S&P/JPX JGB VIX® and the Japanese Yen: Part 1

SCOPE OF THE PAPER

This is the first installment of a two-part empirical paper exploring the interaction between Japanese yen exchange rates and forward-looking Japanese Government Bond (JGB) volatility as measured by the S&P/JPX JGB VIX®. This paper analyzes the economic interaction between interest rate volatility and FX returns and presents basic but novel empirical insights linking the two. The second installment, to be published in January 2017, will focus on the application of these insights to FX trading and risk management.

Highlights

- The S&P/JPX JGB VIX helps isolate the yield spread component of implied yen exchange rate volatility.
- 80% of implied USD/JPY volatility is explained by implied spread and Nikkei volatilities.
- Implied USD-JPY yield spread volatility has strong in-sample predictive power for USD/JPY.

CURRENT MACROECONOMIC LANDSCAPE

The introduction of quantitative and qualitative monetary easing (QQE) with yield curve control on Sept. 21, 2016, reaffirmed the Bank of Japan’s (BOJ’s) commitment to monetary easing until core CPI inflation exceeds its 2% target and maintains stability above that figure. However, many market participants suspect that the BOJ is running out of options, given the gradual reduction in their massive JGB purchase program. The precarious nature of the current policy framework is likely to motivate the BOJ to maintain a near-term status quo, but a surge in the yen’s value could press policymakers to act, despite their emptying toolbox. In addition, FX hedging costs are creeping higher for Japanese market participants that are considering overseas assets as an alternative to the depressed JGB yield environment; in some cases, they are already prohibitively high. This macroeconomic backdrop beams a spotlight on the interaction between JGBs and yen-based exchange rates.

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FOREIGN EXCHANGE AND INTEREST RATES

The relationship between the S&P/JPX JGB VIX and yen exchange rates is best understood initially through principles linking currencies and interest rates. We begin with a review of the uncovered interest rate parity (UIP), a well-studied hypothesis that states that the interest rate differential between two currencies reflects the expected change in their exchange rate. The UIP therefore provides an interpretation of exchange rate risk, measured by volatility, as the sum of interest rate spread risk and a risk premium. This decomposition sets the stage for the S&P/JPX JGB VIX to shine as part of a forward-looking measure for the interest rate spread component of yen exchange rate risk, which appears to possess distinct predictive properties.

Uncovered Interest Rate Parity

The UIP hypothesizes that if two currencies have different interest rates, market participants on aggregate must expect the higher-yielding currency to depreciate and offset the yield spread over the relevant horizon. If this were not true, the theory surmises that rational market participants would then sell the lower-yielding currency against the other to earn positive expected returns and push the spot rate until the UIP was restored.

This framework also accommodates the existence of a risk premium for bearing exposure to certain exchange rates. A “safe haven” currency like the yen that is expected to appreciate sharply during “bad times” (for example, a global financial crisis) is likely to have a negative risk premium, because market participants on the other side of the trade are likely to demand payment to provide such insurance-like payoffs. In the presence of a risk premium, the expected depreciation of the higher-yielding currency need not completely offset the yield differential.

The UIP can be stated concisely as:

Expected Change in Spot Rate = Yield Differential + Risk Premium

An econometrically rigorous treatment of the UIP is complicated and beyond the scope of this paper, but for our present purposes, we will consider interest rate spreads and time-varying risk premia as the primary drivers of FX risk, based on the UIP hypothesis.

Exhibit 1 shows two sets of points to illustrate how the relationship between foreign exchange and interest rates is at once tight (covered interest rate parity [CIP]), but also complicated (UIP). The light blue dots show the relationship between the 3-month USD-JPY yield spread and the future spot return implied by the 3-month forward FX price. The two fall on a nearly straight line, as predicted by the CIP, which is a stronger condition than the UIP and largely enforceable by no-arbitrage, making it immune to the elusive forces of a risk premium.
Speculative Currency Flow and Monetary Policy

Exchange rates are notoriously difficult to predict, and there is little empirical evidence for predictability in currency markets. Exchange rates are notoriously difficult to predict, and there is little empirical evidence for predictability in currency markets. This forces typical implementations of currency trading strategies, such as those based on momentum, purchasing power parity, volatility, calendar spreads, and interest rate differentials, to be biased toward maintaining a positive net carry basket; otherwise, the trading signal has the added burden of requiring enough predictive power to overcome negative carry. This makes yield spreads between traditional funding currencies like the yen and investment currencies like the U.S. dollar an important driver not only of carry trade flows, but also a large share of speculative trading flows, which, in some
significant but nebulous way, interacts with the more fundamental UIP hypothesis.

