

The Informational Content in Option Markets

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SIG at a Glance

The Susquehanna International Group of Companies (SIG) is one of the largest privately held global financial institutions. Combining sophisticated quantitative applications with advanced technology, we make deep, liquid markets in most every major asset class and corresponding derivative product.

Through its affiliate, Susquehanna Financial Group, LLLP (SFG), the company employs dedicated professionals in the areas of sales, fundamental research, market intelligence, and investment banking. Building upon SIG's command of the options marketplace and its quantitative trading capabilities, SFG offers liquidity, industry-leading insights, and execution services.

Founded in 1987 with approximately 40 employees, SIG today employs more than 1,500 people located in North America, Asia, Australia, and Europe.

The SIG Philosophy

SIG built its trading and market making platforms on the principles of probability and astute decision making, and we continue to hone those disciplines to generate success for our clients. Our experience in uncertain market environments gives us an analytical edge in the global marketplace.

Our boutique-like size and flat management structure enable us to adapt easily to changing markets and to commit resources opportunistically. We take pride in using our renowned market making capabilities to serve our clients in ways that distinguish us from our peers.

SIG Market Intelligence Products

SIG Facts - Daily pre-market morning newsletter that recaps and summarizes breaking news stories, company developments, and analyst actions from across all sectors of the market, which also includes previews of upcoming events on an industry-wide and company-specific basis.

SIG Facts Plus - This daily newsletter is released pre-market and provides subscribers with trading intelligence, current news, insider transactions, and portfolio component data that is customized based on a list of symbols provided by the client.

U.S. & Euro Recap - A snapshot of European sector movers and market performance drivers released pre-market on a daily basis that includes a summary of trading in U.S. exchange-listed equity and index options, and ETFs from the previous day.

Intra-Day Significant Activity - A mid-day options recap report that highlights the morning's most notable trading in exchange listed options, ETFs, and indices, coupled with research commentary.

SIG Derivatives Daily - Our key pre-market derivative report highlights notable trends from the previous day's trading, provides actionable trading strategies and notable observations, and includes daily analysis of shifts in volatility.

Quantitative Research

Case Study – “Crash Put” Buying

February 26, 2009

Nasdaq 100 (NDX) spot ~ \$1,127

Opening investors purchase 6,000 May 600 Puts for \$1.90

Banking on a ~47% decline?

Why option traders should think like poker players

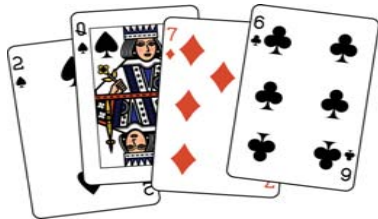
Texas Hold'em example



You



Opponent



Board

Opponent bets
\$5 into \$35 pot,
do you call or
fold?

Why option traders should think like poker players

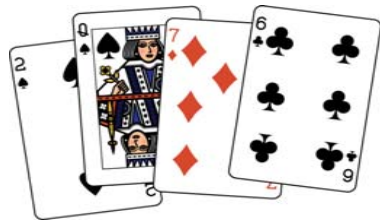
Texas Hold'em example



You



Opponent



Board

7 outs
(any spade, but not a 6 or a 7)
44 unseen cards
7/44 chance
of winning
or 5.3:1
Getting 40:5
odds, or 8:1
So you should call.

Backing out the implied stock distribution

Hypothetical Binary Example

XYZ = \$20

If binary event is Positive → XYZ > \$50

If binary event is Negative → XYZ < \$10

Market Value of May 30/35 call spread = \$1.50

If binary event is Positive → call spread = \$5 (both calls trade for parity)

If binary event is Negative → call spread = \$0 (both calls are worthless)

Call Spread = Sum of possible outcomes * Probability of each outcome

$\$1.50 = (\text{Probability of Positive outcome}) * (\$5) + (\text{Probability of Negative outcome}) * (\$0)$

