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The Compelling Case for Long-Dated SPX Calls

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[redacted]

The current combination of low volatility levels and embedded protection makes longer-dated call strategies attractive to position for further equity appreciation. With call premia near decade-long lows, upside options offer benefits compared to long equity positions or can be used to safely enhance core cash equity holdings. In this note we examine the pricing drivers of SPX 18- to 36-month expiry call options and compare historical returns of different strategies and to outright equity. Broadly, call strategies have exhibited better risk-adjusted returns than holding a cash position in the SPX index.

Long-dated calls on the SPX index are priced attractively

There are two main drivers of long-dated call premia, both of which help make pricing compelling right now

- Long-dated SPX spot implied volatility is extremely low. The depressed rates volatility and low correlation between rates and equities create further downward pressure on the implied volatility of the SPX forward
- The SPX forward itself is depressed vs. the spot level. The currently low level of interest rates and relatively high implied dividend yields have resulted in negative carry costs and have pressured the SPX forward, which makes the option premia appear low optically

Choosing a long-dated call strategy: findings from our 10-year backtest

- We find that call spreads tended to have the highest risk-adjusted returns among the strategies studied.
- Strategies involving selling 1M options to finance the longer-dated calls have performed better than equity and outright calls. These results are consistent with our previous research showing that implied volatility risk-premium is typically rich for short-dated options. However, short 1M options underperform in strongly rallying markets, such as the SPX this year.
- Rolling a long call (spread) position before expiry would have generally (but not always) resulted in higher risk-adjusted returns. Rolling prior to expiry reduces the negative effects of time decay, since shorter-dated options lose time value quickly

Sensitivity of call premia and relative magnitude of risks

While delta is the main driver of call P/L longer-dated options have a higher exposure to other risks. We compare the impact on current SPX call premium from changes in spot, time, implied volatility, rates, and dividend yields.

Risks headline

The loss from a long option or long option spread position is limited to the net premium paid. Please note that hypothetical backtest results are neither an indicator nor a guarantee of future returns.

The basics of long-dated calls

Better risk-adjusted returns at an attractive price

Buying long-dated call options offers benefits to investors seeking equity exposure. They allow for continued upside participation and at the same time provide a floor should the broad market decline rapidly. In this note, we show that longer-dated SPX call strategies have historically provided better risk-adjusted returns compared with buying and holding the broad index.

There are several key features of call options that should appeal to a wide range of equity investors:

- Current pricing: Long-dated calls on the SPX index are priced attractively with levels for both ATM and OTM calls near decade-long lows (see Figure 1)
- Embedded risk management characteristics: Call 'delta' (sensitivity of the call's price to spot moves) increases in a rally and decreases in a sell-off. Thus investors get longer as the market moves higher and less long as the market sells off. This convexity property of long options is especially attractive in a market pullback and is a reason why long-dated calls result in higher risk-adjusted returns in our backtests vs long equity only

Figure 1: Current long-dated call option premium near decade-long lows

Source: Deutsche Bank.

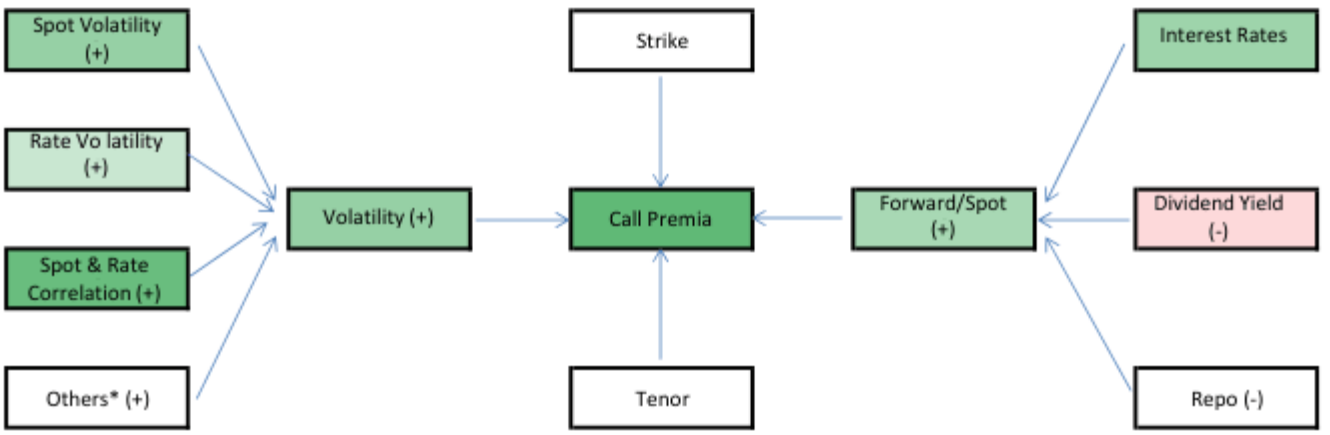
The note is divided into three parts:

- Why current pricing on long-dated calls is attractive relative to history
- How different long-dated call structures have performed historically, including partly cheapening long-dated calls by selling higher strike calls with the same maturity and by selling 1M calls
- What is the relative magnitude of the different risks inherent in long call positions

Low rates, high dividend yields, and low implied volatility levels make long-dated calls historically cheap

Figure 2 shows the drivers of call option pricing, which are now at levels that make current pricing attractive. The colors signify whether these values are low (green) or high (red) within their history since Jan-03. We also annotate the boxes if higher values of these factors affect call premia positively ('+') or negatively ('—'). For example, dividend yields are currently high from a historical perspective (red) and increasing yields would lead to lower call premia ('—' sign). Thus we can infer from the figure that the currently elevated dividend yields help lower call premia. Most of these drivers of long-dated call prices are addressed below.

Figure 2: Low vol, low rates, and high implied dividend yields depress call premia[1]

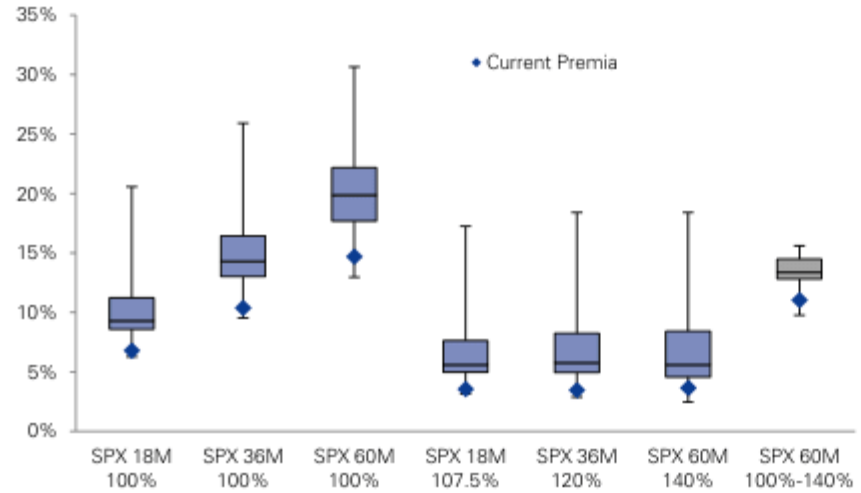


*Others includes dividend yield volatility, repo volatility and some correlation terms
Source: Deutsche Bank

Figure 3 shows the distribution of call pricing for different maturities and strikes over the past ten years. As you can see current pricing for these calls strategies is near the bottom of its range over the past decade. It is particularly notable that levels are near lows for the range of maturities and strikes.

[1] The boxes are color coded depending on the percentile rank of current values compared with their histories over the past eight years. Green color is for a low percentile rank and red is for high.