Further complicating the relationship between foreign exchange and interest rates is the unprecedented monetary policy put in place by major central banks since the global financial crisis of 2008. Numerous rounds of quantitative easing by the U.S. Federal Reserve and the BOJ have kept yield spreads suppressed and pinned within a narrow range (see Exhibit 2), and Japanese interest rate markets entered uncharted territory this year, with much of the curve having pierced through zero. Conversations with strategists at currency-focused funds reveal that the dramatic and sustained changes in market dynamics brought on by these central bank interventions have caused many previously profitable currency strategies to lose their edge. Anecdotally, some funds shuttered before they could figure out how to adjust once tried-and-true strategies in response to the new policy regime. For those still in the game, the future evolution of interest rate spread dynamics should be of particular interest.

Exhibit 2: USD/JPY and USD-JPY 3-Month Deposit Rate Spread

Source: S&P Dow Jones Indices LLC, Bloomberg, and JPX. Data as of Oct. 31, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.
FOREIGN EXCHANGE AND INTEREST RATE VOLATILITY

The exposition up to this point is a mere snapshot of an already well-established empirical literature regarding the economic linkage between FX returns and interest rates; however, much less has been written about the relationship between their respective volatilities or any predictive power they may possess with respect to currency returns. This is in contrast to the rich body of research and investable products that use equity implied volatility, namely the CBOE VIX Index®, as a market-timing signal. Perhaps this disparity exists in part because the VIX series of benchmark volatility indices has only recently been expanded to fixed income markets.

A study by Della Corte, Ramadorai, and Sarno (2016) touches on a related theme, finding cross-sectional FX return predictability in currency variance risk premia among G10 currencies. An industry piece by Merrill Lynch titled “Yen Volatility Nexus” (2006) also looks at the relationship between FX volatility and returns; it uses yield spread adjusted by implied FX volatility as a signal to time the USD/JPY carry trade. Neither study considers predictability from an isolation of the yield spread component of FX volatility, which is the focus of this paper.

While we provide no rigorous theoretical justification as to why the isolation of yield spread volatility may help predict currency returns, the empirical results outlined below provide compelling insights when interpreted through the lens of the various roles played by interest rates in currency markets, as discussed in previous sections.

Historical Realized Volatility

First, we define an appropriate measure of yield spread volatility. Instead of looking at the percentage volatility of spread levels, as a strict interpretation of the UIP would dictate, we consider the more-familiar notion of basis point volatility of spread changes.

Exhibit 3 shows one-month rolling realized volatilities of spot USD/JPY returns and USD-JPY one-month yield spread changes. While they have some common peaks and trends, we can see that the two are not driven by the same risk factors. The adjusted $R^2$ from regressing the realized volatility of spot returns on that of yield spreads is only 24%, which is not surprising given the blue rain in seen in Exhibit 1 that indicates a highly variable and potentially dominant risk premium.
We now construct a forward-looking measure of spread volatility by leveraging the growing series of VIX indices across asset classes and regions.

Yield Spread Implied Volatility Measure

Having empirically confirmed our intuition that yield spread volatility has risk drivers distinct from overall FX volatility, we now construct a forward-looking measure of spread volatility by leveraging the growing series of VIX indices across asset classes and regions. The VIX series of options-implied volatility measures differ from realized volatility and model-driven volatility forecasts in that they seek to track the fair market value of future volatility.

The S&P/JPX JGB VIX measures the 30-day forward implied volatility of 10-year JGB futures based on options traded at the Osaka Exchange. The U.S. counterpart to this is the CBOE/CBOT 10-Year U.S. Treasury Note Volatility IndexSM (TYVIXSM), which is based on options traded at CME Group’s Chicago Board of Trade. Exhibit 4 shows historical levels of the two benchmark government bond volatility indices, both of which are more sensitive to domestic macroeconomic events. The reference section lists further information, including additional empirical studies.
The basis point yield volatility formulations allow us to construct a forward-looking gauge of the basis point USD-JPY yield spread volatility.

Before we mix these two ingredients together to calculate an implied volatility measure for yield spreads (SpIV), we convert the unit of the S&P/JPX JGB VIX and TYVIX from percentage price volatility to basis point yield volatility, which measures the expected volatility of bond yields, instead of price. While there are many ways to model this conversion, we use the following simple approximation assuming minimal switch risk of the cheapest-to-deliver (CTD) bond.