$\$1.50 = (\text{Probability of Positive outcome}) * (\$5)$

Probability of Positive outcome = $\$1.50 / \$5 = 30\%$

Vertical Spread Value ÷ Difference in strikes = Probability stock finishes above/below midpoint

Case study follow-up

SPX May Puts

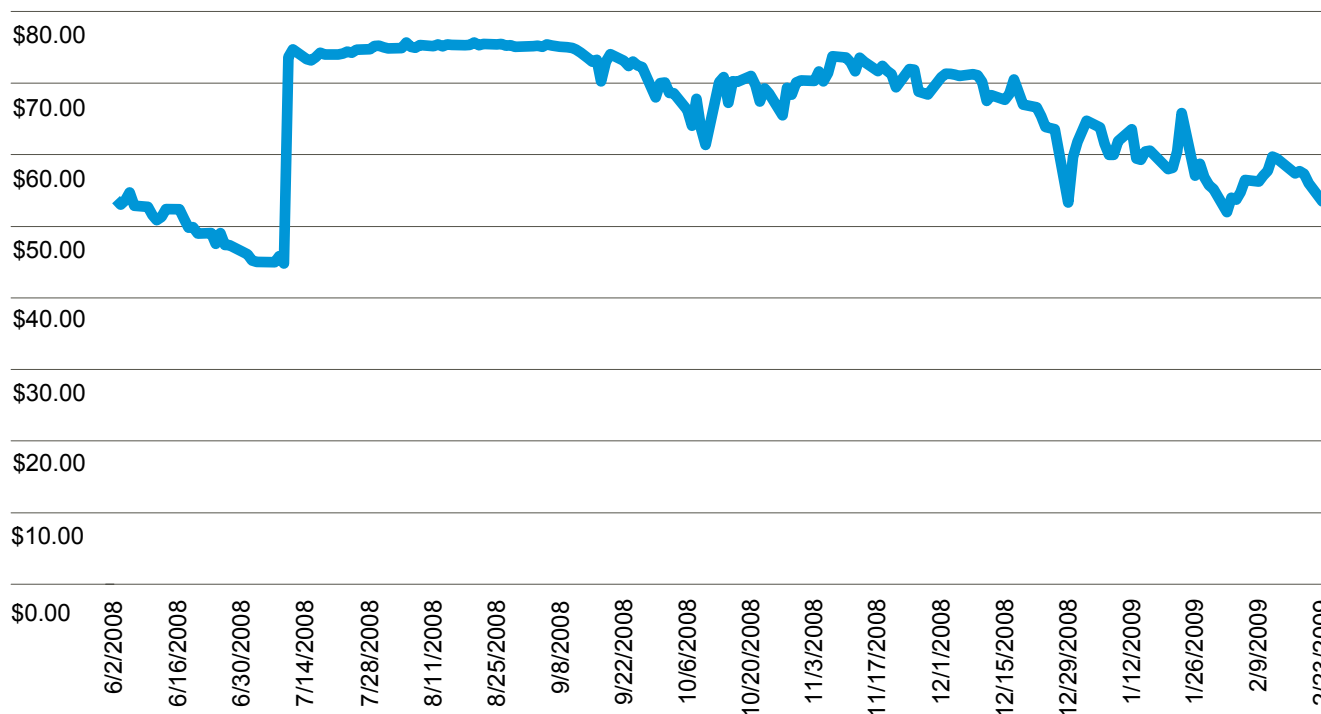
<u>Strike</u>	<u>Put Mid-Market</u>
575	\$1.60
600	\$1.90
625	\$2.20

May 625/575 Put Spread = \$0.60

$\$0.60/\$50.00 = 1.2\%$

Rohm and Haas Co (ROH) — Special Situations

ROH Price Performance



Source: Bloomberg

Using the options market to handicap ROH outcomes

ROH option-implied distribution as of 2/26/2009:

