

What Do Options Tell Us?

An investigative study into OptionMetrics IvyDB

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Disclaimer: All views, interpretations and opinions expressed in this presentation, along with any and all errors, are the sole responsibility of the author.

Summary

- » **Option market data can be used to predict the cross-section of stock returns. This predictability is economically large and statistically significant (slide 9 – 14)**
 - Hedge portfolio based on information from call options yield an average excess return of **~90bps per month**
 - This is enhanced to **~150bps per month**, when we utilize include information from put options as well
- » **Information in option data is ‘unique’ (slide 15 - 16)**
 - Excess returns generated are orthogonal to common factor models
 - Stock characteristics, such as beta, size, book-to-market, momentum, illiquidity, reversal, skewness or co-skewness, fail to capture the monotonic spread of return between sorted portfolios
- » **Predictability persists over a month-long time horizon (slide 17 – 19)**
 - The alpha can potentially be utilized in a medium-frequency strategy
 - Unlike most of the previous literature which looks at predictability over short-time horizons (intraday or daily)
- » **Predictability of option returns (slide 20 – 23)**
 - Predictability of cross-sectional option return using stock market information exists in-principle
 - However, it is difficult to exploit this predictability using simple portfolio construction methodology, since dollar return on options are compounded by various factors, such as time decay, compensation for volatility exposure etc.
- » Section II provides a practical guide to working with OptionMetrics database, along with examples, and using it with CRSP and Compustat databases. Section III covers certain relevant literature.

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I. Cross-Predictability Between Markets

Primary Findings

Establishing Frame Of Reference

» Options are not redundant asset^[1]

- Information asymmetry between markets – informed traders choose from stock / call / put
- ‘Pooling equilibrium’ conditions – relative leverage, liquidity, number of informed traders
- Information is impounded into prices by trading

» Option demand impacts option prices^[2]

- Inability to perfect hedge – incomplete markets, jumps, costs etc.
- Agnostic about the end users’ reasons for trade
- Model suggests symmetric impact on put and call prices

» Deviations from put-call parity have predictive information^[3]

- Put-call parity exists as inequality; can move within bounds
- Deviations represent informed trading

» Cross-predictability between stocks and options^[4]

- Builds on earlier ideas; looks at individual predictive power of calls and puts
- ***Guiding paper; replicated results follow later***

[1] Option Volume and Stock Prices: Evidence on Where Informed Traders Trade, by Easley D., O'Hara M. and Srinivas PS., Journal of Finance, 1998.

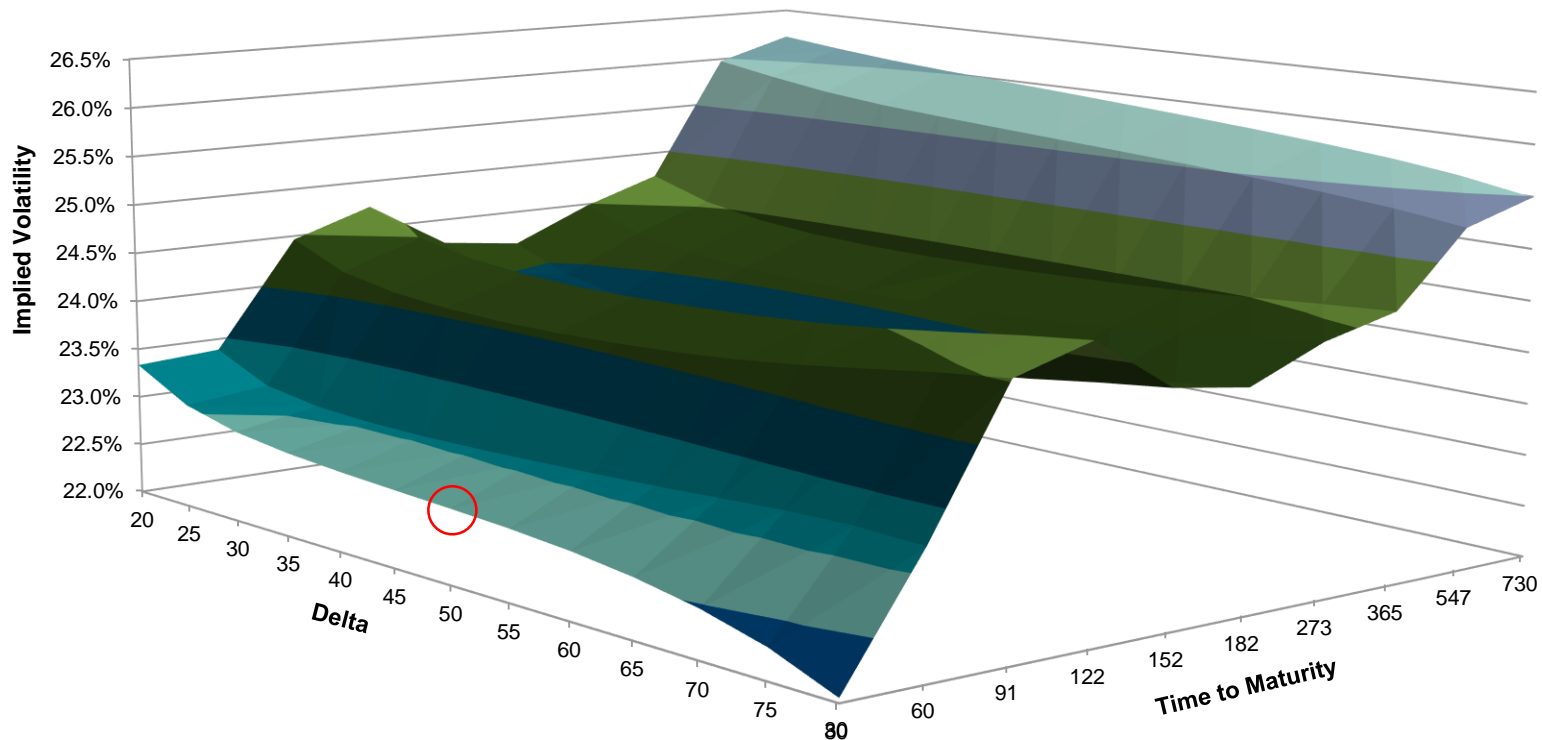
[2] Demand-Based Option Pricing, Gârleanu N., Pedersen LH. and Poteshman AM., Review of Financial Studies, 2009.

[3] Deviations from Put-Call Parity and Stock Return Predictability, Cremers M. and Weinbaum D., Journal of Financial and Quantitative Analysis, 2010.

[4] The Joint Cross Section of Stocks and Options, An B., Ang A., Bali T. and Cakici N., Journal of Finance, 2014.

Information In Volatility Surface (1/2)

Volatility Surface – Call Options^[1]

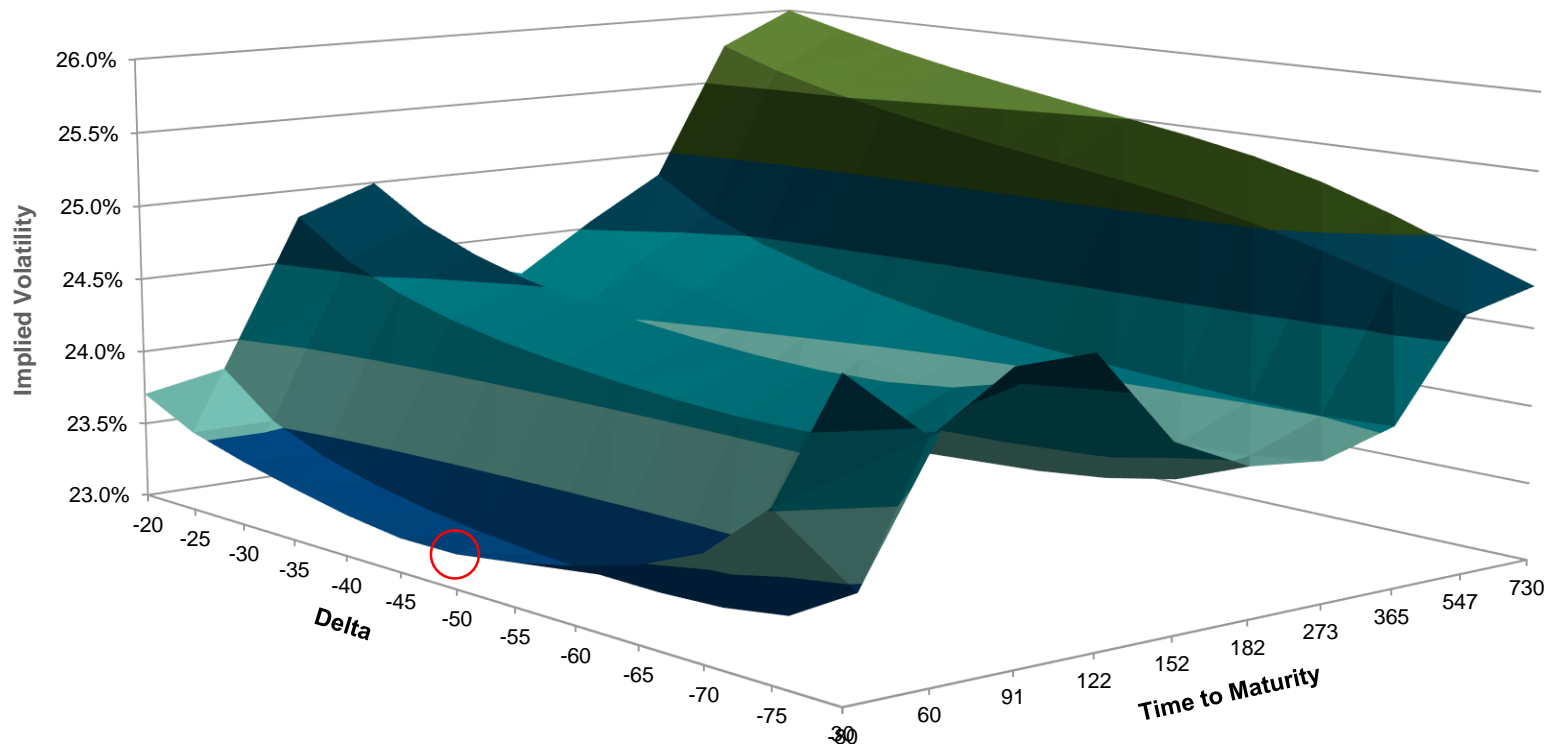


- Information content in Calls \neq Puts
- Implied Volatility tells us something about 'relative' expensiveness
- $CVOL/PVOL$ – Implied volatility $\Delta CVOL / \Delta PVOL$ – Change in implied volatility (information)

[1] Volatility Surface data for Apple Inc., as on January 31, 2014.
Source: OptionMetrics IvyDB.

Information In Volatility Surface (1/2)

Volatility Surface – Put Options^[1]



- Information content in Calls \neq Puts
- Implied Volatility tells us something about 'relative' expensiveness
- $CVOL/PVOL$ – Implied volatility $\Delta CVOL / \Delta PVOL$ – Change in implied volatility (information)

[1] Volatility Surface data for Apple Inc., as on January 31, 2014.
Source: OptionMetrics IvyDB.

Interaction Between Volatilities

Average Firm-Level Correlations^[1]

	CVOL	PVOL	ΔCVOL	ΔPVOL	RVOL	ΔRVOL	RVOL (+1m)	ΔRVOL (+1m)
CVOL	1.00							
PVOL	0.85	1.00						
ΔCVOL	0.39	0.22	1.00					
ΔPVOL	0.23	0.39	0.59	1.00				
RVOL	0.58	0.58	0.10	0.12	1.00			
ΔRVOL	0.06	0.07	0.18	0.22	0.52	1.00		
RVOL (+1m)	0.52	0.52	0.18	0.18	0.44	0.09	1.00	
ΔRVOL (+1m)	-0.05	-0.06	0.09	0.07	-0.51	-0.39	0.53	1.00

- General volatility effect, common to both PVOL and CVOL
- Low correlation of innovations to past volatility

Variables:

CVOL / PVOL – Implied volatilities from the volatility surface

RVOL – Realized volatility, calculated from daily returns over one month period

[1] Pearson correlation; Firms with at least 24 months of data included in the calculation.
Sample period for this study is 01/96 – 12/11, unless otherwise specified.

Predictability Of Stock Returns

Univariate Sorted – Decile Portfolios (Equal Weighted)

Sorting Variable

Result

» $\Delta CVOL$

» $\Delta PVOL$

» $\Delta PVOL - \Delta CVOL$

▪ EW

▪ VW

Decile Portfolios	Avg. Return (per month, %)	Alpha (per month, %)			
		CAPM	FF3	FF5	FF5 + MOM
Low $\Delta CVOL$	0.11	-0.79	-0.93	-0.55	-0.44
2	0.52	-0.28	-0.44	-0.34	-0.27
3	0.64	-0.10	-0.27	-0.19	-0.14
4	0.79	0.06	-0.09	-0.13	-0.09
5	0.92	0.20	0.03	-0.04	0.00
6	0.92	0.19	0.02	-0.01	0.02
7	1.01	0.27	0.10	0.10	0.15
8	1.11	0.34	0.15	0.24	0.29
9	1.11	0.26	0.10	0.23	0.31
High $\Delta CVOL$	1.01	0.04	-0.14	0.20	0.32
10 - 1 Diff.	0.89	0.82	0.78	0.74	0.76
<i>t-stat</i> ^[1]	(2.90)	(2.52)	(2.52)	(2.29)	(2.27)

- Almost monotonic (except for extreme portfolios)
- Robust to factor models

[1] Newey-West t-statistic, calculated with a lag of 6.

FF3: Fama-French Three Factor Model (1993). FF5: Fama-French Five Factor Model (2014). MOM: Carhart Momentum Factor (1997)

Predictability Of Stock Returns

Univariate Sorted – Decile Portfolios (Equal Weighted)

Sorting Variable

Result

» $\Delta CVOL$

» $\Delta PVOL$

» $\Delta PVOL - \Delta CVOL$

▪ EW

▪ VW

Decile Portfolios	Avg. Return (per month, %)	Alpha (per month, %)			
		CAPM	FF3	FF5	FF5 + MOM
Low $\Delta PVOL$	0.70	-0.20	-0.34	-0.05	0.07
2	0.83	0.03	-0.13	0.02	0.09
3	0.84	0.08	-0.08	-0.04	0.02
4	0.90	0.17	0.02	0.00	0.04
5	0.92	0.21	0.03	0.00	0.03
6	1.08	0.36	0.20	0.18	0.22
7	0.89	0.15	-0.02	-0.02	0.01
8	0.87	0.11	-0.07	-0.03	0.03
9	0.87	0.03	-0.16	-0.03	0.05
High $\Delta PVOL$	0.21	-0.74	-0.92	-0.53	-0.39
10 - 1 Diff.	-0.49	-0.55	-0.58	-0.48	-0.45
t-stat^[1]	(2.01)	(-2.24)	(-2.53)	(-1.95)	(-1.82)

▪ No monotonicity; action only in one portfolio (#10)

[1] Newey-West t-statistic, calculated with a lag of 3.

