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What Price Should Be Used in Estimating Reserves?

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Reserves Require Some Price Forecast

- **“Economically Recoverable” is a key concept in most all definitions of reserves and resources. The question is not how many hydrocarbons lie under the ground, but how many can be extracted under various technical and economic conditions. There will always be hydrocarbons that are uneconomic to recover under current and foreseeable conditions. Fields will ultimately be abandoned before every last hydrocarbon is removed.**

The U.S. Uses “Existing Economic Conditions”

- In practice, “Existing Economic Conditions” has come to require the use of year-end prices.
- The SEC encourages use of “year-end” prices when calculating proved reserves reported in the financials.
- FASB requires use of “year-end” prices when calculating the “standardized measure” of discounted future cash flows from proved oil and gas reserves.
- Until recently, some companies had resisted SEC encouragement and used their own internal assumptions. But the Shell reserves misstatements gave added weight to SEC pressure.

Exxon Mobil's Cold Lake Example

- In February 2005, Exxon Mobil announced it was switching its reserve reporting to the SEC's preferred "year-end" rule. But in a press release it announced the reserves calculated both under the old method and reserves under the "year-end" rule.
- *"The use of the single-day, year-end pricing methodology resulted in a total proved reserve addition of 1.3 billion oil-equivalent barrels in 2004. On this basis, the Corporation's reserve replacement ratio, including the effects of year end prices and property sales, was 83 percent."*
- **Under the old method**, *"...additions to its worldwide proved oil and gas reserves totaled 1.8 billion oil-equivalent barrels in 2004, excluding the effects of using single-day, year-end pricing. The Corporation replaced 112 percent of production including property sales, and 125 percent excluding property sales."*

Exxon Mobil's Cold Lake Example (cont.)

- *“The most significant single impact of employing December 31 prices occurred for the Cold Lake field (heavy oil-bitumen steam project in Canada), where approximately 0.5 billion barrels were removed from the proved category while still remaining part of our total resource base. Prices for Cold Lake were strong for most of 2004. However, on the day of December 31, 2004, prices were unusually low due to seasonally depressed asphalt sales and industry upgrader problems in Western Canada. Prices quickly rebounded from December 31, and through January 2005, returned to levels that have restored the reserves to the proved category.”*
- **A temporary price dip at year-end that had dissipated before the actual release of the annual report approximately 1 month!**