ROH Price at July expiration spot=\$53.75	Option-implied probability
<\$30.00	~25%
<\$35.00	~29%
<\$40.00	~32%
<\$45.00	~36%
<\$50.00	~37%
>\$55.00	~62%
>\$60.00	~58%
>\$65.00	~44%
>\$70.00	~31%
>\$75.00	~18%

Source: Bloomberg

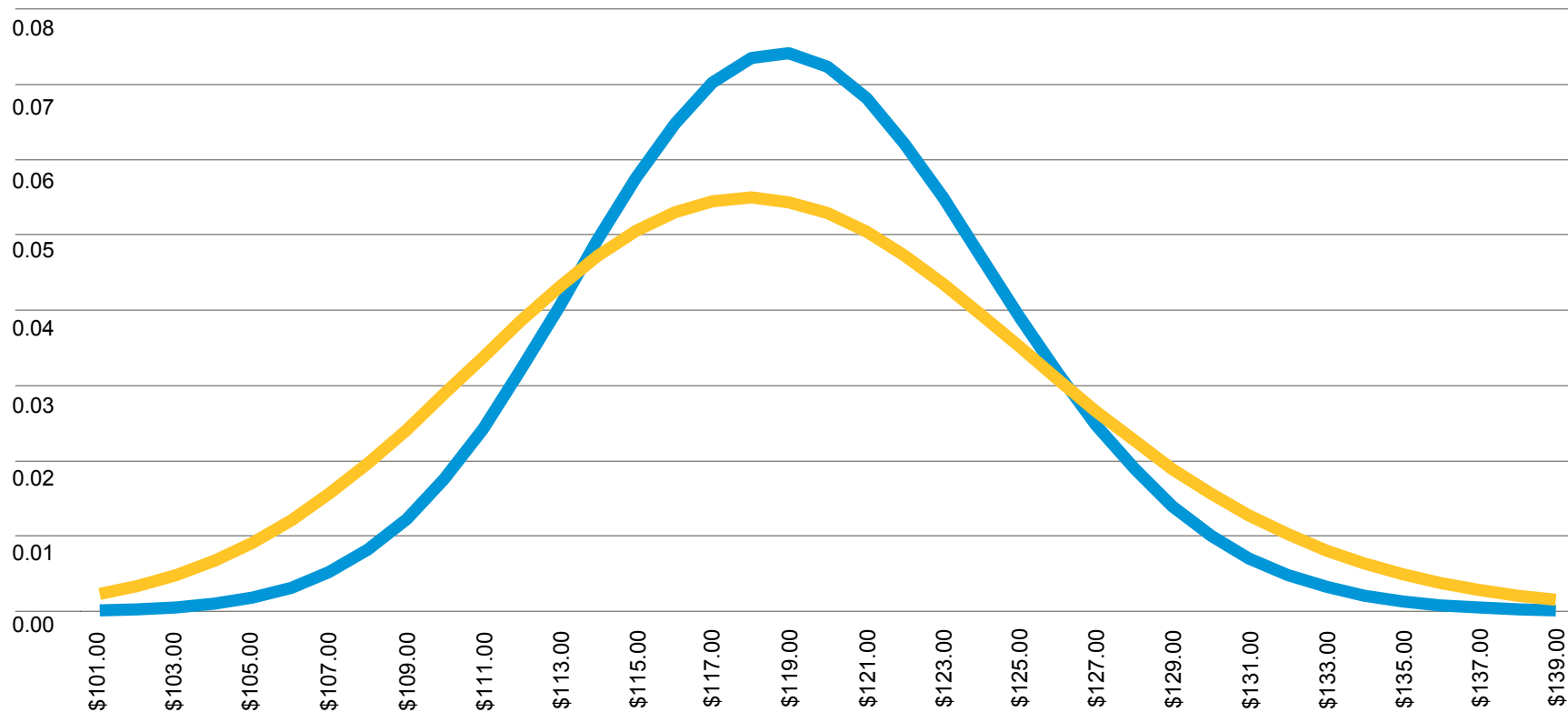
DNA Outcomes

DNA option-implied distribution as of 3/3/2009:

DNA Price at June expiration spot=\$82.13	Option-implied probability
<\$77.50	~33%
<\$80.00	~37%
<\$82.50	~41%
>\$85.00	~56%
>\$87.50	~53%
>\$90.00	~44%
>\$92.50	~35%
>\$95.00	~27%
>\$97.50	~19%
>\$100.00	~14%

Source: Bloomberg

Application of the option-implied distribution



Case Study - DELL

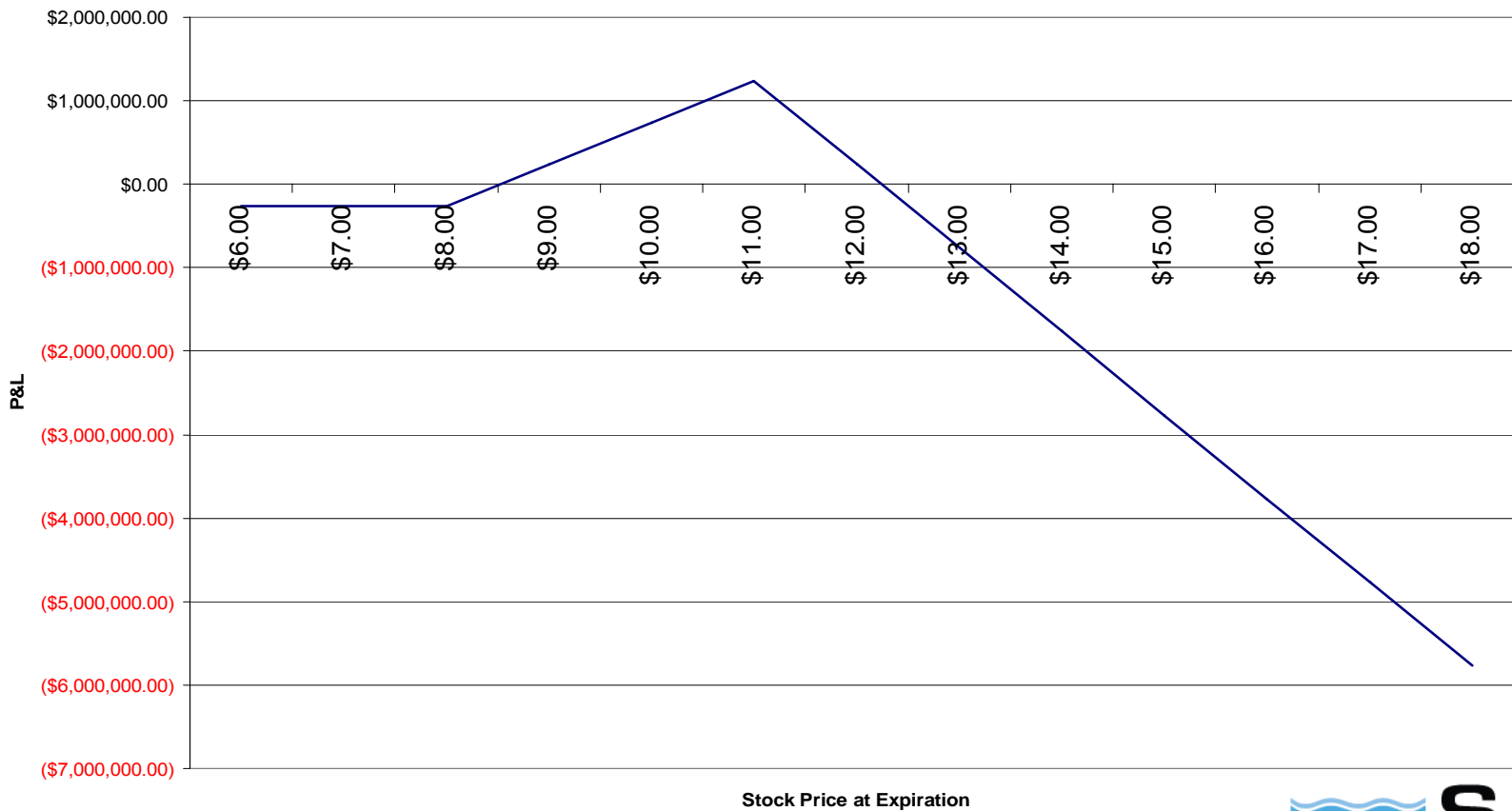
February 23, 2009

Dell Inc. (DELL) Spot \$8.25

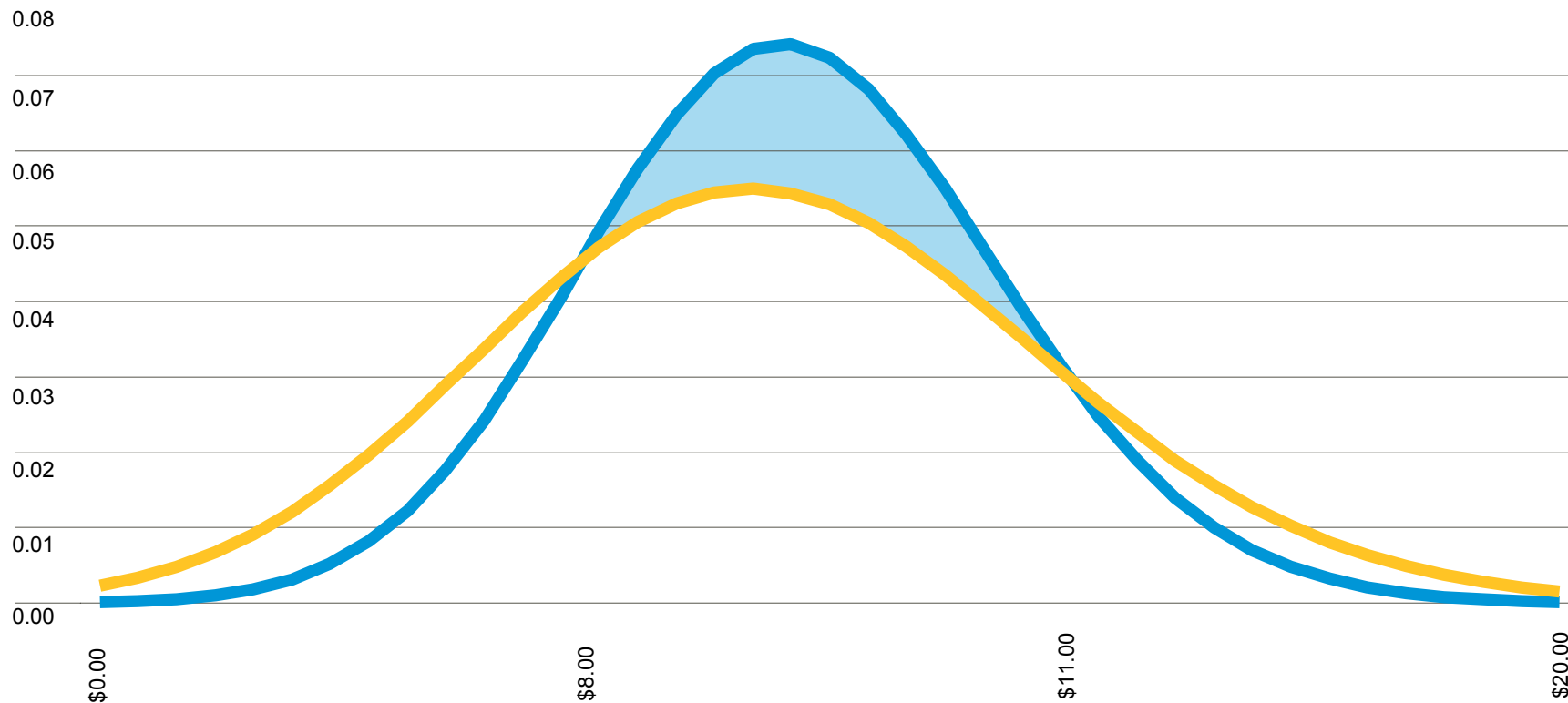
Opening investors purchase 5,000 May 8 Calls for \$1.16
vs. selling 15,000 May 11 calls @ \$0.21