FF3: Fama-French Three Factor Model (1993). FF5: Fama-French Five Factor Model (2014). MOM: Carhart Momentum Factor (1997)

Predictability Of Stock Returns

Univariate Sorted – Decile Portfolios (Equal Weighted)

Sorting Variable

Result

» $\Delta CVOL$

» $\Delta PVOL$

» $\Delta PVOL - \Delta CVOL$

▪ EW

▪ VW

Decile Portfolios	Avg. Return (per month, %)	Alpha (per month, %)			
		CAPM	FF3	FF5	FF5 + MOM
Low $\Delta P - \Delta C$	1.43	0.52	0.32	0.56	0.69
2	1.15	0.33	0.15	0.27	0.37
3	1.01	0.23	0.07	0.16	0.22
4	0.92	0.17	0.03	0.05	0.09
5	0.92	0.19	0.06	0.05	0.07
6	0.92	0.18	0.05	0.05	0.07
7	0.78	0.03	-0.11	-0.07	-0.05
8	0.62	-0.16	-0.34	-0.31	-0.26
9	0.47	-0.34	-0.50	-0.34	-0.25
High $\Delta P - \Delta C$	-0.09	-0.97	-1.18	-0.92	-0.78
10 - 1 Diff.	-1.52	-1.50	-1.50	-1.48	-1.48
t-stat ^[1]	(-6.19)	(-6.11)	(-5.96)	(-5.48)	(-5.53)

- Stronger monotonic pattern – when using combined signal
- Hedge portfolio based on deviation shows widest spread
- Significant excess return (~ 69 to 78bps) in both directions

[1] Newey-West t-statistic, calculated with a lag of 6.

FF3: Fama-French Three Factor Model (1993). FF5: Fama-French Five Factor Model (2014). MOM: Carhart Momentum Factor (1997)

Predictability Of Stock Returns

Univariate Sorted – Decile Portfolios (Value Weighted)

Sorting Variable

Result

» $\Delta CVOL$

» $\Delta PVOL$

» $\Delta PVOL - \Delta CVOL$

▪ EW

▪ VW

Decile Portfolios	Avg. Return (per month, %)	Alpha (per month, %)			
		CAPM	FF3	FF5	FF5 + MOM
Low $\Delta P - \Delta C$	1.44	0.64	0.52	0.67	0.75
2	0.87	0.17	0.11	0.15	0.20
3	1.03	0.33	0.36	0.50	0.52
4	0.89	0.23	0.25	0.23	0.22
5	0.73	0.09	0.09	0.01	-0.03
6	0.68	0.01	0.07	0.03	0.01
7	0.44	-0.20	-0.19	-0.24	-0.24
8	0.33	-0.33	-0.39	-0.40	-0.37
9	0.12	-0.60	-0.66	-0.50	-0.47
High $\Delta P - \Delta C$	-0.09	-0.90	-1.03	-0.78	-0.68
10 - 1 Diff.	-1.53	-1.54	-1.55	-1.46	-1.43
t-stat ^[1]	(-5.64)	(-5.60)	(-5.36)	(-4.96)	(-4.88)

- Performance of hedge portfolio is robust to value-weightings
- Significant excess return (~ 68 to 75bps) in both directions

[1] Newey-West t-statistic, calculated with a lag of 0

FF3: Fama-French Three Factor Model (1993). FF5: Fama-French Five Factor Model (2014). MOM: Carhart Momentum Factor (1997)

Predictability Of Stock Returns

Bivariate Sorted – Decile Portfolios (Equal Weighted)

Sorting Variable	Result												
» $\Delta CVOL$		$\Delta CVOL$ (monthly return, %)										Long-Short	
		1	2	3	4	5	6	7	8	9	10	10 - 1	<i>t-stat</i>
» $\Delta PVOL$	$\Delta PVOL1$	0.03	0.51	-0.01	0.64	0.58	0.89	0.94	1.22	0.71	1.52	1.49	(3.24)
	$\Delta PVOL2$	0.15	0.69	0.48	0.45	0.67	1.03	1.03	0.76	1.30	1.72	1.57	(3.67)
	$\Delta PVOL3$	0.23	0.46	0.93	0.40	1.05	0.71	0.74	1.28	0.78	1.78	1.55	(4.21)
	$\Delta PVOL4$	0.49	0.31	0.41	1.14	0.74	0.83	0.94	0.88	1.35	1.96	1.47	(4.13)
	$\Delta PVOL5$	0.48	0.36	0.67	1.07	0.89	1.34	0.81	1.05	1.09	1.40	0.91	(3.34)
	$\Delta PVOL6$	0.64	0.94	1.05	0.97	0.92	1.05	1.27	1.13	1.35	1.51	0.88	(2.06)
	$\Delta PVOL7$	-0.07	0.47	0.55	1.05	0.97	0.78	1.28	1.05	1.27	1.51	1.58	(3.89)
	$\Delta PVOL8$	0.43	0.56	0.89	0.93	0.56	0.91	1.06	0.88	1.17	1.35	0.93	(2.24)
	$\Delta PVOL9$	0.16	0.14	0.31	1.11	0.97	0.54	1.28	1.12	1.46	1.61	1.45	(4.22)
	$\Delta PVOL10$	-0.81	-0.12	-0.45	0.43	0.91	0.84	0.64	0.40	0.85	-0.61	0.21	(0.44)
		Average										1.20	(5.78)
		FF5 + MOM										1.16	(4.67)

- General trend is consistent; most deciles are individually significant
- ΔCVOL contains independent information

[1] Newey-West t-statistics, calculated with lag of {0,0,0,2,9,7,0,0,6,9} for respective Long-Short portfolios and of {6} for regressions on factor models.
 FF5: Fama-French Five Factor Model (2014). MOM: Carhart Momentum Factor (1997)

Predictability Of Stock Returns

Bivariate Sorted – Decile Portfolios (Equal Weighted)

Sorting Variable

Result

» $\Delta CVOL$

» $\Delta PVOL$

	$\Delta PVOL$ (monthly return, %)										Long-Short	
	1	2	3	4	5	6	7	8	9	10	10 - 1	t-stat
$\Delta CVOL1$	0.47	0.53	-0.01	0.13	0.28	0.32	0.17	-0.07	-0.19	-0.49	-0.96	(-2.19)
$\Delta CVOL2$	1.00	1.07	0.92	0.42	0.25	0.28	0.62	0.20	0.30	0.19	-0.81	(-1.90)
$\Delta CVOL3$	1.08	0.84	0.83	0.71	0.53	0.60	0.59	0.30	0.39	0.54	-0.53	(-1.35)
$\Delta CVOL4$	1.04	0.80	0.90	0.91	0.83	0.54	0.74	0.99	0.51	0.60	-0.44	(-1.36)
$\Delta CVOL5$	1.54	1.26	0.89	0.99	1.02	0.92	0.86	0.79	0.77	0.09	-1.45	(-4.00)
$\Delta CVOL6$	0.90	0.61	0.99	0.74	1.35	1.15	0.95	1.34	0.73	0.39	-0.50	(-1.26)
$\Delta CVOL7$	1.07	0.91	1.26	1.38	0.89	1.10	1.06	1.12	0.73	0.54	-0.53	(-1.42)
$\Delta CVOL8$	1.58	1.55	1.19	1.23	0.88	0.76	1.11	1.14	1.33	0.33	-1.25	(-3.16)
$\Delta CVOL9$	1.12	1.74	1.19	1.07	1.21	1.31	1.34	0.78	1.04	0.24	-0.88	(-1.84)
$\Delta CVOL10$	1.61	1.69	1.50	1.35	1.33	1.56	0.75	0.93	0.26	-0.93	-2.53	(-3.91)
Average											-0.99	(-5.97)
FF5 + MOM											-0.97	(-5.57)

- General trend is consistent; individual deciles not very robust
- $\Delta PVOL$ contains independent information

[1] Newey-West t-statistics, calculated with lag of {0,0,0,0,0,10,0,9,6,8} for respective Long-Short portfolios and of {0} for regressions on factor models.
FF5: Fama-French Five Factor Model (2014). MOM: Carhart Momentum Factor (1997)

Is There An Underlying Characteristic Driving This Spread?

Portfolio Characteristics – Controlling for $\Delta PVOL$

		$\Delta CVOL1$	2	3	4	5	6	7	8	9	$\Delta CVOL10$
Monotonicity in returns and alpha											
RETURN (%)	t+1	0.17	0.43	0.48	0.82	0.83	0.90	1.00	0.98	1.13	1.38
FF5+MOM	t+1	-0.52	-0.36	-0.34	0.02	-0.01	0.08	0.17	0.16	0.30	0.64

No discernible pattern

BETA	t	1.15	1.10	1.04	1.05	1.02	1.03	1.04	1.05	1.09	1.14
SIZE	t	6.24	6.91	7.26	7.46	7.55	7.56	7.45	7.25	6.92	6.23
B/M	t	0.45	0.44	0.42	0.41	0.41	0.41	0.41	0.42	0.43	0.46

U-shaped

MOM	t	-4.36	4.14	7.13	9.03	10.21	10.41	10.29	9.15	7.07	0.04
ILLIQ	t	0.11	0.05	0.03	0.03	0.02	0.02	0.03	0.03	0.05	0.13
SKEW	t	0.32	0.26	0.23	0.22	0.22	0.22	0.23	0.23	0.24	0.28
COSKEW	t	-2.12	-1.39	-0.92	-0.72	-0.73	-0.68	-0.81	-0.84	-1.37	-2.12

Can Reversal be driving this? – probably not, inconsistent between call/put sorted portfolios

REV	t	3.66	2.28	1.74	1.18	0.77	0.31	-0.19	-0.88	-1.79	-4.10
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Consistent with definition

QSKEW	t	6.23	5.27	4.82	4.51	4.28	4.15	4.03	3.91	3.60	1.86
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ALPHA: FF5 + MOM factor model. **BETA:** Using daily returns over last 1 month. **SIZE:** Log of Market Cap. **B/M:** Book to Market. **MOM:** Cumulative return over last 11 months. **REV:** Return in the portfolio formation month. **ILLIQ:** See Amihud (2002). **SKEW:** Realized skewness in one year of daily returns. **COSKEW:** Realized co-skewness with market (daily returns for one year). **QSKEW:** Risk-neutral skewness (calculated from volatility surface).

Is There An Underlying Characteristic Driving This Spread?

Portfolio Characteristics – Controlling for $\Delta CVOL$

		$\Delta PVOL1$	2	3	4	5	6	7	8	9	$\Delta PVOL10$
Monotonicity in returns and alpha											
RETURN (%)	t+1	1.14	1.10	0.97	0.89	0.86	0.86	0.82	0.75	0.59	0.15
FF5+MOM	t+1	0.41	0.31	0.21	0.12	0.02	0.03	-0.01	-0.10	-0.28	-0.56

No discernible pattern

BETA	t	1.10	1.08	1.04	1.02	1.03	1.04	1.03	1.08	1.11	1.17
SIZE	t	6.25	6.90	7.22	7.42	7.54	7.51	7.46	7.26	6.95	6.28
B/M	t	0.46	0.43	0.42	0.42	0.41	0.41	0.41	0.42	0.43	0.46

U-shaped

MOM	t	-2.02	5.42	7.92	9.50	9.90	9.94	9.67	8.85	5.93	-1.97
ILLIQ	t	0.11	0.05	0.03	0.03	0.02	0.02	0.03	0.03	0.05	0.11
SKEW	t	0.31	0.26	0.24	0.23	0.22	0.22	0.21	0.23	0.24	0.29
COSKEW	t	-2.24	-1.28	-1.01	-0.82	-0.72	-0.68	-0.85	-0.96	-1.17	-2.13

Can Reversal be driving this? – probably not, inconsistent between call/put sorted portfolios

REV	t	0.52	0.70	0.73	0.75	0.61	0.58	0.53	0.29	-0.34	-1.44
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Consistent with definition

QSKEW	t	3.78	4.01	4.05	4.10	4.11	4.22	4.37	4.55	4.79	5.40
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ALPHA: FF5 + MOM factor model. **BETA:** Using daily returns over last 1 month. **SIZE:** Log of Market Cap. **B/M:** Book to Market. **MOM:** Cumulative return over last 11 months. **REV:** Return in the portfolio formation month. **ILLIQ:** See Amihud (2002). **SKEW:** Realized skewness in one year of daily returns. **COSKEW:** Realized co-skewness with market (daily returns for one year). **QSKEW:** Risk-neutral skewness (calculated from volatility surface).

When Is Information Impounded In Option Prices?

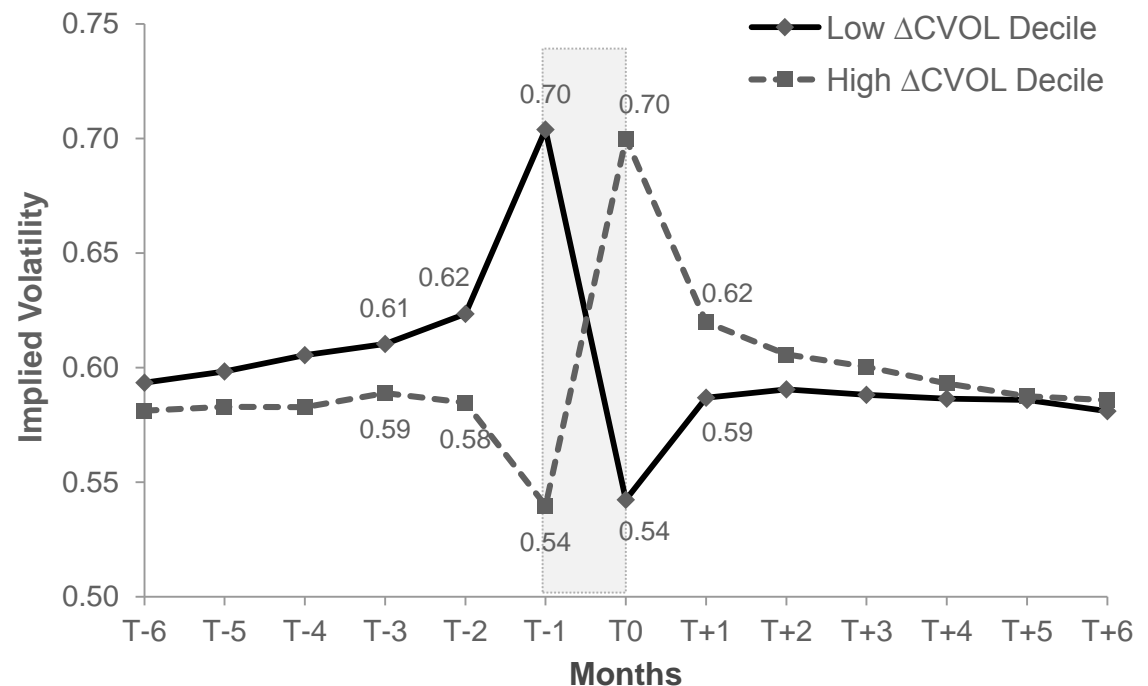
Implied Volatilities in the Pre- and Post- Formation Months

Controlling For

» $\Delta PVOL$

» $\Delta CVOL$

Result



- Informed traders move option prices today; no further adjustment
- Stock market adjusts over next month

When Is Information Impounded In Option Prices?

