout and temporary nature of demand shock, *F* doesn't change
- Both cash prices rise, and the Market 1 price rises more. Even though the cash basis weakens, the futures basis strengthens
- Basic result: basis more likely to strengthen in tight supply conditions than in abundant supply conditions

Numerical Analysis of Another Market Structure

- Simpler economy. Demand in one market ("terminal market"). Commodity produced and stored in tributary market
- Delivery against futures in terminal market
- Temporary demand shocks
- Use simplified version of the numerical analysis to solve how basis depends on demand shocks and stocks

An Easier Case

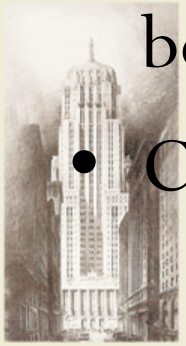
- Demand in Market 2 rises
- Both prices rise, but P_2 rises more than P_1
- P_1 rises more than F (theory of storage)
- Therefore, both cash basis and futures basis strengthen

Basis Effects of a Demand Shock

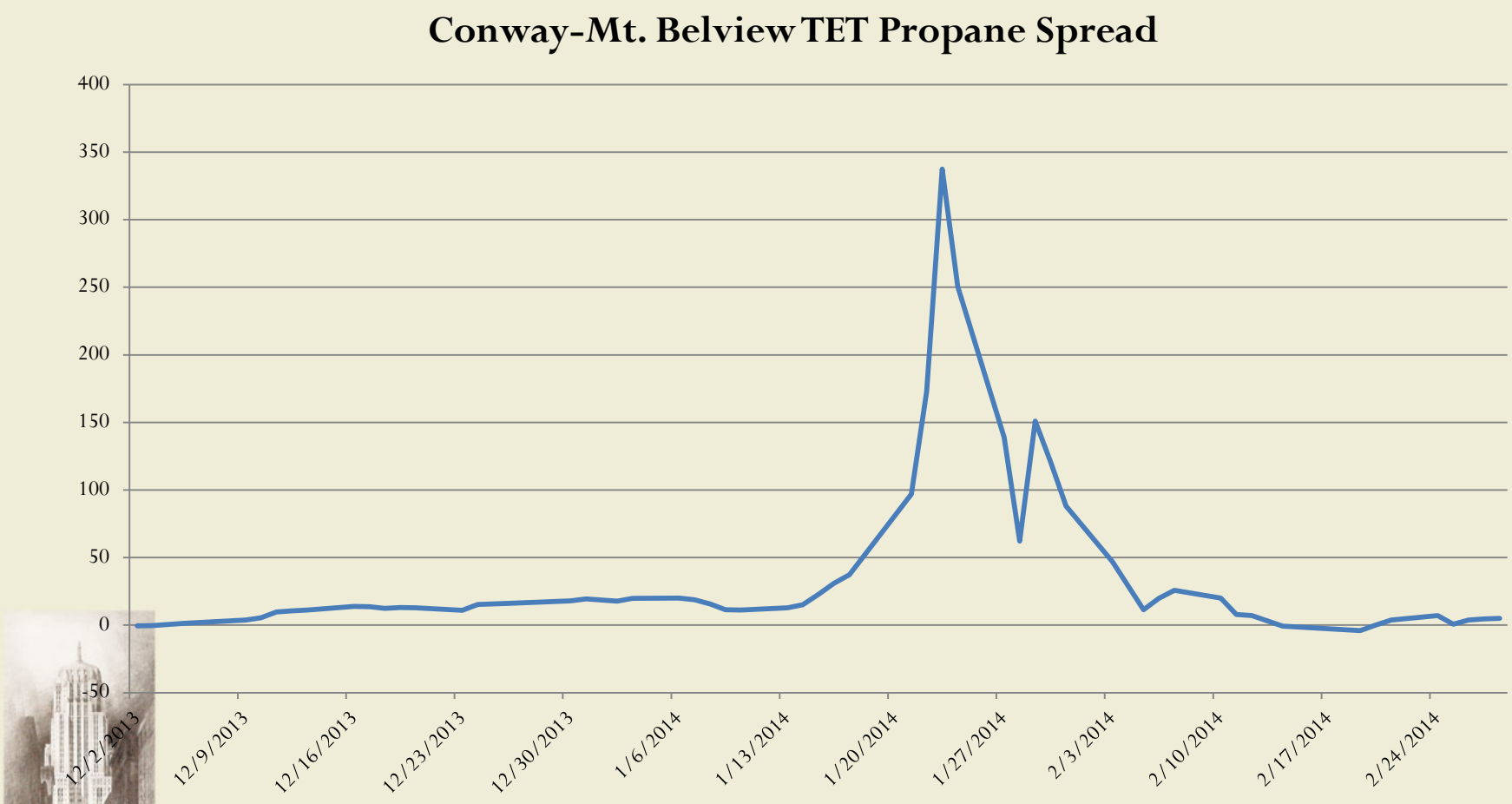
- Demand increase causes cash basis in tributary market to weaken to attract supplies to the terminal market
- Market moves towards backwardation: this tends to strengthen cash-futures basis
- When demand is above average the latter effect dominates: cash-futures basis strengthens
- Effect is stronger, the lower are stocks

Example of the Easy Case

- Propane in 2014 as discussed before
- Demand shock in Midwest due to cold weather
- Cold snap temporary (thankfully!)
- Price in the Midwest (Conway, KS) spiked relative to main pricing benchmark in Texas
- Transportation bottleneck prevented shock from being communicated fully to TX
- Conway basis (vs. Mont Belvieu) spiked dramatically



Propane & the Polar Vortex



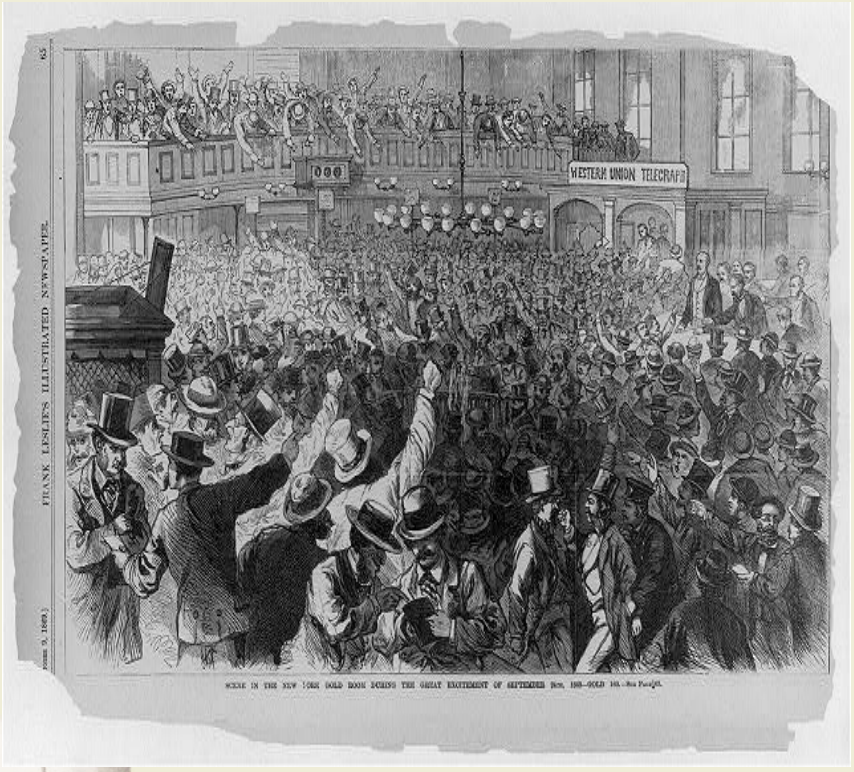
Some Basic Takewaways

- Basis movements depend on supply/demand conditions
- Where does the supply/demand shock take place?
- Are supplies abundant or scarce? Is the market in backwardation or contango?