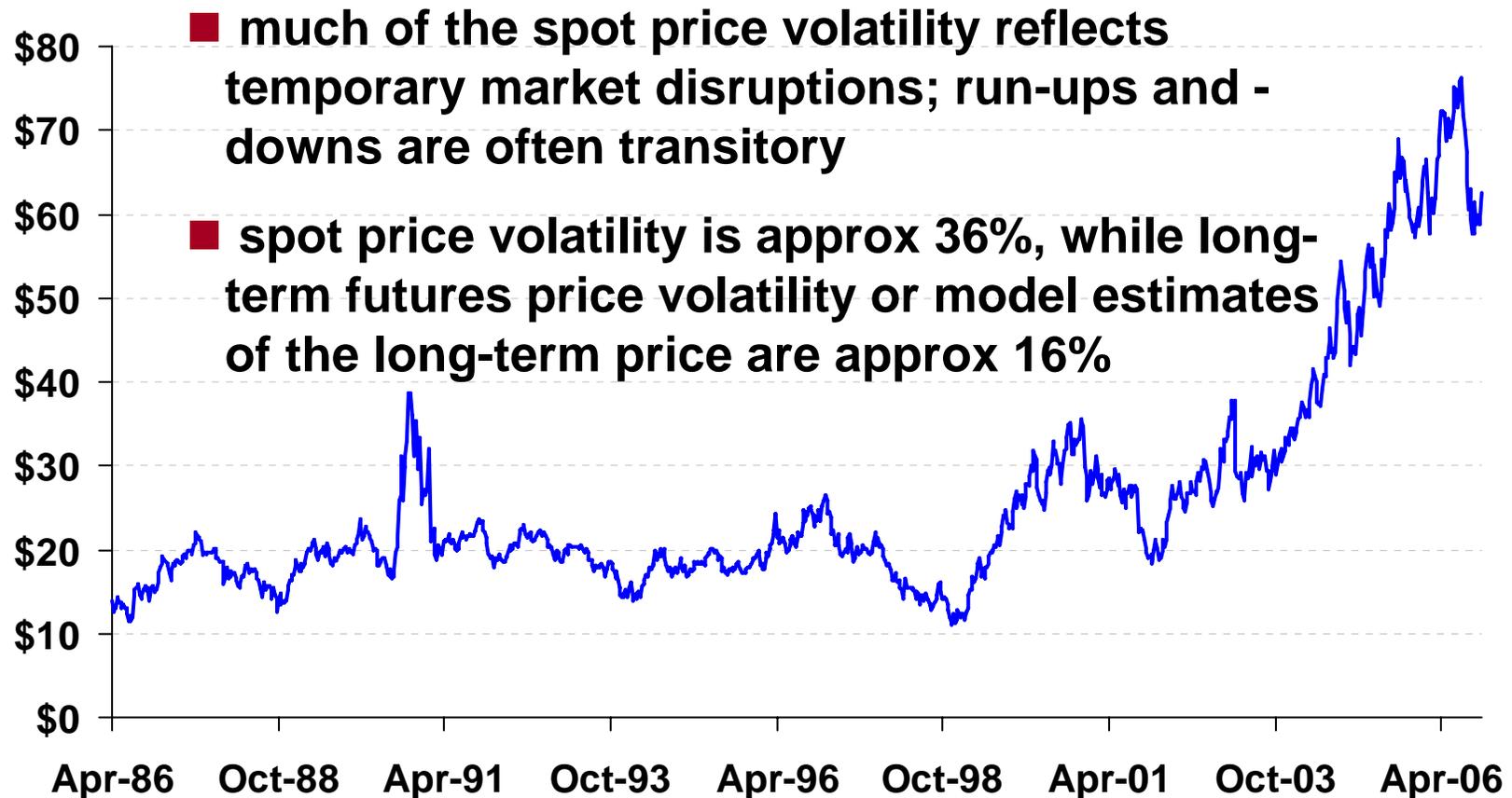
What Price Should Be Used?

- Year-end spot price
- Internal corporate forecasts
- Historical average, e.g., 1-year of spot prices
- Futures price, e.g., year-end, 1-year maturity contract price
- Model price, publicly reported

