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Market Volatility

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John F. O. Bilson

Professor of Finance

Illinois Institute of Technology

Topics for Today's Talk

- What is market volatility?
- How do we measure it?
- How can we deal with it?
- Volatility products: Indices and Contracts.
- How can we tame volatility?
- Should we?

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The Problem

- In the 1880's, grain prices were very volatile.
- Farmers were reluctant to grow corn because they were uncertain about the price at harvest.
- Banks were unwilling to lend to farmers because of the instability of their revenue.
- Land values were low because farming was considered to be a very risky business.

The Solution

- Futures prices on grains were introduced at the Chicago Board of Trade in 1880.
- Farmers could make their planting decisions based upon futures prices.
- Farmers could lock in prices by selling corn in the futures market.
- Farming became far less risky to lenders.
- Farm land became more valuable and agricultural output increased.

The Lesson

- The key to managing volatility is to create instruments to trade it.
- This allows volatility to be held by those who are most comfortable with it, and it allows others to reduce their exposure to volatility that they are uncomfortable with.
- The range of volatility related instruments is wide and it is growing rapidly.

The Instruments

- Futures and Forward Contracts
- Options Contracts
- Implied Volatility Contracts
- “Crash” option contracts.

- Each of these instruments allows for market volatility to be transferred between counterparties.
- They are the fundamental building blocks for financial engineers.

The volatility debate:

- Classical (efficient market) perspective
  - Volatility is caused by rational revisions of expectations about future cash flows and by variation in risk premia.
- Behavioral Finance (heretical) view:
  - Market values are too volatile relative to rational revisions in earnings.
  - Markets are not efficient.

Milton Friedman

- Profit making speculators must buy low and sell high.
- Consequently, profitable speculation is stabilizing.
- If markets are too volatile, they must be mean reverting.
- Mean reverting strategies do not do well relative to buy and hold.

Forecasting Volatility

$$v_t = \ln(O_t / C_{t-1})^2 + .5 * \ln(H_t / L_t)^2 - .3 * \ln(C_t / O_t)^2$$

Overnight IntraDay Range Close to Open

	Open	High	Low	Close
17-Nov-06	3877	3892	3836	3853
20-Nov-06	3853	3867	3794	3856
	0.00%	1.90%	0.09%	0.09%
	ln(O/C)	ln(H/L)	ln(C/O)	ln(C/C)

Forecasting Volatility

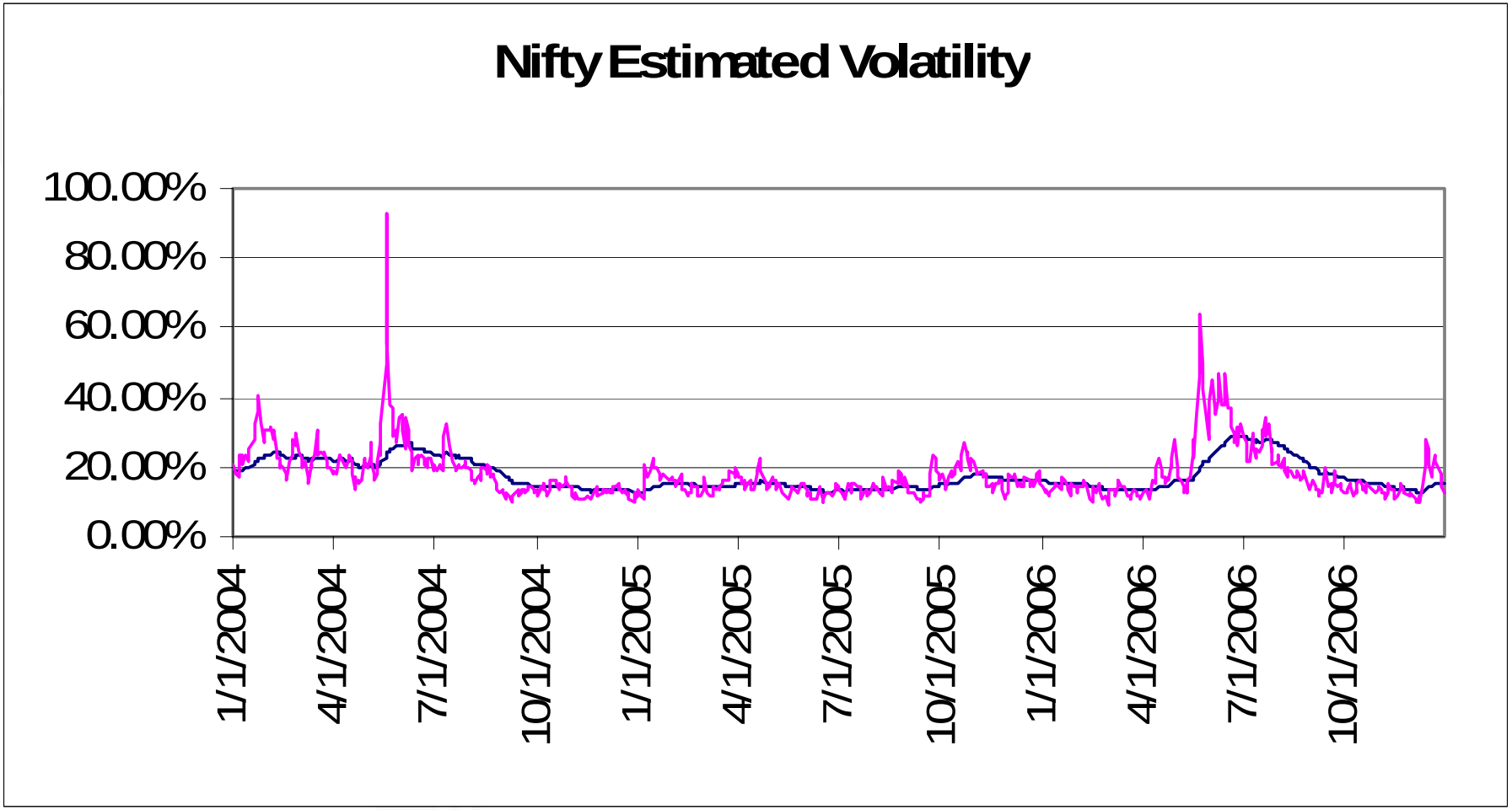
$$h_t = h_{t-1} + \phi_1[\ln(v_{t-1}) - h_{t-1}] + \phi_2[g_{t-1} - h_{t-1}] + \phi_3 r_{t-1}$$

