University of Sussex

Event-Driven Finance

Lecture 1: Introduction.
The Market (Reality).

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- ## What is event-driven finance?

A first, naïve, answer is this: Event-driven finance concerns the pricing of (derivative) securities concomitant to some temporal event.

This first answer is somewhat tautological. And in any case, events happen all the time. So why might we wish to introduce this new category of finance?

To answer this question we need to reexamine our preexisting ideas about derivatives pricing.

- In the course of doing so we shall see that standard approaches to pricing involve *assumptions of equilibrium.*
- These assumptions include the notion that many events may be averaged over; the events form a heat-bath in whose presence the expected stock behavior may be calculated.
- BUT what if we are not interested in the average behavior of a stock, but only its behavior in the temporal vicinity of ONE event.
- We should expect the pricing of the derivative securities to have a prominent time dependence- and it does.

- So the story is two-fold:

Events are typically discrete changes in some characteristic at a fixed time;

And event-driven finance means that we are interested in the time-dependent price of securities *near* that time.

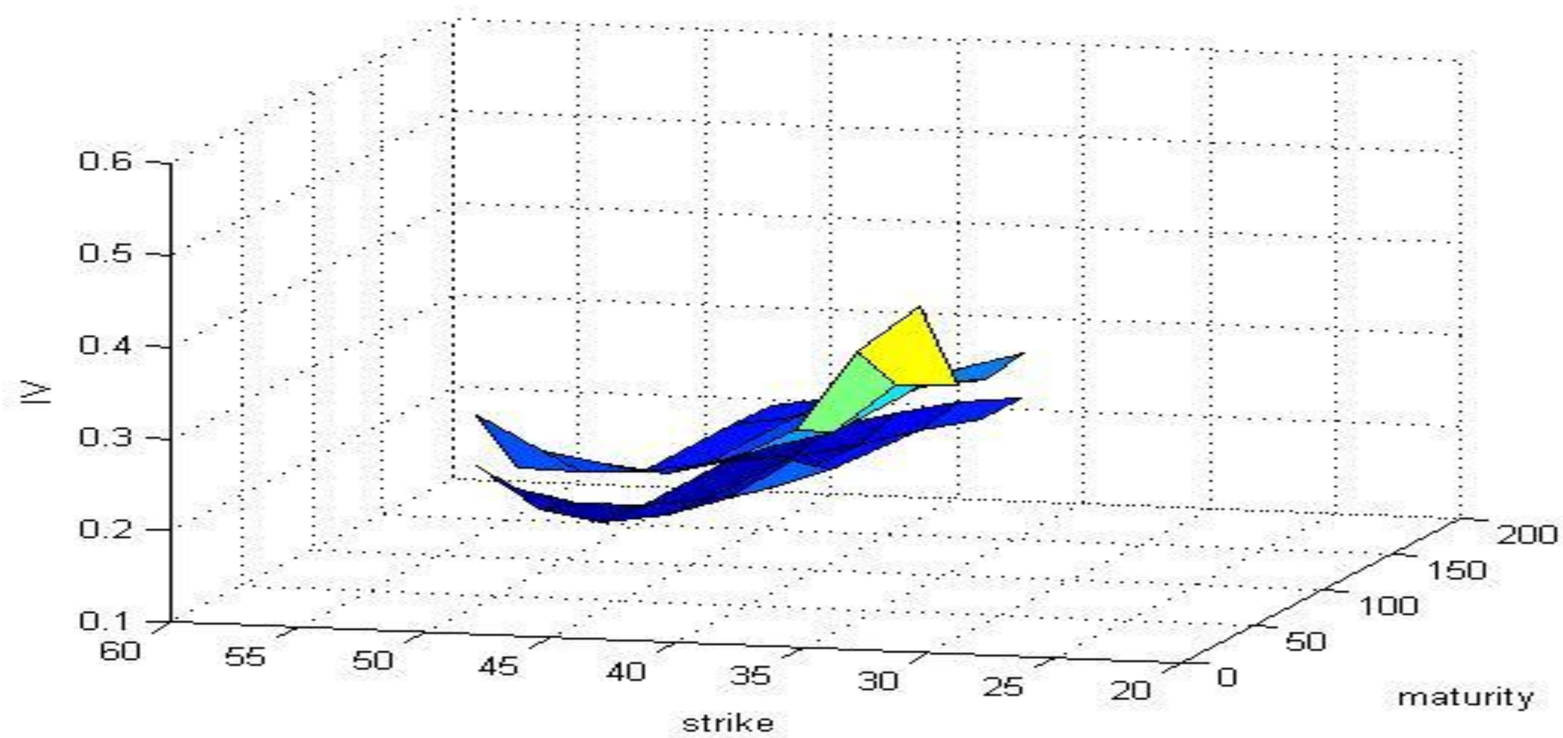
- Let’s look at some pictures:

case1

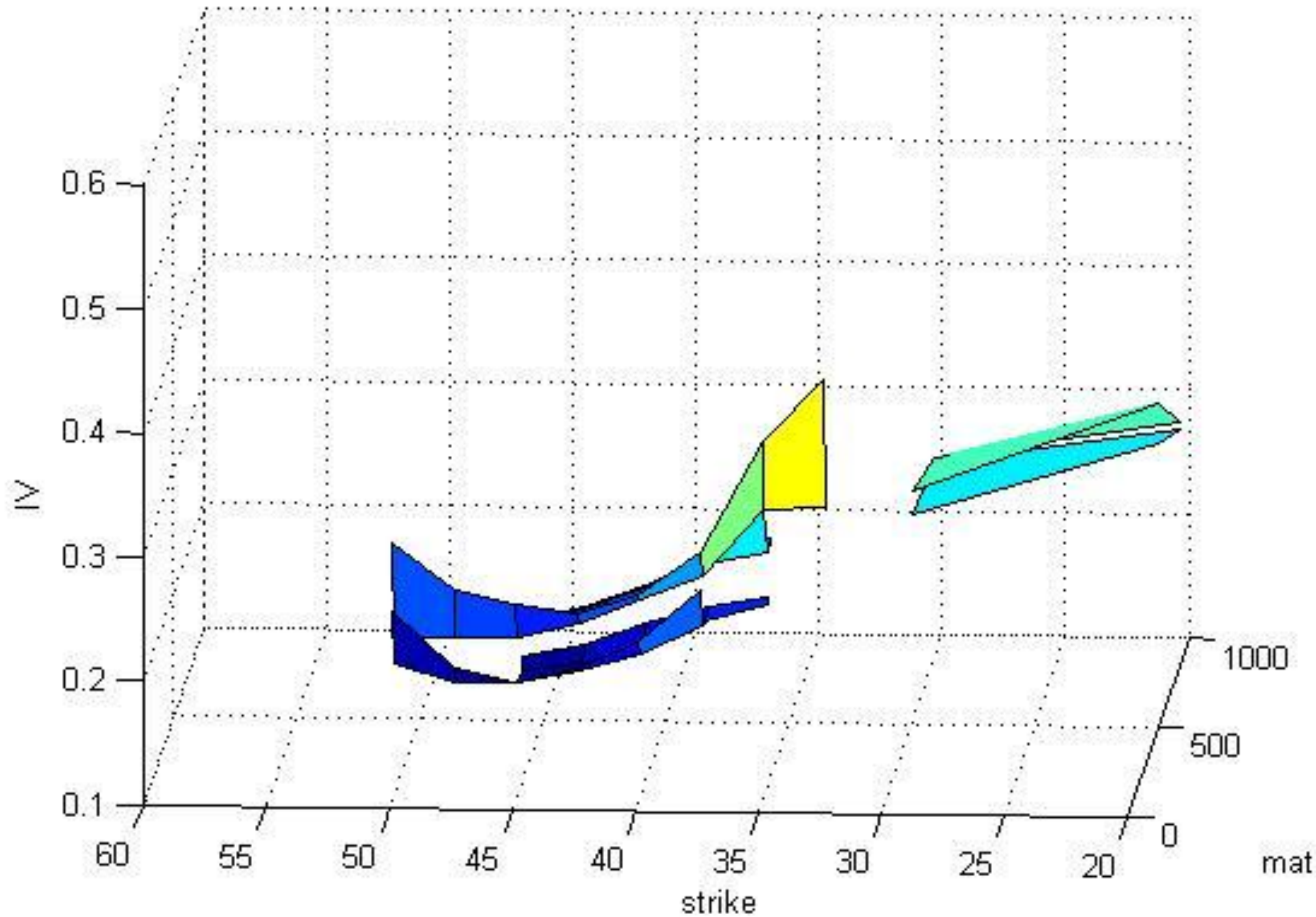
- The following three plots show the volatility surface for the stock, FDC, at the close of trading, September 15, 2005, (upper surface)

- And below it, the lower surface shows the same stock 1 day later:

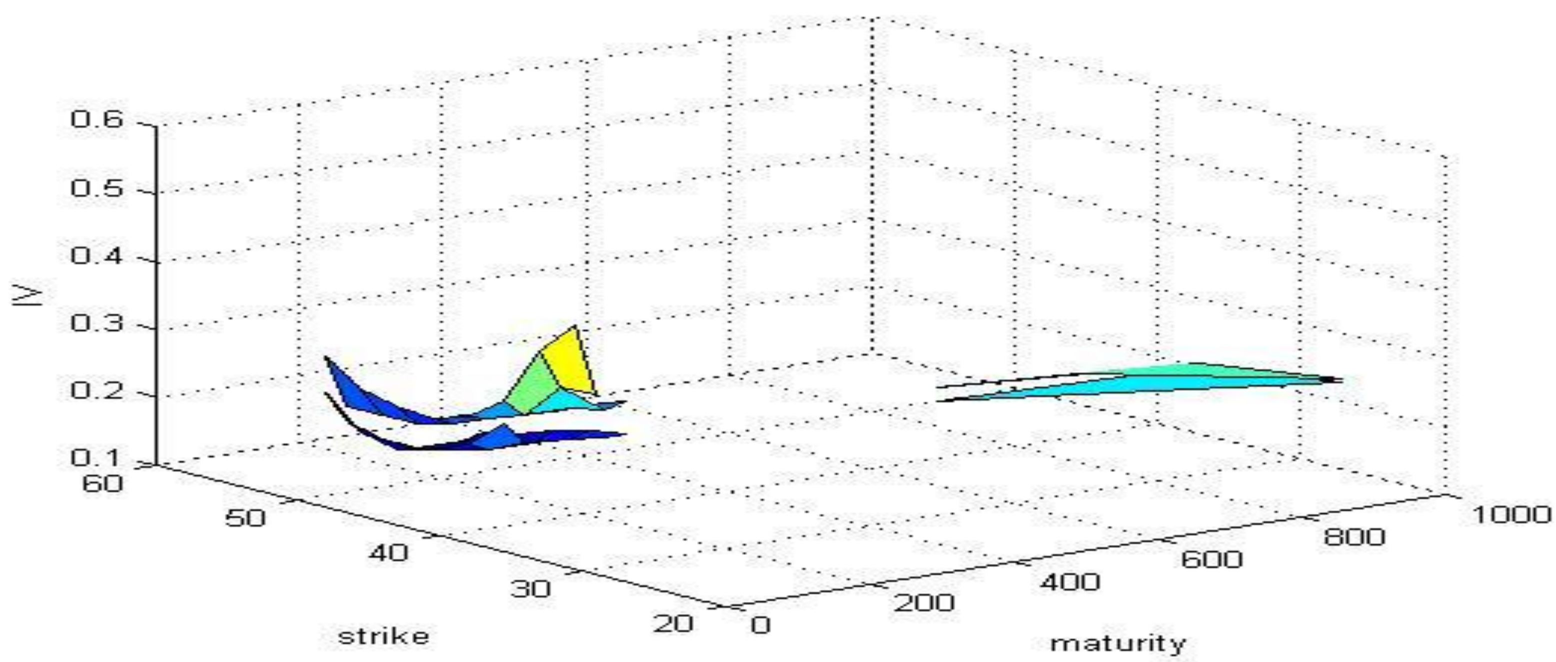
FDC impact


0.6
0.5
0.4
0.3
0.2
0.1
IV
60
55
50
45
40
35
30
25
20
strike
0
50
100
150
200
maturity

FDC impact



FDC impact



IV
0.6
0.5
0.4
0.3
0.2
0.1
60
50
40
30
20
strike
0
200
400
600
800
1000
maturity

FDC impact

- Clearly some *event* had occurred to *lower the implied volatilities* across all expiries.
- This means that theoretical pricing of securities required a discrete change of input parameters.

- We will discuss what happened later, but you may be surprised to note that classical stochastic models do not include a parameter which directly encompasses this change.

- Some more pictures:

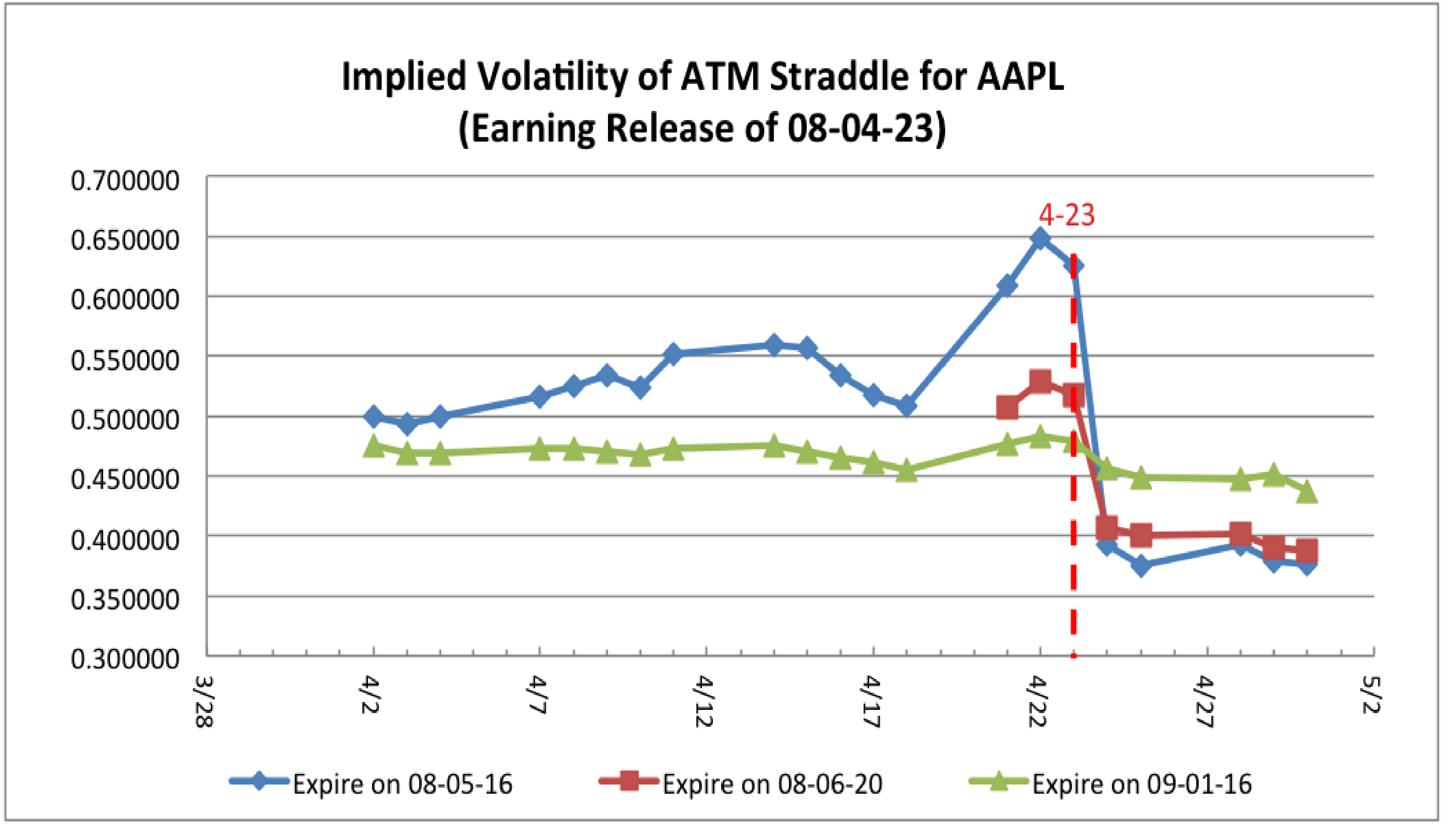
case2

- Here is a graph of implied volatility for a period of four weeks in April, 2008 in the stock, AAPL

- For three of those weeks the implied volatility was steadily rising; after a crash, the volatility appears to flatten

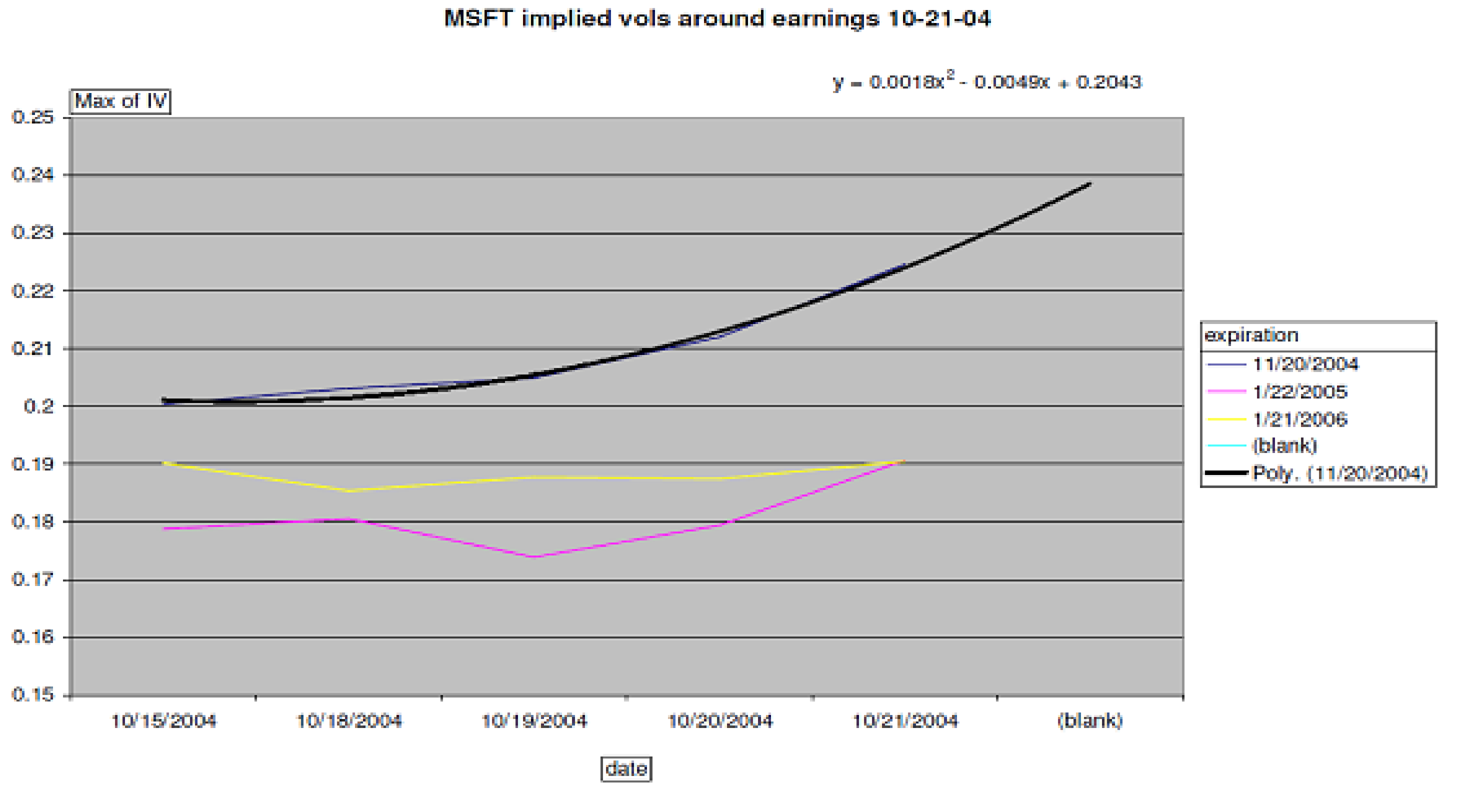
- After that, a similar *fitted* plot in MSFT

AAPL vol crest



MSFT vol crest

- Here is the rising portion of a similar graph for MSFT in October 2004



case 2

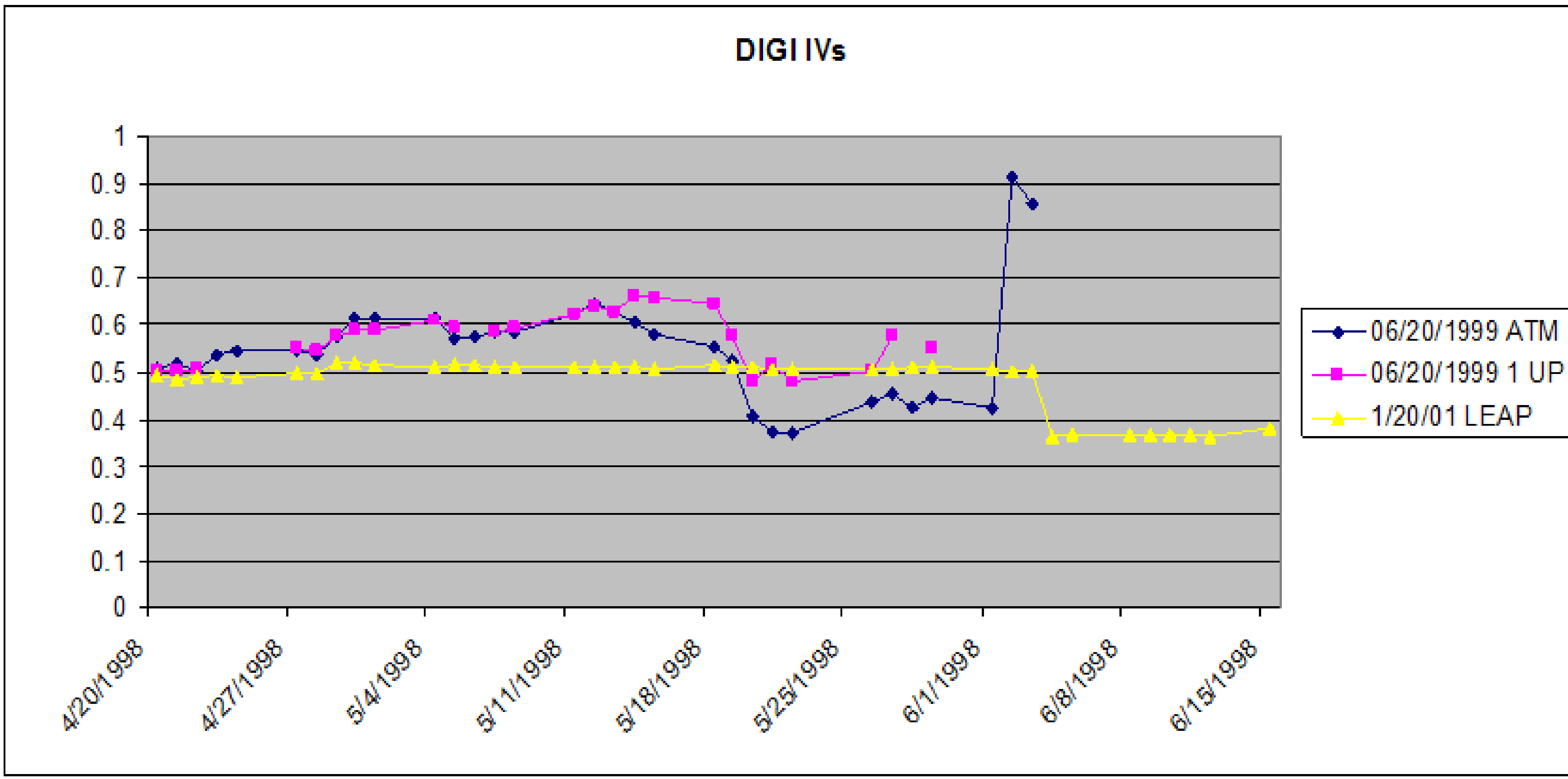
- For the previous two images, it is clear that while there appears to be an event *date*, the impact of the event is spread out over several *earlier* weeks broadly.

- This is typical of a certain class of events which we shall revisit in Lecture 3; they are clearly *anticipatory* in that we see effects in the volatility surface in advance of the event.

- The following is a graph of implied volatilities for several strikes in the stock, DIGI, for three months in 1998.

- At a certain date (ca. May 14) the volatility surface *pleats*- the front month at-the-money implied volatility dropping below the volatility of the next higher strike on a relative basis.

DIGI pleat

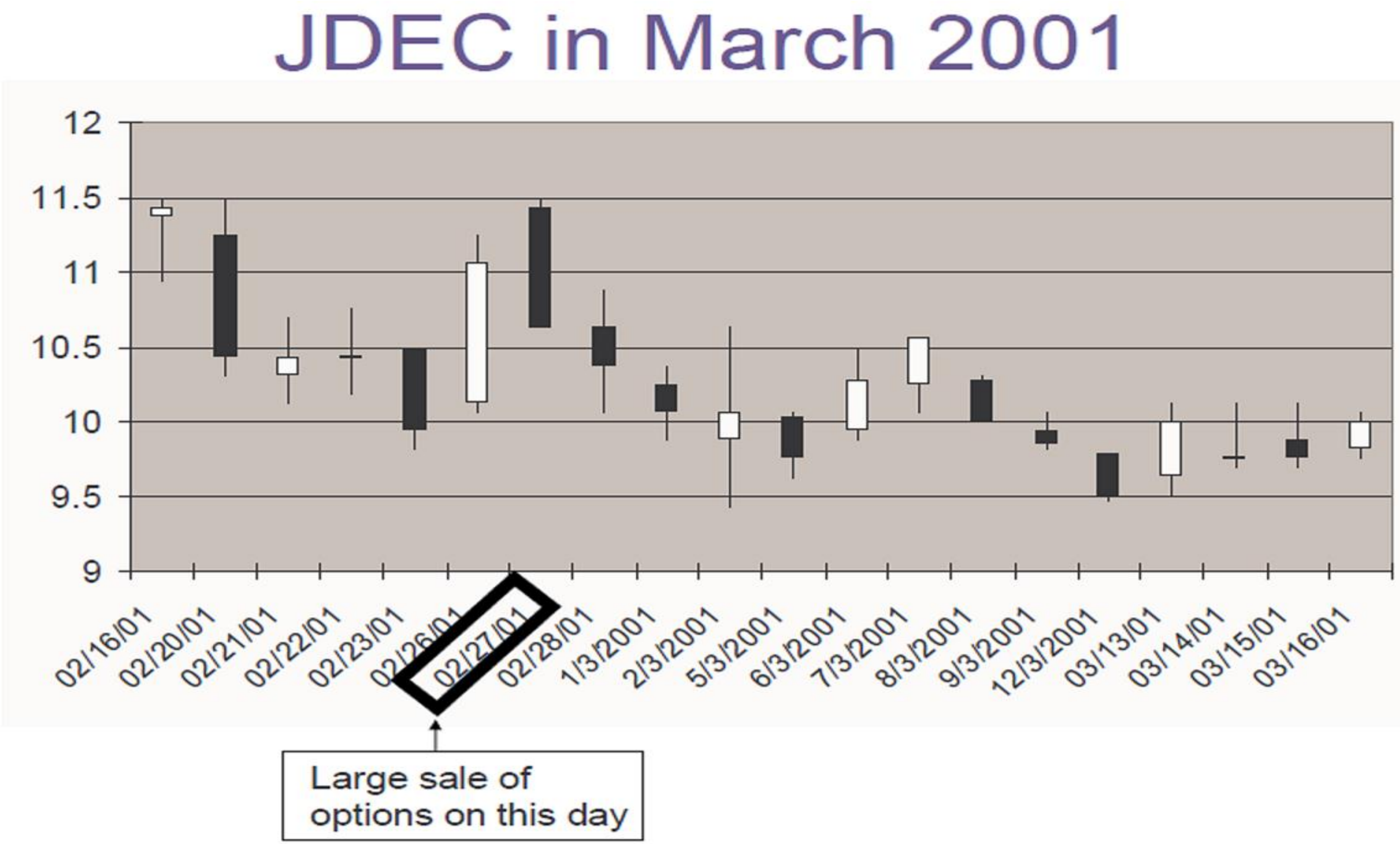

DIGI IVs
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4/20/1998
4/27/1998
5/4/1998
5/11/1998
5/18/1998
5/25/1998
6/1/1998
6/8/1998
6/15/1998
06/20/1999 ATM
06/20/1999 1 UP
1/20/01 LEAP

- In Lecture 4 we will come back to this example and discuss what happens here in more detail. This is a complex event in that it has multiple parts.
- Looking carefully at the long-term volatility, one sees that it drops abruptly in the first week of June.
- This sudden drop in the long-term volatility is, in fact, what most people would identify as the *event.*
- But while the volatility pleating of mid-May is consistent with the June occurrence it is not pre-ordained by it- nor the reverse!

- Here is a plot of stock price for the stock JDEC for a month (February - March) in 2001.

- The Japanese candlesticks indicate a large drop in daily volatility for the stock after Feb 27, and the stock zeroes in on the price of $10.

JDEC pin



JDEC in March 2001
12
11.5
11
10.5
10
9.5
9
02/16/01
02/20/01
02/21/01
02/22/01
02/23/01
02/26/01
02/27/01
02/28/01
1/3/2001
2/3/2001
5/3/2001
6/3/2001
7/3/2001
8/3/2001
9/3/2001
12/3/2001
03/13/01
03/14/01
03/15/01
03/16/01
Large sale of options on this day

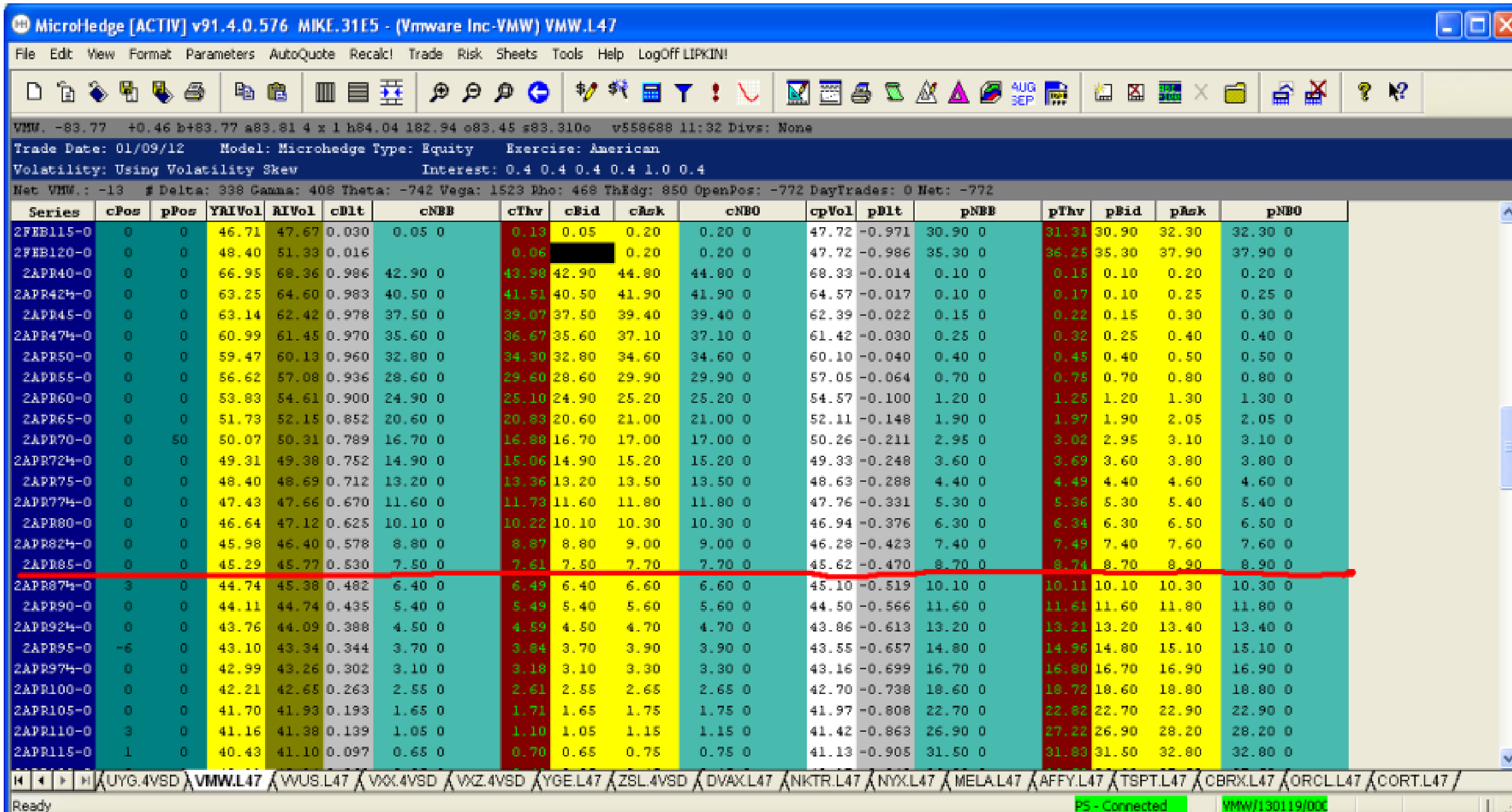
case 4

- In case 1, an event on Sept 16 in FDC produced a discrete immediate response in the volatility surface.
- In case 2, an event at a later date caused an anticipatory change in the volatility surface over several weeks.
- In case 3, a complex event stretches over several months and has variable temporal effects on the volatility surface.
- In case 4, -*contrast with case 2*- the *event* in JDEC can be associated with the date, Feb 27, but the effect on the volatility surface and stock price stretches forward in time. We will discuss this case in detail next Lecture.

- Let’s jump in with a real world problem:

The Market (Reality)

- Suppose you are working at a desk and running a variant of Black-Scholes, as sophisticated as you care to make it, and a hedge fund shows you 15000 contracts $0.15 through your theoretical value: "I can sell you 15000 VMW Apr 85 calls for $7.46."



Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
2FEB115-0	0	0	46.71	47.67	0.030	0.05 0	0.13	0.05	0.20	0.20 0	47.72	-0.971	30.90 0	31.31	30.90	32.30	32.30 0
2FEB120-0	0	0	48.40	51.33	0.016		0.06	[redacted]	0.20	0.20 0	47.72	-0.986	35.30 0	36.25	35.30	37.90	37.90 0
2APR40-0	0	0	66.95	68.36	0.986	42.90 0	43.98	42.90	44.80	44.80 0	68.33	-0.014	0.10 0	0.15	0.10	0.20	0.20 0
2APR42½-0	0	0	63.25	64.60	0.983	40.50 0	41.51	40.50	41.90	41.90 0	64.57	-0.017	0.10 0	0.17	0.10	0.25	0.25 0
2APR45-0	0	0	63.14	62.42	0.978	37.50 0	39.07	37.50	39.40	39.40 0	62.39	-0.022	0.15 0	0.22	0.15	0.30	0.30 0
2APR47½-0	0	0	60.99	61.45	0.970	35.60 0	36.67	35.60	37.10	37.10 0	61.42	-0.030	0.25 0	0.32	0.25	0.40	0.40 0
2APR50-0	0	0	59.47	60.13	0.960	32.80 0	34.30	32.80	34.60	34.60 0	60.10	-0.040	0.40 0	0.45	0.40	0.50	0.50 0
2APR55-0	0	0	56.62	57.08	0.936	28.60 0	29.60	28.60	29.90	29.90 0	57.05	-0.064	0.70 0	0.75	0.70	0.80	0.80 0
2APR60-0	0	0	53.83	54.61	0.900	24.90 0	25.10	24.90	25.20	25.20 0	54.57	-0.100	1.20 0	1.25	1.20	1.30	1.30 0
2APR65-0	0	0	51.73	52.15	0.852	20.60 0	20.83	20.60	21.00	21.00 0	52.11	-0.148	1.90 0	1.97	1.90	2.05	2.05 0
2APR70-0	0	50	50.07	50.31	0.789	16.70 0	16.88	16.70	17.00	17.00 0	50.26	-0.211	2.95 0	3.02	2.95	3.10	3.10 0
2APR72½-0	0	0	49.31	49.38	0.752	14.90 0	15.06	14.90	15.20	15.20 0	49.33	-0.248	3.60 0	3.69	3.60	3.80	3.80 0
2APR75-0	0	0	48.40	48.69	0.712	13.20 0	13.36	13.20	13.50	13.50 0	48.63	-0.288	4.40 0	4.49	4.40	4.60	4.60 0
2APR77½-0	0	0	47.43	47.66	0.670	11.60 0	11.73	11.60	11.80	11.80 0	47.76	-0.331	5.30 0	5.36	5.30	5.40	5.40 0
2APR80-0	0	0	46.64	47.12	0.625	10.10 0	10.22	10.10	10.30	10.30 0	46.94	-0.376	6.30 0	6.34	6.30	6.50	6.50 0
2APR82½-0	0	0	45.98	46.40	0.578	8.80 0	8.87	8.80	9.00	9.00 0	46.28	-0.423	7.40 0	7.49	7.40	7.60	7.60 0
2APR85-0	0	0	45.29	45.77	0.530	7.50 0	7.61	7.50	7.70	7.70 0	45.62	-0.470	8.70 0	8.74	8.70	8.90	8.90 0
2APR87½-0	3	0	44.74	45.38	0.482	6.40 0	6.49	6.40	6.60	6.60 0	45.10	-0.519	10.10 0	10.11	10.10	10.30	10.30 0
2APR90-0	0	0	44.11	44.74	0.435	5.40 0	5.49	5.40	5.60	5.60 0	44.50	-0.566	11.60 0	11.61	11.60	11.80	11.80 0
2APR92½-0	0	0	43.76	44.09	0.388	4.50 0	4.59	4.50	4.70	4.70 0	43.86	-0.613	13.20 0	13.21	13.20	13.40	13.40 0
2APR95-0	-6	0	43.10	43.34	0.344	3.70 0	3.84	3.70	3.90	3.90 0	43.55	-0.657	14.80 0	14.96	14.80	15.10	15.10 0
2APR97½-0	0	0	42.99	43.26	0.302	3.10 0	3.18	3.10	3.30	3.30 0	43.16	-0.699	16.70 0	16.80	16.70	16.90	16.90 0
2APR100-0	0	0	42.21	42.65	0.263	2.55 0	2.61	2.55	2.65	2.65 0	42.70	-0.738	18.60 0	18.72	18.60	18.80	18.80 0
2APR105-0	0	0	41.70	41.93	0.193	1.65 0	1.71	1.65	1.75	1.75 0	41.97	-0.808	22.70 0	22.82	22.70	22.90	22.90 0
2APR110-0	3	0	41.16	41.38	0.139	1.05 0	1.10	1.05	1.15	1.15 0	41.42	-0.863	26.90 0	27.22	26.90	28.20	28.20 0
2APR115-0	1	0	40.43	41.10	0.097	0.65 0	0.70	0.65	0.75	0.75 0	41.13	-0.905	31.50 0	31.83	31.50	32.80	32.80 0

- Here is another page of VMW quotes:

MicroHedge [ACTIV] v91.4.0.576 MIKE.31E5 - (Vmware Inc-VMW) VMW.L47

File Edit View Format Parameters AutoQuote Recalc! Trade Risk Sheets Tools Help LogOff LIPKIN!

VMW. -83.91 +0.60 b-83.90 a83.94 2 x 2 h84.04 182.94 o83.45 s83.310o v570702 11:34 Divs: None

Trade Date: 01/09/12 Model: Microhedge Type: Equity Exercise: American

Volatility: Using Volatility Skew Interest: 0.4 0.4 0.4 0.4 1.0 0.4

Net VMW.: -13 # Delta: 386 Gamma: 412 Theta: -738 Vega: 1526 Rho: 473 ThEdg: 716 OpenPos: -608 DayTrades: 0 Net: -608

Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
2APR120-0	0	0	40.11	40.43	0.064	0.35 0	0.41	0.35	0.50	0.50 0	40.17	-0.939	36.20 0	36.42	36.20	37.50	37.50 0
2APR125-0	0	0	40.80	40.10	0.043	0.15 0	0.25	0.15	0.35	0.35 0	40.25	-0.960	39.90 0	41.27	39.90	43.30	43.30 0
2APR130-0	-20	0	40.79	41.56	0.035	0.15 0	0.20	0.15	0.25	0.25 0	41.71	-0.969	46.00 0	46.22	46.00	47.00	47.00 0
2APR135-0	0	0	40.41	41.64	0.023	0.05 0	0.13	0.05	0.20	0.20 0	41.78	-0.980	49.80 0	51.15	49.80	53.20	53.20 0
2APR140-0	0	0	41.28	41.35	0.016		0.08	[redacted]	0.15	0.15 0	41.78	-0.988	54.70 0	56.12	54.70	58.50	58.50 0
2APR145-0	0	0	41.76	43.78	0.010		0.05		0.15	0.15 0	41.78	-0.994	59.40 0	61.10	59.40	63.50	63.50 0
2JUL40-0	0	0	62.06	62.97	0.966	43.40 0	44.56	43.40	45.80	45.80 0	62.86	-0.034	0.50 0	0.57	0.50	0.65	0.65 0
2JUL424-0	0	0	60.73	61.24	0.958	41.10 0	42.22	41.10	43.10	43.10 0	61.56	-0.042	0.65 0	0.72	0.65	0.75	0.75 0
2JUL45-0	0	0	59.11	59.21	0.950	37.60 0	39.85	37.60	40.90	40.90 0	59.09	-0.050	0.75 0	0.84	0.75	0.95	0.95 0
2JUL474-0	0	0	57.51	57.83	0.940	36.10 0	37.55	36.10	38.90	38.90 0	57.70	-0.060	0.95 0	1.04	0.95	1.15	1.15 0
2JUL50-0	0	0	56.21	56.53	0.927	34.20 0	35.31	34.20	36.60	36.60 0	56.40	-0.073	1.20 0	1.29	1.20	1.40	1.40 0
2JUL55-0	0	0	53.64	54.36	0.896	29.90 0	30.94	29.90	31.20	31.20 0	54.22	-0.104	1.85 0	1.91	1.85	2.00	2.00 0
2JUL60-0	0	0	51.59	51.81	0.858	25.70 0	26.74	25.70	27.00	27.00 0	51.85	-0.142	2.60 0	2.71	2.60	2.80	2.80 0
2JUL65-0	0	0	49.75	50.21	0.811	22.60 0	22.82	22.60	23.00	23.00 0	50.05	-0.189	3.70 0	3.77	3.70	3.90	3.90 0
2JUL70-0	0	0	48.29	48.70	0.756	19.00 0	19.22	19.00	19.40	19.40 0	48.52	-0.244	5.10 0	5.17	5.10	5.30	5.30 0
2JUL724-0	0	0	47.56	47.75	0.726	17.40 0	17.52	17.40	17.70	17.70 0	47.55	-0.274	5.90 0	5.96	5.90	6.10	6.10 0
2JUL75-0	0	0	46.77	47.13	0.694	15.80 0	15.92	15.80	16.10	16.10 0	46.97	-0.306	6.80 0	6.86	6.80	7.00	7.00 0
2JUL774-0	0	0	46.04	46.40	0.661	14.30 0	14.43	14.30	14.60	14.60 0	46.25	-0.340	7.80 0	7.86	7.80	8.00	8.00 0
2JUL80-0	0	0	45.40	45.78	0.626	12.90 0	13.02	12.90	13.20	13.20 0	45.74	-0.374	8.80 0	8.95	8.80	9.10	9.10 0
2JUL824-0	0	0	44.88	45.09	0.591	11.50 0	11.70	11.50	11.80	11.80 0	45.10	-0.409	10.00 0	10.12	10.00	10.30	10.30 0
2JUL85-0	0	0	44.31	44.66	0.556	10.40 0	10.49	10.40	10.60	10.60 0	44.67	-0.445	11.30 0	11.41	11.30	11.50	11.50 0
2JUL874-0	0	0	43.84	44.09	0.520	9.20 0	9.32	9.20	9.50	9.50 0	44.01	-0.481	12.60 0	12.74	12.60	12.90	12.90 0
2JUL90-0	0	0	43.25	43.57	0.484	8.20 0	8.29	8.20	8.40	8.40 0	43.55	-0.517	14.10 0	14.20	14.10	14.30	14.30 0
2JUL924-0	0	0	42.78	43.08	0.448	7.20 0	7.31	7.20	7.40	7.40 0	43.07	-0.553	15.60 0	15.73	15.60	15.90	15.90 0
2JUL95-0	0	0	42.24	42.62	0.414	6.30 0	6.43	6.30	6.60	6.60 0	42.57	-0.588	17.20 0	17.35	17.20	17.50	17.50 0
2JUL974-0	0	0	42.06	42.24	0.380	5.50 0	5.66	5.50	5.80	5.80 0	42.28	-0.621	18.90 0	19.07	18.90	19.20	19.20 0

UYG.4VSD VMW.L47 VVUS.L47 VXX.4VSD VXZ.4VSD YGE.L47 ZSL.4VSD DVAX.L47 NKTR.L47 NYX.L47 MELA.L47 AFFY.L47 TSPT.L47 CBRX.L47 ORCL.L47 CORT.L47

Ready PS - Connected CAT/120218/000

EMC to maintain 80% VMware stake

EMC Corp., which specializes in high-end computer storage systems, is based in Hopkinton. (Neal Hamberg/ Bloomberg News/ File 2004)

Bloomberg News / March 3, 2010

- Do you buy them?
  - What considerations do we need make?
  - What if the hedge fund wanted to sell 500 options only?
- Volatility/Vega
- Risk
- The above is an example of a volatility depression (spike). After the trade there will be a new volatility profile.
- What will that profile look like?
- Would it surprise you to know that there is no existing, accepted theory of the ***dynamics*** of pricing?
  - What we are interested in having at our disposal is not a **static** (or thermodynamic) model which allows stochastic volatility, but a way of learning about the "**response function**" of a real market.
- In a sophisticated theory, the following kind of mathematical object would be calculable: $<\Delta\sigma(K_1,t_1)\Delta\sigma(K_2,t_2)>$.

- As you can imagine. If we do decide to buy the Apr 85 calls we will have greatly increased our Vega. From the discussion it is clear that in any case, prices will decline in other strikes and series.
  - By how much?
  - No one knows. There is (almost) a complete absence of theory.
- If the Apr 85 calls decline by 1.5 (implied) vol points,
  - how many points will the Apr 90 calls come in by?
- The market there is $5.40-$5.60.
  - Does it make sense to *hit* the bid? (What does *hit* mean?)
- The July 85 calls are $10.40-$10.60.
  - Should you sell the calls at $10.40 as a hedge?
  - Is this better than the $5.40 sale?
  - What if there are earnings between April and July?

- ***Should you sell EMC volatility instead?!?***

- Suppose that the hedge fund "informs" you that the calls will trade.
  - Should you be ***leaning*** short?
  - What does this say about the assumption that the stock process is independent of option trading?
  - Is there a flaw in the Martingale assumption?

- Later (Lecture 2) we will see that option volume can affect stock prices.

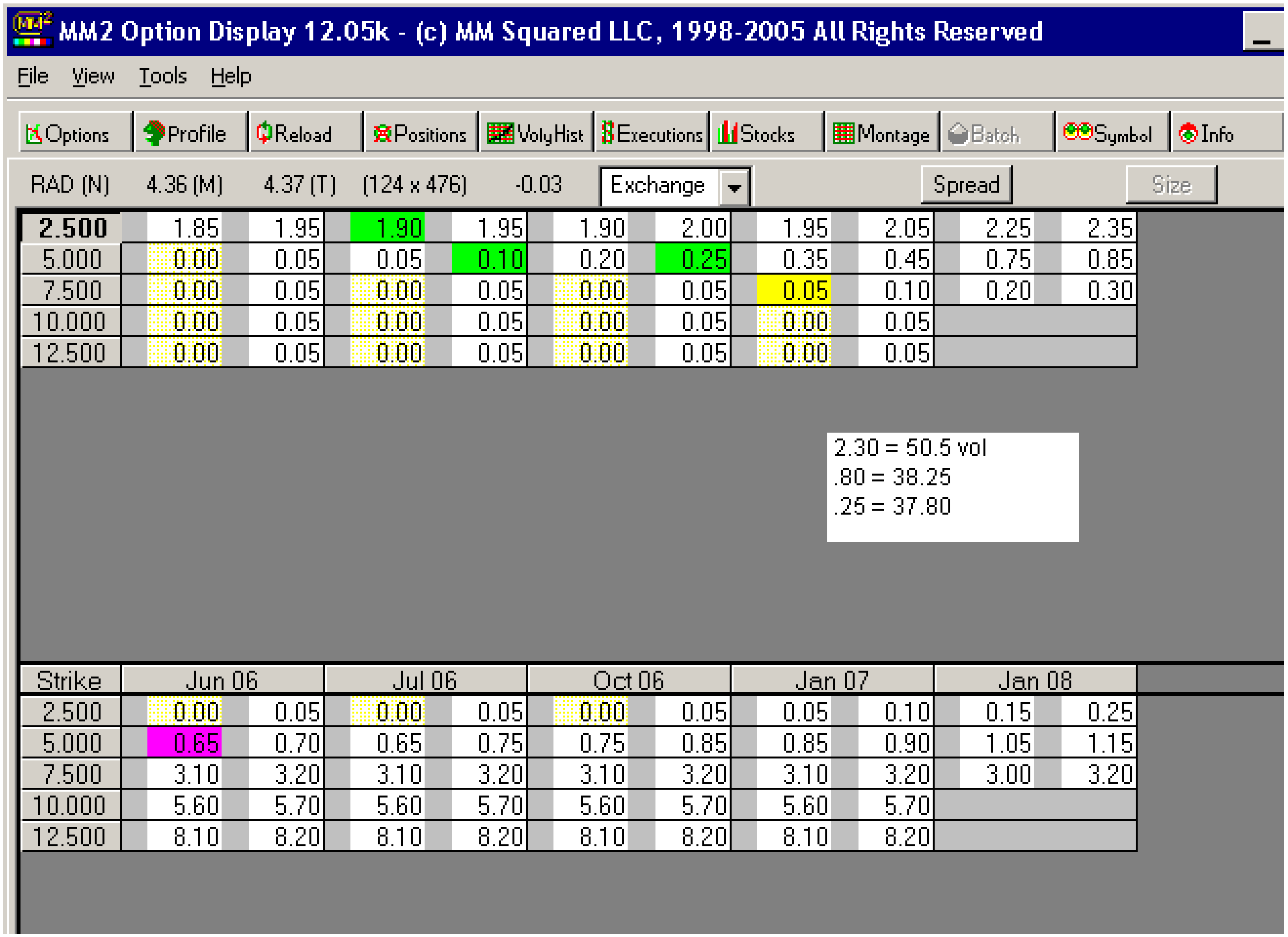
- Here are some Real World examples:

- On September 16, 2005, a BA customer sold 150,000 **FDC Jan 40 calls** to market-makers, mostly within a two-hour window.
- The implied volatility of at-the-money options went from 23 to 19 in January and from 28 to 20 in November.

this was ***case 1*** above

- On Tuesday, May 23, 2006, market-makers were told "133,000 RAD Jan '08 2½ calls will trade at 2.35 vs. 4.38 stock. How much would you like to sell?"

The Market (Reality)



2.500	1.85	1.95	1.90	1.95	1.90	2.00	1.95	2.05	2.25	2.35
5.000	0.00	0.05	0.05	0.10	0.20	0.25	0.35	0.45	0.75	0.85
7.500	0.00	0.05	0.00	0.05	0.00	0.05	0.05	0.10	0.20	0.30
10.000	0.00	0.05	0.00	0.05	0.00	0.05	0.00	0.05		
12.500	0.00	0.05	0.00	0.05	0.00	0.05	0.00	0.05		

Strike	Jun 06		Jul 06		Oct 06		Jan 07		Jan 08	
2.500	0.00	0.05	0.00	0.05	0.00	0.05	0.05	0.10	0.15	0.25
5.000	0.65	0.70	0.65	0.75	0.75	0.85	0.85	0.90	1.05	1.15
7.500	3.10	3.20	3.10	3.20	3.10	3.20	3.10	3.20	3.00	3.20
10.000	5.60	5.70	5.60	5.70	5.60	5.70	5.60	5.70		
12.500	8.10	8.20	8.10	8.20	8.10	8.20	8.10	8.20		

The Market (Reality)

RAD = $4.38
133,300 CONTRACTS TRADE 2.35

DO YOU SELL?

Option Order Entry

31556@ 2.3081144@ 2.35

WVBAZ JAN 08 2.50 Call | Katama MLipkin | Limit

Qty: 25 KP | Price: 2.25 KP | MM | IOC

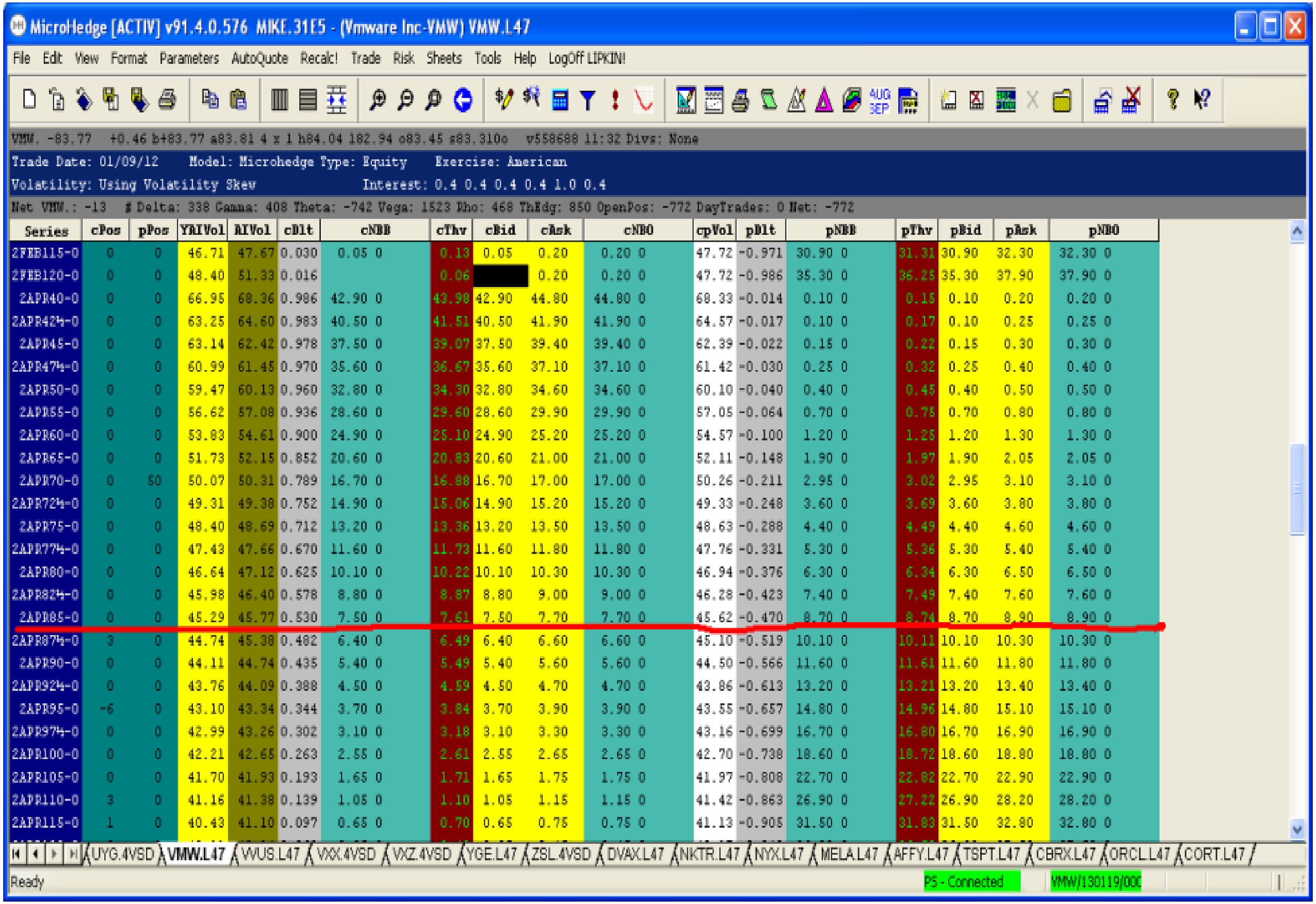
DoneAway | ISE | No PIP | Open | Sweep | None

Exch	Size	Bid	Vol
ISE	29	2.25	52
CBOE	40	2.20	0
PCX	10	2.20	133300
PHLX	20	2.20	0
BOX	30	2.20	0
AMEX	10	2.15	0

Exch	Size	Ask	Last
ISE	114	2.35	2.30
CBOE	57	2.35	0.00
AMEX	20	2.35	0.00
PCX	38	2.35	2.35
PHLX	71	2.35	0.00
BOX	51	2.35	0.00

SELL | Snd+Shw | Show | Spread | Close

The Market (Reality)



Series	cPos	pPos	YRIVol	RIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
2FEB115-0	0	0	46.71	47.67	0.030	0.05 0	0.13	0.05	0.20	0.20 0	47.72	-0.971	30.90 0	31.31	30.90	32.30	32.30 0
2FEB120-0	0	0	48.40	51.33	0.016		0.06		0.20	0.20 0	47.72	-0.986	35.30 0	36.25	35.30	37.90	37.90 0
2APR40-0	0	0	66.95	68.36	0.986	42.90 0	43.98	42.90	44.80	44.80 0	68.33	-0.014	0.10 0	0.15	0.10	0.20	0.20 0
2APR42½-0	0	0	63.25	64.60	0.983	40.50 0	41.51	40.50	41.90	41.90 0	64.57	-0.017	0.10 0	0.17	0.10	0.25	0.25 0
2APR45-0	0	0	63.14	62.42	0.978	37.50 0	39.07	37.50	39.40	39.40 0	62.39	-0.022	0.15 0	0.22	0.15	0.30	0.30 0
2APR47½-0	0	0	60.99	61.45	0.970	35.60 0	36.67	35.60	37.10	37.10 0	61.42	-0.030	0.25 0	0.32	0.25	0.40	0.40 0
2APR50-0	0	0	59.47	60.13	0.960	32.80 0	34.30	32.80	34.60	34.60 0	60.10	-0.040	0.40 0	0.45	0.40	0.50	0.50 0
2APR55-0	0	0	56.62	57.08	0.936	28.60 0	29.60	28.60	29.90	29.90 0	57.05	-0.064	0.70 0	0.75	0.70	0.80	0.80 0
2APR60-0	0	0	53.83	54.61	0.900	24.90 0	25.10	24.90	25.20	25.20 0	54.57	-0.100	1.20 0	1.25	1.20	1.30	1.30 0
2APR65-0	0	0	51.73	52.15	0.852	20.60 0	20.83	20.60	21.00	21.00 0	52.11	-0.148	1.90 0	1.97	1.90	2.05	2.05 0
2APR70-0	0	50	50.07	50.31	0.789	16.70 0	16.88	16.70	17.00	17.00 0	50.26	-0.211	2.95 0	3.02	2.95	3.10	3.10 0
2APR72½-0	0	0	49.31	49.38	0.752	14.90 0	15.06	14.90	15.20	15.20 0	49.33	-0.248	3.60 0	3.69	3.60	3.80	3.80 0
2APR75-0	0	0	48.40	48.69	0.712	13.20 0	13.36	13.20	13.50	13.50 0	48.63	-0.288	4.40 0	4.49	4.40	4.60	4.60 0
2APR77½-0	0	0	47.43	47.66	0.670	11.60 0	11.73	11.60	11.80	11.80 0	47.76	-0.331	5.30 0	5.36	5.30	5.40	5.40 0
2APR80-0	0	0	46.64	47.12	0.625	10.10 0	10.22	10.10	10.30	10.30 0	46.94	-0.376	6.30 0	6.34	6.30	6.50	6.50 0
2APR82½-0	0	0	45.98	46.40	0.578	8.80 0	8.87	8.80	9.00	9.00 0	46.28	-0.423	7.40 0	7.49	7.40	7.60	7.60 0
2APR85-0	0	0	45.29	45.77	0.530	7.50 0	7.61	7.50	7.70	7.70 0	45.62	-0.470	8.70 0	8.74	8.70	8.90	8.90 0
2APR87½-0	3	0	44.74	45.38	0.482	6.40 0	6.49	6.40	6.60	6.60 0	45.10	-0.519	10.10 0	10.11	10.10	10.30	10.30 0
2APR90-0	0	0	44.11	44.74	0.435	5.40 0	5.49	5.40	5.60	5.60 0	44.50	-0.566	11.60 0	11.61	11.60	11.80	11.80 0
2APR92½-0	0	0	43.76	44.09	0.388	4.50 0	4.59	4.50	4.70	4.70 0	43.86	-0.613	13.20 0	13.21	13.20	13.40	13.40 0
2APR95-0	-6	0	43.10	43.34	0.344	3.70 0	3.84	3.70	3.90	3.90 0	43.55	-0.657	14.80 0	14.96	14.80	15.10	15.10 0
2APR97½-0	0	0	42.99	43.26	0.302	3.10 0	3.18	3.10	3.30	3.30 0	43.16	-0.699	16.70 0	16.80	16.70	16.90	16.90 0
2APR100-0	0	0	42.21	42.65	0.263	2.55 0	2.61	2.55	2.65	2.65 0	42.70	-0.738	18.60 0	18.72	18.60	18.80	18.80 0
2APR105-0	0	0	41.70	41.93	0.193	1.65 0	1.71	1.65	1.75	1.75 0	41.97	-0.808	22.70 0	22.82	22.70	22.90	22.90 0
2APR110-0	3	0	41.16	41.38	0.139	1.05 0	1.10	1.05	1.15	1.15 0	41.42	-0.863	26.90 0	27.22	26.90	28.20	28.20 0
2APR115-0	1	0	40.43	41.10	0.097	0.65 0	0.70	0.65	0.75	0.75 0	41.13	-0.905	31.50 0	31.83	31.50	32.80	32.80 0

- Let's take the previous slide of VMW as a template.
- The standard approach to market pricing is calibration. All market models take input data from the actual prices out there. Suppose that the resultant model now "fits" the market, in the sense that no theoretical prices lie outside the bid-offer spreads.
  - Does this mean that the market is correctly priced?
- Suppose that over the next week, buyers show up for all the VMW 87.5 line options (previous slide S_0=83.77). As a result,
  - what will happen to the normal skew?
- If the skew "inverts", does this mean that the prices are wrong?
- We will see, (Lecture 4), that under certain circumstances such as take-overs the skew can take a strange but characteristic shape.

- The main point is this: **if all our (derivatives) prices are fit by calibrating an initial model- and then the prices no longer fit**- we…

- *cannot know if our model is now wrong*
- or *if profitable trading is now possible*
- This is because events create a *phase change* in the system we are studying/trading

- Case 2: earnings dates in AAPL and MSFT
- Case 3: anticipation of, and then take-over of DSC (DIGI) by Alcatel
- Case 4: the *expiration pinning* of JDEC

- Let's try to summarize some of the ideas we have discussed.
- The **size** of a trade matters. The **time scale for** the ***relaxation*** of the market subsequent to a trade matters. A quant analyzing the *thermodynamics* of the market will not see many of the time scales needed to understand market dynamics.
- It is important to pay strict attention to time scales.
- Ex.: *Optionmetrics* **IVY database** – closing prices
- This time scale suffices to look at earnings, drug announcements, take-overs and mini-crashes (Lectures 3 and 4). It does not allow us to look at the response to size trades.
  - What kind of database would you need for that?
  - Would such a database be useful for a trading house?
  - Do you think the *elasticity* of the response is a function of the individual stock? the open interest? the illiquidity of the stock? Anything else?

- Let's conclude this introductory talk by considering a typical problem about which there is a lack of theoretical understanding. The objective will be to abstract the nature of the problem, consider the time scales involved, and finally to propose a database *experiment* to search for market behavior.
- Let's take the VMW, EMC example. These are two related companies. Suppose we run a book with positions in VMW and EMC. When we are offered a large trade in VMW, we would like to know if we need to be hedging in EMC. Notice that this is not asking if stock prices are correlated (although they may be), but rather if volatility surfaces are correlated.
- For example, suppose that we are short 5000 Vega in VMW and long 5000 Vega in EMC. If we buy VMW premium we will become flat, say.
  - Do we need to sell some amount of EMC volatility?
  - If that is true, what would that tell us and how would we quantify it?
  - What time scale would the vol changes occur on?

- To begin with we need to **locate** significant volatility changes in the histories of VMW and EMC. We need these changes to occur over a characteristic time scale, say one or two days, and then we need to see if there is a subsequent change in the volatility of the partner stock. The following quantities may be relevant:

$$\langle \Delta\sigma_{VMW}(t,K_{\Delta 1})\Delta\sigma_{EMC}(t+\tau,K_{\Delta 1})\rangle \qquad (1)$$

- What is this object? $\Delta\sigma$ is the change in vol, τ is the lag time (unknown but possibly very short) between the change in VMW vol and the subsequent change in EMC vol, $\tau > 0$ assumed. $K_{\Delta 1}$ is the strike corresponding to similar deltas in both products. (Notice how the assumptions are multiplying!!) From the physics of dynamical systems, this quantity is called a response function– for obvious reasons.

- Impact is frustrating (for me) in that it exposes the lack of theory.
- Given some set of parameters involving market cap, supply/demand, initial volatility surface, etc., a complete theory would explicitly yield the *new* volatility surface which results, given a large instantaneous trade of size, Q.
- This is far away, however:

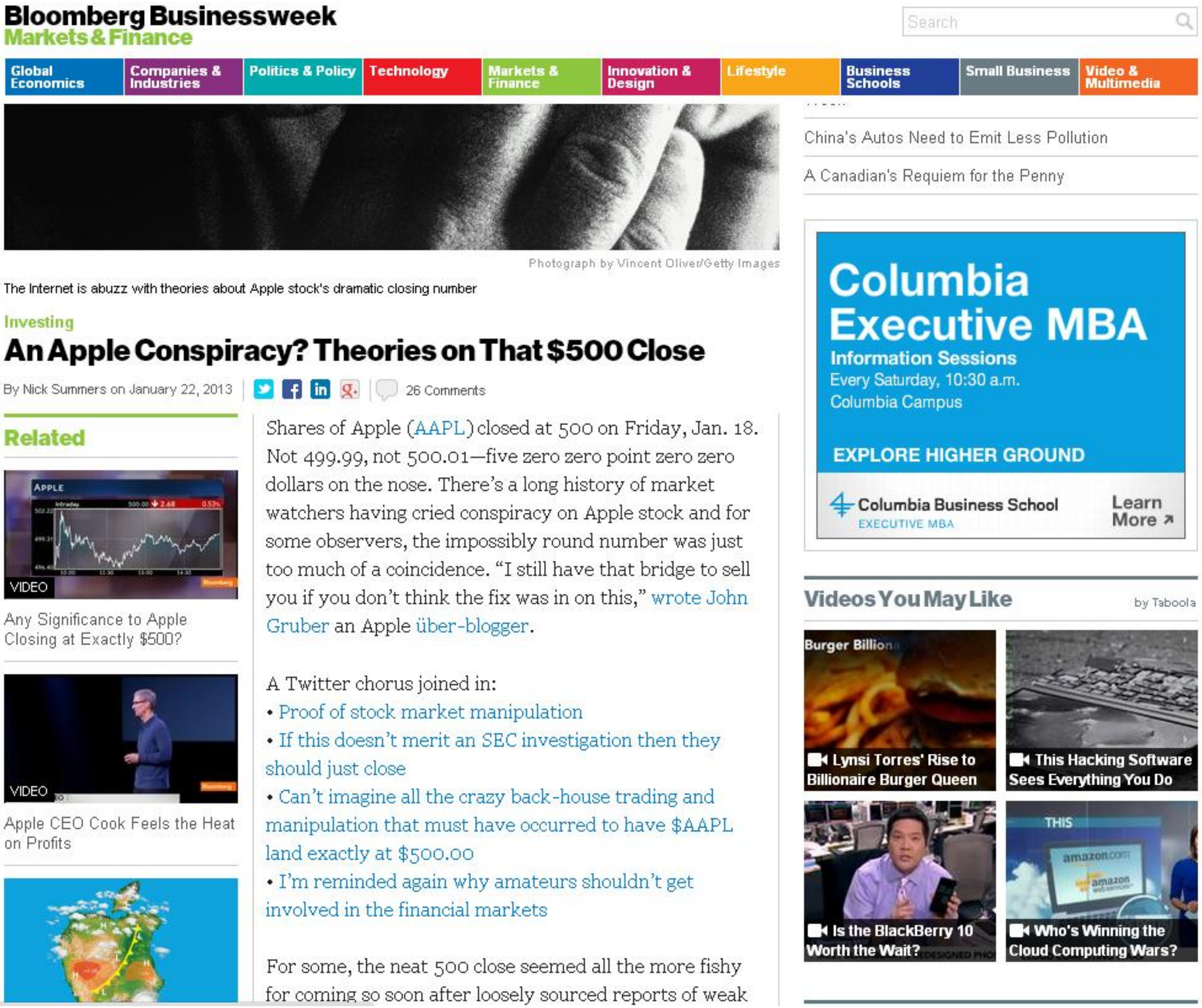
- A "complete" solution exists for stock pinning (Lec. 2)
- "Partial" solutions exists for earnings and take-overs (Lecs. 3 and 4)
- A "complete" (hard) solution exists for hard-to-borrowness (another mini-course)
- The general technical approach is to identify *slow* variables in which reformulated static modeling approximately holds.
- **We will see this next time…**

Event-Driven Finance

Lecture 2: Pinning.

Mike Lipkin
Columbia University (IEOR)

Pinning


Bloomberg Businessweek
Markets & Finance

Global Economics | Companies & Industries | Politics & Policy | Technology | Markets & Finance | Innovation & Design | Lifestyle | Business Schools | Small Business | Video & Multimedia

Photograph by Vincent Oliver/Getty Images

The Internet is abuzz with theories about Apple stock's dramatic closing number

Investing

An Apple Conspiracy? Theories on That $500 Close

By Nick Summers on January 22, 2013 | 26 Comments

Shares of Apple (AAPL) closed at 500 on Friday, Jan. 18. Not 499.99, not 500.01—five zero zero point zero zero dollars on the nose. There's a long history of market watchers having cried conspiracy on Apple stock and for some observers, the impossibly round number was just too much of a coincidence. "I still have that bridge to sell you if you don't think the fix was in on this," wrote John Gruber an Apple über-blogger.

A Twitter chorus joined in:
- Proof of stock market manipulation
- If this doesn't merit an SEC investigation then they should just close
- Can't imagine all the crazy back-house trading and manipulation that must have occurred to have $AAPL land exactly at $500.00
- I'm reminded again why amateurs shouldn't get involved in the financial markets

For some, the neat 500 close seemed all the more fishy for coming so soon after loosely sourced reports of weak

Related

VIDEO
Any Significance to Apple Closing at Exactly $500?