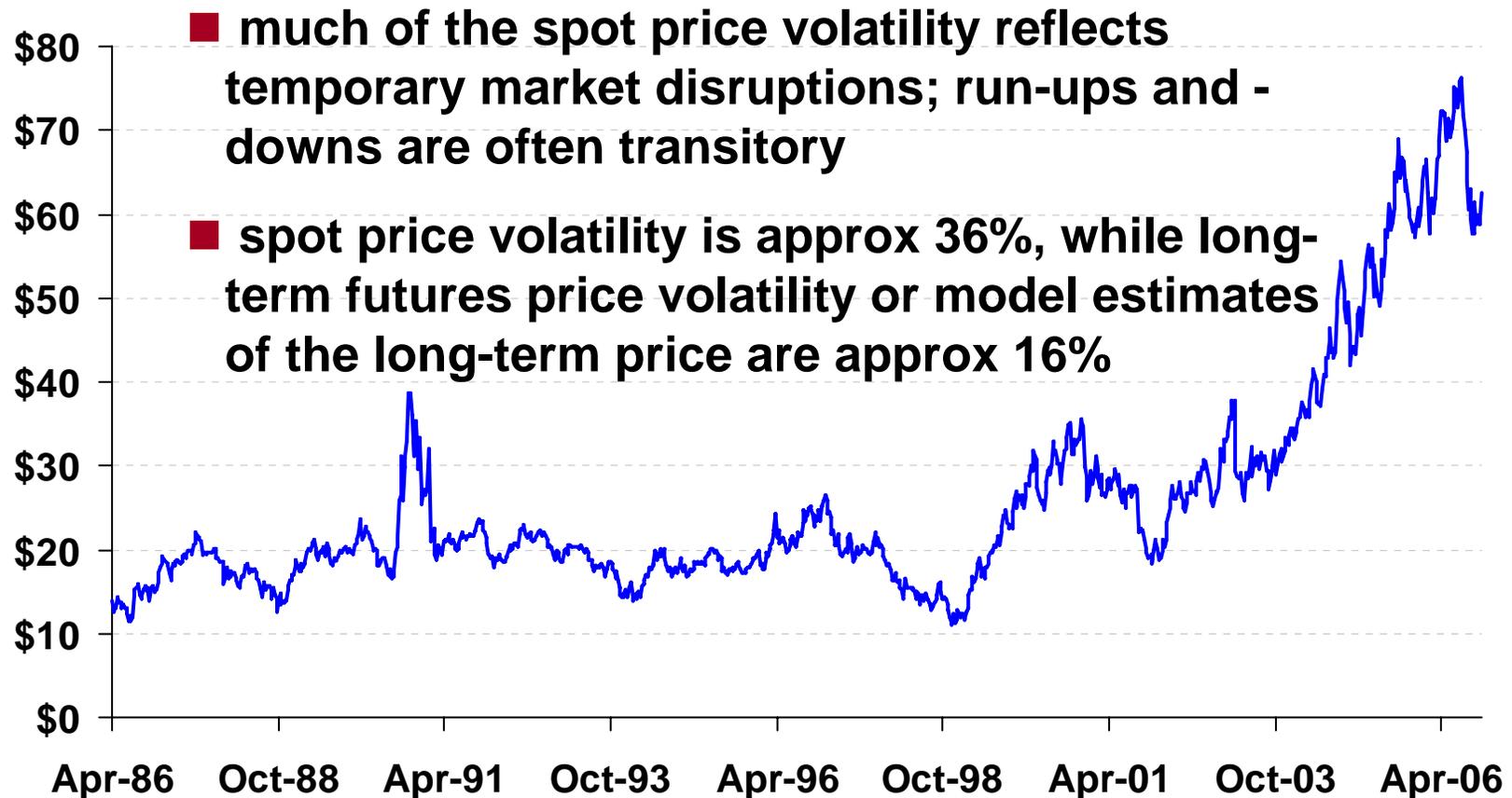
Spot Price Contains Excess Volatility



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■ situation is worse for products like bitumen

Internal Corporate Forecasts

- **these forecasts are generally not revealed,**
- **possible lack of comparability across companies, and even through time for the same company**
- **creates room for discretionary accounting**
 - and while it may appear to solve the excess volatility problem, it may be at the expense of “big bath” style adjustments
- **supported by the contention that “this is how the company is managed” as if that somehow corresponds to the rationale for reserves**
 - reserves as forecasts or reserves as inventory on the shelf
 - disclosure as forecasts or as data for outside investors
- **but has also worked in the past and elsewhere**
- **much room for research and empirical evidence**

Historical Average

- **definitely less volatile than spot prices**
- **but backward looking**
- **works excellently for a stable, mean reverting price process with no long-term uncertainty**
- **postpones recognition of changing long-term price prospects – e.g., the recent 2003-2006 price run-up**

Futures Prices

- **also markedly less volatile than spot prices**
- **theoretically forward looking**
 - significant, if poor quality research on the validity of the expectations hypothesis
 - clearly significant volatility even for the long-term
 - bias reflects a risk premium that is hard to estimate and possibly changing
- **questions about the depth or liquidity of the market and therefore the validity of the reported price**
 - historically true for WTI, but things have changed
 - CFTC study documents marked growth in the WTI futures market at all maturities

CFTC Study

“The NYMEX crude oil futures market has grown steadily this century across all futures expiration dates. In nearby contracts (those expiring within three months) where price discovery is centered, daily net positions have grown by 145% from early 2000 through mid-2006. Growth has been even more dramatic in long-dated contracts (those expiring in three years or more), exceeding 262% over this same time frame. Contracts for six or more years did not exist prior to 1999. As recently as 2000, the crude oil futures market was relatively illiquid at the far end, with open interest in long-dated contracts amounting to less than 4.5% of total open interest. For most categories of traders, however, we find that growth in the long-dated market has now made the size of daily net positions in long-dated futures comparable in magnitude to the size of the nearby market in 2000.”

from *Market Growth, Trader Participation and Derivative Pricing* by Michael S. Haigh, Jeffrey H. Harris, James A. Overdahl, Michel A. Robe, 2007

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 - CFTC study documents marked growth in the WTI futures market at all maturities
- **limited selection of commodities for which meaningful benchmarks exist**

Model Prices

- **No obvious choice based on consensus**
 - not only are there choices across models, but a wide array of choices across parameter estimation methods, inputs, etc.
- **Allowing companies to choose a model just brings us back to internal forecasts, whether good or bad**

What Do The Data Say?



