

Non-Standard Time Series

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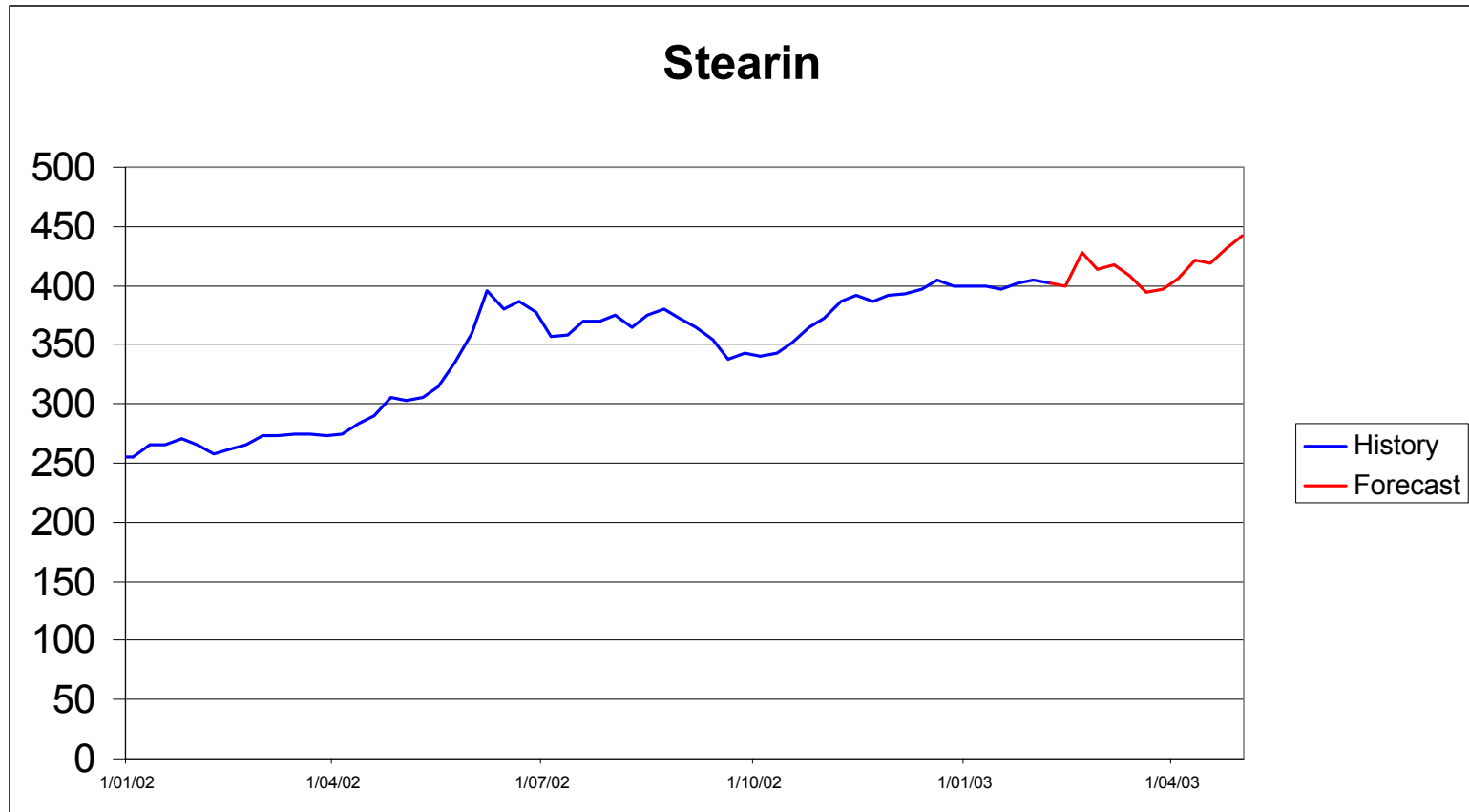
Value at Risk

- Banks and commodity traders do not have to balance their purchase and sales of futures contracts
- This leaves them open to risk of prices moving adversely
- They can cover their positions by more trading, by purchasing options or by holding capital

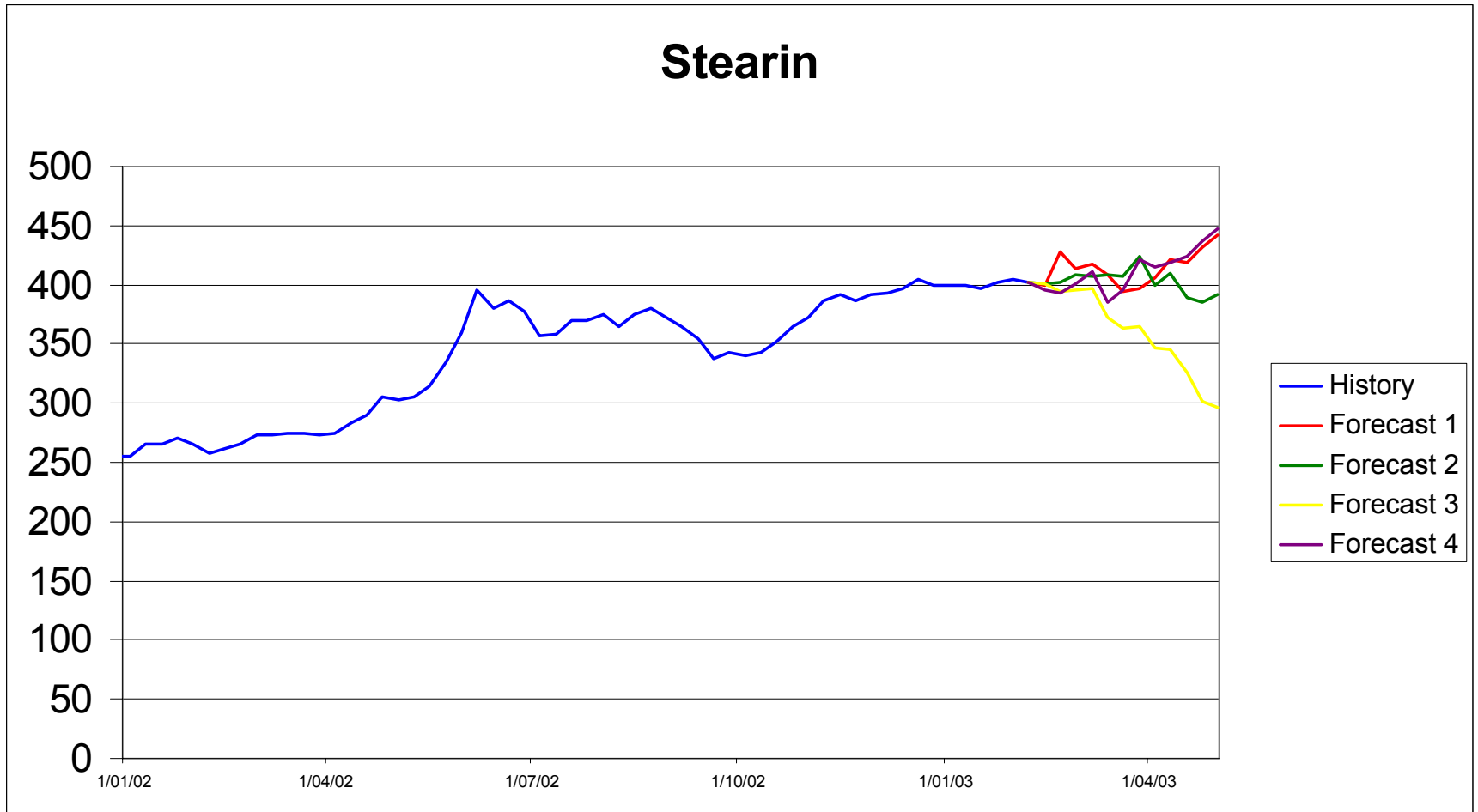
Value at Risk

- Cannot fully hedge some products – so must hold capital instead – but must determine how much capital is required
- Sometimes can partially hedge
- Measure objective trading limits
- Recommended trades to reduce exposure from a position

Is it Forecasting?