More Takeaways

- Basis more volatile under tight supply/demand conditions
- Basis movements can be in same direction or opposite direction of price movements
- Economic frictions (e.g., transportation bottlenecks) make basis more volatile, and more dependent on supply/demand conditions

MANIPULATION



Non-Competitive Pricing: Manipulation

- The foregoing analysis is predicated on the assumption that the market is competitive
- But there is no guarantee that will be the case
- Indeed, futures and forward markets create the potential for the exercise of market power
- Market power can distort forward curves (and basis relations)

Corners, Squeezes, Hugs

- A large trader can sometimes accumulate a futures/forward position that is larger than the supply of the commodity in the delivery market at the competitive price
- Additional supplies can be brought into the market, but only by distorting flows, and distortions are costly
- Upward sloping supply curve in the delivery market due to transformation costs

Exploiting Transformation Costs/Frictions

- By demanding delivery of more than the competitive quantity, a large long can force the market up the supply curve, thereby driving up prices
- The large long can liquidate his remaining positions at this elevated price
- If his position is sufficiently larger than the competitive quantity in the delivery market, the profit on the contracts liquidated at the inflated price is larger than the loss he takes on the units delivered to him, making this profitable

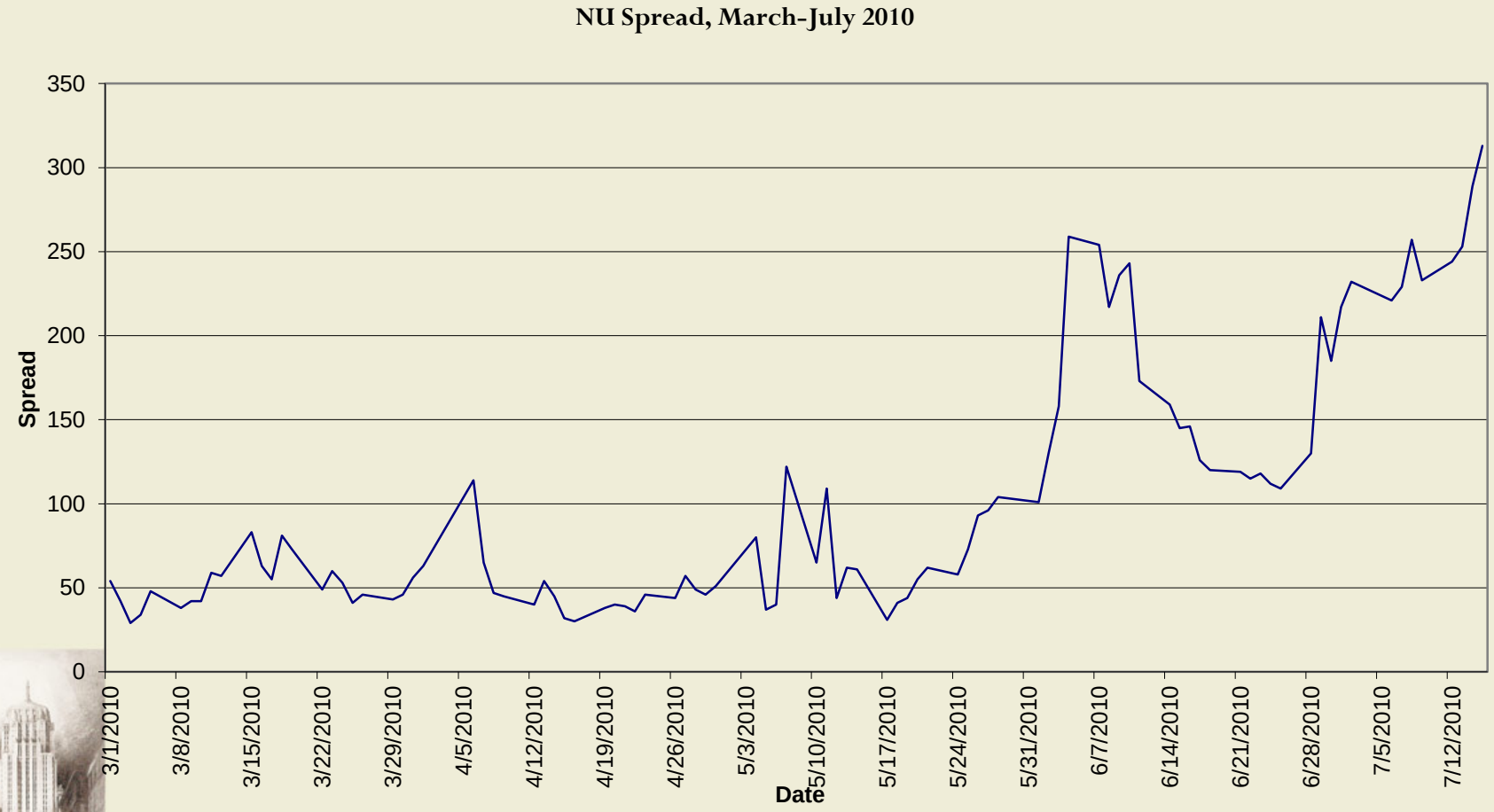
Burying the Corpse

- A corner works by demanding excessive deliveries
- The cornerer has to dispose of this stuff after the corner is over: it is said that this is the "corpse he has to bury"
- Lose money on burying the corpse