Net, the trade cost \$0.53 to put on

Case Study – DELL 1x3 P&L



Case Study – DELL Distribution



Black-Scholes inputs

Black-Scholes formula

$$C = Se^{-qt} N(d1) - Ke^{-rt}N(d2)$$

where:

$$d1 = \frac{\ln (S/K) + (r - q + .5\sigma^2)T}{\sigma\sqrt{T}}$$

$$d2 = \frac{\ln (S/K) + (r - q - .5\sigma^2)T}{\sigma\sqrt{T}}$$

N(x) is the Standard Normal

Variables that affect options pricing

Stock price = S

Strike price = K

Interest rates = r

Dividends = q (in yield terms)

Time to expiration = T

Volatility = σ

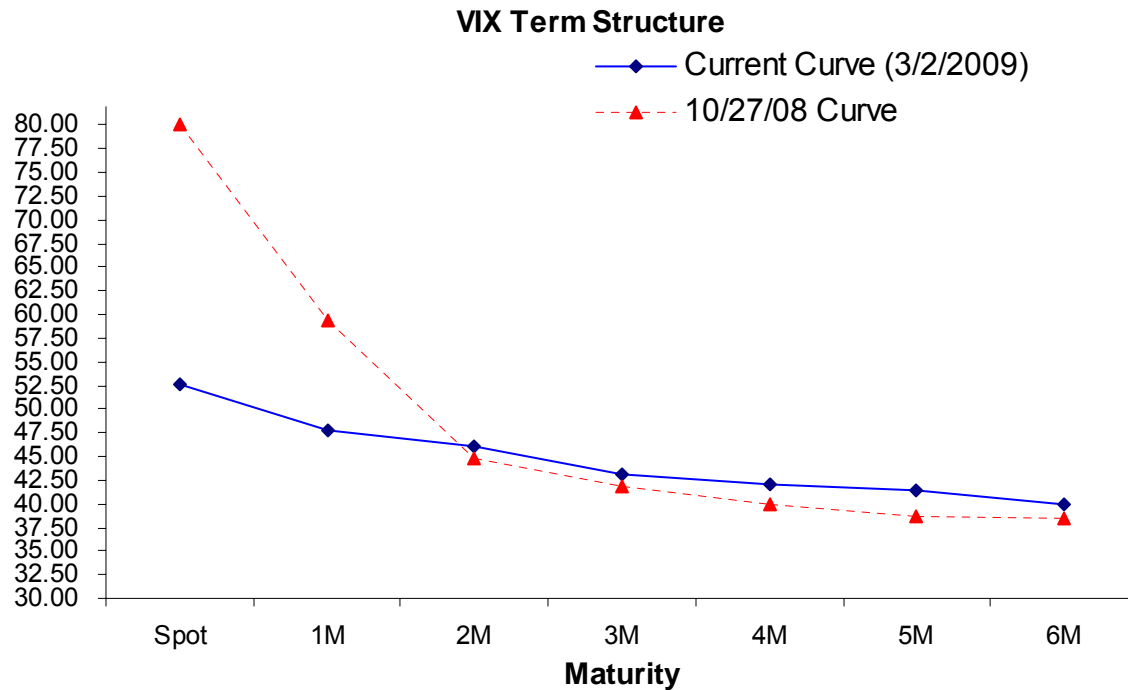
Implied dividends

February 26, 2009 Snapshot: GE

Price	\$9.35
Strike	January '10 12.50
Interest	\$0.11
Expected dividends (3*\$0.31)	\$0.93
Theoretical combo ((S-K)+PV(Int)-PV(DVD))	(\$3.97)
Market Combo (Call-Put)	(\$3.36)
Market Combo – Theoretical Combo	\$0.61
Implied Dividends	\$0.32

Source: SFG Research
and Bloomberg

Can the VIX be misleading?