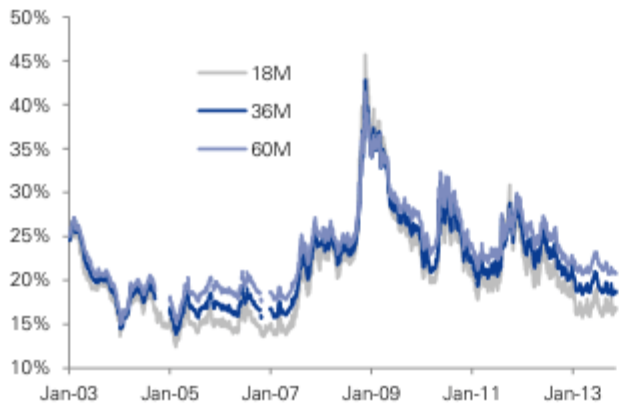
Figure 3: Current premia for long-dated SPX calls and call spreads is low



Source: Deutsche Bank
Max-Min lines represent the distance between the maximum and minimum of the call option premia since Jan-2003.
Hi-Lo bars represent the distance between the 75th and 25th percentile of the call option premia since Jan-2003.
The line between the Hi-Low bars represents the median call option premia since Jan-2003. Solid dots represent the current level of the indicator.

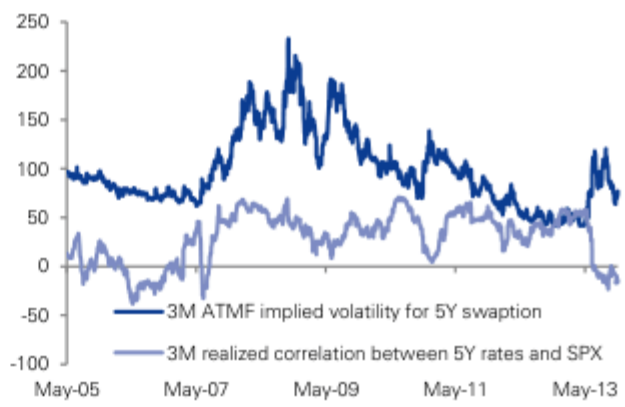
The main driver of the depressed option premium is due to SPX spot implied which has declined sharply throughout 2013 (see Figure 4). Further downward pressure on SPX long-dated call premia is also due to low rate volatility and the decreased correlation between rates and equities (longer maturity equates to greater sensitivity to the volatility of the forward vs. short-dated options, see Figure 5).

Figure 4: SPX long-dated ATMS implied vols are near historically low levels…



Source: Deutsche Bank

Figure 5: …as are rate implied volatility and rate-equity correlations*



Source: Deutsche Bank, Bloomberg Finance LP
**We show realized correlations as a proxy for implied due to data unavailability*

A second effect is due to the SPX forward itself which is materially lower vs. the spot level. This makes the SPX option premia appear low optically. The following equations help understand the drivers of the forward:

$$\text{Forward} = \text{Spot} + \text{Cost of Carry}$$

$$\text{Cost of Carry} = \text{Spot} \times (\text{Interest Rate - Repo - Dividend Yield}) \times \text{Time}$$

US interest rates have been depressed by the iterations of QE programs and dividend payments have been increasing in the post financial crisis recovery. The low level of rates (see Figure 6) and relatively high implied dividend yields (see Figure 7) have resulted in negative carry costs and have reduced the SPX forward (the spot value 'grown' by the carrying costs, see Figure 8).

Please note that the effect of the forward on the call premia is 'optics' – dividends will reduce the price of the underlying (and call options as well if actual dividends are higher than priced into options). However, as shown in Figure 2, rates rising from these low levels and/or dividend yields falling will result in a mark-to-market gain on the long call position, all else equal.

Figure 6: Low rates…

Source: Deutsche Bank, Bloomberg Finance LP

Figure 7: …and relatively high SPX implied dividend yields…

Source: Deutsche Bank

Figure 8: …have depressed SPX forward levels

Source: Deutsche Bank

Anecdotally, a less material impact on SPX call premia is due to repo rates which decreased significantly at the beginning of 2013 and have rebased to a much lower range since then. The lower repo level and elevated repo volatility are factors that have pushed call prices slightly higher from where they would otherwise be.

The low forward combined with depressed long-dated implied volatility has resulted in the most attractive pricing on long-dated call options in many years. As an example of how marked this difference can be, if we compare prices of 60-month maturity SPX ATMS calls on 30-Jun-03 and 11-Oct-13, two periods with the same implied volatilities but very different forwards, the difference in premium is ~4.5% (19.1% vs. 14.6%). However, if we compare the option prices in terms of the forward (ATMF strikes), then the above mentioned spread in the premium disappears.

Historical performance of long-dated calls

Option strategies have had better risk-adjusted returns vs index performance

In this section, we look at the historical performance of different long-dated call strategies[2]. We compare the performance of the option positions vs. the total return on the SPX Index. These backtests[3] focus on SPX 18M and 36M options. We chose the 18M maturity for our backtests since many investors prefer exchange-listed options to OTC and 18M is the farthest listed maturity for which we had consistent data for the SPX. We chose the 36M maturity to study the results for even longer-dated options whose vega exposure does not decay as rapidly. Our results are largely similar among the two maturities studied and include those for

- Calls and call spreads either held to maturity or rolled[4] after some time has passed in the life of the option
- Call diagonals (buy long-dated calls financed by selling 1M calls) where the long-dated call is either held to maturity or rolled after some time has passed in the life of the option

We find that:

- Call spreads tend to have the highest risk-adjusted return, even after scaling their delta higher to match the initial delta of just the long call leg
- Selling 1M 2% annualized premia calls to finance the purchase of long-dated calls has had better risk-adjusted performance compared with equity or outright calls
- Rolling long-dated calls and call spreads prior to expiry has generally (but not always) resulted in higher risk-adjusted returns than holding them to expiry

The table below displays the performance of these strategies in up and down market periods. The option strategies have tended to suffer less during market downturns but have underperformed in rising markets. This is expected as call options have a delta of less than 1- for every $1 change in the SPX, the call price will change by less than 1 (by their delta value to be exact), all else equal.

[2] Backtests are for the Dec-02 to Sep-13 period. We assume a transactions cost of 0.30 vols for outright long dated calls and for those calls financed by selling 1M puts. In addition, we assume that the 1M options are sold at the bid. We assume a transaction cost of 0.20 vols for call spreads, which is applied to the closer-to-the-money strike. As an example, if the 18M ATM call has a vega or volatility sensitivity of 4, then we add 0.3x4=$1.2 to the mid ATM call price as transaction cost.

[3] The backtests below assume that a long investor replaces his long delta-one position with an equivalent notional of calls (that is 1 outright call or spread contract per 100 'shares' in the index). All excess funds are invested in short-term Treasury securities.

[4] We roll the long-dated calls after 1/3rd and 2/3rds of the option's time has passed.

Figure 9: Comparing performance under rising and falling markets: Equity vs. various 36M call option strategies rolled after 24M

	Dec-02 to Oct-07		Oct-07 to Mar-09		Mar-09 to Sep-13		Apr-13 to Sep-13		Dec-02 to Sep-13		
	Return	Volatility	Return	Volatility	Return	Volatility	Return	Volatility	Return	Volatility	Ret/Vol
Equity	13.3%	12.8%	-55.3%	37.8%	22.3%	18.7%	18.9%	11.3%	8.0%	20.3%	39.2%
Outright: ATM	8.3%	10.4%	-22.0%	11.7%	10.3%	11.4%	13.5%	7.9%	5.1%	11.0%	46.2%
Spread: ATM - 6%	5.8%	5.0%	-11.3%	6.7%	8.1%	7.5%	4.5%	2.0%	4.5%	6.4%	70.1%
Spread: ATM - 2%	7.9%	8.6%	-18.1%	9.8%	10.1%	10.3%	10.1%	5.2%	5.3%	9.5%	55.8%
Spread: ATM - 1M 2%	9.1%	9.6%	-20.1%	11.3%	9.8%	10.5%	-3.1%	7.1%	5.5%	10.2%	53.6%

Source: Deutsche Bank, Bloomberg Finance LP

Since the total return (price appreciation + dividends) on the SPX has been positive over the period studied (Dec-02 to Sep-13), the options strategies[5] studied have underperformed the SPX (see Figure 10). However, after adjusting returns by the level of realized volatility (return/realized volatility) for the entire period, the option strategies had better performance when compared with equity[6]. The lower portfolio volatility of the call strategies is a key attraction for investors who are seeking equity returns but are put off by the typically high volatility of equity portfolios.