- Basis point yield volatility = 100 x percentage price volatility / modified duration
The basis point yield volatility formulations allow us to construct a forward-looking gauge of the basis point USD-JPY yield spread volatility from the previous section.

\[
\text{SpIV} = 100 \times \sqrt{\text{Var}(\Delta y_S - y_Y)}
\]

\[
= 100 \times \sqrt{\text{Var}(\Delta y_S) - 2\text{Cov}(\Delta y_S, \Delta y_Y) + \text{Var}(\Delta y_Y)}
\]

\[
= 100 \times \sqrt{\left(\frac{\text{TYVIX}}{D_{TY}}\right)^2 - 2 \frac{\text{TYVIX}}{D_{TY}} \frac{\text{JGBVIX}}{D_{JGB}} \rho + \left(\frac{\text{JGBVIX}}{D_{JGB}}\right)^2}
\]

where \(D_{TY}\) and \(D_{JGB}\) are the modified durations of the CTD bonds into the Treasury and JGB futures contracts, respectively, and \(\rho\) is the correlation between the CTD yield changes \(\Delta y_S\) and \(y_Y\). For \(\rho\), as there are no traded options that allow us to estimate a model-independent implied correlation, we use a rolling six-month correlation of realized CTD yield changes as an ad hoc proxy.

Exhibit 5 shows historical levels of SpIV plotted alongside the CBOE/CME FX Yen Volatility IndexSM (JYVIXSM) tracking the 30-day forward implied volatility of USD/JPY futures based on options traded at the CME, i.e., the implied volatility analogues to the realized volatilities shown in the previous section. The time series starts in January 2008 based on the availability of historical S&P/JPX JGB VIX levels.

Exhibit 5: SpIV Versus JYVIX

For \(\rho\), we use a rolling six-month correlation of realized CTD yield changes as an ad hoc proxy.
The first interesting empirical phenomenon between SpIV and JYVIX is that past changes in SpIV are significantly correlated with future changes in JYVIX, as seen in the autocorrelation function (ACF) below.

**Exhibit 6: Correlation Between JYVIX Change and SpIV Change**

The chart shows the autocorrelation function between the change in JYVIX and the change in SpIV. The correlation coefficient is high, indicating a strong relationship.

This lagged correlation is silent about the direction of causality, which would be a stronger statement, but it does provide a sense of information propagation, i.e., perceived uncertainty is more likely to travel from rates to FX. As an illustration, on Monday Aug. 8, 2011, commonly referred to as “Black Monday” because of the turmoil following the U.S. sovereign debt downgrade by S&P Global Ratings on the previous Friday, SpIV shot up 17.64% (see Exhibit 7). JYVIX barely reacted that day, but it jumped the next day.

**Exhibit 7: Change in SpIV, JYVIX, and USD/JPY Following Black Monday**

<table>
<thead>
<tr>
<th>DATES</th>
<th>CHANGE IN SPIV PROXY</th>
<th>CHANGE IN JYVIX</th>
<th>CHANGE IN USD/JPY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 8, 2011</td>
<td>17.64%</td>
<td>1.23%</td>
<td>-0.8%</td>
</tr>
<tr>
<td>Aug. 9, 2011</td>
<td>-1.3%</td>
<td>19.3%</td>
<td>-1.0%</td>
</tr>
</tbody>
</table>

Due to the difference in time zone and market hours, it requires a bit of mental gymnastics to understand the lead-lag relationship between U.S.-
Regression Analysis

We dive deeper into the relationship between perceived FX and interest rate spread implied volatilities using regression analysis. First, we regress JYVIX on SpIV and obtain an adjusted $R^2$ of 60%, meaning that SpIV explains over one-half of the variation in JYVIX. This is arguably higher than what one may have expected based on the findings above, which pointed to the non-yield spread component, i.e., risk premium, being the major driver of realized FX spot returns.

We then regress the residuals, i.e., the part of JYVIX not explained by SpIV, on VIX based on the common interpretation of VIX as a market-wide risk aversion measure and therefore a potentially good proxy for the USD/JPY risk premium component motivated by the UIP. The adjusted $R^2$ from this regression is an unexciting 4%. However, when we replace VIX with the Nikkei Stock Average Volatility Index (VNKY), we obtain a meaningfully higher adjusted $R^2$ of 32%, which resonates with the popular pastime of traders tracking the co-movement of USD/JPY and the Nikkei.
Theories abound as to why USD/JPY and the Nikkei appear so intertwined, mostly based on fund flow arguments, but we will leave that discussion for another time.