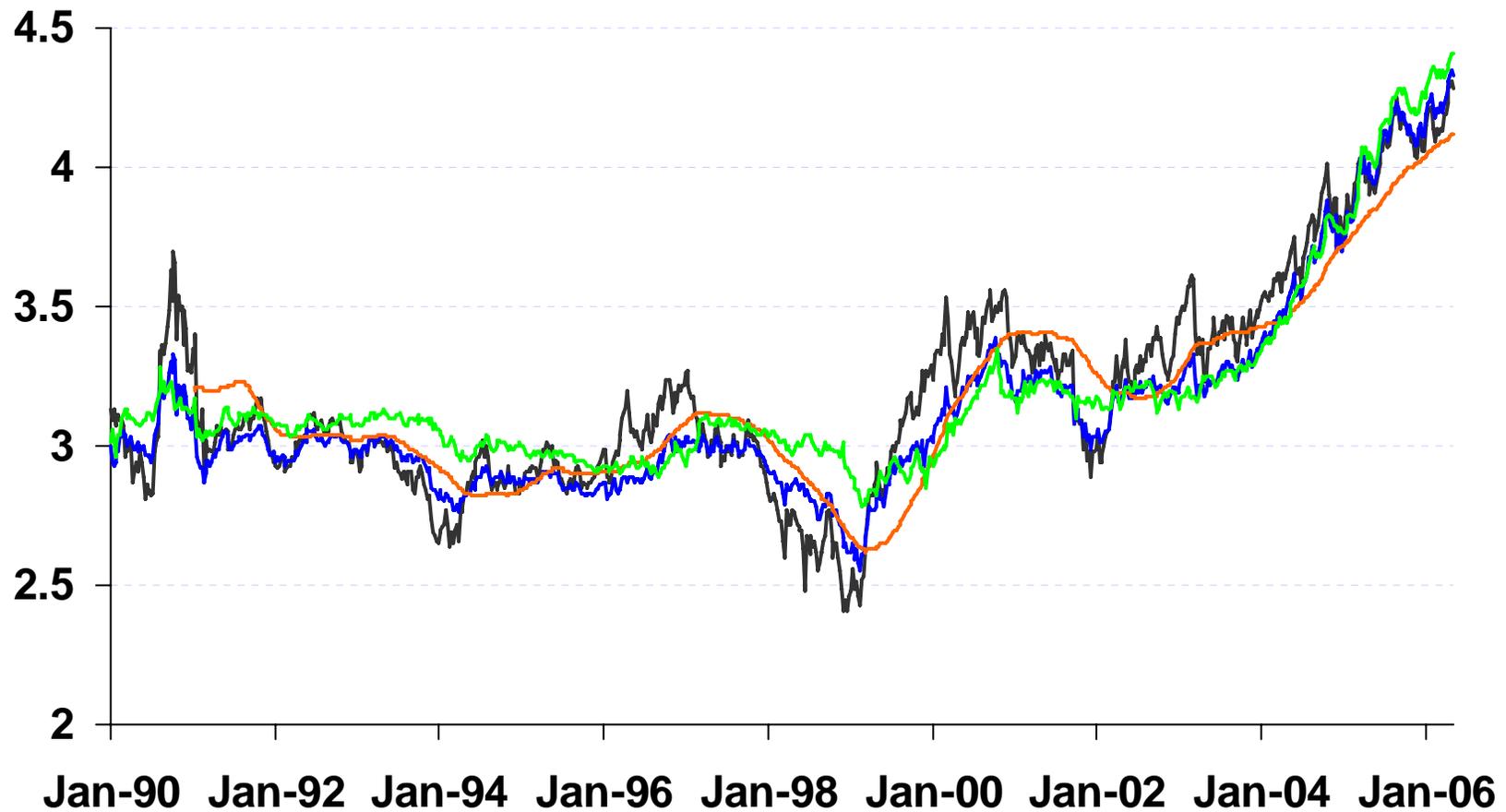
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4 Series: 1990-2006



