S&P Dow Jones Indices

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APPLIED ACADEMICS

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S&P/JPX JGB VIX® and the Japanese Yen: Part 2

EXECUTIVE SUMMARY

This is the second 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. The first installment (published in December 2016) documents how the forward-looking implied volatility of the yield spread between the U.S. dollar and the Japanese yen exhibits in-sample predictive power for USDJPY spot foreign exchange (FX) returns since the inception of the S&P/JPX JGB VIX in 2008. This paper investigates how Japanese market participants may leverage the preceding results to better manage the FX risk inherent in making broad-based foreign equity investments.

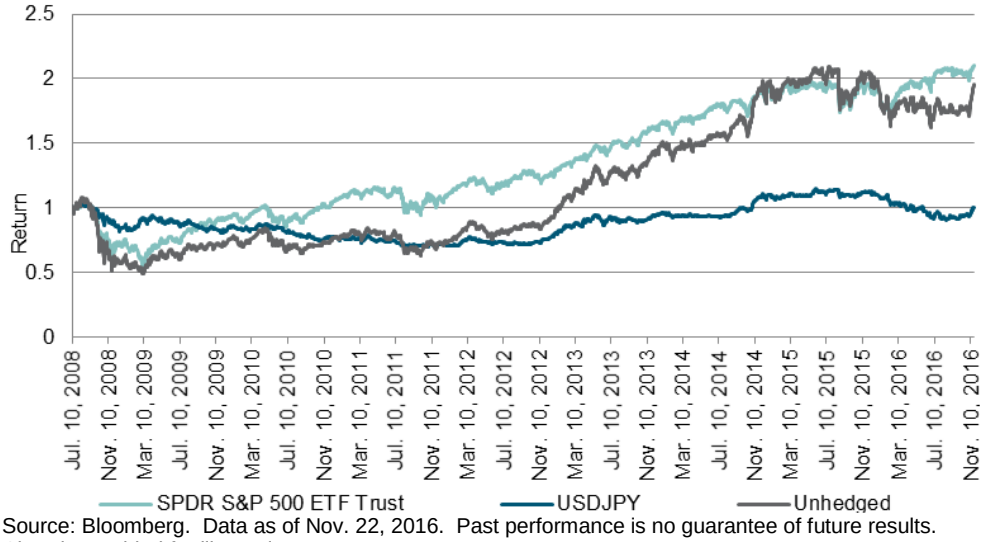
Highlights

- FX risk in foreign equity investments is an economically meaningful thorn in the Japanese market participant's side.
- A statically "hedged" currency position tends to create a drag on returns from negative carry, whereas an "unhedged" currency position generally boosts volatility.
- The S&P/JPX JGB VIX and CBOE/CBOT TYVIX may be useful to Japanese market participants for dynamically managing the FX risk embedded in U.S. and European equity holdings.

FOREIGN EQUITY INVESTMENTS AND FX RISK

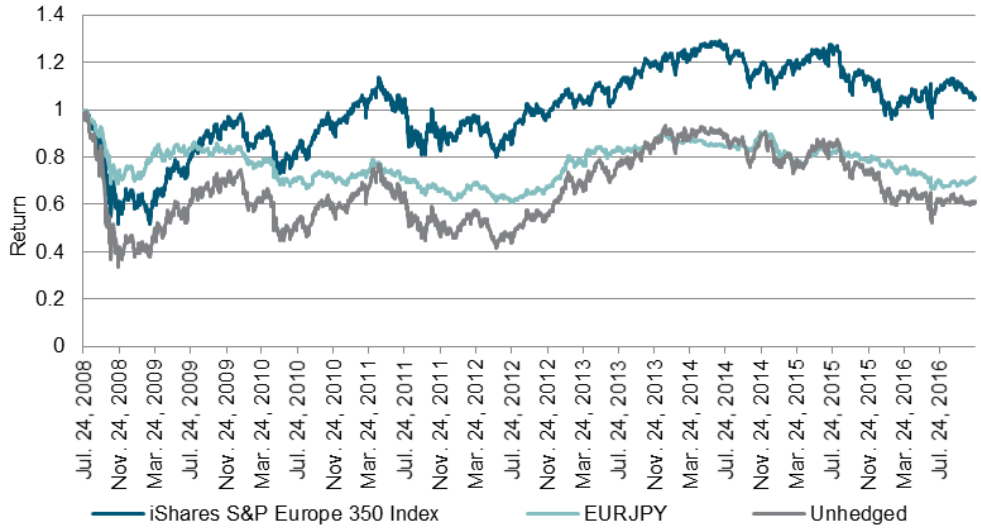
Japanese market participants looking for foreign equity market exposure must deal with the FX risk imposed by the need to convert between the currency of their capital base and that of the asset. Exhibit 1 compares returns based on the SPDR S&P 500® ETF Trust from the perspectives of dollar- and yen-based market participants to demonstrate how significant FX risk can be. From 2008 to 2016, the SPDR S&P 500 ETF Trust experienced an annualized volatility of 21.1%, which jumped to 27.5% when combined with USDJPY fluctuations, and the two diverged significantly during certain periods. An even larger volatility impact was observed when adding EURJPY exposure to the iShares S&P Europe 350 Index (see Exhibit 2). The main message here is that FX risk in foreign equity investments is an economically meaningful thorn in the Japanese market participant's side.

Exhibit 1: U.S. Dollar-Based Returns



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Exhibit 2: Euro-Based Returns



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

ETF providers offer both "hedged" and unhedged versions of foreign equity index ETFs that are denominated in the domestic currency.

"Hedged" Versus Unhedged: A False Dichotomy?

This problem is commonly posed as a choice between hedging and not hedging the FX risk in foreign equity investments; for example, some exchange-traded fund (ETF) providers offer both "hedged" and unhedged versions of foreign equity index ETFs that are denominated in the domestic currency. However, we put the word "hedged" in quotations as we are not aware of any hedging strategy that can remove the FX risk completely, which makes the problem not as clean cut as it seems at first blush. It does not take any complicated equations to recognize that a yen-based market participant wishing to mute the FX risk must in one form or another go long on yen against higher-yielding currencies like the U.S. dollar and the euro,

which may reduce spot FX risk, but not without a drag on returns from negative carry.

Exhibit 3 juxtaposes the cumulative returns of the iShares MSCI Currency Hedged Japan ETF (HEWJ), which seeks to track the JPX-Nikkei Index 400 while reducing the impact of USDJPY fluctuations, against the JPX-Nikkei Index 400 itself from 2014 to 2016. Even though interest rate spreads were low during this period and in favor of the USD-based market participant, excess returns of the ETF over the index (see Exhibit 4) were volatile and had a downward drift, which corroborates the absence of a perfect hedge.