For good measure, we throw both SpIV and VNKY into a multiple regression and obtain an adjusted $R^2$ of 78%. Thus, we conclude that implied interest rate spreads and Japanese equity volatilities explain the majority of implied FX volatility. One caveat here is that the S&P/JPXJGB VIX and TYVIX both track the 30-day implied volatilities of 10-year bond futures, and these relationships may vary as one moves across the interest rate volatility surface, so the results reported here should be interpreted with restricted generality.

**SpIV and USD/JPY Returns**

Now we get to the most intriguing empirical property of SpIV to be uncovered in this paper—its ability to predict in-sample FX returns using a parsimonious signal design that was inspired by the Stabilis family of volatility-based asset rotation strategies, which uses implied volatility indices to define regimes. The regimes are defined by upward and downward crossings of six-month rolling quantile bands of the signal; in this case, we define a “high” regime when the signal crosses the 60th percentile from below and a “low” regime when it crosses the 40th percentile from above. The objective is to study whether SpIV-based regimes have the ability to separate FX returns.

Building on the piece by Merrill Lynch (2006), we construct regimes based on various risk-adjusted yield spread signals. The authors’ original rationale for dividing by implied FX volatility was that, in a traditional carry trade, the interest rate differential is locked in and the residual risk is the depreciation of the higher-yielding currency. Therefore, when FX volatility-adjusted spread is high, more market participants are likely to enter the trade and put downward pressure on the yen. We agree with this rationale, but we also believe that it does not preclude yield spread volatility from having distinct predictive power for spot or carry returns, since yield spreads interact with exchange rates through many channels besides a buy-and-hold carry trade mechanism, as discussed above.

The table below summarizes the FX return separation results for the high and low regimes based on yield spreads divided by various volatility measures. The unadjusted yield spread does a decent job on its own of separating USD/JPY returns into a low spread regime, with -2.55% average return, and a high regime, with 3.40% average return, annualized, for an in-sample separation of 5.95%. Adjusting by SpIV boosts this separation to a remarkable 10.41%. In contrast, adjusting by the realized volatility of yield spreads does more harm than good, and the same can be said of JYVIX. The same story holds if we contrast volatility-adjusted returns in columns four and five of Exhibit 9.
**Exhibit 9: Risk-Adjusted Yield Spread Regimes**

<table>
<thead>
<tr>
<th>REGIME SIGNAL SPECIFICATION</th>
<th>RETURN (L) (%)</th>
<th>RETURN (H) (%)</th>
<th>SR (L)</th>
<th>SR (H)</th>
<th>DAYS (L)</th>
<th>DAYS (H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield Spread (Unadjusted)</td>
<td>-2.55</td>
<td>3.40</td>
<td>-0.22</td>
<td>0.33</td>
<td>1126</td>
<td>1027</td>
</tr>
<tr>
<td>Yield Spread / SpIV</td>
<td>-5.58</td>
<td>4.83</td>
<td>-0.44</td>
<td>0.52</td>
<td>939</td>
<td>1214</td>
</tr>
<tr>
<td>Yield Spread / Spread RV</td>
<td>-0.86</td>
<td>1.23</td>
<td>-0.07</td>
<td>0.12</td>
<td>968</td>
<td>1185</td>
</tr>
<tr>
<td>Yield Spread / JYVIX</td>
<td>-0.74</td>
<td>1.26</td>
<td>-0.06</td>
<td>0.14</td>
<td>1044</td>
<td>1109</td>
</tr>
<tr>
<td>Yield Spread / VIX</td>
<td>-3.62</td>
<td>3.20</td>
<td>-0.30</td>
<td>0.32</td>
<td>920</td>
<td>1233</td>
</tr>
<tr>
<td>Yield Spread / Nikkei ATM IV</td>
<td>-3.18</td>
<td>2.89</td>
<td>-0.25</td>
<td>0.31</td>
<td>922</td>
<td>1231</td>
</tr>
</tbody>
</table>

Source: S&P Dow Jones Indices LLC, Bloomberg, and JPX. Data from July 10, 2008, to Oct. 28, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Note: (H): high regime; (L): low regime; SR: return divided by volatility without subtracting risk-free rate.

All signs and magnitudes of in-sample predictability are consistent with our conjecture that a forward-looking yield spread volatility indicator based on the S&P/JPX JGB VIX and TYVIX is able to isolate return drivers that get lost in overall implied FX volatility.