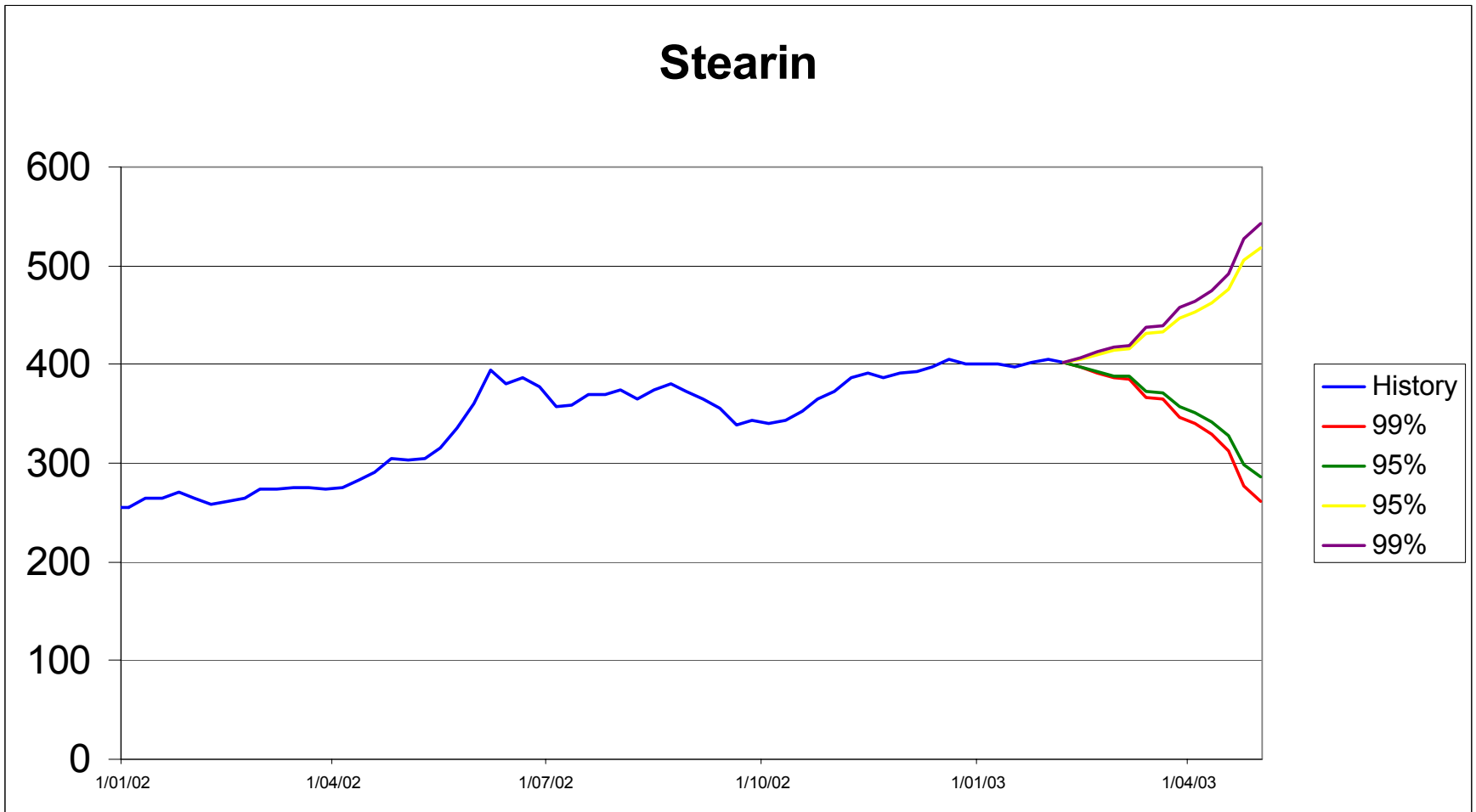


Simulate Possible Future Scenarios

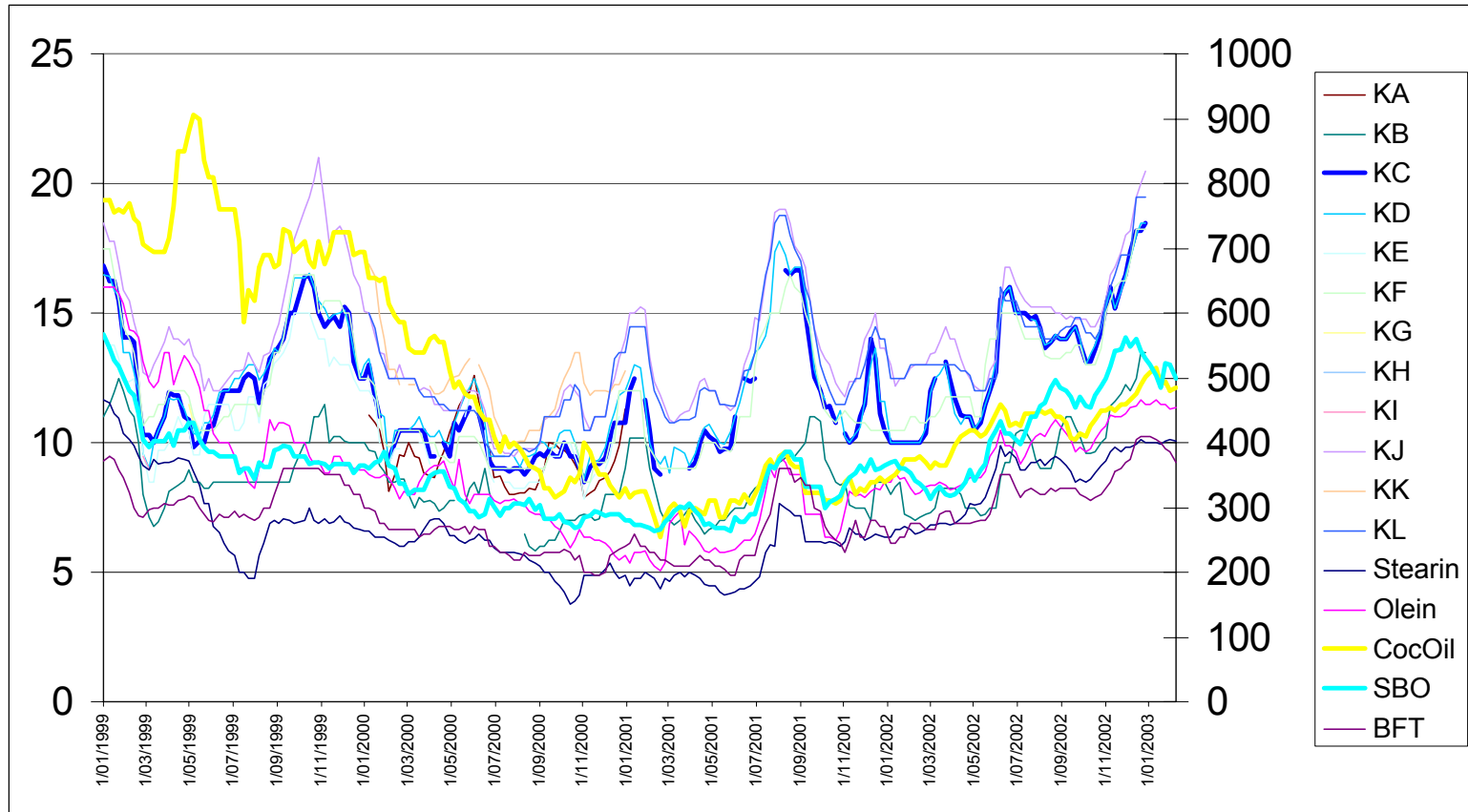


Expanding Funnel of Doubt

- confidence intervals using *lots* of simulations

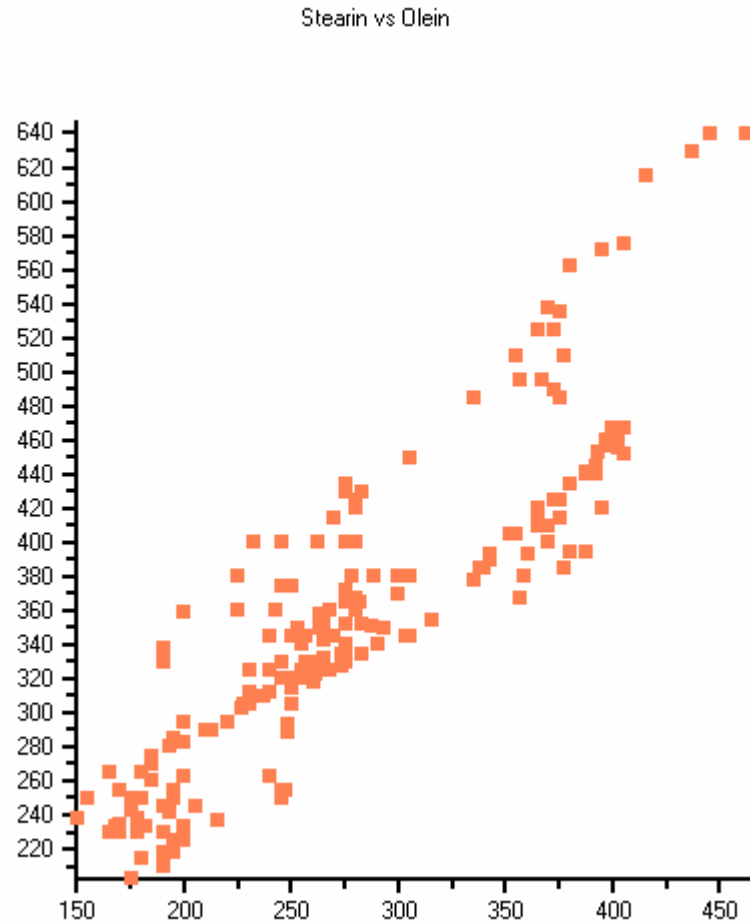


Historical Period



- have there been structural breaks in the series? (Coc Oil?)
- which groups of commodities should move together?
- are there any price leaders?

Correlations



Correlations

- How much prices move together
- How much severe price shocks affect a range of commodity prices
- Measured by *correlation coefficients* and *tail dependence factors*

Correlation Coefficients

	Stearin	Olein	CocOil	SBO	BFT	KA	KB	KC	KD
Stearin	1	0.89	0.47	0.92	0.81	0.26	0.61	0.62	0.55