VIDEO
Apple CEO Cook Feels the Heat on Profits

China's Autos Need to Emit Less Pollution

A Canadian's Requiem for the Penny

Videos You May Like
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Lynsi Torres' Rise to Billionaire Burger Queen

This Hacking Software Sees Everything You Do

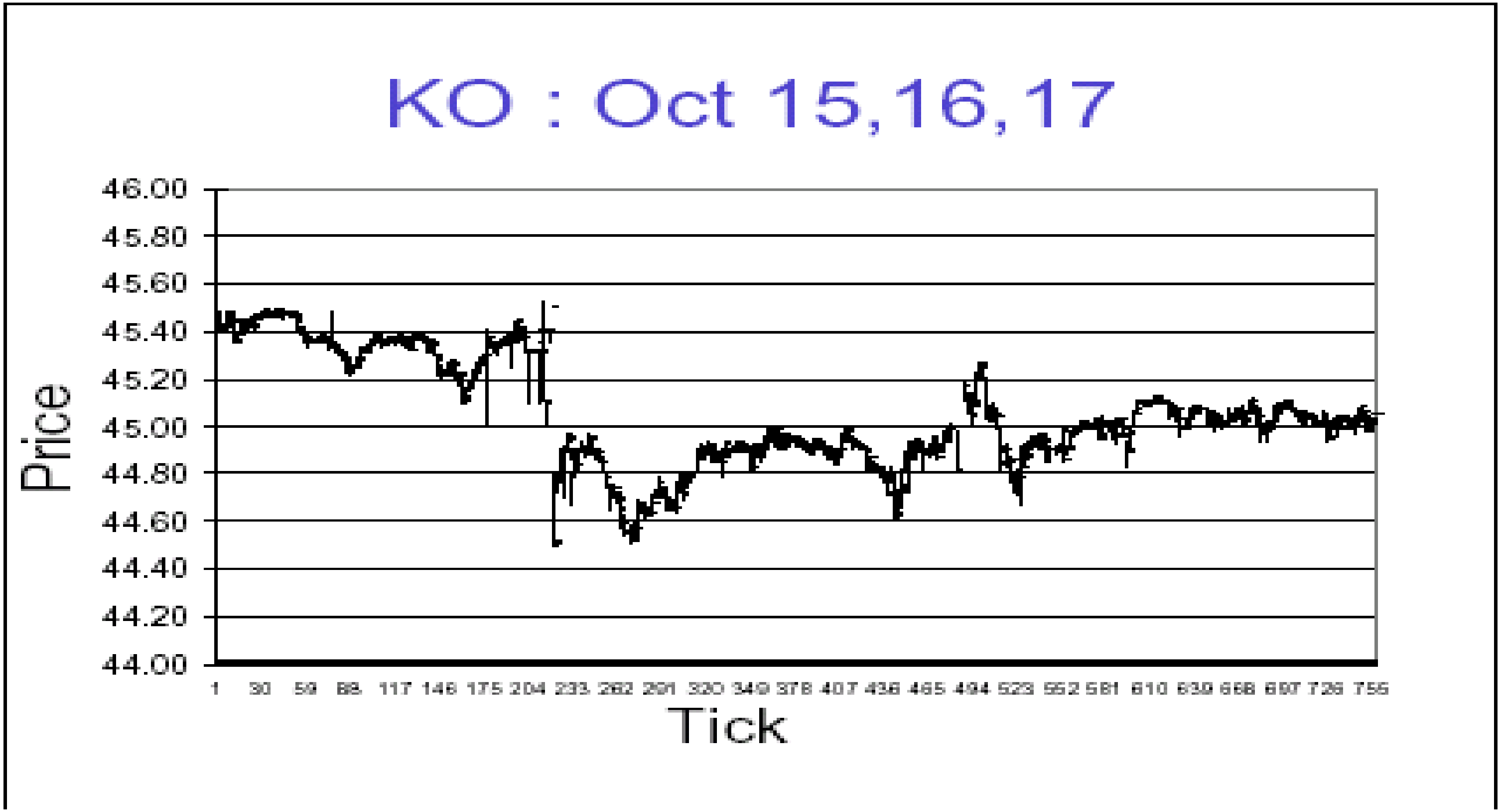
Is the BlackBerry 10 Worth the Wait?

Who's Winning the Cloud Computing Wars?

Pinning

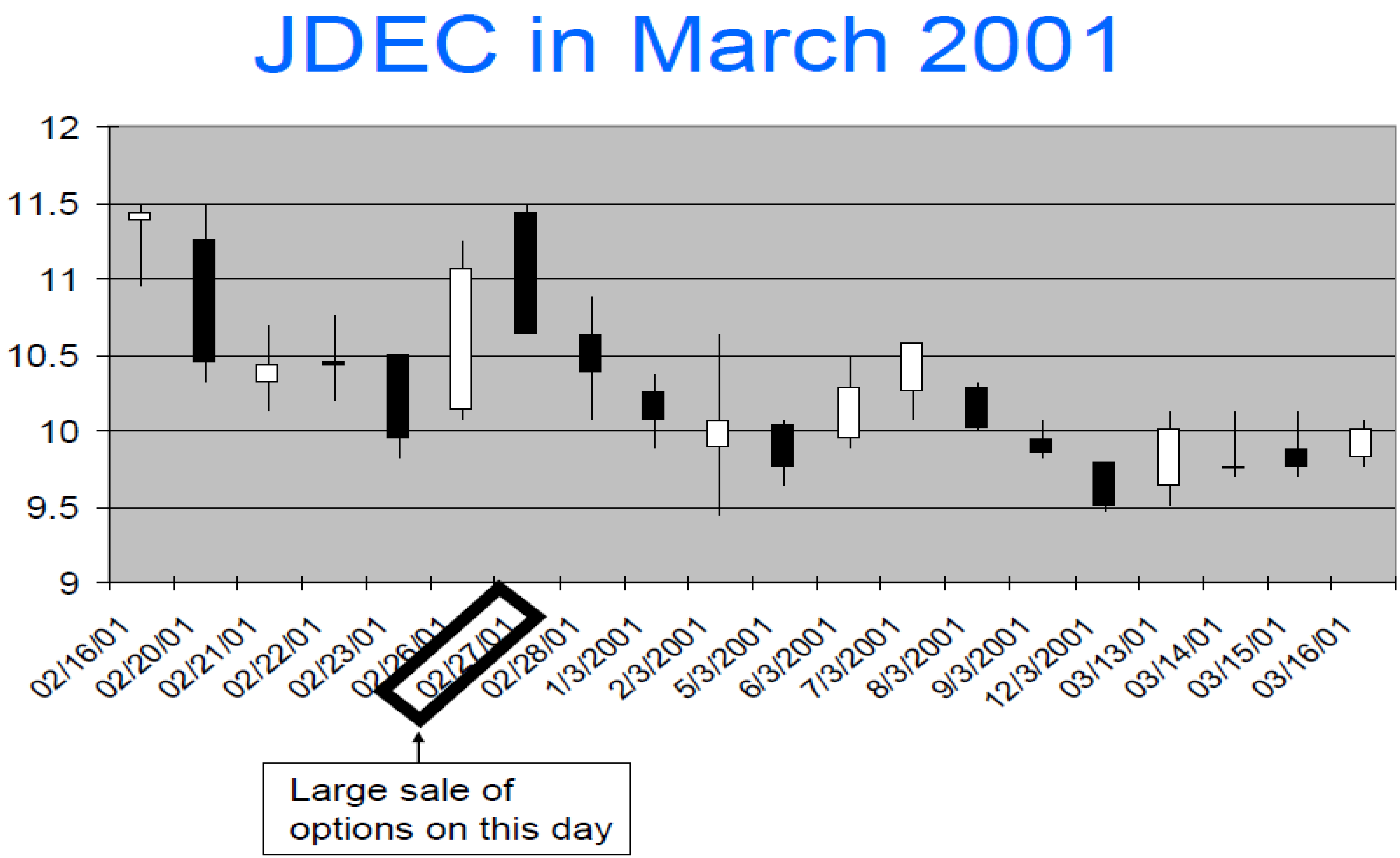

Zoom: 1d 5d 1m 3m 6m YTD 1y 5y 10y All
Jan 18, 2013 - Jan 30, 2013 -45.68 (-9.09%)
505
504
503
502
501
500
499
498
11 am
12 pm
1 pm
2 pm
3 pm
Tue Jan 22
10 am
Volume (mil / 30min)
3
1.5
2011
2012
2013
Settings | Plot feeds | Technicals | Link to this view
Volume delayed by 15 mins.

3 days to expiration; KO

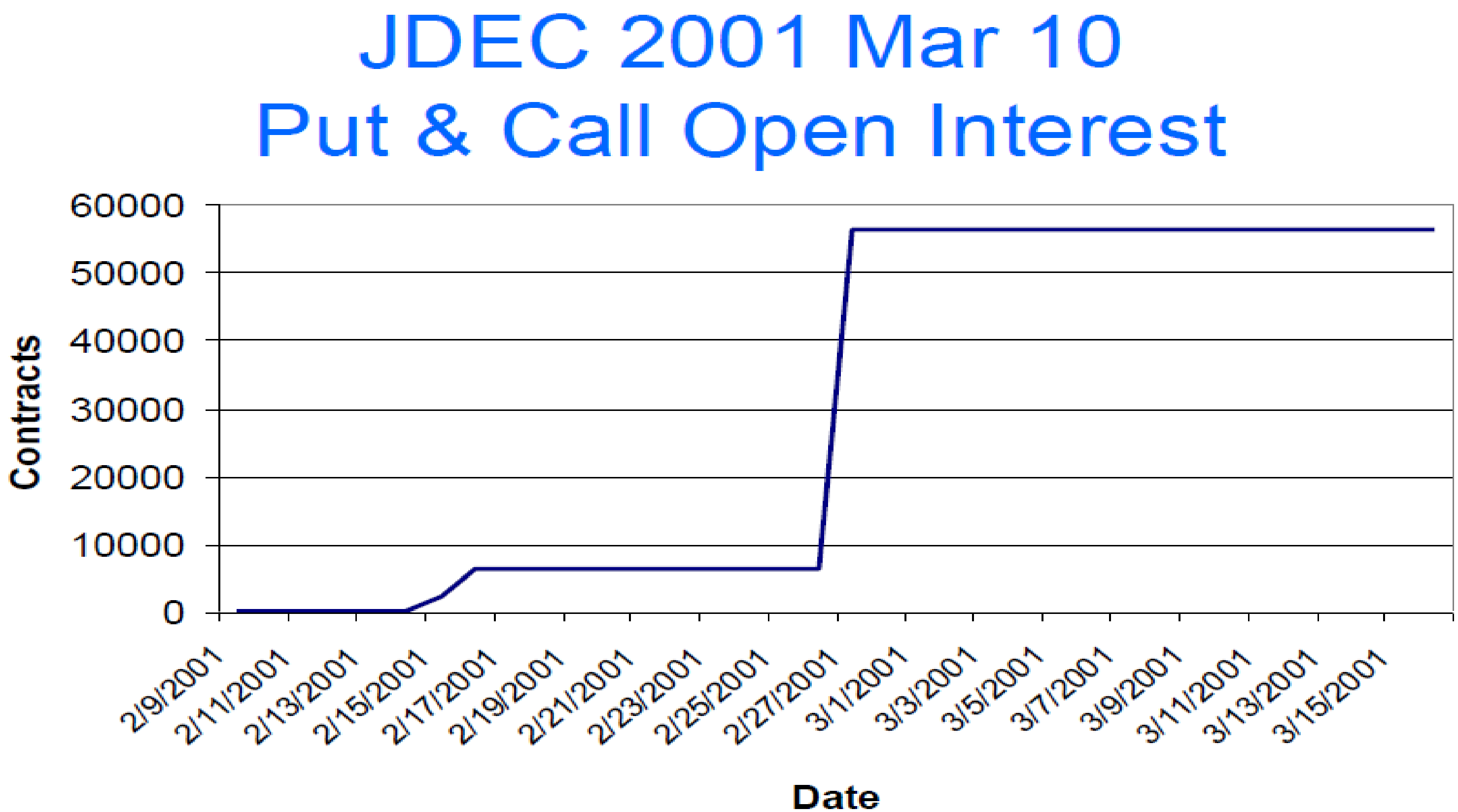


KO pinning to 67.50 (weeklies)

- (JDEC pin)


JDEC in March 2001
12
11.5
11
10.5
10
9.5
9
02/16/01
02/20/01
02/21/01
02/22/01
02/23/01
02/26/01
02/27/01
02/28/01
1/3/2001
2/3/2001
5/3/2001
6/3/2001
7/3/2001
8/3/2001
9/3/2001
12/3/2001
03/13/01
03/14/01
03/15/01
03/16/01
Large sale of options on this day

Large trade *initiates* regime



Average traded vol in stocks = 1MM shares

Notional number of shares corresponding to OI = 5.6 MM shares

- Today we want to look at a static property of the option markets.
- Not all phenomena which appear to violate "standard" option theory are dynamic. As you know, there are many assumptions made in standard classical finance which we know, or suspect, cannot hold in the real markets.
- Suppose you see the following market:

XYZ	Jun 40 C	8.50 – 8.80	(100 x 450)
(Underlying)		48.46 – 48.52	(650 x 75)

Expiration day.

- First of all, what does this mean? What is the fair value of the calls?
- Classical theory says that the Jun 40 calls are overpriced. By how much? Why haven't they traded?

- Costs are an obvious area typically ignored in order to price options.
- A more subtle idea is the assumption of a *stock process*. This is a stochastic process for the stock, *independent* of the presence of options trading.
- Suppose someone bids for 25000 calls all at once. (On Friday, April 28, 2006 this happened in MSFT May 25 (at-the-$) calls.) Do you suspect that the stock would move in a correlated fashion? Which way? (In MSFT the stock price moved from 24.05 to 24.17 in 15 minutes from the origin of the order.)
- **This means that on certain time scales a demand for (supply of) stock moves the stock.** Quantifying this effect theoretically means identifying an *Impact Function*.
- What about the very presence of outstanding option open interest?

  Typically it would seem not, because undoubtedly positions are hedged. And yet, sometimes option positions lead to *changing* deltas.

Pinning

- Suppose you hold an XYZ Jun 40 C; it is expiration day and the stock is at 40.35 at 10:30. You calculate the delta and find it is 58.
- At 1:30, three hours later, the stock is still at 40.35. What has happened to the delta of the call? When you recalculate the option delta, it is now 66. Why?
- To stay delta-neutral you must sell an additional 8 shares.
- Now couple this to the assumption that supply (demand) of the stock pushes the stock down (up) and the changing deltas of the option lead to long option holders selling the stock.
- An analogous argument applies with the stock below the strike; now buyers push the stock up toward the strike.
- In the Black-Scholes, classical world, there are an equal number of short option holders doing the exact opposite thing. The net effect should be zero.

- But is this an accurate assumption? Market makers are generally active hedgers. When they are long a strike they aggressively hedge, especially close to expiration. But when they are short a strike and since they cannot **continuously** hedge, they avoid hedging as long as possible.

- Consider the region over which the delta is changing most rapidly. This is also the region where $\theta \equiv -(\partial C/\partial t)$ is largest. So there is an incentive for a trader to avoid hedging his short option, as long as the possibility of pinning remains high. On the other hand, the long option holder risks losing all the option value to pinning.

- So unlike the Black-Scholes world, real hedging strategies are asymmetric. Coupled with an additional non-classical assumption of stock price movement to supply/demand, there is the possibility of **pinning** the stock at expiry, that is a non-zero probability of the stock exactly closing at a strike price.

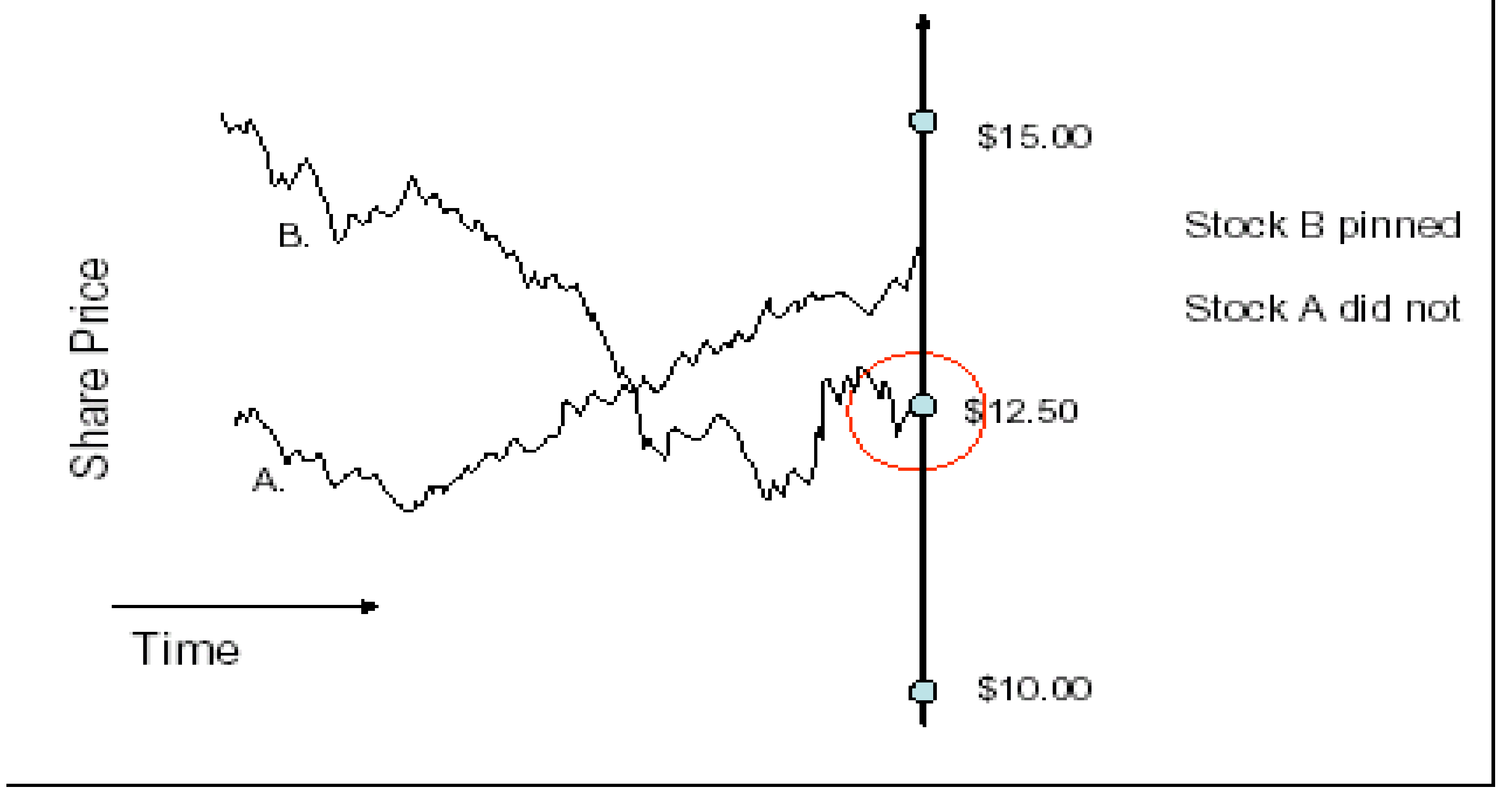
What is stock pinning?

- At the expiration of options, the close of trading on the third Friday of each month, a stock is **pinned** if it closes *exactly* at a strike price.

- For practical reasons, pinning can be considered to have occurred if the closing price is *close* to a strike (±$0.25, say)

- Mathematically: $P\{|K-S|< \varepsilon\} > 0$ at expiration for all $\varepsilon>0$.

Pinning on Option Expiration Dates



UI Urbana Study: Optionable vs. Non-Optionable Stocks

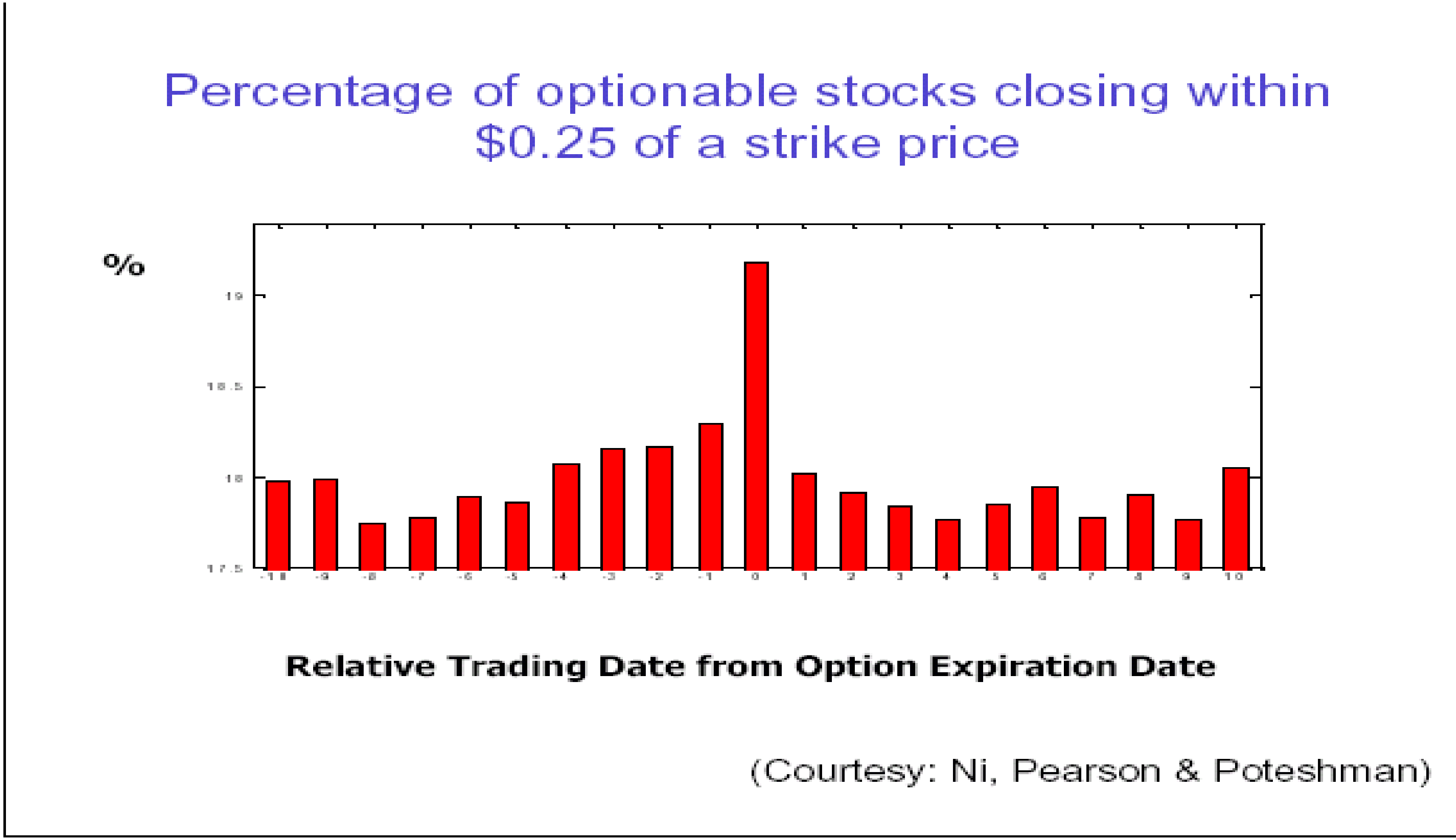
- At least 80 expiration dates

- 4,395 optionable stocks on at least one date
- 184,449 optionable stock-expiration pairs

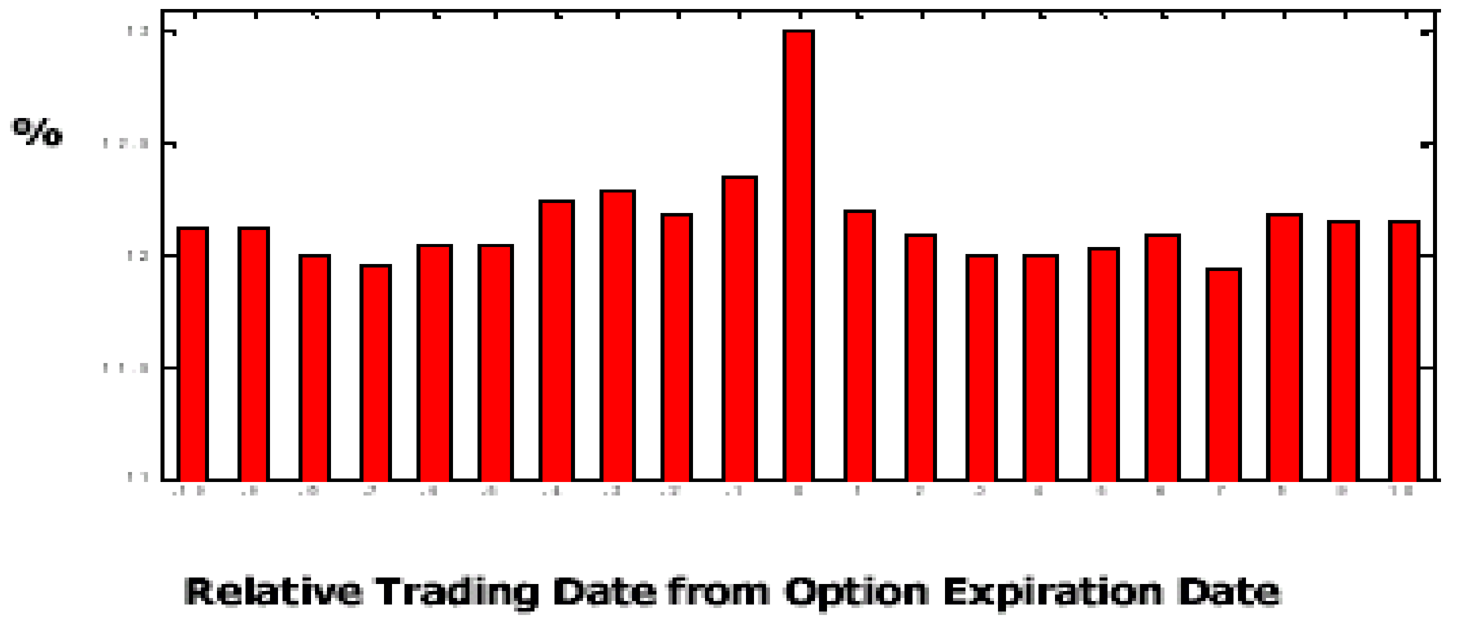
- 12,001 non-optionable stocks on at least one date
- 417,007 non-optionable stock-expiration pairs

Pinning

Several results from the UI group. Data from January 1996 through September 2002

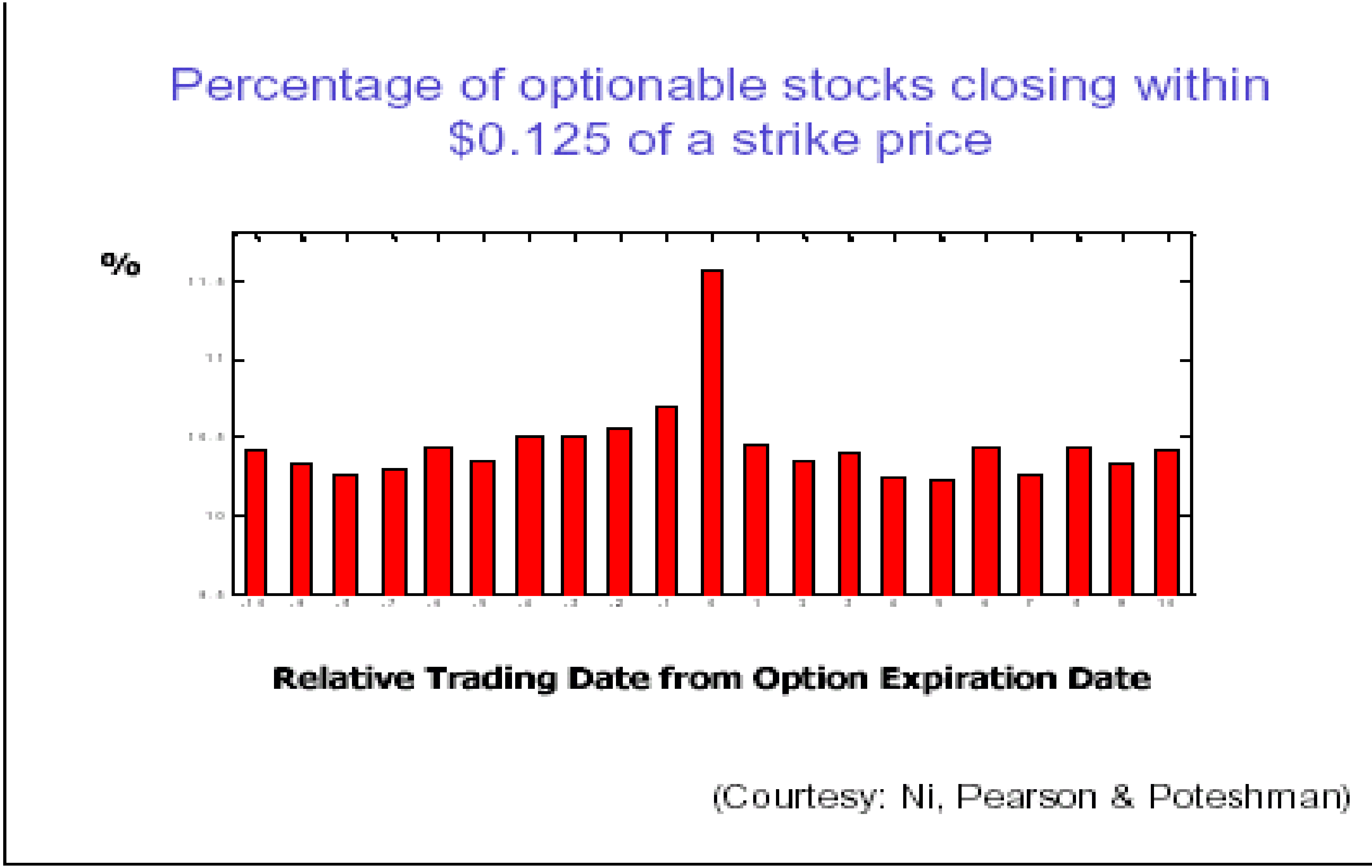


Percentage of optionable stocks closing within $0.25 of an integer multiple of $5



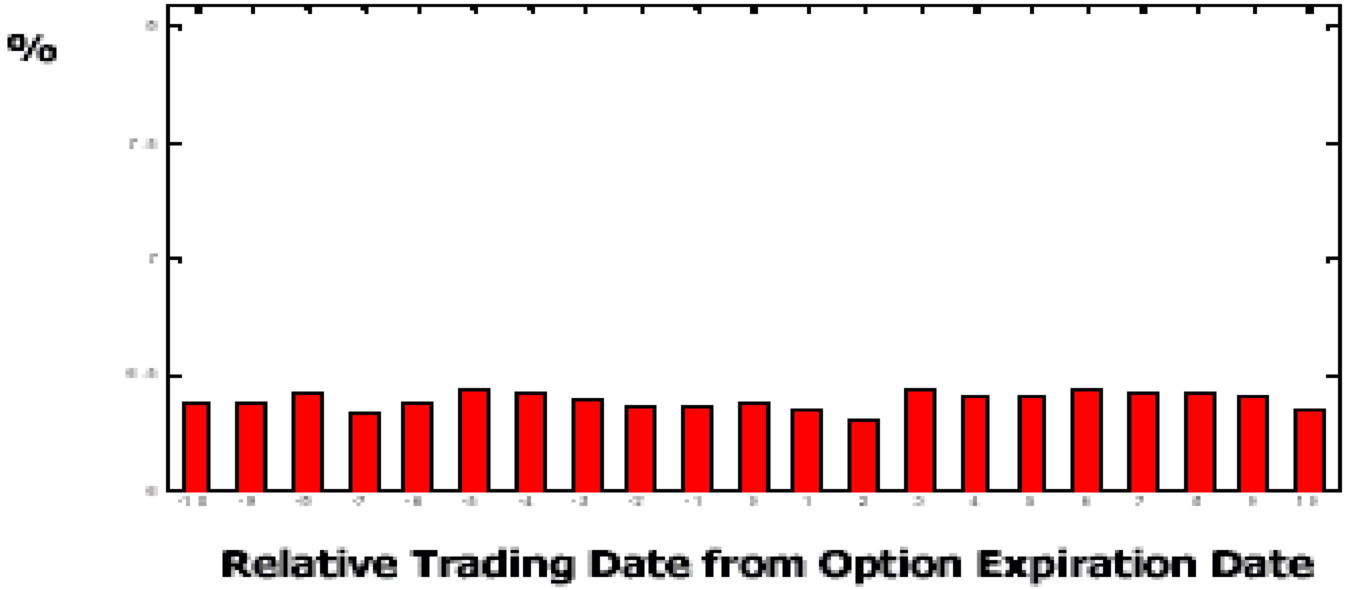
(Courtesy: Ni, Pearson & Poteshman)

Pinning


Percentage of optionable stocks closing within
$0.125 of a strike price
%
Relative Trading Date from Option Expiration Date
(Courtesy: Ni, Pearson & Poteshman)

Pinning

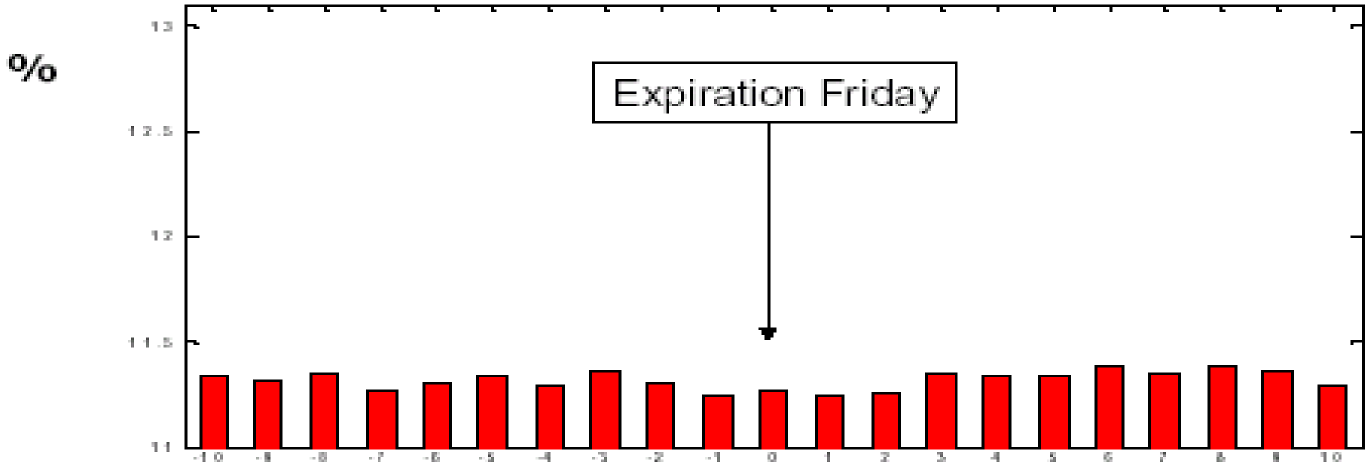
Percentage of non-optionable stocks closing within $0.125 of an integer multiple of $5



(Courtesy: Ni, Pearson & Poteshman)

Pinning

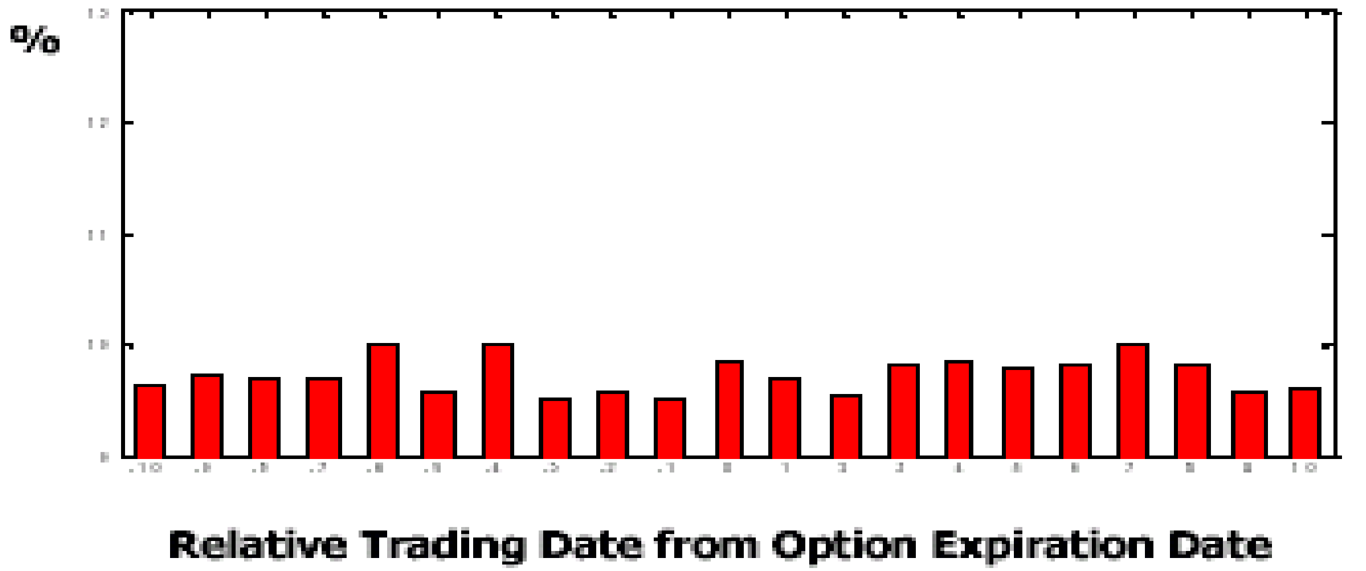
Percentage of non-optionable stocks closing within $0.25 of an integer multiple of $5



Relative Trading Date from Option Expiration Date

(Courtesy: Ni, Pearson & Poteshman)

Non-optionable stocks that were previously optionable closing within $0.125 of an integer multiple of $2.50



- So there is plenty of evidence for pinning, but only in *optionable* stocks. **What models might suffice to explain the effect?**

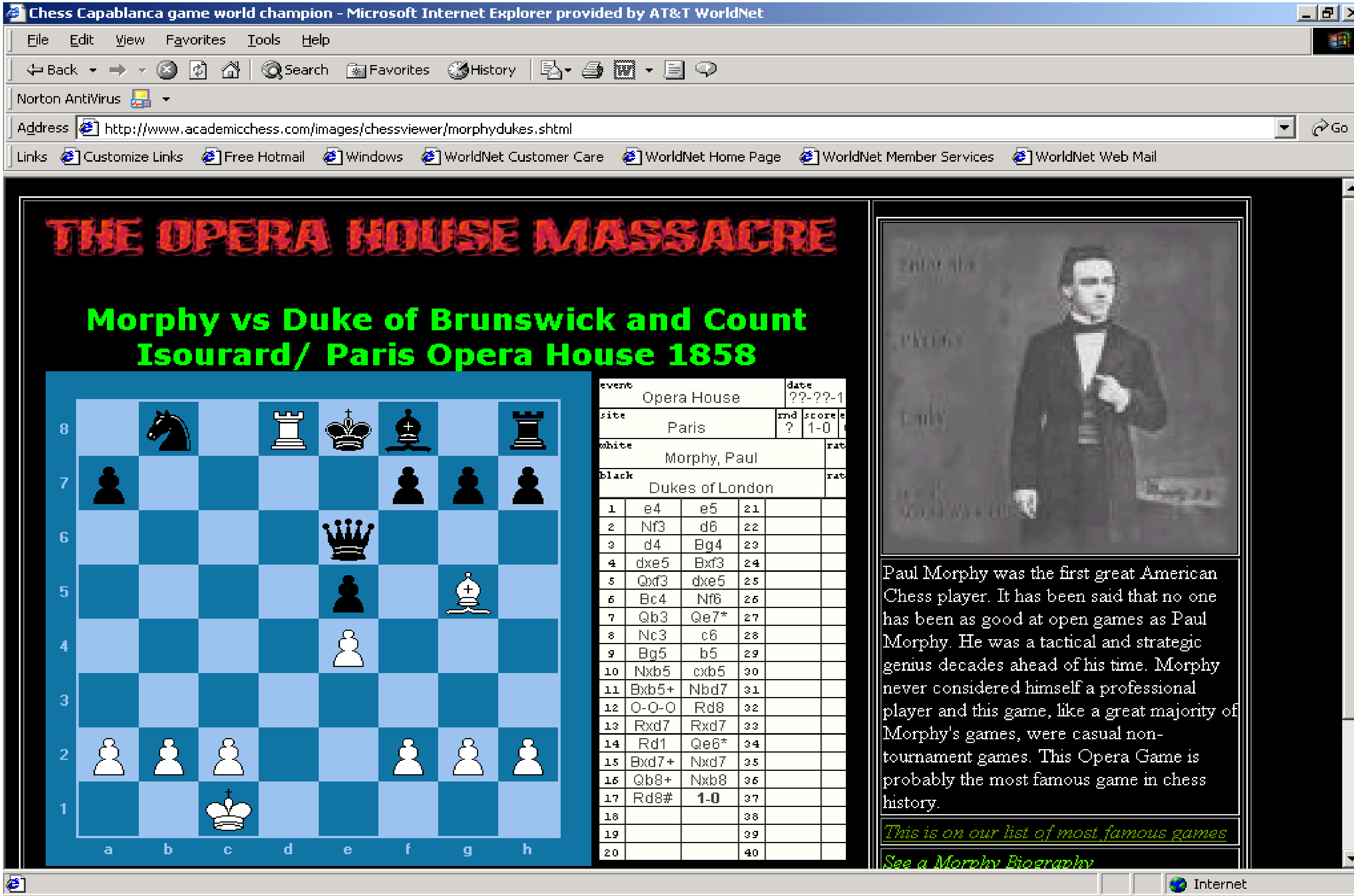
- Krishnan and Nelkin attack the problem of pinning by assuming that there exists an a priori mixture of pinning paths and independent random walks for the stock price. This model can get any desired probability of pinning, but leaves unanswered how actual option data and parameters, and stock price, may affect the probabilities. Also, once the KN mixture is fixed, the price of the straddle cannot be accurate for all eventual stock paths.