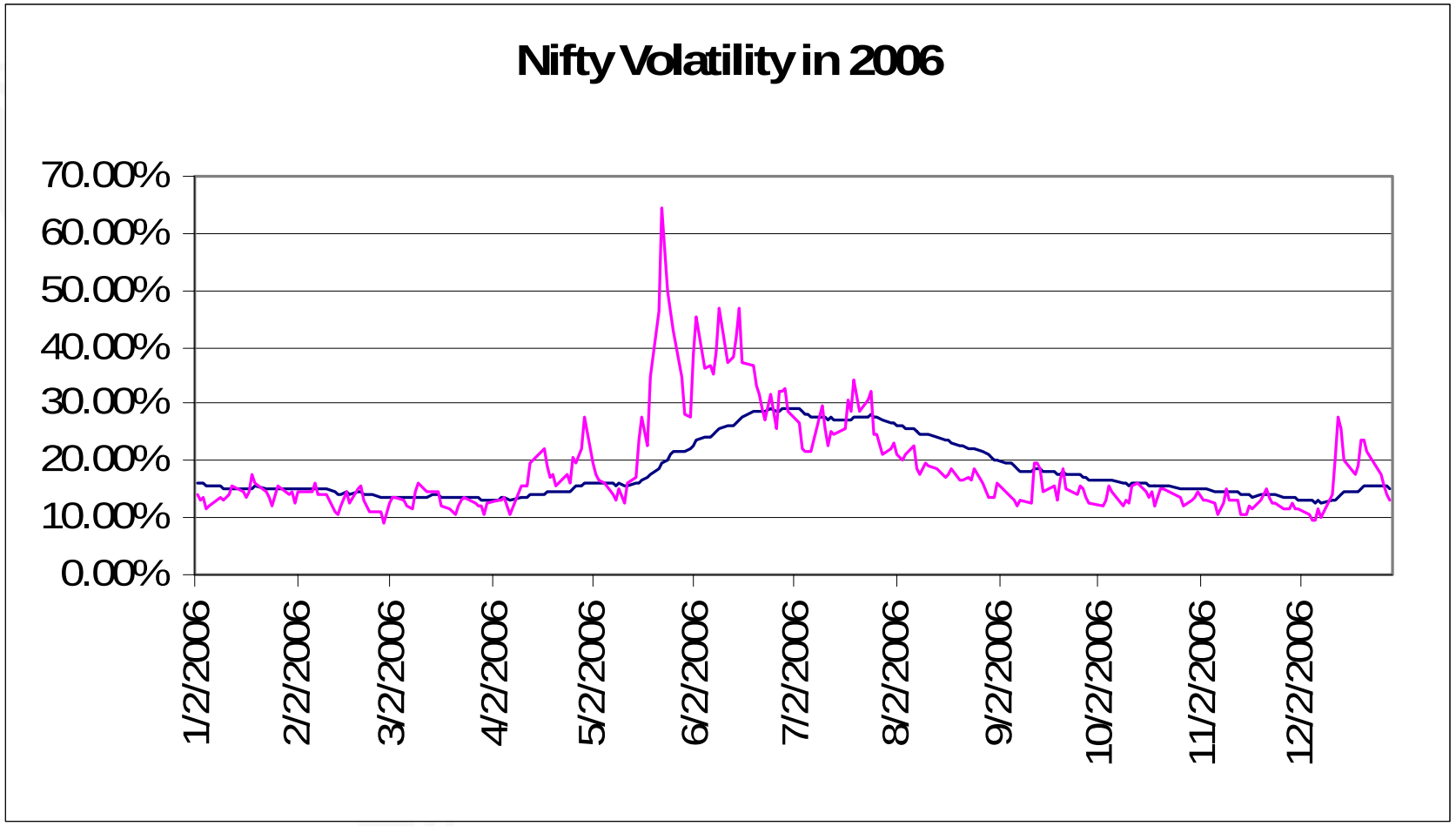
$$g_t = g_{t-1} + \phi_4[\ln(v_{t-1}) - g_{t-1}]$$