Olein	0.89	1	0.74	0.85	0.74	0.21	0.51	0.5	0.45
CocOil	0.47	0.74	1	0.46	0.5	0.26	0.32	0.26	0.23
SBO	0.92	0.85	0.46	1	0.84	0.07	0.7	0.71	0.65
BFT	0.81	0.74	0.5	0.84	1	0.62	0.78	0.88	0.86
KA	0.26	0.21	0.26	0.07	0.62	1	0.49	0.79	0.84
KB	0.61	0.51	0.32	0.7	0.78	0.49	1	0.81	0.79
KC	0.62	0.5	0.26	0.71	0.88	0.79	0.81	1	0.99
KD	0.55	0.45	0.23	0.65	0.86	0.84	0.79	0.99	1
KE	0.35	0.39	0.57	0.53	0.86	0.88	0.78	0.95	0.96
KF	0.66	0.56	0.31	0.72	0.9	0.6	0.81	0.95	0.94
KG	0.82	0.84	0.65	0.85	0.72	0.72	0.95	0.79	0.47

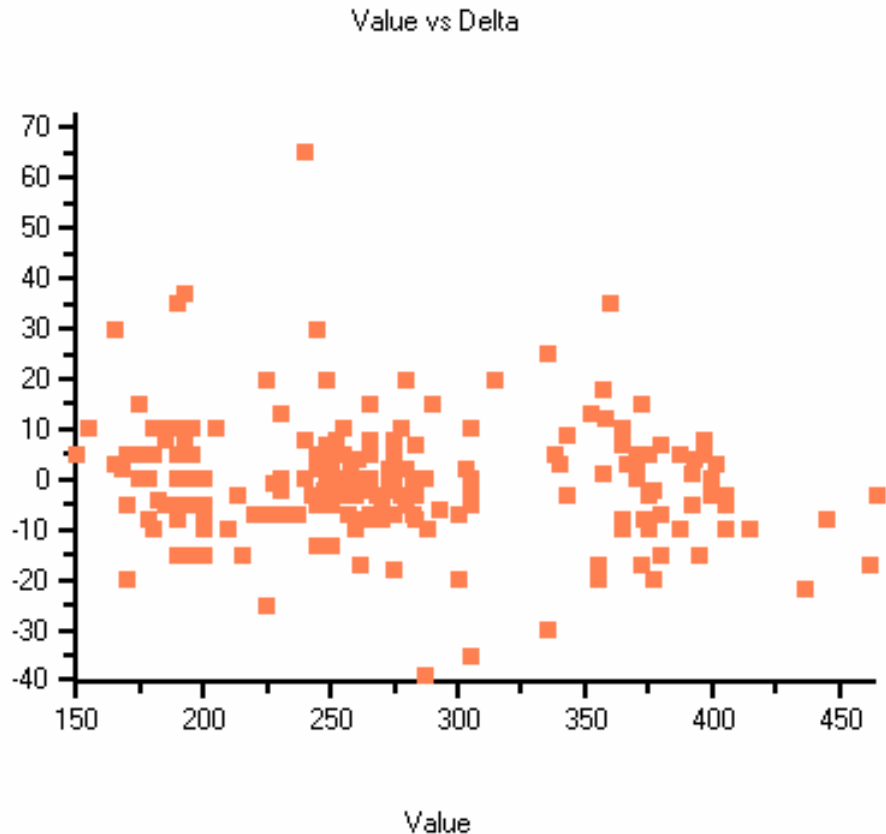
- High correlations mean that different commodities can *hedge* each other
- High correlations mean very little benefit from *diversification*