- Ni, Poteshman, Pearson originally suspected **collusion** on the part of market participants. (Post our work, somewhat less so.)

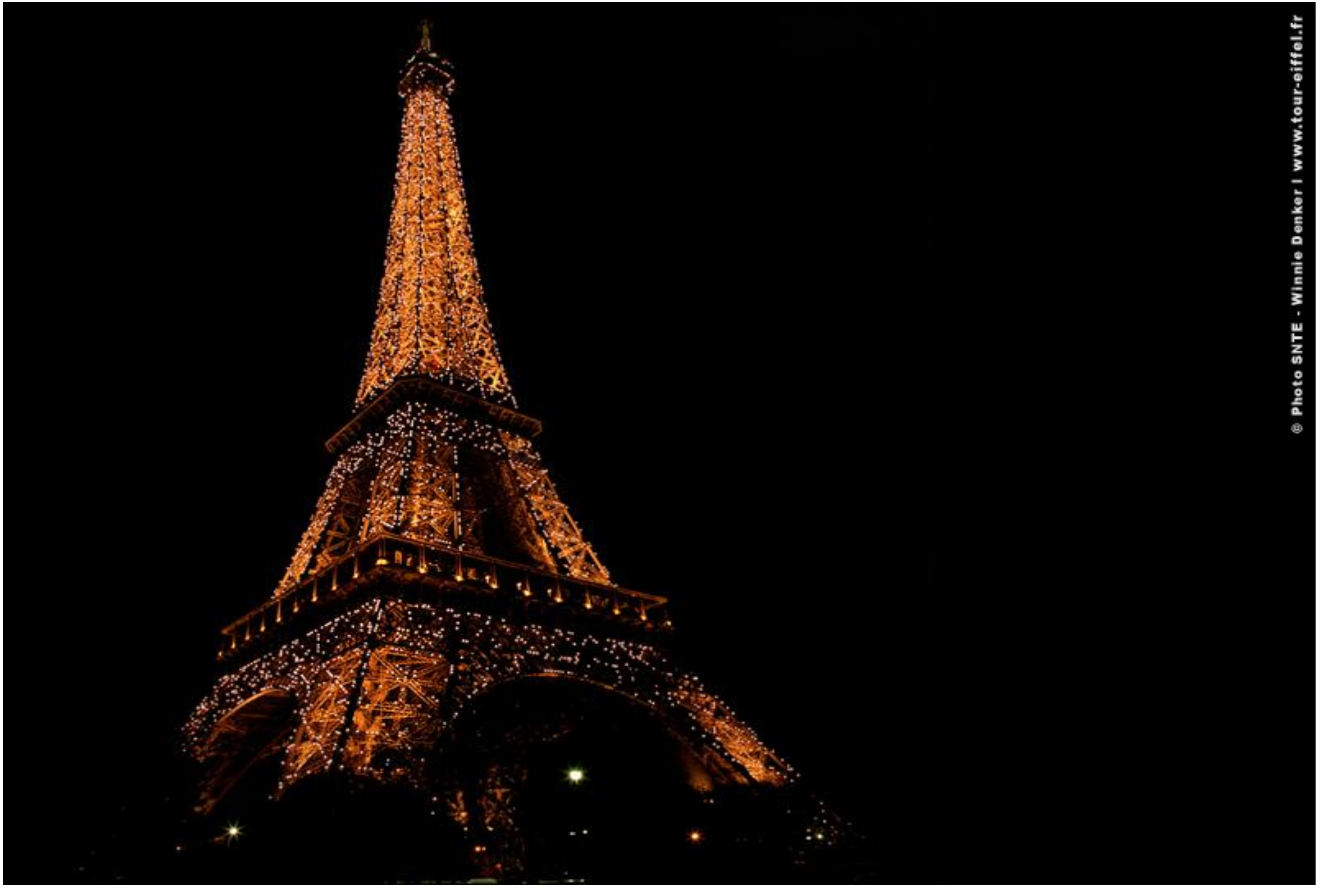
- **Which of the following three slides doesn’t belong?**
- **(And what are they?!)**

Pinning

Pinning


Chess Capablanca game world champion - Microsoft Internet Explorer provided by AT&T WorldNet
File Edit View Favorites Tools Help
Back Search Favorites History
Norton AntiVirus
Address http://www.academicchess.com/images/chessviewer/morphydukes.shtml
Go
Links Customize Links Free Hotmail Windows WorldNet Customer Care WorldNet Home Page WorldNet Member Services WorldNet Web Mail
THE OPERA HOUSE MASSACRE
Morphy vs Duke of Brunswick and Count Isourard/ Paris Opera House 1858
8 7 6 5 4 3 2 1
a b c d e f g h
event Opera House
date ??-??-1
site Paris
rnd ?
score 1-0
white Morphy, Paul
black Dukes of London
1 e4 e5
2 Nf3 d6
3 d4 Bg4
4 dxe5 Bxf3
5 Qxf3 dxe5
6 Bc4 Nf6
7 Qb3 Qe7*
8 Nc3 c6
9 Bg5 b5
10 Nxb5 cxb5
11 Bxb5+ Nbd7
12 O-O-O Rd8
13 Rxd7 Rxd7
14 Rd1 Qe6*
15 Bxd7+ Nxd7
16 Qb8+ Nxb8
17 Rd8# 1-0
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Paul Morphy was the first great American Chess player. It has been said that no one has been as good at open games as Paul Morphy. He was a tactical and strategic genius decades ahead of his time. Morphy never considered himself a professional player and this game, like a great majority of Morphy's games, were casual non-tournament games. This Opera Game is probably the most famous game in chess history.
This is on our list of most famous games
See a Morphy Biography
Internet

Pinning



- The answer is: the Eiffel tower. Both the termite mounds and the chess game are constructs of independent agents. In other words, although both those slides show a very specific final ordered result, they are the consequence of two or many agents playing out a game. NO MASTER ARCHITECT exists.

- In the game of options trading, individual market-makers play at HEDGING their positions. They do not collude to maintain unbalanced positions.

Pinning

- All possible models cannot be known, but one which involves market-makers acting independently to maintain approximately delta-neutral positions satisfies Occam's razor. It requires the fewest assumptions about the outside world. A kind of greatest entropy model.

- It should be noted that there are two distinctions which may be drawn between market participants. Some, market-makers and desk proprietary traders among them, are active hedgers. Others, investors and positional traders, put on positions (often but not always long delta), and let them play out.

- This asymmetry will be important.

- A number of groups have examined the response of markets to orders entering an order book.

- One group is associated with J D Farmer:

  Lillo, Farmer, Montegna: *Nature* **421(**2003) pp 129-130,

  Daniels, Farmer, Guillemot, Iori, Smith: cond-mat/0112422, a Los Alamos National Lab preprint.

- Another group is associated with JP Bouchaud (CFM).

- These groups all agree on the common sense notion that BUYING stock raises the market price, and SELLING stock lowers the market price.

- Curiously they all disagree on the functional way in which the changing market varies with S/D. (This will be a subject for discussion later.)

- $\Delta S/S = f(Q) = EQ + E_2 Q^2 + E_3 Q^3 + \ldots = EQ + g(Q)$,

  g analytic. This is a simple Taylor's expansion for market price change as a function of the demand for (supply of) stock. For simplicity, we throw out g(Q) and simply assume a linear form.

Estimating the Demand for Deltas using Black-Scholes

$$\Delta\delta = \frac{\partial \delta}{\partial t} dt, \qquad \tau = T - t$$

$$\delta = 2N(d_1), \qquad d_1 = \frac{1}{\sigma\sqrt{\tau}}\left(\ln\left(\frac{S}{K}\right) + \left(\mu + \frac{\sigma^2}{2}\right)\frac{\sqrt{\tau}}{2\sigma}\right)$$

From Black-Scholes

$$y = \ln\left(\frac{S}{K}\right), \qquad a = \mu + \frac{\sigma^2}{2},$$

$$\frac{\partial \delta}{\partial t} = -\frac{1}{\sqrt{2\pi}} \frac{y - a\tau}{\sigma\tau^{3/2}} e^{-\frac{(y+a\tau)^2}{2\sigma^2\tau}}$$

Taking into account demand for stock: Price-Impact Functions

$$\frac{dS}{S} \propto E\left(\frac{D}{<V>}\right)^p \qquad \frac{D}{<V>} >> 1$$

p=0.22	Farmer, Lillo, Mantegna
p=0.5	X. Gabaix
p=1	linear model, (A. & Lipkin)
p=1.5	convex model (Bouchaud, …)

Dimensionless Model for Power-Law Price-Impact Function (p>0)

Price change=
Price impact+
noise

$$\frac{dS}{S} \propto -const.\left|\frac{\partial\delta}{\partial t}\right|^{p} sign\left(\frac{\partial\delta}{\partial t}\right)dt + \sigma dW$$

The linear model

Dynamics for Stock Price

$$\frac{dS}{S} = \frac{E.OI}{\langle | D | \rangle} \frac{\partial \delta}{\partial t} dt + \sigma dW \qquad y = \ln\left(\frac{S}{K}\right)$$

$$dy = -\frac{E.OI}{\langle | D | \rangle \sqrt{2\pi}} \cdot \frac{y - a(T-t)}{\sigma (T-t)^{3/2}} e^{-\frac{(y + a(T-t))^2}{2\sigma^2 (T-t)}} dt + \sigma dW$$

\`coupling constant'

restoring force

bounded support

noise

Dimensionless Variables

$$z = \frac{y}{\sigma\sqrt{T}}, \qquad s = \frac{t}{T}, \qquad z_0 = \frac{y_0}{\sigma\sqrt{T}} = \frac{1}{\sigma\sqrt{T}}\ln\left(\frac{S_0}{K}\right)$$

$$\alpha = \frac{a\sqrt{T}}{\sigma}, \qquad \beta = \frac{E.OI}{\langle | D | \rangle \sqrt{2\pi\sigma^2 T}}$$

$$dz = -\frac{\beta\left(z - \alpha(1-s)\right)}{(1-s)^{3/2}} e^{-\frac{(z+\alpha(1-s))^2}{2(1-s)}} ds + d\overline{W}$$

Dimensionless variables

- **z** represents the dimensionless (logarithmic) distance to the strike; it's presence in the formulation insures that the likelihood of pinning is subject to a feedback of the stock price itself
- **β** describes the strength of the pinning force. It is proportional to the open interest, OI, and the unknown elasticity constant, E, and inversely proportional to the stock volatility, σ
- **β** represents the strength of the coupling to the "pinning field"
  - You can think of OI as *charge,* E as the dimensionful *coupling constant*, and $\sigma\sqrt{T}$ as a *temperature*
- **α** the drift term we will arbitrarily set to 0

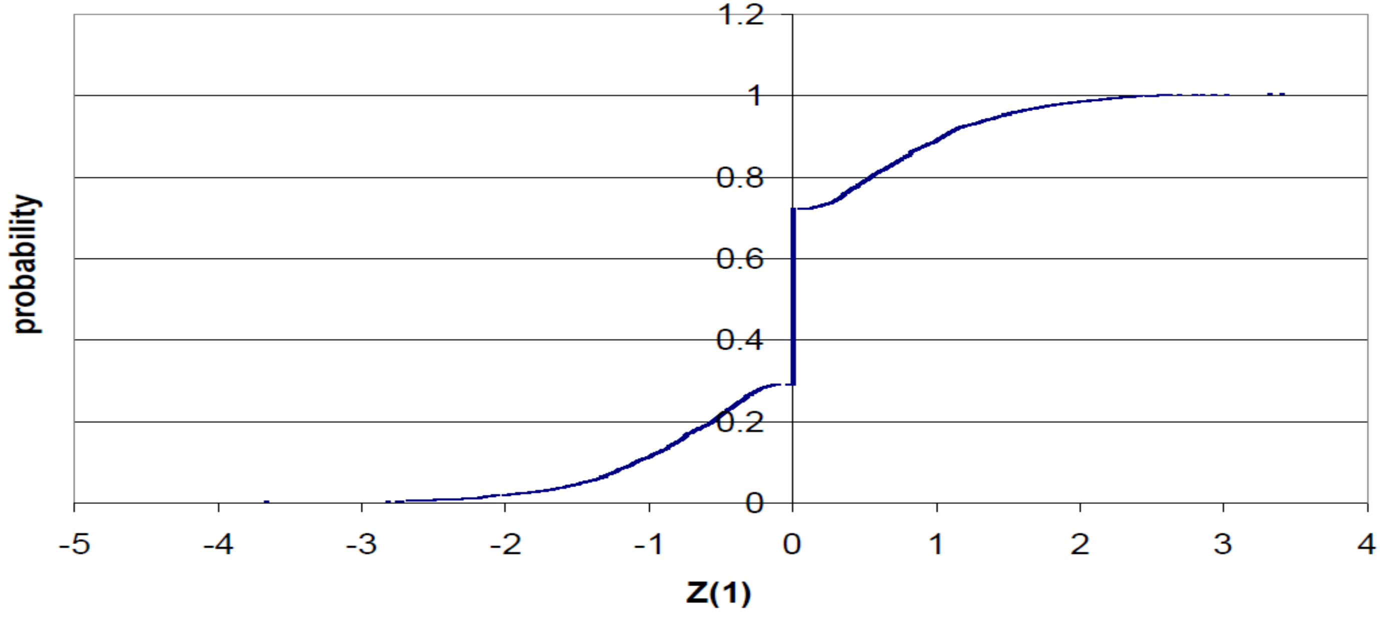
Dimensionless Model (alpha=0) for Linear Price-Impact Function

$$dz = -\frac{\beta \cdot z}{(1-s)^{3/2}} e^{-\frac{z^2}{2(1-s)}} ds + d\overline{W}$$

Linear restoring force with increasing coupling with time and compact support.

Pinning naturally appears in this model

Cumulative PDF for price at expiration date (Beta=0.1)



Solving the linear response model (p=1)

Assume Alpha=0

Forward Fokker-Planck equation:

$$\frac{\partial F}{\partial s} + \frac{1}{2}\frac{\partial^2 F}{\partial z^2} - \frac{\beta z}{\tau^{3/2}} e^{-\frac{z^2}{2\tau}} \frac{\partial F}{\partial z} = 0, \qquad \tau = 1 - s$$

Look for solution of the form:

$$F(z,s) = \exp\left(\frac{1}{\sqrt{\tau}}\phi\left(\frac{z}{\sqrt{\tau}}\right)\right), \qquad \phi(\varsigma) \text{ unknown}, \quad \varsigma = \frac{z}{\sqrt{\tau}}$$

ODE for the `Phase Function' (WKB)

$$\frac{\phi+\varsigma\phi'+\phi''}{2\tau^{3/2}}+\frac{(\phi')^2-2\beta\varsigma\phi' e^{-\frac{\varsigma^2}{2}}}{2\tau^2}=0$$

$O(\tau^{-2})$ $$(\phi')^2-2\beta\varsigma\phi' e^{-\frac{\varsigma^2}{2}}=0$$ Eikonal Equation

$\therefore$ $$\phi(\varsigma)=-2\beta e^{-\frac{\varsigma^2}{2}}+c$$

$O(\tau^{-3/2})$ $$\phi+\varsigma\phi'+\phi''=c \qquad c=0$$

$$F(z,s)=\exp\left[-\frac{2\beta}{\sqrt{1-s}}e^{-\frac{z^2}{2(1-s)}}\right]$$

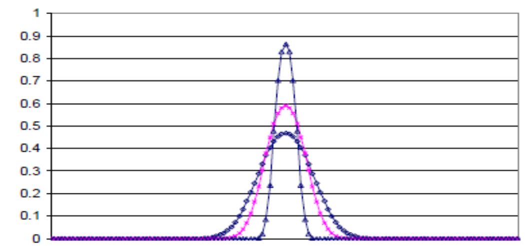
Exact solution of the FFP Equation!

A Formula for the Pinning Probability

$$P(z,s) = 1 - \exp\left[-\frac{2\beta}{\sqrt{1-s}} e^{-\frac{z^2}{2(1-s)}} \right]$$

Satisfies :

$$\begin{cases} \lim_{s \to 1+} P(z,s) = 0 \\ \lim_{s \to 1+} P(0,s) = 1 \end{cases}$$

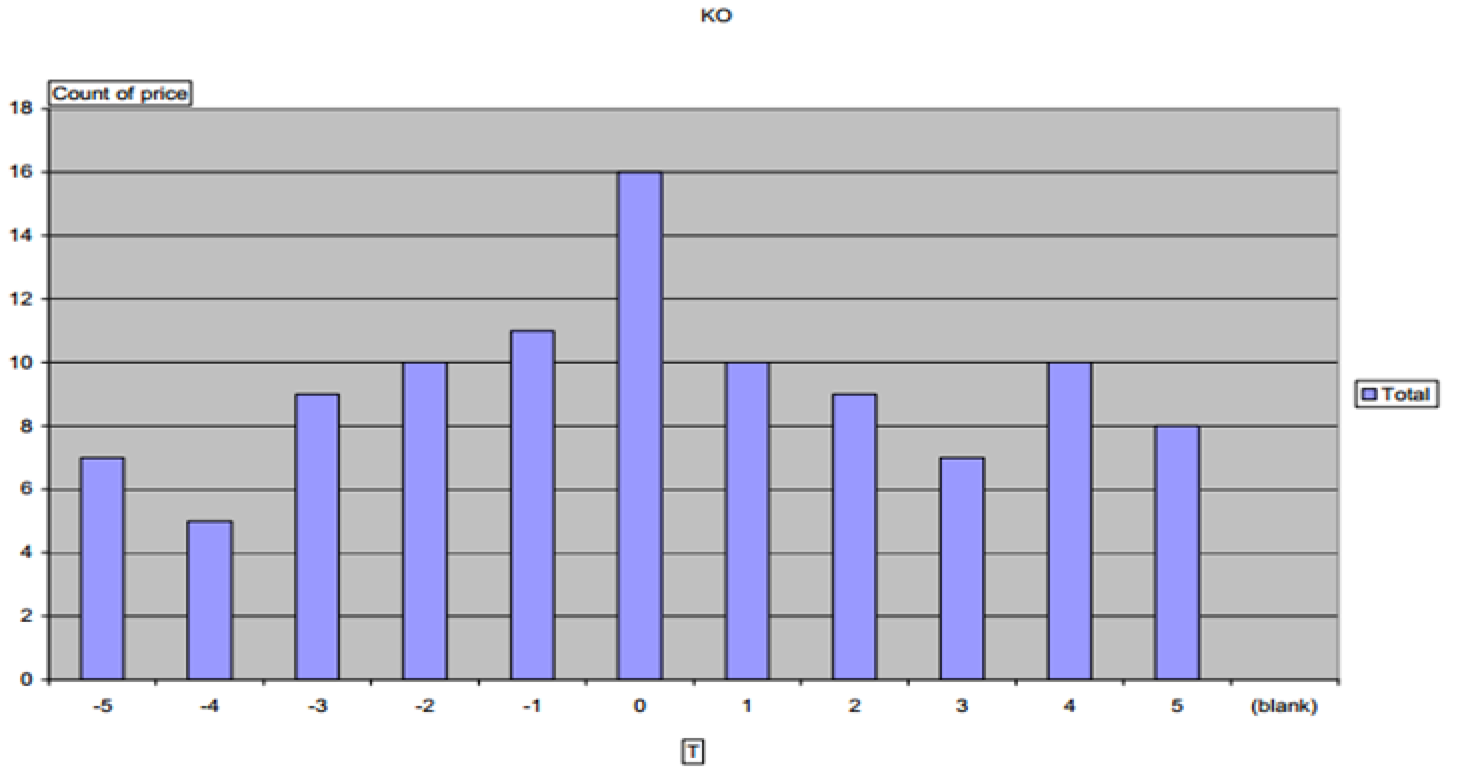


$$\mathrm{Prob}\big(z(1) = 0 \mid z(0) = z_0\big) = 1 - e^{-2\beta e^{-\frac{z_0^2}{2}}}$$

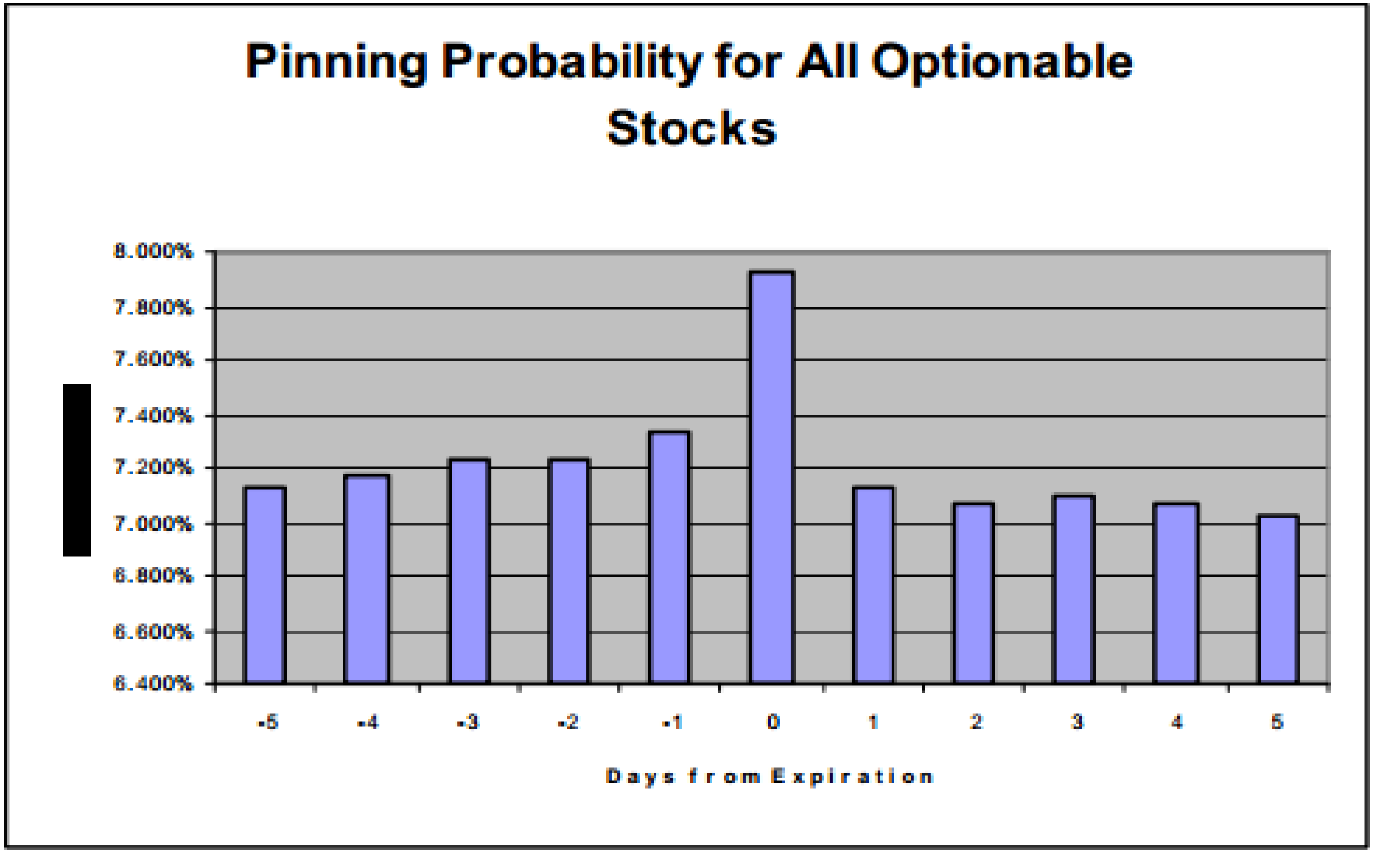
Predicted pinning characteristics

- From the solution (last slide), we see that to first order, the pinning probability should increase linearly in β- essentially the OI/σ
- However as β increases the pinning probability should saturate
- As z increases the pinning probability should fall off quadratically to lowest order
- The following show unpublished work of my students- actually their PS solutions for the Event-Driven Finance class

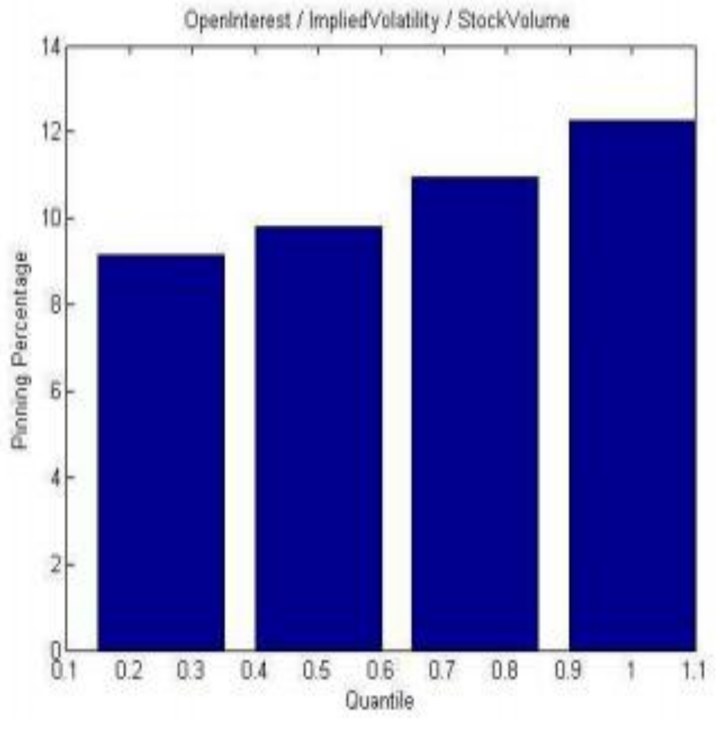
PPN graph KO; 1/1/96-1/1/2010; 0.15 pinning criterion



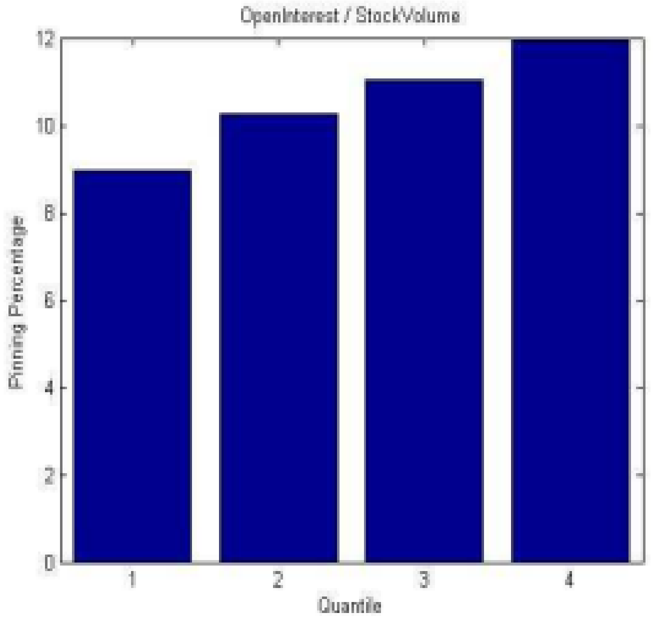
2002; all stocks; 0.15

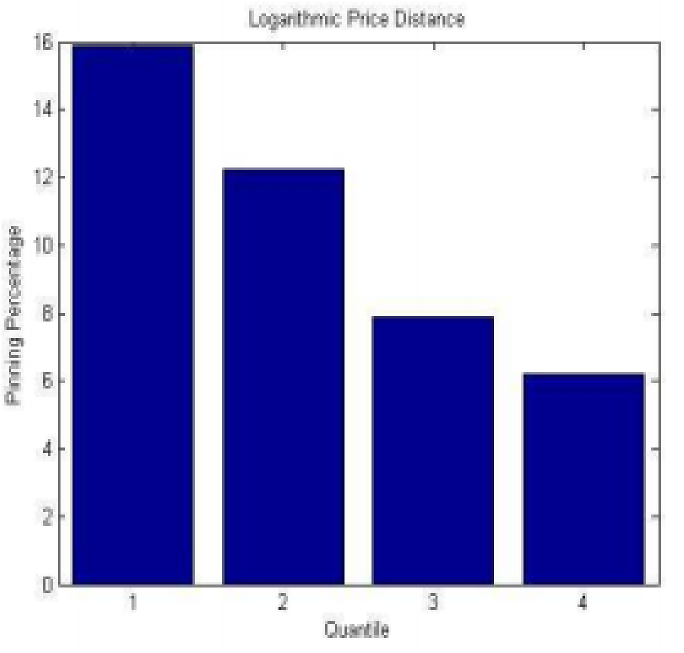


All stocks 2002-2003

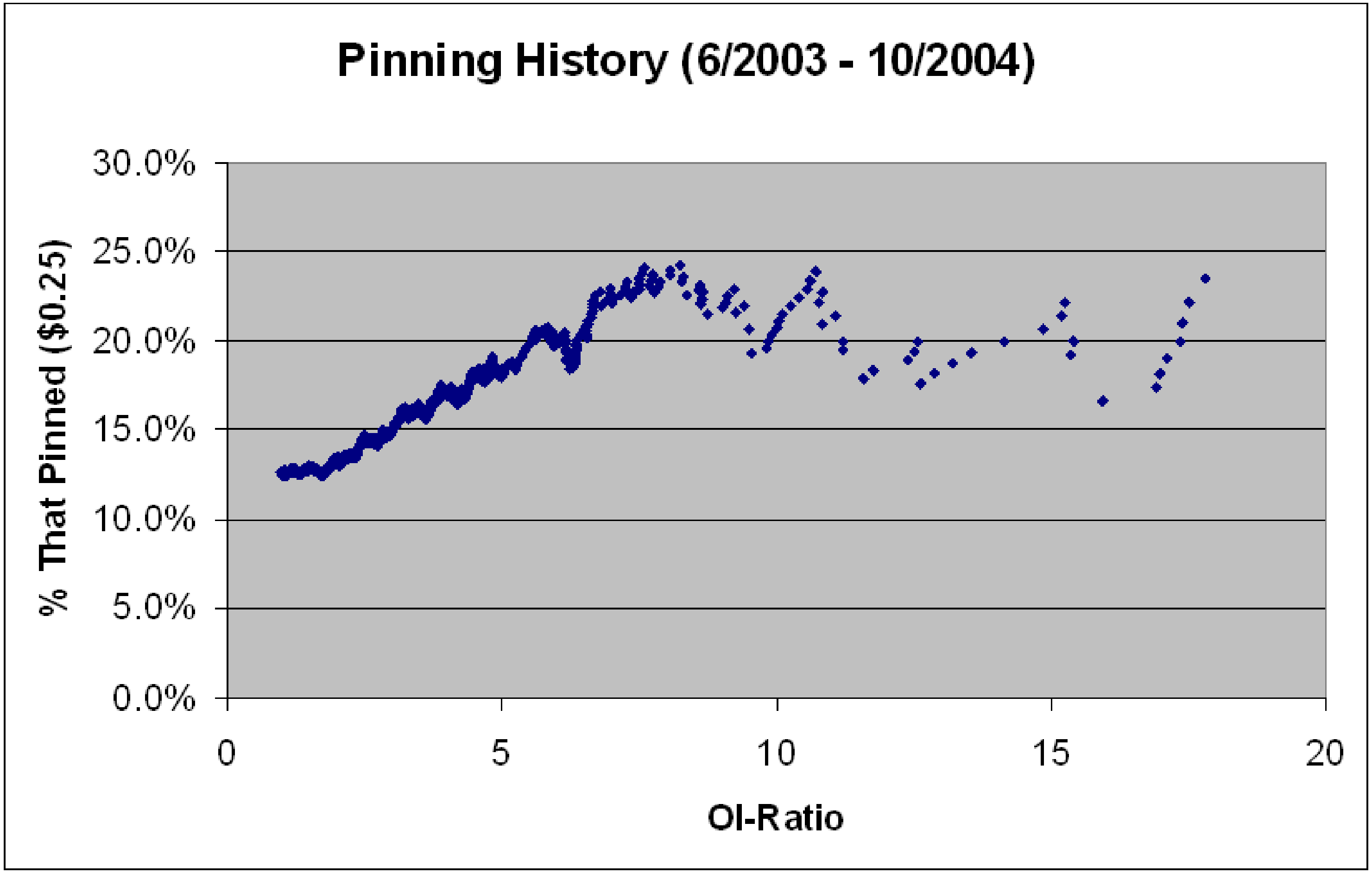


All stocks 2002-2003
(log distance with 1 week to expiry in 2d graph)