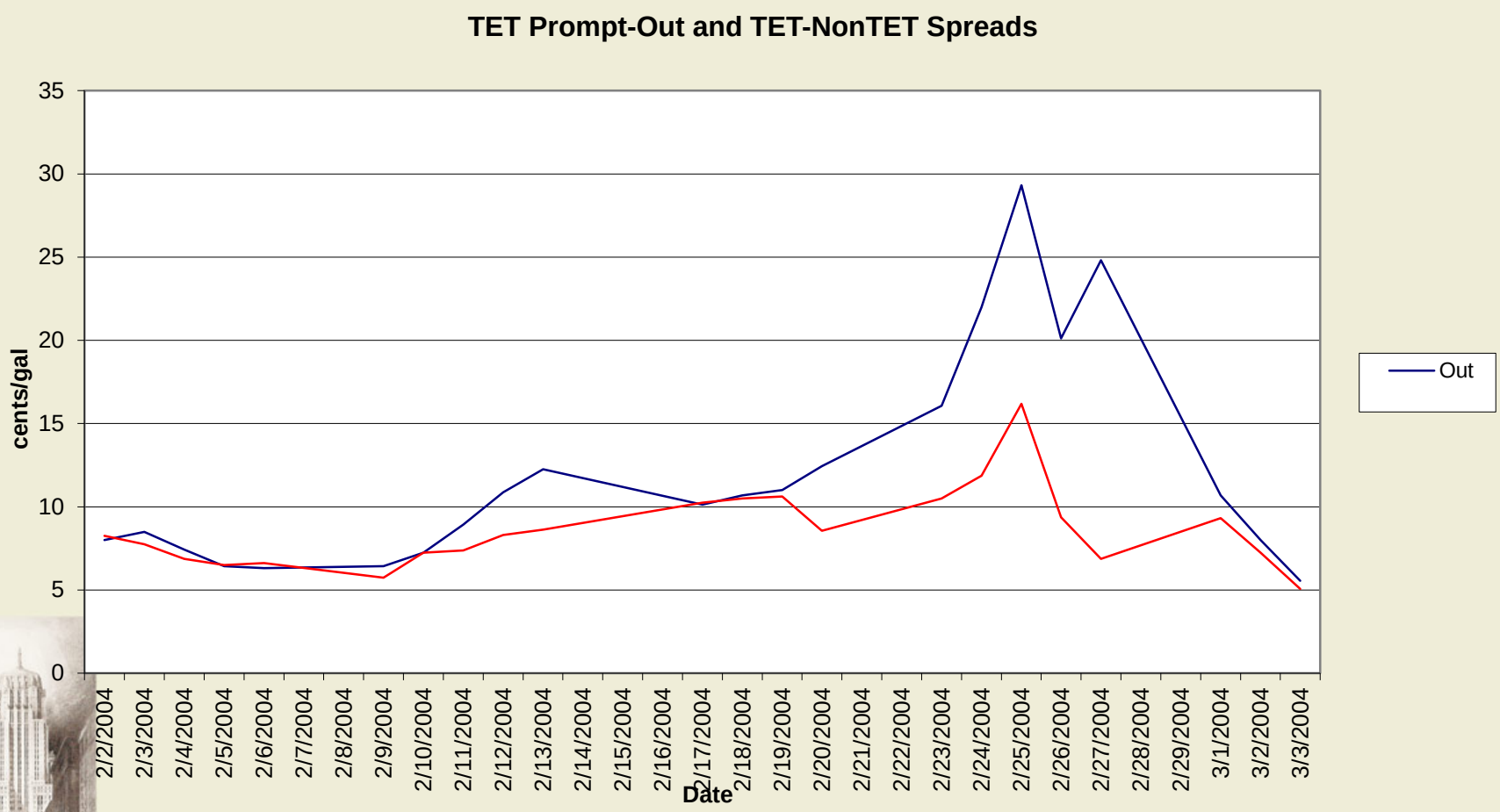
Price Effects of a Corner

- Artificial demand for the commodity elevates the price of the manipulated contract (and the spot price) until the manipulation ends
- Anticipation of the corpse being dumped on the market depresses forward price for expiries later than cornered contract
- These effects mean that corners can cause backwardations
- Price of deliverable rises relative to prices of related commodities, or of the same commodity at other locations (i.e., basis effects)
- Spot price crashes when corpse is buried

Cocoa Corner



Propane


TET Prompt-Out and TET-NonTET Spreads
cents/gal
35
30
25
20
15
10
5
0
2/2/2004
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2/4/2004
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Date
Out

Quantity Effects of a Corner

- Excessive flows of the commodity to the delivery point before the corner ends, excessive flows away from the delivery point after it ends
- Atypical directions of commodity flows ("water flowing uphill")
- Inventories in delivery market elevated
- Level of inventories high even though market is in backwardation (or less than full carry): completely contrary to what you'd expect if the market were competitive

How Do You Know Somebody Wants to Corner?

- Cornerers make transactions that would otherwise be uneconomic
- They take delivery of the commodity at a higher price than they could obtain it in the markets where they actually want to consume it (example to follow)
- Hold inventories of the commodity even though spreads say that is very costly
- "Sharp pencil tests"

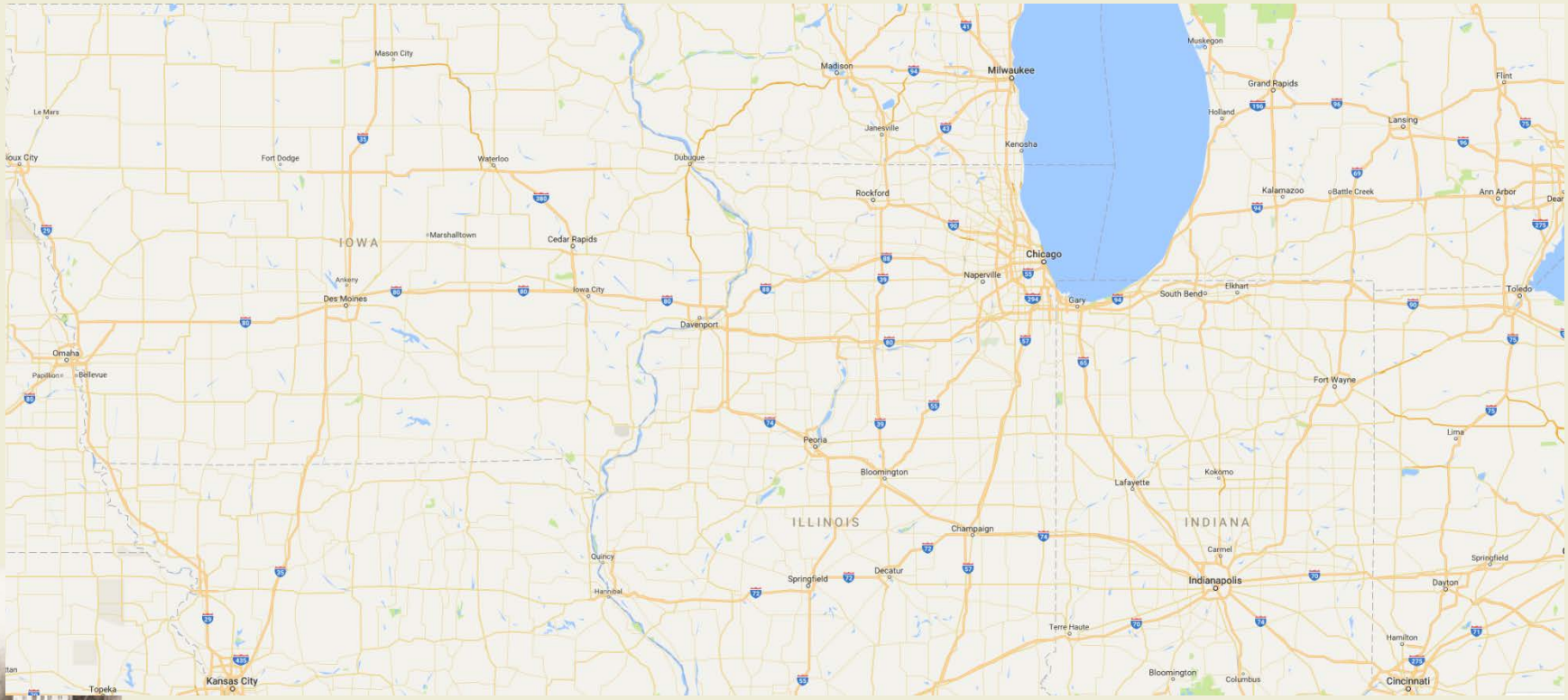
Corner Examples

- Ferruzzi soybeans, 1989
- Sumitomo copper, 1995
- BP propane, 2004
- Cocoa, 2010

