# Energy Market Speculation (and Manipulation)

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# Why Are Oil Prices So High?

- As oil flirts with $100/bbl, economists, policymakers, and consumers ask why?
- There is some consensus that growing demand and tight supply are contributing to high prices, but numerous analysts argue that they cannot explain all of the price rises.
- So, the question remains: Whodunnit?

# Round Up the Usual Suspects

# SPECULATORS!

- Speculators widely blamed for adding $10-$30 per bbl to the oil price.
- “We believe the hike in speculative positions has been a key driver for the latest surge in commodity prices.”
  - Citigroup, May, 2006

# SPECULATORS!

- “Unlike natural gas we estimate that the impact of speculators on oil prices is roughly equivalent in magnitude to the impact of shifts in supply and demand fundamentals (as reflected in stocks).”
  - Goldman Sachs, 2004

# SPECULATORS!

- “Inventory data continues to demonstrate that crude stocks are ample. US crude stocks are now at nine-year highs. Inadequate refinery capacity, ongoing glitches in US refinery operations, geopolitical tensions and increased speculation in the futures market are, however, driving high oil prices.”
  - OPEC Chairman Al-Badri, 2007

# Into the Wayback Machine

- So, now everybody pretty much agrees that long speculators are driving up oil prices.
- But. . . . About 10 years ago, everybody pretty much agreed that short hedgers were driving down gold prices!

# Gold: Hedgers Depress Prices

- “Among the factors depressing the gold price in recent years, forward selling and other hedging activities have been prominent. Producer hedging has added as much as two years' of future production since year end 1996 to normal mine supply. By accelerating future supply, the gold mining industry has exacerbated its woes. In trying to protect against the downside, hedgers have magnified it.”
  - John Hathaway, “The Folly of Gold Hedging,” 1998.

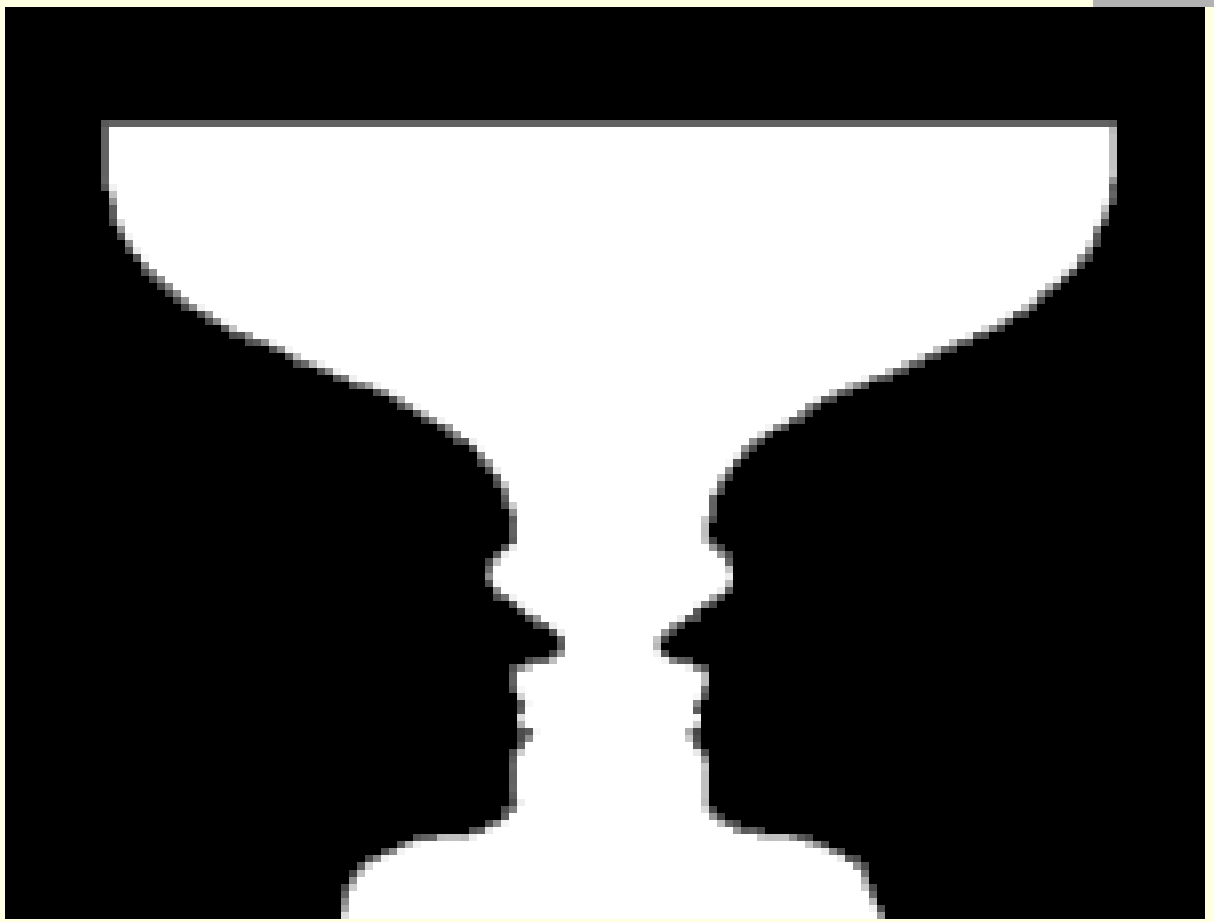
# Gold: Hedgers Depress Prices

- “But hedging has been blamed for contributing to downward pressure on the price - which hit a 20-year low of almost $250 (£156) last summer - because it contributed to flooding the market.”
  - BBC, 8 February, 2000
- In 2002, Blanchard & Co. sued American Barrick and JP Morgan Chase for artificially depressing gold prices through forward sales hedging