Time Series Characteristics

- Mean reversion / unit roots
- Continuity of prices
- Correlations of consecutive price changes

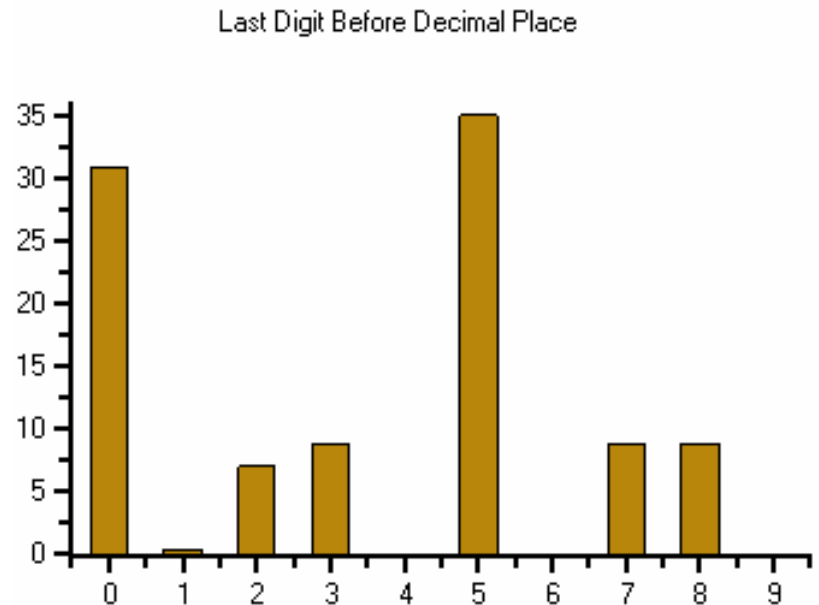
Mean Reversion

- Historical mean reversion is extremely weak
- Cannot reject unit root – possible random walk model, not a simple autoregressive time series



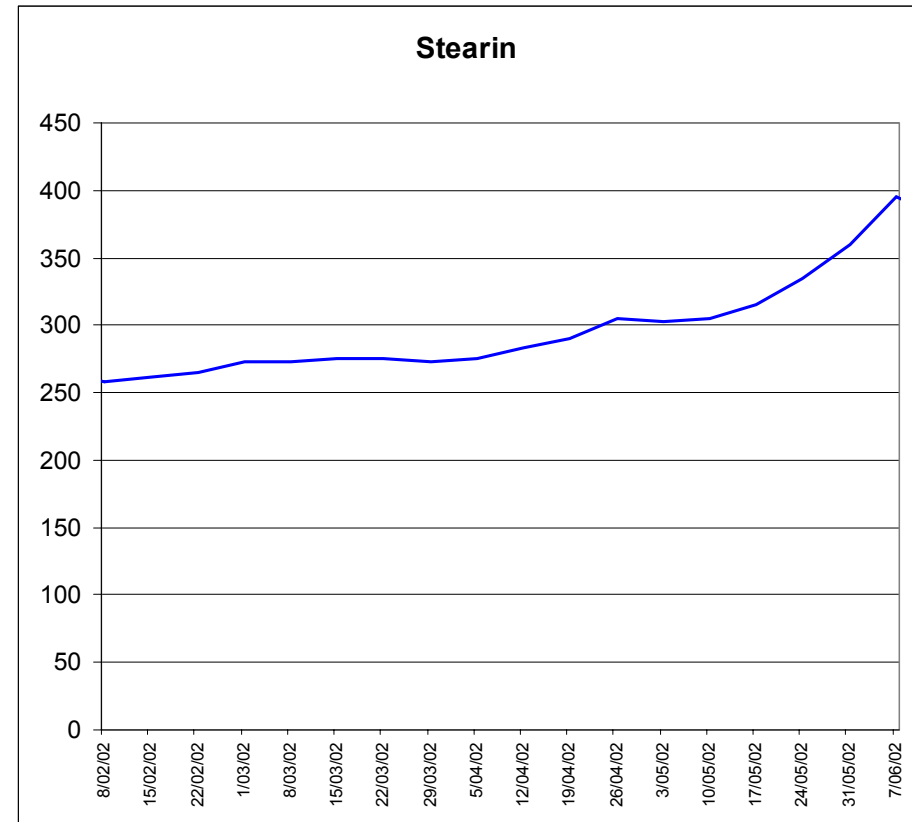
Continuity of Prices

- In a liquid market all prices are as likely and prices can move small amounts
- But historical prices tend to sit around multiples of 5 and 2.5 so price movements tend to be multiples of 5 and 2.5



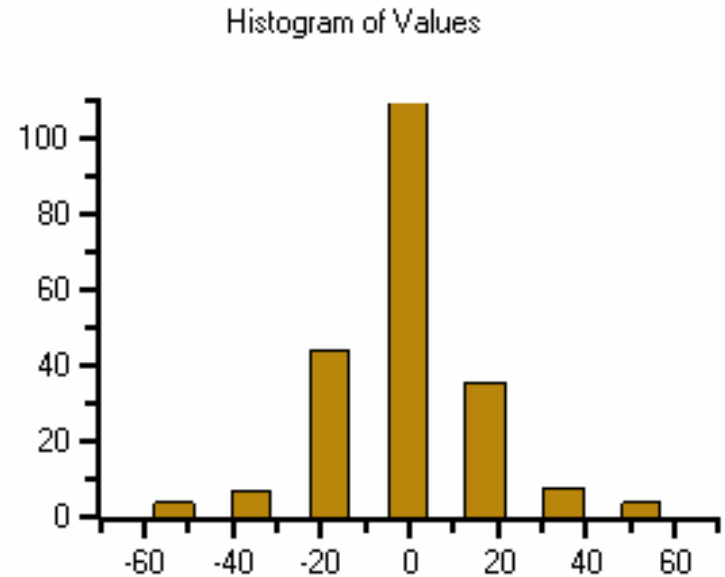
Correlations of Consecutive Price Changes

- In an efficient market prices do not have trends – they instantly and completely react to information
- But historical data shows that consecutive price movements are correlated and there are *periods with a trend*