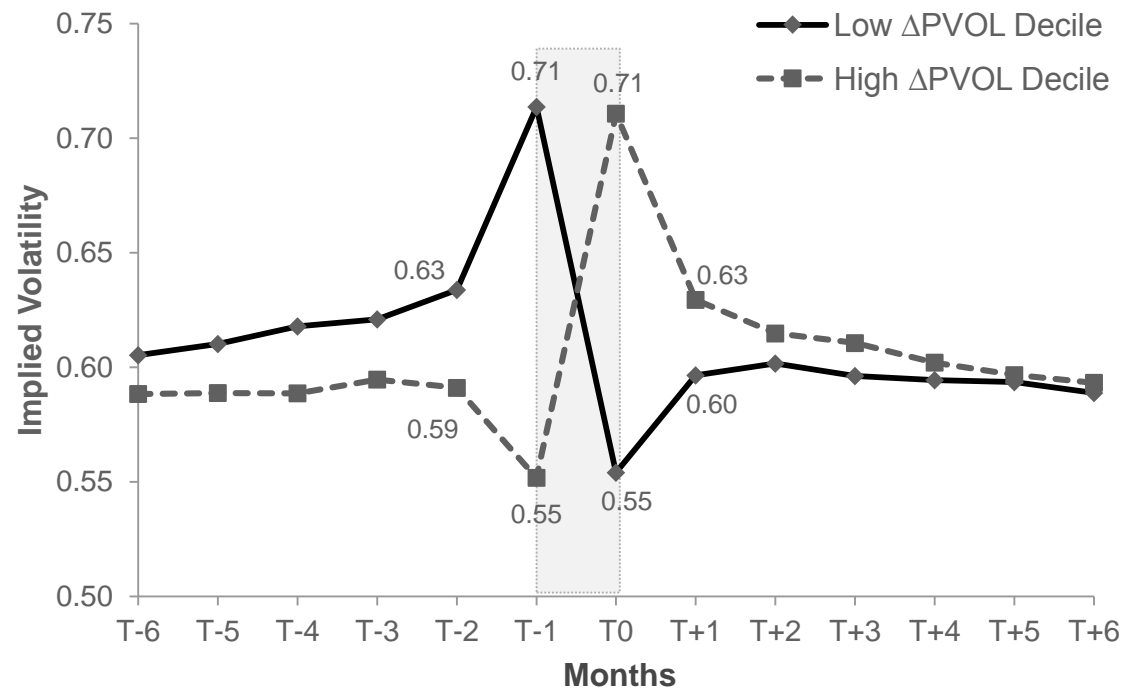
Implied Volatilities in the Pre- and Post- Formation Months

Controlling For

» $\Delta PVOL$

» $\Delta CVOL$

Result



- Informed traders move option prices today; no further adjustment
- Stock market adjusts over next month

How Long Does Predictability Last?

Incremental Return each Subsequent Month

	1-Month	2-Month	3-Month	4-Month	5-Month	6-Month
Ranking on ΔCVOL controlling for ΔPVOL						
Average return diff. (%)	1.20	-0.12	0.11	0.01	0.14	0.07
<i>t-stat</i>	(5.77)	(-0.68)	(0.62)	(0.09)	(0.83)	(0.44)
FF3 Alpha diff. (%)	1.14	-0.13	0.12	0.01	0.11	0.06
<i>t-stat</i>	(5.20)	(-0.76)	(0.71)	(0.08)	(0.71)	(0.38)
Ranking on ΔPVOL controlling for ΔCVOL						
Average return diff. (%)	-0.99	0.00	-0.08	0.03	-0.04	0.17
<i>t-stat</i>	(-5.98)	(0.01)	(-0.47)	(0.18)	(-0.30)	(0.94)
FF3 Alpha diff. (%)	-1.01	0.00	-0.08	0.06	-0.03	0.16
<i>t-stat</i>	(-6.08)	(0.02)	(-0.49)	(0.45)	(-0.20)	(0.96)

- Predictability in stock returns does not stretch beyond first month
- This is in contrast with the authors' result, wherein they claim predictability over longer horizon

[1] Newey-West t-statistics for long-short portfolio calculated with lag of {6,0,8,10,0,0} when controlling for Δ PVOL, and {0,0,2,0,5,10} when controlling for Δ CVOL
 FF3: Fama-French Three Factor Model (1993).

Predictive Power In Stocks?

Predicting the Cross Section of Implied and Realized Volatilities (Fama – MacBeth regression)

	$t+1$	ΔCVOL	ΔPVOL	$\Delta\text{CVOL} - \Delta\text{PVOL}$	ΔRVOL	
Stock's Alpha	t	3.52 (7.7)	1.75 (4.3)	1.78 (6.4)	-15.54 (-8.7)	<ul style="list-style-type: none"> ALPHA: predictability higher for call vs. puts Intuition: informed traders trade both stock & options; thereby resolving some uncertainty
BETA	t	0.06 (1.9)	0.05 (1.0)	0.01 (0.3)	1.95 (5.8)	
SIZE	t	-0.01 (-0.1)	-0.05 (-1.5)	0.04 (1.0)	-3.89 (-45.2)	
BM	t	-0.16 (-2.3)	-0.09 (1.5)	-0.07 (-2.2)	-2.63 (-4.7)	
MOM	t	0.06 (0.7)	0.09 (1.1)	-0.03 (-0.6)	0.48 (0.6)	
ILLIQ	t	0.40 (4.0)	0.22 (2.5)	0.17 (2.0)	1.45 (6.2)	
RVOL	t	-1.89 (-6.3)	-2.27 (-7.8)	0.38 (1.8)	-63.61 (-33.2)	<ul style="list-style-type: none"> RVOL: subsequent drop in ImpVol; investors overreact^[1]
ΔOI (Calls)	t	-0.86 (-2.2)	-0.75 (-2.4)	-0.11 (-0.7)	-0.68 (-1.3)	
ΔOI (Puts)	t	-0.79 (-2.8)	-0.55 (-1.4)	-0.25 (-1.2)	1.39 (2.2)	
QSKEW	t	27.12 (13.8)	-5.27 (-3.0)	32.39 (9.5)	-6.24 (-2.5)	<ul style="list-style-type: none"> QSKEW: implies reversion
R ²	t	7.64 (12.4)	5.01 (9.1)	7.42 (15.8)	35.17 (42.0)	

ALPHA: Sum of daily idiosyncratic stock return over 1 month. BM: Log book-to-market. OI: Open Interest in options. [1] Consistent with Goyal & Saretto (2009).

Predictive Power In Stocks?

Univariate Sorted – Decile Portfolios (Equal Weighted)

Sorting Variable

Result

» Stock Alpha

Decile Portfolios	ΔCVOL	$\Delta\text{CVOL} - \Delta\text{PVOL}$	ΔRVOL	ΔPVOL
Low Alpha	-1.32	-0.84	-0.95	-0.48
2	-0.53	-0.46	3.57	-0.07
3	-0.29	-0.22	3.47	-0.07
4	-0.09	-0.02	2.79	-0.06
5	0.03	-0.04	2.45	0.07
6	0.20	0.11	1.85	0.09
7	0.34	0.28	1.28	0.06
8	0.32	0.16	0.18	0.16
9	0.64	0.46	-2.20	0.18
High Alpha	0.40	0.66	-14.12	-0.27
10 - 1 Diff.	1.72	1.51	-13.18	0.22
<i>t-stat¹¹</i>	(6.55)	(6.24)	(8.00)	(1.09)

- Consistent with results from Fama-MacBeth regression
- ΔCVOL shows monotonicity, however ΔPVOL does not show any meaningful trend
- ImpVol proxies 'relative' richness/cheapness – what about \$ value?

Testing With Actual Option Price Data

Univariate Sorted – Quintile Portfolios (Equal Weighted)

CALL options

Portfolio Rank	Avg. Stock Alpha	Mid Point (Bid+Offer)/2	Price Taker (exercise)		Price Taker (close-posn.)		Market Maker	
			Buyer	Seller	Buyer	Seller	Seller	Buyer ^[1]
0	-16%	10.3%	-10.3%	-30.2%	-16.5%	-63.2%	16.5%	63.2%
1	-4%	15.6%	-5.3%	-35.4%	-11.7%	-68.1%	11.7%	68.1%
2	1%	12.5%	-8.5%	-32.4%	-14.9%	-67.8%	14.9%	67.8%
3	6%	6.8%	-12.6%	-24.7%	-18.8%	-56.9%	18.8%	56.9%
4	18%	-4.7%	-22.7%	-8.0%	-28.0%	-39.9%	28.0%	39.9%

Performance of Hedge Portfolio (0-4)



- Impact from Bid-Ask spread turns any +ve return to -ve return
- Price taker earns -ve return either buying or shorting a portfolio (quintile or hedge)
- Impact from spread is higher for options that are further OTM or illiquid

[1] Possible explanation might be that end-buyers are net short individual stock options, so market maker earn premium for providing liquidity (see Gârleanu et al., 2009)

Testing With Actual Option Price Data

Univariate Sorted – Quintile Portfolios (Equal Weighted)

PUT options

Portfolio Rank	Avg. Stock Alpha	Mid Point (Bid+Offer)/2	Price Taker (exercise)		Price Taker (close-posn.)		Market Maker	
			Buyer	Seller	Buyer	Seller	Seller	Buyer ^[1]
0	-16%	2.6%	-14.6%	-12.6%	-19.5%	-39.7%	19.5%	39.7%
1	-4%	2.1%	-13.4%	-14.1%	-20.2%	-40.8%	20.2%	40.8%
2	0%	3.5%	-14.0%	-15.3%	-19.3%	-44.7%	19.3%	44.7%
3	5%	0.2%	-16.2%	-8.4%	-20.9%	-36.3%	20.9%	36.3%
4	17%	3.2%	-11.8%	-13.3%	-17.3%	-36.5%	17.3%	36.5%

Performance of Hedge Portfolio (4-0)



- Impact from Bid-Ask spread turns any +ve return to –ve return
- Price taker earns –ve return either buying or shorting a portfolio (quintile or hedge)
- Impact from spread is higher for options that are further OTM or illiquid

[1] Possible explanation might be that end-buyers are net short individual stock options, so market maker earn premium for providing liquidity (see Gârleanu et al., 2009)

Conclusions

- » Information from option market predicting stock return
 - » Meaningful predictability exists (consistent with previous literature)
 - » Outperformance is robust to popular factor models
 - » However, as suspected, part of the action is driven by relatively small and illiquid stocks
 - » We could look at more sophisticated ways of extracting information from the volatility surface to develop better signal
- » Information from stock market predicting option return
 - » 'In principle' some predictability exists
 - » Option dollar returns, however,, are compounded by time decay, dynamic delta, volatility exposure compensation (severe in case of ATM options) etc.
 - » Bid-ask spread has a significant negative impact on dollar returns



Appendix

Does Predictability Vary By Stock Characteristic?

Equal Weighted – Controlling For Stock Characteristic

SIZE	$\Delta\text{CVOL (sort)}$				$\Delta\text{CVOL spread}^{[1]}$	$\Delta\text{Volume}^C / \text{Volume}^C^{[2]}$	ILLIQ	$\Delta\text{CVOL (sort)}$				$\Delta\text{CVOL spread}$	$\Delta\text{Volume}^C / \text{Volume}^C$
	0	4	4-0	t-stat				0	4	4-0	t-stat		
0	-0.05	1.02	1.07	(3.54)	0.46	3.40%	0	0.41	1.16	0.75	(2.49)	0.18	1.36%
1	0.47	1.25	0.77	(3.08)	0.32	2.39%	1	0.64	0.74	0.10	(0.44)	0.21	1.78%
2	0.33	0.87	0.54	(2.19)	0.25	1.90%	2	0.35	0.84	0.50	(1.83)	0.25	1.97%
3	0.63	1.06	0.43	(1.75)	0.21	1.98%	3	0.25	1.22	0.96	(3.41)	0.31	2.33%
4	0.44	0.84	0.40	(1.53)	0.15	1.66%	4	0.01	1.16	1.15	(3.12)	0.44	3.88%

SIZE	$\Delta\text{PVOL (sort)}$				$\Delta\text{PVOL spread}$	$\Delta\text{Volume}^P / \text{Volume}^P$	ILLIQ	$\Delta\text{PVOL (sort)}$				$\Delta\text{PVOL spread}$	$\Delta\text{Volume}^P / \text{Volume}^P$
	0	4	4-0	t-stat				0	4	4-0	t-stat		
0	0.68	0.13	-0.55	(-2.00)	0.46	3.12%	0	0.77	0.95	0.18	(0.61)	0.17	1.13%
1	1.14	0.50	-0.64	(-2.09)	0.31	2.13%	1	0.85	0.54	-0.30	(-1.33)	0.21	1.57%
2	0.61	0.67	0.06	(0.23)	0.25	1.78%	2	0.73	0.54	-0.19	(-0.75)	0.25	1.88%
3	0.86	0.83	-0.03	(-0.11)	0.20	1.72%	3	0.76	0.51	-0.25	(-1.07)	0.31	2.16%
4	0.64	0.61	-0.03	(-0.09)	0.15	1.53%	4	0.87	0.20	-0.66	(-2.50)	0.44	3.56%

» As firm size and liquidity increase:

- Spread in implied volatility innovations, and change in volume reduce
- Return on long-short portfolio of stocks reduce

[1] Spread in innovations is between portfolios with extreme rank. [2] %age change in volume is average for all portfolios with same level of control variable.

Do Other Points On The Volatility Surface Tell A Different Story?

Univariate Sorted – Decile Portfolios (Equal Weighted)

Other Points on Volatility Surface		Ranked Portfolios										Hedge Portfolio Performance	
		1	2	3	4	5	6	7	8	9	10	10-1	t-stat ^[1]
Delta	Days	Ranked by $\Delta CVOL$											
0.5	30	0.11	0.52	0.64	0.79	0.92	0.92	1.01	1.11	1.11	1.01	0.89	2.90
0.2	30	0.29	0.44	0.61	0.75	0.87	0.92	1.12	1.08	1.14	0.89	0.60	2.08
0.8	30	0.18	0.40	0.69	0.74	0.94	0.86	1.07	1.09	1.12	1.03	0.86	3.08
0.2	91	0.33	0.60	0.59	0.79	0.85	1.03	0.96	0.99	1.05	0.93	0.60	2.38
0.5	91	0.12	0.47	0.55	0.75	0.97	0.95	0.97	1.13	1.09	1.12	1.00	3.69
Delta	Days	Ranked by $\Delta PVOL$											
0.5	30	0.70	0.83	0.84	0.90	0.92	1.08	0.89	0.87	0.87	0.21	-0.49	-2.01
0.2	30	0.69	0.78	0.74	1.02	0.83	0.98	0.94	0.90	0.90	0.34	-0.35	-1.42
0.8	30	0.71	0.85	0.93	1.04	0.91	0.99	0.88	0.97	0.65	0.18	-0.53	-2.55
0.2	91	0.69	0.70	0.87	0.86	0.85	1.00	0.94	0.91	0.95	0.34	-0.35	-1.56
0.5	91	0.55	0.88	0.76	1.01	0.90	1.00	0.85	1.00	0.83	0.34	-0.21	-0.90
Delta	Days	Ranked by $\Delta PVOL - \Delta CVOL$											
0.5	30	1.43	1.15	1.01	0.92	0.92	0.92	0.78	0.62	0.47	-0.09	-1.52	-6.19
0.2	30	1.14	1.02	1.06	0.98	0.95	0.82	0.83	0.72	0.58	0.02	-1.12	-5.32
0.8	30	1.16	1.05	1.10	0.90	0.99	0.93	0.76	0.64	0.51	0.09	-1.07	-5.41
0.2	91	1.07	1.07	0.82	1.02	0.92	0.85	0.74	0.94	0.45	0.24	-0.84	-5.20
0.5	91	1.42	1.18	0.94	0.95	0.95	0.89	0.75	0.60	0.54	-0.10	-1.52	-6.51

- We get similar spread in case we use other points on the Volatility Surface

[1] Newey-West t-statistics for long-short portfolio calculated with lag of {6,2,6} for $\Delta CVOL$, $\Delta PVOL$ and $\Delta PVOL - \Delta CVOL$ ranked portfolios respectively.