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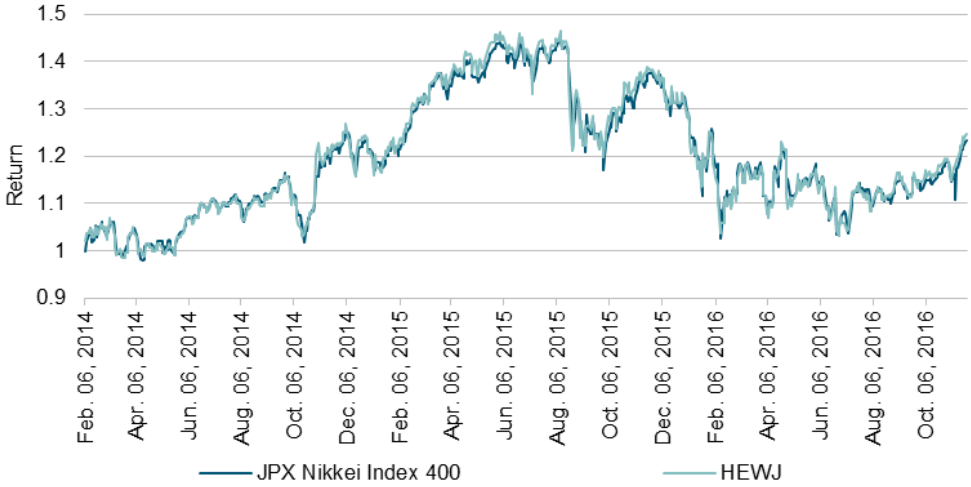
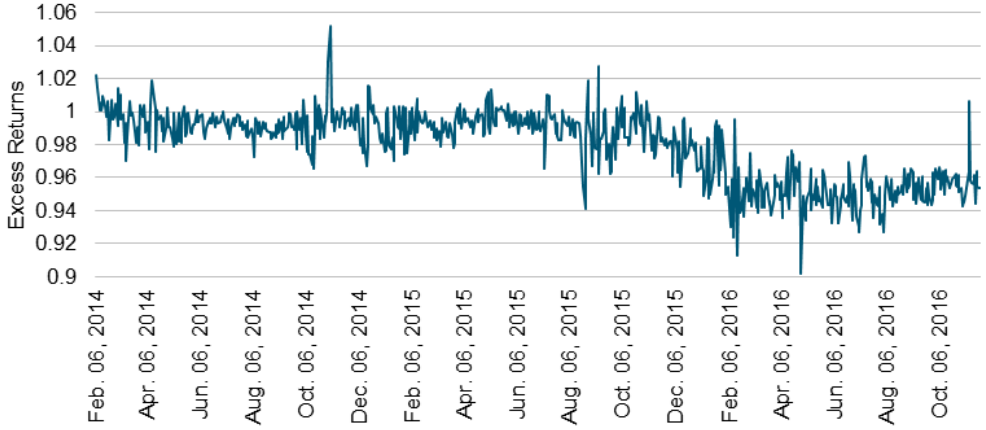
Exhibit 3: Cumulative Returns of the JPX Nikkei Index 400 and HEWJ



Source: Bloomberg, iShares, and JPX. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Exhibit 4: Excess Return of the HEWJ Over the JPX Nikkei Index 400



Source: Bloomberg, iShares, and JPX. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

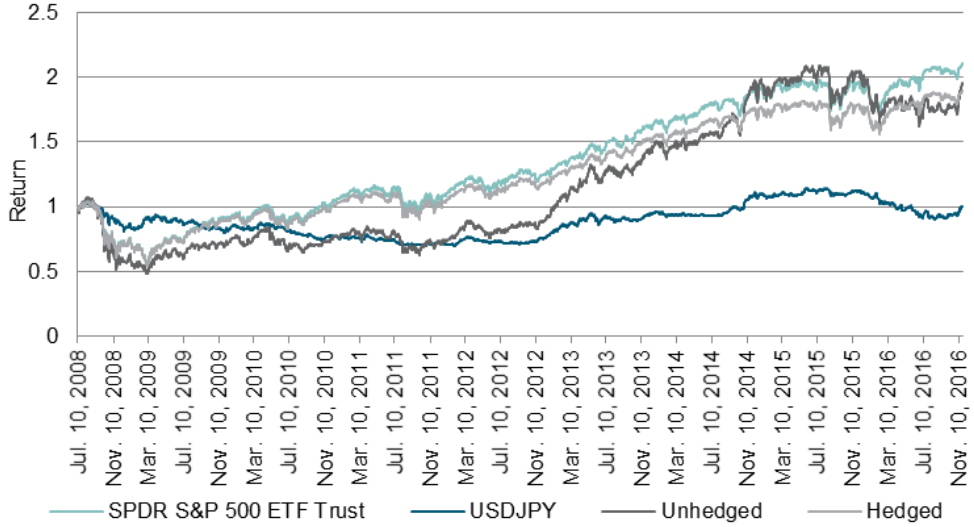
One straightforward FX hedging procedure is to buy an overnight forward and reset the hedge each day. On days when neither the equity return nor the spot rate change is outsized, the net profit and loss is approximately equal to the equity return minus the overnight USD-JPY or USD-EUR yield

spread. Even if we assume zero transaction cost on the FX forward, this simple recipe would likely have cost a Japan-based investment in the SPDR S&P 500 ETF Trust and the iShares S&P Europe 350 Index over 120 bps and 70 bps per year, respectively, to remove the FX volatility. The return deterioration is particularly acute for the lowest-yielding funding currencies like the yen.

This stylized example is useful in highlighting that the traditional framework forces yen-based market participants into the unenviable position of having to choose between significantly higher volatility (unhedged) or significantly lower returns (hedged) compared with the performance enjoyed by those with capital denominated in the native currency (see Exhibits 5-8).