Figure 10: Comparing performance of equity with various 36M calls rolled after 24M

Source: Deutsche Bank, Bloomberg Finance LP

In the following section we show results for only a select number of strategies studied. The results are largely consistent across other strategies studied and are available in the Appendix.

Strategies involving selling 1M options to finance the longer-dated ~ATM calls have had higher risk-adjusted returns than equity and outright calls

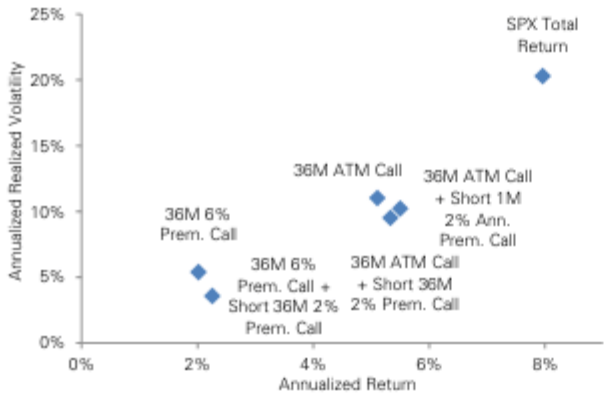
Strategies involving selling 1M options to finance the longer-dated near-the-money calls have had slightly better performance than outright calls: these had

[5] Please note that a 6% premium strategy targets trading a strike that nets a total 6% premium for the specific maturity (not annualized). Only the premium for the 1M 2% options are annualized: strikes are chosen corresponding to 2%/12 premium.

[6] Please see the Appendix for an expanded table of all strategies studied

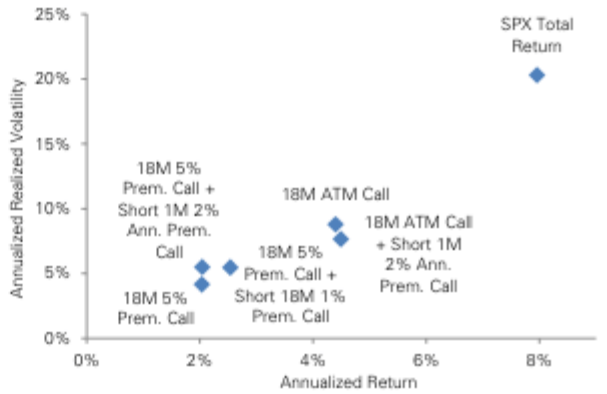
slightly higher returns at slightly lower volatility vs. outright calls. However, they did have equivalent to slightly higher volatility than some of the call spread strategies (see Figure 11 and Figure 12).

Figure 11: 36M calls and spreads rolled after 24M, Dec-02 through Sep-13



Source: Deutsche Bank, Bloomberg Finance LP

Figure 12: 18M calls and spreads rolled after 12M, Dec-02 through Sep-13



Source: Deutsche Bank, Bloomberg Finance LP

These results are consistent with our previous research showing that implied volatility risk premium is typically rich for short-dated options[7]. That is, 1M implied volatility tends to be higher than 1M realized volatility. So, selling 'expensive' 1M upside call options to finance the purchase of longer-dated calls has generally been attractive.

Strategies selling 1M SPX calls have not performed recently

Looking again at Figure 10 above, strategies selling 1M calls have, not surprisingly, "banked" close to the entire 2% annualized premia only during market downturns (for instance, compare the performance of ATM calls and ATM – 1M 2% calls for the Oct-07 to Mar-09 period in the table). In the rising markets of Dec-02 to Oct-07, these strategies "banked" ~0.8% to 1.2% of the 2% premia depending on the strategy.

However, the bull market between May-09 to Sep-13 saw strategies selling 1M options have lower returns than buying outright calls. This is largely due to the Apr-13 to Sep-13 period, which saw large up and down moves that resulted in large losses from some of the short 1M call that were rolled every month while the long-dated call was up relatively little (see Figure 13).

[7] Please see The DNA of Overwriting – A US Perspective, 02-Apr-2013, contact [redacted]

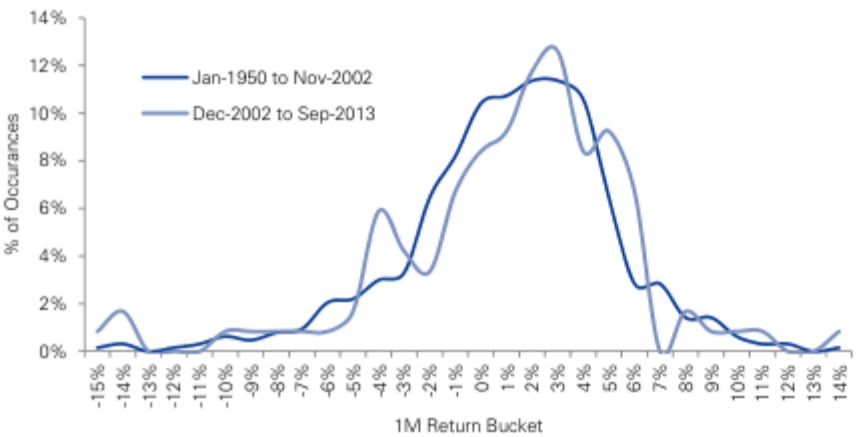
Figure 13: The Apr-13 to Sep-13 period has seen significant underperformance from financing long-dated calls with 1M calls

Source: Deutsche Bank, Bloomberg Finance LP

The backtest period is very representative for 1M risk

The main risk of the short 1M call occurs in violent rallies. Figure 14 shows that the frequency of sharp rallies in our backtest period is comparable to that from the prior ~50 years. If anything, we tended to see slightly higher occurrences of big 1M rallies in our backtest period.

Figure 14: Distribution of 1M SPX returns



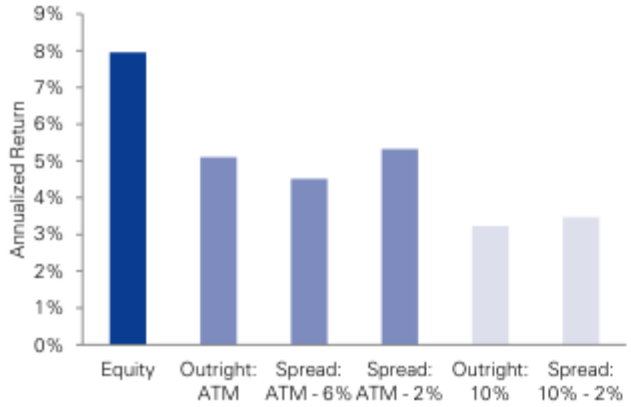
Source: Deutsche Bank, Bloomberg Finance LP

Call spreads have had better risk-adjusted performance than all other strategies studied

Spreading a call option by selling a higher strike call reduces net delta exposure. So, call spreads tend to have lower returns in rallying markets but provide better downside protection (see Figure 9 above).

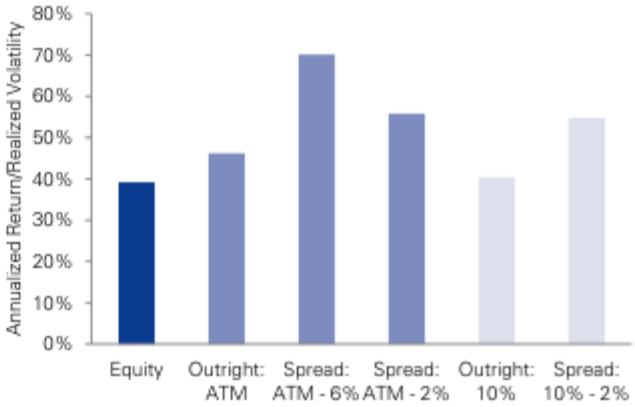
However, looking at the entire backtest period between Dec-02 and Sep-13 (both up and down markets), we find that call spreads tended to have annualized returns largely in line with outright call positions. Not surprisingly, call spread strategies experienced much lower volatility and higher risk-adjusted returns (see Figure 15 to Figure 18).