Sample Period For This Study: 1996 - 2011

Descriptive Statistics For Implied Volatilities

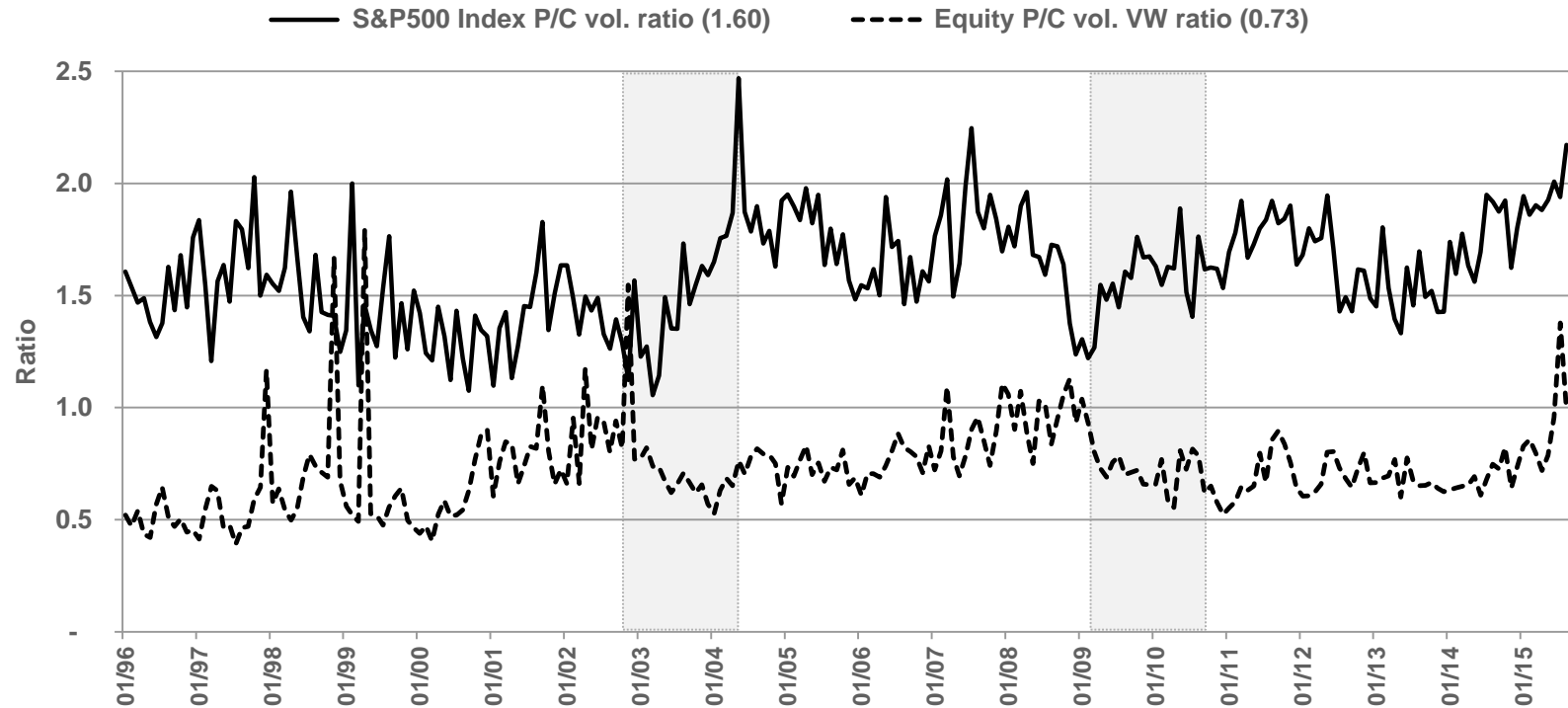
Year	Stocks	CVOL		PVOL	
		Avg.	Std.	Avg.	Std.
1996	1,687	44.0	21.6	44.9	21.8
1997	1,999	46.3	21.5	46.9	21.0
1998	2,226	52.9	24.9	53.2	24.2
1999	2,263	59.4	25.7	60.2	25.5
2000	2,029	74.1	33.8	75.2	33.7
2001	1,861	63.9	30.8	66.1	32.3
2002	1,862	55.8	25.4	57.1	27.6
2003	1,771	43.9	19.9	44.4	20.0
2004	1,883	39.4	18.6	40.2	19.3
2005	2,010	37.5	19.2	38.5	19.5
2006	2,100	37.7	18.0	38.5	18.4
2007	2,215	40.1	19.8	40.9	20.4
2008	2,168	60.5	28.6	63.0	31.4
2009	2,104	60.2	28.3	60.0	28.0
2010	2,207	46.8	23.7	46.2	24.3
2011	2,316	48.3	26.1	49.0	27.4
Avg.	2,044	50.7	24.1	51.5	24.7

- » Average of 2,000 firms in a year
- » Spike in volatility during 2000 and 2008
- » Data corresponding to options with delta of 50 and 30 days to expiry, on the volatility surface
- » Includes shares with share code 10 and 11

Source: OptionMetrics Ivy DB.

General Trend: Volume & Open Interest (1/2)

Put/Call Ratio For Monthly Trading Volumes

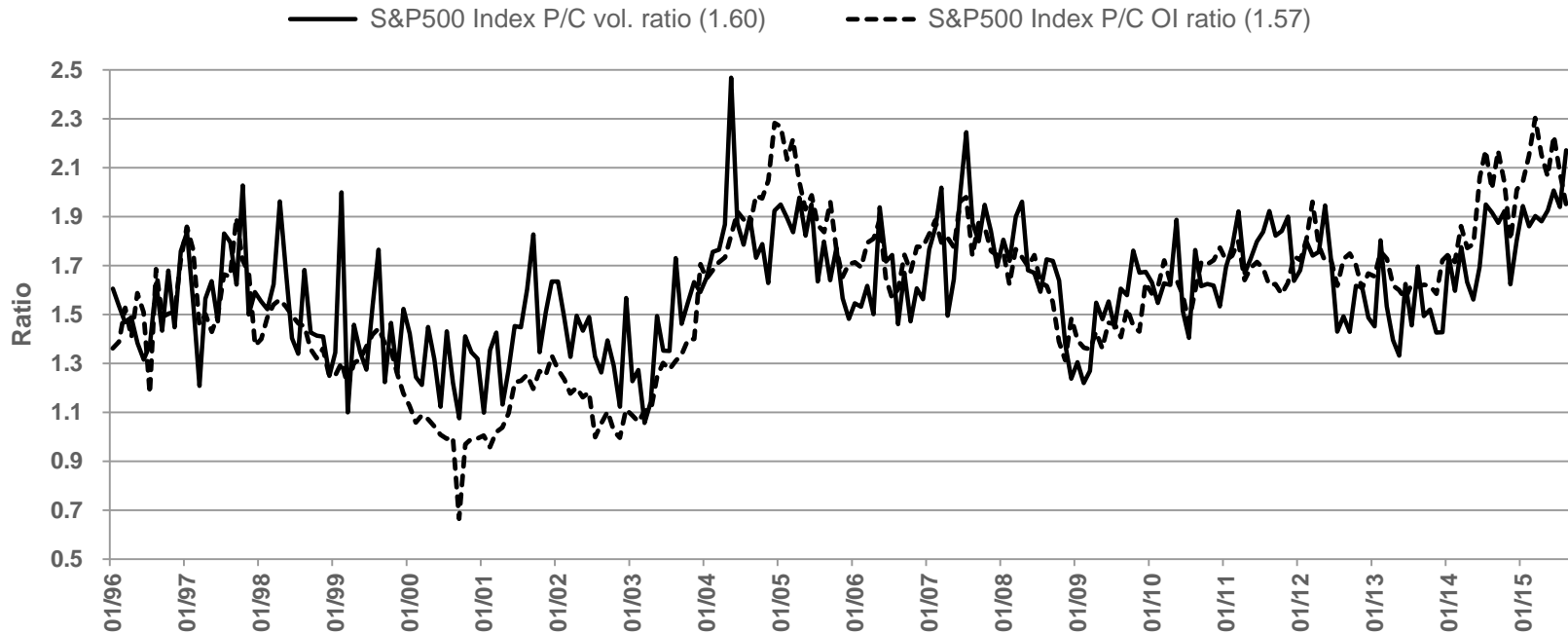


- » More demand for puts on the Index – hedging needs
- » In contrast to index options, stock options witness larger trading volume in call options
- » After market declines: Index put options are bid up; for individual options, however, call options are bid up^[1]

[1] Cremers and Weinbaum (2010)

General Trend: Volume & Open Interest (1/2)

S&P500 Index P/C Ratio – Traded Volume vs. Open Interest^[1]



» P/C ratio for open interest largely mimics the ratio of traded volume

[1] Calculated end of month.



II. Working With OptionMetrics IvyDB

Looking Under-the-hood

VOLATILITY SURFACE DATA

VOLATILITY_SURFACE

SECURITYID: int DATE: smalldatetime DAYS: int DELTA: int
CALLPUT: char(1) IMPLIEDVOLATILITY: real IMPLIEDSTRIKE: real IMPLIEDPREMIUM: real DISPERSION: real

- SecurityID is unique identifier for security – akin to PERMNO
- Frequency: daily data
- Multiple values for Delta (13x) and Days (10x) - *select values to restrict dimensions of data*
- Delta is +ve for Calls and –ve for Puts
- Data is stored in monthly data files – *need a loop to pull data*
- Implied Volatility can exist without trading volume

Exhibit: 1.1

SECURITY

SECURITYID: int
CUSIP: char(8) TICKER: char(6) SIC: char(4) INDEXFLAG: char(1) EXCHANGEFLAGS: int CLASS: char(1) ISSUETYPE: char(1) INDUSTRYGROUP: char(3)

- Latest information for each SecurityID (1 obs. per SecID)
- CUSIP attribute is the current value – **do not use this**
- IssueType (~ShrCd) and IndexFlag is to identify index securities. However, there are still many cases of incorrect categorization – **currently not robust, do not use these**
- **Use CRSP ShrCd & Exchcd to filter relevant securities**
- This table is currently redundant, but may be useful in future, once robust

Exhibit: 2.1 – 2.6

SECURITY_NAME

SECURITYID: int DATE: smalldatetime
CUSIP: char(8) TICKER: char(6) CLASS: char(1) ISSUERDESCRIPTION: char(28) ISSUEDESCRIPTION: char(20) SIC: char(4)

- Tracks historical changes to **CUSIP**, ticker, issuer etc.
- CUSIPs will be the matching key between this dataset and CRSP dataset
- DATE helps to identify the period during which the information was relevant
- Reading Issue and Issuer Description is useful in understanding the nature of SecurityID in certain cases

Exhibit: 3.1

MODIFIED LINKING TABLE

Primary Key:
PERMNO + Year + Month

Add CUSIPs from CRSP monthly data file

1-to-1 map b/w PERMNO & CUSIP

- In general, 1 PERMNO can be linked to multiple CUSIPs, but not vice-versa
- However, these instances will be over non-overlapping periods of time
- i.e., CUSIP & PERMNO have 1-to-1 mapping at **any point in time**
- This allows us to map CUSIPs with PERMNOs
- CRSP's monthly data file has CUSIP values that are actual 'point-in-time' values

Exhibit: 4.1 – 4.3

VOLATILITY_SURFACE

1.1 – GENERAL COMMENTS

» Dimensionality:

- Data exists for multiple values for
 1. Time to Expiry (30,60,91,122,152,182,273,365,547, & 730 calendar days)
 2. Moneyness (delta ranges from 20 to 80 in intervals of 5; +ve for Calls and –ve for Puts)
- In the code, we restrict for these two dimensions by specifying specific values for them

» Implied Volatility (IV):

- OptionMetrics uses binomial tree model using Cox, Ross, and Rubinstein, to calculate Implied Volatility
- Proprietary pricing algorithm uses advanced techniques to achieve convergence in a fraction of the processing time required by the standard CRR model.
- Set to –99.99 if an insufficient number of option data points are available to perform the interpolation
- Trading volume is not required to calculate Implied Volatility, simple valid quotes (for option contracts)

» Implied Greeks:

- Based on estimated Implied Volatility; cannot exist without valid value for Implied Volatility

» OptionMetrics comments:

- IvyDB US is now in version 3.0 and periodically makes improvements to its volatility calculation methodology to ensure the most accurate and least “noisy” surfaces possible – ***this can change historical data***
- IV in Volatlity_Surface data file is derived from IV estimated for underlying contracts: first step is to calculate the implied volatility on each contract in Option_Price table. The next step is to generate the surface based on the options in Option_Price table

VOLATILITY_SURFACE

1.2 – CASES OF MISSING SECURITYID

- » Few (3 cases) SecurityIDs in the Volatility Surface data file were found to have no/blank header information

SecurityID	Date	Delta	Days	IV
11769	11/29/2013	-50	30	-99.99
11769	12/31/2013	-50	30	-99.99
1128515	02/26/2010	-50	30	-99.99
104327	07/31/2000	-50	30	0.34
104327	08/31/2000	-50	30	0.34
...
104327	11/29/2013	-50	30	0.18
104327	12/31/2013	-50	30	0.24

Missing information in Security datafile

SecurityID	CUSIP	Ticker	SIC	IndexFlag	ExchangeFlags	Class	IssueType
104327	<blank>			0	1		0

» **Issue:**

- SecurityID 11769 and 1128515 do not have any information
- SecurityID 104327 has historical information (in Security_Name), but the most recent entry has a <blank> CUSIP

» **Clarification from OptionMetrics:**

- Due to the incorrect information from the vendor, CUSIP was missing from the Security table for Securityid=104327. SecurityID =104327 information has been updated and the changes are now in production
- Information for 11769 and 1128515 have been removed from the Volatility_Surface table
- These updates will be available in the new IvyDB release scheduled for October 2015

SECURITY

2.1 – ISSUE TYPE

» Incorrect IssueType

Example from Security datafile

Cross checked in Security_Name datafile

SecurityID	CUSIP	Ticker	Company	Index Flag	Exchange Flags	Issue Type	IssuerDescription	IssueDescription
147684	90138A10	VNET	7379	0	4	0	21VIANET GROUP INC	SPONSORED ADR
147804	47737410	DATE	7299	0	4	0	JIAYUAN COM INTL LTD	SPONSORED ADR
148059	39843840	GRFS	2833	0	4	0	GRIFOLS S A	SP ADR REP B NVT
148643	12640Y20	CSRE	3674	0	4	0	CSR PLC	SPONSORED ADR
162295	74735M10	QIWI	6099	0	4	0	QIWI PLC	SPON ADR REP B
189594	22671810	CRTO	7389	0	4	0	CRITEO S A	SPONS ADS
189669	74906P10	QUNR	6799	0	4	0	QUNAR CAYMAN IS LTD	SPNS ADR CL B
102276	67555N20	OCLR	3674	0	4	0	OCLARO INC	COM NEW
112253	D1668R12	DAI	3711	0	0	0	DAIMLER AG	REG SHS
122338	90130A20	FOX	2711	0	4	0	TWENTY FIRST CENTY FOX INC	CL B

- » IssueType field was added in version 2.5, and is still being updated
- » Examples above, are where Securities have been incorrectly marked '0' (IssueType code for Common Stock), while it should have been 'F' (for ADR/ADS)
- » IssueType allows for <blank> values, where research has not been completed – ***such <blank> values may be categorized into any other bucket once the research is complete***
- » These cases were highlighted to OptionMetrics and were subsequently corrected
- » Avoid using flags provided in Security data file; use flags from CRSP data instead

SECURITY

2.2 – ISSUE TYPE

» Incorrect IssueType

SecurityID	CUSIP	Ticker	Company	Issue Description	Issue Type	Index Flag	Exchange Flags
101254	01903Q10	ALLC	ALLIED CAPITAL CP		7	0	0
107346	58392810	TAXI	MEDALLION FINL CORP	COM	7	0	4
122851	74440J10	PSDV	PSIVIDA CORP	COM	F	0	4
146290	55933J20	MX	MAGNACHIP SEMICONDUCTOR CORP	COM	F	0	1
148154	69835410	P	PANDORA MEDIA INC	COM	F	0	1
166807	40416M10	HDS	HD SUPPLY HLDGS INC	COM	7	0	4

» Issue:

- Some securities have conflicting IssueType in OptionMetrics when compared with CRSP header information, e.g. securities shown above, have Issue Type marked as '7' or 'F' in OptionMetrics, while CRSP shows these securities to be of type 'common equity'. This was further corroborated by checking for these online

» Clarification from OptionMetrics:

- The 'IssueType' field value for these cases have been updated to common equity

[1] Email dated July 14.

