Convexity Maven

A Commentary by Harley Bassman

May 23, 2016

"Options for the Magical Path"

STOP…..before your eyes glaze over and this Commentary is recycled into the composter, I promise this will not be a mind-numbing research document, but rather a PIMCO scalable "better-beta" strategy with just enough supporting preamble to provide fiduciary comfort.

I will take it as a given that the mere fact that you are still reading this Commentary implies that you are familiar with the basics of vanilla options and their standard "hockey stick" pay-out function. So the slight twist here is to introduce what are often called "light exotics", these are options where the pay-out function has an additional bend, kink or discrete jump – the most basic are Digital, Knock-in and Knock-out options.

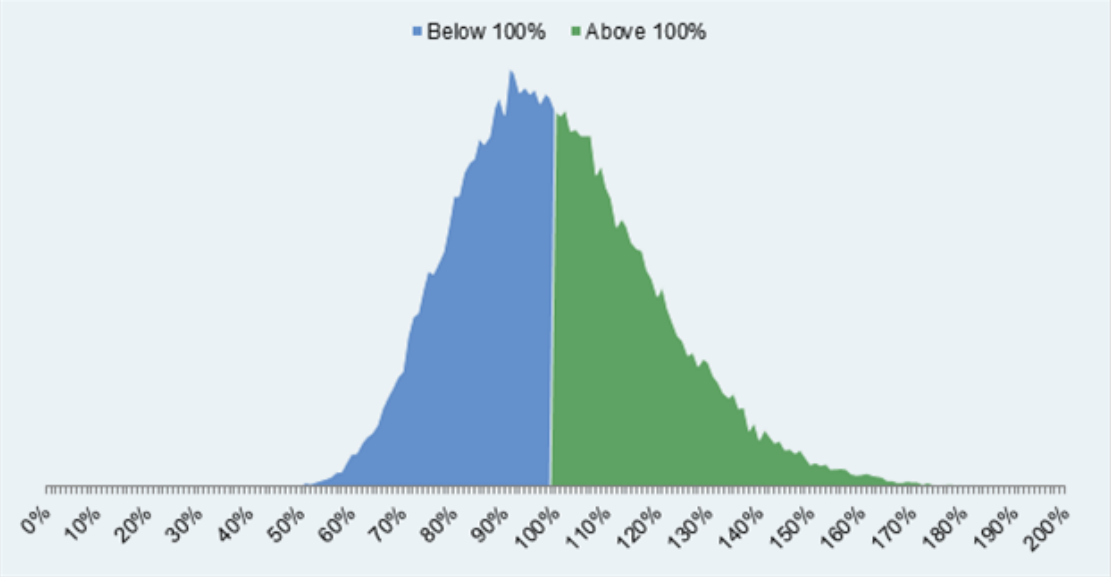
Digital options are the simplest of the light exotics, in fact, they are the easiest to grasp of all contingent claim instruments (a fancy term for the entire option genre) since the payout is either zero or one. An example: AAPL stock is presently at $97; one could pay $3.55mm today and receive either zero or $10mm depending on whether this stock is below or above the price of $105 a year from now. These are also known as binary options for the obvious reason that the payout function is either a "yes" or "no".

And as much as gambling analogies are generally frowned upon in custodial finance, the cold fact is that digital options are functionally a straight bet on a specific outcome, with the given "odds" implied by the price of the option.

So it should not be too much of a leap to guess that an at-the-money (forward) digital option might cost close to 50% of the potential payout since, ex ante, today's price is one's best guess for tomorrow's price (or at least that's what they taught us at UChicago).

It turns out that for Equity options this assumption is close, but not quite right. The slight twist is the need to account for the fact that a stock has unlimited upside, but its downside is limited by zero, i.e., it's lognormally distributed.