Figure 15: Call spread returns similar to calls (36M calls and spreads rolled after 24M)...



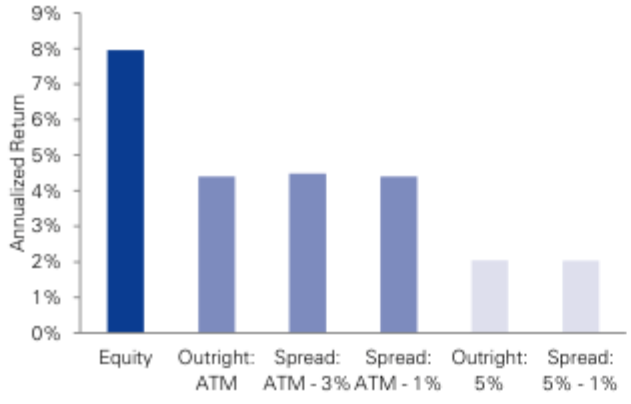
Source: Deutsche Bank, Bloomberg Finance LP

Figure 16: ... but with much higher risk-adjusted returns (36M calls and spreads rolled after 24M)



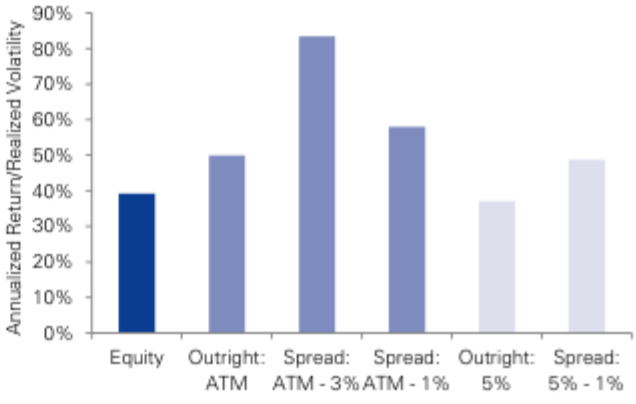
Source: Deutsche Bank, Bloomberg Finance LP

Figure 17: Call spread returns similar to calls (18M calls and spreads rolled after 12M)...



Source: Deutsche Bank, Bloomberg Finance LP

Figure 18: ... but with much higher risk-adjusted returns (18M calls and spreads rolled after 12M)



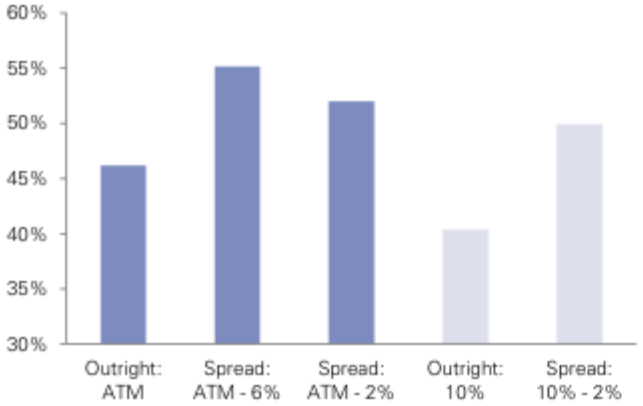
Source: Deutsche Bank, Bloomberg Finance LP

Given the attractive levels of long-dated calls currently, investors may still want to stick with outright call options rather than spreads to maintain a higher delta. However, an alternative approach could be to scale up the call spread notional and have a similar delta exposure (at least initially) to an outright call.

In Figure 19 and Figure 20, we look at the risk-adjusted returns for different call and call spread strategies after we scale up the call spread notionals. We assume that the investor trades an equivalent *initial* delta on the call spread as an outright call, which is then only rebalanced on the roll date of the long-dated call. For instance, if on trade date the 36M ATM call option has a delta of 0.50 and the 36M ATM-6% premia call spread has a delta of 0.20, we would buy 2.5x contracts of the call spread instead of each call contract.

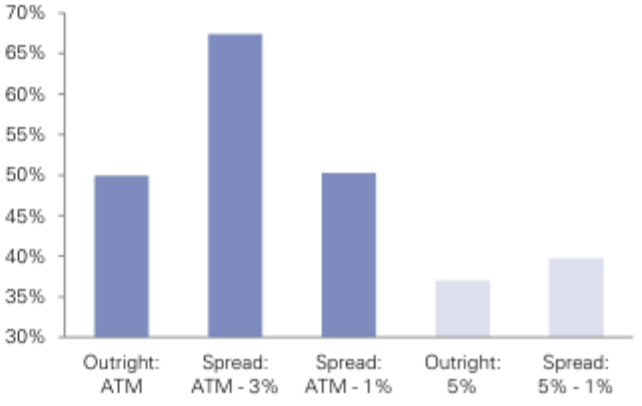
In the historical backtests, returns and risk-adjusted returns are both better for call-spreads after scaling to equivalent delta as the outright call. The higher delta notional does increase the volatility more than the return of the call-spread strategies and drives down the return/vol slightly from what's shown in Figure 16 and Figure 18.

Figure 19: Annualized returns/realized volatility for 36M calls and spreads rolled after 24M, Call spread notional scaled by delta



Source: Deutsche Bank

Figure 20: Annualized returns/realized volatility for 18M calls and spreads rolled after 12M, Call spread notional scaled by delta



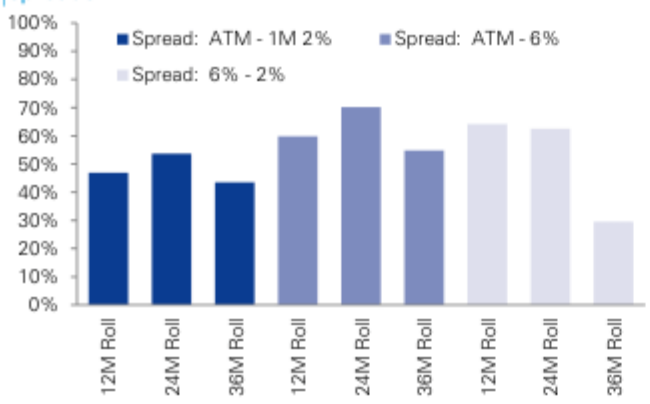
Source: Deutsche Bank

Roll prior to expiry

Figure 21 and Figure 22 show that rolling the call spread position before expiry would have generally (but not always) resulted in higher risk-adjusted returns, across many different strategies[8]. Rolling prior to expiry allows you to reduce the negative effects of time decay, since shorter-dated options lose their time value quickly.

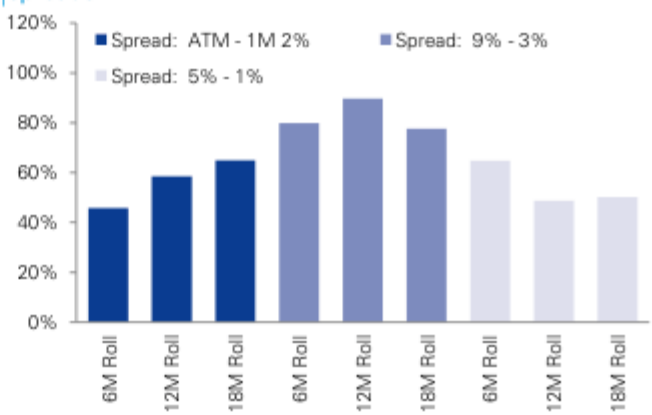
Rolling early also allows you to re-strike the calls, which is especially important for options that have become far out-of-the-money. Rolling will rebalance the delta exposure higher in these cases. However, note that rolling early will result in higher transactions cost.