SECURITY

2.3 – ISSUE TYPE

- » Changes to IssueType are not tracked

SecurityID	CUSIP	Ticker	SIC	Index Flag	Exchange Flags	Class	Issue Type	IndustryGroup
102276	67555N20	OCLR	3674	0	4		0	834

SecurityID	Date	CUSIP	Ticker	Class	IssuerDescription	IssueDescription
102276	4/11/2000	09856Q10	BKHYM		BOOKHAM TECHNOLOGY PLC	SPONSORED ADR
102276	11/28/2000	09856Q10	BKHYM		BOOKHAM TECHNOLOGY PLC	SPONSORED ADR
102276	8/9/2001	09856Q10	BKHYM		BOOKHAM TECHNOLOGY PLC	SPONSORED ADR
102276	9/10/2004	09856E10	BKHM		BOOKHAM INC	COM
102276	6/30/2006	09856E10	BKHM		BOOKHAM INC	COM
102276	4/28/2009	67555N10	OCLR		OCLARO INC	COM
102276	4/30/2010	67555N20	OCLRD		OCLARO INC	COM NEW
102276	5/28/2010	67555N20	OCLR		OCLARO INC	COM NEW
102276	6/10/2011	67555N20	OCLR		OCLARO INC	COM NEW

- » Security data file only gives the current values, and does not track historical changes
 - E.g., in 2004, through reverse merger into a US listed entity, Bookham changed its status from ADR to common equity; subsequently in 2009 it merged with another company to form Oclaro
 - The IssueType flag in Security data file has a value of '0' corresponding to the current status
- » Only way to track such an issue, is to get actual point-in-time Share Code from the CRSP monthly data file

SECURITY

2.4 – CLASS

- » Class attribute doesn't do what one might expect

SecurityID	CUSIP	Ticker	SIC	Index Flag	Exchange Flags	Class	Issue Type	Industry Group
207214	00439V10	VXUP	6733	0	4		0	
207215	00439V20	VXDN	6733	0	4		0	
124166	25470F10	DISCA	4841	0	4		0	725
124221	25470F20	DISCB	4841	0	4		0	725
137684	25470F30	DISCK	9999	0	4		0	725
115117	25770120	DGICA	6331	0	4		0	432
103918	25770130	DGICB	6331	0	4		0	432

- » **Issue:**

- The manual mentions that in cases where there are multiple classes of stock, the ticker attribute only contains the base value e.g. it should contain BKS for both BKS.A and BKS.B
- However, there are multiple instances where ticker comprises both base value + class identifier; and the CLASS attribute has <blank> value
- The above screenshot presents some examples generated from a sample query on the SECURITY data file

- » **Clarification from OptionMetrics:**

- All these examples are valid since this is how these tickers are defined by an exchange
- This information comes to OptionMetrics from its vendor IDC
- OptionMetrics only assign 'class' to a security with a duplicate ticker name

SECURITY

2.5 – EXCHANGEFLAGS

- » ExchangeFlag may have incorrect values

Header information from Security datafile

SecurityID	CUSIP	Ticker	SIC	Index Flag	Exchange Flags	Class	Issue Type	Industry Groups	CUSIP6
109505	30049A10	EPM	1311	0	16		0	121	30049A
116913	44378710	HSON	7363	0	16		0	764	443787
145632	88677Q10	TTS	5211	0	16		0	736	88677Q

- » **Issue:**
 - Instances where a SecurityID has been given an ExchangeFlag of 16 (value for OTC Bulletin Board), However, online search for these CUSIPs show that these stocks are trading on NYSE or NASDAQ
- » **Clarification from OptionMetrics:**
 - These are cases, where IDC failed to update OptionMetrics when these securities moved from OTC to NYSE/NASDAQ exchanges
 - The cases highlighted above have now been updated
 - More instances of such type were highlighted to OptionMetrics, and they have added them to their data quality checklist

SECURITY

2.6 – MISMATCH BETWEEN FLAGS

» Mismatch between ExchangeFlag and IndexFlag

SecurityID	Date	Days	Delta	CP	ImpliedVolatility	Cusip	Ticker	Issuer Description	Issue Type	Index Flag	Exchange Flags
104189	11/28/2003	30	50	C	0.424389005	28224R10	EFDS	EFUNDS CORP	0	0	32768
104189	9/30/2003	30	-50	P	0.394841999	28224R10	EFDS	EFUNDS CORP	0	0	32768
104189	2/28/2002	30	-50	P	0.587970972	28224R10	EFDS	EFUNDS CORP	0	0	32768
104189	9/28/2001	30	50	C	0.595324993	28224R10	EFDS	EFUNDS CORP	0	0	32768
104189	5/30/2003	30	-50	P	0.453363001	28224R10	EFDS	EFUNDS CORP	0	0	32768
104189	2/28/2003	30	-50	P	0.740629017	28224R10	EFDS	EFUNDS CORP	0	0	32768
104189	12/31/2001	30	-50	P	0.629940987	28224R10	EFDS	EFUNDS CORP	0	0	32768

» Issue:

- In the examples above, the Security data file has an Exchange Flag value of 32768, which implies that “the security is an index”, while the value of Index Flag indicates that it is not an index
- This is contradictory

» Clarification from OptionMetrics:

- This was a one-off case. OptionMetrics would verify its data and correct any other similar entries
- » While we do not use flags from Security data file in the current SAS code; in future, if they are used, it is advisable to check for such inconsistencies

SECURITY_NAME

3.1 – INCOMPLETE HEADER INFORMATION

Data from Volatility_Surface

SecurityID	Date	Days	Delta	CP	ImpliedVolatility
7365	1/31/1996	30	50	C	0.48161
7365	1/31/1996	30	-50	P	0.48148
7365	2/29/1996	30	-50	P	0.42295
7365	2/29/1996	30	50	C	0.52537
7365	3/29/1996	30	50	C	0.48237
7365	3/29/1996	30	-50	P	0.51185
7365	4/30/1996	30	-50	P	0.41206
7365	4/30/1996	30	50	C	0.43856
7365	5/31/1996	30	-50	P	0.44868
7365	5/31/1996	30	50	C	0.45296

Header information from Security datafile

SecurityID	Date	CUSIP	Ticker	Class	IssuerDescription
7365	4/25/2000	69554210	PAGEE		PAGING NETWORK INC
7365	6/23/2000	69554210	PAGE		PAGING NETWORK INC
7365	7/28/2000	69554210	ZZZZ		PAGING NETWORK INC
7365	8/1/2000	69554210	PAGE		PAGING NETWORK INC
7365	11/20/2000	69554210	ZZZZ		PAGING NETWORK INC
7365	10/31/2003	69554210	PAGE0		PAGING NETWORK INC

» **Issue:**

- For 100+ securities, the historical record (in the SECURITY_NAME data file) does not start as early as the actual data in the VOLATILITY_SURFACE file
- E.g. SecurityID 7365 has data in VOLATILITY_SURFACE file starting Jan '96, however, its earliest record in SECURITY_NAME file starts from April 2000

» **Clarification from OptionMetrics:**

- There are some inconsistencies between SECURITY_NAME and VOLATILITY_SURFACE tables, which are not a high priority and would be corrected at a later stage
- » The SAS code adjusts for such cases, by moving the 'Date' of the first observation back in time to include period from 1/1/1996 (start date of OptionMetrics database)

MODIFIED LINKINGTABLE

4.1 – USE CUSIPs FROM CRSP DATA (1/2)

- » Volatility Surface data file has continuous data for SecurityID 110611

Data in Volatility_Surface file

SecurityID	Date	Days	Delta	PC	ImpVol
110611	1/31/1996	30	-50	P	0.63
110611	1/31/1996	30	50	C	0.59
110611	2/29/1996	30	-50	P	0.51
110611	2/29/1996	30	50	C	0.53
...
110611	10/30/2009	30	-50	P	0.51
110611	10/30/2009	30	50	C	0.56
110611	11/30/2009	30	-50	P	0.35
110611	11/30/2009	30	50	C	0.32
110611	12/31/2009	30	-50	P	0.17
110611	12/31/2009	30	50	C	0.18

- » Security_Name data file also has complete and accurate information (note: CUSIP changes in 2007)

Header Information in Security_Name

securityID	Date	CUSIP	Ticker	Class	IssuerDescription	IssueDescrip	SIC
110611	2-Jan-96	86681010	SUNW		SUN MICROSYSTEMS INC	COM	
110611	28-Nov-00	86681010	SUNW		SUN MICROSYSTEMS INC	COM	3571
110611	27-Aug-07	86681010	JAVA		SUN MICROSYSTEMS INC	COM	3571
110611	12-Nov-07	86681020	JAVAD		SUN MICROSYSTEMS INC	COM NEW	3571
110611	11-Dec-07	86681020	JAVA		SUN MICROSYSTEMS INC	COM NEW	3571
110611	27-Jan-10	86681020	ZZZZ		SUN MICROSYSTEMS INC	COM NEW	3571

MODIFIED LINKINGTABLE

4.1 – USE CUSIPs FROM CRSP DATA (2/2)

- » While LinkTable provides primary link starting from 1986, it does not capture the change in CUSIP. This is because linktable backfills CUSIPs, and only shows the current CUSIP. This is also the situation in case of an M&A, where the CUSIP for the acquired company is updated to match the one from acquiring company

Linktable information

CUSIP	LIID	LinkDt	LinkEndDt	LinkPrim	LPERMCO	LPERMNO	CONM	Ticker	GVKEY
86681020	1	19860304	20100129	P	8021	10078	SYSTEMS INC	JAVA	12136

- » However, the important thing is that this ‘point-in-time’ CUSIP information is correctly captured in CRSP monthly data file. Therefore, we augment the raw linking table, with CUSIP information from CRSP monthly data file

CRSP monthly data

Permno	CUSIP	Company	Ticker	SHRCD	EXCHCD	Year	Month
10078	86681010	SUN MICROSYSTEMS INC	SUNW	11	3	1986	4
10078	86681010	SUN MICROSYSTEMS INC	SUNW	11	3	1986	5
10078	86681010	SUN MICROSYSTEMS INC	SUNW	11	3	1986	6
...
10078	86681010	SUN MICROSYSTEMS INC	JAVA	11	3	2007	10
10078	86681010	SUN MICROSYSTEMS INC	JAVA	11	3	2007	11
10078	86681020	SUN MICROSYSTEMS INC	JAVA	11	3	2007	12
10078	86681020	SUN MICROSYSTEMS INC	JAVA	11	3	2008	1
...
10078	86681020	SUN MICROSYSTEMS INC	JAVA	11	3	2009	11
10078	86681020	SUN MICROSYSTEMS INC	JAVA	11	3	2009	12

MODIFIED LINKINGTABLE

4.2 – CUSIPs

- » This is only for illustration: in case one were to use LinkingTable from WRDS, cases of M&A would be captured as follows:

Linking table from WRDS

CUSIP	LIID	LinkDt	LinkEndDt	LinkPrim	PERMCO	PERMNO	CONM	Tic	GVKEY
8860600	1	19990709	20110831	P	16643	87054	PETROHAWK ENERGY CORP	BHP1	121934
8860610	90		22220202	P	653	75039	BHP BILLITON GROUP (AUS)	BHP	13312

- » CUSIP of the acquired company (Petrohawk Energy) has been backfilled with that of the acquiring company (BHL Billiton) – notice the same first 6 digits of CUSIP for both the securities
- » On the other hand, header information in the Security_Name data file correctly captures the CUSIPs

Security_Name header information

securityID	Data	CUSIP	Ticker	Class	IssuerDescription	IssueDescription	SIC
102115	16JUL2004:00:00:00	71649510	HAWK		PETROHAWK ENERGY CORP	COM	1311
102115	13MAR2007:00:00:00	71649510	HK		PETROHAWK ENERGY CORP	COM	1311
102115	26AUG2011:00:00:00	71649510	HK		PETROHAWK ENERGY CORP	COM	1311
102122	30OCT2000:00:00:00	8860610	?	?	BHP LTD -ADR		
102122	28NOV2000:00:00:00	8860610	BHP		BHP LTD	SPONSORED ADR	1011
102122	29JUN2001:00:00:00	8860610	BHP		BHP BILLITON LTD	SPONSORED ADR	1011

MODIFIED LINKINGTABLE

4.3 – MISSING LINKDATE

- » In certain cases, it was found that while OptionMetrics contained information, the CRSP linking table only marked the CUSIP primary at a later date (CUSIP did not change during that time), e.g.

Volatility_Surface file has data for this CUSIP

SecurityID	Date	Days	Delta	PC	ImplVol	CUSIP	CONM	TIC
103094	1/31/1996	30	-50	P	0.45	18490210	CLEARNET COMMUNICATIONS INC	CLNT
103094	1/31/1996	30	50	C	0.60	18490210	CLEARNET COMMUNICATIONS INC	CLNT
103094	2/29/1996	30	50	C	0.53	18490210	CLEARNET COMMUNICATIONS INC	CLNT
103094	2/29/1996	30	-50	P	0.52	18490210	CLEARNET COMMUNICATIONS INC	CLNT
103094	3/29/1996	30	50	C	0.44	18490210	CLEARNET COMMUNICATIONS INC	CLNT
103094	3/29/1996	30	-50	P	0.49	18490210	CLEARNET COMMUNICATIONS INC	CLNT
103094	4/30/1996	30	50	C	0.43	18490210	CLEARNET COMMUNICATIONS INC	CLNT

- » Relevant entry from Linking Table (pulled from WRDS)

CUSIP	LIID	LINKDT	LINKENDDT	LINKPRIM	LPERMCO	LPERMNO	CONM	TIC	GVKEY
18490210	1	19980430	20010131	P	13368	80963	CLEARNET COMMUN INC -CL A	CLNT.	30779

- » **Clarification from CRSP Support:** The primary link for that security is split up between 2 LIIDs (01 & 01C). The reason for this is that Compustat only has data for the US-trading security from 1998-2001. We have a LX linktype for when Compustat has data for the Canadian-trading security (1994-2001)

Link History						

LINKDT	LINKENDDT	LPERMNO	LPERMCO	LIID	LINKTYPE	LINKPRIM
19900501	19941012	0	0	00X	NU	C
19980430	20010131	80963	13368	01	LU	P
19941013	19980429	80963	13368	01C	LX	C
19980430	20010131	80963	13368	01C	LX	N
20010201	20010228	0	0	99X	NU	C

OPTION PRICE DATA

OPTION_PRICE

OPTION_PRICE

SYMBOLFLAG: char(1)
SYMBOL: char(5)
DATE: smalldatetime
SECURITYID: INTEGER
STRIKE: int
EXPIRATION: smalldatetime
CALLPUT: char(1)
BESTBID: real
BESTOFFER: real
LASTTRADEDATE: smalldatetime
VOLUME: int
OPENINTEREST: int
SPECIALSETTLEMENT: char(1)
IMPLIEDVOLATILITY: real
DELTA: real
GAMMA: real
VEGA: real
THETA: real
OPTIONID: int
ADJUSTMENTFACTOR: int

