New Developments in Options and Volatility-Based Benchmarks

William Speth, VP Research & Product Development

September 26, 2016
Forward Looking Statements

This presentation may contain forward-looking statements, within the meaning of the Private Securities Litigation Reform Act of 1995. Forward-looking statements are those statements that reflect our expectations, assumptions or projections about the future and involve a number of risks and uncertainties. These statements are only predictions based on our current expectations and projections about future events. There are important factors that could cause actual results to differ materially from that expressed or implied by the forward-looking statements, including: the loss of our exclusive licenses to list certain index options; decreases in the amount of trading volumes or a shift in the mix of products traded on our exchanges; legislative or regulatory changes affecting the options markets; increasing competition by foreign and domestic entities, including increased competition from new entrants into our markets and consolidation of existing entities; increasing price competition; our ability to maintain access fee revenues; economic, political and market conditions; our ability to operate our business without violating the intellectual property rights of others and the costs associated with protecting our intellectual property rights; our ability to accommodate increases in trading volume and order transaction traffic without failure or degradation of performance of our systems; our ability to protect our systems and communication networks from security risks, including cyber attacks; our ability to attract and retain skilled management and other personnel; our ability to maintain our growth effectively; our dependence on third party service providers; and the ability of our compliance and risk management methods to effectively monitor and manage our risks.

More detailed information about factors that may affect our performance may be found in our filings with the SEC, including in our Annual Report on Form 10-K for the year ended December 31, 2011 and other filings made from time to time with the SEC.
New Trends in Strategy Indexes

- Demand for passive investment continues to grow
- “Smart-Beta” is the fastest growing segment of passive investing
- Smart Beta combines best of passive, active and alternatives:
  - Research-driven strategies to achieve benchmark outperformance
  - Systematic approach – intuitive & lower cost
  - Alpha capture improved with cutting edge exposures
- Options & futures are becoming the new tools to build strategies that offer compelling risk/return profiles
- Attractive risk-adjusted returns vs. strategy complexity
- Product innovation / Education innovation
New Trends in Strategy Indexes

Growing demand for new strategy-based indexes

- CBOE Russell 2000® Conditional BuyWrite Index
- CBOE S&P 500® “Smile” Index
- CBOE Target Outcome Indexes
  - CBOE S&P 500® Buffer Protect Strategy Series
  - CBOE S&P 500® Enhanced Growth Strategy Series
- CBOE SMA Large Cap Index
- CBOE Stabilis Index
Call sale depends on level of CBOE Russell 2000 Volatility Index (RVX)

- Sell 1 ATM call if RVX > 20
- Sell ½ ATM call if RVX < 20
A symmetric or “flat” option skew has historically been linked to rising markets.
CBOE S&P 500 “SMILE” Index

SMILE alternates between a risk reversal (short 1M 25-delta put and long 1M 25-delta call – “flat” skew) and a short strangle (short 1M 25-delta put and short 1M 25-delta call – “steep” skew) conditional on the symmetry of the SPX option skew or “smile”.

<table>
<thead>
<tr>
<th></th>
<th>SMILE</th>
<th>SPTR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Return</td>
<td>Volatility</td>
</tr>
<tr>
<td>YTD</td>
<td>4.50%</td>
<td>8.41%</td>
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<tr>
<td>1 Year</td>
<td>11.39%</td>
<td>8.21%</td>
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<tr>
<td>3 Year</td>
<td>31.79%</td>
<td>8.13%</td>
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<tr>
<td>5 Year</td>
<td>69.42%</td>
<td>8.00%</td>
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<tr>
<td>10 Year</td>
<td>78.01%</td>
<td>14.81%</td>
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<tr>
<td>Inception</td>
<td>1877.70%</td>
<td>11.73%</td>
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</table>
Educating Investors - Traditional Approach

- Long S&P 500
- Long ATM Put
- Short 10% OTM Put
- Short OTM Call (call premium to cover cost of put spread)