$$\hat{\sigma}_t = \exp(h_t)$$

	VolModel
LRMA	0.03
Persist	0.29
Mrever	0.16
Return	-5.48

Persistence Mean Reversion Market Impact

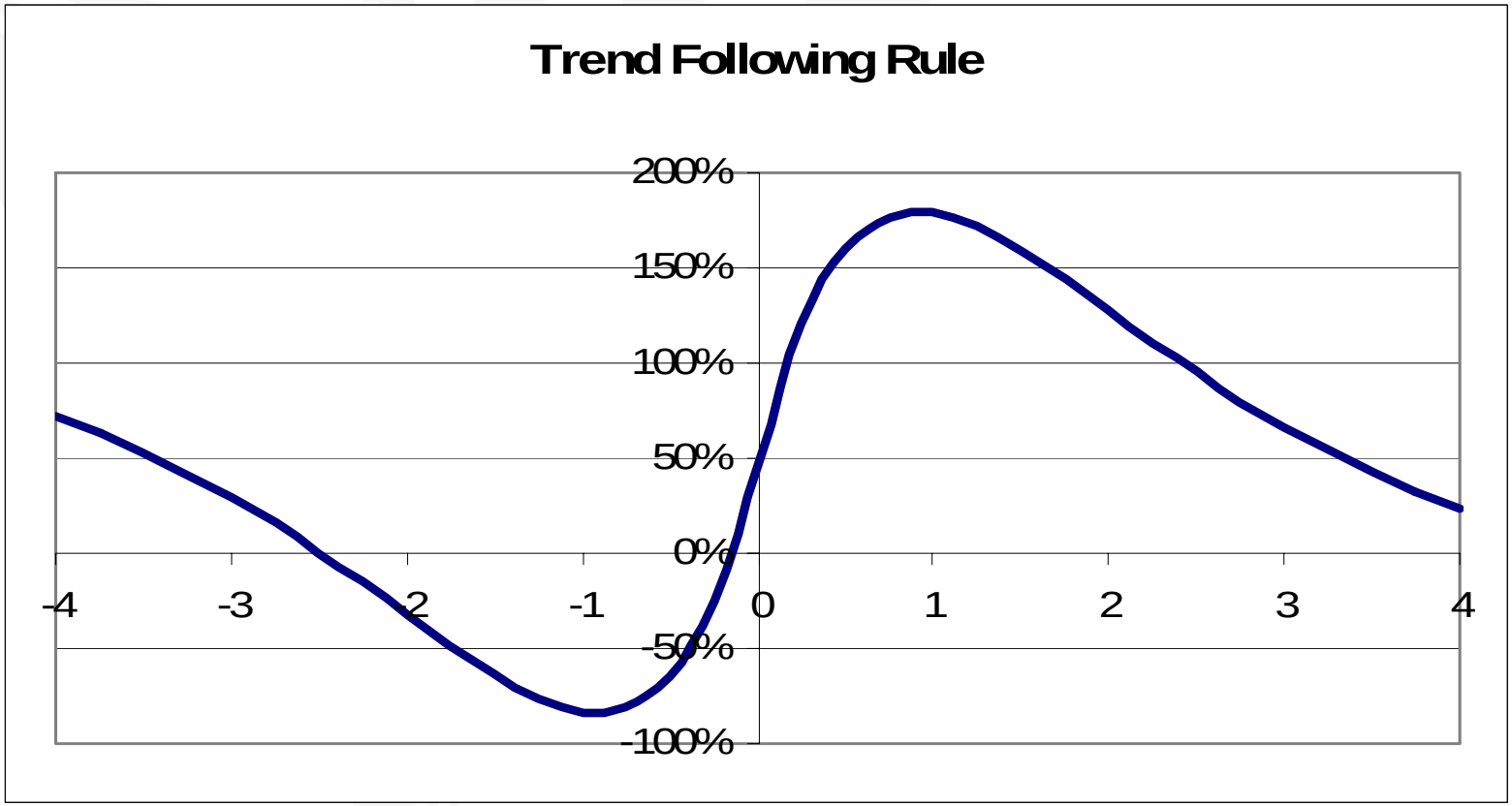

Nifty Estimated Volatility
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
1/1/2004
4/1/2004
7/1/2004
10/1/2004
1/1/2005
4/1/2005
7/1/2005
10/1/2005
1/1/2006
4/1/2006
7/1/2006
10/1/2006


Nifty Volatility in 2006
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
1/2/2006
2/2/2006
3/2/2006
4/2/2006
5/2/2006
6/2/2006
7/2/2006
8/2/2006
9/2/2006
10/2/2006
11/2/2006
12/2/2006