- Frequency: daily data
- However, data is missing if Bid/Ask = 0 or Quote Condition is set to 'Halt' or 'Canceled'
- While the stated primary key for the dataset is Symbol + Flag + Date, there are various reasons for which Symbol for a contract may change
- Instead, we **use OptionID (given by OptionMetrics) + Date as a pseudo primary key**
- Quotes are gathered from different exchanges, and the best bid and best offer are captured in the DB
- It is important to understand the impact of various corporate actions on the data, when working with this dataset
- Adjustment Factor & Special Settlement flag are useful in tracking such changes

Exhibit: 5.1 – 5.12

Merging with information from Security, Security_Name and Modified Linking Table is same as when using data from Volatility_Surface

SECURITY



SECURITY_NAME



MODIFIED LINKING TABLE

OPTION_PRICE

5.1 – SYMBOL NOMENCLATURE (1/3)

- » Option symbols in the database correspond to two different nomenclatures used over the years
 - Before February, 2010, OCC used a five-character option symbol (see illustration below)
 - On February 12, 2010, the five-character ticker format stopped being used in the US and Canada. In the first few months after February 12, large amounts of options for a given issuer were consolidated into a single root ticker for a given underlying symbol. March 2010 - May 2010 was the symbol consolidation period in which all outgoing option roots were replaced with the underlying stock symbol
- » Old option symbol nomenclature:^[1]

Option Ticker Symbol	Option Symbol	Expiration Date of Call or Put	Strike Price of Option
MRKJG	MRK	J	G

To help you decode any option ticker, we are providing you with a code sheet:

Codes To Determine a Call or Put Expiration Month												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Calls	A	B	C	D	E	F	G	H	I	J	K	L
Puts	M	N	O	P	Q	R	S	T	U	V	W	X

Codes for Determining the Strike Price of an Option																									
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100						2.5
105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	7.5	12.5	17.5	22.5	27.5	32.5
205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	37.5	42.5	47.5	52.5	57.5	62.5
305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395	400	67.5	72.5	77.5	82.5	87.5	92.5
405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	485	490	495	500	97.5	102.5	107.5	112.5	117.5	122.5
505	510	515	520	525	530	535	540	545	550	555	560	565	570	575	580	585	590	595	600	127.5	132.5	137.5	142.5	147.5	152.5
605	610	615	620	625	630	635	640	645	650	655	660	665	670	675	680	685	690	695	700	157.5	162.5	167.5	172.5	177.5	182.5
705	710	715	720	725	730	735	740	745	750	755	760	765	770	775	780	785	790	795	800	187.5	192.5	197.5	202.5	207.5	212.5
																				217.5	222.5	227.5	232.5	237.5	242.5

[1] <http://www.investopedia.com/ask/answers/05/052505.asp>

OPTION_PRICE

5.1 – SYMBOL NOMENCLATURE (2/3)

- » **New option symbol nomenclature:**
 - Symbol changed from 5 character to 21 character
 - OptionID assigned by OptionMetrics is robust to such changes

CHANGE OF SYMBOL METHODOLOGY

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Open Interest	Special Settle.	ImpVol	Delta	Gamma	Vega	Theta	OptionID	Adj. Factor
101594	21-Dec-09	APV.NQ	0	185000	20-Feb-10	P	6.05	6.1	21-Dec-09	1072	0	0	0.37	-0.30	0.01	27.79	-31.31	45643036	1
101594	22-Dec-09	APV.NQ	0	185000	20-Feb-10	P	5.25	5.3	22-Dec-09	292	683	0	0.37	-0.27	0.01	26.59	-30.15	45643036	1
...
101594	10-Feb-10	APV.NQ	0	185000	20-Feb-10	P	0.72	0.75	10-Feb-10	5871	50668	0	0.32	-0.14	0.02	6.88	-45.12	45643036	1
101594	11-Feb-10	APV.NQ	0	185000	20-Feb-10	P	0.33	0.34	11-Feb-10	6283	51999	0	0.34	-0.07	0.01	4.12	-31.76	45643036	1
101594	12-Feb-10	APV 100220P185000	1	185000	20-Feb-10	P	0.15	0.16	12-Feb-10	6525	50478	0	0.34	-0.04	0.01	2.42	-21.10	45643036	1
101594	16-Feb-10	APV 100220P185000	1	185000	20-Feb-10	P	0.07	0.09	16-Feb-10	16239	49291	0	0.53	-0.02	0.01	0.96	-30.78	45643036	1
101594	17-Feb-10	APV 100220P185000	1	185000	20-Feb-10	P	0.02	0.04	17-Feb-10	12130	42134	0	-99.99	-99.99	-99.99	-99.99	-99.99	45643036	1
101594	18-Feb-10	APV 100220P185000	1	185000	20-Feb-10	P	0	0.01	18-Feb-10	1303	38293	0	-99.99	-99.99	-99.99	-99.99	-99.99	45643036	1
101594	19-Feb-10	APV 100220P185000	1	185000	20-Feb-10	P	0	0.01	19-Feb-10	62	38431	0	-99.99	-99.99	-99.99	-99.99	-99.99	45643036	1

- » **Under the old nomenclature, in case of long-dated options, OCC provided additional ‘first three characters’ to identify them from usual option series**
 - In the following example ‘YUU’ and ‘OWY’ are alternate codes to identify the long dated options for ‘VIP’

LEAPS GET DIFFERENT SYMBOLS

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Open Interest	OptionID	Adj. Factor
108486	1-May-09	YUU.AB	0	10000	16-Jan-10	C	2.6	2.85	30-Apr-09	0	421	33593188	1
108486	1-May-09	OWY.AB	0	10000	22-Jan-11	C	3.8	4.2	30-Apr-09	0	128	46046519	1
108486	1-May-09	VIP.JW	0	17500	17-Oct-09	C	0.45	0.55	29-Apr-09	0	26	45305192	1

OPTION_PRICE

5.1 – SYMBOL NOMENCLATURE (3/3)

- » Similarly, for weekly options (aka Weeklies), which were introduced in October 2005
 - Note how the third character varies to signify the week to which the option corresponds

EXAMPLE OF NOMENCLATURE IN WEEKLYS

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Open Interest	OptionID
108105	1-May-06	JXA.EP	0	1280000	5-May-06	C	24.7	26.7	.	0	0	31977343
108105	1-May-06	JXA.ES	0	1295000	5-May-06	C	12.1	13.7	1-May-06	6	4	31977344
108105	5-May-06	JXB.EQ	0	1285000	12-May-06	C	39.6	41.6	.	0	0	31981189
108105	5-May-06	JXB.ET	0	1300000	12-May-06	C	25.3	27.3	5-May-06	10	0	31981187
108105	19-May-06	JXD.EH	0	1240000	26-May-06	C	30.5	32.9	.	0	0	31997311
108105	19-May-06	JXD.EK	0	1255000	26-May-06	C	18.2	20.2	19-May-06	2	0	31997309

- » Further option symbols re-cycle, once the contract expires, and a new contract with same features is initiated
 - In the following example both symbols 'OWY.AB' and 'OWY.AC' are reintroduced once the base contract expires

SYMBOLS REPEAT (CIRCULATE) FOR THE SAME "TYPE" OF CONTRACT

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Open Interest	OptionID
108486	1-May-08	OWY.AB	0	10000	17-Jan-09	C	20	21	30-Apr-08	0	374	32028083
108486	1-May-09	OWY.AB	0	10000	22-Jan-11	C	3.8	4.2	30-Apr-09	0	128	46046519
108486	1-May-08	OWY.AC	0	15000	17-Jan-09	C	15.4	16.4	30-Apr-08	0	2860	32799670
108486	1-May-09	OWY.AC	0	15000	22-Jan-11	C	2.45	2.8	23-Apr-09	0	183	46443895

5.2 – CORPORATE EVENTS' IMPACT ON OPTIONS

» Corporate events have a wide range of impact on Option contracts

- Following table provides a good overview of how option contracts undergo change for some common corporate actions^[1]

Causes of Adjusted Options					
	Size/Type	Symbol change	Strike price change	Multiplier change	Contract size (deliverable change)
Ordinary cash dividend ¹		No	No	No	No
Extraordinary cash dividend ²	< \$12.50/contract	No	No	No	No
	> \$12.50/contract	No	Yes: reduced	No	Sometimes
Stock dividend	All	Yes	Yes: reduced	Yes: increased	Yes: increased
Rights offering		Yes	No	No	Yes: increased
Spin-off		Yes	No	No	Yes: increased
Stock split	2 for 1	No	Yes: reduced	No	No
	3 for 1	No	Yes: reduced	No	No
	4 for 1	No	Yes: reduced	No	No
	5 for 1	No	Yes: reduced	No	No
	3 for 2	Yes	Yes: reduced	Yes: increased	Yes: increased
	4 for 3	Yes	Yes: reduced	Yes: increased	Yes: increased
	5 for 4	Yes	Yes: reduced	Yes: increased	Yes: increased
	6 for 5	Yes	Yes: reduced	Yes: increased	Yes: increased
	7 for 5	Yes	Yes: reduced	Yes: increased	Yes: increased
Reverse stock split	1 for 2	Yes	No	No	Yes: reduced
	1 for 5	Yes	No	No	Yes: reduced
	1 for 7	Yes	No	No	Yes: reduced
	1 for 10	Yes	No	No	Yes: reduced
	1 for 20	Yes	No	No	Yes: reduced
	1 for 50	Yes	No	No	Yes: reduced
	1 for 100	Yes	No	No	Yes: reduced
Merger or acquisition	Acquirer	Sometimes	No	No	No
	Acquiree	Yes	No	No	Yes
Stock symbol or company name change		Sometimes	No	No	No

[1] https://www.schwab.com/public/file/P-3951800/INF57995_114923.pdf

5.3 – CASES OF SYMBOL CHANGE (1/5)

Non-standard Split of 3:2; Goes into Special Settlement

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
101590	1-Feb-01	OAQ.BE	0	25000	17-Feb-01	C	29.5	30.5	18-Dec-00	0	11830706	1
101590	2-Feb-01	OAQ.BE	0	25000	17-Feb-01	C	29.38	30.375	18-Dec-00	0	11830706	1
101590	5-Feb-01	OAQ.BE	0	25000	17-Feb-01	C	28.63	29.625	18-Dec-00	0	11830706	1
101590	6-Feb-01	POU.BV	0	16625	17-Feb-01	C	19.88	20.625	18-Dec-00	1	11830706	1
101590	7-Feb-01	POU.BV	0	16625	17-Feb-01	C	21.25	22.25	18-Dec-00	1	11830706	1
101590	8-Feb-01	POU.BV	0	16625	17-Feb-01	C	21.88	22.875	18-Dec-00	1	11830706	1
101590	9-Feb-01	POU.BV	0	16625	17-Feb-01	C	20.75	21.75	9-Feb-01	1	11830706	1
101590	12-Feb-01	POU.BV	0	16625	17-Feb-01	C	19.25	20	9-Feb-01	1	11830706	1
101590	13-Feb-01	POU.BV	0	16625	17-Feb-01	C	19.88	20.625	9-Feb-01	1	11830706	1
101590	14-Feb-01	POU.BV	0	16625	17-Feb-01	C	19.5	20.25	9-Feb-01	1	11830706	1
101590	15-Feb-01	POU.BV	0	16625	17-Feb-01	C	19.88	20.625	9-Feb-01	1	11830706	1
101590	16-Feb-01	POU.BV	0	16625	17-Feb-01	C	19.63	20.375	9-Feb-01	1	11830706	1

» Comment from OptionMetrics:

- Please note that the adjustment factor is defined as an integer
- It is not changed in case of the odd splits as those options are set to Special Settlement options
- This is because there is always some cash settlement involved in the odd split settlement, which means that even if the adjustment factor in OPTION_PRICE was set to, say 1.5 in case of a 3:2 split, it would still not reflect the real adjustment as ruled by the OCC
- The adjustment factor is reliable for non-special options only
- In this particular case, OptionID 11830706 on 06 Feb 2001, has a SpecialSettlement flag of 1

5.3 – CASES OF SYMBOL CHANGE (2/5)

EXAMPLE OF NAME CHANGE

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
112893	1-Oct-13	NRGY 131019C10000	1	10000	19-Oct-13	C	3.70	3.90	19-Sep-13	0	101131432	1
112893	2-Oct-13	NRGY 131019C10000	1	10000	19-Oct-13	C	3.80	4.10	19-Sep-13	0	101131432	1
112893	3-Oct-13	NRGY 131019C10000	1	10000	19-Oct-13	C	3.60	3.80	19-Sep-13	0	101131432	1
112893	4-Oct-13	NRGY 131019C10000	1	10000	19-Oct-13	C	3.50	4.20	19-Sep-13	0	101131432	1
112893	7-Oct-13	NRGY 131019C10000	1	10000	19-Oct-13	C	3.40	3.70	19-Sep-13	0	101131432	1
112893	8-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	3.50	4.00	19-Sep-13	0	101131432	1
112893	9-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	2.90	3.40	19-Sep-13	0	101131432	1
112893	10-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	3.20	3.60	19-Sep-13	0	101131432	1
112893	11-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	4.00	4.40	19-Sep-13	0	101131432	1
112893	14-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	4.30	4.90	19-Sep-13	0	101131432	1
112893	15-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	4.40	5.00	19-Sep-13	0	101131432	1
112893	16-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	4.10	5.10	19-Sep-13	0	101131432	1
112893	17-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	4.30	4.90	19-Sep-13	0	101131432	1
112893	18-Oct-13	CEQP 131019C10000	1	10000	19-Oct-13	C	4.20	4.50	18-Oct-13	0	101131432	1

- » Such cases of name change can only be tracked by using OptionId, instead of Symbol as a primary key across time

5.3 – CASES OF SYMBOL CHANGE (3/5)

SPECIAL DIVIDEND - STRIKE ADJUSTS BUT OPTION CONTRACT IS SAME / NO ADJUSTMENT REQUIRED FOR PRICES

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
101205	2-Dec-13	ALU 131221P500	1	500	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	3-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	4-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	5-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	6-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	9-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	10-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	11-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	12-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	13-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1
101205	16-Dec-13	ALU 131221P330	1	330	21-Dec-13	P	0.00	0.05	.	0	100791826	1

- » In this case of special dividend, OCC adjusted the strike price, but everything else was unchanged

5.3 – CASES OF SYMBOL CHANGE (4/5)

INCORRECT OPTION SYMBOL IN THE DATA

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor	
109906	26-Mar-01	ONS.AW	0	47500	18-Jan-03	C	4.63	5.00	.	0	20194950	2	
109906	27-Mar-01	ONS.AW	0	17500	18-Jan-03	C	12.38	13.00	27-Mar-01	0	20194950	2	no event

- » This was a peculiar case in the dataset, since its strike seemed to fall by 1/3, however its quoted price jumped up by 3x
- » Clarification from OptionMetrics:
 - One of the exchanges provided a wrong option symbol in this case (Securityid = 109906 ONS.AW)
 - These symbols should have been merged together
 - OptionMetrics will look into this with their development team, and consider this for a future project
- » While, this was a one-off case, there is no way to distinguish this from cases of special dividend (primary key also didn't change), where only strike price is adjusted downward, and nothing else changes
 - In the current SAS code, we have built additional filters to check for these cases

5.3 – CASES OF SYMBOL CHANGE (5/5)