Figure 21: Annualized returns/realized volatility for 36M spreads



Source: Deutsche Bank

Figure 22: Annualized returns/realized volatility for 18M spreads



Source: Deutsche Bank

[8] Results for rolling prior to expiry hold for outright calls as well

Understanding volatility, rate, and dividend yield risks for long-dated calls

In this section we provide a more in-depth look at how implied vols evolve after a spot rally and also how changes in rates and dividends impact the price of calls.

Vega – implied volatility sensitivity

Buyers of options are long vega, and an increase in implied volatility will result in an increase in the price of a call option. Vega is proportional to time-to-maturity: longer-dated options have higher vega and as time passes the sensitivity of the options to changes in implied volatility declines.

Investors holding outright long calls will benefit from the delta exposure in a SPX rally, but will likely suffer from implied volatilities decreasing in two ways:

- Term-structure effect: As time passes, the implied volatility will slide down the typically upwards-sloping implied volatility term-structure, all else equal.
- Skew effect: Implied volatility changes are negatively correlated with spot changes (see Figure 24: spot higher, implied volatility lower). Thus, as spot prices move around, the reference implied volatilities will change. However, the most recent six months have seen long-dated fixed-strike (not ATM) implied volatilities rise slightly as the market has rallied (these would correspond to points in the upper right quadrant in Figure 24), a situation that has helped these call positions doubly.

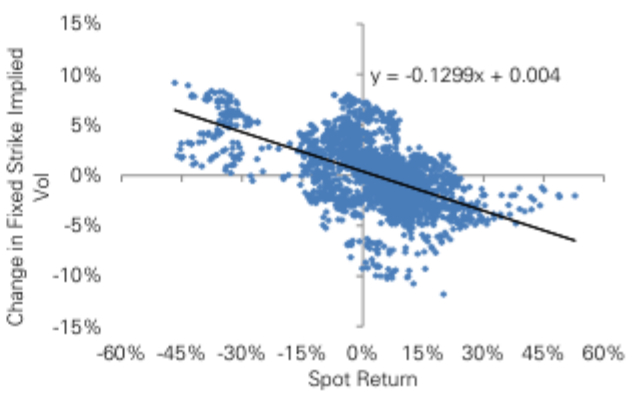
In Figure 23 and Figure 24 we look at the relative magnitude of the decrease in fixed-strike implied volatilities contingent on a market rally. It is notable that the fixed-strike implied volatilities change has been on the order of 1-2 vol points in our table. Not surprisingly, longer-dated options have lower volatility sensitivity to spot price moves, and a bigger move is associated with sharper implied volatility declines.

Figure 23: Median change in fixed-strike implied vol given a minimum spot move over the period (Dec-02 to Sep-13)

	Median Change in Vol After Spot Move Over Period		
Spot Move (Greater Than)	18M Call After 6M	36M Call After 18M	60M Call After 24M
0%	-0.3%	-0.1%	-0.2%
5%	-0.8%	-0.3%	-0.3%
10%	-1.0%	-0.7%	-0.5%
15%	-1.4%	-1.1%	-0.7%
20%	-2.0%	-1.7%	-1.0%

Source: Deutsche Bank

Figure 24: Regressing spot changes and changes in 36M fixed strike implied vols over the subsequent 6M



Source: Deutsche Bank

The figures below show the simulated P/Ls for 36M and 18M ATM options under different volatility and spot change scenarios after one-year has passed. The price sensitivity to spot moves does tend to dominate any volatility P/L. Also, you can see for the 36M trade that if fixed strike vols and spot are unchanged then your option loses a fifth of its value due to time decay (the 18M option loses almost half its value in the same situation). A 5% up move in spot and a 100 bps decline in vol leaves the 36M ATM call option holder relatively flat.

Figure 25: Simulated P/L of 36M ATM options after 12M have passed under different volatility and spot change scenarios (all else held the same)

		% Change in Spot				
		-10%	-5%	0%	5%	10%
Change in Vol	-5.00	-81%	-67%	-48%	-22%	8%
	-4.50	-79%	-65%	-45%	-20%	11%
	-4.00	-77%	-63%	-42%	-17%	13%
	-3.50	-76%	-60%	-40%	-14%	16%
	-3.00	-74%	-58%	-37%	-11%	19%
	-2.50	-72%	-55%	-34%	-9%	21%
	-2.00	-70%	-53%	-32%	-6%	24%
	-1.50	-68%	-51%	-29%	-3%	27%
	-1.00	-65%	-48%	-27%	-1%	29%
	-0.50	-63%	-46%	-24%	2%	32%
	0.00	-61%	-43%	-21%	5%	35%
	0.50	-59%	-41%	-19%	8%	38%
	1.00	-57%	-38%	-16%	10%	40%
	1.50	-55%	-36%	-13%	13%	43%
	2.00	-53%	-34%	-11%	16%	46%
	2.50	-50%	-31%	-8%	19%	48%
	3.00	-48%	-29%	-5%	21%	51%
	3.50	-46%	-26%	-3%	24%	54%
	4.00	-44%	-24%	0%	27%	57%
	4.50	-41%	-21%	3%	29%	59%
	5.00	-39%	-19%	5%	32%	62%

Source: Deutsche Bank

Figure 26: Simulated P/L of 18M ATM options after 12M have passed under different volatility and spot change scenarios (all else held the same)

		% Change in Spot				
		-10%	-5%	0%	5%	10%
Change in Vol	-5.00	-99%	-91%	-68%	-23%	39%
	-4.50	-98%	-90%	-66%	-21%	40%
	-4.00	-98%	-88%	-64%	-20%	41%
	-3.50	-97%	-87%	-62%	-18%	42%
	-3.00	-96%	-85%	-60%	-16%	43%
	-2.50	-96%	-84%	-58%	-14%	44%
	-2.00	-95%	-82%	-56%	-12%	45%
	-1.50	-94%	-81%	-54%	-10%	47%
	-1.00	-93%	-79%	-51%	-8%	48%
	-0.50	-92%	-78%	-49%	-6%	49%
	0.00	-91%	-76%	-47%	-4%	51%
	0.50	-90%	-74%	-45%	-3%	52%
	1.00	-89%	-72%	-43%	-1%	54%
	1.50	-88%	-71%	-41%	1%	56%
	2.00	-87%	-69%	-39%	3%	57%
	2.50	-86%	-67%	-37%	5%	59%
	3.00	-84%	-66%	-35%	7%	60%
	3.50	-83%	-64%	-33%	9%	62%
	4.00	-82%	-62%	-31%	11%	64%
	4.50	-81%	-60%	-29%	13%	66%
	5.00	-79%	-58%	-27%	15%	67%

Source: Deutsche Bank

Rho – interest rate sensitivity

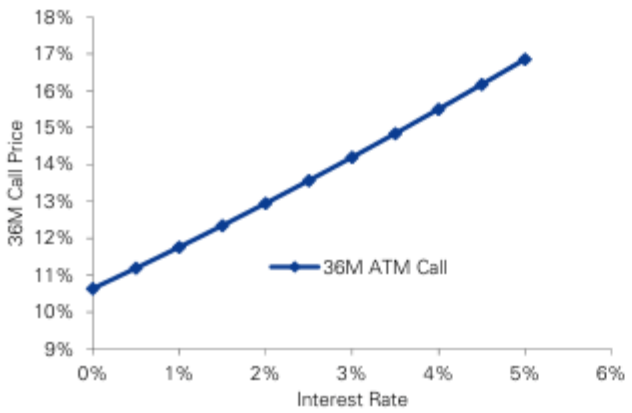
Interest rate levels drive the pricing of call options in two ways.