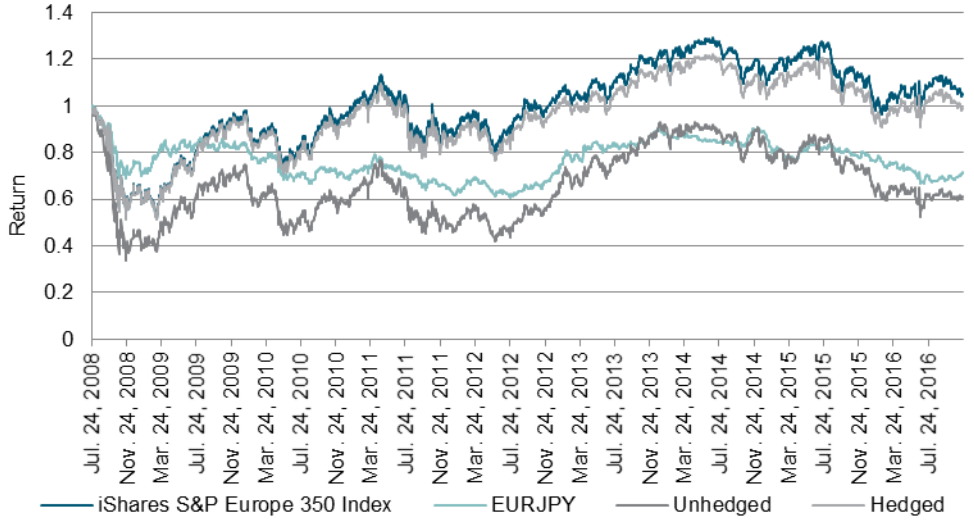
The return deterioration is particularly acute for the lowest-yielding funding currencies like the yen.

Exhibit 5: Returns of Hedged U.S. Dollar-Based Strategies



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Exhibit 6: Returns of Perfectly Hedged Euro-Based Strategies



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Exhibit 7: Characteristics of U.S. Dollar-Based Strategies

CATEGORY	SPDR S&P 500 ETF TRUST	USDJPY	UNHEDGED	HEDGED
Annualized Return (%)	9.35	0.51	9.86	8.12
Annualized Standard Deviation (%)	21.09	10.97	27.46	21.09
Annualized Sharpe Ratio (Rf=0%)	0.44	0.05	0.36	0.39

Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes.

Exhibit 8: Characteristics of Euro-Based Strategies

CATEGORY	iSHARES S&P EUROPE 350 INDEX	EURJPY	UNHEDGED	HEDGED
Annualized Return (%)	0.0293	-0.0359	-0.0066	0.022
Annualized Standard Deviation (%)	0.3159	0.1378	0.4188	0.3159
Annualized Sharpe Ratio (Rf=0%)	0.0929	-0.2605	-0.0157	0.0695

Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes.

A more appropriate way to frame the problem may be as “how to jointly manage equity and FX risk” instead of “to hedge or not to hedge.”

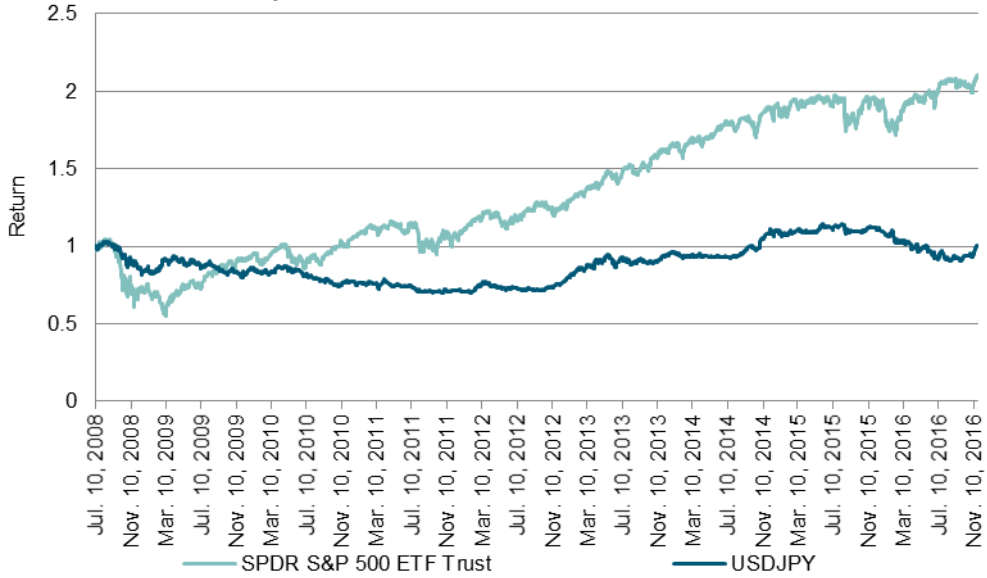
INTERPLAY BETWEEN EQUITIES AND FX

The absence of a perfect hedge means that Japanese market participants are exposed to FX risk one way or another, so a more appropriate way to frame the problem may be as “how to jointly manage equity and FX risk” instead of “to hedge or not to hedge.” This less rigid perspective provides greater potential for market participants to leverage the economic linkage between equity and FX returns instead of treating the FX risk separately as a nuisance or an afterthought. This viewpoint is similar in spirit to the work of Campbell, Serfaty, and Viceira (2010), which proposes a framework for minimizing the overall risk of a multi-currency portfolio of global stocks by using FX positions based on covariances between equity and FX returns.

S&P 500 and USDJPY

The correlation between SPDR S&P 500 ETF Trust and USDJPY returns was 41% at the daily frequency during our sample period (see Exhibit 9). This phenomenon has been ascribed, mostly anecdotally, to various market forces such as capital flows between the U.S. and Japan and the “safe haven” status of the yen. However, long-term correlations and anecdotes only scratch the surface of the rich macroeconomic forces underlying the dynamics between the two.

Exhibit 9: Relationship Between the SPDR S&P 500 ETF Trust and USDJPY



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Looking closer at the co-movement through time, Exhibit 10 shows the three-month rolling correlation oscillating significantly between -40% and 80%. From a purely quantitative perspective, this suggests that a static position in FX is unlikely to be optimal in the sense of combined return per unit risk. Economically, one may interpret this to mean that the two are driven, at least in part, by distinct risk factors. For example, periods of negative correlation coincide with changes in fiscal or monetary policy in Japan, accompanied by open market operations ranging from outright FX intervention by the Ministry of Finance to additional easing measures by the Bank of Japan.

A static position in FX is unlikely to be optimal in the sense of combined return per unit risk.

Exhibit 10: Three-Month Rolling Correlation Between the Returns of the SPDR S&P 500 ETF Trust and USDJPY

Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Looking at it from yet another angle, Exhibits 11 and 12 uncover asymmetry in the correlation that is conditional on the SPDR S&P 500 ETF Trust increasing or decreasing, with negative equity returns having higher correlation. Moreover, there were significant outliers that inflated observed correlation levels, again suggesting the potential advantage of a dynamic FX position.