WORST CASE OF SYMBOL CHANGE

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
103042	1-Mar-01	WCY.AB	0	26250	19-Jan-02	C	5.50	5.88	1-Mar-01	0	11850180	1
103042	2-Mar-01	WCY.AB	0	26250	19-Jan-02	C	4.25	4.38	2-Mar-01	0	11850180	1
...
103042	16-Mar-01	WCY.AB	0	26250	19-Jan-02	C	3.13	3.25	16-Mar-01	0	11850180	1
103042	19-Mar-01	WCY.AB	0	26250	19-Jan-02	C	3.38	3.63	19-Mar-01	0	11850180	1
103042	20-Mar-01	WCY.AM	0	26250	19-Jan-02	C	2.63	2.81	20-Mar-01	0	11850180	4
103042	21-Mar-01	WCY.AM	0	26250	19-Jan-02	C	2.63	2.88	21-Mar-01	0	11850180	4
103042	22-Mar-01	WCY.AM	0	26250	19-Jan-02	C	2.88	3.13	22-Mar-01	0	11850180	4
103042	23-Mar-01	WCY.AM	0	26250	19-Jan-02	C	2.38	2.63	22-Mar-01	0	11850180	4

nothing in distribution file
nothing in distribution file
nothing in distribution file
nothing in distribution file

103042	21-Mar-01	WCY.AB	0	10000	19-Jan-02	C	10.25	10.50	.	0	20288480	1
103042	22-Mar-01	WCY.AB	0	10000	19-Jan-02	C	10.63	11.00	.	0	20288480	1
103042	23-Mar-01	WCY.AB	0	10000	19-Jan-02	C	9.75	10.00	23-Mar-01	0	20288480	1
103042	26-Mar-01	WCY.AB	0	10000	19-Jan-02	C	9.00	9.25	26-Mar-01	0	20288480	1
103042	27-Mar-01	WCY.AB	0	10000	19-Jan-02	C	9.25	9.50	27-Mar-01	0	20288480	1
103042	28-Mar-01	WCY.AB	0	10000	19-Jan-02	C	7.13	7.38	28-Mar-01	0	20288480	1
103042	29-Mar-01	WCY.AB	0	10000	19-Jan-02	C	6.75	7.00	29-Mar-01	0	20288480	1
103042	30-Mar-01	WCY.AB	0	10000	19-Jan-02	C	7.13	7.38	30-Mar-01	0	20288480	1

- » This was the worst case of Symbol change, where Symbol was changed even before the original contract expired
 - On March 20th the underlying option contract changed symbol from 'WCY.AB' to 'WCY.AM'
 - On the same day, 'WCY.AB' got allotted to another underlying contract (note the strike)
 - Such cases can only be tracked by using OptionID as primary key instead of Symbol

5.4 – WHY USE OPTOINIDS (1/2)

» Comments from OptionMetrics:

- OptionMetrics does not recommend using OptionID + Date as a primary key. It's very unlikely, but there might be some cases where a duplicate OptionID is assigned on the same day
- By design, however, they do not recycle optionIDs
- Additionally, making OptionID a primary key is not feasible at this time, due to the complexity of consistently assigning OptionIDs

» So while, OptionIDs are not recycled, there may be cases where OptionID repeats on a particular date for multiple contracts

- In practice, when working with contracts expiring in the same month, 338 observations (daily freq.) comprising 11 SecurityIDs were found over the entire sample period
- This number is very low compared to the size of database (139 million total observations for same month expiry contracts). Note, however, that these cases are not restricted to any specific time period
- Once we control for these instances of duplicates, 'OptionID' provides a much better way to handle and work with this dataset

CASES OF DUPLICATE OPTIONIDS (SAME MONTH EXPIRY CONTRACTS)

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade Date	Volume	Open Interest	Special Settle.	ImpVol	Delta	Gamma	Vega	Theta	OptionID	Adj. Factor
108146	2-Mar-01	FQC.CW	0	17500	17-Mar-01	C	4.75	5.13	1-Mar-01	0	24	0	1.15	0.88	0.04	0.89	-14.03	20252295	1
108146	2-Mar-01	FQC.CS	0	17500	17-Mar-01	C	4.63	5.00	1-Mar-01	0	0	0	0.99	0.90	0.04	0.74	-10.43	20252295	1
101594	7-May-01	AAQ.QW	0	17500	19-May-01	P	0.00	0.10	30-Apr-01	0	0	0	-99.99	-99.99	-99.99	-99.99	-99.99	20265723	1
101594	7-May-01	AAQ.QS	0	17500	19-May-01	P	0.00	0.10	30-Apr-01	0	917	0	-99.99	-99.99	-99.99	-99.99	-99.99	20265723	1
108132	6-Nov-01	NZZ.WZ	0	12500	17-Nov-01	P	0.00	0.20	19-Oct-01	0	0	0	-99.99	-99.99	-99.99	-99.99	-99.99	20454909	1
108132	6-Nov-01	NZZ.WV	0	12500	17-Nov-01	P	0.00	0.15	19-Oct-01	0	182	0	-99.99	-99.99	-99.99	-99.99	-99.99	20454909	1
106437	15-Nov-05	IGH.WX	0	68500	19-Nov-05	P	0.00	0.15	18-Jul-05	0	57	0	0.35	-0.07	0.06	0.90	-19.07	25079216	4
106437	15-Nov-05	IGH.WS	0	63500	19-Nov-05	P	0.00	0.15	17-Oct-05	0	8	0	0.77	-0.04	0.02	0.52	-24.32	25079216	4

5.4 – WHY USE OPTOINIDs (2/2)

- » In case we do not restrict our sample for contracts with same month expiry, we get ~7,730 cases of duplicate OptoinID + Date
- » These cases have been shared with OptionMetrics



Microsoft Excel
Worksheet

- » **Clarification from OptionMetrics:**
 - Some of the duplicates in this list are due to the errors in the option symbol/ strike/expiration date provided by different exchanges for the same contract
 - This is similar to the case of OptionID = 566427 / SecurityId = 109764 / Symbol RZB.KK, discussed before.
 - Also, when option symbol changed in the past, some exchanges issued a new option symbol with a delay that caused a duplicate OptionID assignment
 - OptionMetrics is already working towards correcting such instances, and all the highlighted cases are on their list, to be researched and fixed as a part of data cleanup effort

5.5 – OPTOINIDs; SOME OTHER ISSUES

- » Some other issues of seemingly incorrect OptionID assignments stem for errors in underlying data in the database, e.g.

SAME OPTION ID TO TWO SYMBOLS

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	BestBid	BestOffer	Last Trade Date	Volume	Open Interest	Special Settle.	ImpVol	Delta	Gamma	Vega	Theta	OptionID	Adjust ment Factor
108486	12-May-08	VIP.AP	0	16000	17-Jan-09	C	18.8	19.3	30-Apr-08	0	0	0	1.08	0.90	0.01	4.82	-4.09	32272862	1
108486	12-May-08	VIP.AQ	0	16000	17-Jan-09	C	17	17.5	30-Apr-08	0	0	0	0.97	0.88	0.01	5.46	-4.20	32272862	1
108486	12-May-08	VIP.MQ	0	18000	17-Jan-09	P	0.35	0.55	30-Apr-08	0	0	0	0.55	-0.06	0.01	3.15	-1.21	32307513	1
108486	12-May-08	VIP.MS	0	18000	17-Jan-09	P	0.6	0.75	30-Apr-08	0	0	0	0.62	-0.07	0.01	3.74	-1.62	32307513	5

DIFFERENT OPTIONID TO SEEMINGLY SAME CONTRACT

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	BestBid	BestOffer	Last Trade Date	Volume	Open Interest	Special Settle.	ImpVol	Delta	Gamma	Vega	Theta	OptionID	Adjust ment Factor
109764	4-Nov-05	RZB.KK	0	555000	11-Nov-05	C	7.6	8.6	4-Nov-05	4	704	0	0.12	0.80	0.03	19.96	-90.03	31728085	1
109764	7-Nov-05	RZB.KK	0	555000	12-Nov-05	C	7.7	8.6	7-Nov-05	12	4	0	-99.99	-99.99	-99.99	-99.99	-99.99	31728860	1

» Clarification from OptionMetrics:

- Corrected the strike to 14000 for the symbol 'VIP.AP' and re-assigned an OptionID of 32181612
- Similarly, corrected the strike to 16000 for the symbol 'VIP.MQ' and re-assigned an optionID of 108735290
- These corrections will be delivered in the next database release, as we do not patch historical data
- In case of 'RZB.KK', expiration date was corrected to '2005-11-12', along with the OptionID

- » In the SAS code, we have built a filter to check for cases with duplicate OptionIDs, and treat them more carefully

OPTION_PRICE

5.6– LASTTRADEDATE

MISSING LAST TRADE DATE

SecurityID	Date	Symbol	Symb1 Flag	Strike	Expiration	CallPut	BestBid	BestOffer	Last Trade Date	Volume	Open Interest
123617	4-Jan-96	0B417.52	0	360000	20-Jan-96	C	4.375	4.75	.	3	3
123617	5-Jan-96	0B417.52	0	360000	20-Jan-96	C	2.1875	2.5625	.	20	23
123617	8-Jan-96	0B417.52	0	360000	20-Jan-96	C	1.25	1.5	.	0	23
123617	9-Jan-96	0B417.52	0	360000	20-Jan-96	C	0.125	0.375	.	13	16
123617	10-Jan-96	0B417.52	0	360000	20-Jan-96	C	0.1875	0.4375	.	0	16
123617	11-Jan-96	0B417.52	0	360000	20-Jan-96	C	0.1875	0.4375	.	3	13

- » Last Trade Date is not a robust field. In this particular example, even though there was trading on those days (non-zero volume), LastTradeDate field is missing
- » **Clarification from OptionMetrics:**
 - Data prior to November 28, 2000, was obtained in chunks from IDC, and is very noisy, with missing special settlement flag, symbol, strike, etc.
 - While tremendous effort has been put to clean this data, there are some errors which still remain. Unfortunately, due to lack of access to alternative source of option data, this cannot be verified at the moment

OPTION_PRICE

5.7– BID / OFFER QUOTES

» Following are seemingly incorrect cases of Bid/Ask quotes

- Sometimes academic papers exclude such observations (e.g. Goyal & Saretto 2009)

» Clarification from OptionMetrics:

- These are valid cases, since the best bid and the best offer are picked from quotes across all exchanges, the contract is traded on
- Implied volatility is calculated as long as the midpoint is above the intrinsic value.

Cases of seemingly incorrect Bid/Ask

Type 1 - Minimum tick for options trading below 3 is .05 and for all other series, .10.

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Open Interest	OptionID
151427	31-Dec-13	621C5000	1	5000	21-Jun-14	C	0.25	0.28	31-Dec-13	169	3572	101952907
151427	31-Dec-13	117C5000	1	5000	17-Jan-15	C	0.56	0.58	31-Dec-13	84	7719	83533130
102021	2-Dec-13	13P17000	1	17000	13-Dec-13	P	1.50	1.53	2-Dec-13	39	258	102055410
102021	2-Dec-13	21C13000	1	13000	21-Dec-13	C	2.58	2.61	2-Dec-13	233	10	101749236

Type 2 - Bid > Ask

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Open Interest	OptionID
102556	4-Jan-96	099C6.26	0	20000	20-Jul-96	C	2.63	2.56	4-Jan-96	912	754	10077734
8239	4-Jan-96	09EFC.27	0	70000	20-Jan-96	P	6.50	6.38	4-Jan-96	398	342	10419239
143439	1-Nov-13	1P180000	1	180000	1-Nov-13	P	18.09	18.00	1-Nov-13	154	1096	101772256
138600	1-Nov-13	21P73000	1	73000	21-Dec-13	P	8.90	8.85	1-Nov-13	26	64	101789507

Type 3 - Same Bid and Ask

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Open Interest	OptionID
8449	4-Jan-96	099A6.E5	0	35000	20-Jan-96	C	1.50	1.50	4-Jan-96	277	417	10069733
7303	4-Jan-96	09AD2.D9	0	25000	20-Jan-96	C	0.81	0.81	4-Jan-96	276	1166	10146521
7303	4-Jan-96	09B42.4B	0	30000	20-Jul-96	P	11.50	11.50	4-Jan-96	25	34	10175051
111137	4-Jan-96	09D73.CD	0	15000	20-Jul-96	C	1.69	1.69	4-Jan-96	270	2626	10318797

5.8 – ADJUSTMENT FACTOR (1/3)

- » Adjustment Factor and Special Settlement Flag allow us to track various changes to the option contract, and properly adjust for them.
- » In the following example, the stock underwent a 2:1 stock split, which reduced its strike price to 1/2x original
 - To maintain the same option economics, in such cases, OCC increases delivery quantity by a factor of 2x
 - Also, the quoted prices are adjusted by a factor of 1/2x
 - Therefore, to accurately track the dollar value of the option contract, one must multiply quoted price with adjustment factor.

USING ADJUSTMENT FACTOR

SecurityID	Date	Symbol	Symb1 Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
124062	1-Nov-13	DSW 131116C60000	1	60000	16-Nov-13	C	25.90	29.00	.	0	101683522	1
124062	4-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	11.70	15.00	.	0	101683522	2
124062	5-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	12.30	15.50	.	0	101683522	2
124062	6-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	13.80	16.10	.	0	101683522	2
124062	7-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	13.10	14.00	.	0	101683522	2
124062	8-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	12.60	15.40	.	0	101683522	2
124062	11-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	12.70	16.40	.	0	101683522	2
124062	12-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	12.90	16.70	.	0	101683522	2
124062	13-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	14.30	16.20	.	0	101683522	2
124062	14-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	15.10	16.70	.	0	101683522	2
124062	15-Nov-13	DSW 131116C30000	1	30000	16-Nov-13	C	14.50	17.70	.	0	101683522	2

5.8 – ADJUSTMENT FACTOR (2/3)

» However, adjustment factor is not without its own errors.