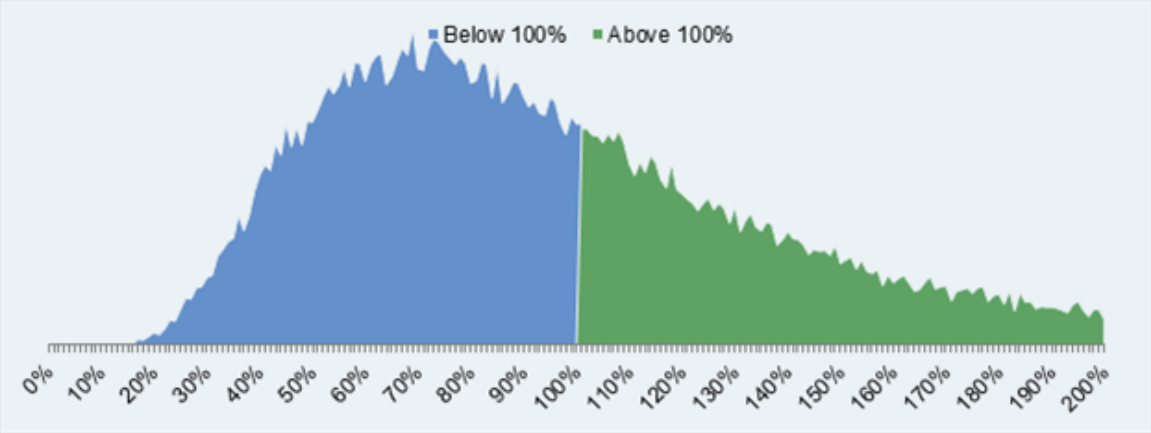
Below is the distribution of returns for a stock whose spot and forward price equal 100 with an Implied Volatility of 20% for all strikes (no skew) for one year. Your eyes are not lying if it seems that there are more –cornflower- observations (paths) on the left than the –pistachio- paths on the right. This difference is a consequence of the need to offset the asymmetric return profile so the expected value (probability times the return) on either side of the mean is balanced. However, since the return of a Digital option can only be zero or one, the value of such an option is simply the probability (or number of paths), so in this case the at-the-money digital put option would be worth 53.94%.



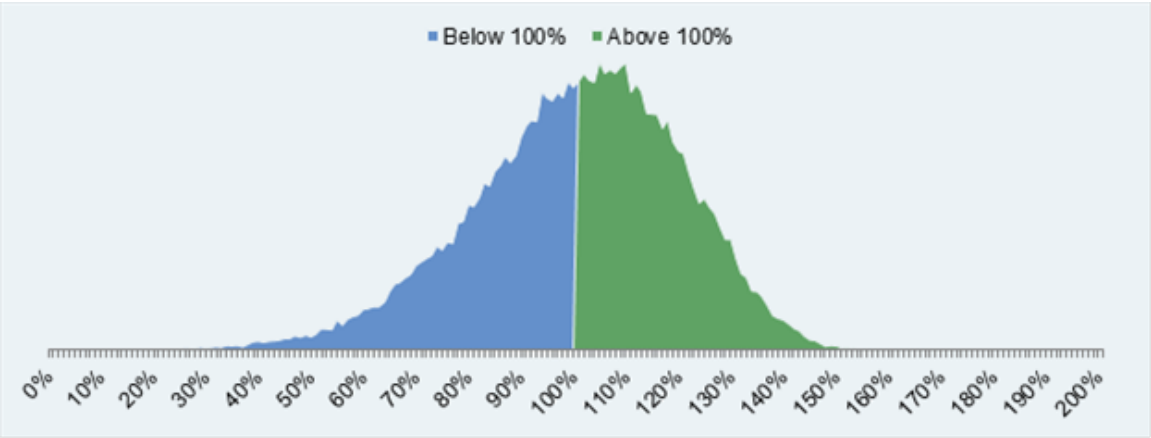
Source: JPMorgan

If you appreciate this concept, it will not be too much of a leap to imagine how the distribution, and digital option price, might change if the Implied Volatility for all option strikes were lifted to 50%, which is the return profile in our next diagram. In a nutshell, the greater Volatility increased the value of the upside paths more than the decline in value of downside paths, so a larger number of less valuable paths on the left are

required to balance the scales. In this case, an ATM put option would cost 59.77% (equal to the number of paths).