An Example: Ferruzzi Soybean Corner

- In 1989 Ferruzzi accumulated ~20mm bu futures position when deliverable supplies were ~8mm bu, of which Ferruzzi owned half
- There were soybeans in western Iowa, but it was economical to process those locally or to ship them to the Mississippi River to load for shipment to NOLA—shipment to Chicago inefficient

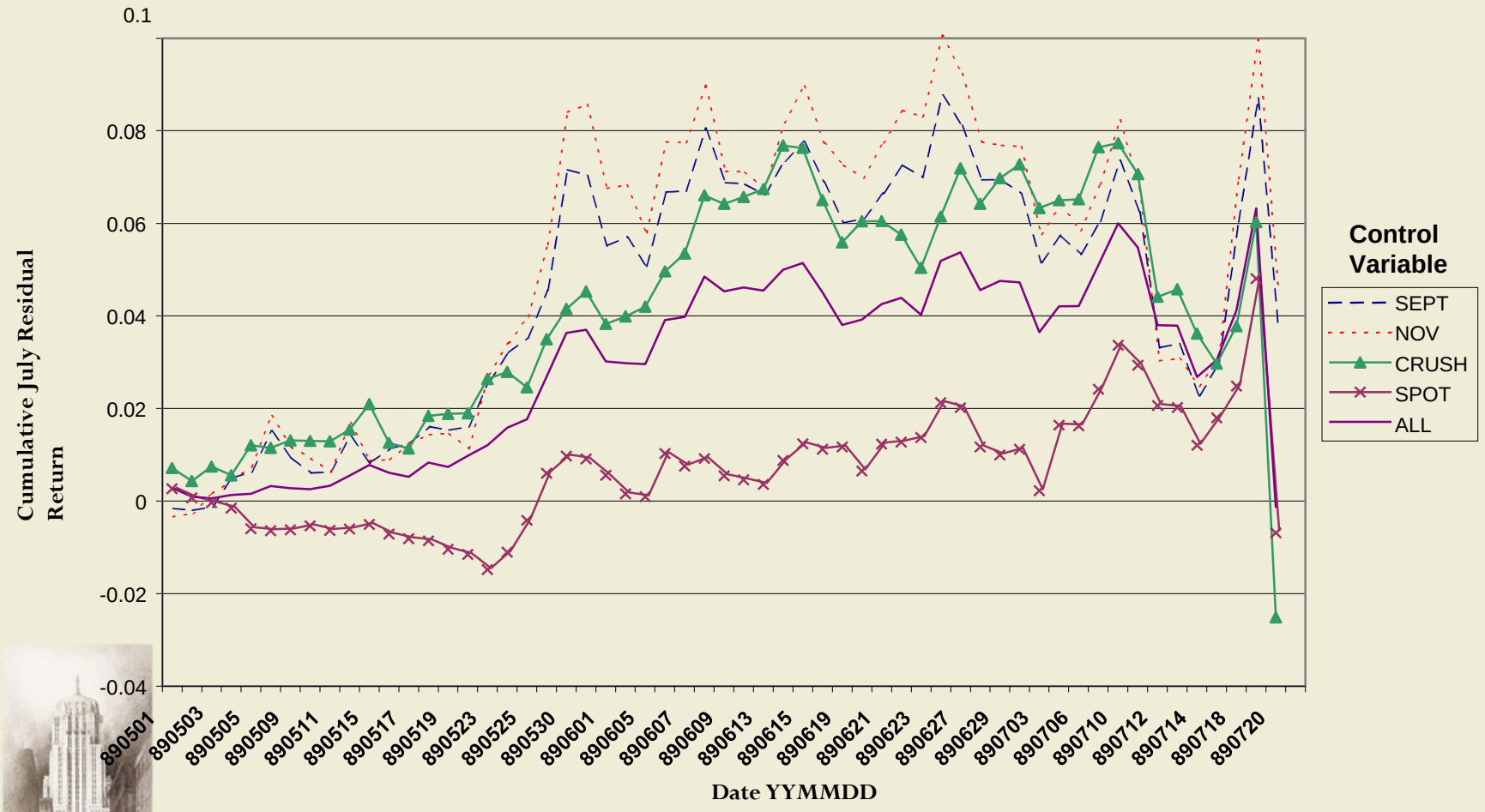
Economic Geography



Ferruzzi's Impact

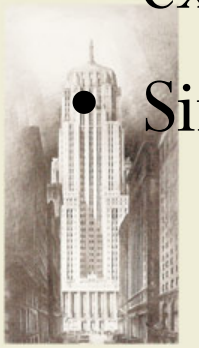
- July futures price (and Chicago cash price) rose relative to deferred futures prices, and cash prices outside Chicago
- NOLA basis went from about +35 to -1, and then post-manipulation rose to +40
- Increase in shipments to Chicago, including movements up-river, with barges loaded with beans passing one another along the Illinois River, some going to Chicago, others from Chicago

July Soybean Futures Cumulative Residuals



Ferruzzi's Intent

- Ferruzzi claimed it needed soybeans to satisfy export contracts "to the Russians" and for domestic processing
- But, taking into account loadout (.06/bu), barge freight (.225/bu), grade differentials (.075/bu #2 delivered vs. #1 export quality), it was $.365/bu to export delivered SY than buy at NOLA for export
- Similar calculation for domestic processing



Implications for Trading

- Don't do it—it's illegal (both in the US & the EU)
- Try not to get caught short in a corner
- Commercial intelligence is important: want to know about positions being accumulated in the market, because they might be used to run a corner
- Keep an eye out for anomalous pricing relations, and anomalous commodity flows