- Following is an example where adjustment factor incorrectly reverts/ reduces to original value after undergoing a change. The distribution file indicated that the adjustment factor should have remained 3

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
104992	23-Jul-13	BEN 140118C195000	1	195000	18-Jan-14	C	0.15	0.30	5-Jun-13	0	100552156	1
104992	24-Jul-13	BEN 140118C195000	1	195000	18-Jan-14	C	0.10	0.40	5-Jun-13	0	100552156	1
104992	25-Jul-13	BEN 140118C195000	1	195000	18-Jan-14	C	0.10	0.25	5-Jun-13	0	100552156	1
104992	26-Jul-13	BEN 140118C65000	1	65000	18-Jan-14	C	0.00	0.15	5-Jun-13	0	100552156	3
104992	29-Jul-13	BEN 140118C65000	1	65000	18-Jan-14	C	0.00	0.10	5-Jun-13	0	100552156	1
104992	30-Jul-13	BEN 140118C65000	1	65000	18-Jan-14	C	0.05	0.15	5-Jun-13	0	100552156	1
104992	31-Jul-13	BEN 140118C65000	1	65000	18-Jan-14	C	0.05	0.15	5-Jun-13	0	100552156	1

» Clarification from OptionMetrics:

- The adjustment factor should have remained as 3 after 26 July 2013 (for SecurityID 104992), and should have remained as 2 on May 18 2012 (for SecurityID 103943)
- These cases have been fixed in the database

» In the SAS code, for securities which are tagged to more than 1 value of Adjustment Factor, we have built additional checks to identify the last valid observation – which in this case would be the observation from July 26, 2013

5.8 – ADJUSTMENT FACTOR (3/3)

- » **Additional ~2,300 cases where Adjustment Factor reduced over the life of the contract, were highlighted to OptionMetrics**
 - Surprising thing is, most of them were from recent years, and are clustered around certain dates



Microsoft Excel
Worksheet

- » **Comment from OptionMetrics:**
 - All these cases have been fixed at the backend, and would be available in the next release
- » **Hopefully, in the next release there would be no further instances of reduction in adjustment factor during the life of the contract**

OPTION_PRICE

5.9 – SPECIALSETTLEMENT FLAG

- » **Special Settlement flag can take any of the following values:**
 - 0 – standard settlement
 - 1 – non-standard settlement
 - E – non-standard expiration date; usually due to an error in historical data
- » **In practice, many instances will be encountered where due to some corporate event (M&A, high cash dividend, stock dividend etc.), a contract may go into special settlement**
 - The Options Clearing Corporation, which is the governing body, decides the impact from corporate events, and whether a contract goes into special settlement
 - This link (<http://www.theocc.com/webapps/infomemos>) provides a listing of all their historical memos – great resource for identifying reasons for out-of-place data
- » **In addition, OptionMetrics stops calculating Implied Volatility for any contract which goes into special settlement category**

CASE OF M&A - SPECIAL SETTLEMENTS GET -99.99 IMP_VOL

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Volume	Interest	Open Settle.	ImpVol	Delta	Gamma	Vega	Theta	OptionID	Adj. Factor
102037	1-Feb-01	QBS.BW	0	17500	17-Feb-01	C	3.75	4.125	26-Jan-01	0	22	0	0.77	0.91	0.05	0.70	-7.40	20019826	1
110539	2-Feb-01	QBJ.BW	0	17500	17-Feb-01	C	5.2	5.5	.	0	22	1	-99.99	-99.99	-99.99	-99.99	-99.99	20019826	1
110539	5-Feb-01	QBJ.BW	0	17500	17-Feb-01	C	6	6.5	5-Feb-01	2	22	1	-99.99	-99.99	-99.99	-99.99	-99.99	20019826	1
110539	6-Feb-01	QBJ.BW	0	17500	17-Feb-01	C	5.9	6.4	5-Feb-01	0	20	1	-99.99	-99.99	-99.99	-99.99	-99.99	20019826	1
110539	7-Feb-01	QBJ.BW	0	17500	17-Feb-01	C	6.6	7.1	5-Feb-01	0	20	1	-99.99	-99.99	-99.99	-99.99	-99.99	20019826	1
...
110539	16-Feb-01	QBJ.BW	0	17500	17-Feb-01	C	6.3	6.8	5-Feb-01	0	20	1	-99.99	-99.99	-99.99	-99.99	-99.99	20019826	1

5.10– IMPACT FROM CERTAIN DISTRIBUTIONS (1/2)

- The value of 'Distribution Type' column helps us identify these corporate events
- Following are examples of some of these corporate events, which do not occur very frequently, to help us better understand the nature of their impact on underlying data

■ 1 – Regular dividend	2 – Split	3 – Stock dividend
■ 4 – Capital gain distribution	5 – Special dividend	6 – Spin-off
■ 7 – New equity issue (same company)	8 – Rights offering	9 – Warrants issue

2 EXAMPLE OF REVERSE SPLIT - 0.25, GOES INTO SPECIAL SETTLEMENT AS WELL

3 EXAMPLE OF STOCK DIVIDEND - PREDOMINANTLY GOES INTO SPECIAL SETTLEMENT

7 EXAMPLE OF NEW EQUITY ISSUE (NEW CLASS OF SHARES TO EXISTING SHAREHOLDERS)

65

OPTION_PRICE

5.10– IMPACT FROM CERTAIN DISTRIBUTIONS (2/2)

» continued...

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
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8 EXAMPLE OF RIGHTS OFFERING - EVERYTHING GOES INTO SPECIAL SETTLEMENT

100931	6-Nov-02	KUH.AA	0	5000	17-Jan-04	C	5.20	5.30	29-Oct-02	1	20354977	1
100931	6-Nov-02	LYU.AU	0	7500	18-Jan-03	C	2.25	2.50	6-Nov-02	1	20684669	1
117075	16-Jul-02	MBY.VX	0	22500	19-Oct-02	P	3.20	3.50	10-Jul-02	1	20619742	1
116305	5-Nov-03	EBB.XH	0	40000	20-Dec-03	P	0.20	0.75	28-Oct-03	1	21131716	1

9 EXAMPLE OF WARRANTS ISSUE (VERY FEW CASES) - CASE BY CASE BASIS

127511	12-Sep-13	MHR 150117C7500	1	7500	17-Jan-15	C	0.80	0.95	12-Sep-13	0	83381872	1
101397	20-Jan-11	AIG1 110122P2500	1	2500	22-Jan-11	P	0.00	0.05	20-Jan-11	1	33702401	1
110856	29-Aug-13	TRC1 130921P30000	1	30000	21-Sep-13	P	0.05	4.90	.	1	101370833	1

» Since most of these special cases are flagged off by special settlement flag, we do not need to specifically check for each of these in the data

» For further insights into these examples, please refer to the OCC memos



OCC Memos.7z

5.11– DATA QUALITY ISSUES PRIOR TO 2000

» Data quality concerns prior to November 2000:

- Prior to November 28, 2000, data was obtained in chunks from IDC and was very noisy with missing/incorrect attributes. Tremendous effort has been put in cleaning this data, however, some errors still remain
- The 'Symbol' assigned to option price records older than 11/28/2000 were generated by OptionMetrics since the actual symbols under which the contracts were traded are not available
- These symbols were generated and assigned ***without any regard to the nomenclature*** norms at the time
- The purpose of those generated symbols was to facilitate the creation of primary key on the table

SYMBOL DOES NOT CHANGE BUT STRIKE DOES - Pre 2000

SecurityID	Date	Symbol	Symbl Flag	Strike	Expiration	CallPut	Best Bid	Best Offer	Last Trade	Special Settle.	OptionID	Adj. Factor
8239	5-Jan-96	0989E.9F	0	60000	20-Jan-96	C	11.88	12.25	5-Jan-96	0	10002079	1
8239	8-Jan-96	0989E.9F	0	30000	20-Jan-96	C	5.75	6.13	8-Jan-96	0	10002079	1
104628	15-Jan-96	098AC.A6	0	125000	20-Jan-96	P	4.13	4.50	15-Jan-96	0	10005670	1
104628	16-Jan-96	098AC.A6	0	31250	20-Jan-96	P	1.06	1.31	16-Jan-96	0	10005670	1
105880	19-Jan-96	098B9.1C	0	65000	17-Feb-96	P	17.25	18.00	.	0	10008860	1
105880	22-Jan-96	098B9.1C	0	32500	17-Feb-96	P	8.75	9.25	.	0	10008860	1

split 2

split 4

split 2

- Change in strike price without any change in adjustment factor suggested that these were instances of 'special dividend'. Upon further investigation, however, these were found to be cases of split, which wasn't correctly represented in the adjustment factor value
- Due to such errors in the data (prior to 2000) – we've only used data for underlying option contracts, starting from January 2001

MISCELLANEOUS NOTES

- » **FLEXible EXchange Options (FLEX Options) are long dated options:**
 - Expiry of FLEX options can go as long as 15 years
 - Trade information on FLEX options is available at : <http://www.optionsclearing.com/webapps/flex-reports>
 - OptionMetrics database does not have information on these contracts
 - Refer to SAS code “Long_Dated_Options” for more details

- » Using **Option_Price** data file in place of **Option_Volume**:
 - Option_Volume table is derived from the Option_Price table
 - Hence we have used Option_Price table directly in the SAS code

- » Distribution data file has entries where Ex-Date is 1Jan1900
 - This is a dummy date in the distribution table, for those cases where distribution has no impact

III. Literature Overview

Option Volume and Stock Prices: Evidence on Where Informed Traders Trade

Easley, O'Hara and Srinivas (Journal of Finance, 1998)

Overview:

- » Develop an asymmetric information model
 - Key aspect: allows informed traders to choose whether to buy / sell the stock, buy / sell a put, or buy / sell a call
- » “Option is a derivative security and so its price should be dictated unilaterally by the stock price” only holds in complete markets
- » Investigate the informational role of transactions volume in options markets
 - Information is impounded into prices by trading, then the ability of informed traders to transact in options markets means that the option trading process is not redundant
 - Informed traders trade: this new information is first revealed in the option volume and not in option prices (which are still based off old stock price and volatility)
 - Thus ***option volume today tells us something about stock returns tomorrow***
- » Pooling equilibrium:
 - Informed trader uses stock market – if the liquidity of the options market is low
 - Informed trader uses option market – leverage effect of options is large enough, liquidity in stocks is low, number of informed traders is large (some go to options)

Results:

- » Show empirically that "positive news" option volumes and "negative news" option volumes have predictive power for stock price movements
 - Option volumes are categorized as positive / negative based on the quote and trade information^[1]
 - If option volumes are not sorted using our information-based theory, there is little or no evidence of information content in option trades

[1] Lee and Ready (1991) present an excellent survey of techniques currently in use and evaluate their efficiency using NYSE transactions data.

Demand Based Option Pricing

Gârleanu, Pedersen and Poteshman (Review of Financial Studies, 2009)

Overview:

- » Model departs fundamentally from the no-arbitrage framework by recognizing that option market makers cannot perfectly hedge their inventories, and consequently, option demand impacts option prices
- » If competitive intermediaries can hedge perfectly — as in a Black-Scholes-Merton economy — then option prices are determined by no-arbitrage and demand pressure has no effect.
- » In reality, intermediaries cannot hedge options perfectly – due to incomplete markets, impossibility of trading continuously, stochastic volatility, jumps in the underlying, and transaction costs, capital constraints and agency problems etc.
- » Model is agnostic about the end users' reasons for trade
- » Model shows that demand pressure in one option contract increases its price by an amount proportional to the variance of the un-hedgeable part of the option. Similarly, the demand pressure increases the price of any other option by an amount proportional to the covariance of the un-hedgeable parts of the two options

Results:

- » First to document that end users have a net long position in S&P500 options with large net positions in OTM puts^[1]
 - The end-user demand for index options can help to explain the two puzzles that index options appear to be expensive, and that low-moneyness options seem to be especially expensive
- » Estimate **1/3rd of the “expensiveness” is due to demand affects.**
 - Remaining is due to compensation for other risks (stochastic volatility, jumps etc.)
- » Individual stock options shows much flatter smile than index options – explained by the fact that end-buyers are net short individual stock options
- » Their model imply symmetric impact on call and put prices of either call or put demand i.e. put-call parity still holds

[1] Rubinstein 1994, described this as end-users sufferings from “crashophobia”

[2] Related paper: Bollen and Whaley (2004), demonstrate that changes in implied volatility are correlated with signed option volume

Deviations from Put-Call Parity and Stock Return Predictability

Cremers and Weinbaum (Journal of Financial and Quantitative Analysis, 2010)

Overview:

- » Option prices can deviate from put-call parity by a significant amount without there being an arbitrage opportunity
- » Several interpretations of this deviation:
 - Apparent deviations from put-call parity may simply be the random outcome (noise)
 - Reflect short-sale constraints^[1]
 - Reflect trading activity of informed investors and hence predictability – this paper provides analysis of this hypothesis

Results:

- » Predictability is due to informed trading, based on following results:
 - Deviations are more likely to occur when underlying stock faces a more asymmetric information environment^[2]
 - Abnormal returns are 2x larger for high PIN^[2] group, compared to low PIN group
 - Degree of predictability is higher when the option signal is based on options with more leverage^[3]
 - More predictability among stocks with higher residual analyst coverage
 - Deviations are significantly related to the transactions volume in puts and calls initiated by option buyers^[4]
- » Long short portfolio earns an abnormal return of 42 basis points over the next month (t-stat of 2.88)
 - Even stronger results when we form portfolios based on both changes and levels of volatility spreads
- » Degree predictability decreases considerably over the sample period (1996 - 2005)
- » Option prices can lead stock prices by several days, not simply minutes
- » Results not only imply that price discovery takes place in the options market, but also point to market inefficiency

[1] See Lamont and Thaler (2003), Ofek and Richardson (2003) and Ofek, Richardson and Whitelaw (2004). Battalio and Schultz (2006) use intraday options data, rather than closing quotes, and resolve the apparent violations of put-call parity. However, they do not address the finding of predictability in returns.

[2] Easley, Kiefer and O'Hara (1997) and Easley, Hvidkjaer and O'Hara (2002).

[3] Consistent with Easley, O'Hara and Srinivas (1998) model. [4] Consistent with Pan and Poteshman (2006).

Volatility Risk Premiums Embedded in Individual Equity Options

Bakshi and Kapadia (Journal of Derivatives, 2003)

Overview:

- » Index Options incorporate negative volatility risk premium, i.e. they are relatively more expensive than Black-Scholes price
 - As markets go down, volatility goes up → increasing the price of the option
 - Equity options show same characteristic, but to lesser extent
- » If volatility risk is not priced, portfolio of Call (+) and Stock (-) should earn only risk-free return
- » **Intuition:** Shocks to market volatility are negatively correlated with market returns; hence, including options in a portfolio will help hedge market risk, as the option vega is positive.
 - Vega is highest for ATM options
- » The hedging motive makes investors willing to pay a risk premium for a long option position, implying a negative volatility risk premium.

Results:

- » On average, near-money Black-Scholes implied volatilities from individual equity options are greater than historical realized volatilities
- » Delta-hedged gains of individual equity options are more negative than positive
 - Over all firms, on average, the delta hedging strategy loses a statistically significant 0.03% of underlying asset value. The same delta-hedging strategy for the index loses 0.07% of the underlying index level
 - **Strategy loses about 0.13% for at-the-money calls, this amounts to 8% of the option value and is economically large^[1]**
- » Individual equity delta-hedged gains are significantly negatively correlated with the level of market volatility
- » Cross-sectional regression results indicate that delta-hedged gains are negatively related to vega^[1]

[1] Related paper: Delta-Hedged Gains and the Negative Market Volatility Risk Premium (Bakshi and Kapadia, The Review of Financial Studies, 2003).

Informed Trading in Stock and Option Markets

Chakravarty, Gulen and Mayhew (Journal of Finance, 2004)

Overview:

- » First unambiguous evidence that stock option trading contributes to price discovery in the underlying stock market
- » Document that the level of contribution of the option market to price discovery is related to market frictions
- » Theory suggests several factors that might influence the informed trader's choice of strike price
 - Out-of-the-money (OTM) options offer an informed trader the greatest leverage. On the other hand, comparing transactions costs for delta equivalent positions, bid-ask spreads and commissions tend to be widest for OTM options
 - Bid-ask spreads tend to be lowest for ATM options, while commissions tend to be lowest for ITM options
 - Trading volume by volatility traders tends to be concentrated in ATM options, and this provides camouflage for informed traders. But ATM options also expose informed traders to higher “vega” (volatility) risk

Results:

- » On average, ~17 – 18% of price discovery occurs in the option market
- » Find no significant difference between estimates based on ATM (strike within 5% of underlying) and ITM options, the information share estimate tends to be higher for OTM options, on average across the 60 stocks.

A. Information Share			
	ATM	ITM	OTM
Information Share (60 stocks)	0.1746	0.1768	0.2158
Information Share (IBM)	0.1902	0.1858	0.1594

- This suggests that leverage may be the primary force driving price discovery in the options market
- Informed traders value both leverage and liquidity (many researchers have concluded this)
- In case of IBM, ATM options are more telling than OTM options; IBM has unusually high ATM trading volume relative to OTM volume, very low ATM bid-ask spread relative to OTM spread, and a resulting information share is higher for ATM options than OTM options.

Note: This paper used only call options for analysis, whereas Cremers and Weinbaum (2010) combined puts and calls, allowing them to find significant evidence of stock return predictability.

Thank You