Leptokurtosis

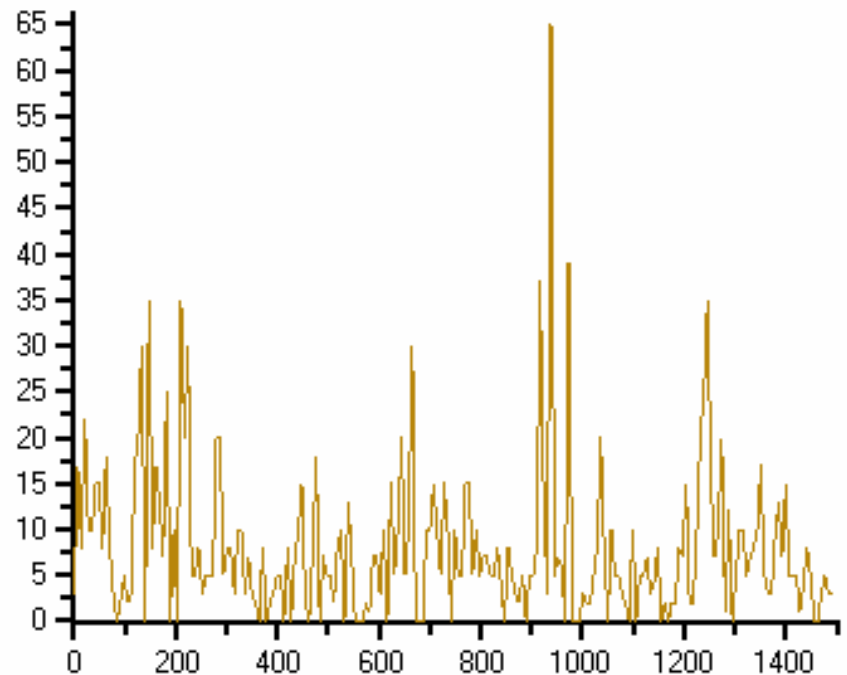
- Standard models use Normal or Log Normal assumptions
- Leptokurtosis means *fat tailed*
- Historical data shows that *extreme price changes* are more likely than suggested by a Normal or Log Normal distribution



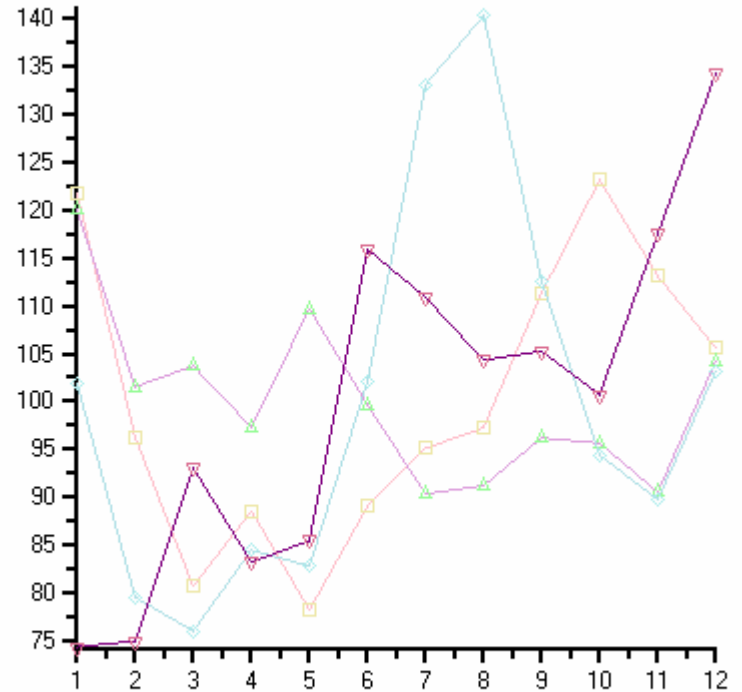
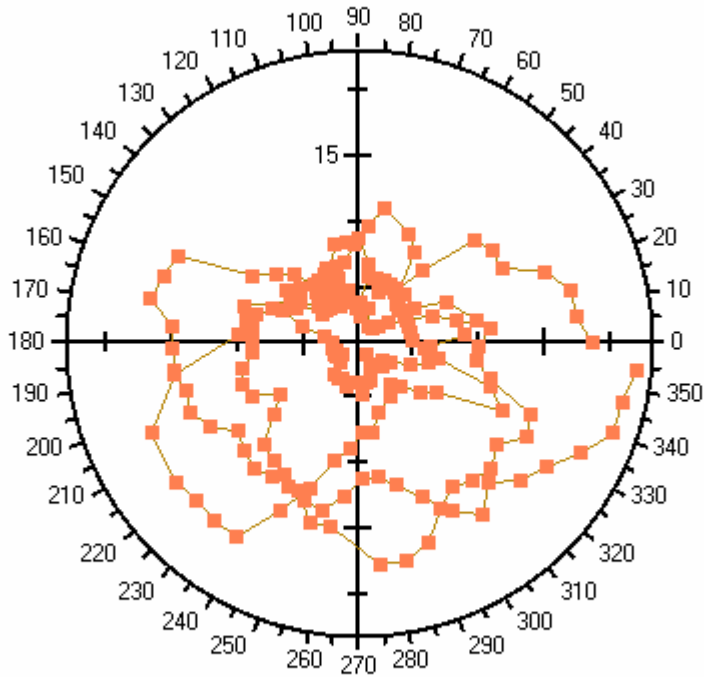
Heteroskedasticity

- simple models assume *constant* spot price volatility
- historical data shows that spot prices have periods of greater *volatility* and periods of relative *stability*