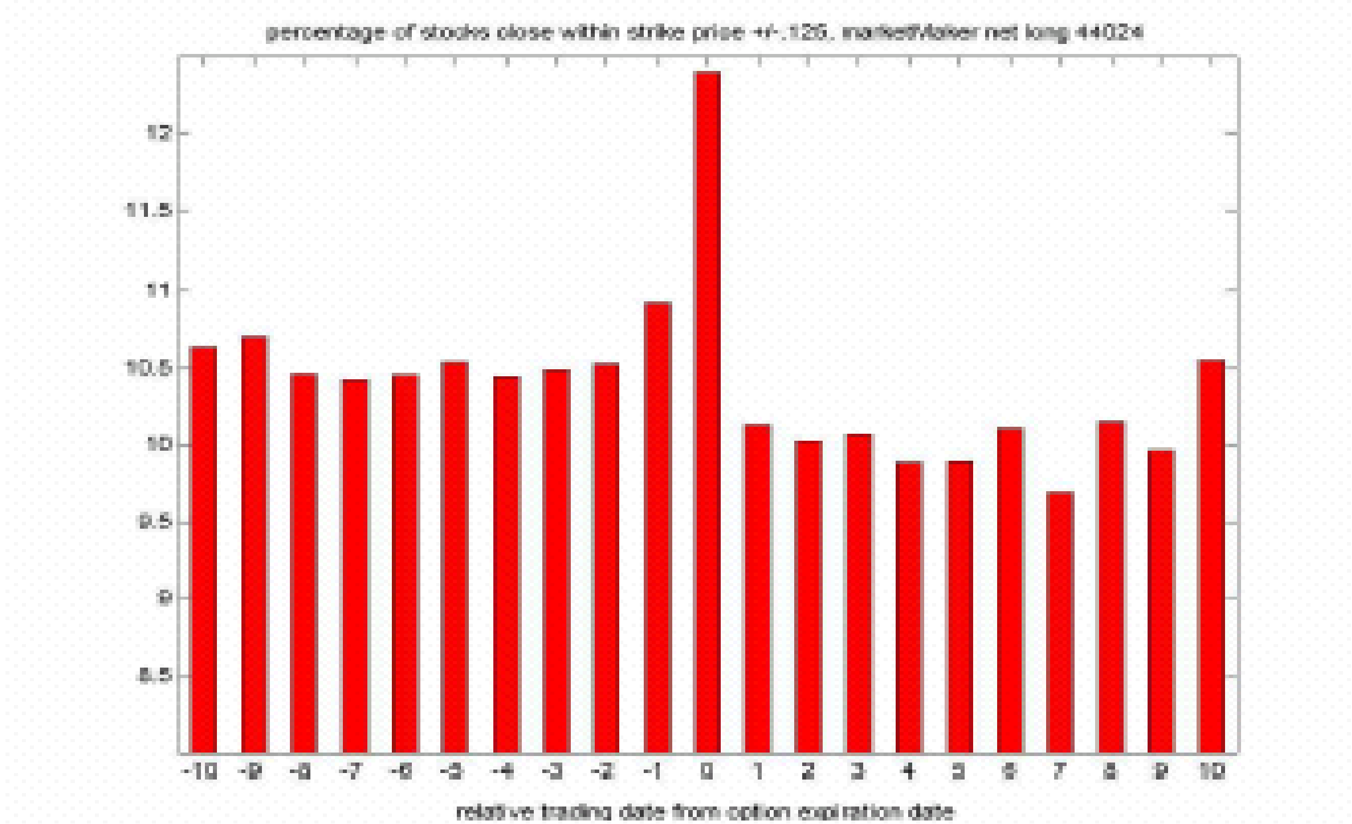
Cumulative likelihood of pinning with 1 week to go to expiry (T. MacFarland)



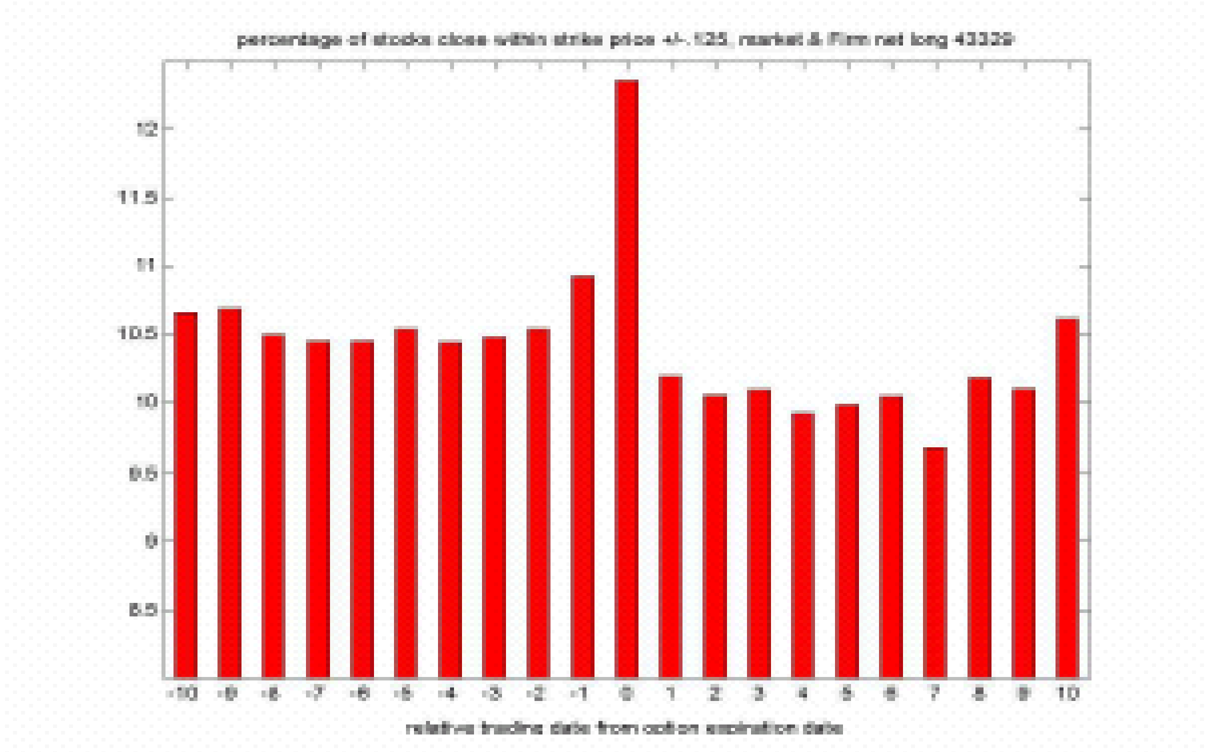
Indices do not pin

Pinning

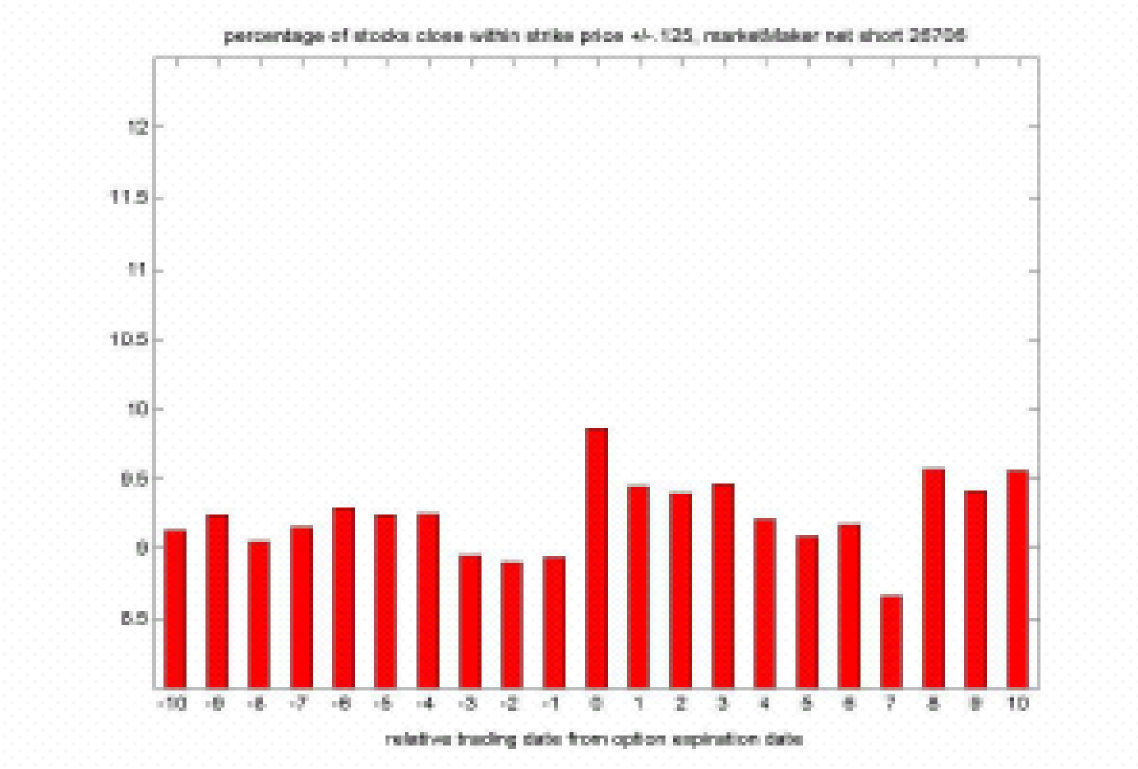
Observations with market-makers net long (~$0.125)



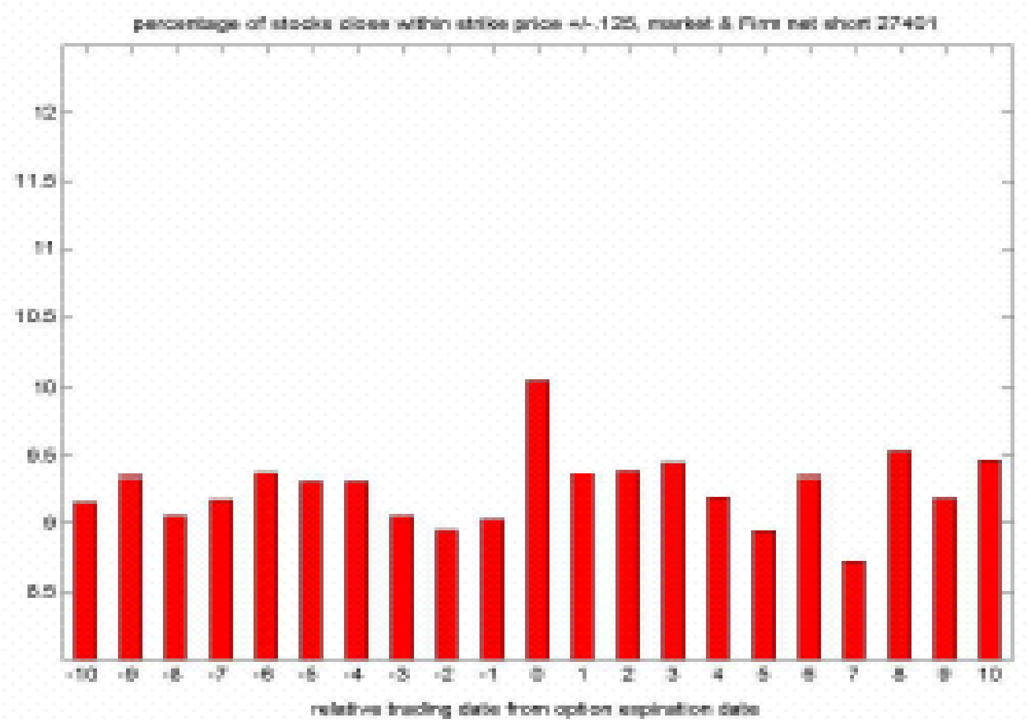
Market-makers + firm proprietary traders net long



Market-makers net short



Market-makers + firm proprietary traders net short



Dimensionless Model for Power-Law Price-Impact Function (p>0)

Price change=
Price impact+
noise

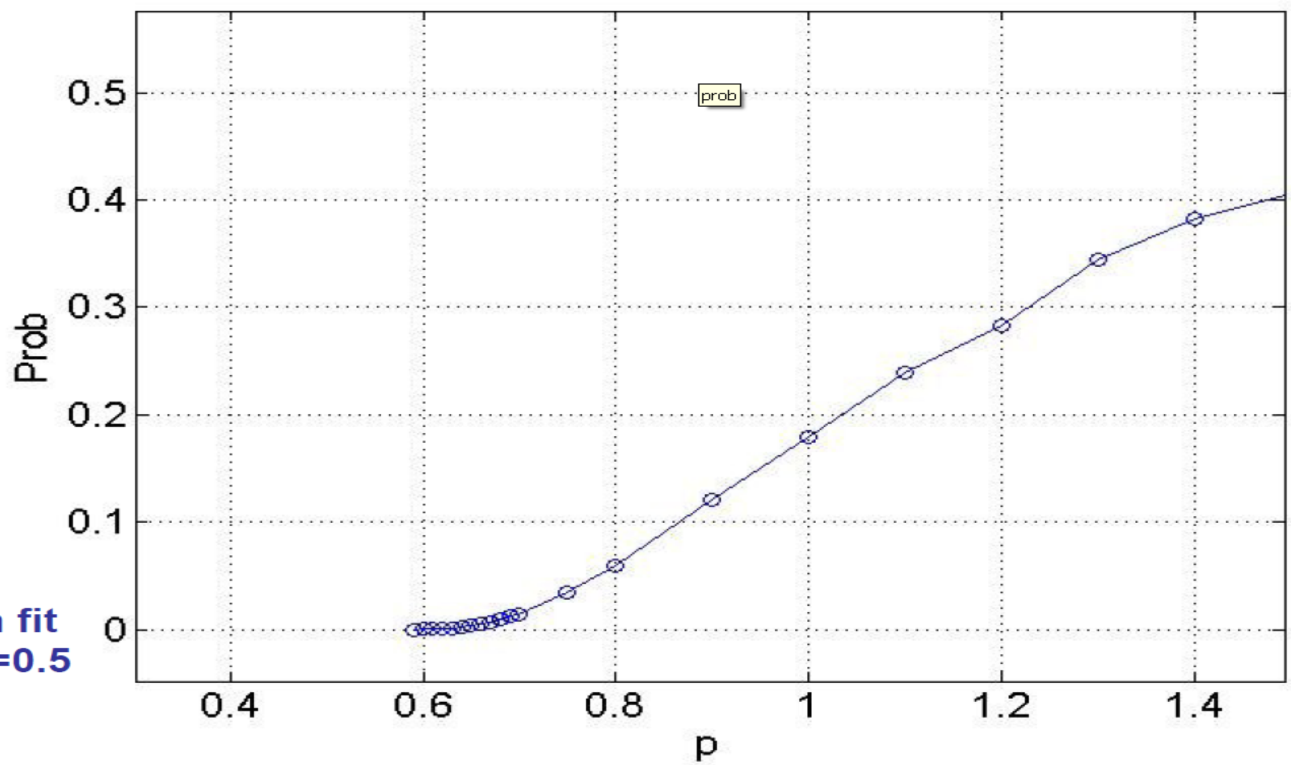
$$\frac{dS}{S} \propto -const.\left|\frac{\partial\delta}{\partial t}\right|^{p} sign\left(\frac{\partial\delta}{\partial t}\right)dt + \sigma dW$$

$$dz = -\frac{\beta\cdot|z|^{p}\ sign(z)}{(1-s)^{3p/2}} e^{-\frac{pz^2}{2(1-s)}} ds + d\overline{W}$$

Dimensionless eq. without irrelevant drift terms (alpha=0).

p=0.5 infinite order phase transition

Calculation of Pinning Probabilities by MC Simulation (Gennady Kasyan)



Smooth fit near p=0.5

p=0.5 infinite order phase transition

Pinning under non-linear price-impact models

(i) If p<=1/2, there is no pinning, i.e. P[z(1)=0|z(0)=z]=0, for all z.

(ii) If p>1/2 pinning occurs with finite probability (<1) and

$$\ln \mathrm{P}(\mathrm{z}(1)=0 \mid \mathrm{z}(0)=\mathrm{z}) \propto -\frac{C(\beta, z)}{2p-1}$$

$$P_{pin} \propto e^{-\frac{C}{2p-1}}, \qquad p > 1/2$$

Impact functions

- The power, p, in the previous slides is included to suggest the possibility of a spectrum of (non-analytic) impact functions
- Recent work by R. Cont supports the value 1.0 for p
- p may be thought of as a measure of the competition between diffusion and pinning pressure- as p decreases, the impact of hedging becomes less and less
- Viewing this as a physicist would, we should typically expect a phase transition in the p- parameter space from pinning to non-pinning as p declines
- If this is the case (we shall see it is), then the **experimental fact of pinning** should constrain the possible impact models

Real world extensions

- As OI changes with time:
  - Integrate this model
- As other strikes compete:
  - Sum over strikes
- Should work for other instruments that are singly hedged (interest rate, commodity, etc.) but not necessarily indices depending on indirect hedging over multiple instruments

conclusions

- Complex pricing may result from feedback situations
- Here, independent agents (traders) drive the stock price, which in turn alters their hedging behavior, etc., etc.
- Nevertheless simple models work, as long as they are constrained by appropriate boundary conditions
- Allowing the price impact to be a variable leads to the expected result of a phase transition
- Impact functions weaker than square root are *suspect*- they cannot explain pinning via our mechanism; if they hold for a class of stocks, those stocks will not pin

- Extra material after here…

feedback

- What we constructed in this fashion was essentially a feedback mechanism of independent agents
- *Trader* ⟺ *stock* ⟺ *stock price* ⟺ *Trader*
- But for the purposes of this approach it is only necessary to imagine 1 agent hedging the entire outstanding delta position

feedback

- As time advances, the delta of an option (not exactly at the money) moves away from 50 and toward 0 or 100
- Hedging requires a repeated selling or buying of stock which positively impacts the stock price and drives it toward the strike
- We follow the math now...

Impact functions

- The power, p, in the previous slides is included to suggest the possibility of a spectrum of (non-analytic) impact functions
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Occam's razor

- You may have noted the use of BS for the calculation of delta in the demand equation
- This returns us to our initial discussion:
  - We look for simple modular approaches to pricing where the hard part has been moved to the boundaries
  - Too often the presence of market events is used to justify a complex stochastic model designed to price an entire state space
  - The crux of the approach I am outlining here is to use the simplest (Occam) sufficient model with the most comprehensive boundary conditions- the boundaries being selected by the events themselves

Real world extensions

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  - Integrate this model
- As other strikes compete:
  - Sum over strikes
- Should work for other instruments that are singly hedged (interest rate, commodity, etc.) but not necessarily indices depending on indirect hedging over multiple instruments

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Event-Driven Finance

Lecture 3: Dynamics.
Earnings. Drug
announcements. News

Mike Lipkin
Columbia University (IEOR)

- Consider the following scenarios:
  Stock XYZ; price, S_0= 50.00; 3 weeks to go to expiration.

- Earnings date: 4 weeks away.
- For concreteness, we take the front month options to be the Junes.

- Which option generally has the *higher* implied vol, the Jun 50 C or Jul 50 C?

- Suppose that XYZ announces a change in the earnings announcement, *moving the date ahead 1 week*. What will happen to the implied vols?

- Suppose XYZ *preannounces* earnings today;
  - what will happen to the vols?
  - Will it matter whether the announcement is better than expected, or worse?

- Usually, only bad earnings gets preannounced.

- Some basics:
  - How many times a year are earnings announced?
  - What would happen if a stock fails to announce earnings?

- Imagine that earnings are coming out in 2 days (Jun expiry), and XYZ drops $3 to $47.00.
  - What will happen to the Jun 50 vol?

- Suppose earnings *are* announced and XYZ drops $3 to $47.00.
  - What will happen to the Jun 50 vol?

- What is the difference between these two scenarios?

- There are two kinds of new information that get disseminated in the marketplace. They are ***scheduled*** events and ***unscheduled*** ones.

- It is often pretty easy to distinguish between the two. Let's try some examples:

  - *Earnings*
  - *Drug trial results*
  - *Upgrades/downgrades by analysts*
  - *Terrorist bombing in USA or Western Europe*
  - *Articles in the news media*
  - *Fed open market meeting/short rate change*
  - *Mergers/take-overs/acquisitions*
  - *State/federal actions for improprieties*
  - *Corporate personnel changes (CEO, CFO, etc.)*

- One of the things which we should like to understand is how the volatility surfaces adjust themselves before and after both kinds of events. In a thorough research project, one would examine stocks in different industry groups, of different market caps, etc., and look for regularity.

- Is there an existing theory which addresses these concerns?

- No.

- Note: Theory is different than empirical results. Good (predictive) results will never get published!

  - Why???

- Earnings announcements come (usually) at very specific, well-defined times. What frequency?

- For some stocks, earnings are a small effect;
  - which ones might these be?

- For others, earnings announcements move the stock more than any typical daily move. As a result, the implied volatilities increase strongly heading into earnings. In this way, IVs are anticipative.

- The following is a graph of the IVs for CAT over a six-month interval. (Brown curve; ignore the blue.)

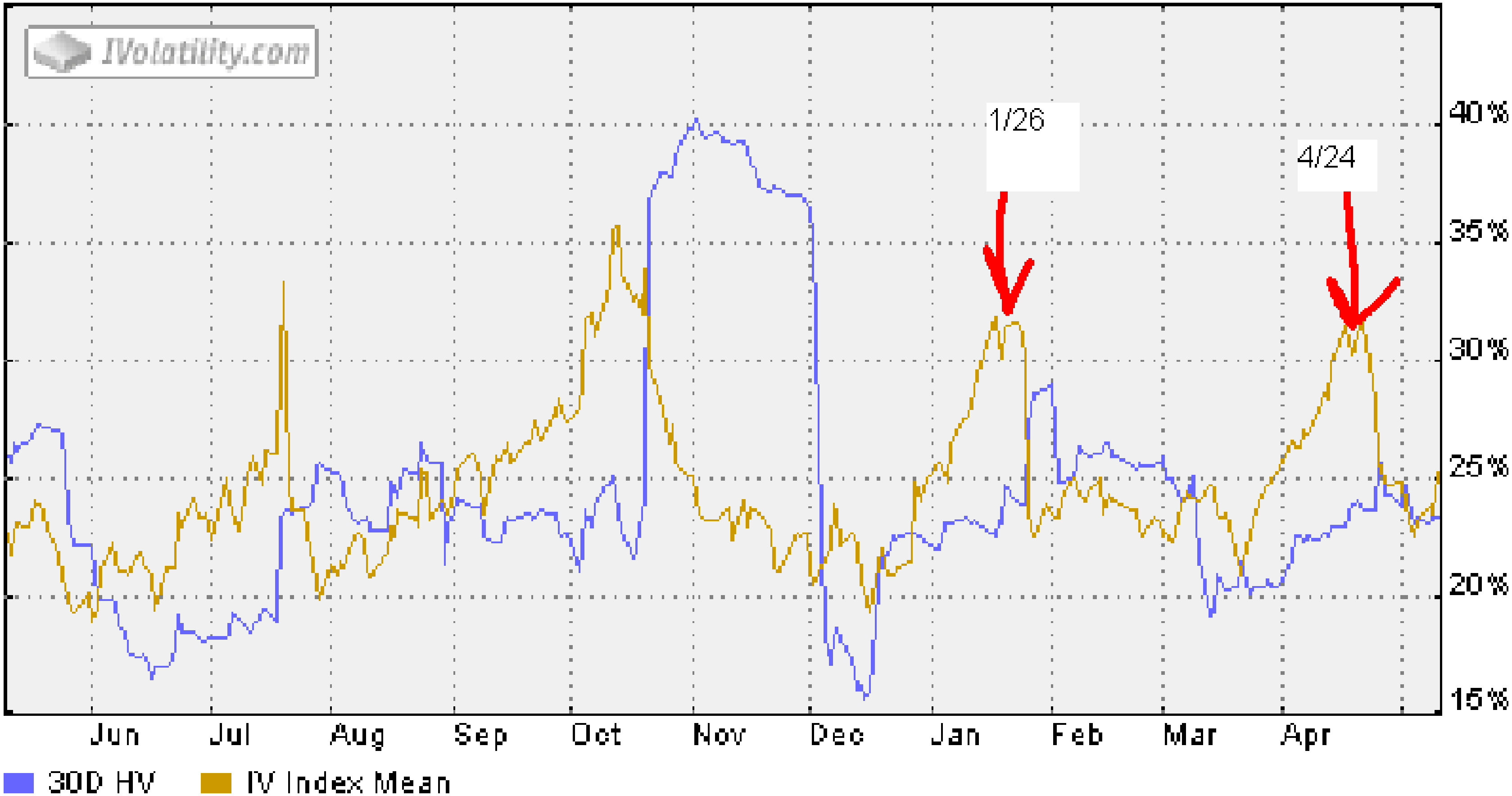
  - Can you identify the earnings dates?

  - About how long before earnings does volatility appear to begin climbing?

- My students at Columbia examine the dynamics of earnings in the database.

Dynamics


IVolatility.com
40 %
35 %
30 %
25 %
20 %
15 %
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
30D HV
IV Index Mean



CAT VOL + EARNINGS DATES

MicroHedge [ACTIV] v91.4.0.576 MIKE.31E5 - (LinkedIn Corporation-LNKD) LNKD.L47

File Edit View Format Parameters AutoQuote Recalc! Trade Risk Sheets Tools Help LogOff LIPKIN!

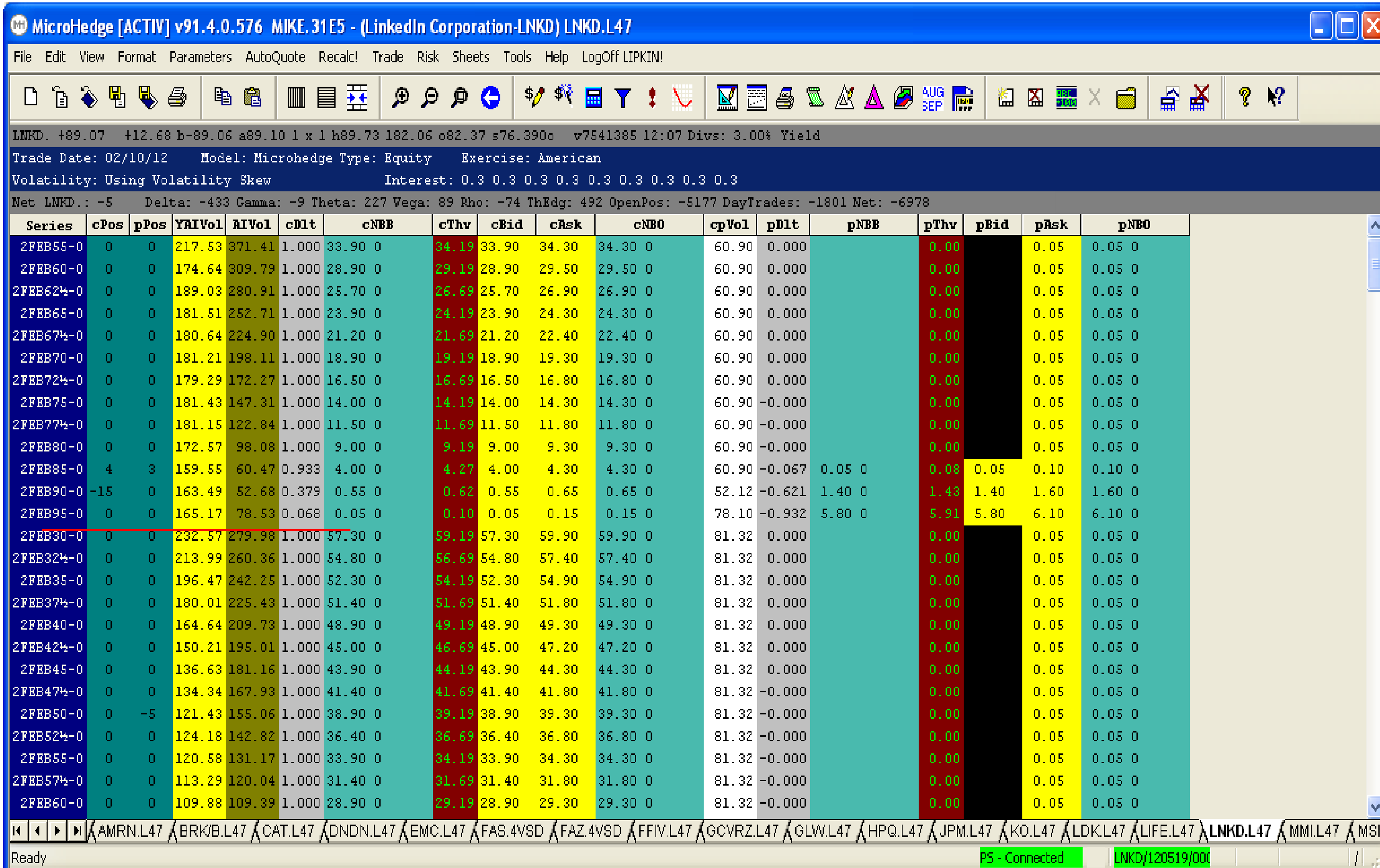
LNKD. +76.58 +0.04 b-76.52 a76.58 8 x 3 h77.70 174.32 o76.50 s76.540o v1932778 14:44 Divs: 2.00% Yield
Trade Date: 02/09/12 Model: Microhedge Type: Equity Exercise: American
Volatility: Using Volatility Skew Interest: 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3
Net LNKD.: 2 # Delta: 22 Gamma: 17 Theta: -432 Vega: -125 Rho: -107 ThEdg: 322 OpenPos: -923 DayTrades: 48 Net: -875

Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
2FEB62½-0	0	0	93.30	105.06	0.896	14.50 0	14.72	14.50	15.00	15.00 0	108.48	-0.105	0.55 0	0.67	0.55	0.65	0.65 0
2FEB65-0	0	0	92.87	103.86	0.851	12.40 0	12.60	12.40	12.70	12.70 0	107.22	-0.150	0.90 0	1.05	0.90	1.00	1.00 0
2FEB67½-0	0	0	89.56	103.59	0.796	10.40 0	10.61	10.40	10.80	10.80 0	105.87	-0.204	1.40 0	1.55	1.40	1.55	1.55 0
2FEB70-0	0	0	89.21	102.12	0.732	8.50 0	8.77	8.50	8.90	8.90 0	104.48	-0.268	2.05 0	2.22	2.05	2.20	2.20 0
2FEB72½-0	-5	0	87.53	102.32	0.661	6.90 0	7.10	6.90	7.30	7.30 0	103.11	-0.340	2.90 0	3.05	2.90	3.10	3.10 0
2FEB75-0	0	-5	86.19	101.09	0.583	5.50 0	5.66	5.50	5.80	5.80 0	101.79	-0.417	3.90 0	4.10	3.90	4.20	4.20 0
2FEB77½-0	0	0	85.44	99.95	0.503	4.30 0	4.41	4.30	4.50	4.50 0	100.56	-0.497	5.20 0	5.35	5.20	5.40	5.40 0
2FEB80-0	0	0	85.11	99.52	0.424	3.30 0	3.35	3.30	3.50	3.50 0	99.44	-0.576	6.60 0	6.80	6.60	6.90	6.90 0
2FEB82½-0	0	0	84.46	99.35	0.348	2.50 0	2.49	2.50	2.60	2.60 0	98.45	-0.652	8.30 0	8.44	8.30	8.60	8.60 0
2FEB85-0	0	0	83.20	99.11	0.279	1.80 0	1.81	1.80	1.95	1.95 0	97.62	-0.721	10.10 0	10.26	10.10	10.50	10.50 0
2FEB87½-0	0	4	82.86	99.15	0.219	1.30 0	1.30	1.30	1.45	1.45 0	96.95	-0.781	12.10 0	12.25	12.10	12.50	12.50 0
2FEB90-0	40	-5	82.82	97.72	0.168	0.90 0	0.91	0.90	1.00	1.00 0	96.45	-0.833	14.20 0	14.36	14.20	14.60	14.60 0
2FEB92½-0	0	0	83.81	97.76	0.127	0.60 0	0.64	0.60	0.75	0.75 0	96.42	-0.873	16.40 0	16.59	16.40	16.80	16.80 0
2FEB95-0	0	0	84.04	96.88	0.094	0.40 0	0.44	0.40	0.50	0.50 0	96.42	-0.906	17.80 0	18.89	17.80	20.00	20.00 0
2FEB97½-0	0	0	88.24	97.99	0.069	0.25 0	0.30	0.25	0.40	0.40 0	96.42	-0.931	20.10 0	21.25	20.10	22.50	22.50 0
2FEB100-0	0	0	89.47	98.70	0.049	0.15 0	0.20	0.15	0.30	0.30 0	96.42	-0.951	23.50 0	23.65	23.50	23.90	23.90 0
2FEB105-0	0	0	89.92	94.64	0.024		0.09		0.15	0.15 0	96.42	-0.976	28.40 0	28.53	28.40	28.80	28.80 0
2FEB110-0	0	0	88.33	100.50	0.011		0.03		0.10	0.10 0	96.42	-0.989	33.30 0	33.48	33.30	33.60	33.60 0
2FEB115-0	0	-5	97.81	102.97	0.005		0.01		0.05	0.05 0	96.42	-0.995	38.10 0	38.46	38.10	38.70	38.70 0
2FEB120-0	0	-5	106.67	112.31	0.002		0.01		0.05	0.05 0	96.42	-0.998	43.10 0	43.45	43.10	43.60	43.60 0
2FEB125-0	0	-5	114.77	120.85	0.001		0.00		0.05	0.05 0	96.42	-0.999	47.30 0	48.45	47.30	49.80	49.80 0
2FEB130-0	0	-4	122.56	129.06	0.000		0.00		0.05	0.05 0	96.42	-1.000	53.30 0	53.45	53.30	54.20	54.20 0
2FEB135-0	0	-4	130.06	136.96	0.000		0.00		0.05	0.05 0	96.42	-1.000	57.40 0	58.44	57.40	59.80	59.80 0
2FEB140-0	0	0	137.29	144.58	0.000		0.00		0.05	0.05 0	96.42	-1.000	62.40 0	63.44	62.40	64.80	64.80 0
2FEB145-0	0	0	144.27	151.94	0.000		0.00		0.05	0.05 0	96.42	-1.000	67.40 0	68.44	67.40	69.80	69.80 0
2FEB150-0	0	0	151.01	159.05	0.000		0.00		0.05	0.05 0	96.42	-1.000	72.40 0	73.44	72.40	74.80	74.80 0

AGQ.4VSD AMRN.L47 BRK/B.L47 CAT.L47 DNDN.L47 EMC.L47 FAS.4VSD FAZ.4VSD FFIV.L47 GCVRZ.L47 GLW.L47 HPQ.L47 JPM.L47 KO.L47 LDK.L47 LIFE.L47 **LNKD.L47** MI

Ready PS - Connected TZA/120721/0001

Day before **LNKD** **earnings**



MicroHedge [ACTIV] v91.4.0.576 MIKE.31E5 - (LinkedIn Corporation-LNKD) LNKD.L47

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LNKD. +89.07 +12.68 b-89.06 a89.10 1 x 1 h89.73 182.06 o82.37 s76.390o v7541385 12:07 Divs: 3.00% Yield

Trade Date: 02/10/12 Model: Microhedge Type: Equity Exercise: American

Volatility: Using Volatility Skew Interest: 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3

Net LNKD.: -5 Delta: -433 Gamma: -9 Theta: 227 Vega: 89 Rho: -74 ThEdg: 492 OpenPos: -5177 DayTrades: -1801 Net: -6978

Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
2FEB55-0	0	0	217.53	371.41	1.000	33.90 0	34.19	33.90	34.30	34.30 0	60.90	0.000		0.00		0.05	0.05 0
2FEB60-0	0	0	174.64	309.79	1.000	28.90 0	29.19	28.90	29.50	29.50 0	60.90	0.000		0.00		0.05	0.05 0
2FEB62½-0	0	0	189.03	280.91	1.000	25.70 0	26.69	25.70	26.90	26.90 0	60.90	0.000		0.00		0.05	0.05 0
2FEB65-0	0	0	181.51	252.71	1.000	23.90 0	24.19	23.90	24.30	24.30 0	60.90	0.000		0.00		0.05	0.05 0
2FEB67½-0	0	0	180.64	224.90	1.000	21.20 0	21.69	21.20	22.40	22.40 0	60.90	0.000		0.00		0.05	0.05 0
2FEB70-0	0	0	181.21	198.11	1.000	18.90 0	19.19	18.90	19.30	19.30 0	60.90	0.000		0.00		0.05	0.05 0
2FEB72½-0	0	0	179.29	172.27	1.000	16.50 0	16.69	16.50	16.80	16.80 0	60.90	0.000		0.00		0.05	0.05 0
2FEB75-0	0	0	181.43	147.31	1.000	14.00 0	14.19	14.00	14.30	14.30 0	60.90	-0.000		0.00		0.05	0.05 0
2FEB77½-0	0	0	181.15	122.84	1.000	11.50 0	11.69	11.50	11.80	11.80 0	60.90	-0.000		0.00		0.05	0.05 0
2FEB80-0	0	0	172.57	98.08	1.000	9.00 0	9.19	9.00	9.30	9.30 0	60.90	-0.000		0.00		0.05	0.05 0
2FEB85-0	4	3	159.55	60.47	0.933	4.00 0	4.27	4.00	4.30	4.30 0	60.90	-0.067	0.05 0	0.08	0.05	0.10	0.10 0
2FEB90-0	-15	0	163.49	52.68	0.379	0.55 0	0.62	0.55	0.65	0.65 0	52.12	-0.621	1.40 0	1.43	1.40	1.60	1.60 0
2FEB95-0	0	0	165.17	78.53	0.068	0.05 0	0.10	0.05	0.15	0.15 0	78.10	-0.932	5.80 0	5.91	5.80	6.10	6.10 0
2FEB30-0	0	0	232.57	279.98	1.000	57.30 0	59.19	57.30	59.90	59.90 0	81.32	0.000		0.00		0.05	0.05 0
2FEB32½-0	0	0	213.99	260.36	1.000	54.80 0	56.69	54.80	57.40	57.40 0	81.32	0.000		0.00		0.05	0.05 0
2FEB35-0	0	0	196.47	242.25	1.000	52.30 0	54.19	52.30	54.90	54.90 0	81.32	0.000		0.00		0.05	0.05 0
2FEB37½-0	0	0	180.01	225.43	1.000	51.40 0	51.69	51.40	51.80	51.80 0	81.32	0.000		0.00		0.05	0.05 0
2FEB40-0	0	0	164.64	209.73	1.000	48.90 0	49.19	48.90	49.30	49.30 0	81.32	0.000		0.00		0.05	0.05 0
2FEB42½-0	0	0	150.21	195.01	1.000	45.00 0	46.69	45.00	47.20	47.20 0	81.32	0.000		0.00		0.05	0.05 0
2FEB45-0	0	0	136.63	181.16	1.000	43.90 0	44.19	43.90	44.30	44.30 0	81.32	0.000		0.00		0.05	0.05 0
2FEB47½-0	0	0	134.34	167.93	1.000	41.40 0	41.69	41.40	41.80	41.80 0	81.32	-0.000		0.00		0.05	0.05 0
2FEB50-0	0	-5	121.43	155.06	1.000	38.90 0	39.19	38.90	39.30	39.30 0	81.32	-0.000		0.00		0.05	0.05 0
2FEB52½-0	0	0	124.18	142.82	1.000	36.40 0	36.69	36.40	36.80	36.80 0	81.32	-0.000		0.00		0.05	0.05 0
2FEB55-0	0	0	120.58	131.17	1.000	33.90 0	34.19	33.90	34.30	34.30 0	81.32	-0.000		0.00		0.05	0.05 0
2FEB57½-0	0	0	113.29	120.04	1.000	31.40 0	31.69	31.40	31.80	31.80 0	81.32	-0.000		0.00		0.05	0.05 0
2FEB60-0	0	0	109.88	109.39	1.000	28.90 0	29.19	28.90	29.30	29.30 0	81.32	-0.000		0.00		0.05	0.05 0

AMRN.L47 BRK/B.L47 CAT.L47 DNDN.L47 EMC.L47 FAS.4VSD FAZ.4VSD FFIV.L47 GCVRZ.L47 GLW.L47 HPQ.L47 JPM.L47 KO.L47 LDK.L47 LIFE.L47 LNKD.L47 MMI.L47 MSI.