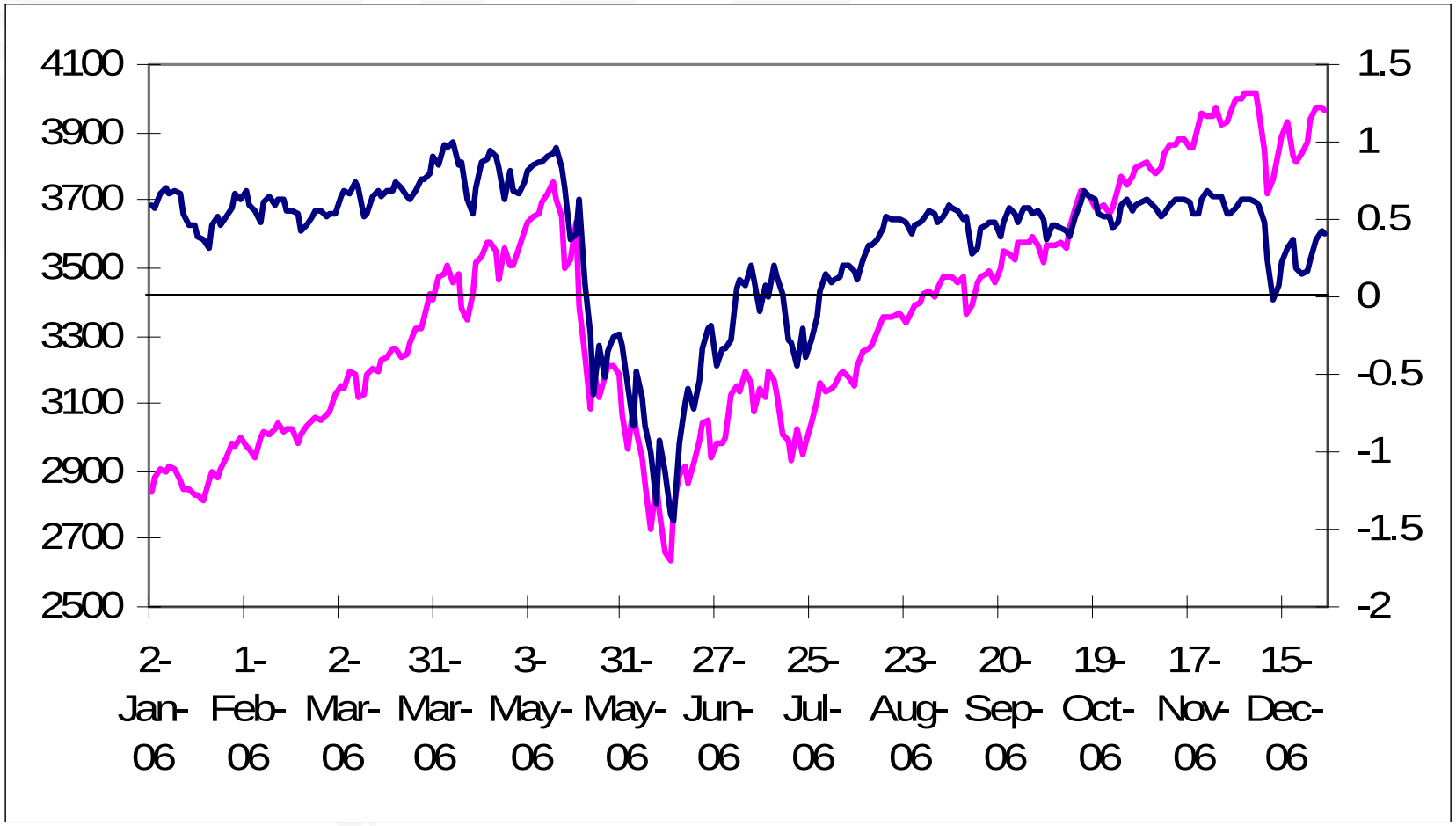
The Value of Volatility Forecasts

- Mean-Variance portfolio optimization
- Valuation of Derivatives
- Value at Risk analysis
- Trading
  - Suppose we want to develop a trend following trading model for the Nifty
  - We will use the volatility forecast to determine whether the trend is too large or small.

Past Trends and Future Returns



Positions in 2006



The Black-Scholes Formula

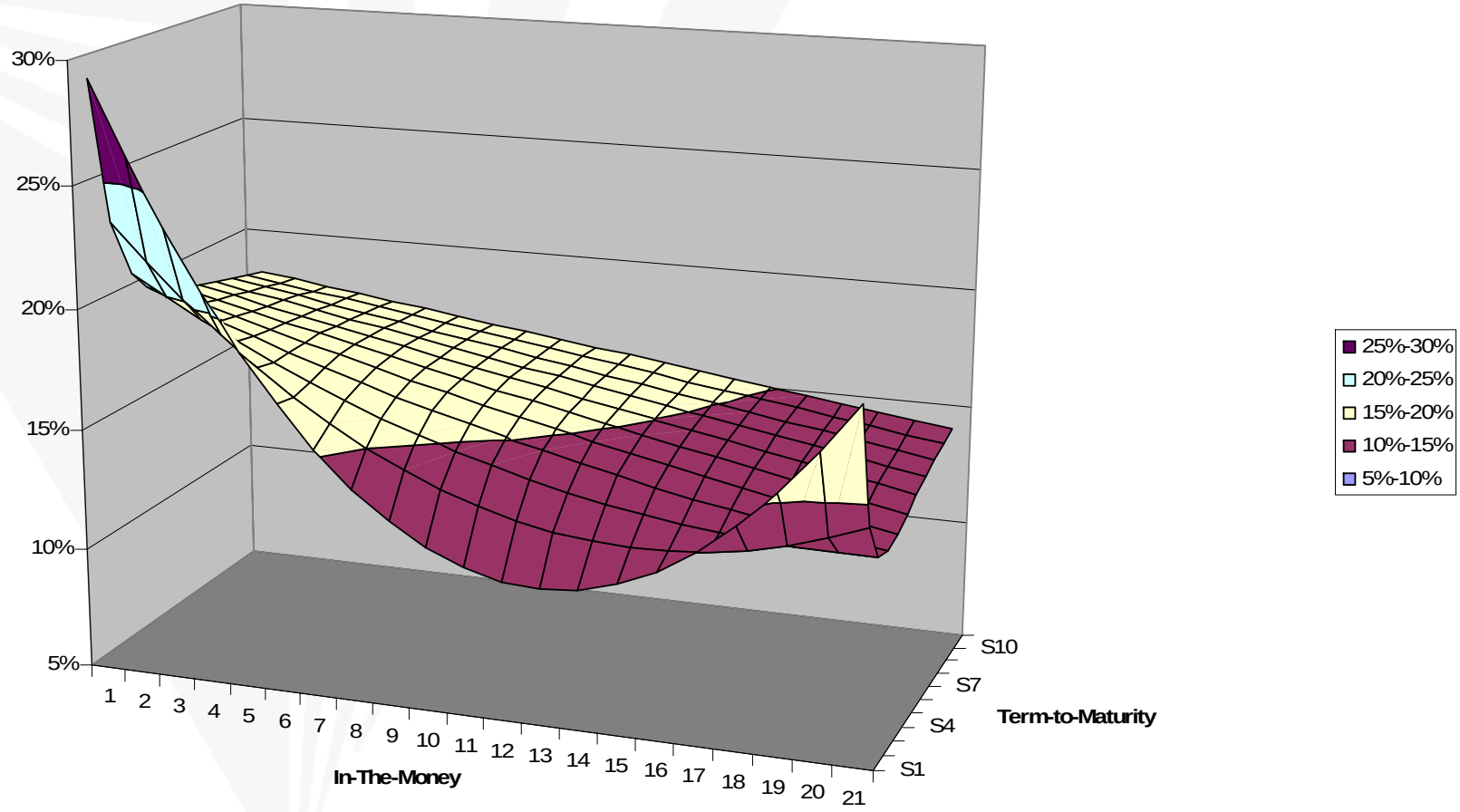
$$C(S,K,r,T,\sigma) = S\phi(d_1) - Ke^{-rT}\phi(d_2)$$