Volatility Time Series



Seasonality

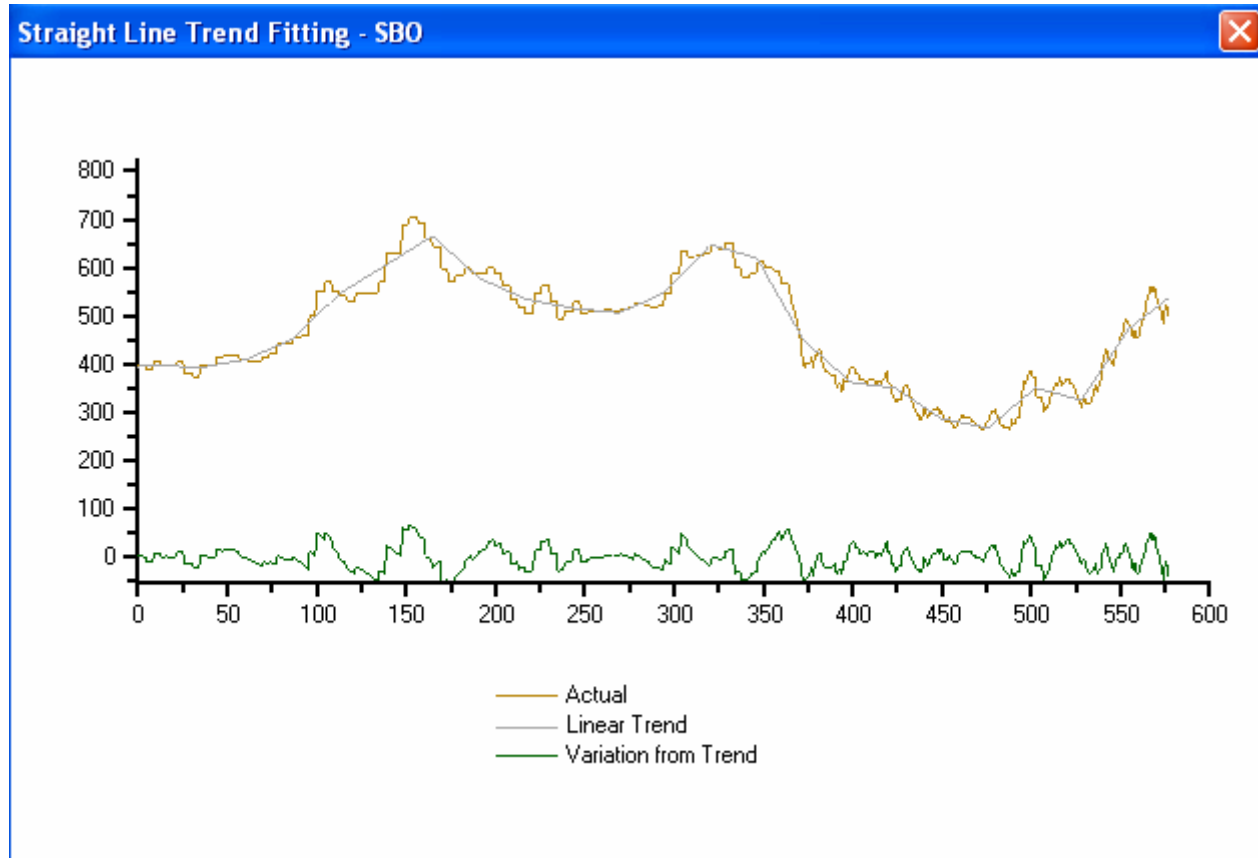


Complexity of Multiple Data Series

Stearin	1	0.89	0.47	0.92	0.81	0.26	0.61	0.62	0.55	0.35	0.66	0.82	NaN	0.78	0.55	0.17	0.62
Olein	0.89	1	0.74	0.85	0.74	0.21	0.51	0.5	0.45	0.39	0.56	0.84	NaN	0.81	0.46	0.2	0.59
CocOil	0.47	0.74	1	0.46	0.5	0.26	0.32	0.26	0.23	0.57	0.31	0.65	NaN	0.76	0.3	0.57	0.22
SBO	0.92	0.85	0.46	1	0.84	0.07	0.7	0.71	0.65	0.53	0.72	0.85	NaN	0.8	0.61	0.43	0.7
BFT	0.81	0.74	0.5	0.84	1	0.62	0.78	0.88	0.86	0.86	0.9	0.72	NaN	0.66	0.86	0.6	0.84
KA	0.26	0.21	0.26	0.07	0.62	1	0.49	0.79	0.84	0.88	0.6	0.72	NaN	NaN	0.55	0.6	0.42
KB	0.61	0.51	0.32	0.7	0.78	0.49	1	0.81	0.79	0.78	0.81	0.95	NaN	0.84	0.8	0.74	0.8
KC	0.62	0.5	0.26	0.71	0.88	0.79	0.81	1	0.99	0.95	0.95	0.79	NaN	0.76	0.92	0.76	0.93
KD	0.55	0.45	0.23	0.65	0.86	0.84	0.79	0.99	1	0.96	0.94	0.47	NaN	0.79	0.92	0.68	0.92
KE	0.35	0.39	0.57	0.53	0.86	0.88	0.78	0.95	0.96	1	0.92	0.94	NaN	1	0.89	0.76	0.75
KF	0.66	0.56	0.31	0.72	0.9	0.6	0.81	0.95	0.94	0.92	1	0.99	NaN	0.63	0.93	0.73	0.92
KG	0.82	0.84	0.65	0.85	0.72	0.72	0.95	0.79	0.47	0.94	0.99	1	NaN	NaN	0.91	0.35	-0.5
KH	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	1	NaN	NaN	NaN	NaN
KI	0.78	0.81	0.76	0.8	0.66	NaN	0.84	0.76	0.79	1	0.63	NaN	NaN	1	0.85	NaN	NaN
KJ	0.55	0.46	0.3	0.61	0.86	0.55	0.8	0.92	0.92	0.89	0.93	0.91	NaN	0.85	1	0.87	0.98
KK	0.17	0.2	0.57	0.43	0.6	0.6	0.74	0.76	0.68	0.76	0.73	0.35	NaN	NaN	0.87	1	0.82
KL	0.62	0.59	0.22	0.7	0.84	0.42	0.8	0.93	0.92	0.75	0.92	-0.5	NaN	NaN	0.98	0.82	1

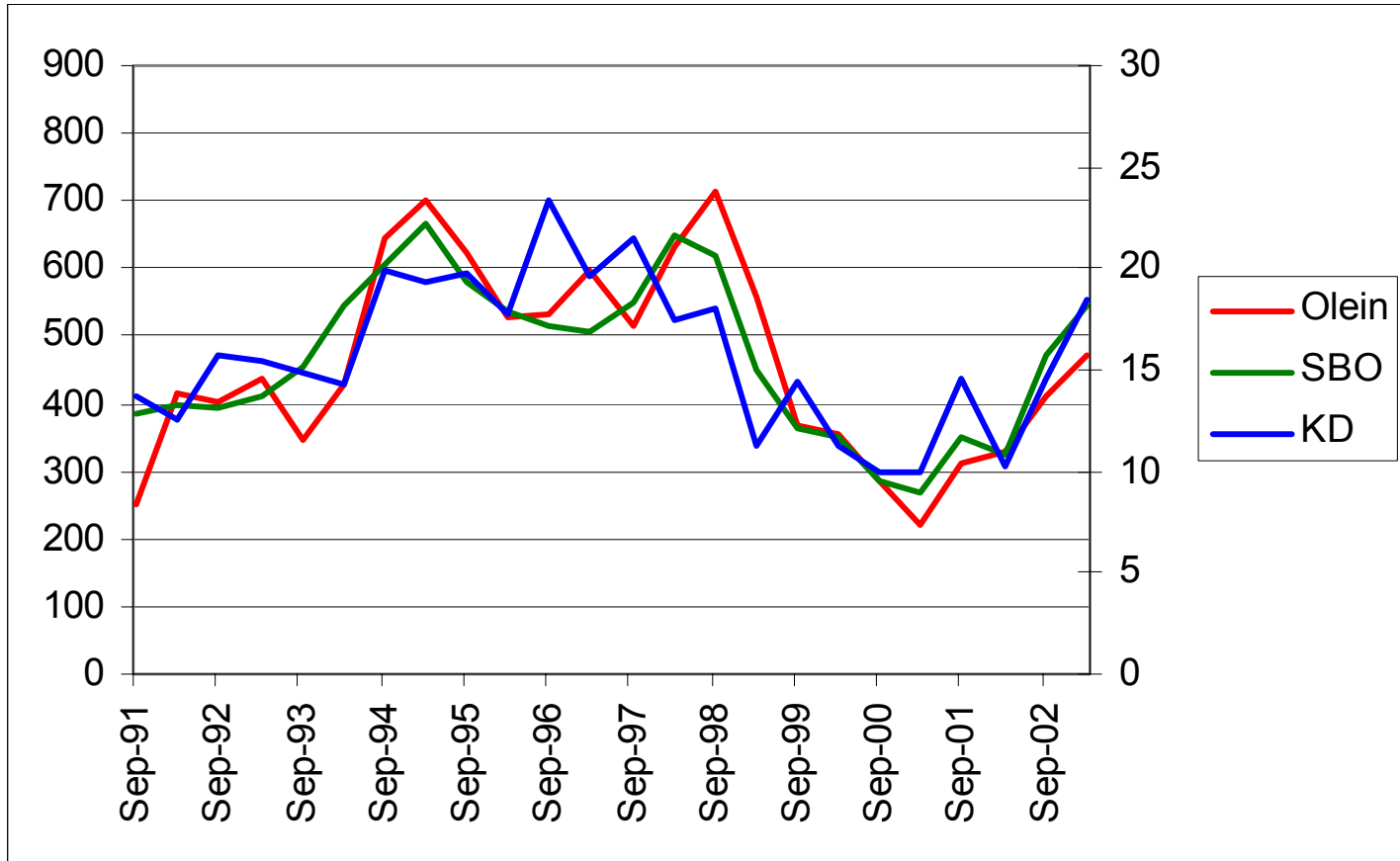
- Correlation matrix is large
- Then we need autocorrelations and tail dependence
- Too many parameters
- Need a simpler, more intuitive model