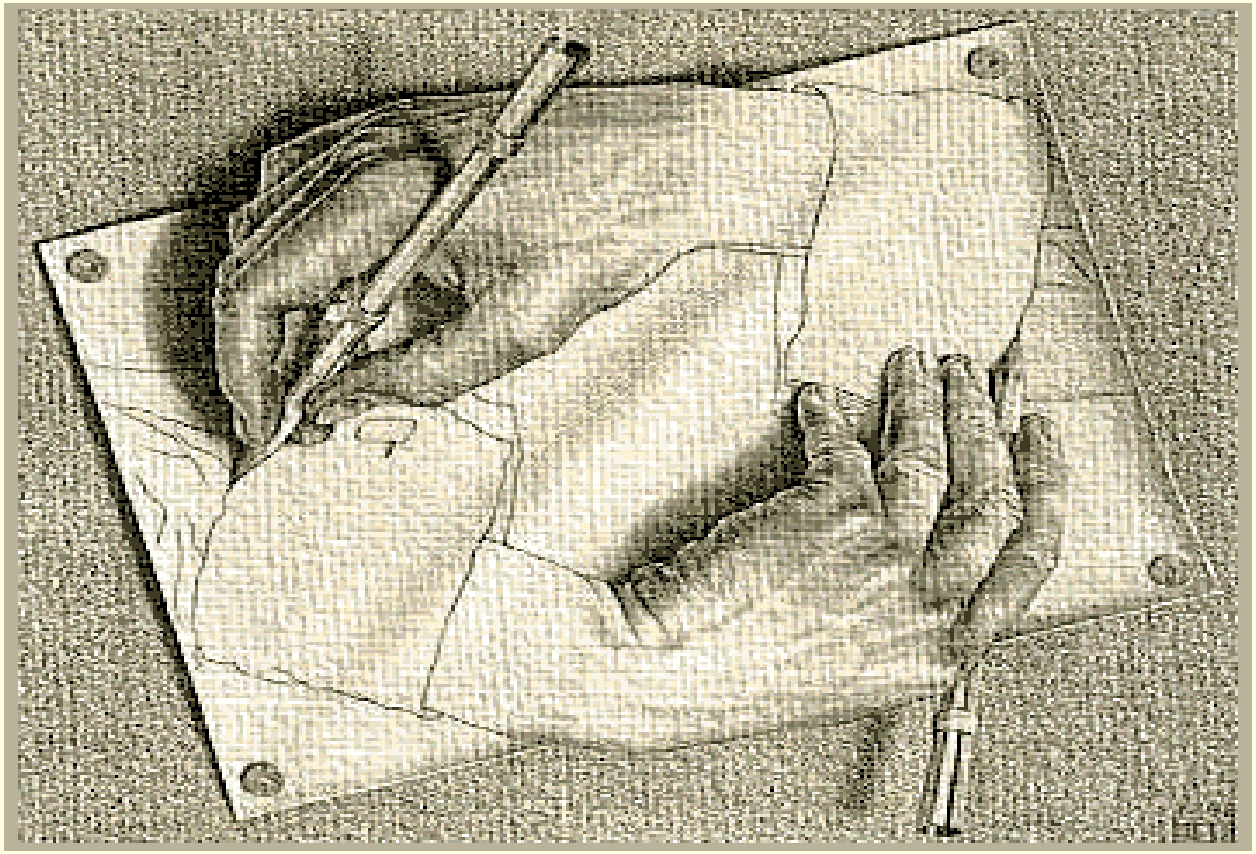
# Does This Make Any Sense?

- Net hedging and net speculation are of opposite sign
- So, short hedging in gold=>long spec in gold
- Long spec in oil=>short hedging in oil
- So, why isn’t short hedging in oil causing low prices?
- Why didn’t long spec in gold cause high prices?

# It All Depends on How You Look at It



# Or Is It This?



# Don’t Overinterpret Accounting Identities!

- As the foregoing shows, you can use data on speculative and hedging interest to support any view on prices you want!
- Think prices too low?—Emphasize short hedging!
- Think prices too high?—Emphasize long speculation!
- Are prices “just right” (sayeth Goldilocks) only when nobody trades???

# A Little More Substance

- Some analysts and market participants discern the influence of speculation by attempting to control for fundamentals
- Most notably, they attempt to control for inventories—a crude (no pun intended) control for supply conditions.
- Especially in 2005-2006, oil inventories were relatively high by historical standards even when prices were high.

# Explaining the Structural Change

- Numerous analysts have asserted that this change in the structural relationship between prices and stocks is the speculative fingerprint
- A US Senate study emphasizes this angle

# Senate Report

- Figure 6 shows the relationship between U.S. crude oil inventories and prices over the past 8 years, and how the relationship between physical supply and price has fundamentally changed since 2004. For the period from 1998 through 2003, the chart shows that the price-inventory relationship generally centered around a line sloping from the middle-left of the chart down to the lower right, meaning that low inventories were accompanied by high prices, and high inventories were accompanied by low prices. For 2004, 2005, and through May 2006, which is the most recently available data, the inventory-price relationships fall nowhere near this downward sloping line; if anything, the points seem to go in the opposite direction, such that higher inventories seem to be correlated with higher prices. Figure 6 clearly indicates that there has been a fundamental change in the oil industry, such that the previous relationship between price and inventory no longer applies.

  Senate Permanent Subcomittee on Investigations, p. 18

# More From the Report

- A number of energy industry participants and analysts have noted the divergence between the ample supplies of crude oil and natural gas, and record-high prices for those commodities, and have attributed some of this disconnect to the presence of speculators in the market. “Gold prices don’t go up just because jewelers need more gold, they go up because gold is an investment,” one consultant said. “The same has happened to oil.”
- “The answer to the puzzle posed by rising prices and inventories, industry analysts say, lies not only in supply constraints such as the war in Iraq and civil unrest in Nigeria and the broad upswing in demand caused by industrialization of China and India. Increasingly, they say, prices also are being guided by a continuing rush of investor funds in commodities investments.”
- Another gas trader said: “It’s all about futures speculators shooting for irrational price objectives, as well as trying to out-think other players – sort of like a twisted game of chess.”