Ready PS - Connected LNKD/120519/00(

Day after LNKD earnings

- Drug announcements come in two varieties.
  - There are scheduled dates for stage trial announcements,
  - but also sudden news releases.

- I'm not sure which one applies to the following, but you can see the potential for trading opportunities and blunders!


DNA (Genentech, Inc.) NYSE
© StockCharts.com
11-Apr-2005
O 57.17 H 57.74 L 56.21 C 56.60 V 5.6M Chg -1.06 (-1.84%)
90
70
50
30
10
DNA (Daily)
58
56
54
52
50
48
46
44
30M
20M
10M
2005 10 18 24 Feb 7 14 22 Mar 7 14 21 28 Apr 11
2
1
0
-1
2005 10 18 24 Feb 7 14 22 Mar 7 14 21 28 Apr 11

Monday, Mar 14, 2005

Interim Analysis of Phase III Trial Shows Avastin Plus Chemotherapy Extends Survival of Patients with First-Line Non-Squamous, Non-Small Cell Lung Cancer

-- First Positive Phase III Results with an Anti-Angiogenesis Therapy in Lung Cancer --

- When a corporate event happens suddenly and unexpectedly, a typical response in the market is to have a large size trading day. We have just seen this with DNA. However, size trading can accompany big **increases** or **decreases** in volatility and sometimes no change at all.
- The DNA event, a large upward price jump, was accompanied by a big spike in volume. Below are two spikes in volume coinciding with down moves.

- What do you imagine may have happened with the following news event?

- Why?


MCD
McDonald's Corp.
Industry: Restaurants
Exchange: NYSE
Price Alerts
34.88
-0.47 (-1.33%)
Last Trade
4:02 PM EST
5/12/2006
Print Snapshot
Glossary
FAQ
Get Option Quotes
Real-Time Quotes
SEC Filings
Annual Reports
Price Check Calculator (New!)
Alerts for MCD: Price | News (New!)
View Charting for:
$29.00
$28.50
$28.00
$27.50
$27.00
Apr 1, 2004
May 1, 2004
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
McDonald's chairman, CEO dies unexpectedly
Cantalupo suffers heart attack; fast-food giant taps replacement


prophet
JavaCharts
Scottrade
More broker for your money.
WE'VE IMPROVED OUR TRADING PLATFORMS.
MEMBER SIPC MORE SPEED. MORE POWER. STILL JUST $7.
Symbol: MCD GO Candle 4 Yr D TOOLS
My Studies
Technical Studies
Indices
NYSE
NASDAQ
AMEX
Mcdonalds Cp 34.12 -0.32 -0.93%
28.5
28
27.5
27
26.5
26
25.5
25
24.5
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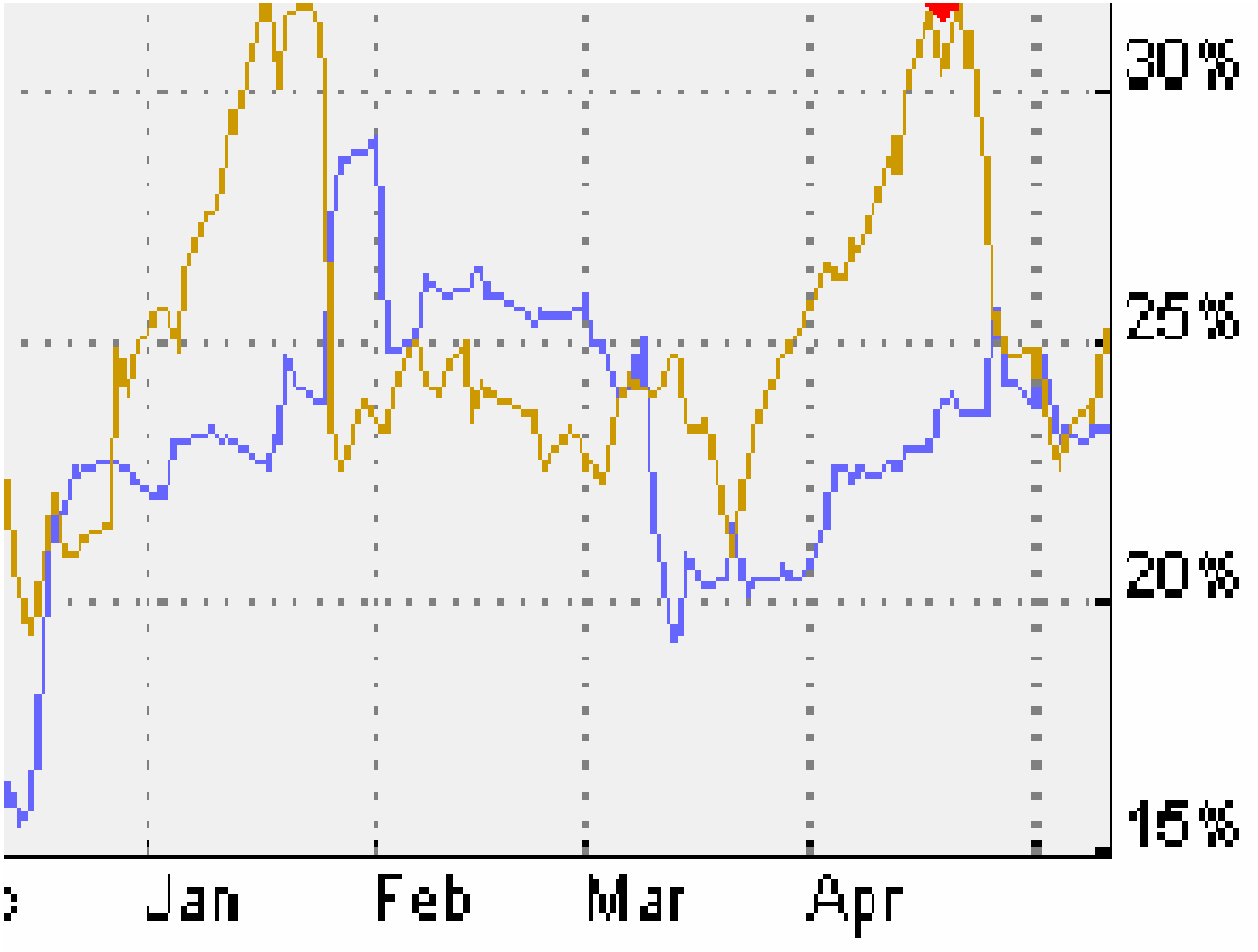
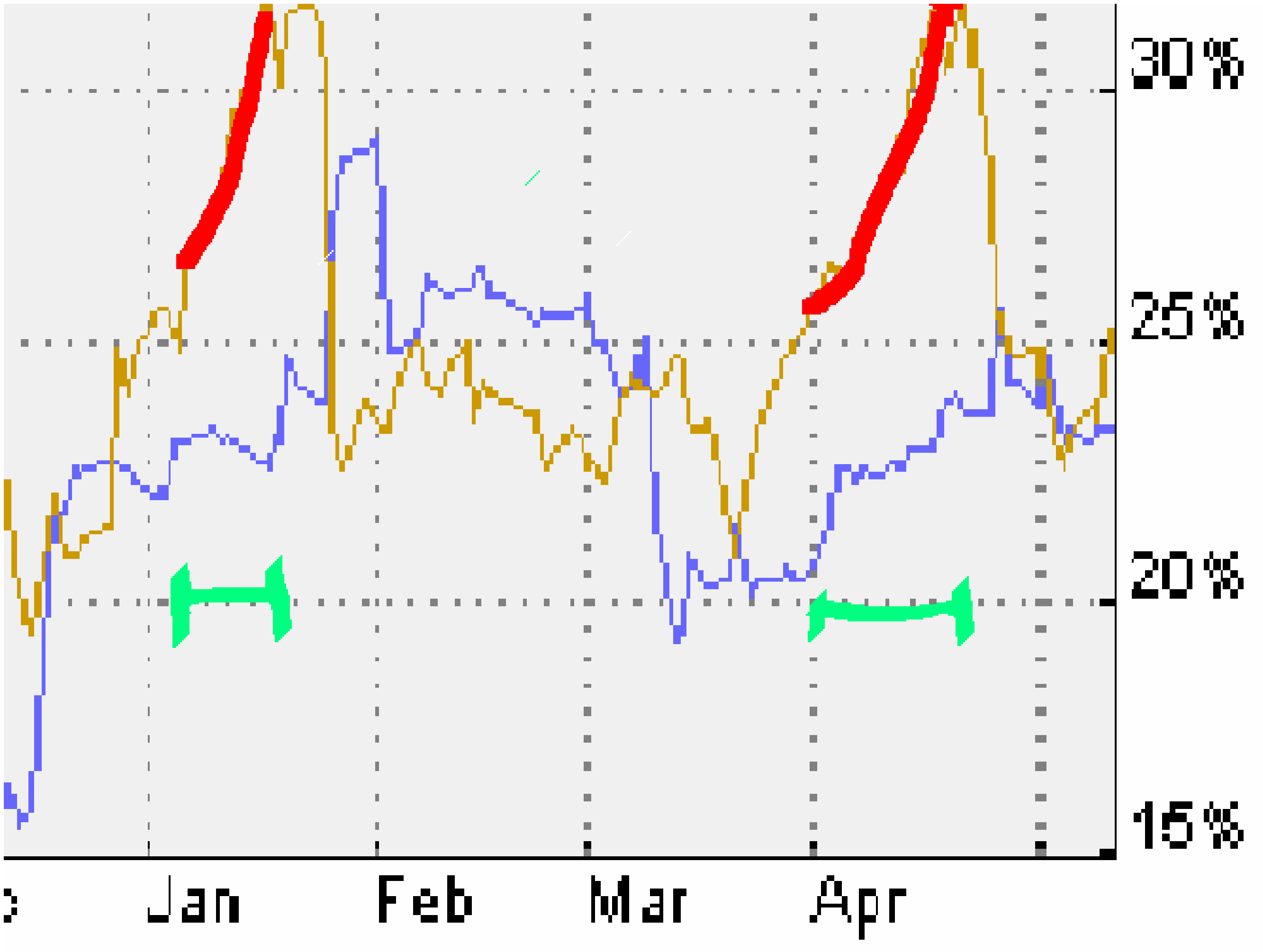
Volume (Millions)
18
15
12
9
6
3
0
04/05
04/12
04/19
04/26
05/03
05/10
05/17
Options
Log Scale
Color Bars
Hide Studies
Hide Drawn Items
Hide Volume
Expand Chart
ATTACH
CLONE

- When a news event is *anticipated*, such as earnings, there is a lag time for dealing with the event. The volatility must go up for earnings, drug announcements, etc.
  - Why?
  - Can you think of a future, scheduled event which will reduce volatility? (We will discuss such an event in a later week.)
- What would cause the volatility to go up *slowly*? In other words, why wouldn't the vol stay high from earnings to earnings?
- Let's take a look again at a blow up of the CAT preearnings chart:

Dynamics




30%
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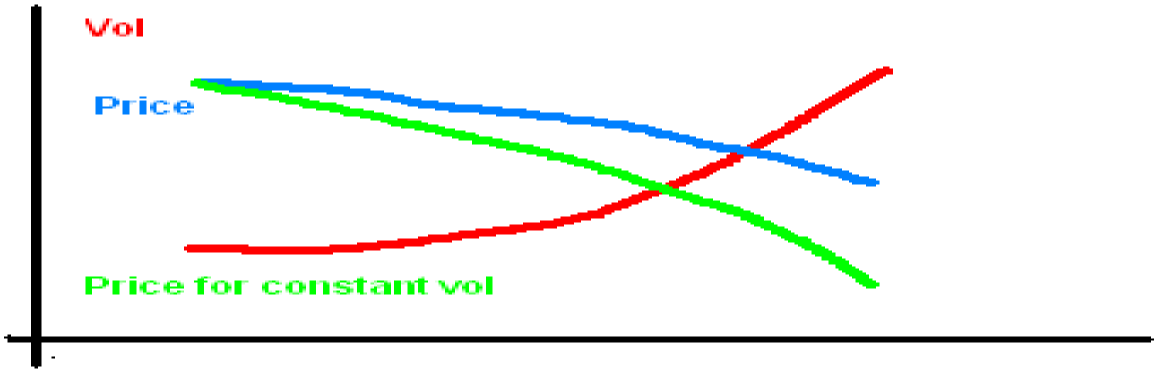

- This is why vol doesn't stay high from start to finish. Rising vol just means prices decline at a slower pace.

- It is important to understand the change in volatility heading into earnings announcements. For typical curves of this sort there are two elements of interest:
  - The size of the change, and
  - The characteristic time scale over which this change occurs.
- Why would it be insufficient to only know one of these properties?
- Characteristic time scales can be eye-balled off the graph, however if the growth curve is exponential, it is conventional to identify the half-life of the curve, the time required to double in value (from a baseline).
- Is there a well-formulated theory of this effect in the literature?
  - The only one I know is:

    Johannes, Michael S. and Dubinsky, Andrew L., "EarningsAnnouncements and Option Prices" (June 2005). SSRN: http://ssrn.com/abstract=600593

- Enough about volatility before these events.
  - What can we say about volatility after these events?
- The behavior of vol about scheduled and unscheduled events will generally be very different.
  - Why?
- How do you expect CAT vol after earnings to compare with CAT vol **well** before earnings? (What does well before mean?)
- What are some of the consequences of this understanding?
- What about vol after the CEO of McDonald's dies suddenly?
  - (There may be a characteristic time post this event).
- The following two slides show Hewlett-Packard (HPQ) through its earnings event: AMC 2/18/09, near months then mid-months.

HPQ. +31.26 -2.82 b+31.25 a31.26 33 x 9 h32.92 131.10 o32.79 s34.080o v37916844 13:39 Divs: 03/09/09 0.08 06/09/09 0.08 09/09/09 0.08 12/09/09 0.08 03/

Trade Date: 02/19/09 Model: Microhedge Type: Equity Exercise: American

Volatility: Using Volatility Skew Interest: 1.1 1.1 1.1 1.1 1.1 1.1

Net HPQ.: 278 I# Delta: 411 Gamma: 900 Theta: -459 Vega: -50 Rho: -547 ThIdg: 182 OpenPos: -1334 DayTrades: -580 Net: -1914

Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
9FEB25-0	0	-9	[illegible]	[illegible]	0.977	6.10 OQWYABPX	6.29	6.10	6.40	6.40 OWYABPX	152.96	-0.023		0.03		0.05	0.05 OWYABPX
9FEB27½-0	-25	17	131.28	94.07	0.964	3.70 OWYABPX	3.79	3.70	3.90	3.90 OQWYABPX	95.66	-0.036		0.03		0.05	0.05 OWYABPX
9FEB30-0	0	-3	115.09	49.88	0.855	1.30 OQWYABPX	1.35	1.30	1.40	1.40 OQWYABPX	51.98	-0.145	0.05 OQWYABPX	0.09	0.05	0.10	0.10 OWYBPX
9FEB32½-0	-2	3	109.05	47.31	0.134	0.05 OWYABPX	0.06	0.05	0.10	0.10 OQWYABPX	45.16	-0.866	1.25 OQWYABPX	1.30	1.25	1.35	1.35 OQWYABPX
9FEB35-0	-65	77	99.97	82.96	0.036		0.02		0.05	0.05 OWYABPX	81.34	-0.964	3.70 OWYABPX	3.76	3.70	3.80	3.80 OWYBPX
9FEB37½-0	4	15	97.67	123.37	0.027		0.02		0.05	0.05 OWYABPX	121.86	-0.973	6.10 OQWYABPX	6.26	6.10	6.30	6.30 OWYABPX
9FEB40-0	31	-25	89.29	158.89	0.023		0.02		0.05	0.05 OQWYABPX	157.48	-0.977	8.60 OWYABPX	8.76	8.60	8.90	8.90 OQWYABPX
9FEB42½-0	26	25	116.88	190.68	0.020		0.02		0.05	0.05 OWYABPX	189.27	-0.981	11.10 OQWYABPX	11.26	11.10	11.40	11.40 OQWYABPX
9FEB45-0	-2	0	141.40	220.67	0.018		0.02		0.05	0.05 OWYABPX	219.26	-0.983	13.60 OQWYABPX	13.76	13.60	13.90	13.90 OQWYABPX
9FEB50-0	-3	0	186.62	275.61	0.015		0.02		0.05	0.05 OWYABPX	274.26	-0.985	18.50 OQWYABPX	18.76	18.50	18.90	18.90 OQWYABPX
9MAR25-0	0	-5	71.00	56.34	0.926	6.30 OQWYABPX	6.42	6.30	6.50	6.50 OQWYABPX	56.82	-0.080	0.15 OQWYABPX	0.18	0.15	0.20	0.20 OQWYBPX
9MAR27½-0	0	-29	64.92	51.74	0.821	4.10 OQWYABPX	4.21	4.10	4.30	4.30 OQWYABPX	52.32	-0.185	0.45 OQWYABPX	0.49	0.45	0.50	0.50 OQWYABPX
9MAR30-0	-50	78	60.95	46.83	0.642	2.25 OQWYABPX	2.34	2.25	2.35	2.35 OWYABPX	47.41	-0.362	1.10 OQWYABPX	1.13	1.10	1.15	1.15 OQWYABPX
9MAR32½-0	35	21	57.01	44.23	0.407	1.00 OQWYABPX	1.06	1.00	1.10	1.10 OQWYABPX	44.37	-0.595	2.30 OQWYABPX	2.35	2.30	2.40	2.40 OQWYABPX
9MAR35-0	26	-50	54.81	42.41	0.196	0.35 OQWYABPX	0.36	0.35	0.40	0.40 OQWYABPX	41.78	-0.806	4.10 OQWYABPX	4.15	4.10	4.20	4.20 OX
9MAR37½-0	-69	36	50.36	43.17	0.082	0.10 OQWYABPX	0.12	0.10	0.15	0.15 OQWYABPX	42.70	-0.919	6.30 OQWYABPX	6.41	6.30	6.50	6.50 OQWYABPX
9MAR40-0	38	25	48.43	46.01	0.037		0.05		0.10	0.10 OQWYABPX	45.61	-0.964	8.80 OWYBPX	8.84	8.80	8.90	8.90 OQWYABPX
9MAR42½-0	3	0	46.09	49.49	0.020		0.02		0.05	0.05 OQWYABPX	49.12	-0.981	11.20 OQWYABPX	11.32	11.20	11.40	11.40 OQWYABPX
9MAY15-0	0	-3	79.44	73.18	0.990	16.20 OWYBPX	16.29	16.20	16.50	16.50 OWYBPX	73.38	-0.013		0.05		0.10	0.10 OWYABPX
9MAY20-0	0	29	68.42	62.09	0.947	11.40 OWABX	11.46	11.40	11.50	11.50 OWYBPX	62.35	-0.054	0.20 OWYABPX	0.23	0.20	0.25	0.25 OWYABPX
9MAY22½-0	0	48	64.42	57.41	0.903	9.10 OQWYABPX	9.17	9.10	9.20	9.20 OWYBPX	57.72	-0.098	0.40 OQWYABPX	0.43	0.40	0.45	0.45 OQWYBPX
9MAY25-0	0	15	60.72	53.48	0.835	6.90 OQWYABPX	7.03	6.90	7.10	7.10 OWYABPX	53.81	-0.165	0.75 OQWYABPX	0.79	0.75	0.80	0.80 OP
9MAY27½-0	-17	82	56.48	50.19	0.740	5.00 OQWYABPX	5.09	5.00	5.10	5.10 OWYBPX	50.06	-0.260	1.30 OQWYABPX	1.34	1.30	1.40	1.40 OQWYABPX
9MAY30-0	0	72	53.94	47.32	0.617	3.40 OQWYABPX	3.47	3.40	3.50	3.50 OWYABPX	47.36	-0.384	2.20 OQWY	2.22	2.20	2.25	2.25 OQWYABPX
9MAY32½-0	-33	-11	50.27	44.69	0.477	2.10 OQWYABPX	2.19	2.10	2.20	2.20 OQWYABPX	44.99	-0.525	3.40 OQWYABPX	3.44	3.40	3.50	3.50 OQWYABPX
9MAY35-0	-3	23	48.06	42.21	0.334	1.20 OQUAPX	1.24	1.20	1.25	1.25 OQWYABPX	42.24	-0.668	4.90 OQWYABPX	4.98	4.90	5.10	5.10 OQWYABPX
9MAY37½-0	-2	-1	45.48	40.04	0.215	0.60 OQWYABPX	0.66	0.60	0.65	0.65 OQWYABPX	40.82	-0.789	6.80 OQWYABPX	6.90	6.80	7.00	7.00 OQWYABPX

MicroHedge [ACTIV] v4.62.126 MIKE.31E5 - (Hewlett Packard Co-HPQ WPW VHP) HPQ.31E5

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HPQ. -30.84 -3.24 b+30.84 a30.85 27 x 31 h32.92 l30.67 c32.79 s34.080o v43028152 14:21 Divs: 03/09/09 0.08 06/09/09 0.08 09/09/09 0.08 12/09/09 0.08 03

Trade Date: 02/19/09 Model: Microhedge Type: Equity Exercise: American

Volatility: Using Volatility Skew Interest: 1.1 1.1 1.1 1.1 1.1 1.1

Net HPQ.: 278 I# Delta: 159 Gamma: 886 Theta: -450 Vega: -17 Rho: -543 ThEdg: -641 OpenPos: -216 DayTrades: -986 Net: -1202

Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
9MAR25-0	0	-5	71.00	57.78	0.911	6.00 OX	6.05	6.00	6.10	6.10 OQWYABPX	57.96	-0.096	0.20 OWYABPX	0.23	0.20	0.25	0.25 OQWYABPX
9MAR27½-0	0	-29	64.92	52.53	0.799	3.80 OWYABPX	3.87	3.80	3.90	3.90 OWYABPX	51.80	-0.207	0.55 OQWYABPX	0.56	0.55	0.60	0.60 OQWYABPX
9MAR30-0	-49	78	60.95	47.34	0.607	2.00 OWYABPX	2.06	2.00	2.10	2.10 OQWYABPX	46.79	-0.397	1.25 OQWYABPX	1.26	1.25	1.35	1.35 OQWYABPX
9MAR32½-0	35	21	57.01	43.91	0.367	0.85 OQWYABPX	0.89	0.85	0.90	0.90 OQWYAX	44.16	-0.634	2.55 OQWYABPX	2.59	2.55	2.65	2.65 OQWYABPX
9MAR35-0	26	-50	54.81	42.53	0.177	0.25 OQWYABPX	0.32	0.25	0.35	0.35 OQWYABPX	43.41	-0.825	4.40 OQWYABPX	4.52	4.40	4.60	4.60 OWYABPX
9MAR37½-0	-69	36	50.36	41.00	0.070	0.05 OQWYABPX	0.10	0.05	0.10	0.10 OWYABPX	43.31	-0.931	6.70 OQWYABPX	6.80	6.70	6.90	6.90 OWYABPX
9MAR40-0	38	25	48.43	48.07	0.037		0.05		0.10	0.10 OQWYABPX	47.92	-0.964	9.10 OQWYABPX	9.25	9.10	9.30	9.30 OWYBPX
9MAR42½-0	3	0	46.09	51.37	0.020		0.02		0.05	0.05 OQWYABPX	51.23	-0.981	11.60 OQWYABPX	11.73	11.60	11.80	11.80 OWYABPX
9MAY15-0	0	-3	79.44	72.09	0.990	15.60 OWYBPX	15.88	15.60	16.00	16.00 OWYBPX	72.17	-0.013		0.05		0.10	0.10 OWYABPX
9MAY20-0	0	29	68.42	62.25	0.942	10.90 OWYABPX	11.08	10.90	11.10	11.10 OWYBPX	62.35	-0.059	0.20 OWYABPX	0.25	0.20	0.30	0.30 OWYABPX
9MAY22½-0	0	48	64.42	57.66	0.894	8.70 OWYABPX	8.81	8.70	8.90	8.90 OQWYABPX	57.78	-0.106	0.45 OQWYABPX	0.48	0.45	0.50	0.50 OQWYABPX
9MAY25-0	0	15	60.72	54.15	0.823	6.50 OQWYABPX	6.69	6.50	6.70	6.70 OWYABPX	53.66	-0.178	0.85 OQWYABPX	0.86	0.85	0.90	0.90 OQWYABPX
9MAY27½-0	-17	82	56.48	49.89	0.722	4.70 OQWYABPX	4.80	4.70	4.80	4.80 OWYABPX	50.06	-0.278	1.40 OQWYABPX	1.46	1.40	1.50	1.50 OQWYABPX
9MAY30-0	0	72	53.94	46.68	0.595	3.10 OQWYABPX	3.21	3.10	3.20	3.20 OWYABPX	47.03	-0.406	2.35 OQABX	2.37	2.35	2.40	2.40 OQWYABPX
9MAY32½-0	-33	-11	50.27	44.07	0.453	1.90 OQWYABPX	2.00	1.90	1.95	1.95 OWYBPX	44.77	-0.549	3.60 OQWYABPX	3.65	3.60	3.70	3.70 OQWYABPX
9MAY35-0	-3	23	48.06	41.72	0.311	1.00 OQWYABPX	1.10	1.00	1.10	1.10 OQWYABPX	42.08	-0.692	5.20 OQWYABPX	5.25	5.20	5.40	5.40 OQWYABPX
9MAY37½-0	-2	-1	45.48	39.68	0.195	0.50 OQWYABPX	0.57	0.50	0.55	0.55 OWY	40.70	-0.810	7.20 OQWYABPX	7.23	7.20	7.30	7.30 OWYABPX
9MAY42½-0	4	-25	41.18	39.11	0.059	0.10 OY	0.12	0.10	0.15	0.15 OQWYABPX	39.01	-0.947	11.70 OQWYABPX	11.79	11.70	11.90	11.90 OWYABPX
9AUG27½-0	1	2	53.33	49.10	0.694	5.80 OWYABPX	5.89	5.80	5.90	5.90 OWYBPX	48.86	-0.307	2.55 OWYABPX	2.56	2.55	2.65	2.65 OWYABPX
9AUG40-0	-4	25	43.28	39.67	0.226	0.90 OWYABPX	0.94	0.90	1.00	1.00 OWYABPX	39.57	-0.778	10.00 OWYABPX	10.08	10.00	10.20	10.20 OWYABPX
9AUG42½-0	4	0	41.47	38.46	0.161	0.55 OWYABPX	0.59	0.55	0.60	0.60 OYBP	38.87	-0.844	12.20 OWYABPX	12.23	12.20	12.40	12.40 OWYABPX
9AUG47½-0	6	0	39.48	36.80	0.069	0.15 OWYABPX	0.20	0.15	0.25	0.25 OWYABPX	36.73	-0.938	16.80 OWYABPX	16.83	16.80	17.00	17.00 OWYABPX

- Now let's consider the vol surfaces.
- For simplicity let us restrict the discussion to one stock, one series. (For concreteness, we could imagine the XYZ Jun options with May being the front month.)
  - What is the usual shape of the volatility surface for this series?
  - What will happen if the stock experiences a ***gradual*** price change which shifts the at-the-$?
  - What will happen if the stock experiences a ***sudden*** price change which shifts the at-the-$?
- Is there a theory which covers this behavior?
- No.

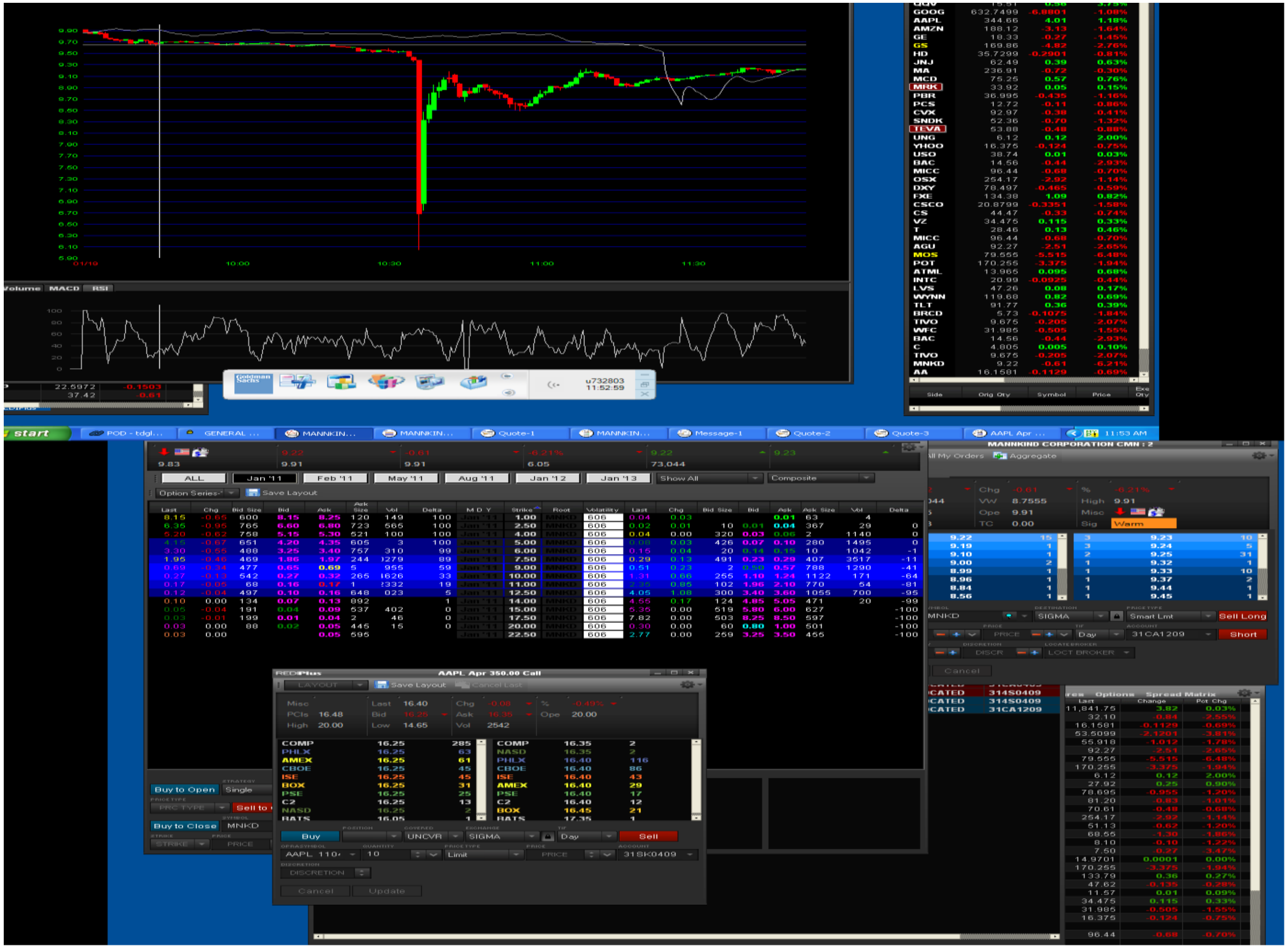
Dynamics

- Let's be blunt about standard option pricing theory!
- It applies when every option is well-priced. ONLY!
- In other words, if conditions materially change, standard option theory will not be able to distinguish between the need to alter the parameters of the model used and the presence of arbitrage!

*I am plenty **redundant** about this point!!!!!!!!!*

- When a stock drops dramatically, the vol often changes. But it can go down and up!
- A theory would be a dynamic theory, but there is no such theory currently.
- An attempt to patch statics to dynamics is sticky strike/sticky delta.
- The following two slides show recent flashcrashes: AAPL; MNKD

This is significant selling pressure.
The volume spike is enoumous and
the move down wasn't orderly.
Not orderly SElling. That's $3 of
disorderly selling pressure
354.45
13:00
14:00



- What is sticky strike?
- What is sticky delta?

- Sticky strike postulates that as the stock moves the vol skew stays put. This gibes with our intuition that as the stock moves lower the volatility might go up. But is this true?

- What if XYZ drops suddenly on uncertain news?

- What if XYZ drops suddenly because of definitive news (such as earnings or a drug trial results)?

- Will up moves be different than down moves?

- Sticky delta postulates that as the stock moves the vol skew stays with the corresponding option, delta by delta. This gibes with our intuition that the at-the-$ options should have a depressed vol.
- Why?
- Should a time scale matter here? In other words, if the stock drifts gently up or down is this different than if the stock shoots quickly to another value?
- How would you define such a time scale?

- The same kinds of spikes can happen in the entire market's volatility. Here is a 3-year graph of the VIX. The data set I used ended with the onset of a vol spike in May 2006.