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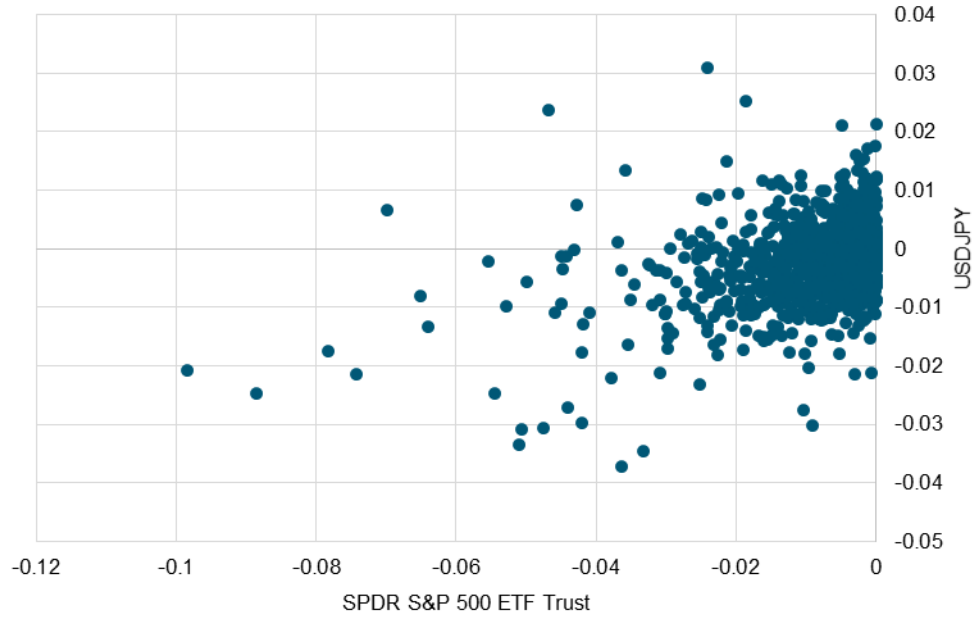
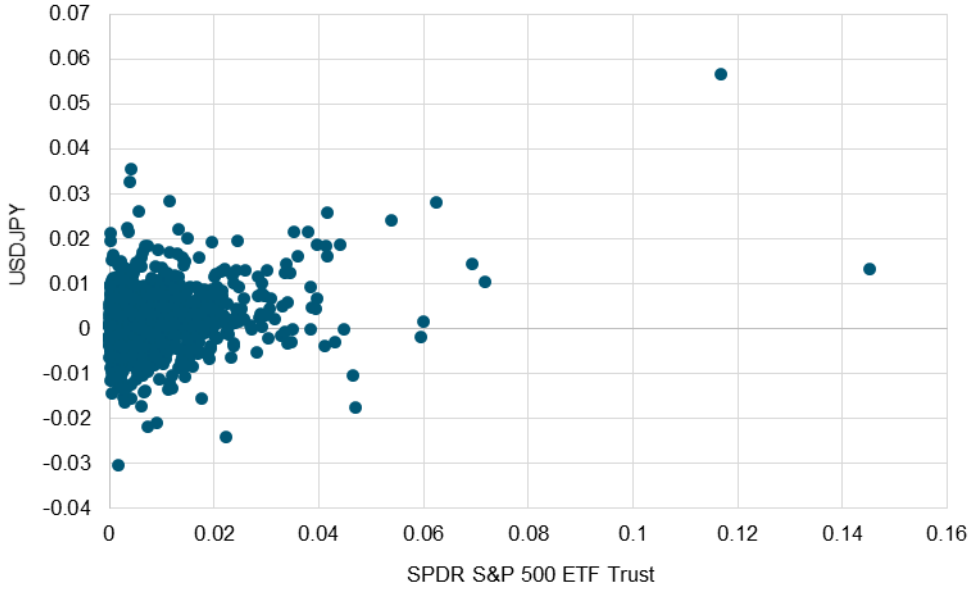
Exhibit 11: Scatter Plot When SPDR S&P 500 ETF Trust Return Is Less Than Zero



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Exhibit 12: Scatter Plot When SPDR S&P 500 ETF Trust Return Is Greater Than Zero



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

S&P Europe 350 and EURJPY

We repeat the same analysis as above for the iShares S&P Europe 350 Index and EURJPY (see Exhibit 13). The correlation between the two is higher (at 64%) during the same period.

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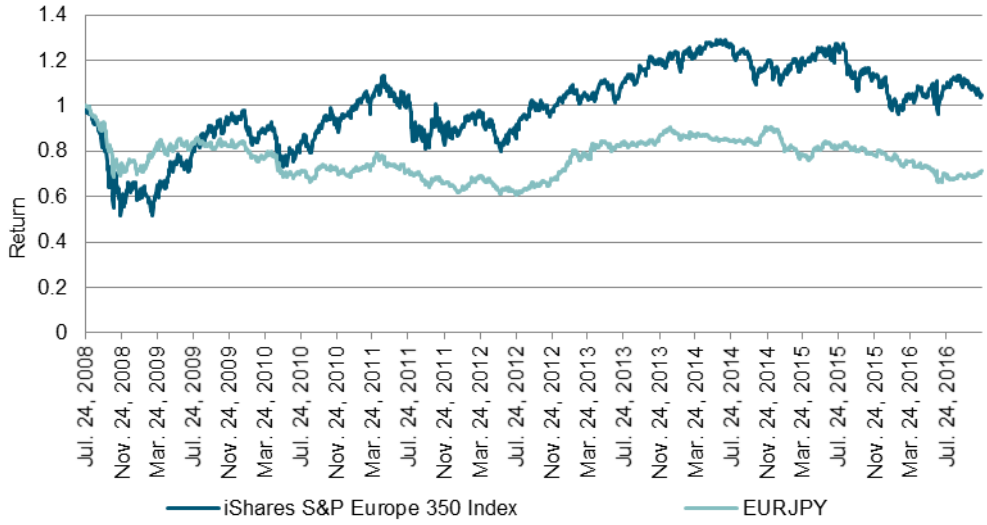
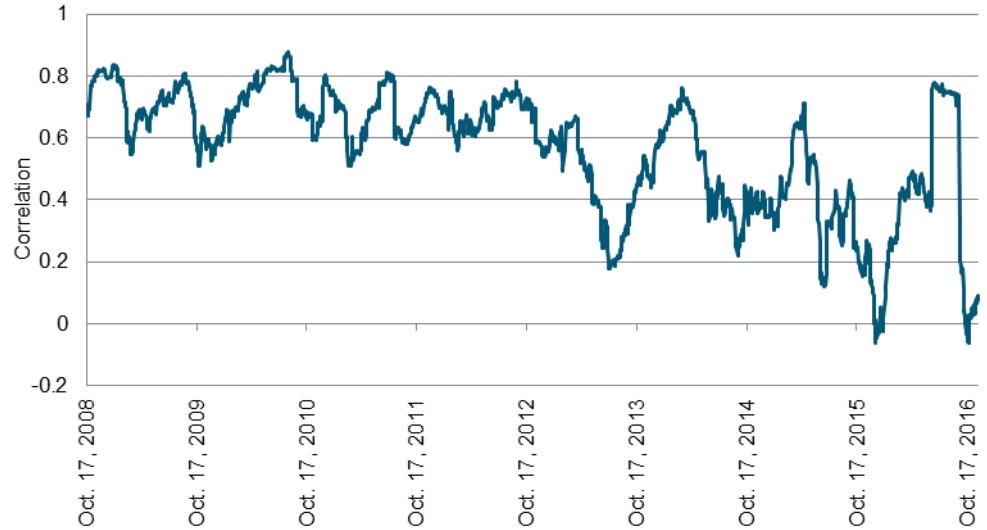
Exhibit 13: Relationship Between the iShares S&P Europe 350 Index and EURJPY