# Yet More

- As will be discussed in the next section, one reason underlying this change is the influx of billions of dollars of speculative investment in the crude oil and natural gas futures markets. As energy prices have not only increased but become more volatile, energy commodities have become an attractive investment for financial institutions, hedge funds, pension funds, commodity pools, and other large investors. One oil economist has calculated that over the past few years more than $60 billion has been spent on oil futures in the NYMEX market below. . . . this frenzy of speculative buying has created additional demand for oil futures, thereby pushing up the price of those futures. The increases in the price of oil futures have provided financial incentives for companies to buy even more oil and put it into storage for future use, resulting in high prices despite ample inventories.

  - Senate Permanent Subcomittee on Investigations, pp. 18-19

# Is There any There There?

- Is the change in the price-inventory relationship the smoking gun?
- There is room for skepticism: both quantities are endogenous (and simultaneously determined), but many analyses seem to treat inventories as an exogenous variable
- Takes a model to beat a “model” (and I’m being generous in characterizing critics of speculation as possessing a “model”)
- What model is appropriate?

# Modeling Storables Prices

- Equilibrium for storable commodities in a competitive economy allocates consumption and production over time in an efficient way
- Need to solve a dynamic programming problem to understand the relationship between prices and inventories
- Inventories are endogenous and determined simultaneously with prices; too often inventory taken as exogenous

# The Literature

- Scheinkman-Schectman (1983)
- Williams-Wright (1991)
- Deaton-Laroque (1995)
- All of these models posit a single net i.i.d. demand shock, and typically focus on agricultural commodities, low frequency data

# Moving On

- Preferable to consider persistent net demand shocks, shorter decision making and price frequency, and non-seasonal production to get a better model for the oil market (and other commodity markets such as copper)
- This allows modeling of high-frequency price dynamics, which is good, as we have a lot of high frequency data on spot prices and forward curves, and for some markets, inventories

# Model I

- Single persistent demand shock
- Competitive agents make inventory decisions daily
- Store to point that spot price equals discounted value of 1 day forward price subject to constraint that storage is non-negative
- Market can go into “daily backwardation” with zero inventories (“stockout”)
- Prices can be at less than full carry over longer maturities even with non-zero stocks

# Model specifics

- Net demand shock follows an OU process (constant variance)
- Slow mean reversion (half-life of a couple of years)
- Convex marginal cost curve with finite capacity for daily output
- In what follows, all parameters are in the equivalent measure (e.g., the drifts in forward price equations include a market price of risk)

# Forward Price

- Forward price solves standard parabolic PDE:

$$0 = F_t - \mu z_t F_z + .5\sigma^2 F_{zz}$$

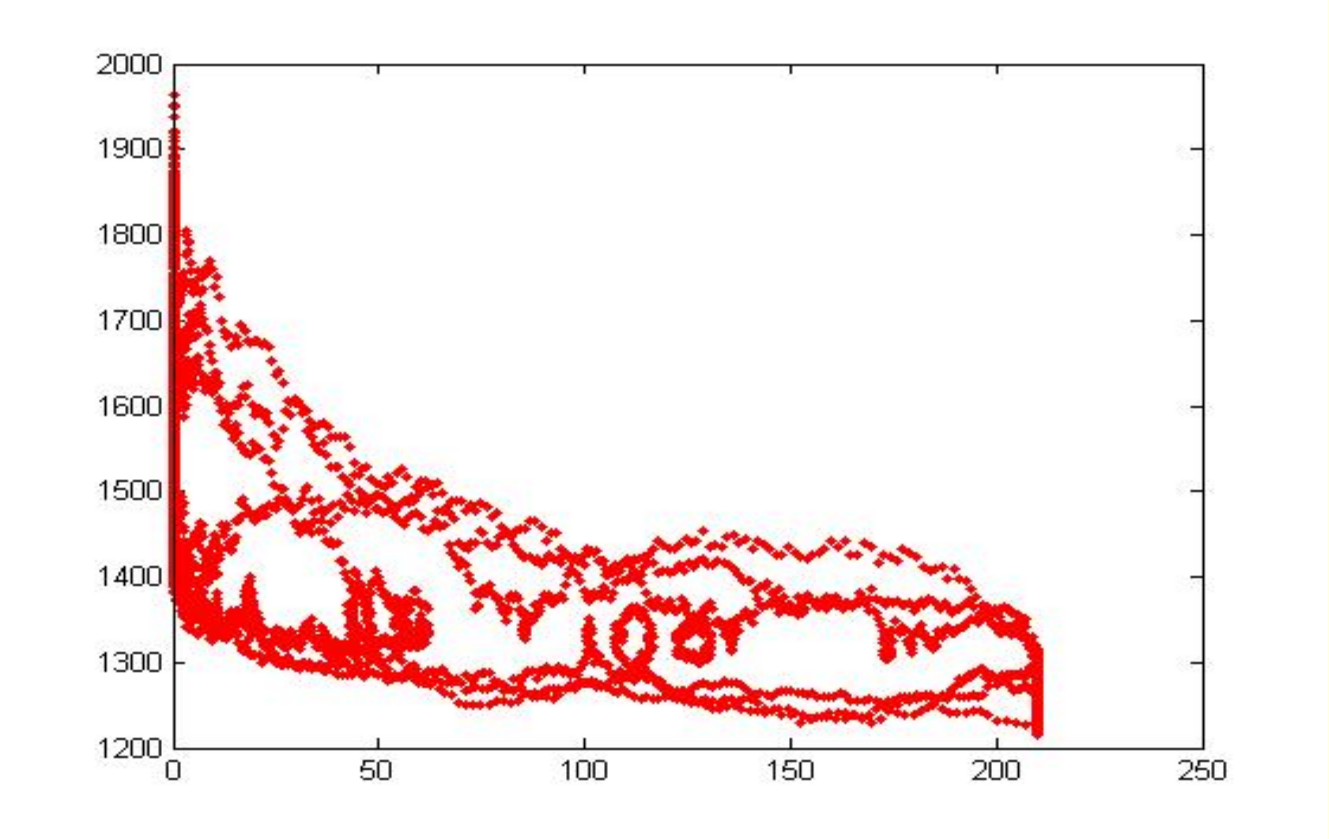
# Solution Technique

- Solve PDE for each level of inventory using finite differences based on guess for spot price function (of inventory and demand shock)
- Solve for equilibrium inventory
- This implies a new spot price function
- Wash, rinse, repeat, until spot price function converges