$VIX (Volatility Index - New Methodology) INDX
© StockCharts.com
8-Jun-2006 Open 17.92 High 20.75 Low 17.88 Close 18.34 Chg +0.54 (+3.03%)
RSI(14) 60.97
90
70
50
30
10
$VIX (Daily) 18.34
MA(50) 13.52
MA(200) 12.77
Volume undef
23
22
21
20
19
18
17
16
15
14
13
12
11
10
Jul
Oct
04
Apr
Jul
Oct
05
Apr
Jul
Oct
06
Apr
MACD(12,26,9) 1.126, 1.053, 0.074
1
0
-1

So, here is a mini-quiz!

The following slide is a picture of a stock I traded for a number of months in 2006.

Can you look at it and deduce what happened to the volatility surface from before to after the event in question?

One thing that did not change much was the realized vol on either side of the event!

Why would the implied volatility not be a reflection of the realized volatility?

The key story is that implied volatilities assimilate the *expected* movement over an extended time horizon. They are a poor man's representation of a jump process.

Telik, Inc. (Public, NASDAQ:TELK) - Add to Portfolio - Discuss TELK

Find more results for **telk**

6.02
-0.27 (-4.33%)
Feb 9, 4:00PM ET

Open: 6.26		**Mkt Cap:** 315.07M		**P/E:** -4.01	
High: 6.27		**52Wk High:** 22.70		**F P/E:** N/A	
Low: 6.01		**52Wk Low:** 4.32		**Beta:** 0.81	
Vol: 842,130.00		**Avg Vol:** 2.89M		**EPS:** -1.50	

Compare ▼ Settings ▼

After Hours: 6.02 +0.00 (0.00%) Feb 9, 6:04PM ET

Newer news | Latest news

A Hot Stocks of the Week: Telik Tanks
BusinessWeek - 29 Dec 2006

B Health Highlights: Dec. 27, 2006
Forbes - 27 Dec 2006

C AFTER HOURS Telik, Vascular shares active in late trade
MarketWatch - 26 Dec 2006

D Telik's Shares Plunge as Cancer Drug Fails in Trials (Update6)
Bloomberg - 26 Dec 2006
Telik cancer drug fails trials; stock plummets Reuters.uk
Telik cancer drug fails trials; stock plunges Reuters
Smartmoney.com - MarketWatch

E Volume Spikes: TELK CTIB ZICA PFSW
BusinessWeek - 26 Dec 2006

F Tuesday's Small-Cap Winners & Losers
TheStreet.com - 26 Dec 2006 - Related articles »

Older news | View all news for TELK »

- Here is a similar stock, in this case prior to an announcement:

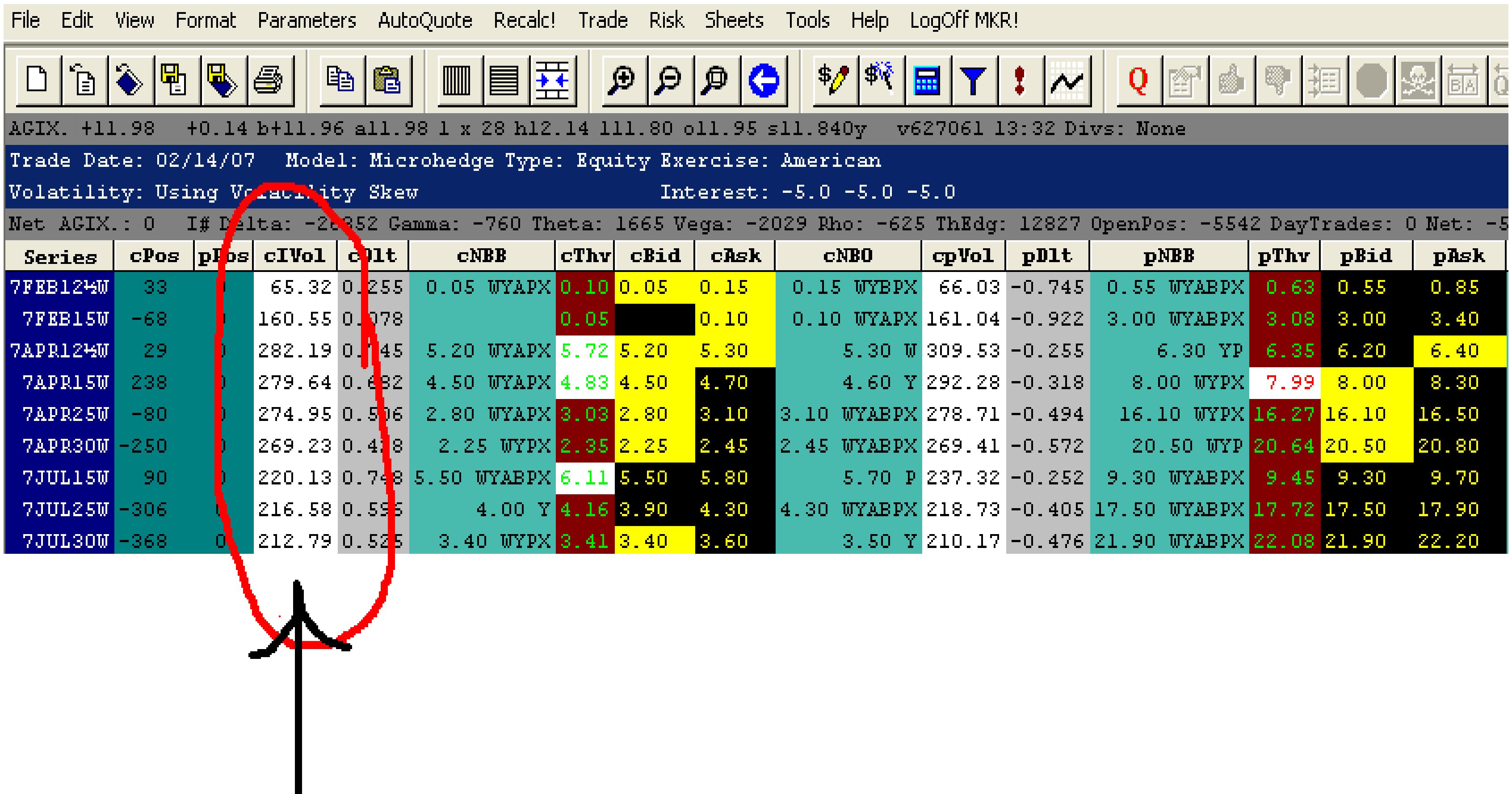
Options | Profile | Reload | Positions | Executions | Stocks | Montage | Batch | Symbol | Info | Allocate

AGIX (Q) 10.61 (Q) 10.64 (D) (10 x 10) + 0.38 Exchange Spread Size

Strike	Feb 07		Mar 07		Apr 07		Jul 07		Jan 08		Jan 09	
2.50	7.90	8.30	7.90	8.30	8.00	8.40	8.20	8.50	7.70	8.70	7.70	9.20
5.00	5.40	5.80	5.50	5.90	6.50	6.80	6.90	7.40	7.00	7.60	6.80	8.20
7.50	3.00	3.30	3.50	3.80	5.50	5.80	6.20	6.50	6.20	7.00	6.20	8.30
10.00	0.95	1.00	1.90	2.00	4.50	4.80	5.50	5.80	5.60	6.40	5.60	7.90
12.50	0.25	0.30	1.10	1.30	3.70	3.90	5.00	5.20	5.20	5.80	5.00	7.40
15.00	0.10	0.20	0.75	0.85	3.20	3.30	4.40	4.80	4.80	5.20	5.00	6.40
17.50	0.10	0.15	0.55	0.65	2.75	2.95	3.90	4.30	4.60	5.00	4.40	6.40
20.00	0.05	0.15	0.25	0.45	2.50	2.60	3.60	3.90	4.00	4.50	4.00	6.40
22.50	0.00	0.10	0.20	0.45	2.10	2.30	3.30	3.60				
25.00	0.00	0.10	0.20	0.35	1.85	1.95	3.00	3.30	3.60	4.00	3.30	4.90
30.00	0.00	0.10	0.10	0.30	1.50	1.60	2.40	2.70	2.90	3.30	2.45	4.10
35.00	0.00	0.10	0.10	0.20	1.15	1.25	1.90	2.20	2.30	2.65	[illegible]	[illegible]
40.00	0.00	0.10			0.90	1.00	1.35	1.60	1.90	2.20		
45.00	0.00	0.10			0.70	0.75	0.95	1.25				

Jan 24, 2007

Strike	Feb 07		Mar 07		Apr 07		Jul 07		Jan 08		Jan 09	
Strike	Feb 07		Mar 07		Apr 07		Jul 07		Jan 08		Jan 09	
2.50	0.00	0.05	0.00	0.20	0.30	0.35	0.55	0.75	0.70	0.95	0.75	1.10
5.00	0.05	0.10	0.35	0.40	1.40	1.45	1.90	2.10	2.00	2.30	2.10	2.50
7.50	0.10	0.25	0.80	0.85	2.85	2.90	3.50	3.90	4.10	4.40	4.00	5.40
10.00	0.50	0.60	1.65	1.80	4.30	4.40	5.30	5.70	5.70	6.20	5.50	6.80
12.50	2.15	2.40	3.20	3.80	6.10	6.20	7.40	7.80	7.40	8.30	7.40	8.70
15.00	4.50	4.80	5.30	5.80	8.00	8.10	9.50	9.70	10.00	10.40	9.40	10.90
17.50	6.90	7.20	7.50	8.00	10.00	10.30	11.30	12.00	11.40	12.50	11.30	13.00
20.00	9.40	9.70	9.90	10.50	12.10	12.70	13.40	14.10	13.50	14.60	13.20	15.00
22.50	11.90	12.20	12.30	12.90	14.30	14.90	15.60	16.10				
25.00	14.30	14.60	14.70	15.30	16.50	17.10	17.60	18.20	17.90	18.80	17.20	19.20
30.00	19.30	19.60	19.60	20.20	21.20	21.60	22.00	22.70	22.20	23.20	21.00	23.40
35.00	24.30	24.60	24.50	25.20	25.60	26.10	26.40	27.00	26.30	27.60	24.90	28.00


File Edit View Format Parameters AutoQuote Recalc! Trade Risk Sheets Tools Help LogOff MKR!

AGIX. +11.98 +0.14 b+11.96 a11.98 1 x 28 h12.14 l11.80 o11.95 s11.840y v627061 13:32 Divs: None

Trade Date: 02/14/07 Model: Microhedge Type: Equity Exercise: American

Volatility: Using Volatility Skew Interest: -5.0 -5.0 -5.0

Net AGIX.: 0 I# Delta: -2[illegible]852 Gamma: -760 Theta: 1665 Vega: -2029 Rho: -625 ThEdg: 12827 OpenPos: -5542 DayTrades: 0 Net: -5

Series	cPos	pPos	cIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk
7FEB12½W	33	0	65.32	0.255	0.05 WYAPX	0.10	0.05	0.15	0.15 WYBPX	66.03	-0.745	0.55 WYABPX	0.63	0.55	0.85
7FEB15W	-68	0	160.55	0.078		0.05		0.10	0.10 WYAPX	161.04	-0.922	3.00 WYABPX	3.08	3.00	3.40
7APR12½W	29	0	282.19	0.745	5.20 WYAPX	5.72	5.20	5.30	5.30 W	309.53	-0.255	6.30 YP	6.35	6.20	6.40
7APR15W	238	0	279.64	0.682	4.50 WYAPX	4.83	4.50	4.70	4.60 Y	292.28	-0.318	8.00 WYPX	7.99	8.00	8.30
7APR25W	-80	0	274.95	0.506	2.80 WYAPX	3.03	2.80	3.10	3.10 WYABPX	278.71	-0.494	16.10 WYPX	16.27	16.10	16.50
7APR30W	-250	0	269.23	0.428	2.25 WYPX	2.35	2.25	2.45	2.45 WYABPX	269.41	-0.572	20.50 WYP	20.64	20.50	20.80
7JUL15W	90	0	220.13	0.748	5.50 WYABPX	6.11	5.50	5.80	5.70 P	237.32	-0.252	9.30 WYABPX	9.45	9.30	9.70
7JUL25W	-306	0	216.58	0.595	4.00 Y	4.16	3.90	4.30	4.30 WYABPX	218.73	-0.405	17.50 WYABPX	17.72	17.50	17.90
7JUL30W	-368	0	212.79	0.525	3.40 WYPX	3.41	3.40	3.60	3.50 Y	210.17	-0.476	21.90 WYABPX	22.08	21.90	22.20

Subsequent to an event, the vol may be ca. 60.

Here is VMW before the Jan 2008 earnings announcement:

- What do you think happened to the vols after this event?
- Can you tell from the candlesticks what happened to the realized vol?

University of Sussex

Event-Driven Finance

Lecture 4: Take-overs

Mike Lipkin
Columbia University (IEOR)

Take-Overs

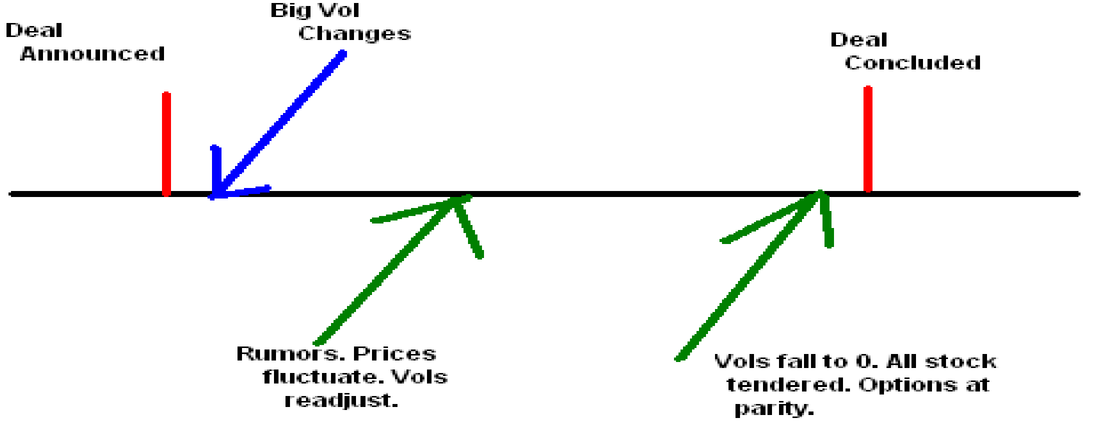
- From time to time stocks are acquired for cash, stock, or some combination of the two.

- There are many scenarios for these deals:
  - Big buyer, small target
  - Equals
  - Take-unders
  - Spin-offs
  - Government intervention
  - Litigation
  - Friendly
  - Hostile
  - Two-tier deal

- SDC Platinum (from Thomson Reuters) for Mergers & Acquisitions.

- The duration for completion of a deal can be brief, i.e. several months, or prolonged, i.e. several years.
- Because there are so many possible scenarios, we will content ourselves with a few choice observations, and also restrict the discussion to cash deals.
- *"January's [2006] cash-based takeovers (24 deals with a combined $15 billion purchase price) tripled 2005's record level, according to Bloomberg."* Kenneth L. Fisher, 03.27.06, Forbes.com.
- A typical cash deal involves a tender offer, by the acquirer, for all the stock of the acquiree, at a premium above the last traded price.

- The timeline for undisputed cash deals looks a little bit as follows:



- After a deal is announced the volatility surface of the acquiree becomes severely distorted. Why?
- The price of the target company moves up, but not to the take-over price.
  - Why?
  - What does the price discount represent?
- Let’s take a concrete example to examine the problem:

- AZZ acquires XYZ for cash, Jun 2008 (XYZ << AZZ)
  - XYZ pre-takeover price, $S_0 = 32.25$
  - Target price, $S_{++} = 46.30$
  - Post price, $S_{+} = 45.26$
  - Pre-takeover, XYZ has flat vol profiles, $\sigma = 35$

- The following might be a typical vol profile after the announcement:
  - σ(Jun 30) = 8, σ(Jun 32.5) = 10, σ(Jun 35) = 35, σ(Jun 37.5) = 60, σ(Jun 40) = 75, σ(Jun 45) = 75, σ(Jun 50) = 8.
  - σ(Jul) = similar to Jun
  - σ(outer months) << Jul, σ(outer 45's) not large.
- Why? Specifically, why are some vols so low and others very high?
- What would happen if the deal doesn't go through?
- Why might this happen?

- Now let’s consider some delicate questions.

- What would be the consequence of insider trading before a take-over?
- What if there were take-over rumors whether they were founded on fact or not?
- Can insider trading be reinforced in the options markets?

- The answer to the last question is YES.

- To get an idea of the consequences of leaked deals and insider trading on the options markets, we need to think about the result of a deal on an option portfolio.

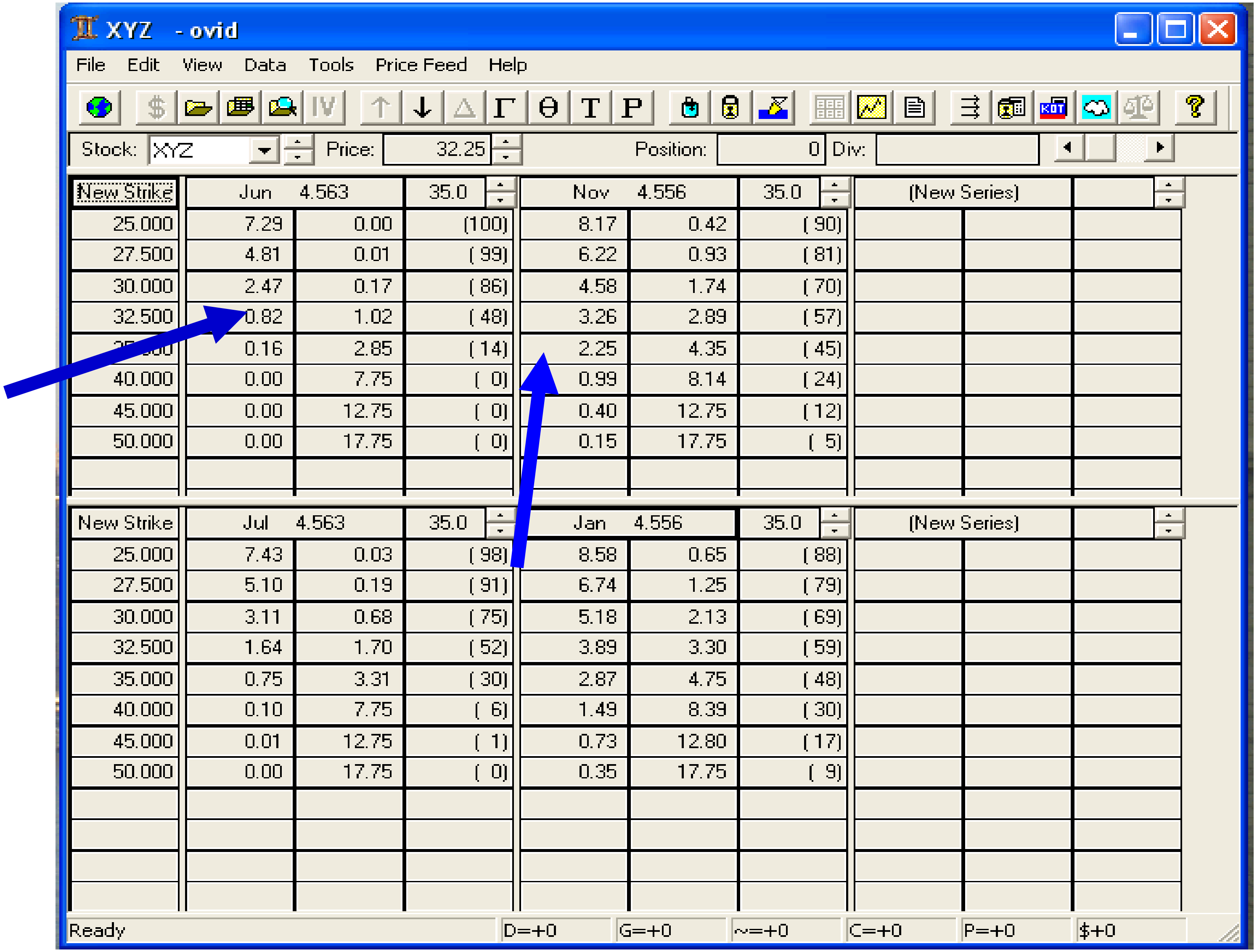
- Consider the following two positions in XYZ:

1. +100 Jun(35) C –100 Nov(35) C

2. – 50 Jun(32.5) C +200 Jun(35) C

- For the parameters we chose, 35 vol, S_0 = 32.25, on June 1, the Jun 35's are worth \$0.16, the Nov 35's \$2.25, and the Jun 32.5's \$0.82.
  – So we can put on the Jun-Nov calendar spread, if we are adroit, for a credit of \$2.10.
  – Likewise, the 32/35 4 x 1, can be done for a credit of \$0.18.

Take-Overs



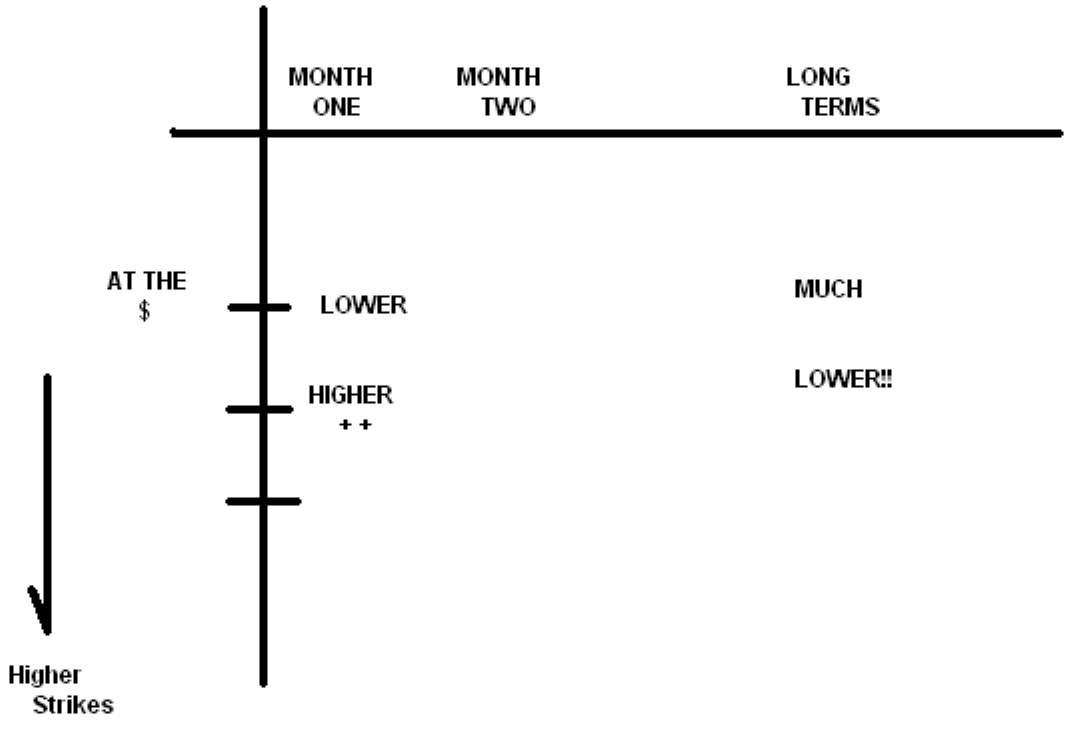
New Strike	Jun 4.563		35.0	Nov 4.556		35.0	(New Series)		
25.000	7.29	0.00	(100)	8.17	0.42	(90)			
27.500	4.81	0.01	(99)	6.22	0.93	(81)			
30.000	2.47	0.17	(86)	4.58	1.74	(70)			
32.500	0.82	1.02	(48)	3.26	2.89	(57)			
35.000	0.16	2.85	(14)	2.25	4.35	(45)			
40.000	0.00	7.75	(0)	0.99	8.14	(24)			
45.000	0.00	12.75	(0)	0.40	12.75	(12)			
50.000	0.00	17.75	(0)	0.15	17.75	(5)			

New Strike	Jul 4.563		35.0	Jan 4.556		35.0	(New Series)		
25.000	7.43	0.03	(98)	8.58	0.65	(88)			
27.500	5.10	0.19	(91)	6.74	1.25	(79)			
30.000	3.11	0.68	(75)	5.18	2.13	(69)			
32.500	1.64	1.70	(52)	3.89	3.30	(59)			
35.000	0.75	3.31	(30)	2.87	4.75	(48)			
40.000	0.10	7.75	(6)	1.49	8.39	(30)			
45.000	0.01	12.75	(1)	0.73	12.80	(17)			
50.000	0.00	17.75	(0)	0.35	17.75	(9)			

- What are the post-takeover values of the spreads?
  - When XYZ goes to $45+, the calendar falls to parity (from $2.10).
  - The 4 x 1 loses $12.76 once and makes $10.26 four times for a gain of $28.28. (But this doesn't include the 18 cent credit we put this play on for. Net $28.46.)
- The temptation for cheating may be very strong!!

- So what will happen if takeover rumors begin and make their way to the trading floor?
  - The Markets will respond by factoring the possibility into the pricing of options.

Take-Overs


MONTH
ONE
MONTH
TWO
LONG
TERMS
AT THE
$
LOWER
MUCH
LOWER!!
HIGHER
+ +
Higher
Strikes

Take-Overs

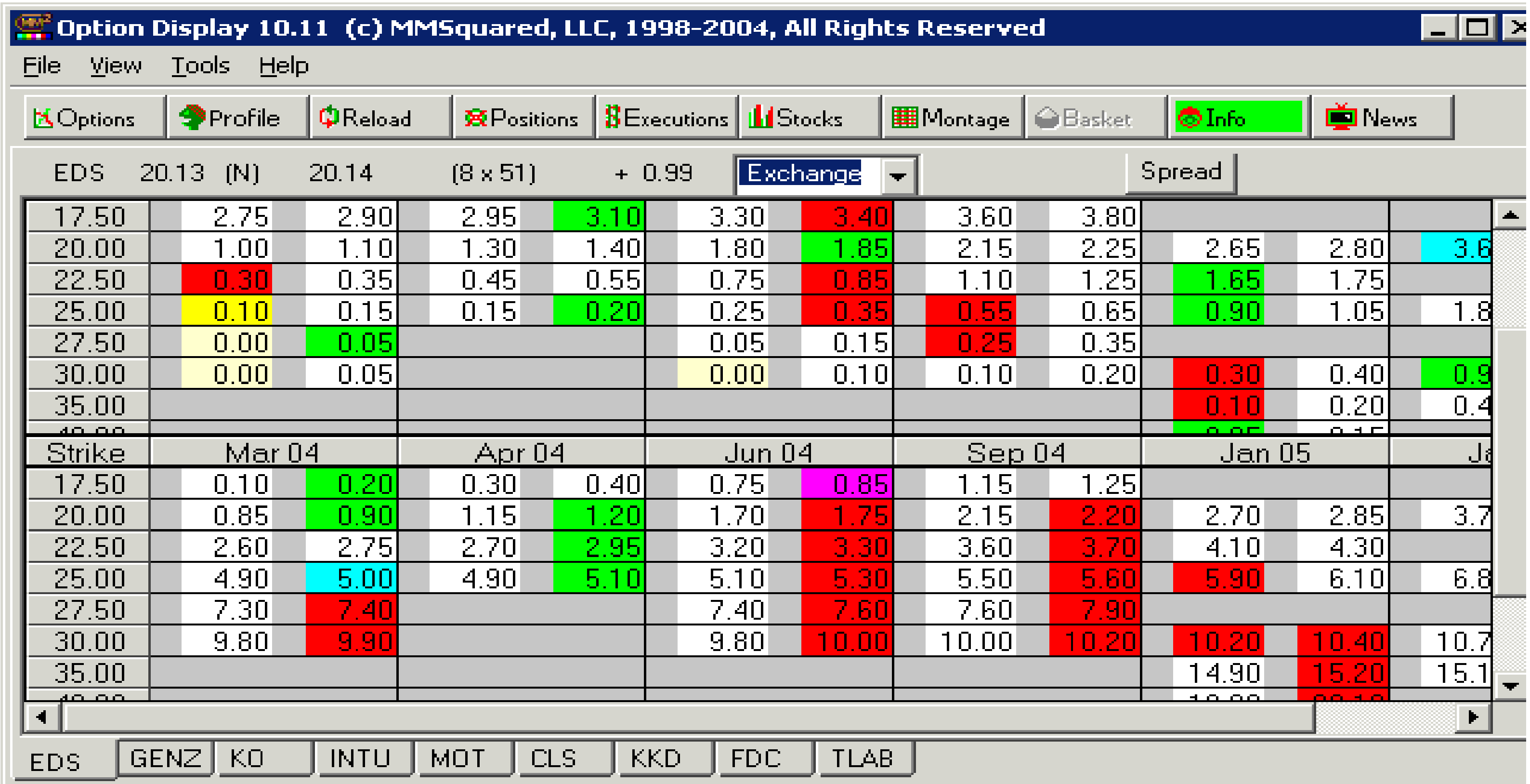
- The previous slide is a caricature of the way volatilities change as a result of takeover potentiality.

- Problem Set VII delves into both the pre- and post- announcement volatility scenarios.
- Option market makers never get asked by the SEC about takeovers, but they should be, because with zero inside information they can abstract a likelihood that information has been leaked.

- Is this just idle speculation? The following is a screen for EDS after (unfounded?) takeover rumors began:

Take-Overs

EDS after takeover rumors began 4 March, 2004

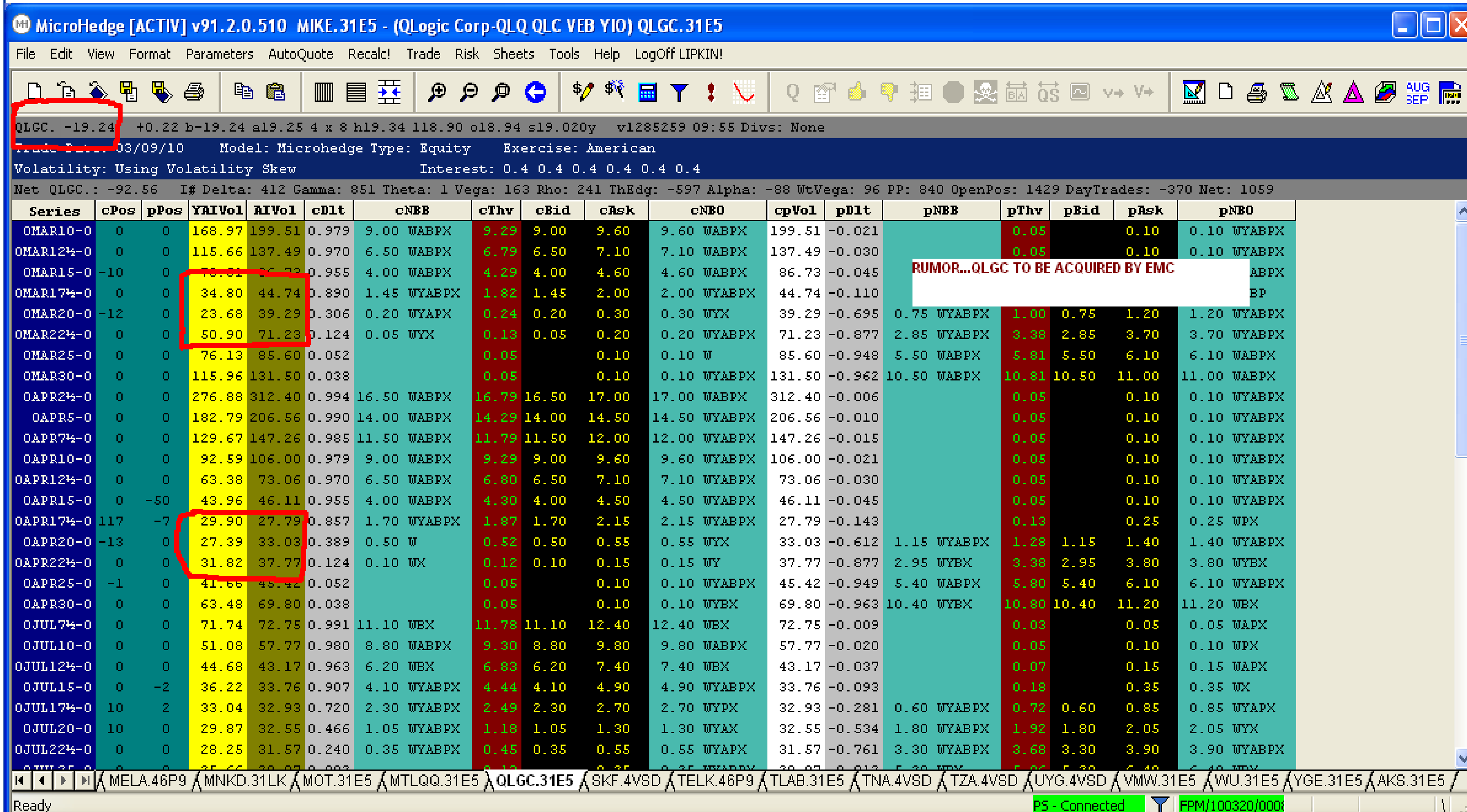


Strike	Mar 04		Apr 04		Jun 04		Sep 04		Jan 05		Ja
17.50	2.75	2.90	2.95	3.10	3.30	3.40	3.60	3.80			
20.00	1.00	1.10	1.30	1.40	1.80	1.85	2.15	2.25	2.65	2.80	3.6
22.50	0.30	0.35	0.45	0.55	0.75	0.85	1.10	1.25	1.65	1.75	
25.00	0.10	0.15	0.15	0.20	0.25	0.35	0.55	0.65	0.90	1.05	1.8
27.50	0.00	0.05			0.05	0.15	0.25	0.35			
30.00	0.00	0.05			0.00	0.10	0.10	0.20	0.30	0.40	0.9
35.00									0.10	0.20	0.4

Strike	Mar 04		Apr 04		Jun 04		Sep 04		Jan 05		Ja
17.50	0.10	0.20	0.30	0.40	0.75	0.85	1.15	1.25			
20.00	0.85	0.90	1.15	1.20	1.70	1.75	2.15	2.20	2.70	2.85	3.7
22.50	2.60	2.75	2.70	2.95	3.20	3.30	3.60	3.70	4.10	4.30	
25.00	4.90	5.00	4.90	5.10	5.10	5.30	5.50	5.60	5.90	6.10	6.8
27.50	7.30	7.40			7.40	7.60	7.60	7.90			
30.00	9.80	9.90			9.80	10.00	10.00	10.20	10.20	10.40	10.7
35.00									14.90	15.20	15.1

Mar 20 53 vol; Mar 22.5 58 vol; Sep 30 32 vol.