$$d_1 = \frac{\ln(S/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

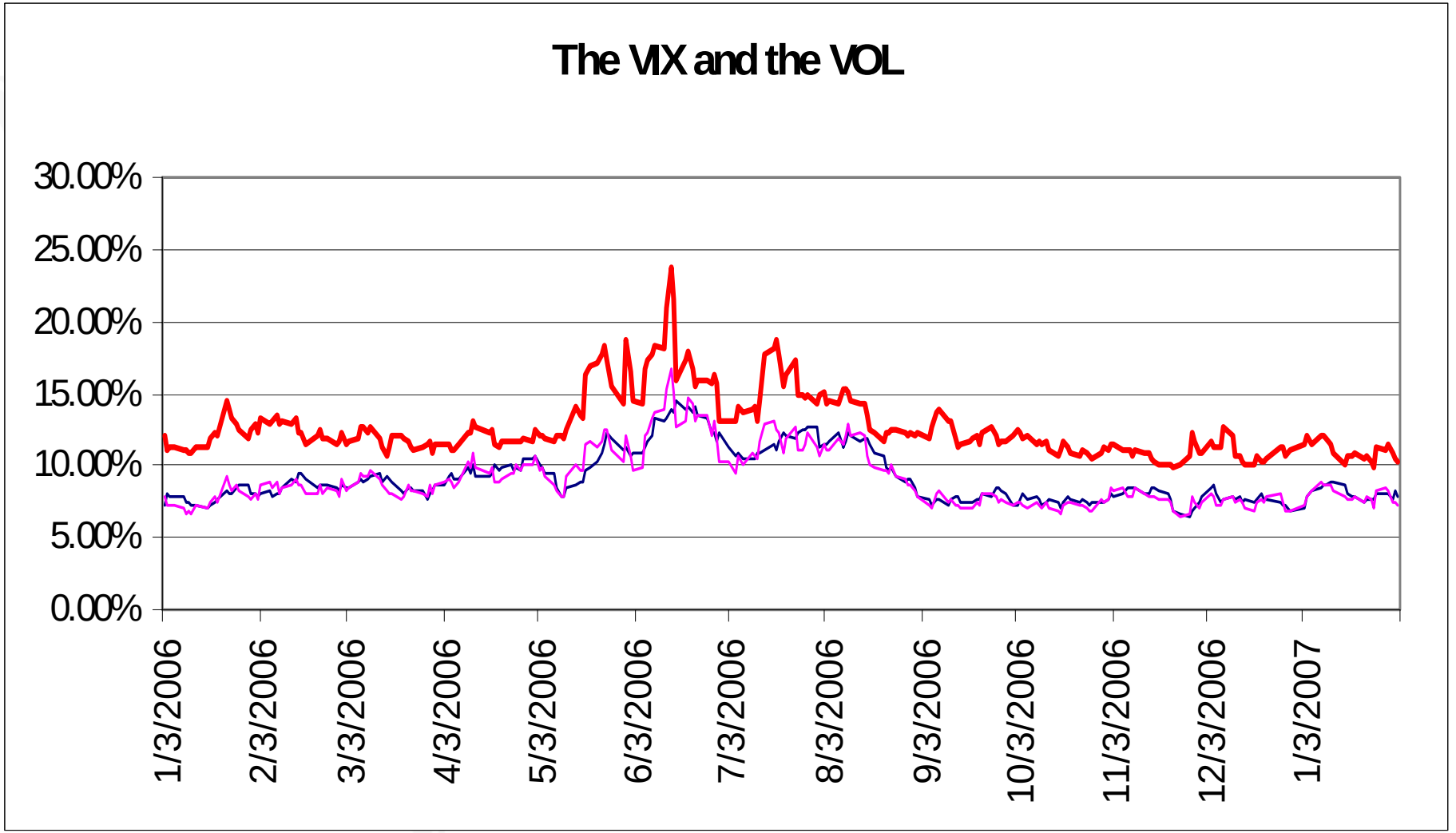
Volatility is the only ingredient that is not known.
We can use the formula to estimate the volatility.

The Volatility Surface



The VIX (and the VXN)