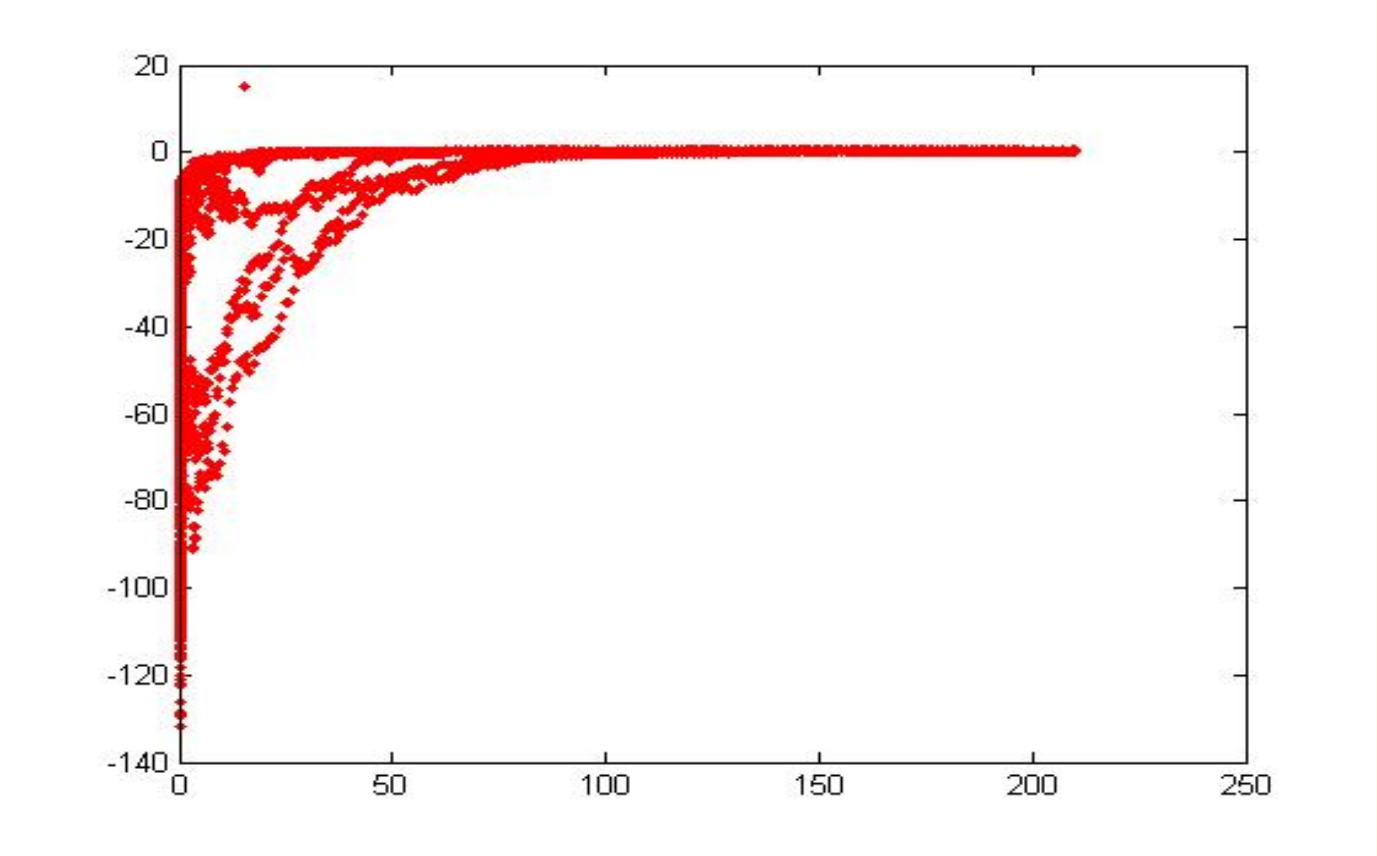
# Results

- Generally price is decreasing in inventory, but there are periods where inventory and prices increase together
- Inventory-Price relation shifts over time, but not dramatically

# Simulated Stock-Spot Scatter



# Simulated Stock-Backwardation



# Going Further

- This is a very simplistic model
- Some thoughts about the reasons for holding inventory suggests some extensions
- Hold inventory to protect against future demand shocks
- This suggests that inventory holding depends on amount of volatility in net demand shock
- There is a reasonable basis to conclude that recent years have seen an increase in volatility of fundamentals

# A Period of High Fundamental Uncertainty

- 2005-2007 was a period of high fundamental uncertainty about hurricanes and geopolitical risk
- After Katrina & Rita (and Ivan in 2004), considerably elevated perception of hurricane risk for 2006
- Geopolitics: Iraq, Lebanon, Iran, Nigeria, Venezuela

# “Petropolitical Risk”

- “Ultimately, the circumstances of risk in [Iraq, Iran, Venezuela, Nigeria] will influence capacity if special situations prevail on a long-term basis. The frequency and impact of disruptions linked to geopolitical problems *appear to be intensifying*.”