Risks

Buying Call: If at expiration the stock finishes below the strike price, the risk to the investor is losing the entire premium paid. The call is profitable if at expiration the stock finishes above the strike price plus the premium paid for the call.

Buying Call Spread: Buying a call spread is buying a call and selling a call with a higher strike that has the same underlying and expiration. If at expiration the stock finishes below the lower strike price, the risk to the investor is losing the entire premium paid for the spread. The call spread is profitable if at expiration the stock finishes above the lower strike price plus the premium paid for the call spread. The call spread's maximum payout occurs when the stock finishes at the higher struck call at expiration.

Buying Put: If at expiration the stock finishes above the strike price, the risk to the investor is losing the entire premium paid. The put is profitable if at expiration the stock finishes below the strike price minus the premium paid for the put.

Buying Put Spread: Buying a put spread is buying a put and selling a put with a lower strike that has the same underlying and expiration. If at expiration the stock finishes above the higher strike priced put, the risk to the investor is losing the entire premium paid for the spread. The put spread is profitable if at expiration the stock finishes below the higher strike price minus the premium paid for the put spread. The put spread's maximum payout occurs when the stock finishes at the lower struck put at expiration.

Buying Straddle: Buying a straddle is buying a call and buying a put with the same underlying, strike and expiration. If at expiration the stock finishes at the strike price, the maximum loss occurs of the total premium paid. The straddle is profitable if at expiration the stock finishes above the strike plus the total premium paid or below the strike price minus the total premium paid.

Selling Call: (Naked – no underlying stock position) If at expiration the stock finishes above the strike price, the risk to the investor is unlimited. The short call is profitable if at expiration the stock finishes below the strike price plus the premium collected for the call. (Covered – versus an underlying stock position) If at expiration the stock finishes above the strike price, the risk to the investor is limiting their upside profit on long stock to strike price plus premium collected for the call. If at expiration the stock finishes below the strike price, the investor profits on the premium collected from the call sale which may help enhance stock returns or offset stock losses.

Selling Call Spread: Selling a call spread is selling a call and buying a call with a higher strike that has the same underlying and expiration. If at expiration the stock finishes above the lower strike price, the risk to the investor is losing the entire premium collected for the sale, with a maximum loss of the difference between the strikes minus the premium collected. The call spread is profitable if at expiration the stock finishes below the lower strike price plus the premium collected for the call spread. The call spread sale's maximum payout occurs when the stock finishes at the lower struck call at expiration.

Selling Put: One risk to selling a put is that if assigned on the short put, investors will be forced to buy shares at the strike price, minus any premium collected for the sale. If at expiration the stock finishes below the strike price, the maximum risk to the investor is the strike price minus the premium collected. The put is profitable if at expiration the stock finishes above the strike price and the investor collects the premium for the put sale.

Selling Put Spread: Selling a put spread is selling a put and buying a put with a lower strike that has the same underlying and expiration. If at expiration the stock finishes below the higher strike priced put, the risk to the investor is losing the entire premium collected for the sale of the spread, with a maximum loss of the difference between the strikes minus the premium collected. The put spread is profitable if at expiration the stock finishes above the higher strike price minus the premium collected for the put spread. The put spread's maximum payout occurs when the stock finishes at the higher struck put at expiration.

Selling Straddle: Selling a straddle is selling a call and selling a put with the same underlying, strike and expiration. If at expiration the stock finishes above the strike price plus the total premium collected or below the strike price minus the total premium collected, the maximum loss is unlimited. The straddle is most profitable if at expiration the stock finishes at the strike price and the investor collects the premium.

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