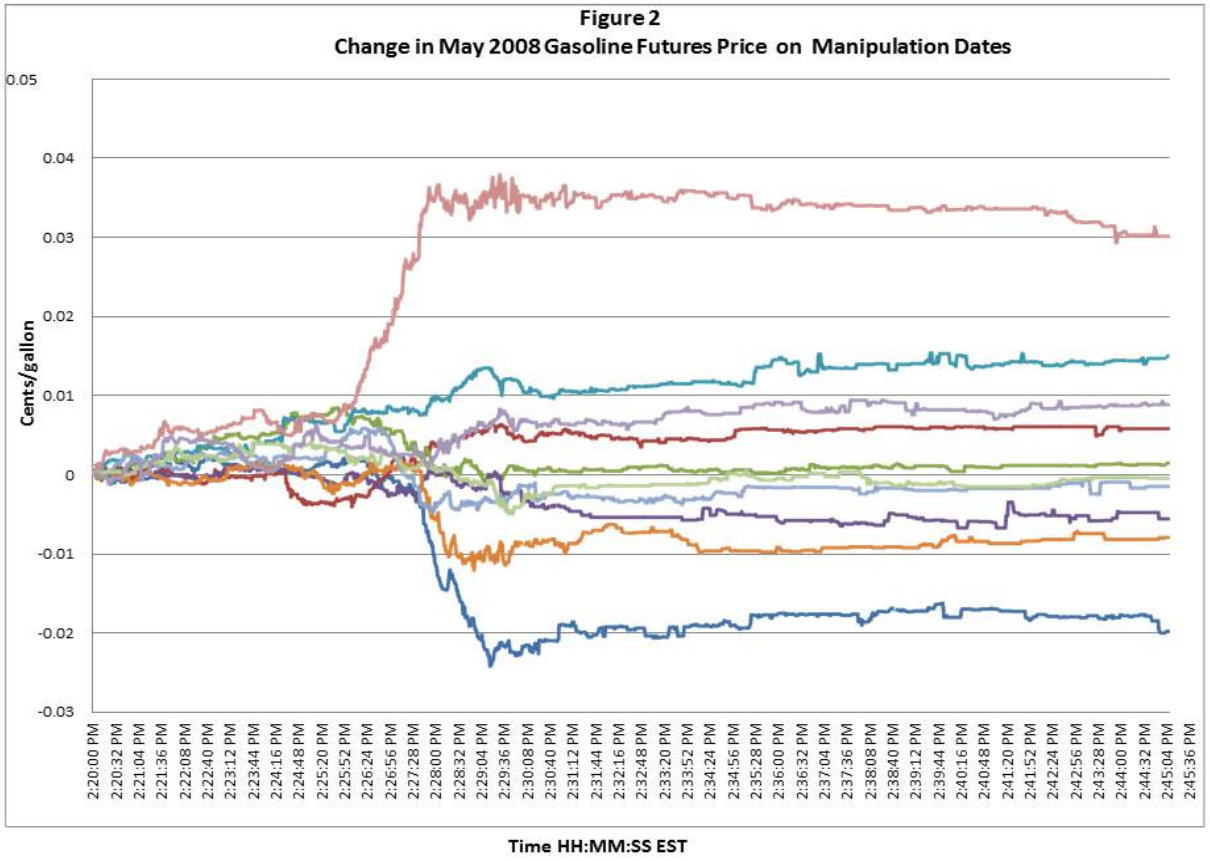
Some Takeaways

- Face some risk when you hedge, but less
- Variability of the basis determines the risk of the hedged position
- Hedges are speculations on the basis
- No hedge is perfect: all hedges are dirty
- Foregoing example assumes 1-for-1 hedge. Can sometimes to better by choosing a different hedge ratio (statistical methods)

Other Kinds of Manipulation

- "Bang the settlement"—trade-based manipulation
  - Trade in large quantities to move the price
  - Usually Done to benefit another position
  - Optiver (RB,HO, CL) & Amaranth (NG)
  - Platts Window
- Fraud (e.g., price reporting, LIBOR)

Optiver RB "Bully Trades"



RISK PREMIA & SPECULATION

Risk Premia

- A forward price is often described as the market's expectation of the future spot price
- NO!
- An expectation is a mathematical concept, not a traded price
- A forward price is a traded price
- A forward transaction involves the transfer of risk, so the forward price also incorporates a price of risk—the risk premium
- Risk premium=profit from speculation/cost of hedging

Theories of the Risk Premium

- "Keynesian Normal Backwardation"—nomenclature alert: this use of the term "backwardation" is different than the common market usage
- Keynes posited that hedging pressure determines the risk premium
- Hedgers want to go short: forward price must be below the expected spot price to attract specs to take the opposite side ("downward bias/upward trend")
- If hedgers want (on net) to go long, get upward bias
- In the Keynes theory, idiosyncratic commodity price risks determine risk premia

Implications

- Speculation affects the risk premium (the price of RISK), not the overall level of prices (except to the extent that speculators are informed and their trades cause prices to reflect that information)
- Some hedgers don't like speculators: specifically, hedgers on the same side of the market as speculators don't like the competition

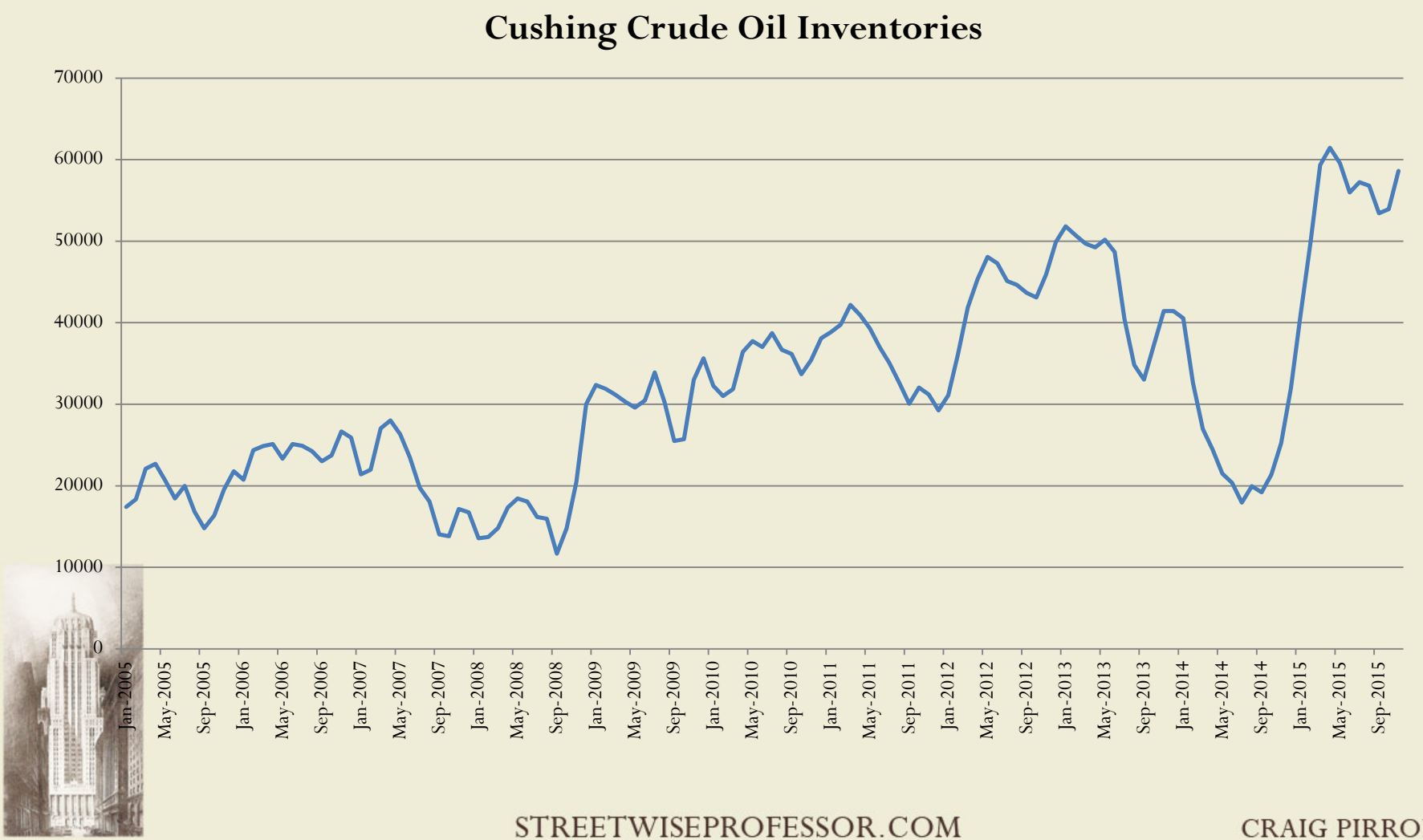
Speculation and Price Levels

- Commonly asserted that speculation distorts price *levels*
- EG, oil prices in 2006-2008, Grains 2006-2007
- Hard to disprove: if we knew what prices *should* be, wouldn't need markets ("knowledge problem")
- Evidence on quantities is important