  Peter Jackson & Robert Esser, CERA

# An Extended Model

- Can explore the effects of random changes in variability of fundamentals by expanding the state space
- Demand shock exhibits stochastic variance
- Specifically, variance of the demand shock follows a mean reverting square root process:

$$dV_t = \kappa(\theta - V_t)dt + \sigma_v V_t^{.5} dB_t$$

# Net Demand Process

- The net demand process now follows:

$$dz_t = -\mu z_t + \sqrt{V_t}\, dW_t$$

# Forward Price PDE

- The forward price now solves a second order parabolic PDE:

$$0 = F_t - \mu_t F_z + \kappa(\theta - V_t)F_V + .5V_t F_{zz} + .5\sigma_v^2 V_t F_{VV} + \rho\sigma_v \sqrt{V_t} F_{zv}$$

# Boundary Conditions

- Lower variance boundary:

$$0 = F_t - \mu z_t F_z + \kappa\theta F_V$$

- Upper variance boundary:

$$0 = F_t - \mu z_t F_z + .5 V_t F_{zz}$$

# Solving the PDE

- Initial guess for spot price function
- Solve PDE for one day forward price using finite differences, dt=1/365
- Splitting technique (readily allows for non-zero correlation)
- Boundary conditions
- Repeat until achieve convergence

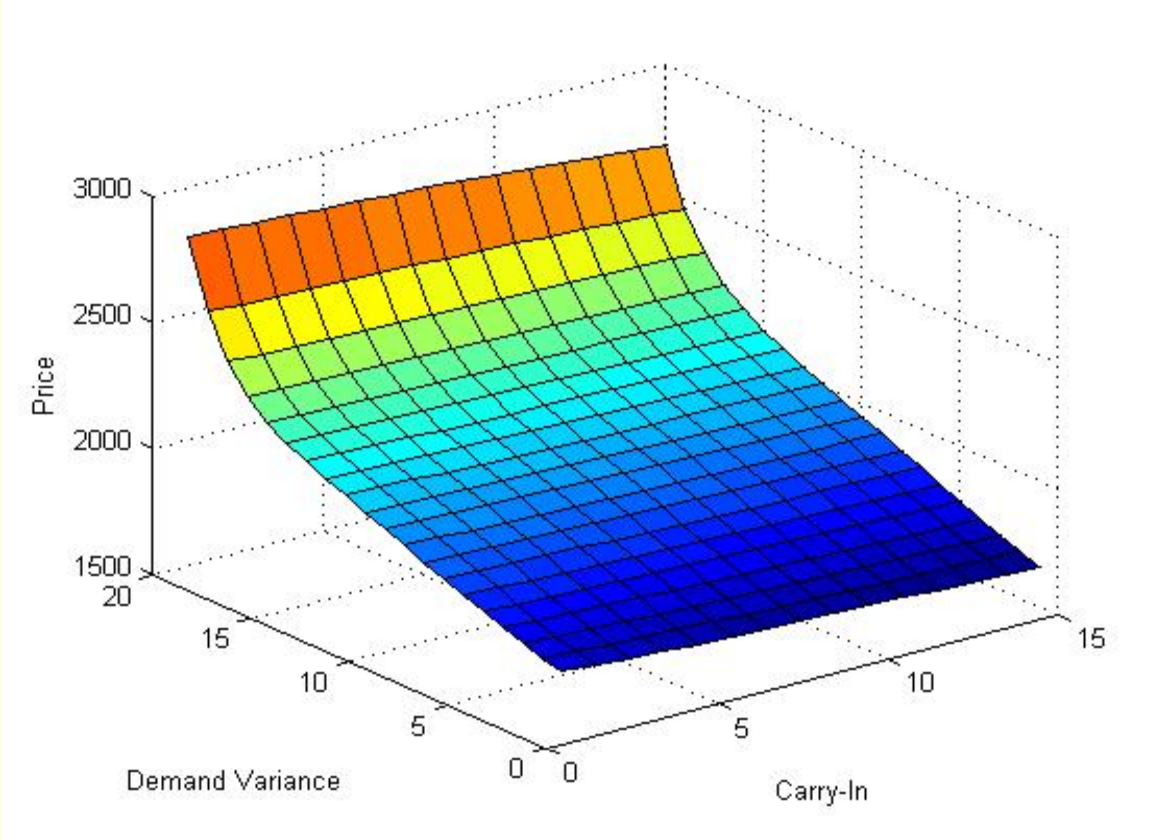
# Results

- Both spot price function (which depends on carry-in, demand state and variance state) and inventory function (ditto) are increasing in instantaneous variance
- Intuitive result
- More volatility—carry more precautionary inventory
- Higher inventory=>lower consumption and higher price
- Convexity of price function=>higher variance=>higher expected price