Some may bemoan the fact that our analysis starts in the middle of the financial crisis, which is an inevitable data constraint given the limited S&P/JPX JGB VIX history. However, others may find this period to be more interesting, as it coincides with the start of monetary policy shifts into prolonged QE programs in both the U.S. and Japan that are still in place today. To isolate the new monetary policy regime even better, the table below repeats the same exercise starting in 2010; it shows that the qualitative conclusions are preserved, which may make these results even more compelling for FX and global macro strategists wrestling with sustained near-zero interest rates.

**Exhibit 10: Risk-Adjusted Yield Spread Regimes**

<table>
<thead>
<tr>
<th>REGIME SIGNAL SPECIFICATION</th>
<th>RETURN (L) (%)</th>
<th>RETURN (H) (%)</th>
<th>SR (L)</th>
<th>SR (H)</th>
<th>DAYS (L)</th>
<th>DAYS (H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield Spread (unadjusted)</td>
<td>0.86</td>
<td>5.43</td>
<td>0.09</td>
<td>0.55</td>
<td>888</td>
<td>767</td>
</tr>
<tr>
<td>Yield Spread / SpIV</td>
<td>-2.08</td>
<td>7.34</td>
<td>-0.20</td>
<td>0.86</td>
<td>766</td>
<td>889</td>
</tr>
<tr>
<td>Yield Spread / Spread RV</td>
<td>0.97</td>
<td>4.74</td>
<td>0.10</td>
<td>0.51</td>
<td>774</td>
<td>881</td>
</tr>
<tr>
<td>Yield Spread / JYVIX</td>
<td>1.93</td>
<td>4.11</td>
<td>0.18</td>
<td>0.53</td>
<td>859</td>
<td>796</td>
</tr>
<tr>
<td>Yield Spread / VIX</td>
<td>-0.04</td>
<td>5.37</td>
<td>0.00</td>
<td>0.58</td>
<td>732</td>
<td>923</td>
</tr>
<tr>
<td>Yield Spread / Nikkei ATM IV</td>
<td>2.52</td>
<td>3.37</td>
<td>0.23</td>
<td>0.42</td>
<td>759</td>
<td>896</td>
</tr>
</tbody>
</table>

Source: S&P Dow Jones Indices LLC, Bloomberg, and JPX. Data from June 28, 2010, to Oct. 28, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Note: (H): high regime; (L): low regime; SR: return divided by volatility without subtracting risk-free rate.
We finish this paper with a teaser for the second part of this two-part empirical study, which will take these basic empirical findings and explore ways to exploit them through simple systematic strategies.

**An Illustrative Carry Strategy Using SpIV-Based Regimes**

Exhibit 11 shows returns of a typical implementation of the USD/JPY carry trade, which was predominantly driven by FX returns during the past few years, as one would expect. The darker gray shading marks the high regimes based on the SpIV-adjusted yield spread signal. Of course, the signal is not a crystal ball and does not catch all upswings or avoid all drawdowns, but one may still visually recognize how the separation works.

**Exhibit 11: Implementation of USD/JPY Carry Trade**

The signal is not a crystal ball and does not catch all upswings or avoid all drawdowns, but one may still visually recognize how the separation works.

**Exhibit 12: Performance Statistics of Carry Trade**

<table>
<thead>
<tr>
<th>REGIME SIGNAL</th>
<th>ANNUAL RETURN (%)</th>
<th>ANNUAL VOLATILITY (%)</th>
<th>RETURN/VOLATILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry Trade</td>
<td>0.64</td>
<td>10.91</td>
<td>0.06</td>
</tr>
<tr>
<td>FX</td>
<td>0.23</td>
<td>10.91</td>
<td>0.02</td>
</tr>
<tr>
<td>Spread</td>
<td>0.42</td>
<td>0.03</td>
<td>12.72</td>
</tr>
</tbody>
</table>

Source: S&P Dow Jones Indices LLC, Bloomberg, and JPX. Data from Sept. 25, 1996 to Oct. 31, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.
One simple illustrative strategy that leverages the separation result from the previous section is to allocate capital between the carry trade and cash as a function of the various volatility-adjusted yield spread signals (see Exhibit 13).