Evidence on Quantities and Speculation

- Prices send signals about how to allocate resources: distort prices, quantities should be distorted
- Driving prices up should lead to higher inventories in hands of speculators
- EG, Hunts, government price supports
- No evidence of quantity distortions during commodity price boom
- Inventories of oil fell when prices rose, and fell when prices plummeted in '08-'09
- Similar experience in metals markets

Oil Inventories During Booms & Busts

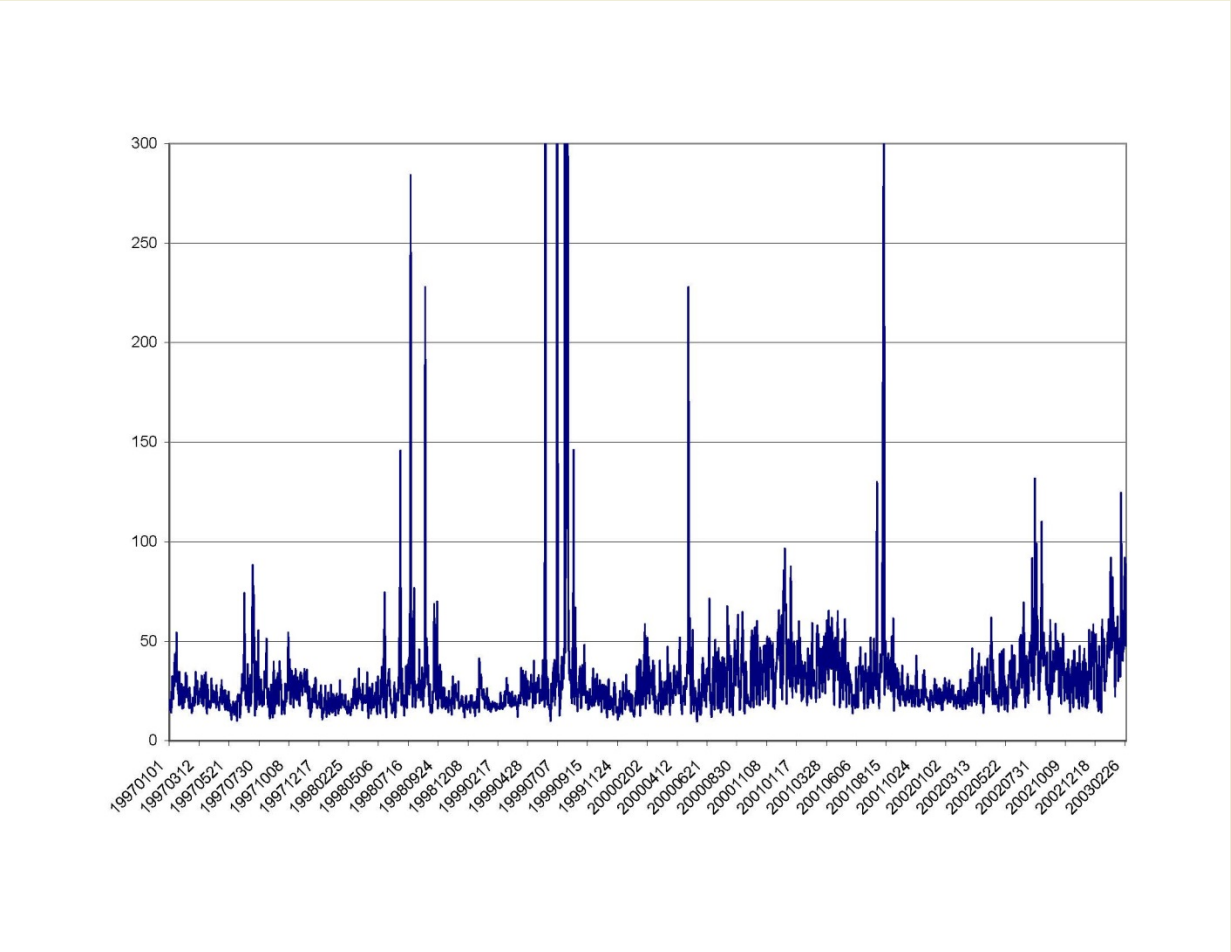


NON-STORABLES

Power Forward Curves

- Power prices exhibit behavior that is not well captured by standard reduced form models
- Structural approaches have some advantages: exploit the transparency of fundamentals
- Structural approaches (relatively) straightforward in fossil fuel dominated markets, more difficult in hydro dominated ones

Spot Power Prices



Structural Modeling Tools—Non-Storables

- In some respects, non-storables are much easier to deal with; dynamic programming considerations absent
- E.g., Pirrong-Jermakyan (2008)
- For some non-storables, structural models can actually be used for contingent claims valuation
- Market price of risk (market incompleteness)

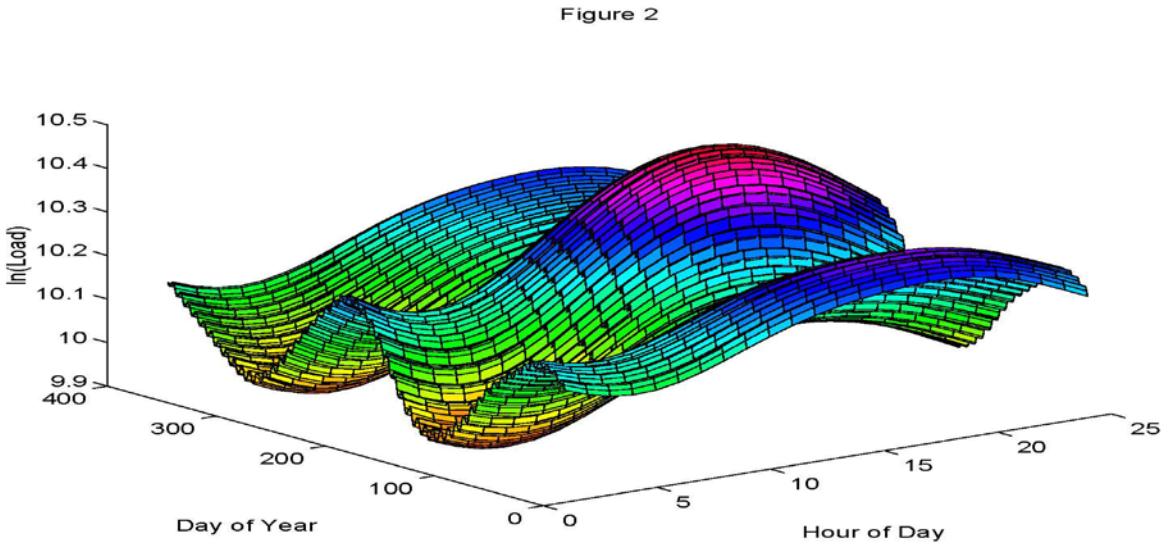
Some Challenges

- For markets with strong hydro presence, there are intertemporal linkages that require dynamic programming tools
- Even primarily fossil fuel driven markets are high dimensional
- Oh, if only the whole world were like Texas
- Still, the one eyed man is king in the land of the blind—even a crude structural model is likely to be better than feasible reduced form ones