“Sticky Trend” Model



- 6 month price trends slowly reverting to mean
- Weekly deviations from trend quickly reverting

Market Segments

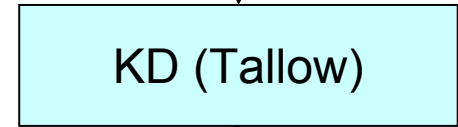
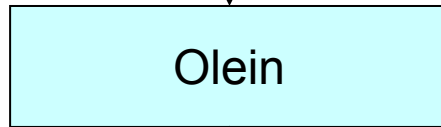


Tiered Model

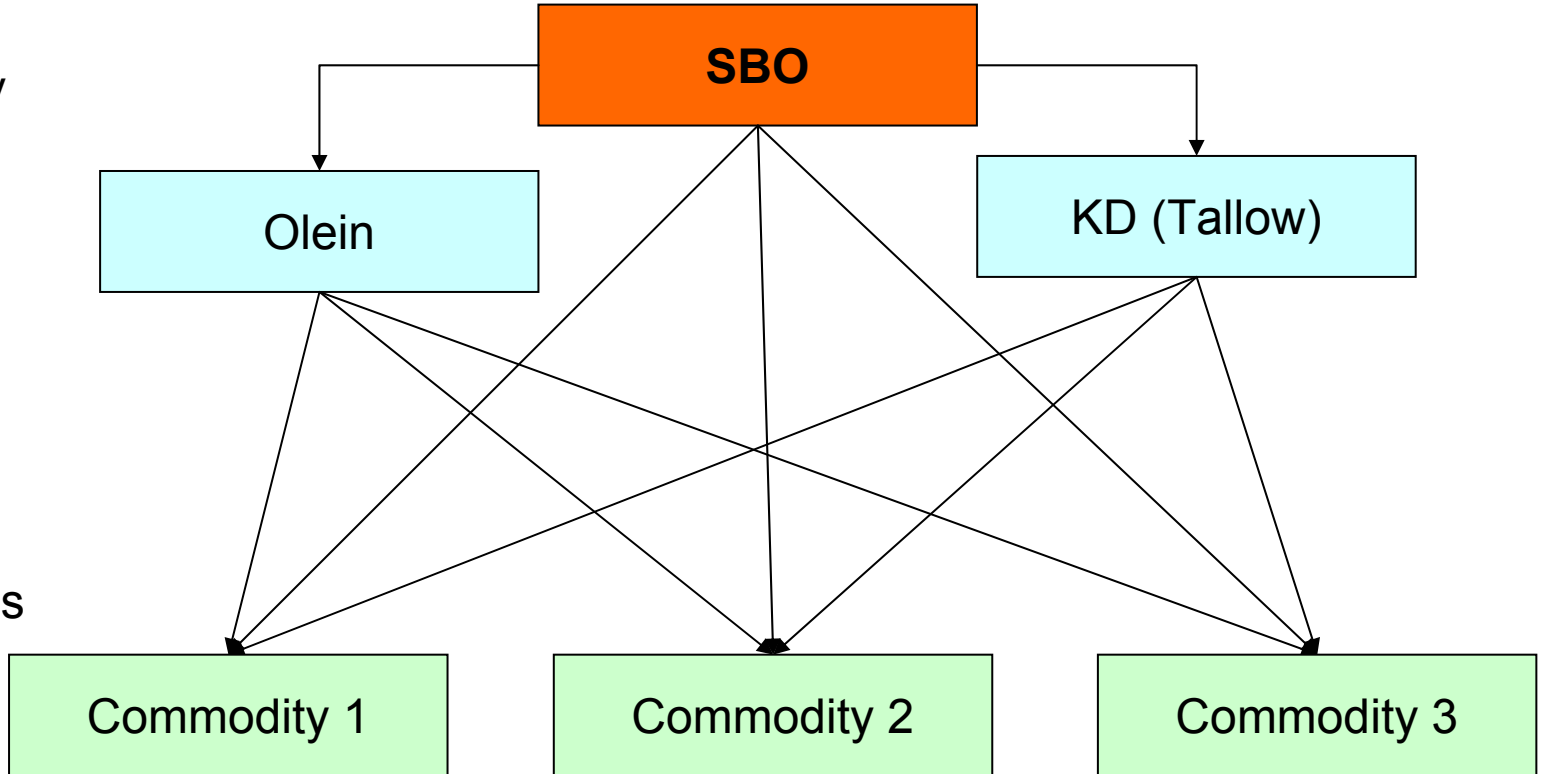
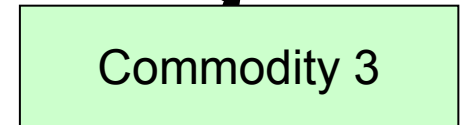
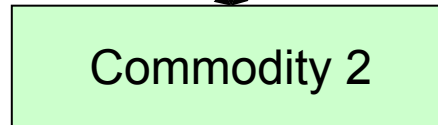
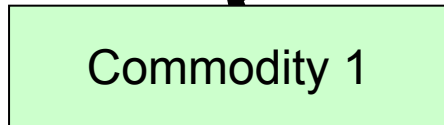
Primary
Commodity