Still with me……. let's add a twist of realism. Previously we assumed that there was no skew, that an option struck out-of-the-money at K (strike price) = 80 had the same Implied Volatility as an at-the-money option struck at K = 100. Below we maintain the Implied Volatility of 20% for the K = 100 strike but we tweak the K = 80 strike to a Volatility of 24%. This slight twist depresses the digital option price to 46.92% of the potential payout as the shift in skew increases the value of the left side paths relative to those on the right.



While this can be a bit confusing, upon reflection it makes sense – increasing the value (returns) of the payout paths on the left reduces the number of them required to maintain an expected value balance on either side of the distribution.

To give one a feel for how the skew tends to overwhelm other the risk vectors when valuing a Digital option, this table indicates the model option price (R) as the K=100 vs K=80 Skew (L) rotates around parity. For reference, the –garnet row- is the first example described with a flat skew at 20% while the –mulberry row- is the subsequent 20% vs 24% skew. For greater clarity, if K=100 has a 20% IVol while the K=80 has a 35% IVol, this 15% skew in the –tangerine row- would produce a Digital option price of 29% of the notional value.

100/80 Skew	Digital Price
-20%	89%
-19%	87%
-17%	84%
-15%	80%
-13%	76%
-11%	73%
-8%	69%
-6%	65%
-4%	61%
-2%	58%
0%	**54%**
2%	50%
4%	**47%**
6%	43%
8%	39%
11%	35%
13%	32%
15%	**29%**
17%	26%
19%	24%
21%	21%
23%	20%
25%	18%
28%	17%
30%	17%

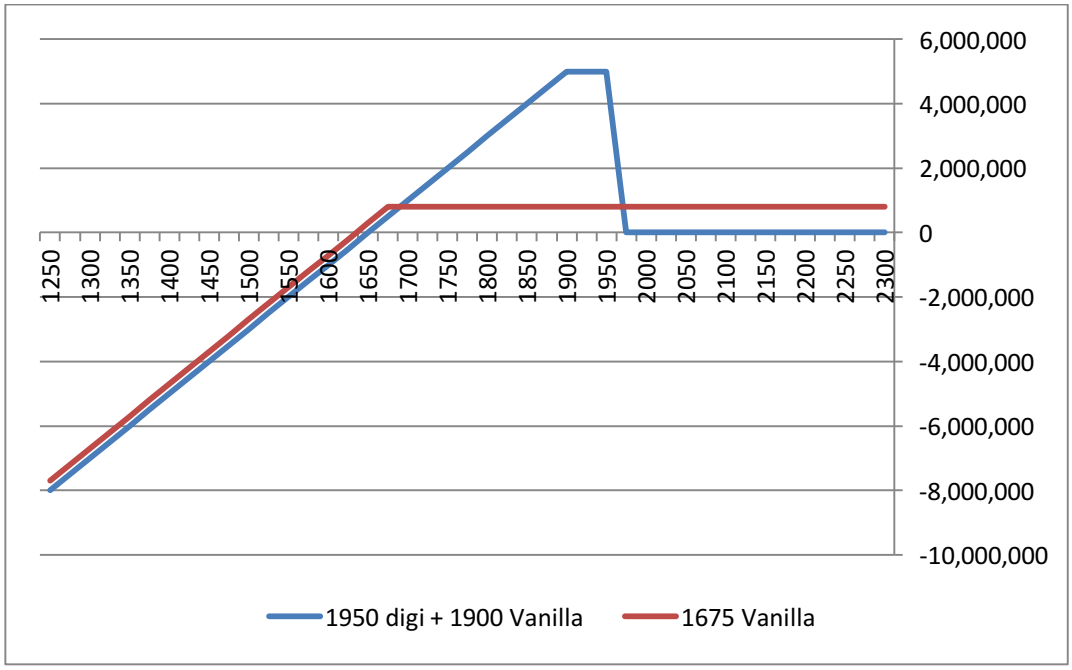
Source: JPMorgan

With the lesson plan complete, let's focus upon why this topic can be especially interesting to active portfolio managers. When a PM employs vanilla options to amplify or hedge an investment profile, he is implicitly absorbing the entire distribution of outcomes. While this is not necessarily bad, there are times when one has an opinion that is starkly different than those implied by a standard option model. In the extreme, digital options allow an investor to isolate a few paths, instead of a probability of all paths. In more visceral terms, it allows a PM to buy just the filet instead of the entire steer. Ignoring transactions costs, these options allow greater specificity by effectively selling the paths you do not like in exchange for more of the paths you desire. They can avail one to truly bespoke investing as it offers the ability to purchase only the paths one wants.