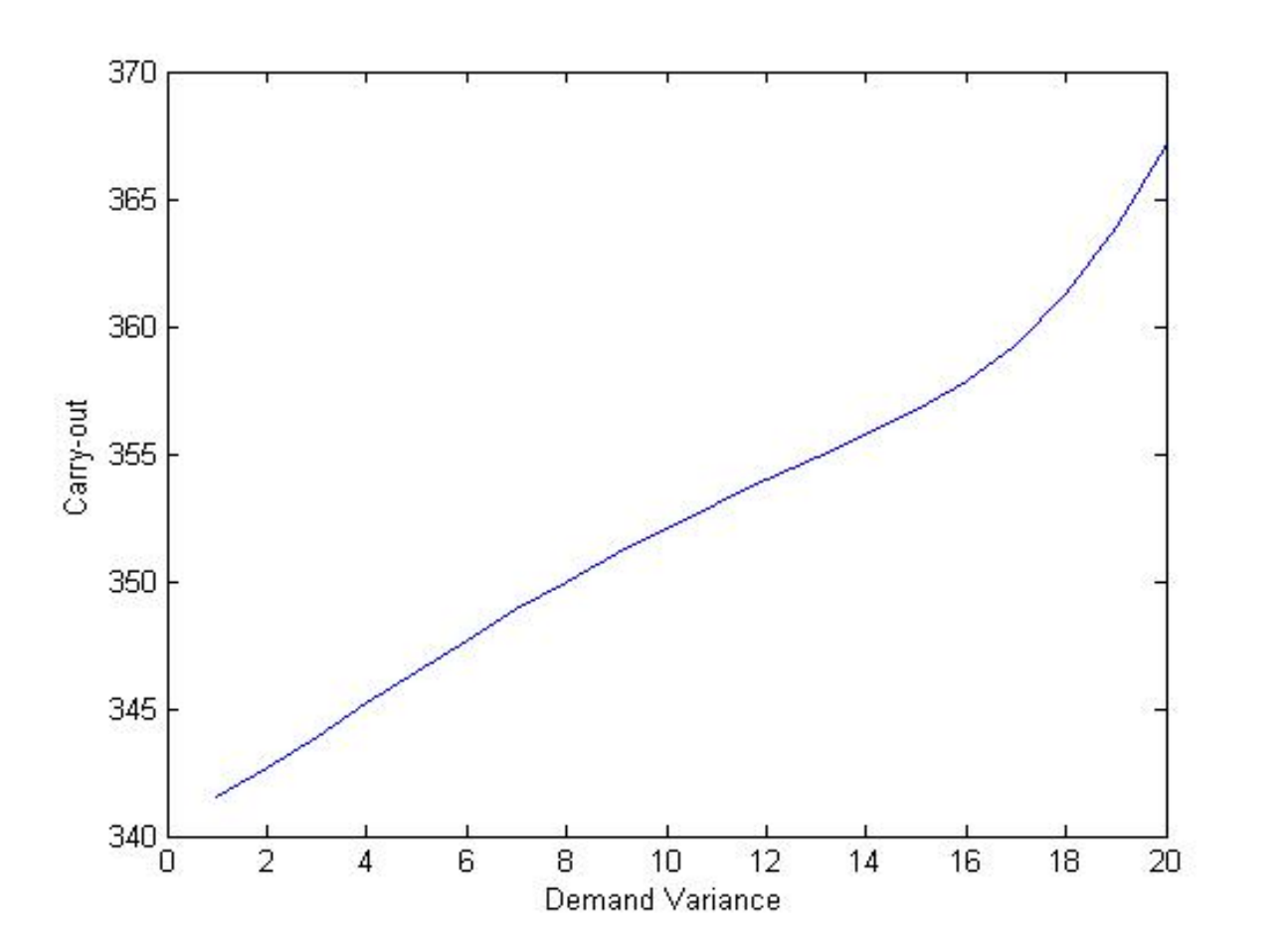
# Implications

- Price-inventory relationship is mis-specified: variance is a missing variable
- Variance shocks can cause shifts in price-inventory relationship
- Indeed, a series of positive variance shocks can lead to simultaneous increases in price and inventories, just like the “anomalous” relation emphasized in the Senate Report