- The discounting or present value effect: the present value of the expected payoff from the call at maturity is lower.
- The forward effect: The cost of carry is lower and hence the expected spot is higher at maturity. This increases the value of the call.

The net effect of these two can be seen by the greek 'rho', which measures the sensitivity of an option with respect to interest rates. Rho is positive for a call option, meaning that the net effect of a rise in rates will be an increase in the call price. The price increase due to the forward rising is higher than the discounting effect.

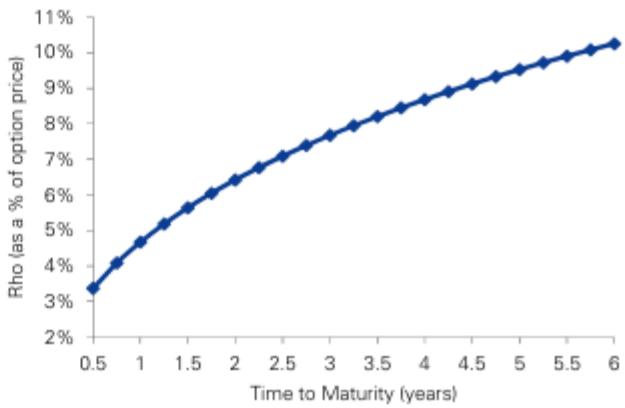
Longer-dated options have higher rate sensitivity (see Figure 27). This makes sense as the forward will be affected more for longer-dated options (as the rate is scaled by the time to maturity). Thus as an option becomes closer to maturity (all else equal), its exposure to changes in interest rates falls rapidly. Because of the changing nature of the interest rate sensitivity (see Figure 28) and the relatively small impact on P/L, investors shouldn't trade long-dated calls solely to gain exposure to higher rates. However, the currently low rates (and low rates volatility) do lead to optically better relative pricing for investors wishing to be long, and any rate increase will have a positive impact on call premia (see Figure 29 and Figure 30).

Figure 27: Call prices increase with rising rates



Source: Deutsche Bank

Figure 28: Rho for an ATM call increases with maturity



Source: Deutsche Bank

The figures below show the simulated P/Ls under different rate and spot scenarios after one-year has passed in the life of the trade. You can see for the 18M trade that a 5% up move in spot and a 100 bps increase in rates would cover the time value lost over the following year, all else equal.

Figure 29: Simulated P/L of 36M options after 12M have passed under different rate and spot change scenarios (assumes vols slide down the curve)

Change in Rates	% Change in Spot				
	-10%	-5%	0%	5%	10%
-0.50	-64%	-46%	-25%	0%	29%
0.00	-61%	-43%	-21%	5%	35%
0.50	-59%	-40%	-17%	10%	40%
1.00	-56%	-37%	-13%	15%	46%
1.50	-54%	-34%	-9%	19%	52%
2.00	-51%	-30%	-5%	24%	57%
2.50	-48%	-27%	-1%	29%	63%

Source: Deutsche Bank

Figure 30: Simulated P/L of 18M options after 12M have passed under different rate and spot change scenarios (assumes vols slide down the curve)

Change in Rates	% Change in Spot				
	-10%	-5%	0%	5%	10%
-0.50	-92%	-77%	-49%	-7%	48%
0.00	-91%	-76%	-47%	-4%	51%
0.50	-91%	-75%	-46%	-2%	54%
1.00	-90%	-74%	-44%	0%	57%
1.50	-90%	-73%	-42%	3%	60%
2.00	-89%	-72%	-41%	5%	63%
2.50	-89%	-71%	-39%	8%	66%

Source: Deutsche Bank

Psi – dividend yield sensitivity

The call's price sensitivity to dividend yield changes is slightly higher than its rate sensitivity since dividend yield changes only affect the forward and not the discount rate. However, dividend yields do not vary as much as rates: we can see in Figure 7, the SPX implied dividend yield has been between 1.6% and 2.8% historically. Figure 31 and Figure 32 show the simulated P/Ls under different rate and dividend yield change scenarios after one year has passed in the life of the trade, all else equal. Not surprisingly, the dividend yield impact is larger for longer-dated options.

Figure 31: Simulated P/L of 36M options after 12M have passed under different dividend yield and spot change scenarios (assumes vols slide down the curve)

Change in Div Yields	% Change in Spot				
	-10%	-5%	0%	5%	10%
-0.75	-57%	-38%	-14%	13%	44%
-0.50	-58%	-40%	-17%	10%	41%
-0.25	-60%	-41%	-19%	8%	38%
0.00	-61%	-43%	-21%	5%	35%
0.25	-63%	-45%	-24%	2%	32%
0.50	-64%	-47%	-26%	0%	29%
0.75	-66%	-49%	-28%	-3%	26%

Source: Deutsche Bank

Figure 32: Simulated P/L of 18M options after 12M have passed under different dividend yield and spot change scenarios (assumes vols slide down the curve)

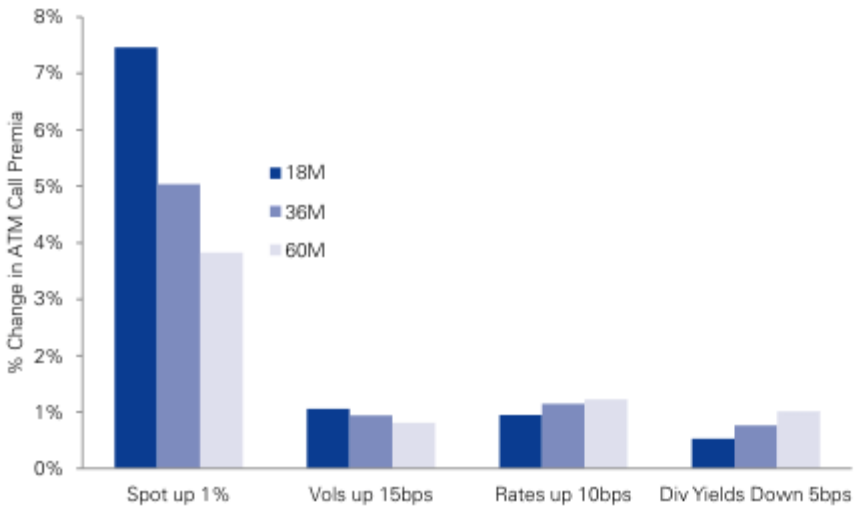
Change in Div Yields	% Change in Spot				
	-10%	-5%	0%	5%	10%
-0.75	-91%	-74%	-45%	-1%	55%
-0.50	-91%	-75%	-46%	-2%	54%
-0.25	-91%	-75%	-47%	-3%	52%
0.00	-91%	-76%	-47%	-4%	51%
0.25	-91%	-76%	-48%	-6%	50%
0.50	-92%	-77%	-49%	-7%	48%
0.75	-92%	-77%	-50%	-8%	47%

Source: Deutsche Bank

Relative magnitude of risks

We now compare the impact on current SPX call premium from an instantaneous change in spot, implied volatility, rates, and dividend yields. Delta risk remains the prominent driver of P/L. Please note that the parameters have been 'bumped' by different amounts to roughly scale the relative movement of these parameters. For instance a 1% move in spot generally sees a much smaller than 100bp change in 36M fixed-strike volatility. Also, we have bumped the parameters in a parallel fashion across the term structure, even though short-dated vols are more volatile.