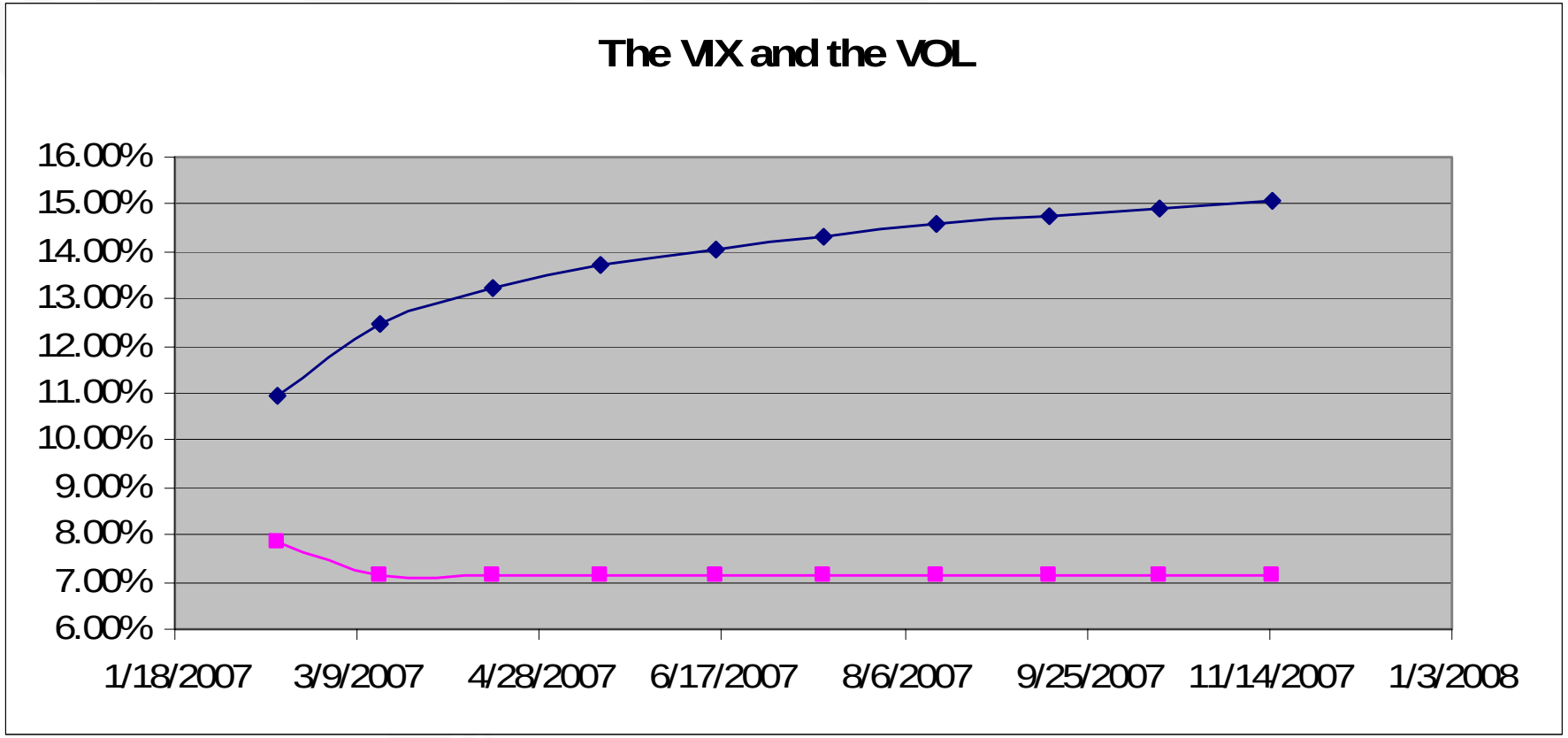
- Implied Volatility of a standardized at-the-money one month option.
- Values calculated continuously during the trading day.
- VIX futures contracts start trading in 2006.
- VIX futures can be used to hedge portfolios of options contracts against changes in implied volatility.


The VIX and the VOL
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
1/3/2006
2/3/2006
3/3/2006
4/3/2006
5/3/2006
6/3/2006
7/3/2006
8/3/2006
9/3/2006
10/3/2006
11/3/2006
12/3/2006
1/3/2007

Why is the VIX higher than the VOL?

- Customers are buyers, Professionals are sellers.
- VIX reflects an equity related risk premium.
- VIX returns are asymmetric.
- Investors are risk averse.

VIX Futures Contracts



The Problem with VIX Vols

- Contracts are written on implied volatility, not actual volatility.
- Implied volatilities are highly skewed to the upside.
- Implied volatilities are high when the market crashes. They have a high market beta and therefore command a substantial risk premium. This risk premium is priced into the forward curve.

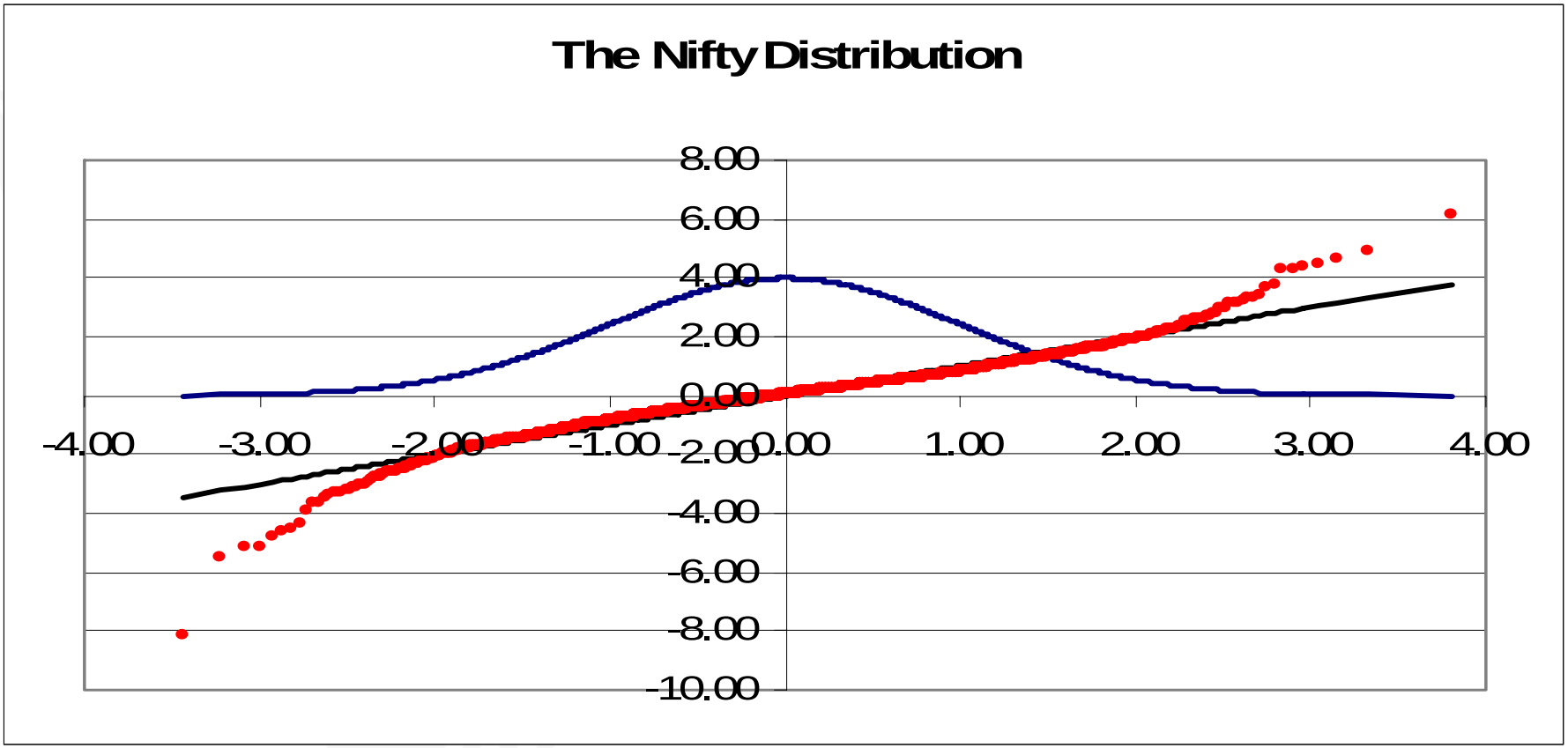
Direct Volatility Contracts: "Crash" Options