Let's put pencil to paper. Imagine the SPX is at 2025 and a moderately bullish PM thinks IVols are high and that he is confident that this index will not decline by more than 17%, or below 1675. He can be paid $800,000 upfront to sell 200 standard put options (about $40mm spot notional) that expire in nine-months and are struck at 1675. This payout profile is represented below by the –currant line-, a standard hockey stick with the premium earned uniformly above the 1675 strike and losses suffered in a linear fashion below the strike.

Another PM has a more focused opinion about the market. She thinks that the S&P 500 will decline slightly to form a new trading range centered near 1900. She creates the targeted risk profile –majorelle line- by purchasing a $5mm notional nine-month Digital put struck at 1950 and concurrently selling 200 vanilla put options struck at 1900 for an equal value (zero net cost).

In comparing these two profiles, she effectively sold all of the profitable payout paths above 1950 and concentrated them into paths between 1950 and 1675. Both strategies have an identical loss pattern, but she has now elevated her maximum profit from $800,000 to $5,000,000 in her target zone.



Source: PIMCO

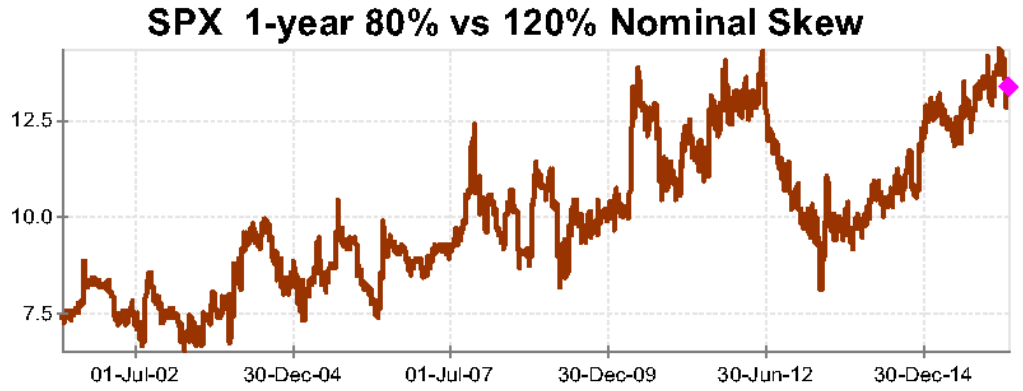
While similarly flavored profiles can be created with vanilla option butterflies or levered spread trades, digital options are the most effective way to concentrate a market view. It is unlikely that digitals will be your primary option tool; however, they are incredibly useful for those few times one "knows" the market's path.

One more twist: Barrier Options

Barrier options effectively embed the Digital/Binary option concept into a vanilla option. A Knock-out option is a vanilla call or put that is extinguished if a certain market level is breached, either at expiry (European) or anytime during market hours up until expiry (American). A Knock-in option is the functional opposite where the option only becomes "live" if the pre-determined barrier level is reached in European or American style.

Converting Skew into Alpha

Since the recovery from the Dot-Com bust, the skew (Ivol on OTM put minus Ivol on OTM call) on US Equity Index options has followed a slow and steady path wider. This was only interrupted by the FED's heavy hand of financial repression during the peak of QE. In fact, skew is presently nearing its "forever" –sienna line- wide at about 2sd's from its twenty-year average.



Source: Credit Suisse Locus

Reasons for this are myriad and include Variable Annuity hedging, ETF call program selling, and Bank stress test limitations. But no matter the reason, exaggerated skew is rarely realized and is thus a risk vector that is potentially ripe for the mining of excess return (alpha).

Such strategies have often been hindered by the tautology that one does not receive a large price for selling out-of-the-money options; the ones with the most excessive skew profile. As such, to earn a decent nominal return, one must employ leverage that can severely damage a portfolio on those rare days these options expire in the money.