— Spot Price (1mos) — Futures Price (12 mos) — Moving Avg (1 yr) — Est.LT Price

4 Series: 1990-2006, Logarithmic Scale

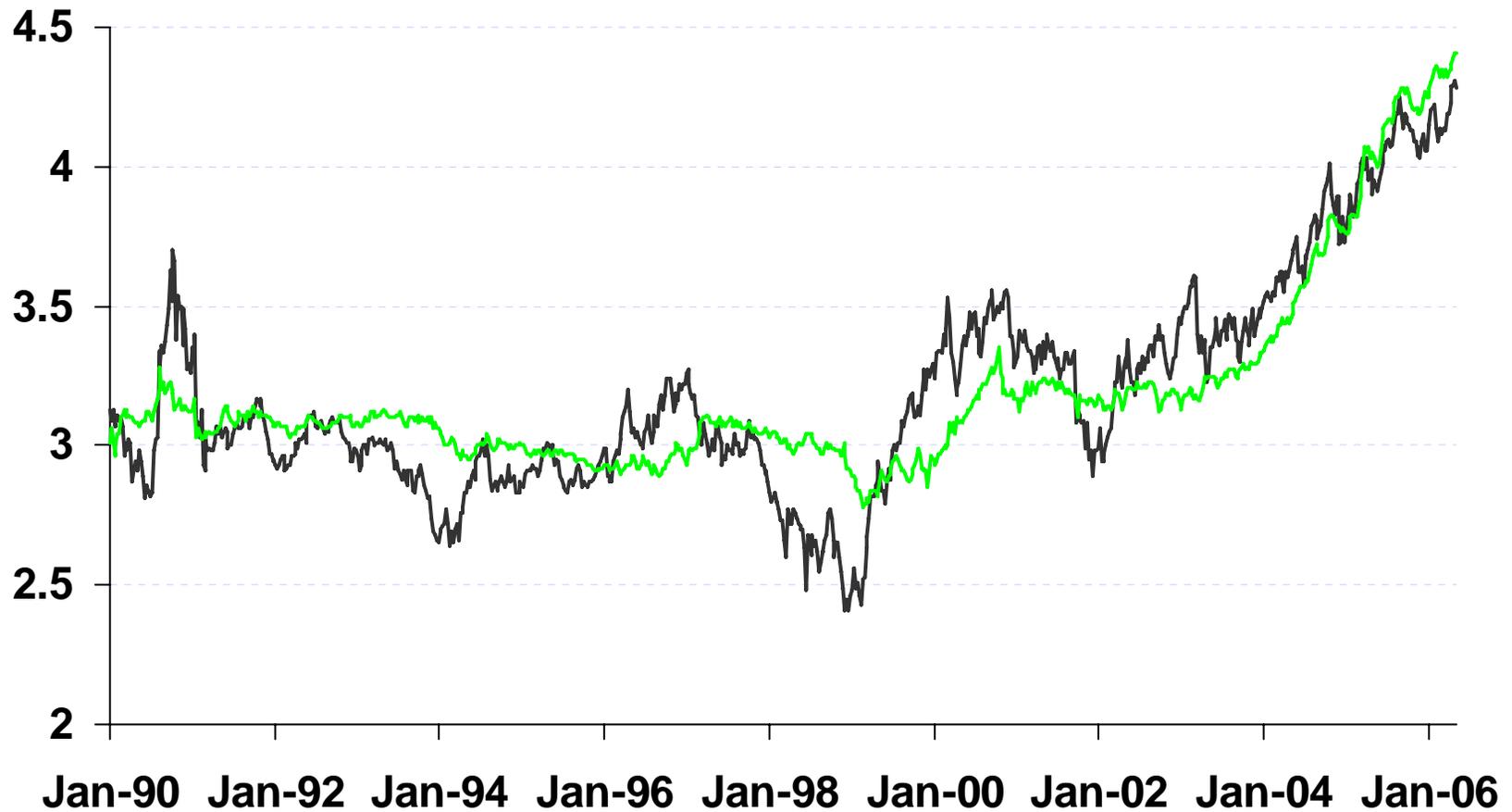


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What is the Benchmark?