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

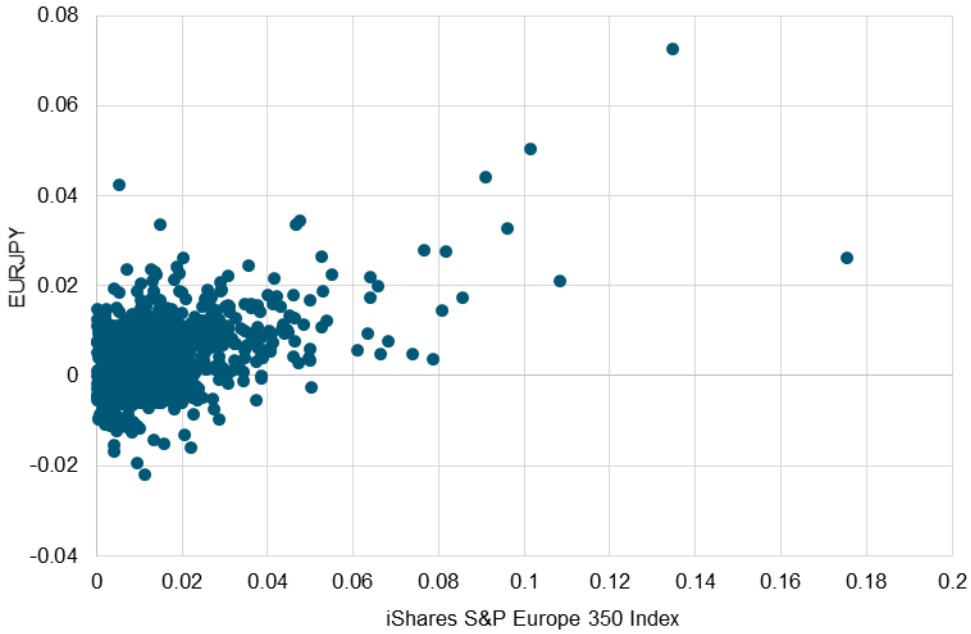
Correlations have become more volatile in recent years and seem to be trending lower, possibly due to the macroeconomic uncertainty caused by the European debt crisis (see Exhibits 14-16). From Spanish bank bailouts to Draghi's famous "whatever it takes" comments to Grexit, the eurozone has been plagued with one dilemma after another.

Exhibit 14: Three-Month Rolling Correlation Between the iShares S&P Europe 350 Index and EURJPY



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

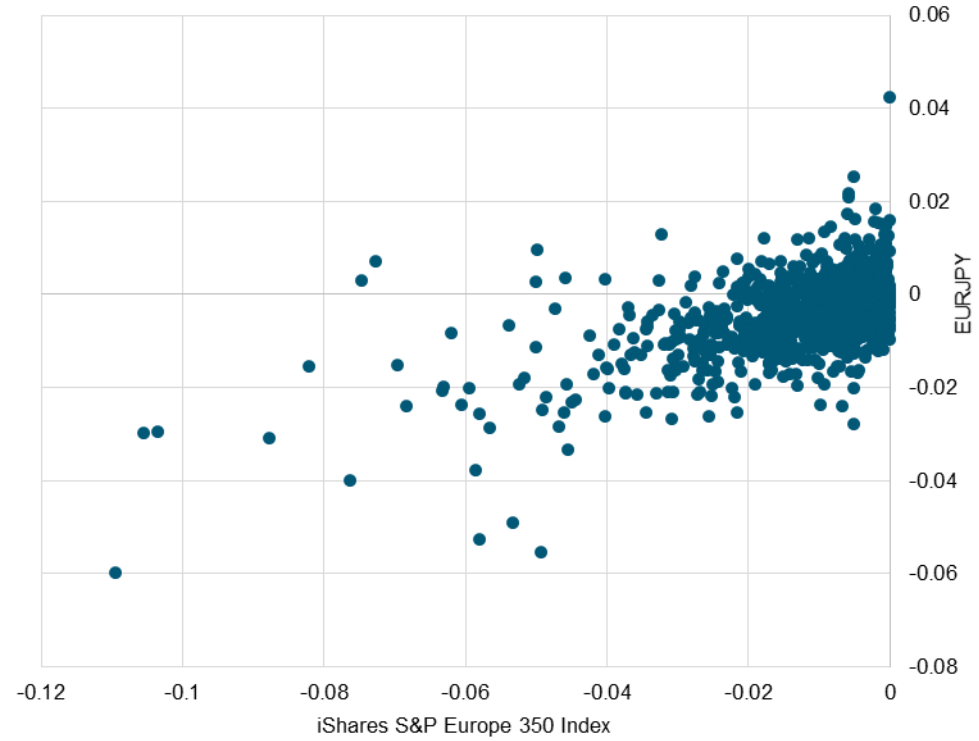
Exhibit 15: Scatter Plot When iShares S&P Europe 350 Index Return Is Greater Than Zero



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Correlations have become more volatile in recent years and seem to be trending lower, possibly due to the macroeconomic uncertainty caused by the European debt crisis.

Exhibit 16: Scatter Plot When iShares S&P Europe 350 Index Return Is Less Than Zero



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

DYNAMIC FX POSITIONING WITH SPREAD IMPLIED VOLATILITY (SpIV)

The foregoing analysis points to the possibility of a better approach for Japanese market participants to manage the FX risk with respect to U.S. and European equities than current standard practices. Referring back to the first installment of this two-part paper, one potential approach is to use a market-timed strategy for managing the FX risk. A dynamic FX position may allow for some balance between muting increased volatility from a short yen exposure and reducing the bleed from a long yen hedge.