Basic Approach: Spot Price Modeling

- Identify major drivers of power prices
  - Load (weather)
  - Fuel prices
  - Outages
- Estimate relationship between power spot prices (e.g., hourly prices) and the major drivers
- Estimate the dynamics of the drivers
- Given driver dynamics and driver-price relationship, can determine price dynamics

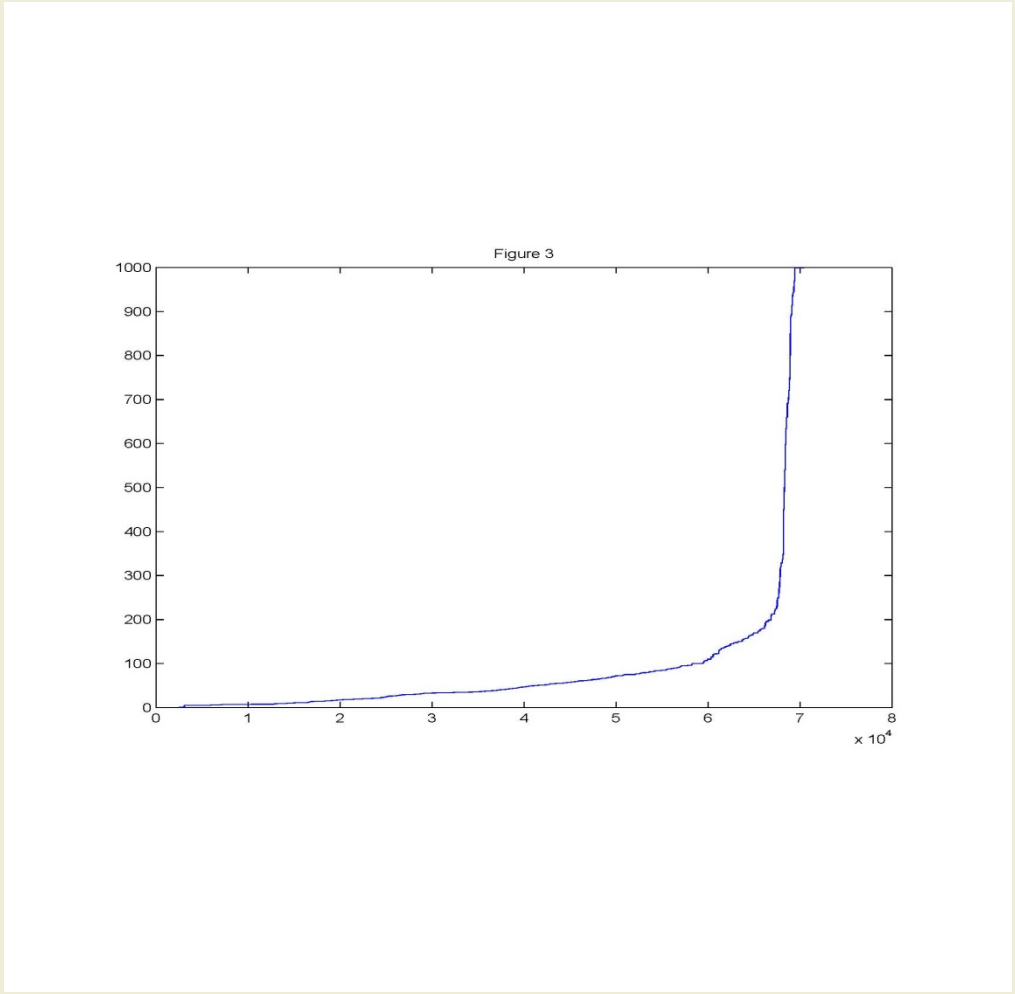
Seasonal Load Patterns



Relation Between Spot Prices and Fundamentals

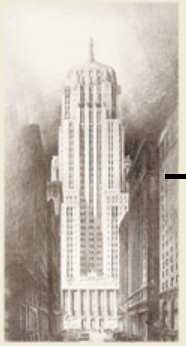
- Power markets relatively transparent: good data on main drivers and prices (at least in markets with RT markets)
- Econometric approach: use data on prices, loads, fuel prices, and outages (if available) to fit a (nonlinear, perhaps non-parametric) relationship
- Bid stack approach: some markets report (on a delayed basis) the actual generator bids that gives the relationship between loads and prices

Load-Price Relation



Driver Dynamics

- Load (or temp):
  - Estimate mean loads as a function of time of day, day of year
  - Use econometric methods to estimate the dynamics of deviations between observed and mean loads (mean reversion)
- Fuel:
  - Challenge in multi-fuel markets: use fuel that is usually at the margin
  - Standard models (e.g., GBM)



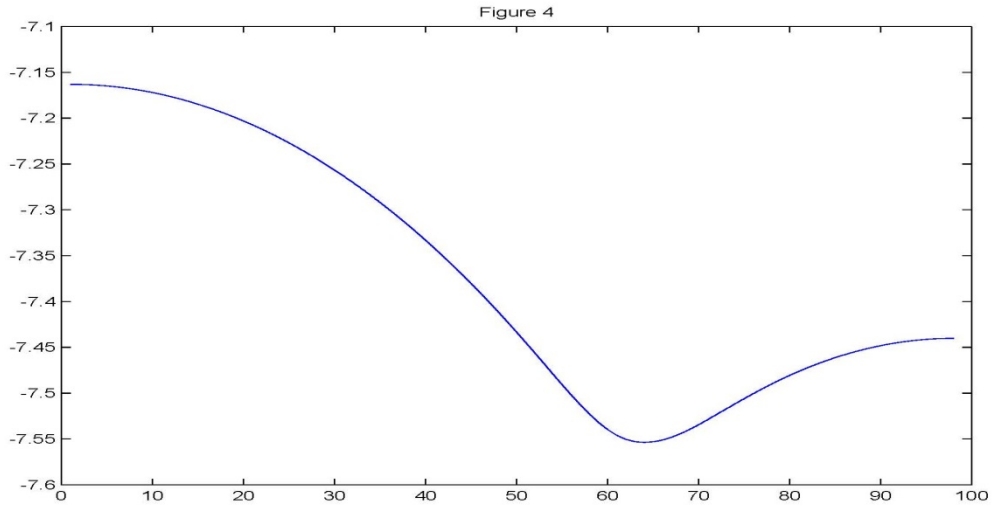
Forward Curves

- Given the price-drivers relationship and a specification of the dynamics of the drivers, possible to forecast spot power prices
- But remember, a forward price is NOT a price forecast/expectation
- Forward prices embed a risk adjustment
- Indeed, in power this adjustment is very large