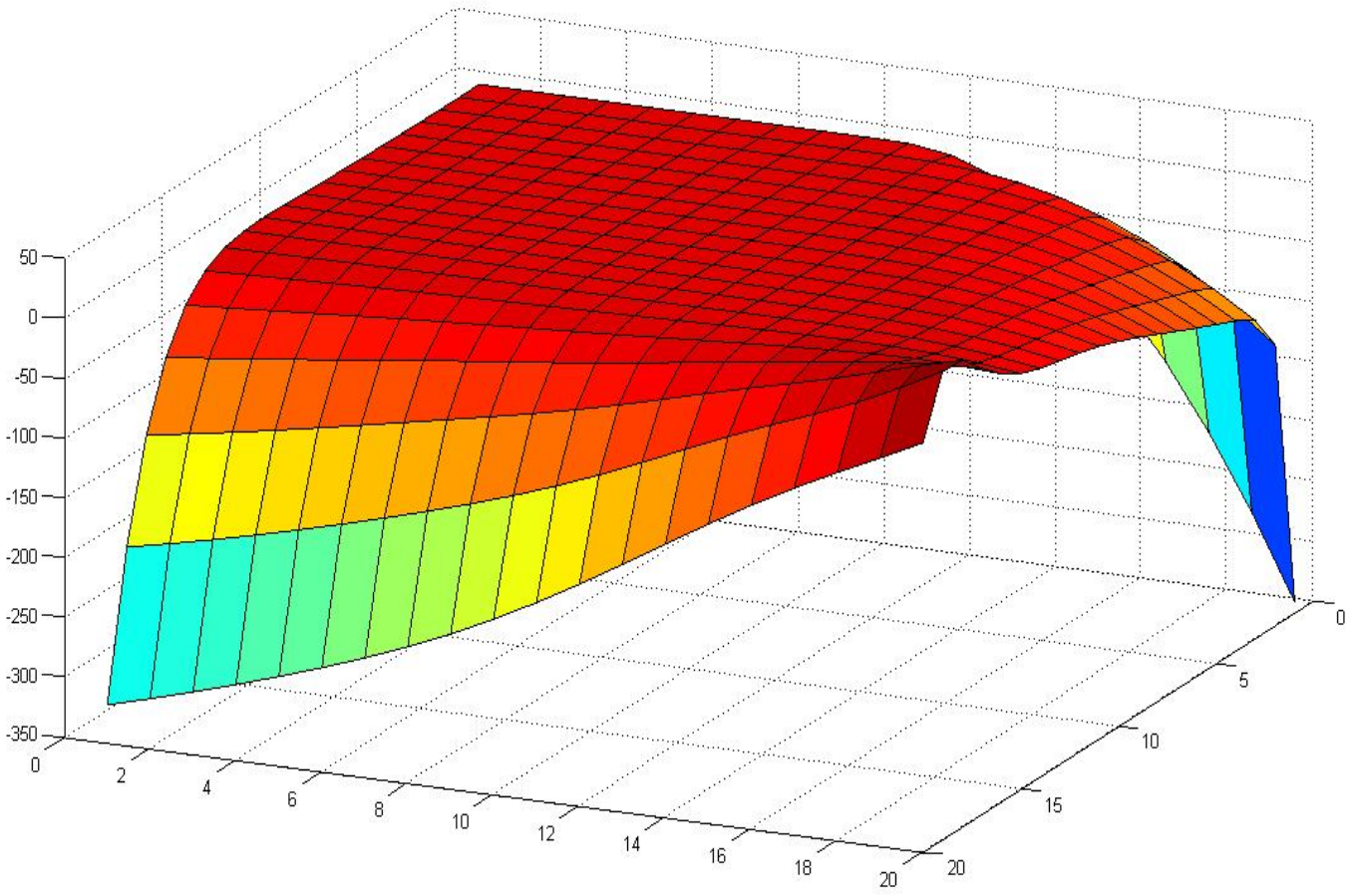
# Price Increasing in Variance



# Storage Increasing in Variance



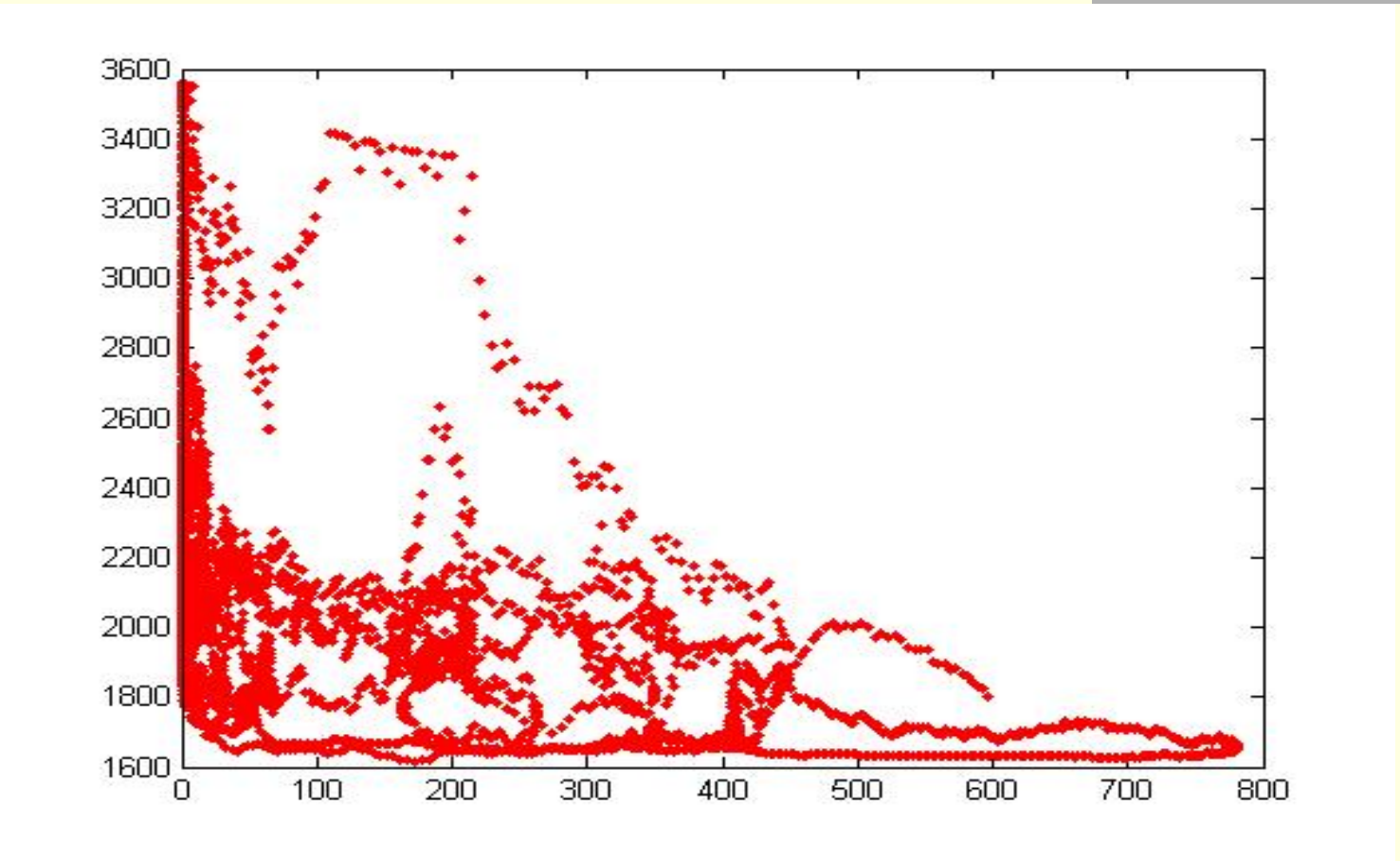
# Backwardation Sometimes Decreasing in Variance