- If the market falls by more than x%, the contract pays –(r-x%) times some face amount.
- Example:
  - Face amount - $100,000
  - Market falls 5%
  - Strike value is 3%
  - Contract pays 2% times $100,000
- Seller places margin of $100,000 and earns interest on the margin.

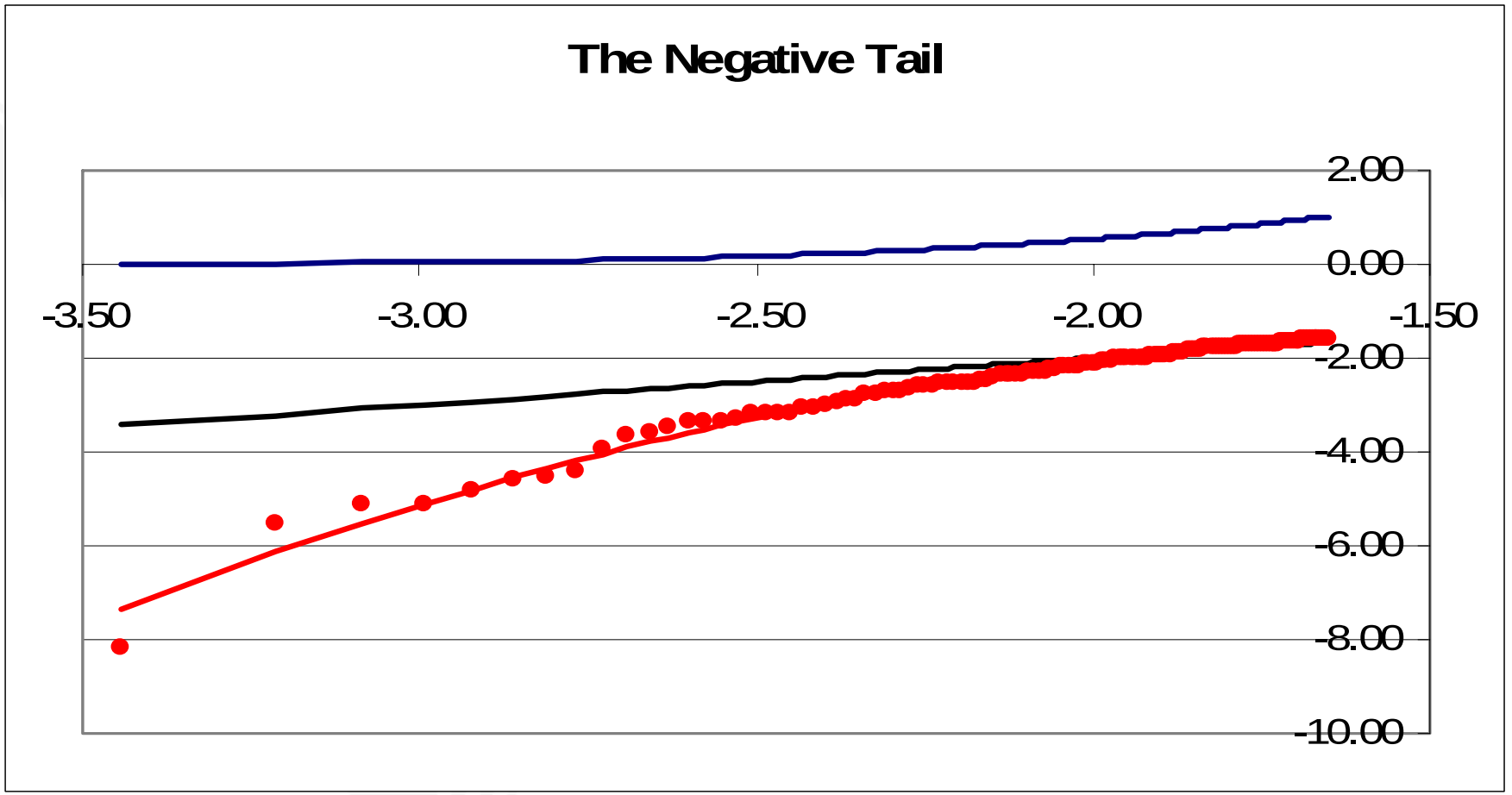
Crash Options can be written for various maturities:

- One Day
- One Week
- One Month
- One Year.

- Let’s look at a one day crash option on the Nifty Index.