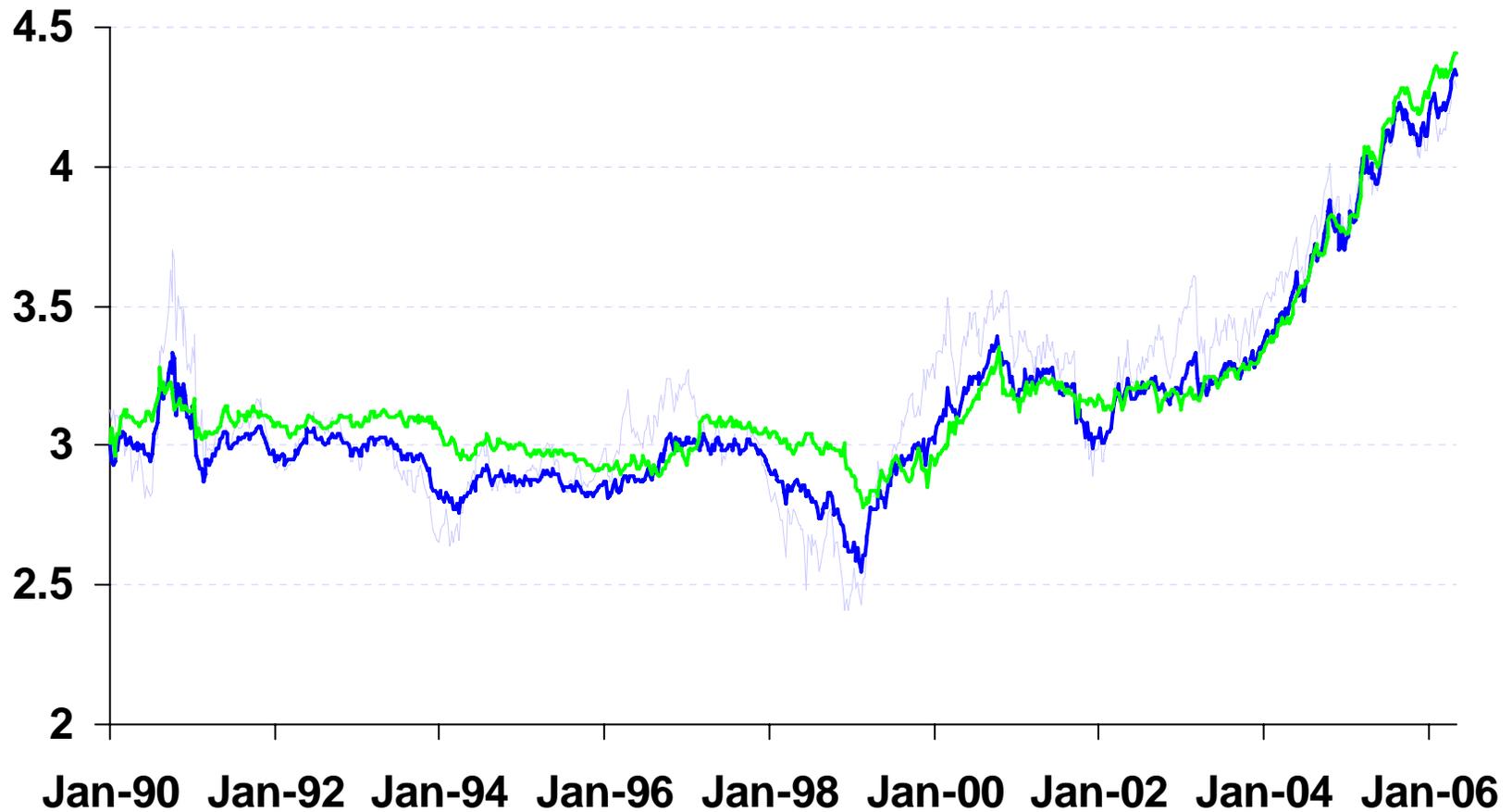
- **Employ a model with an estimate of the current value of the long-term price**
- **A 2-factor model**
 - one factor captures the current value of the long-term cost of oil: the Long-term factor
 - this factor evolves according to a random walk; volatility is 16%
 - second factor captures the current short-term variation of the spot price from the long-term value, embodying short-term supply and demand disruptions
 - this factor evolves according to a mean reverting process: shocks dissipate, eventually to zero with an estimated half-life of 9-10 months; volatility of 31%