- Here is a screen shot of QLGC from March 2010 after rumors:



Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB	pThv	pBid	pAsk	pNBO
OMAR10-0	0	0	168.97	199.51	0.979	9.00 WABPX	9.29	9.00	9.60	9.60 WABPX	199.51	-0.021		0.05		0.10	0.10 WYABPX
OMAR12½-0	0	0	115.66	137.49	0.970	6.50 WABPX	6.79	6.50	7.10	7.10 WABPX	137.49	-0.030		0.05		0.10	0.10 WYABPX
OMAR15-0	-10	0	[illegible]	[illegible]	0.955	4.00 WABPX	4.29	4.00	4.60	4.60 WABPX	86.73	-0.045	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]ABPX
OMAR17½-0	0	0	34.80	44.74	0.890	1.45 WYABPX	1.82	1.45	2.00	2.00 WYABPX	44.74	-0.110	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]BP
OMAR20-0	-12	0	23.68	39.29	0.306	0.20 WYAPX	0.24	0.20	0.30	0.30 WYX	39.29	-0.695	0.75 WYABPX	1.00	0.75	1.20	1.20 WYABPX
OMAR22½-0	0	0	50.90	71.23	0.124	0.05 WYX	0.13	0.05	0.20	0.20 WYABPX	71.23	-0.877	2.85 WYABPX	3.38	2.85	3.70	3.70 WYABPX
OMAR25-0	0	0	76.13	85.60	0.052		0.05		0.10	0.10 W	85.60	-0.948	5.50 WABPX	5.81	5.50	6.10	6.10 WABPX
OMAR30-0	0	0	115.96	131.50	0.038		0.05		0.10	0.10 WYABPX	131.50	-0.962	10.50 WABPX	10.81	10.50	11.00	11.00 WABPX
OAPR2½-0	0	0	276.88	312.40	0.994	16.50 WABPX	16.79	16.50	17.00	17.00 WABPX	312.40	-0.006		0.05		0.10	0.10 WYABPX
OAPR5-0	0	0	182.79	206.56	0.990	14.00 WABPX	14.29	14.00	14.50	14.50 WYABPX	206.56	-0.010		0.05		0.10	0.10 WYABPX
OAPR7½-0	0	0	129.67	147.26	0.985	11.50 WABPX	11.79	11.50	12.00	12.00 WYABPX	147.26	-0.015		0.05		0.10	0.10 WYABPX
OAPR10-0	0	0	92.59	106.00	0.979	9.00 WABPX	9.29	9.00	9.60	9.60 WYABPX	106.00	-0.021		0.05		0.10	0.10 WYABPX
OAPR12½-0	0	0	63.38	73.06	0.970	6.50 WABPX	6.80	6.50	7.10	7.10 WYABPX	73.06	-0.030		0.05		0.10	0.10 WYABPX
OAPR15-0	0	-50	43.96	46.11	0.955	4.00 WABPX	4.30	4.00	4.50	4.50 WYABPX	46.11	-0.045		0.05		0.10	0.10 WYABPX
OAPR17½-0	117	-7	29.90	27.79	0.857	1.70 WYABPX	1.87	1.70	2.15	2.15 WYABPX	27.79	-0.143		0.13		0.25	0.25 WPX
OAPR20-0	-13	0	27.39	33.03	0.389	0.50 W	0.52	0.50	0.55	0.55 WYX	33.03	-0.612	1.15 WYABPX	1.28	1.15	1.40	1.40 WYABPX
OAPR22½-0	0	0	31.82	37.77	0.124	0.10 WX	0.12	0.10	0.15	0.15 WY	37.77	-0.877	2.95 WYBX	3.38	2.95	3.80	3.80 WYBX
OAPR25-0	-1	0	41.66	45.42	0.052		0.05		0.10	0.10 WYABPX	45.42	-0.949	5.40 WABPX	5.80	5.40	6.10	6.10 WYABPX
OAPR30-0	0	0	63.48	69.80	0.038		0.05		0.10	0.10 WYBX	69.80	-0.963	10.40 WYBX	10.80	10.40	11.20	11.20 WBX
OJUL7½-0	0	0	71.74	72.75	0.991	11.10 WBX	11.78	11.10	12.40	12.40 WBX	72.75	-0.009		0.03		0.05	0.05 WAPX
OJUL10-0	0	0	51.08	57.77	0.980	8.80 WABPX	9.30	8.80	9.80	9.80 WABPX	57.77	-0.020		0.05		0.10	0.10 WPX
OJUL12½-0	0	0	44.68	43.17	0.963	6.20 WBX	6.83	6.20	7.40	7.40 WBX	43.17	-0.037		0.07		0.15	0.15 WAPX
OJUL15-0	0	-2	36.22	33.76	0.907	4.10 WYABPX	4.44	4.10	4.90	4.90 WYABPX	33.76	-0.093		0.18		0.35	0.35 WX
OJUL17½-0	10	2	33.04	32.93	0.720	2.30 WYABPX	2.49	2.30	2.70	2.70 WYPX	32.93	-0.281	0.60 WYABPX	0.72	0.60	0.85	0.85 WYAPX
OJUL20-0	10	0	29.87	32.55	0.466	1.05 WYABPX	1.18	1.05	1.30	1.30 WYAX	32.55	-0.534	1.80 WYABPX	1.92	1.80	2.05	2.05 WYX
OJUL22½-0	0	0	28.25	31.57	0.240	0.35 WYABPX	0.45	0.35	0.55	0.55 WYAPX	31.57	-0.761	3.30 WYABPX	3.68	3.30	3.90	3.90 WYABPX

Take-Overs

US University of Sussex

QLGC. -20.48 +0.37 b-20.47 a20.48 11 x 34 h20.51 l20.01 o20.09 s20.110o v1154703 14:35 Divs: None

Trade Date: 03/23/10 Model: Microhedge Type: Equity Exercise: American

Volatility: Using Volatility Skew Interest: 0.4 0.4

Net QLGC.: -119.56 I# Delta: 9554 Gamma: 10145 Theta: -625 Vega: 1030 Rho: 317 ThEdg: 1418 Alpha: 1223 WtVega: 1090 PP:

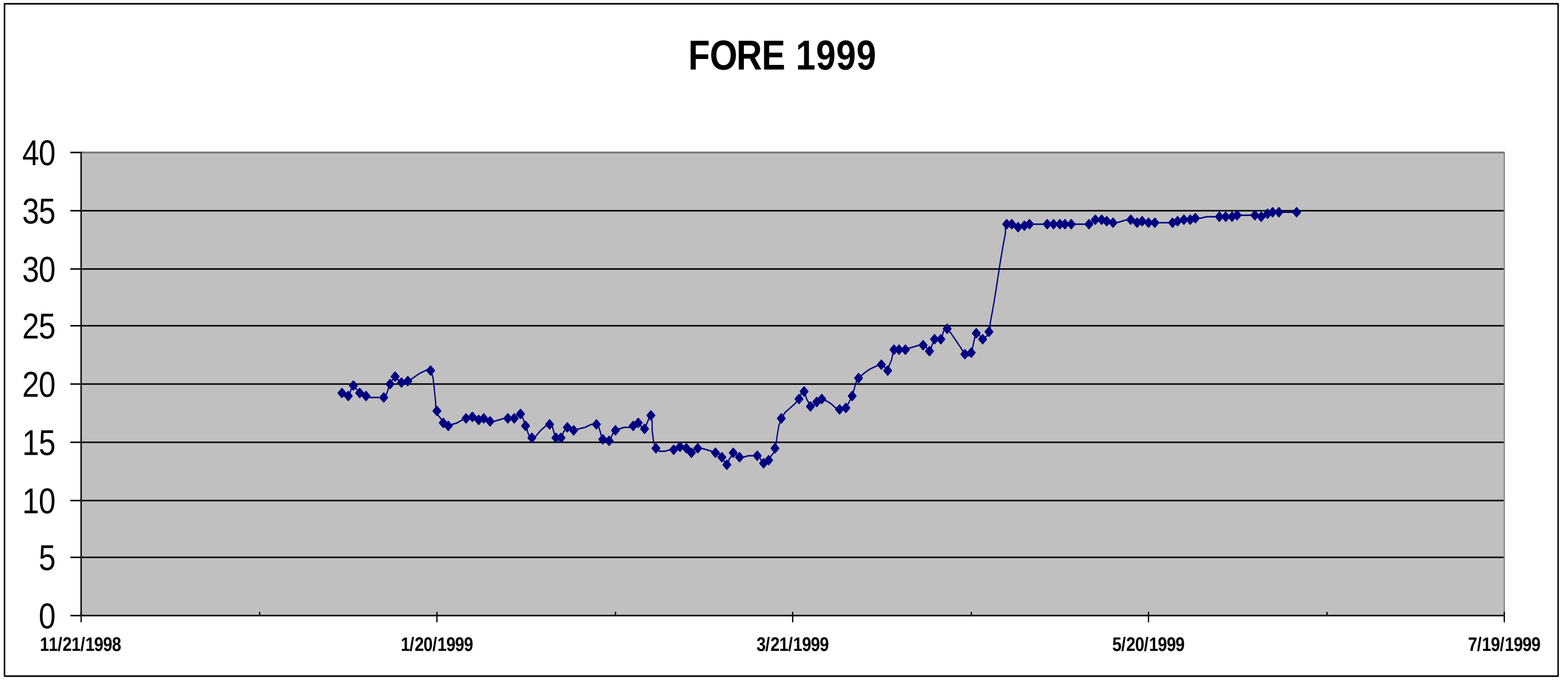
Series	cPos	pPos	YAIVol	AIVol	cDlt	cNBB	cThv	cBid	cAsk	cNBO	cpVol	pDlt	pNBB
0APR15-0	0	-50	56.91	60.96	0.977	5.20 WYBX	5.51	5.20	5.60	5.60 WYBX	60.57	-0.023	
0APR17½-0	117	-7	34.84	38.99	0.942	2.80 WYABPX	3.03	2.80	3.10	3.10 WYABPX	38.53	-0.058	
0APR20-0	-67	0	28.44	28.66	0.633	0.85 WYAPX	0.90	0.85	0.90	0.90 WYAPX	29.77	-0.368	0.35 WYABPX
0APR22½-0	830	0	34.08	32.57	0.159	0.10 WYABPX	0.13	0.10	0.15	0.15 WYABPX	33.16	-0.842	2.05 WYABPX
0APR25-0	-1	0	42.47	40.24	0.038		0.03		0.05	0.05 WYPX	40.65	-0.963	4.40 WYABPX
0JUL15-0	0	-2	38.35	36.62	0.946	5.40 WYABPX	5.60	5.40	5.70	5.70 WYABPX	36.40	-0.054	0.05 WYABPX
0JUL17½-0	10	2	33.49	33.53	0.818	3.30 WYABPX	3.42	3.30	3.50	3.50 WYABPX	34.01	-0.182	0.35 WYABPX
0JUL20-0	10	0	31.15	31.07	0.592	1.60 WYABPX	1.70	1.60	1.70	1.70 WYABPX	31.37	-0.409	1.15 WYABPX

- We can look at several other examples. First let's summarize what we expect to see:

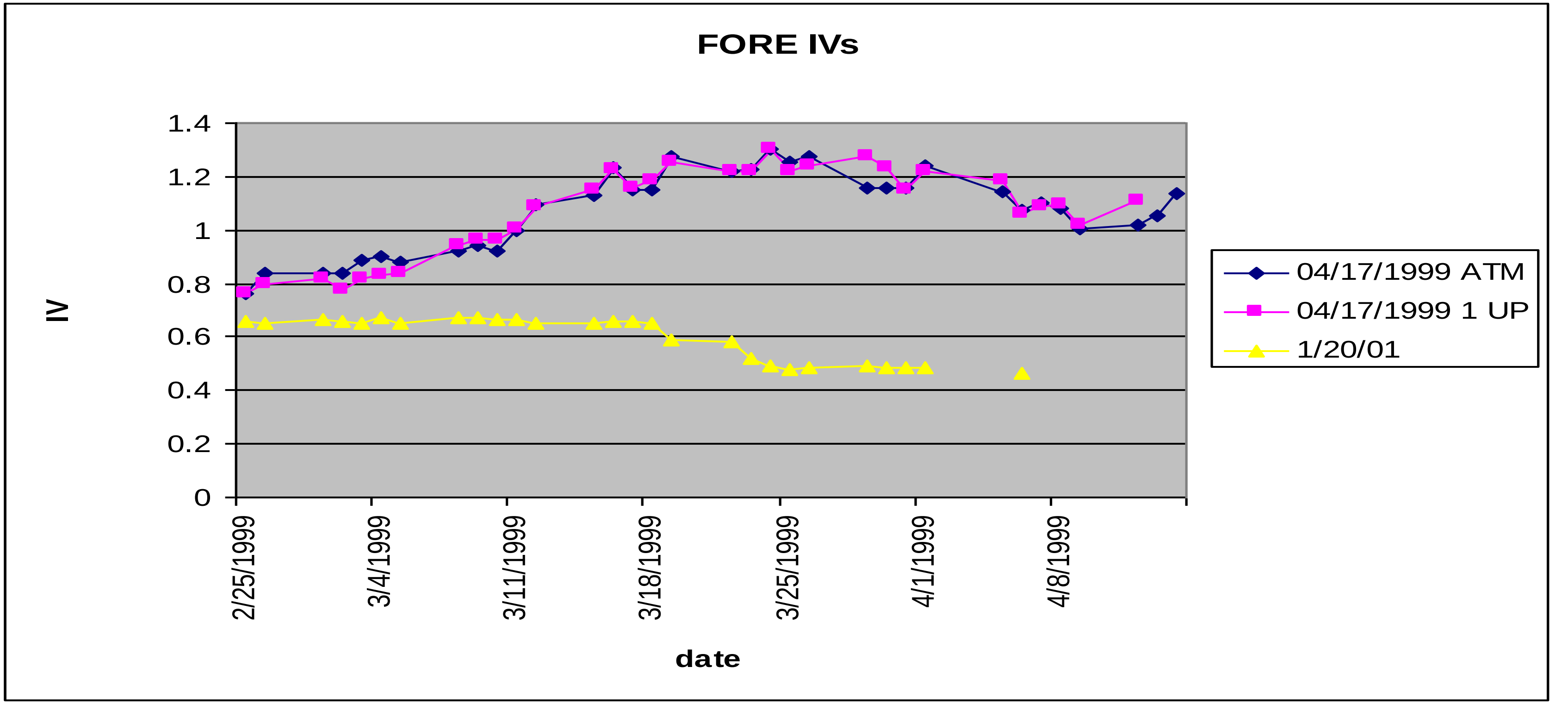
  - 1) near-term 50Δ and next-higher-strike vols may flip
  - 2) long term vols, especially higher strikes should tumble

  - Let's look at three stocks: FORE, DIGI and COFD
  - We will follow the at-the-moneys, next higher strike and an upside leap
  - For one of these, only the long terms came in in advance, for one, the near-terms flipped and for one both characteristics were exhibited.

- Here is a chart of FORE in the year 1999:
- There seems to be a price run-up prior to the $35 announced deal.
- What were options doing?

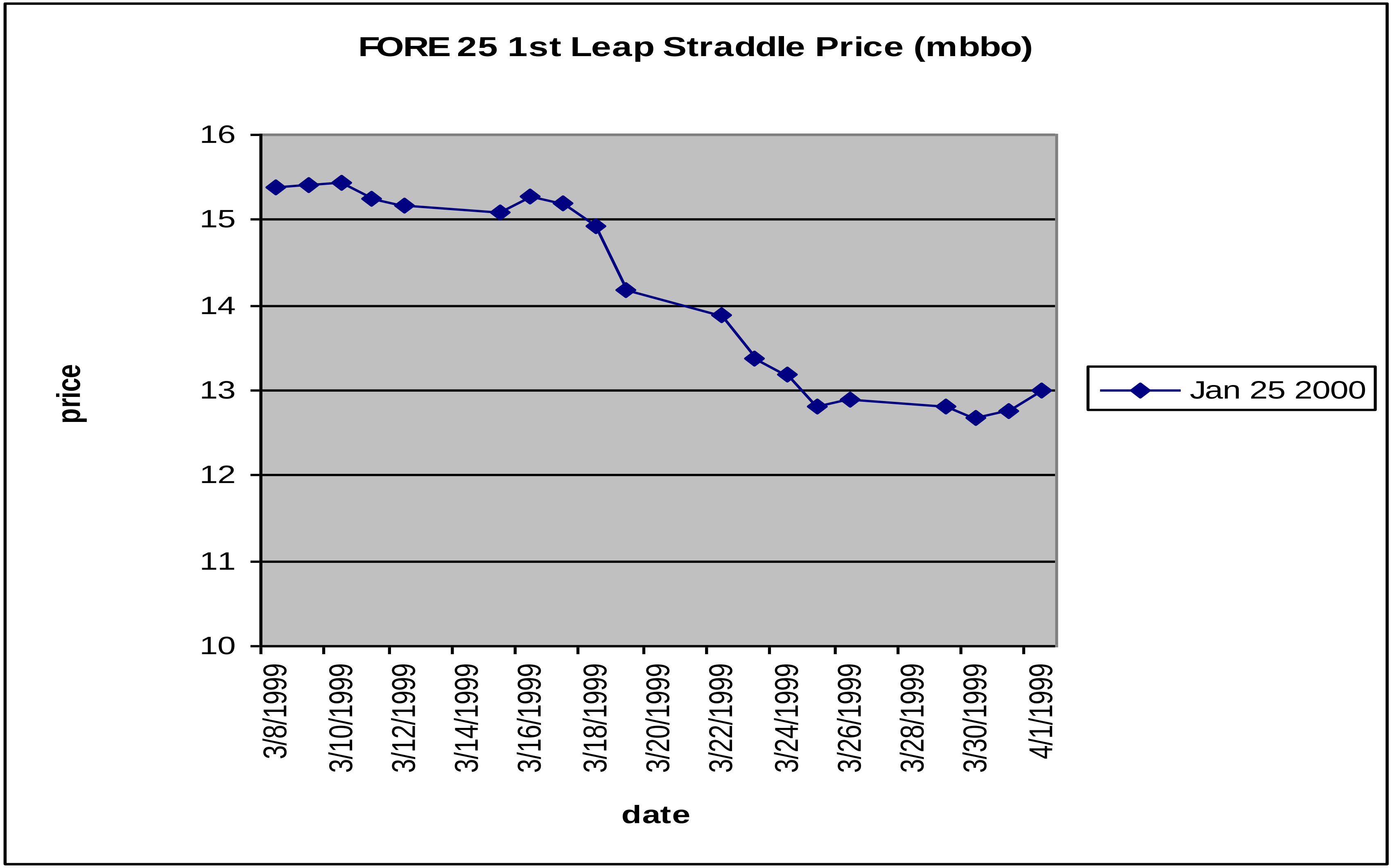


Take-Overs



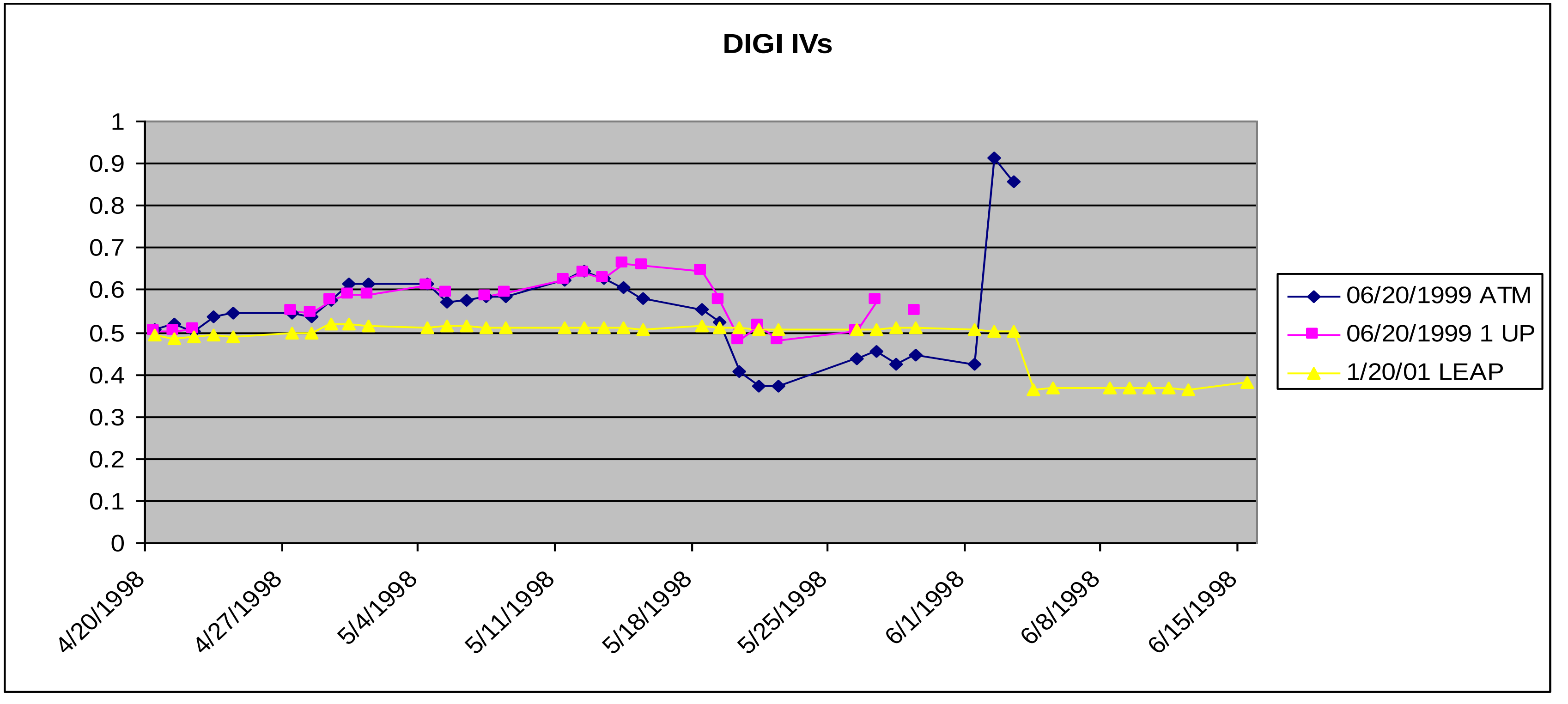
The evidence is extraordinary. Even while near-term volatility exploded to over 100, leap volatility dropped by 33%!

Take-Overs

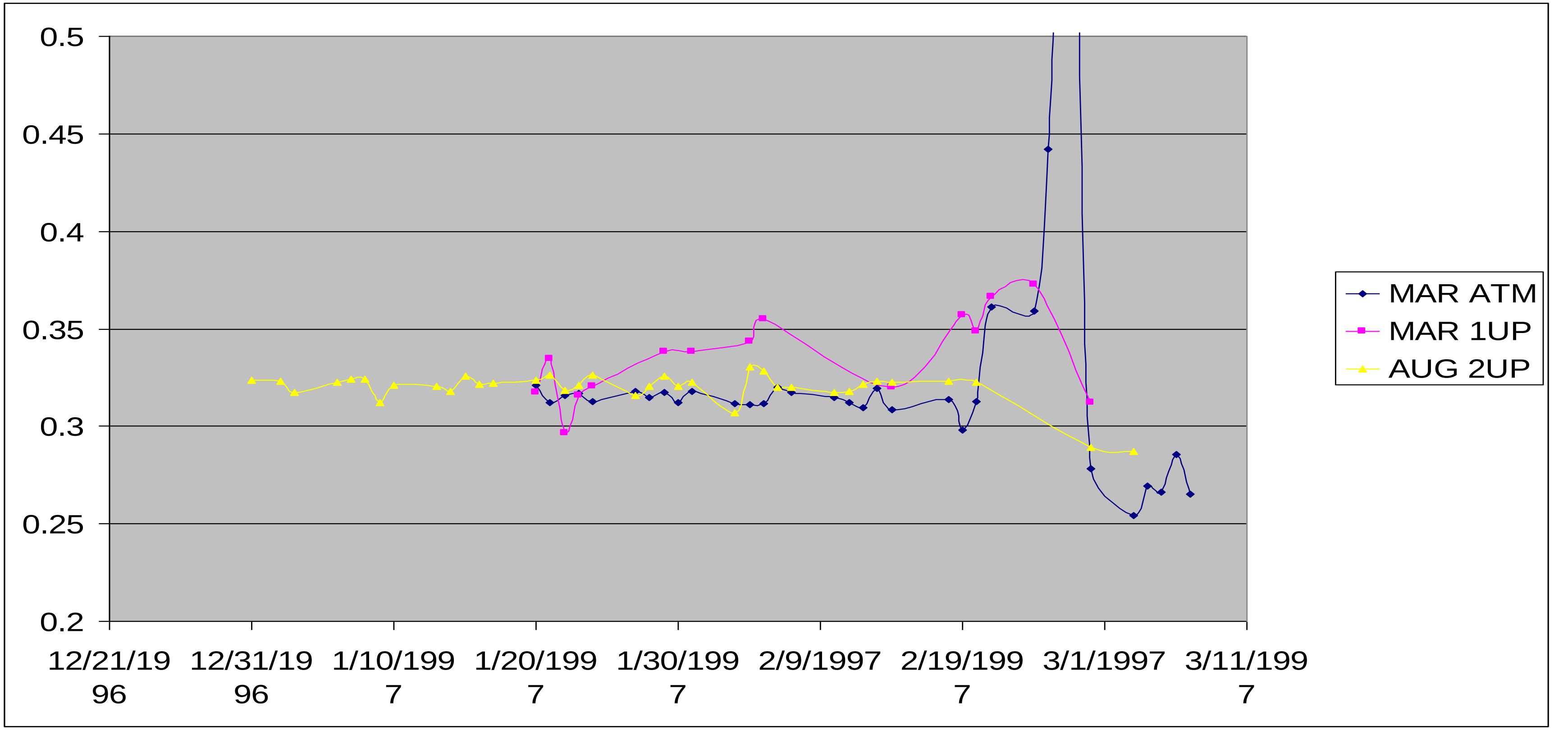

FORE 25 1st Leap Straddle Price (mbbo)
price
16
15
14
13
12
11
10
3/8/1999
3/10/1999
3/12/1999
3/14/1999
3/16/1999
3/18/1999
3/20/1999
3/22/1999
3/24/1999
3/26/1999
3/28/1999
3/30/1999
4/1/1999
date
Jan 25 2000

Take-Overs

- On June 4, 1998 the French phone giant Alcatel acquired DSC (ticker: DIGI) for stock.
- How can you tell it is for stock from this chart?



- On March 17,1997 COFD was acquired for cash. The following graph shows that both long-terms and near-terms behaved as expected:



Take-Overs

- Now let’s look at what happens after a stock take-over has been announced.
- We have already seen for FORE that the stock jumps up to a price **below** that of the announced price.
- There are two reasons for this.

- What are they?

- There are many reasons why a deal can fail.
- Can you name some?
- The post-announcement price is an integration by the marketplace of likelihood of success, final price (What are two reasons why this might be different than the announced price?), and time to completion.
- Why is time to completion relevant?
- Additionally, the stock price will fluctuate dramatically if news alters any of the parameters. One of the stocks I traded even traded above the deal price for a time!! Why?

- Just as the stock prices behave in a circumscribed fashion after a deal announcement, so the options after an announcement assume a very characteristic structure.

- Some strikes have vols of near **0**; others have vols much higher than the levels seen prior to announcement.
- Which strikes would you guess are the fat ones, and which the cheap ones?

- Again, it is a simple bimodal cartoon model which can allow us to analyze the problem.

- Let's take a simple case: XYZ acquired for cash.

  - S_{t-}=25.00
  - S_D=36.00
  - S_{t+}=33.00

- Let's make additional simplifying assumptions:
  - Time to completion or breakup, 90 days
  - Interest rate 5.0%
  - Breakdown price 25.00

- Strategy:
  - Calculate the market's estimate of success
  - Calculate the implied volatilities of the 30 day 30 and 35 strike options

- The carry on the stock for 90 days is:

  33 (1/4) 0.05 = $0.4125

- Let's call the market expectation of success, p;
- p=1-f, the failure probability.

- In this simple picture,

  33=p36+f25-.41

  =25+11p-.41

- p=76%; f=24%

- This same analysis will allow us to find the volatilities of the 90 day 35 and 30 options.

- First ignore carry.
- We will look at two positions:
  - 1) long a 35 call and short N units of stock
  - 2) long a 30 call and short M units of stock

- If both these positions are correctly priced then the returns for both these positions will be equal; from N and M we can determine the deltas.
- Let's look at the initial cash layouts
- T=0; 1) c[35] – 33N

  2) (3+c[30]) -33M
- Here c[X] is the pop of the X-strike call

- r=0
- At t_f , the value for 1 is: (1+(-N)(36))(.76)+(-N)(.24)(25)= -33.36N+.76
- The value for 2 is: (6+(-M)(36))(.76)+(-M)(.24)(25)= -33.36M+4.56

- What are these terms?

- So the payouts are:
  - 1) -33.36N+.76-(c[35]-33N)= -0.36N+.76-c[35]
  - 2) -33.36M+4.56-(3+c[30]-33M)= -0.36M +1.56 – c[30]

- For fairly priced options there should be no advantage to owning the options hedged or owning the bond, so the premium on the 35-call is close to .76.
- The premium on the 30-call is close to 1.20. Why?

- The 30-call is $3 in the money, the $35 is only $2 out of the money, yet the premium on the 30-call is ca. 40% higher than on the 35-strike.
- What does this say about the skew?
- In fact, I used an approximation that the 30's were 100 delta and the 35's 0 delta so the skew is even more extreme!
- If the take-over were at $35, this bimodal assumption would lead to a value of 0 for the 35 call. Why? In fact it would trade at a non-zero bid. What are two reasons for this?

- We can put the pop's into an American pricer and back out volatilities for the 30 and 35 strikes but the point is that the next lowest strike is much fatter than the at-the-money strike.
- The bimodal model also predicts the pop for the 27.5 strike. Is it fatter or cheaper than the 30? Why?

- What would be a good strategy for trading the volatilities of a possible take-over stock if you had an estimate for the likely take-over price?
- For example, suppose XYZ trades at $35 and the likely t.o. price were $46. Which lines in the short term would you want to own? Which lines would you not want to own?
- If the rumor gets strong, the stock may run up quickly to $40 and certain lines will get cheap and others fat. Which ones?
- Suppose you buy the new cheap lines and sell the fat ones. What event are you hoping for?
- Here is a graph of CFC for the first three months of 2007; the stock had been torn between threat of take-over and threat of catastrophic failure in the subprime lender crisis. We know what eventually did happen!!

Countrywide Financial Corporation (Public, NYSE:CFC) - Add to Portfolio - Discuss CFC Find more results fc

34.96
-0.51 (-1.44%)
Mar 16, 4:00PM EDT

Open:	36.38	Mkt Cap:	20.62B	P/E:	8.13
High:	36.50	52Wk High:	45.26	F P/E:	8.49
Low:	34.79	52Wk Low:	32.20	Beta:	0.68
Vol:	13.19M	Avg Vol:	10.57M	EPS:	4.30

Compare ▼ Settings ▼ After Hours: 34.80 -0.16 (-0.46%) Mar 16, 7:53PM EDT

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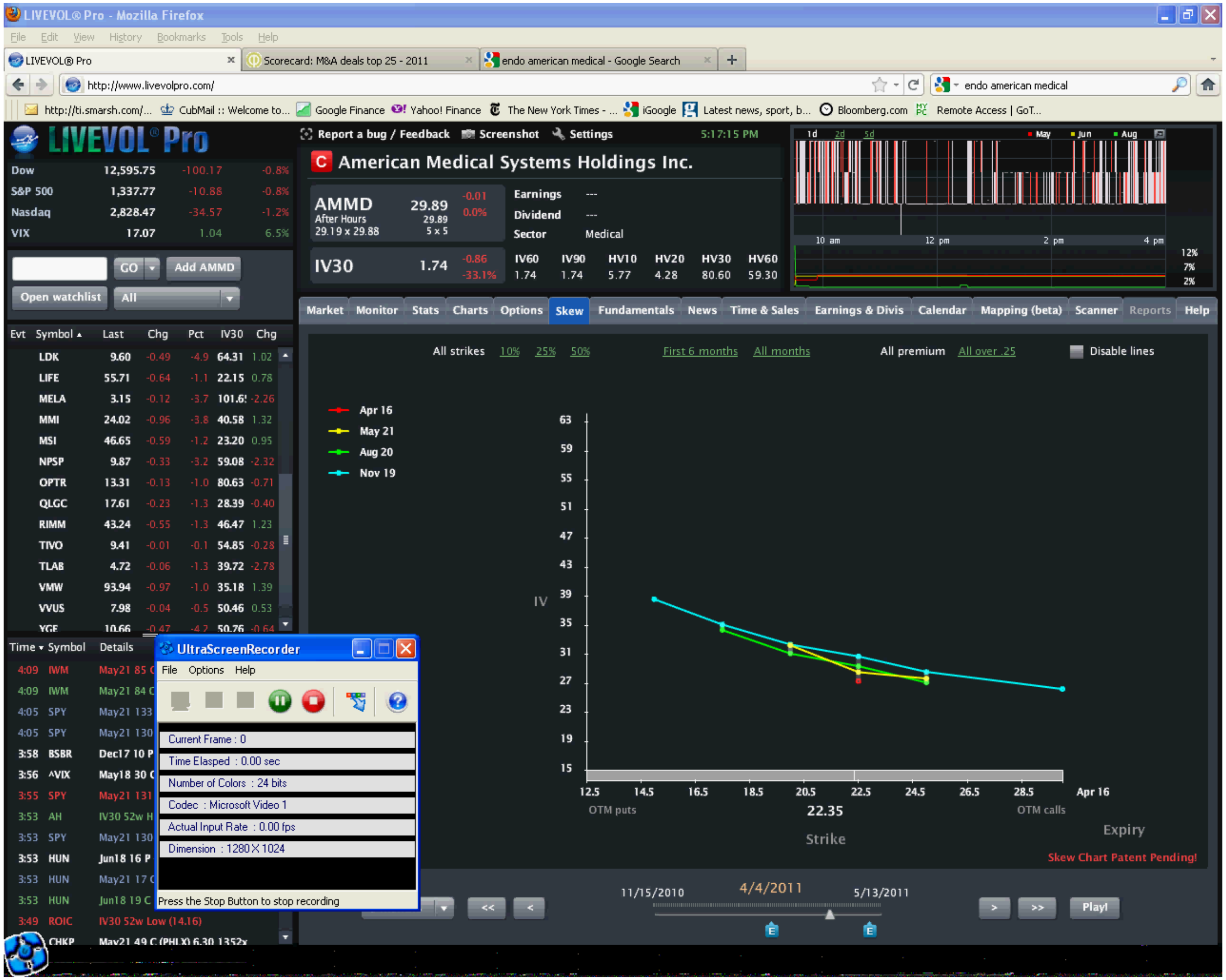
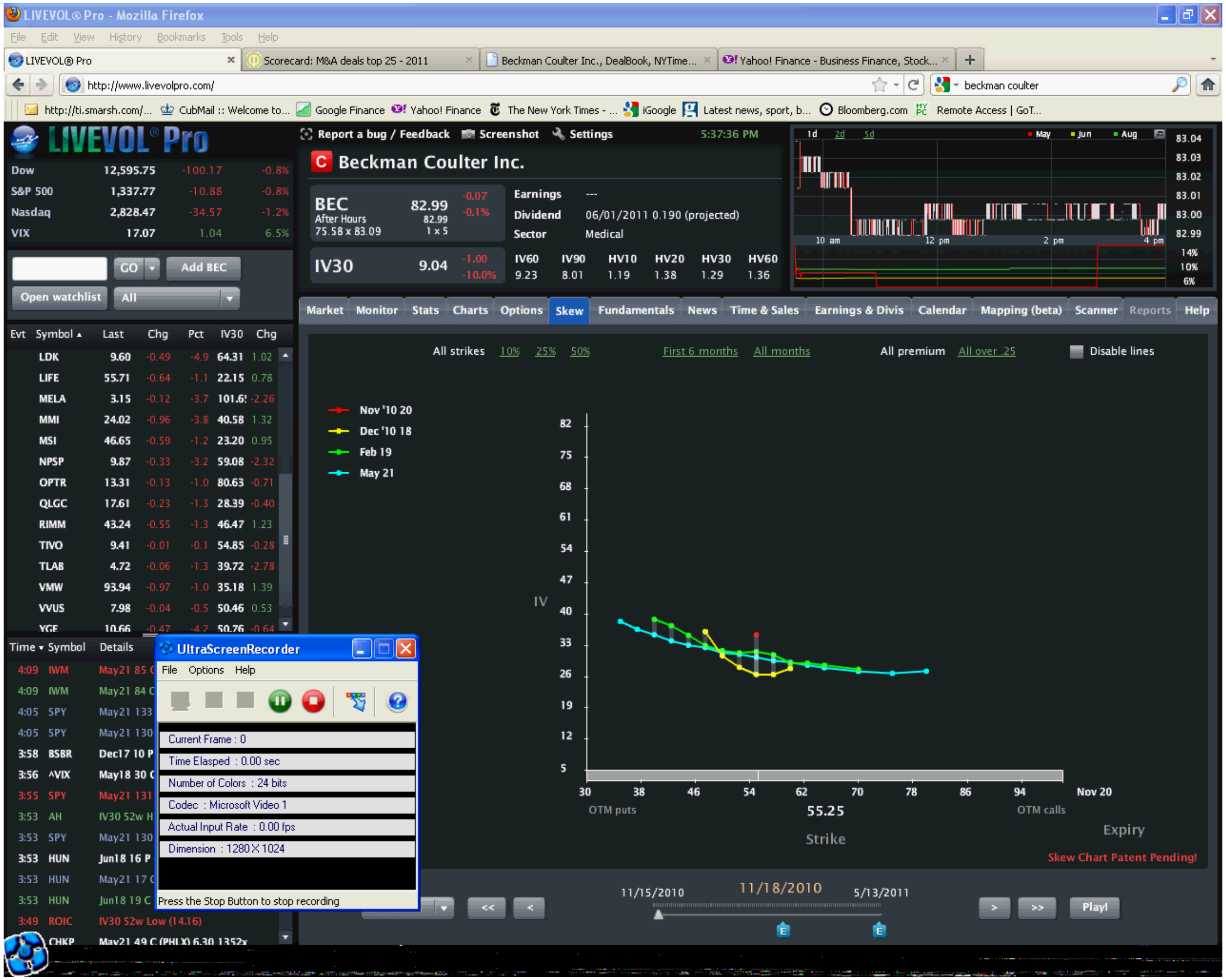
three movies



three movies



three movies