- Long S&P 500
- Long ATM Call
- Short 2 OTM Call (call premium to cover cost of Long ATM call)
Innovative New Approach

“Selling the cake, not the recipe”

Purchased 1-yr FLEX Call Option with strike = 50% of SPY closing price
Written 1-yr FLEX Put Option with strike = 50% of SPY closing price
Written 1-yr FLEX Put Option with strike = 90% of SPY closing price
Purchased 1-yr FLEX Put Option with strike = 100% of SPY closing price
Call 1-yr FLEX Option with strike = 100% of SPY closing price
Written 1-yr FLEX Call Option with strike = Cap_{RollDate(l)}

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Target Outcome Monthly Sub-Index Series

12 monthly index series that roll on the third Wednesday of each month

- Buffer Protect Index January Series (Ticker: SPRO01)
- Buffer Protect Index February Series (Ticker: SPRO02)
- Buffer Protect Index March Series (Ticker: SPRO03)
- Buffer Protect Index April Series (Ticker: SPRO04)
- Buffer Protect Index May Series (Ticker: SPRO05)
- Buffer Protect Index June Series (Ticker: SPRO06)
- Buffer Protect Index July Series (Ticker: SPRO07)
- Buffer Protect Index August Series (Ticker: SPRO08)
- Buffer Protect Index September Series (Ticker: SPRO09)
- Buffer Protect Index October Series (Ticker: SPRO10)
- Buffer Protect Index November Series (Ticker: SPRO11)
- 500 Buffer Protect Index December Series (Ticker: SPRO12)
- Enhanced Growth Index January Series (Ticker: SPEN01)
- Enhanced Growth Index February Series (Ticker: SPEN02)
- Enhanced Growth Index March Series (Ticker: SPEN03)
- Enhanced Growth Index April Series (Ticker: SPEN04)
- Enhanced Growth Index May Series (Ticker: SPEN05)
- Enhanced Growth Index June Series (Ticker: SPEN06)
- Enhanced Growth Index July Series (Ticker: SPEN07)
- Enhanced Growth Index August Series (Ticker: SPEN08)
- Enhanced Growth Index September Series (Ticker: SPEN09)
- Enhanced Growth Index October Series (Ticker: SPEN10)
- Enhanced Growth Index November Series (Ticker: SPEN11)
- Enhanced Growth Index December Series (Ticker: SPEN12)
Target Outcome Sub-Index Series

12 monthly index series that roll on the third Wednesday of each month

Balanced Series

SPRO
Capped Levels for Monthly Series

SPEN
Capped Levels for Monthly Series
CBOE S&P 500 Buffer Protect Index Series
CBOE S&P 500 Enhanced Growth Index Series

CBOE S&P 500 Buffer Protect Index (SPRO) Series is designed to “buffer protect” against the first 10% of losses due to a decline in the S&P 500, while providing upside participation to a capped level.

CBOE S&P 500 Enhanced Growth Index (SPEN) Series is designed to provide 2x leveraged returns on the appreciation of the S&P 500 Index up to a capped level while providing one-to-one exposure to any losses due to a decline in the index.

<table>
<thead>
<tr>
<th></th>
<th>SPRO</th>
<th>S&amp;P 500 TR</th>
<th>SPEN</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Return</td>
<td>Volatility</td>
<td>Return</td>
</tr>
<tr>
<td>YTD</td>
<td>5.60%</td>
<td>8.86%</td>
<td>7.27%</td>
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<td>1 Year</td>
<td>9.02%</td>
<td>9.12%</td>
<td>12.97%</td>
</tr>
<tr>
<td>3 Year</td>
<td>19.86%</td>
<td>7.57%</td>
<td>36.58%</td>
</tr>
<tr>
<td>5 Year</td>
<td>58.67%</td>
<td>8.67%</td>
<td>106.91%</td>
</tr>
<tr>
<td>10 Year</td>
<td>72.96%</td>
<td>14.88%</td>
<td>103.72%</td>
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Actionable Information Content in Social Media
Social Market Analytics - SMA