The Estimated Long-Term Series



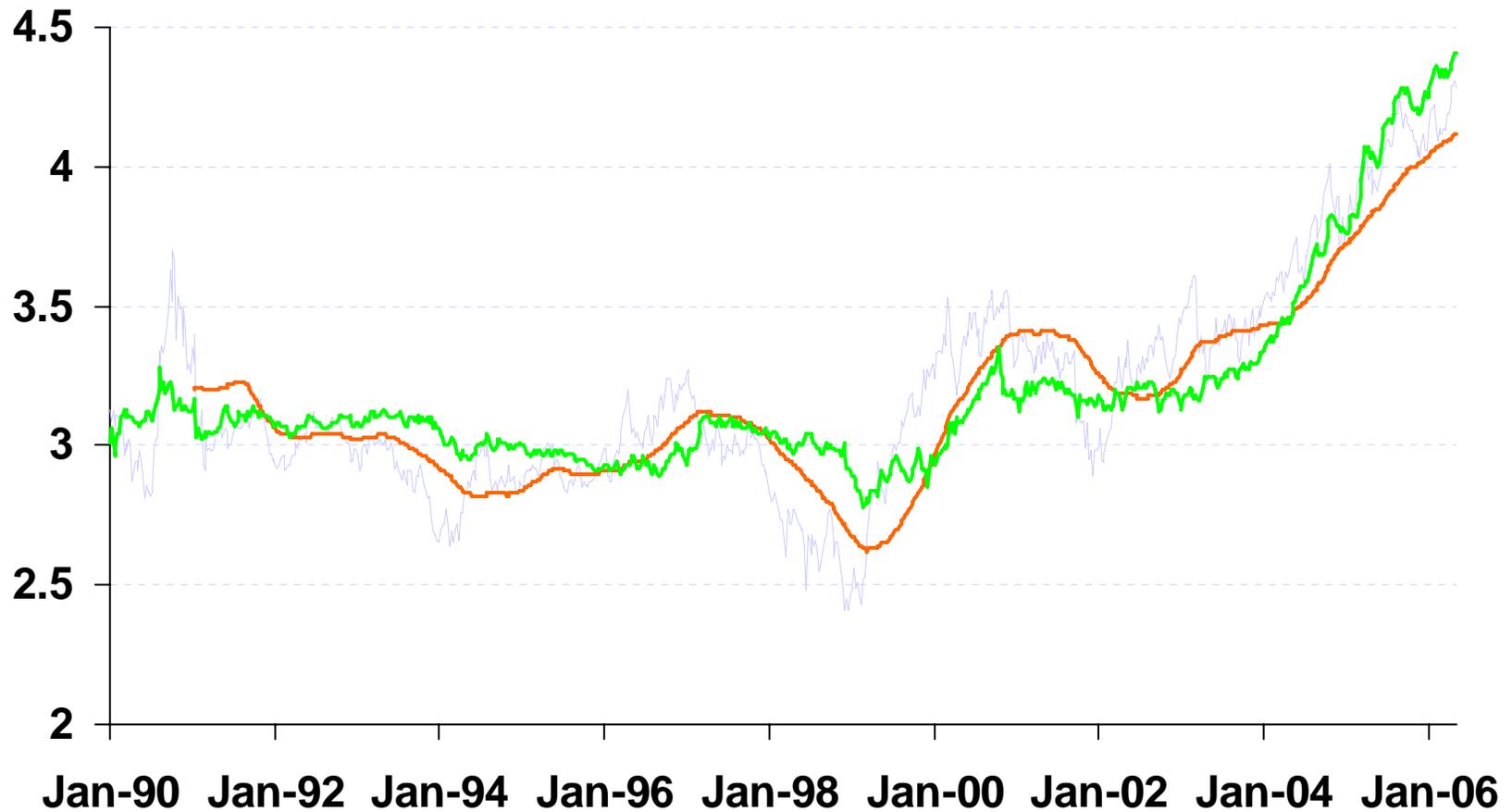
— Spot Price (1mos) — Est.LT Price

Versus the 1 year Futures Price



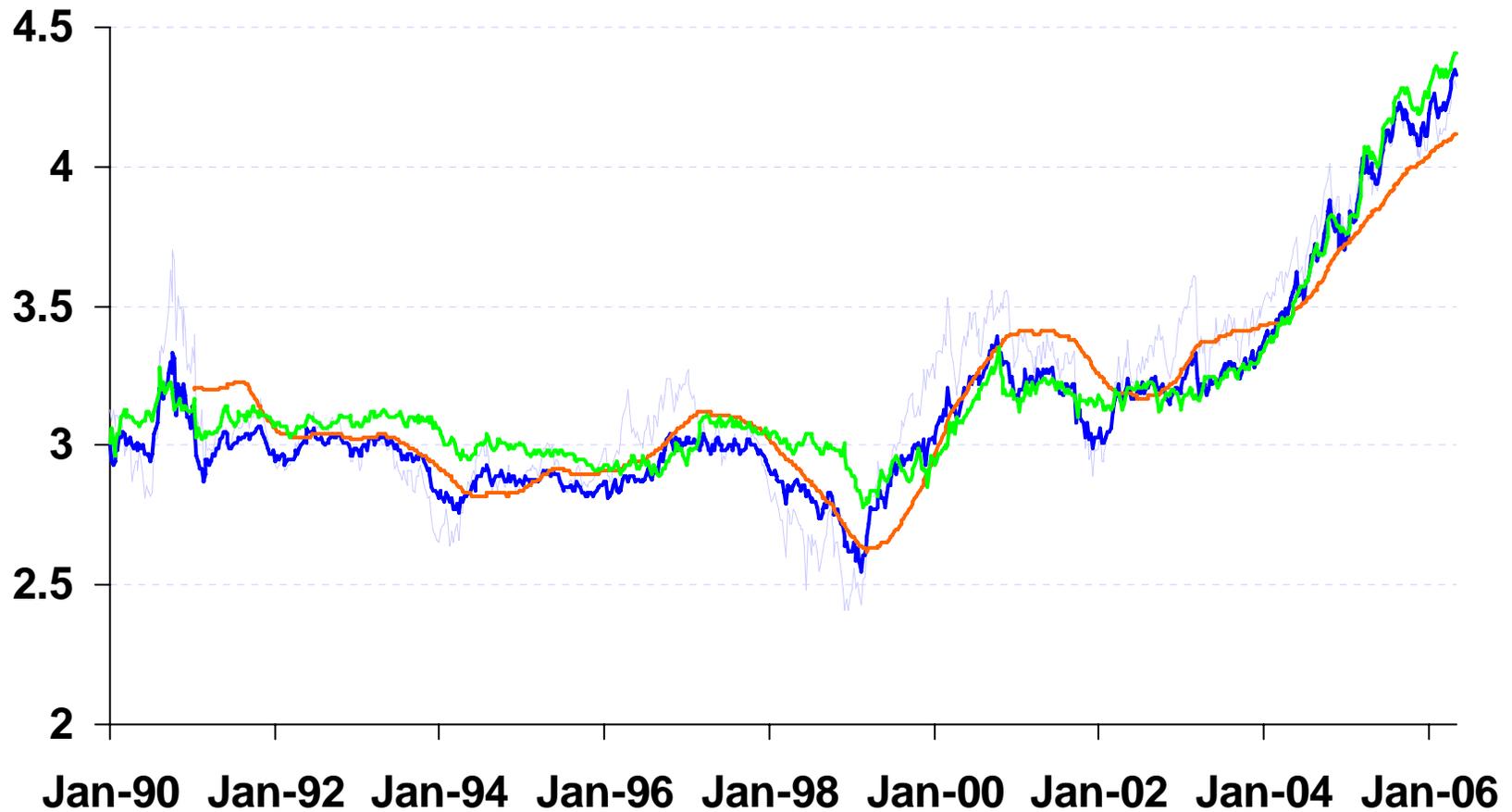
— Spot Price (1mos) — Futures Price (12 mos) — Est.LT Price

Versus the Moving Average



— Spot Price (1mos) — Moving Avg (1 yr) — Est.LT Price

Futures Versus the Moving Average



— Spot Price (1mos) — Futures Price (12 mos) — Moving Avg (1 yr) — Est.LT Price

Simulations

- **Historical Data Provides a Short Sample**
 - 16 annual data points, 1991-2006
 - std dev errors: spot=17%, futures=9%, moving avg=9%
- **Model Can Be Simulated to Produce a Large Sample**
 - e.g., 10,000 runs
 - std dev errors: spot=19%, futures=9%, moving avg=19%