Knitting together the past few pages, an opportunity does exist to capture the high implied volatility of an out-of-the-money option while still receiving a nominally high option premium via the use to Knock-in options on the S&P.

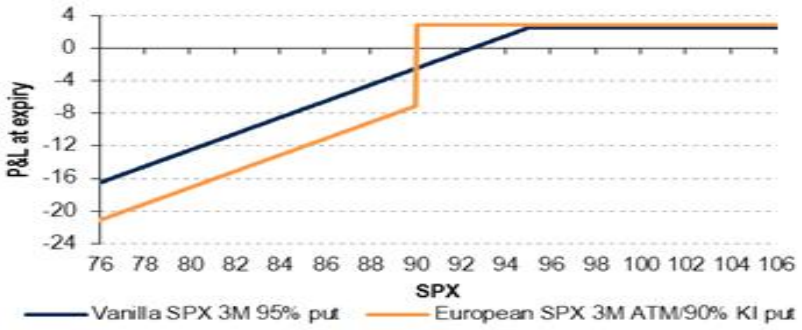
Knock-in Options as a replacement for Vanilla Options

Active total return money managers often sell short to medium-term expiry S&P Index puts as a compliment to a multi-vector risk portfolio. This strategy captures the often-elevated risk premium of Implied Volatility relative to Actual Volatility as well as excessive downside skew.

To create an apples-to-apples comparison, we back-tested the total return performance of three somewhat similar strategies. In each, we sold a three-month option once a week and held it until expiry (no hedging). The option was then cash settled on the last day.

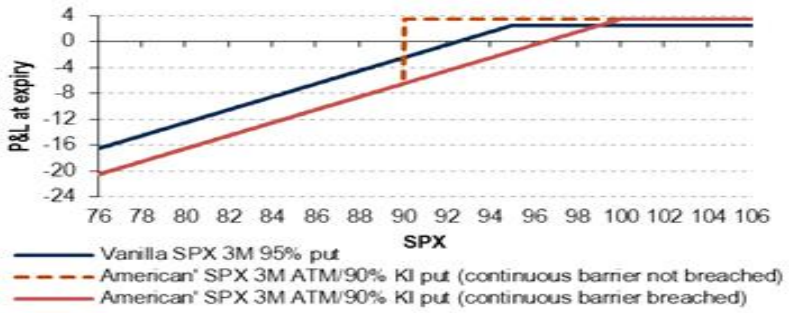
Option #1: SPX vanilla 95% strike put; an example of this -denim line- pay-out profile would be Spot = 2000 with a strike of 1900.

Option #2: SPX 100% strike put with a 90% European Knock-in; an example of this –medallion line- pay-out profile would be Spot and Strike = 2000 but the option is "live" only if the SPX is below 1800 upon expiry.