Figure 33: Sensitivity of current premia for different moves in parameters



Source: Deutsche Bank

Appendix A: Backtest Results

Figure 34: Comparing performance under rising and falling markets: Equity vs. various 18M call option strategies

		Dec-02 to Oct-07		Oct-07 to Mar-09		Mar-09 to Sep-13		Apr-13 to Sep-13		Dec-02 to Sep-13			Dec-02 to Apr-13		
		Return	Vol	Return	Vol	Return	Vol	Return	Vol	Return	Vol	Ret/Vol	Return	Vol	Ret/Vol
	Equity	13.3%	12.8%	-55.3%	37.8%	22.3%	18.7%	18.9%	11.3%	8.0%	20.3%	39.2%	7.5%	20.6%	36.6%
6M Roll	Outright: ATM	6.4%	6.8%	-24.5%	10.4%	8.8%	9.0%	10.8%	7.7%	3.3%	8.4%	39.0%	3.0%	8.4%	35.4%
	Outright: 9%	6.5%	6.8%	-18.6%	8.1%	7.1%	8.6%	11.9%	8.1%	3.4%	7.8%	43.7%	3.1%	7.8%	39.5%
	Outright: 5%	4.5%	4.8%	-10.8%	4.7%	4.0%	6.0%	9.0%	6.8%	2.3%	5.3%	42.4%	2.0%	5.3%	37.9%
	Outright: 3%	3.5%	3.5%	-8.2%	3.7%	2.4%	4.5%	6.5%	5.7%	1.5%	4.0%	36.8%	1.3%	3.9%	32.6%
	Spread: ATM - 3%	5.0%	3.4%	-13.8%	6.7%	6.4%	5.1%	4.5%	2.4%	3.1%	4.7%	64.9%	3.0%	4.8%	62.8%
	Spread: 9% - 3%	5.1%	3.4%	-8.2%	4.3%	4.8%	4.4%	5.6%	2.9%	3.2%	4.0%	79.9%	3.1%	4.0%	76.9%
	Spread: ATM - 1%	6.0%	5.1%	-20.6%	9.2%	8.1%	7.3%	7.9%	4.5%	3.3%	6.8%	49.4%	3.2%	6.9%	46.3%
	Spread: 9% - 1%	6.1%	5.2%	-14.8%	6.8%	6.5%	6.7%	9.0%	5.0%	3.5%	6.1%	57.0%	3.3%	6.2%	53.1%
	Spread: 5% - 1%	4.1%	3.1%	-7.0%	3.4%	3.4%	4.0%	6.1%	3.5%	2.3%	3.6%	64.9%	2.2%	3.6%	60.8%
	Spread: ATM - 1M 2%	7.7%	6.7%	-22.8%	10.4%	7.6%	7.9%	-6.4%	7.6%	3.6%	7.8%	45.8%	4.0%	7.8%	50.8%
	Spread: 9% - 1M 2%	7.9%	6.8%	-16.8%	8.1%	6.1%	7.5%	-4.9%	8.0%	3.8%	7.3%	52.6%	4.2%	7.2%	57.6%
	Spread: 5% - 1M 2%	5.9%	5.0%	-9.7%	5.0%	3.3%	5.4%	-9.4%	7.2%	2.7%	5.2%	52.3%	3.2%	5.1%	62.6%
12M Roll	Outright: ATM	6.7%	7.4%	-19.4%	9.0%	9.4%	10.0%	13.4%	8.7%	4.4%	8.8%	49.9%	4.0%	8.8%	45.9%
	Outright: 9%	6.7%	7.4%	-14.3%	7.1%	6.9%	9.1%	14.2%	9.2%	4.0%	8.1%	48.8%	3.6%	8.1%	44.2%
	Outright: 5%	4.3%	5.1%	-8.6%	4.9%	3.0%	6.0%	11.8%	7.9%	2.0%	5.5%	37.0%	1.7%	5.4%	30.7%
	Outright: 3%	3.0%	3.6%	-6.2%	3.4%	1.7%	4.4%	9.8%	7.0%	1.2%	3.9%	31.1%	0.9%	3.7%	23.5%
	Spread: ATM - 3%	5.9%	4.0%	-10.8%	5.8%	7.8%	6.3%	4.2%	2.2%	4.5%	5.4%	83.4%	4.5%	5.5%	82.4%
	Spread: 9% - 3%	5.8%	4.0%	-5.9%	3.8%	5.3%	5.2%	5.1%	2.7%	4.1%	4.5%	89.8%	4.0%	4.6%	87.9%
	Spread: ATM - 1%	6.8%	5.8%	-15.6%	7.5%	8.2%	9.1%	-4.9%	8.6%	4.4%	7.6%	58.0%	4.8%	7.5%	63.2%
	Spread: 9% - 1%	6.8%	5.8%	-10.5%	5.3%	5.6%	8.0%	-3.9%	8.8%	4.0%	6.8%	58.5%	4.3%	6.7%	63.9%
	Spread: 5% - 1%	4.4%	3.5%	-4.8%	2.8%	1.8%	5.1%	-6.9%	8.4%	2.0%	4.2%	48.7%	2.4%	3.9%	60.8%
	Spread: ATM - 1M 2%	7.9%	7.2%	-16.2%	8.3%	7.4%	7.9%	-3.3%	7.9%	4.5%	7.7%	58.5%	4.8%	7.7%	62.6%
	Spread: 9% - 1M 2%	7.9%	7.3%	-11.7%	6.8%	5.5%	7.5%	-2.4%	8.6%	4.3%	7.3%	58.8%	4.6%	7.3%	62.8%
	Spread: 5% - 1M 2%	5.6%	5.4%	-7.3%	5.3%	2.4%	5.6%	-6.3%	8.6%	2.5%	5.5%	46.3%	2.9%	5.3%	54.2%
18M Roll	Outright: ATM	7.8%	8.7%	-15.9%	7.9%	10.3%	13.7%	10.7%	9.9%	5.7%	11.0%	52.0%	5.5%	11.1%	50.1%
	Outright: 9%	7.5%	8.5%	-11.4%	5.9%	7.0%	12.5%	11.8%	10.2%	4.7%	10.1%	46.7%	4.5%	10.1%	44.0%
	Outright: 5%	4.7%	6.4%	-5.8%	3.6%	1.8%	8.3%	8.7%	10.2%	2.1%	7.0%	29.7%	1.8%	6.9%	26.6%
	Outright: 3%	2.9%	5.0%	-4.0%	2.8%	1.3%	6.0%	5.9%	9.9%	1.3%	5.2%	25.5%	1.2%	5.0%	23.3%
	Spread: ATM - 3%	7.1%	4.5%	-9.5%	5.3%	9.1%	9.5%	5.2%	1.8%	5.7%	7.2%	79.9%	5.7%	7.3%	78.8%
	Spread: 9% - 3%	6.7%	4.2%	-5.3%	3.3%	5.8%	8.1%	6.3%	2.2%	4.7%	6.1%	77.6%	4.7%	6.2%	75.4%
	Spread: ATM - 1%	8.2%	7.6%	-13.3%	6.9%	10.8%	12.4%	12.5%	4.3%	6.4%	9.9%	65.3%	6.2%	10.0%	62.0%
	Spread: 9% - 1%	7.9%	7.3%	-8.9%	4.8%	7.4%	11.1%	13.6%	4.7%	5.5%	8.9%	61.1%	5.1%	9.0%	56.7%
	Spread: 5% - 1%	5.1%	5.2%	-3.3%	2.4%	2.3%	6.6%	10.7%	4.1%	2.8%	5.6%	50.2%	2.5%	5.7%	44.3%
	Spread: ATM - 1M 2%	8.9%	8.2%	-11.0%	6.3%	7.4%	9.6%	-5.3%	8.0%	5.6%	8.7%	64.9%	6.1%	8.7%	69.7%
	Spread: 9% - 1M 2%	8.6%	8.1%	-7.9%	5.1%	5.3%	9.2%	-4.6%	8.8%	5.0%	8.3%	60.3%	5.4%	8.3%	65.0%
	Spread: 5% - 1M 2%	6.0%	6.4%	-3.4%	3.4%	1.5%	7.3%	-9.9%	10.5%	2.8%	6.5%	43.3%	3.3%	6.3%	52.6%

Source: Deutsche Bank

Figure 35: Comparing performance under rising and falling markets: Equity vs. various 36M call option strategies