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Our first paper constructed a forward-looking measure of yield SpIV based on the S&P/JPX JGB VIX and CBOE/CBOT TYVIX, which was motivated by the hypothesis that returns on traditional carry pairs, such as USDJPY and EURJPY, are sensitive not only to the level of yield spreads but also to their expected stability. It then stands to reason that a higher ratio of yield spread to SpIV may predict higher carry returns, and vice-versa. We modified the simple long-only strategy based on this concept from the last installment to allow long and short positions in USDJPY and applied the same rules to EURJPY (see Exhibit 17).

Exhibit 17: Market Timing and Carry Trade Weight

MARKET TIMING RULE	CARRY TRADE WEIGHT (%)
Adjusted spread <= 20th percentile in the past 6 months	-100
20th percentile < Adjusted spread <= 40th percentile in the past 6 months	-50
40th percentile < Adjusted spread <= 60th percentile in the past 6 months	0
60th percentile < Adjusted spread <= 80th percentile in the past 6 months	50
Adjusted spread > 80th percentile in the past 6 months	100

Source: Bloomberg. Data as of Nov. 22, 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.

Exhibits 18 and 19 show the resulting time series of exposures to USDJPY and EURJPY; the two are similar and swing between being long and short the yen. We removed the non-negativity constraint from the first paper to be consistent with the idea that the active FX position should not necessarily be statically long (hedged) or short (unhedged) the yen when combined with equity exposure.

Exhibits 18 and 19 show the resulting time series of exposures to USDJPY and EURJPY; the two are similar and swing between being long and short the yen.

Exhibit 18: Exposure to USDJPY

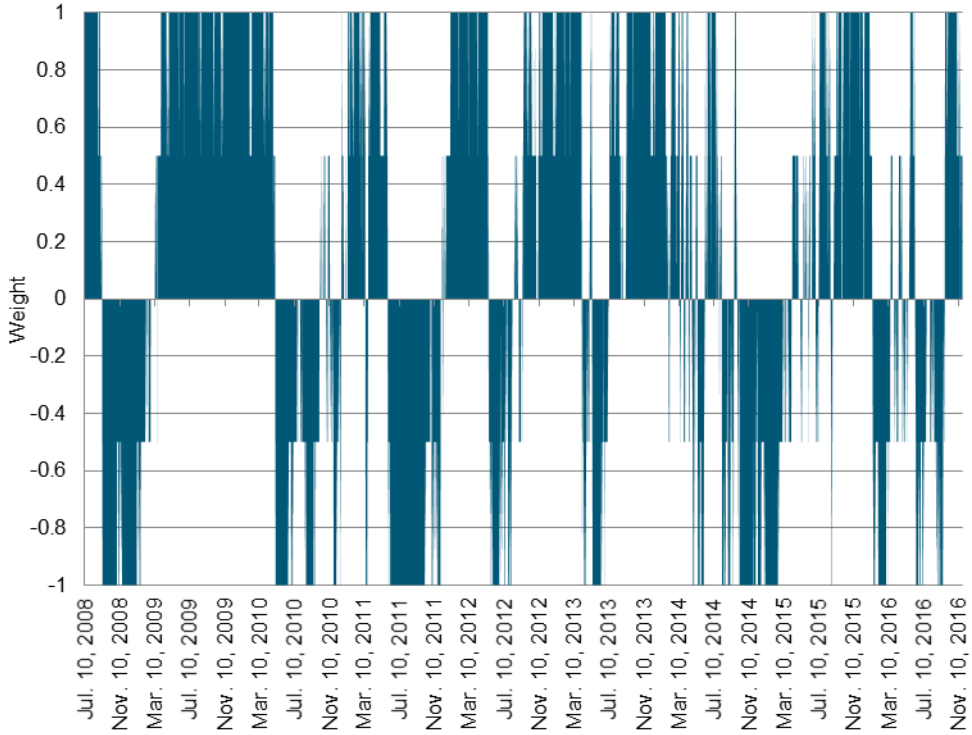

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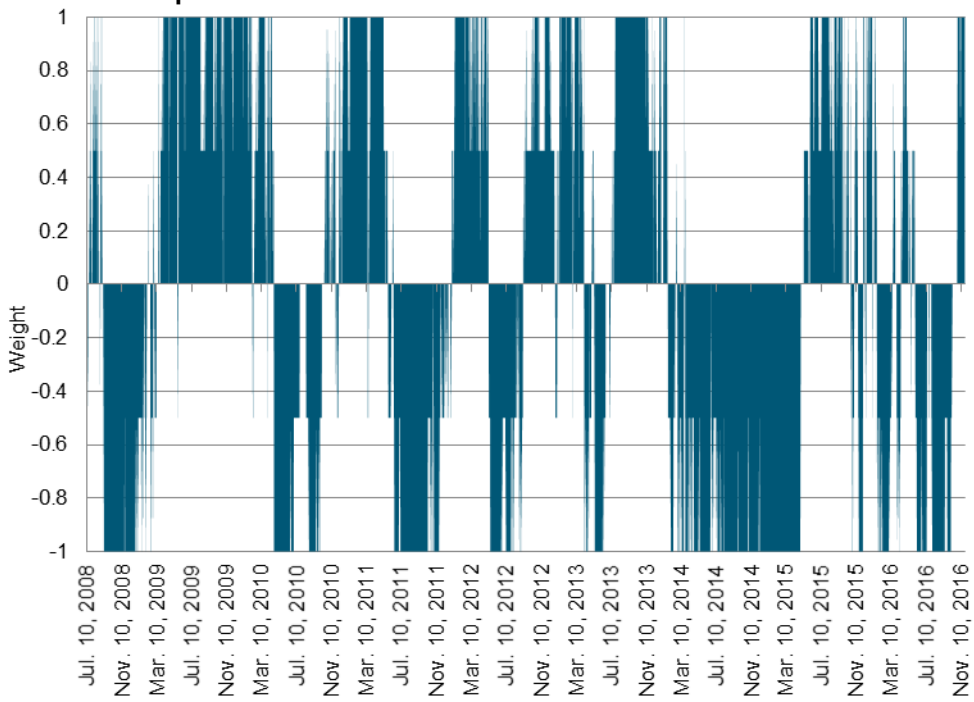
Exhibit 19: Exposure to EURJPY



Source: Bloomberg. Data as of Nov. 22, 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.