**S-FACTOR METRICS VISUALIZED**

- S-Mean
- S-Volatility
- S-Score (prior)
- S-Delta
- S-Score (current)

\[ \sigma = \text{Standard Deviation} \]
Recent Example of Twitter Beating The News

- SMA sentiment signals are predictive for various time periods.
- Signal is predictive for shorter term trading in direction of sentiment.
- Longer term signal identifies a strong negative shock as a buying opportunity.
- “Edge” half-life longer for less popular names.
- Signal length varies – 24 Hour, 50 Day, 200 Day
- Type of momentum factor?
The CBOE SMA Large Cap Index (SMLC) measures the return of a hypothetical portfolio of 25 stocks with high SMA S-Scores that is rebalanced on a daily basis. The stocks are selected from the CBOE Large-Cap Universe, which is comprised of stocks that (a) are in the top 15% capitalization tranche of stocks that are the underlying for options listed on the CBOE and (b) whose market capitalization is greater than or equal to $10 billion.

September 2014 through September 2016
SMA Proprietary S-Factors
(“Statistical Social Media Outputs”)

- **S-Score™**: The Normalized Representation Of A Security’s Sentiment Time Series Over A Look Back Period
- **S-Mean™**: The Average Level Of A Security’s Sentiment Time Series Over A Look Back Period
- **S-Delta™**: The Change In A Security’s S-Score™ Level At An Observation Time Relative To An Earlier Time
- **S-Volume™**: The Volume Of Indicative Tweets Contributing To A Security’s S-Score™ At An Observation Time
- **SV-Score™**: The Normalized Representation Of A Stock’s Indicative Tweet Volume Time Series Over A Look Back Period
- **S-Volatility™**: A Measure Of The Variability Of A Stock’s Sentiment Time Series Over A Look Back Period
- **S-Dispersion™**: A Measure Of The Diversity Of Twitter Sources Contributing To A Security’s S-Score™
Stabilis US Index is a dynamic asset allocation strategy that derives its trading signals from regime changes in the CBOE Volatility Index (VIX) and the CBOE CBOT 10-yr US Treasury Note Volatility Index (TYVIX). The concept underpinning Stabilis is that the interplay of the TYVIX and VIX Indexes has historically predicted the relative performance of diversified equities, bonds and cash.

**Stabilis Investment Regimes**

- **VIX Low / TYVIX Low**
  - Broad Market Calm: 20% S&P 500 ETF (SPY), 70% iShares Core U.S. Aggregate Bond ETF (AGG), 10% iShares 7-10 Year T-Bond ETF (IEF), Fed Funds (Cash)

- **VIX High / TYVIX Low**
  - Isolated Anxiety in Equities: 10% S&P 500 ETF (SPY), 70% iShares Core U.S. Aggregate Bond ETF (AGG), 20% iShares 7-10 Year T-Bond ETF (IEF), Fed Funds (Cash)

- **VIX Low / TYVIX High**
  - Isolated Anxiety in Bonds: 20% S&P 500 ETF (SPY), 10% iShares Core U.S. Aggregate Bond ETF (AGG), 70% iShares 7-10 Year T-Bond ETF (IEF), Fed Funds (Cash)

- **VIX High / TYVIX High**
  - Broad Market Panic: 10% S&P 500 ETF (SPY), 20% iShares Core U.S. Aggregate Bond ETF (AGG), 70% iShares 7-10 Year T-Bond ETF (IEF), Fed Funds (Cash)

TYVIX High regime: TYVIX breaks above 90 quantile of past 6 months
TYVIX Low regime: TYVIX beaks below 10 quantile of past 6 months
VIX High regime: VIX breaks above 90 quantile of past 6 months
VIX Low regime: VIX beaks below 10 quantile of past 6 months
Stabilis US Index

Stabilis has significantly higher risk adjusted returns than the Benchmark (60% SPY, 40% AGG)

For more information, visit apps.appliedacademics.com/Stabilis
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