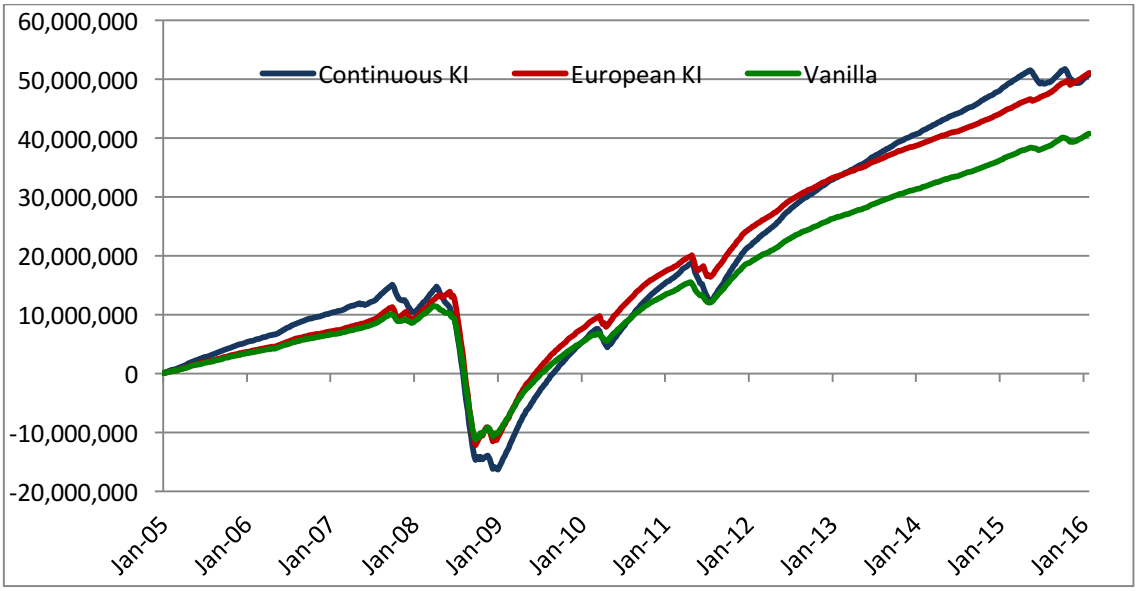
Source: Bank America Merrill Lynch

Option #3: SPX 100% strike put with a 90% American (continuous) Knock-in; an example of this –pinot line- pay-out profile would be Spot and Strike = 2000 but the option is "live" only if the SPX is below 1800 any time before expiry.



Source: Bank America Merrill Lynch

It is difficult to make sweeping conclusions about "path dependent" risk profiles since results can be greatly biased by the selection of your starting point; nonetheless, the chart below presents a reasonably fair summary as it includes both periods of calm and struggle. It captures the high-level notion that a strategy of selling either –Yale line- American or -brick line- European Knock-in options is superior to selling –algae line- Vanilla options.



Source: Goldman Sachs

For this particular study, using calendar year summary data, a strategy of selling Knock-in options beat selling vanilla options nine times in eleven years; and for those two years that the vanilla strategy outperformed, it was only by a small margin.

Casting a wider net, using three different back-test methodologies, the Knock-in strategies consistently beat the vanilla strategy by about 25%, and with a lower volatility of returns. The table below summarizes a strategy of daily option sales since 2010.

	3M 95% Put	3M 100% Put 90% KI
Return	9.4%	11.8%
Vol	7.8%	8.0%
Return/Vol	121.0%	146.9%
Max DD	-8.4%	-8.0%
Return/Max DD	112.1%	147.9%

Source: Deutsche Bank

Investment Implications:

1) Longitudinal financial studies have demonstrated that a strategy of selling short-dated options combined with consistent delta hedging produces a positive return. This occurs because Implied Volatility is persistently higher than Actual Volatility for most liquid assets. Unfortunately, it cannot be concluded definitively that a strategy of only selling puts is superior to owning the underlying asset since the selection of the investment horizon tends to dominate the return profile.
2) Skew on S&P puts is elevated for a variety of reasons and tends not to be realized; as such, it can be a source to harvest high risk adjusted returns.
3) Selling Knock-in put options tends to be superior to selling Vanilla put options over time, although there is some path dependency.
4) Selling American (continuous) Knock–in options does generate a higher nominal return than selling European (single look) Knock-in options; however, the former has a higher volatility of returns. As such, we are agnostic as to which is superior.
5) While vanilla options are more liquid and trade with a tighter market spread, the light exotics market for options on the S&P has greatly expanded over the past few years and is now scalable.
6) Digital options have a different decay (theta) pattern than vanilla options; in fact, at-the-money digital options do not decay at all. As such, light exotics may not be suitable for short-term trading strategies.

Price profile using six month average inputs: S&P spot = 2000; Expiry = 90 days

1) Vanilla put: K = 1900; Ivol = 20.0%; *Price = 1.95%*
2) Euro KI put: K = 2000; KI = 1800; *Price = 2.15%*
3) Amer KI put: K = 2000; KI = 1800; *Price = 2.75%*

Experienced financial managers can ball park the value of a vanilla option by integrating his mathematical expertise with his expectations of market risk; however, light exotic options, particularly single touch digitals, are frequently confounding. Without being too pedantic, I hope the early pages of this Commentary have sharpened your intuition as to how small changes in skew can materially alter an asset's risk profile.

Harley S. Bassman
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