		Dec-02 to Oct-07		Oct-07 to Mar-09		Mar-09 to Sep-13		Apr-13 to Sep-13		Dec-02 to Sep-13			Dec-02 to Apr-13		
		Return	Vol	Return	Vol	Return	Vol	Return	Vol	Return	Vol	Ret/Vol	Return	Vol	Ret/Vol
	Equity	13.3%	12.8%	-55.3%	37.8%	22.3%	18.7%	18.9%	11.3%	8.0%	20.3%	39.2%	7.5%	20.6%	36.6%
12M Roll	Outright: ATM	7.3%	9.0%	-23.0%	12.3%	8.9%	10.1%	13.5%	7.9%	3.9%	10.0%	39.5%	3.6%	10.1%	35.5%
	Outright: 18%	8.1%	11.4%	-22.2%	12.2%	8.7%	10.6%	15.0%	9.1%	4.3%	11.2%	38.3%	3.9%	11.2%	34.3%
	Outright: 10%	5.8%	8.6%	-12.3%	7.4%	4.5%	7.1%	12.1%	7.6%	2.8%	7.9%	35.8%	2.5%	7.9%	31.1%
	Outright: 6%	4.2%	6.7%	-6.8%	5.0%	2.2%	4.7%	9.4%	6.2%	1.9%	5.7%	33.0%	1.6%	5.7%	27.9%
	Spread: ATM - 6%	5.2%	4.9%	-13.0%	7.7%	6.8%	5.9%	4.5%	2.0%	3.4%	5.8%	59.8%	3.4%	5.9%	58.1%
	Spread: 18% - 6%	6.0%	6.2%	-12.3%	7.5%	6.6%	6.2%	6.3%	3.4%	3.8%	6.4%	59.4%	3.7%	6.5%	57.1%
	Spread: ATM - 2%	7.0%	6.8%	-19.5%	10.8%	8.8%	8.8%	10.1%	5.2%	4.2%	8.3%	51.0%	4.0%	8.4%	47.7%
	Spread: 18% - 2%	7.7%	9.3%	-18.8%	10.7%	8.6%	9.2%	11.7%	6.6%	4.6%	9.5%	48.1%	4.3%	9.6%	44.7%
	Spread: 10% - 2%	5.4%	6.0%	-9.0%	5.7%	4.4%	5.6%	8.7%	4.9%	3.1%	5.8%	53.1%	2.9%	5.9%	49.1%
	Spread: ATM - 1M 2%	8.1%	8.4%	-21.0%	11.9%	8.4%	9.3%	-3.1%	7.1%	4.4%	9.3%	46.9%	4.7%	9.4%	49.6%
	Spread: 18% - 1M 2%	8.8%	10.7%	-20.2%	11.8%	8.3%	9.7%	-1.3%	8.2%	4.7%	10.5%	44.9%	4.9%	10.6%	46.8%
	Spread: 10% - 1M 2%	6.6%	8.2%	-10.4%	7.0%	4.0%	6.3%	-4.6%	6.8%	3.2%	7.3%	44.3%	3.5%	7.3%	48.4%
24M Roll	Outright: ATM	8.3%	10.4%	-22.0%	11.7%	10.3%	11.4%	13.5%	7.9%	5.1%	11.0%	46.2%	4.8%	11.1%	42.8%
	Outright: 18%	8.8%	10.9%	-23.5%	12.7%	9.8%	11.5%	15.0%	9.1%	4.9%	11.4%	43.1%	4.5%	11.5%	39.4%
	Outright: 10%	6.5%	8.5%	-13.3%	7.8%	5.0%	7.5%	12.1%	7.6%	3.2%	8.0%	40.4%	2.9%	8.0%	36.0%
	Outright: 6%	4.7%	6.1%	-7.6%	5.2%	2.3%	4.7%	9.4%	6.2%	2.0%	5.4%	37.2%	1.7%	5.4%	32.0%
	Spread: ATM - 6%	5.8%	5.0%	-11.3%	6.7%	8.1%	7.5%	4.5%	2.0%	4.5%	6.4%	70.1%	4.5%	6.5%	69.0%
	Spread: 18% - 6%	6.3%	5.5%	-12.6%	7.7%	7.7%	7.2%	6.3%	3.4%	4.4%	6.6%	66.2%	4.3%	6.7%	64.2%
	Spread: ATM - 2%	7.9%	8.6%	-18.1%	9.8%	10.1%	10.3%	10.1%	5.2%	5.3%	9.5%	55.8%	5.1%	9.7%	53.2%
	Spread: 18% - 2%	8.3%	9.1%	-19.5%	10.9%	9.6%	10.3%	11.7%	6.6%	5.2%	9.9%	52.4%	4.9%	10.0%	49.2%
	Spread: 10% - 2%	6.1%	6.6%	-9.5%	5.8%	4.9%	6.2%	8.7%	4.9%	3.5%	6.3%	54.8%	3.3%	6.4%	51.2%
	Spread: ATM - 1M 2%	9.1%	9.6%	-20.1%	11.3%	9.8%	10.5%	-3.1%	7.1%	5.5%	10.2%	53.6%	5.8%	10.3%	56.3%
	Spread: 18% - 1M 2%	9.5%	10.1%	-21.5%	12.3%	9.4%	10.5%	-1.3%	8.2%	5.3%	10.6%	50.4%	5.6%	10.7%	52.5%
	Spread: 10% - 1M 2%	7.3%	7.7%	-11.5%	7.4%	4.7%	6.7%	-4.6%	6.8%	3.7%	7.3%	50.6%	4.0%	7.3%	54.9%
36M Roll	Outright: ATM	8.7%	11.4%	-26.5%	14.0%	11.3%	15.7%	18.3%	10.8%	5.1%	13.7%	36.9%	4.6%	13.8%	32.9%
	Outright: 18%	9.0%	11.7%	-28.6%	15.6%	9.8%	14.9%	17.8%	11.0%	4.3%	13.7%	31.6%	3.8%	13.8%	27.6%
	Outright: 10%	6.5%	9.6%	-16.7%	9.5%	3.4%	9.9%	15.3%	9.7%	2.1%	9.7%	21.5%	1.6%	9.7%	16.2%
	Outright: 6%	4.1%	7.0%	-9.9%	6.5%	2.1%	4.8%	12.1%	8.1%	1.4%	6.1%	22.8%	1.0%	6.0%	16.1%
	Spread: ATM - 6%	6.8%	5.4%	-13.5%	8.5%	9.2%	12.4%	7.8%	3.7%	5.1%	9.4%	54.8%	5.0%	9.5%	52.9%
	Spread: 18% - 6%	7.2%	5.7%	-15.5%	10.4%	7.9%	11.6%	7.4%	4.0%	4.5%	9.3%	48.3%	4.4%	9.4%	46.3%
	Spread: ATM - 2%	8.4%	9.8%	-21.9%	12.0%	10.9%	15.0%	15.2%	8.0%	5.4%	12.5%	43.3%	5.1%	12.7%	39.8%
	Spread: 18% - 2%	8.8%	10.0%	-23.9%	13.8%	9.4%	14.2%	14.8%	8.3%	4.7%	12.5%	37.8%	4.3%	12.6%	34.2%
	Spread: 10% - 2%	6.3%	8.0%	-12.1%	7.3%	3.1%	9.2%	12.0%	6.8%	2.5%	8.4%	29.5%	2.1%	8.5%	24.9%
	Spread: ATM - 1M 2%	9.4%	10.5%	-24.3%	13.5%	10.8%	14.4%	0.6%	9.9%	5.5%	12.7%	43.5%	5.7%	12.8%	44.7%
	Spread: 18% - 1M 2%	9.7%	10.7%	-26.2%	15.0%	9.4%	13.6%	0.3%	10.1%	4.8%	12.6%	38.2%	5.0%	12.7%	39.3%
	Spread: 10% - 1M 2%	7.3%	8.7%	-14.6%	9.1%	3.1%	8.6%	-3.4%	8.9%	2.6%	8.7%	29.9%	2.9%	8.7%	32.7%

Source: Deutsche Bank

Appendix 1

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