Exhibit 20 shows a rolling six-month percentage of days on which the dynamic FX strategy return was positive. The hit rates oscillated but remained above 50% during most of the eight-year period and averaged around 55% and 45% for USDJPY and EURJPY, respectively, which is nothing to scoff at, given how notoriously difficult FX spot returns are to forecast. While this is in-sample predictability, the simplicity of the strategy and the fact that the same trading rule (which was developed only for USDJPY in the first paper) works similarly for both currencies should provide some confidence in these results.

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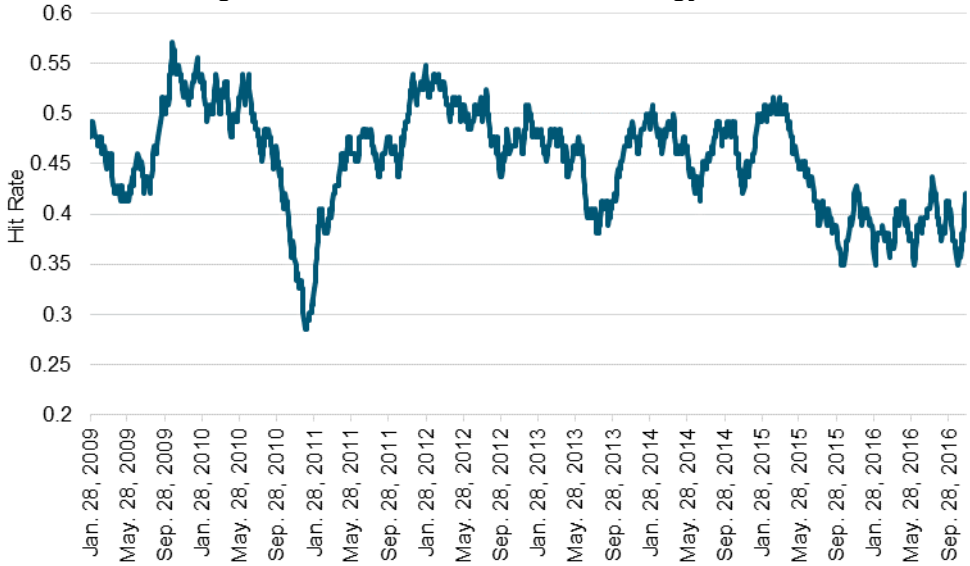
Exhibit 20: Rolling Six-Month Hit Rate for U.S. Dollar Strategy

Source: Bloomberg. Data as of Nov. 22, 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.

Exhibit 21: Rolling Six-Month Hit Rate for Euro Strategy



Source: Bloomberg. Data as of Nov. 22, 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.

Returns from the SpIV-based FX strategy are contrasted with static carry returns in Exhibits 22 and 23. The dynamic strategy generally did well compared to the base case, but also underwent certain periods of underperformance, notably in 2013 and 2014, as one may expect from the results of Exhibits 20 and 21.

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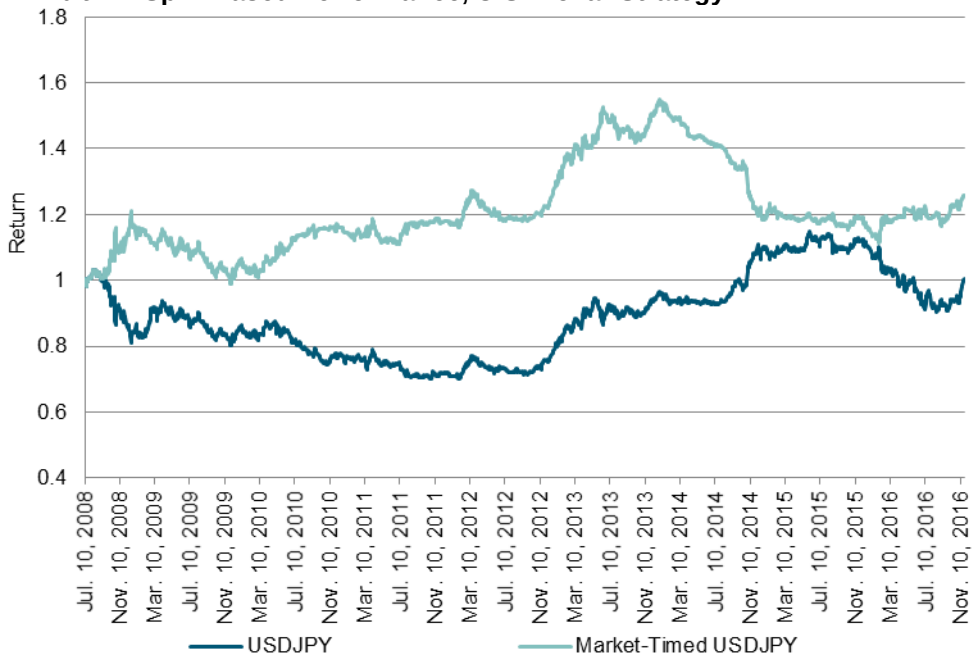
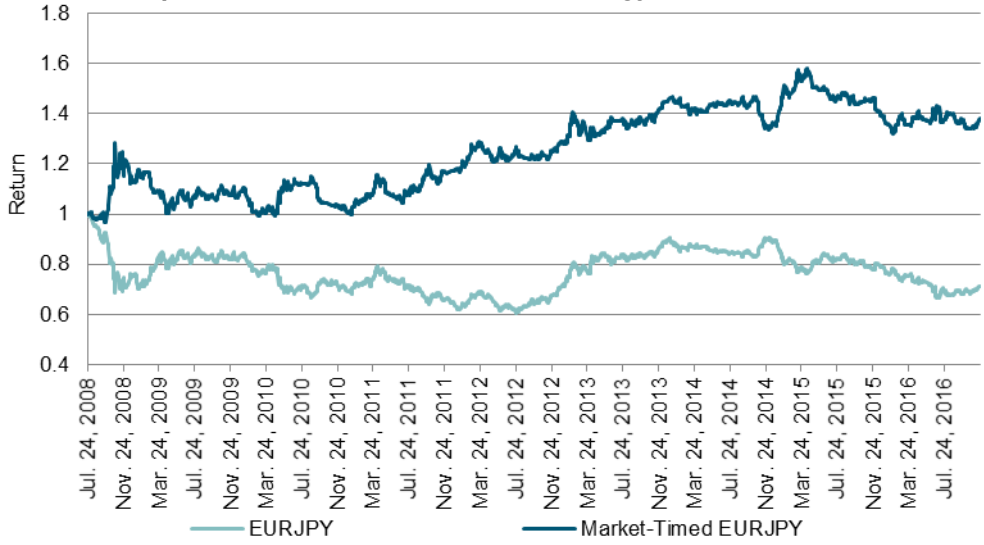
Exhibit 22: SpIV-Based Performance, U.S. Dollar Strategy



Source: Bloomberg. Data as of Nov. 22, 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.