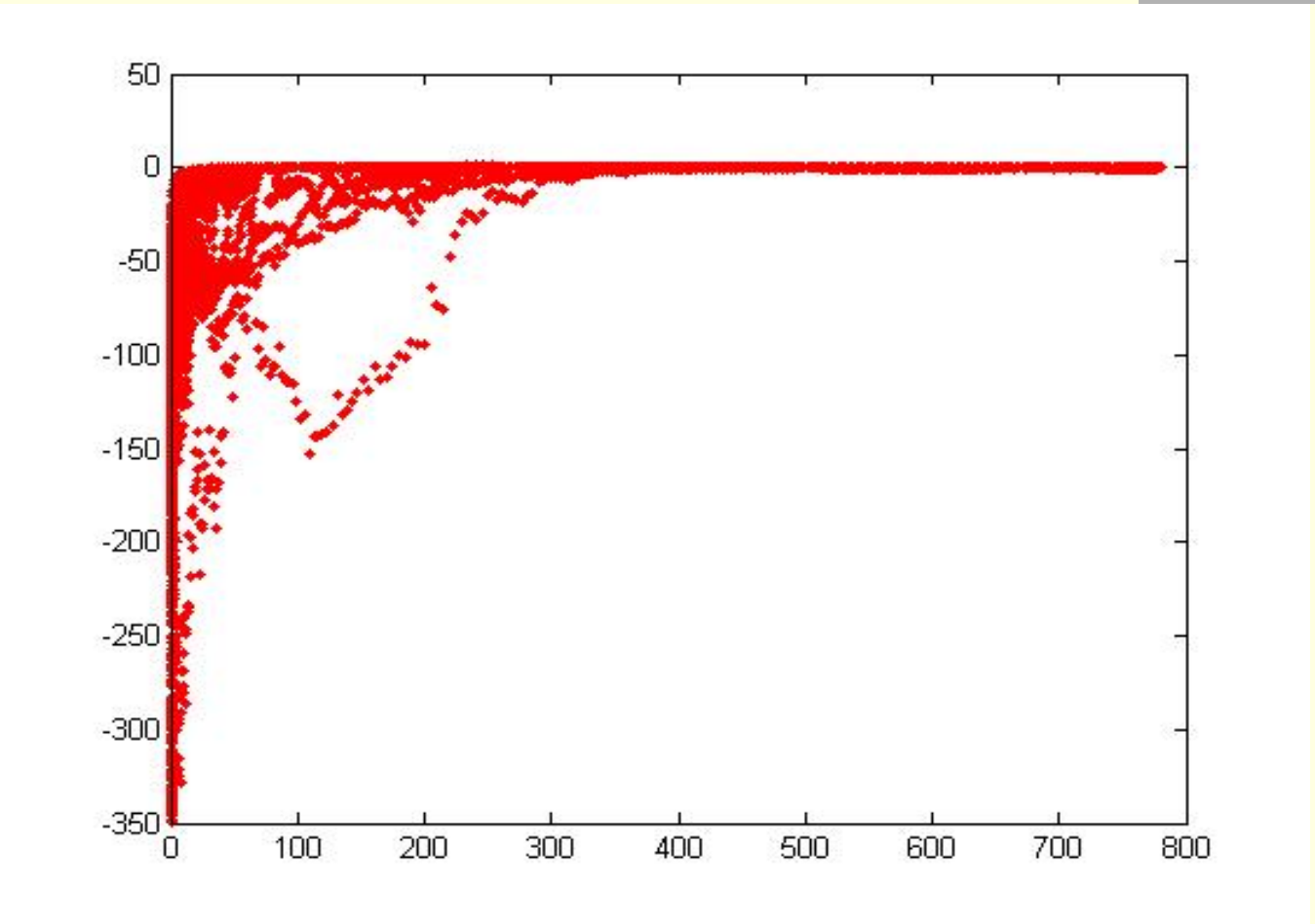
# Simulation Results

- Inventory-price relation much “wilder” than when shock volatility is constant
- Periods of substantial increases in both stocks and prices
- Stocks-backwardation relation exhibits periods with both big stocks and big backwardations

# Relation Between Stocks and Price



# Stocks-Backwardation Relation



# Lessons Learned

- This model is something of a toy, and I have reservations about its ability to capture certain aspects of a complex market, but it does provide insights that cast serious doubt on many analyses of oil market (Remember the one-eyed man is king in the land of the blind!)
- Seemingly anomalous price and inventory patterns make sense when one allows for random shocks to net demand variance
- Variance fluctuations can have a big impact
- Analysts who just make evaluations conditional on current demand-supply balance but neglect variance are omitting a key variable

# Speculators: Crazy Like A Fox?

- Arguably speculators are speculating on the volatility of future net demand shocks
- If they do so, and they rationally take into account random fluctuations in the demand shock variance, in equilibrium they will influence prices in a way that otherwise seem mysterious and irrational
- The Flatland syndrome

# Other Reasons for Skepticism

- Critics of speculation say things like:

- As far as the market is concerned, the demand for a barrel of oil that results from the purchase of a futures contract by a speculator is just as real as the demand for a barrel that results from the futures contract by a refiner or other user of petroleum. The large purchases of crude oil futures by speculators, have, in effect, created an additional demand for oil, driving up the price of oil for future delivery in the same manner that additional demand for contracts for the delivery of a physical barrel of oil today drives up the price for oil on the spot market. (Senate Report, p. 16)

# But . . .

- Speculators in futures typically “roll” their positions before they expire—therefore, they seldom make or take delivery of physical oil.
- Once upon a time, people actually knew better:

“As we have attempted to show, it is a mistake to represent speculation in futures as an organized attempt to depress prices to the producers. First. Because every short seller must become a buyer before he carries out his contract. Second. Because, so far as spot prices are concerned, the short seller appears as a buyer not a seller, and therefore, against his own will is instrumental in raising prices.” (US Industrial Commission, Distribution of Food Products, 1901, p. 233).

# Bottom Line

- The evidence for assertions that speculation is driving prices away from where they “should” be is dubious.
- Economic logic is also problematic.
- However, these arguments are hardy perennials because they are almost impossible to disprove definitively.
- If I knew what the price of oil “should be,” I would be on my yacht sipping Mai Tais, rather than speaking here.
- Nothing personal, of course’-)

# Manipulation

- Manipulation is the other widely cited culprit in the runup of energy prices
- Question is: Just what is manipulation?
- “It is my experience that manipulation is any practice that doesn’t suit the person speaking at the moment.”

# Corners & Squeezes

- Some kinds of manipulation are well understood.
- Corners and squeezes represent the exercise of market power in an expiring futures contract (Pirrong, 1993, 1995, 1996, 2000).
- Distinctive effects on prices and price relations (e.g., Brent squeezes in 1990s-early 2000s.)
- Typically have short-lived effects on prices.
- Not likely to cause deviations of prices from competitive levels for months, let alone years.

# The Key Problem: The End Game

- Arguably a large speculator can cause prices to deviate from the competitive level by buying or selling excessive quantities of futures.
- But . . . . How to profit? Won't liquidation of position cause prices to snap back? Taking transactions costs into account, a symmetric reaction of prices to buys and sells implies these strategies are money losers.
- And how can the speculator finance such a large position?
- Remember the Hunts: turning a large fortune into a small one.
- Bottom line: hard to believe that manipulation is responsible for current price levels in energy markets.