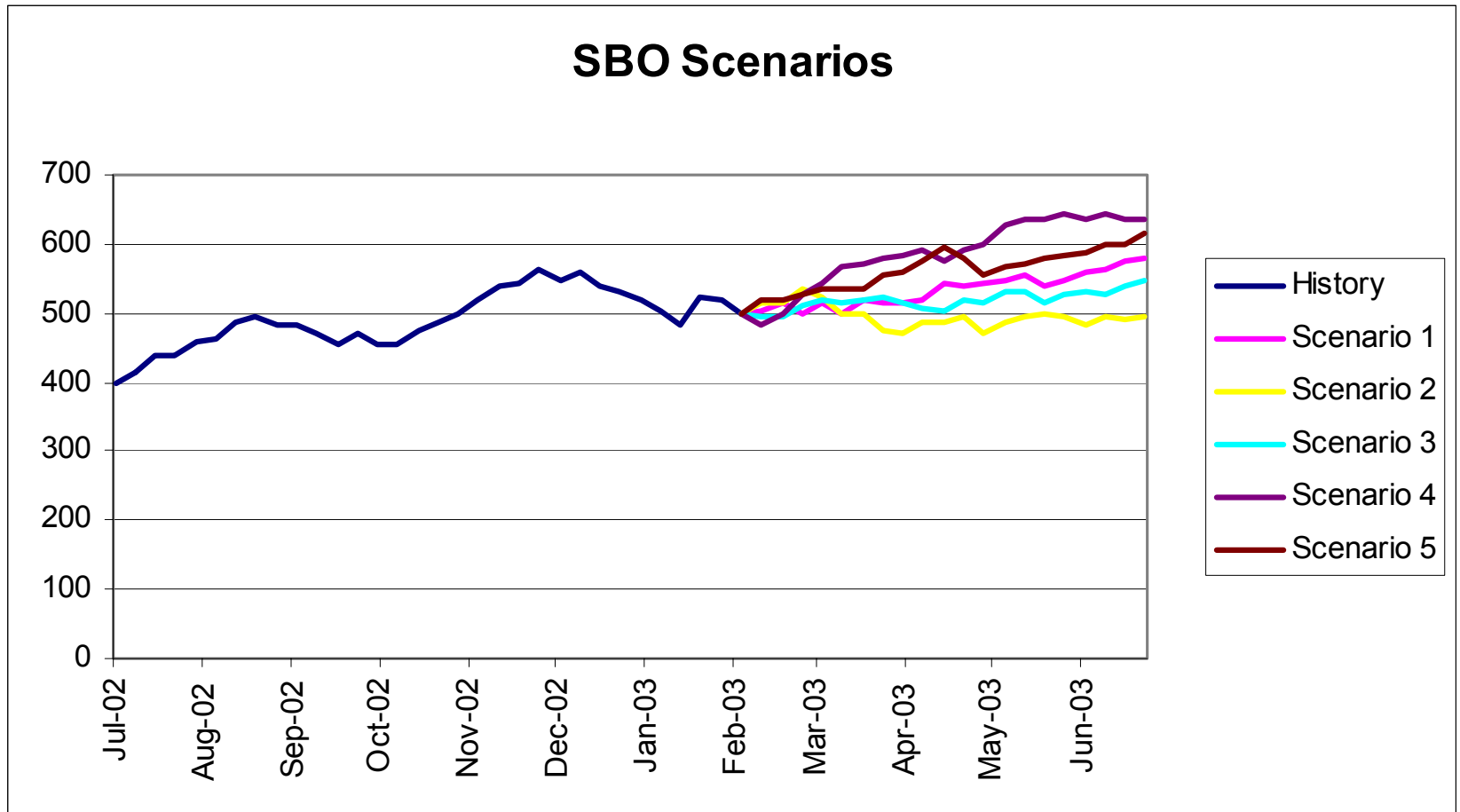
Market
Segments



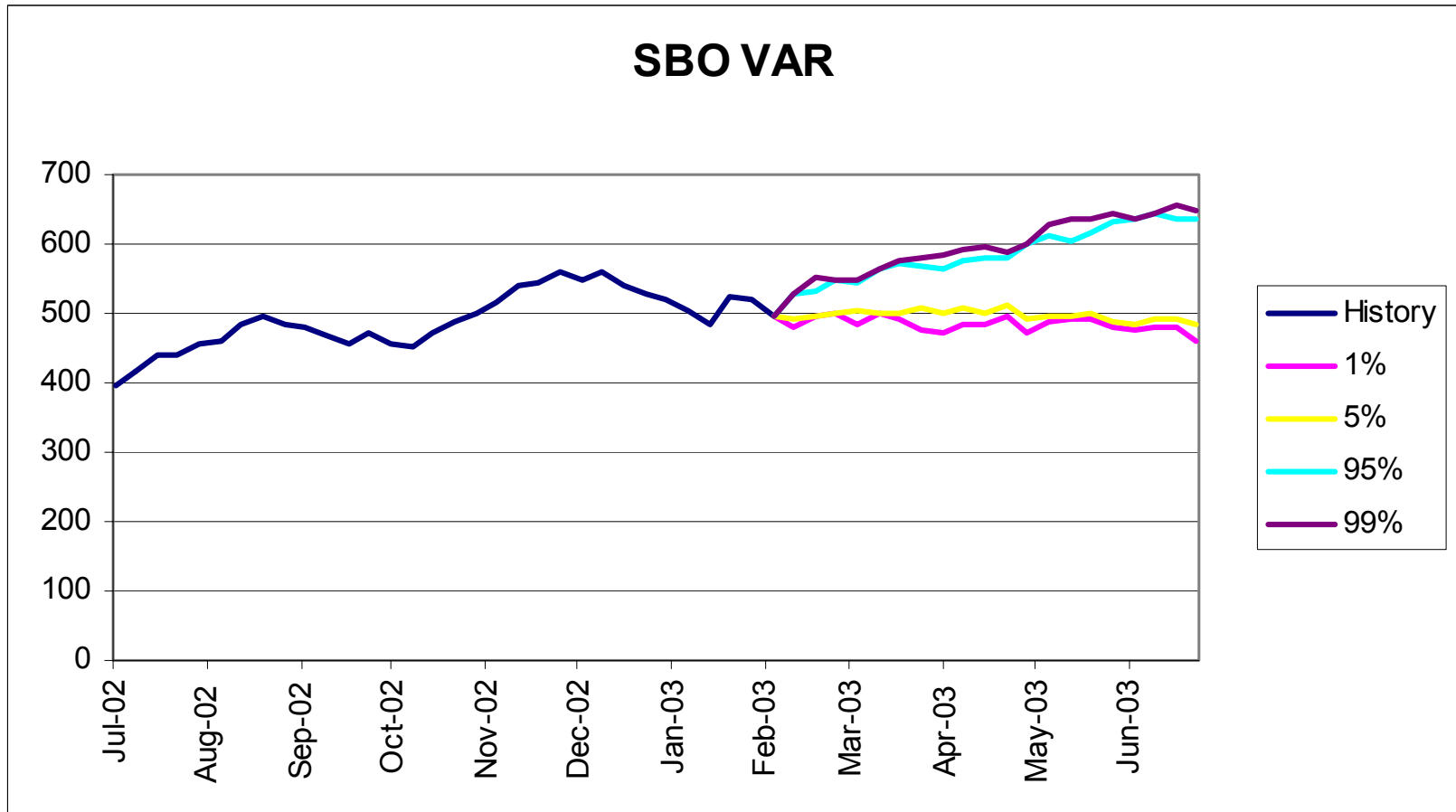
All Other
Commodities



Sample: SBO VAR Model



Sample: SBO VAR Model



Non-Standard Time Series Analysis

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