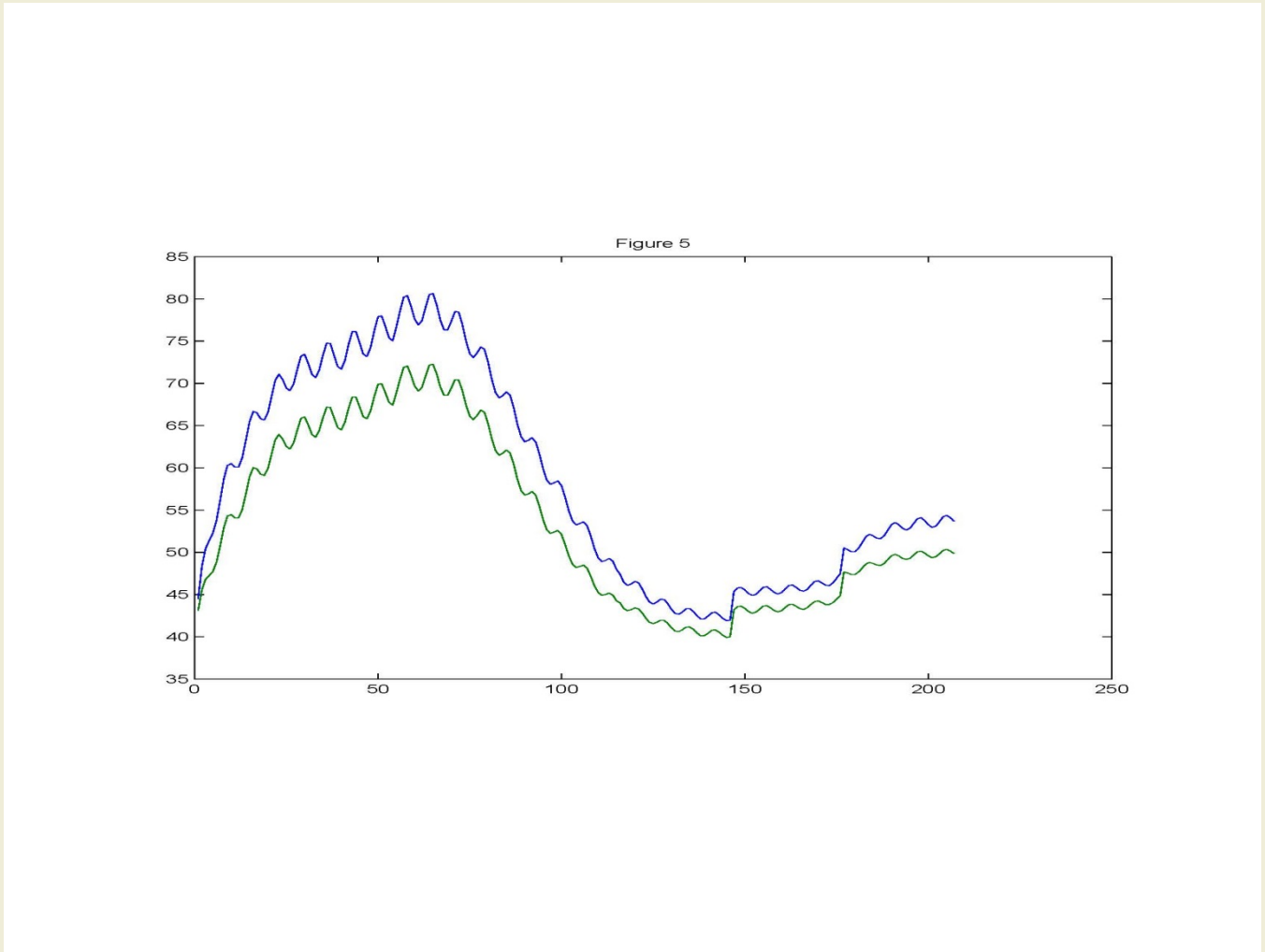
Market Price of Risk

- Power markets "incomplete": power price is not an asset, and important drivers (notably load) are not traded either
- Can use relatively advanced quantitative methods to determine the risk premium—the "market price of risk"—associated with non-traded load
- This MPR is very large
- Big deviation between forward prices and expected spot prices

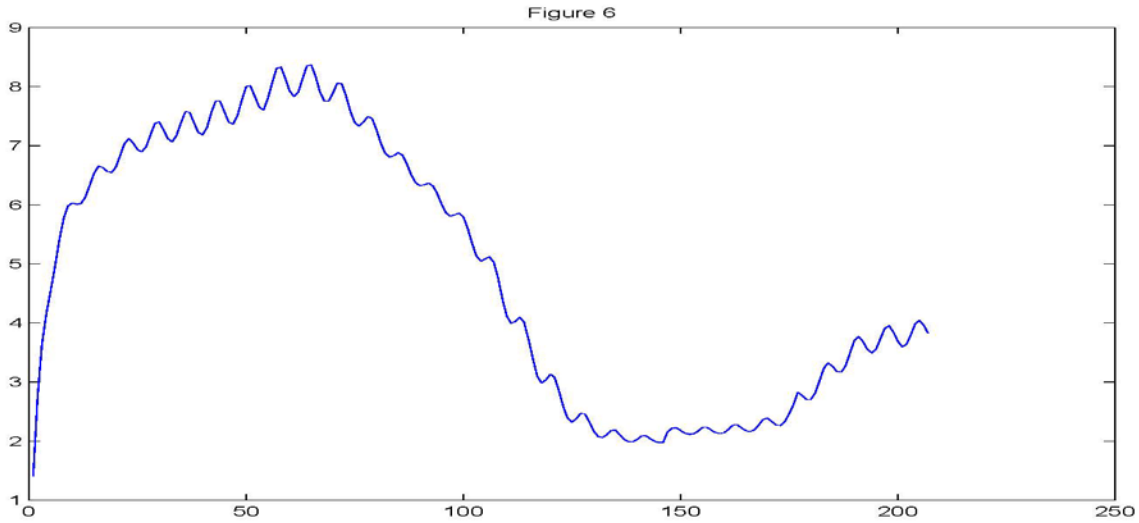
Market Price of Risk Function



Forward & Expected Spot Prices



Risk Premium



Sources of the Risk Premium

- In some respects, large risk premium surprising given that the relevant risk is idiosyncratic (e.g., temperature shocks not correlated with asset prices
- Probably reflects incomplete integration of power markets and broader financial markets
- As markets have become more integrated, premia have declined
- Keynes-type story: "spike-o-phopia"
- Power prices can spike, imposing big losses on shorts: they demand a big premium to sell forward

Hydro Markets

- In the PNW of the US, and in northern Europe, hydro is a major source of generation
- Although power can't be stored, water can be
- Optimal use of water over time is like a storage problem—need to use dynamic programming methods
- Presence of hydro affects price dynamics: more autocorrelation, slower mean reversion