Exhibit 13: Market Timing and Carry Trade Weight

<table>
<thead>
<tr>
<th>MARKET TIMING RULE</th>
<th>CARRY TRADE WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted spread &lt;= 20% percentile in the past 6 months</td>
<td>0%</td>
</tr>
<tr>
<td>20% percentile &lt; Adjusted spread &lt;= 40% percentile in the past 6 months</td>
<td>25%</td>
</tr>
<tr>
<td>40% percentile &lt; Adjusted spread &lt;= 60% percentile in the past 6 months</td>
<td>50%</td>
</tr>
<tr>
<td>60% percentile &lt; Adjusted spread &lt;= 80% percentile in the past 6 months</td>
<td>75%</td>
</tr>
<tr>
<td>Adjusted spread &gt; 80% percentile in the past 6 months</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: S&P Dow Jones Indices LLC, Bloomberg, and JPX. Data as of Oct. 31, 2016. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibits 14 shows the performance of the various timed carry strategies. Despite this rough and naive weighting scheme, the strong separation based on SpIV shines through and outperforms all others by a comfortable margin. The JYVIX-adjusted signal actually underperforms the untimed carry trade, which contrasts with the pre-crisis period results reported by Merrill Lynch (2006). One positive attribute common across the volatility-adjusted market timing strategies seems to be their ability to avoid drawdowns, which is a theme shared by the Stabilis indices.

Exhibit 14: Performance of Timed Carry Strategies

Source: S&P Dow Jones Indices LLC, Bloomberg, and JPX. Data as of Oct. 31, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

The strong separation based on SpIV shines through and outperforms all others by a comfortable margin.
document for more information regarding the inherent limitations associated with back-tested performance.
### Exhibit 15: Annual Return, Volatility, and Max Drawdown of Timed Carry Strategies

<table>
<thead>
<tr>
<th>REGIME SIGNAL</th>
<th>ANNUAL RETURN (%)</th>
<th>ANNUAL VOLATILITY (%)</th>
<th>RETURN / VOLATILITY</th>
<th>MAX DRAWDOWN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry Trade</td>
<td>0.64</td>
<td>10.91</td>
<td>0.06</td>
<td>-30.43</td>
</tr>
<tr>
<td>SpIV-Adjusted</td>
<td>1.58</td>
<td>6.73</td>
<td>0.30</td>
<td>-14.38</td>
</tr>
<tr>
<td>Spread RV-Adjusted</td>
<td>0.70</td>
<td>6.37</td>
<td>0.11</td>
<td>-16.24</td>
</tr>
<tr>
<td>JYVIX-Adjusted</td>
<td>-0.15</td>
<td>6.11</td>
<td>-0.03</td>
<td>-15.36</td>
</tr>
</tbody>
</table>

Source: S&P Dow Jones Indices LLC, Bloomberg, and JPX. Data as of Oct. 31, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

### CONCLUSION AND PREVIEW OF PART 2

This first installment of a two-part empirical study focusing on the relationship between the S&P/JPX JGB VIX and the Japanese yen uncovered promising signal value of implied yield spread volatility with respect to FX returns. In the second installment, we take these basic yet novel empirical observations and perform a deeper dive into their applications for managing FX risk.
REFERENCES


TYVIX. Online primer on TYVIX. http://www.tyvix101.com
PERFORMANCE DISCLOSURE

The S&P JGB VIX was launched on October 2, 2015. All information presented prior to an index’s Launch Date is hypothetical (back-tested), not actual performance. The back-test calculations are based on the same methodology that was in effect on the index Launch Date. Complete index methodology details are available at www.spdji.com.

S&P Dow Jones Indices defines various dates to assist our clients in providing transparency. The First Value Date is the first day for which there is a calculated value (either live or back-tested) for a given index. The Base Date is the date at which the Index is set at a fixed value for calculation purposes. The Launch Date designates the date upon which the values of an index are first considered live: index values provided for any date or time period prior to the index’s Launch Date are considered back-tested. S&P Dow Jones Indices defines the Launch Date as the date by which the values of an index are known to have been released to the public, for example via the company’s public website or its datafeed to external parties. For Dow Jones-branded indices introduced prior to May 31, 2013, the Launch Date (which prior to May 31, 2013, was termed “Date of introduction”) is set at a date upon which no further changes were permitted to be made to the index methodology, but that may have been prior to the Index’s public release date.

Past performance of the Index is not an indication of future results. Prospective application of the methodology used to construct the Index may not result in performance commensurate with the back-test returns shown. The back-test period does not necessarily correspond to the entire available history of the Index. Please refer to the methodology paper for the Index, available at www.spdji.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Another limitation of using back-tested information is that the back-tested calculation is generally prepared with the benefit of hindsight. Back-tested information reflects the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities, fixed income, or commodities markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

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