Kurtosis can be modeled as a non-linear payoff function, Drawn on a normal distribution.


The Negative Tail
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-3.50
-3.00
-2.50
-2.00
-1.50

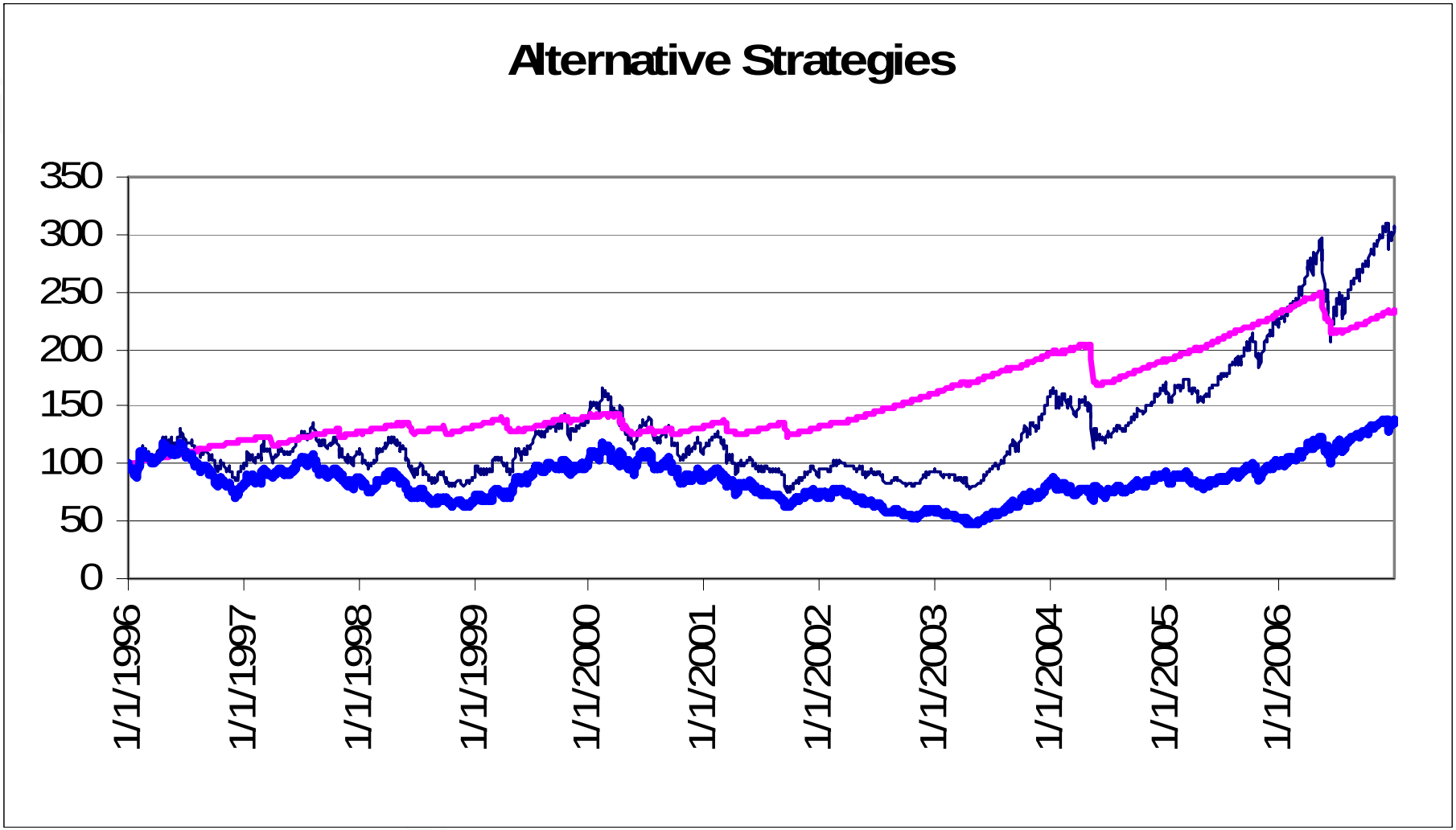
VaR and CeL

- VaR = -2.6% at 1 day horizon and 5% confid.
- CeL = -3.8%
- VAR
  - There is a 5% probability (1 day per month) that the loss will exceed 2.6%.
- CeL
  - If the VaR is exceeded, the expected loss is 3.8%.
- There should be 12.5 violations of the VaR each year.
- The cost of the insurance is 14.5% per year.

The Seller

- Short term Interest Rate is 7.5%
- Crash Option pays 14.5%
- Performance bond is R. 1000 paying 22%

- If the market falls by more than 2.6% in one day, seller pays –(r-2.6%)*1000.
- If the sum of the payouts exceeds R. 1000, seller is released from the contract.


Alternative Strategies
350
300
250
200
150
100
50
0
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006

For the moment:

- We do not have crash options on U.S. equity indices.
- We do have a large and growing market in credit derivatives, which are closely related instruments.
- We also have a growing market in catastrophe bonds for the insurance market.
- Weather derivatives are also closely related to crash options.
- Energy derivatives share many of the features of these instruments.

Concluding Remarks

- Should we attempt to control market volatility?
  - By controlling political decisions?
  - By controlling the central bank?
  - By controlling the influence of other risk factors?
- Whether you want to or not, these actions are typically beyond the control of the financial markets.

What financial markets can do

- Create instruments that allow volatility to be transferred to the party most interested in holding it.
- The ultimate control over volatility is diversification. By opening the market, we can make it easier for outside investors to purchase internal risk.
- While this may make the internal market less subject to internal risk factors, it runs the risk of exposing it to global risk.

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- Thank you for the opportunity to speak at your conference today.
- I hope to see your sons and daughters at the
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- The other IIT!