Exhibit 23: SpIV-Based Performance, Euro Strategy



Source: Bloomberg. Data as of Nov. 22, 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 static currency carry returns had predominantly positive correlation with their corresponding equity index returns during the sample period.

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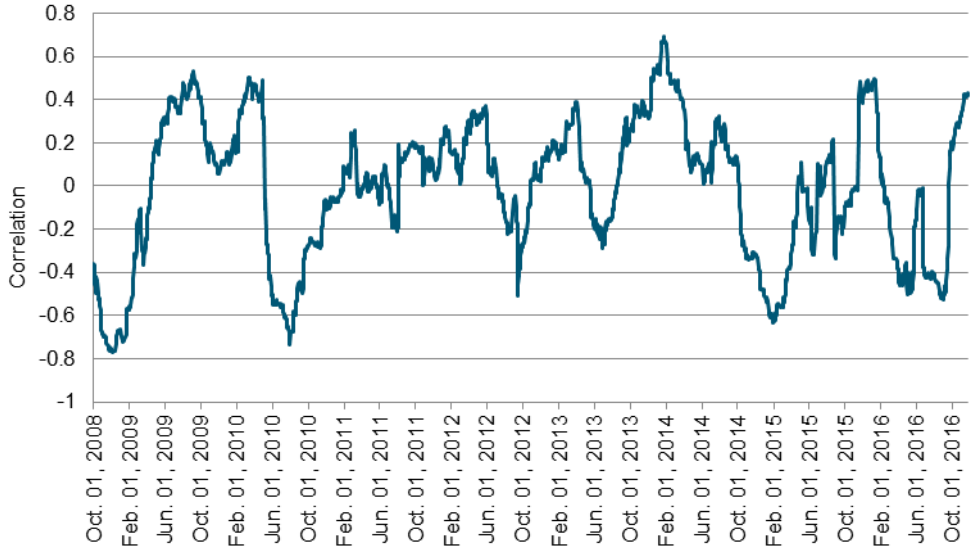
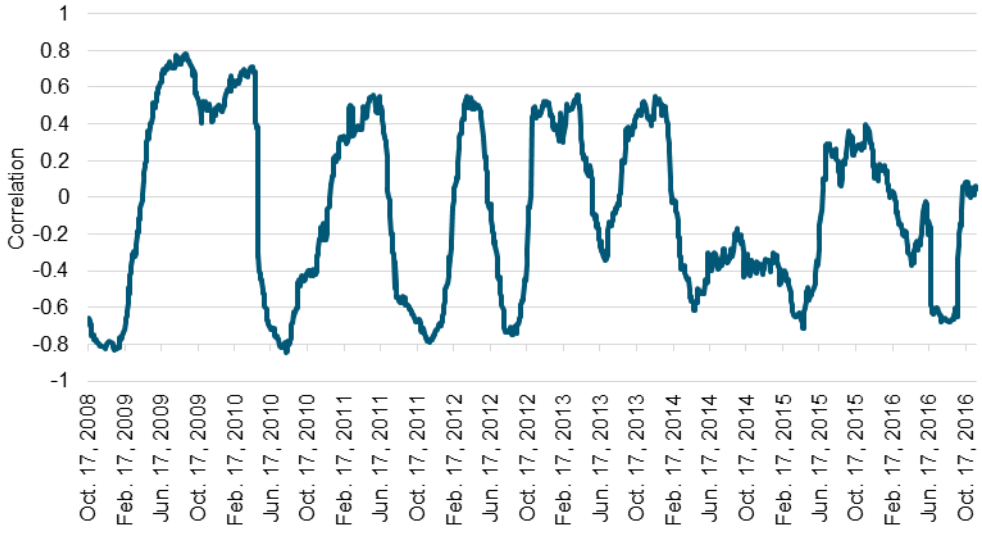
Exhibit 24: Rolling Three-Month Correlation Between Market-Timed USDJPY and SPDR S&P 500 ETF Trust



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Exhibit 25: Rolling Three-Month Correlation Between Market-Timed EURJPY and the iShares S&P Europe 350 Index



Source: Bloomberg. Data as of Nov. 22, 2016. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Finally, we overlaid the dynamic FX exposure to the SPDR S&P 500 ETF Trust and the iShares S&P Europe 350 Index (see Exhibits 26 and 27) and found that it handily outperformed the hedged, unhedged, and native currency cases in terms of annualized return and Sharpe ratio (see Exhibits 28 and 29). To make the comparison even more exciting, we also ran it against the equity index combined with a static FX position for which the weight was optimized in sample. Despite the fact that the static strategy used look-ahead information, the dynamic strategy still beat in the case of the SPDR S&P 500 ETF Trust and almost matched in the case of the iShares S&P Europe 350 Index.

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Exhibit 26: Dynamic Hedging, U.S. Dollar Strategy

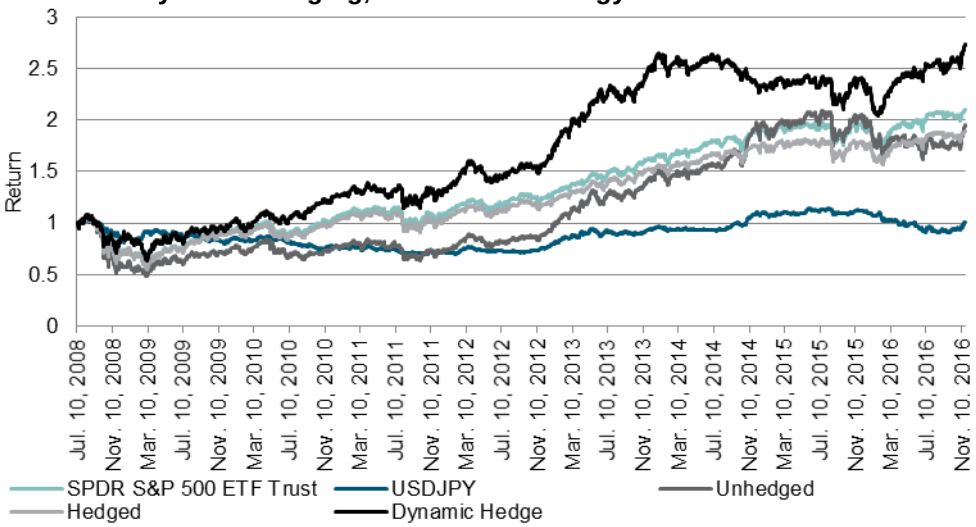

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Exhibit 27: Dynamic Hedging, Euro Strategy

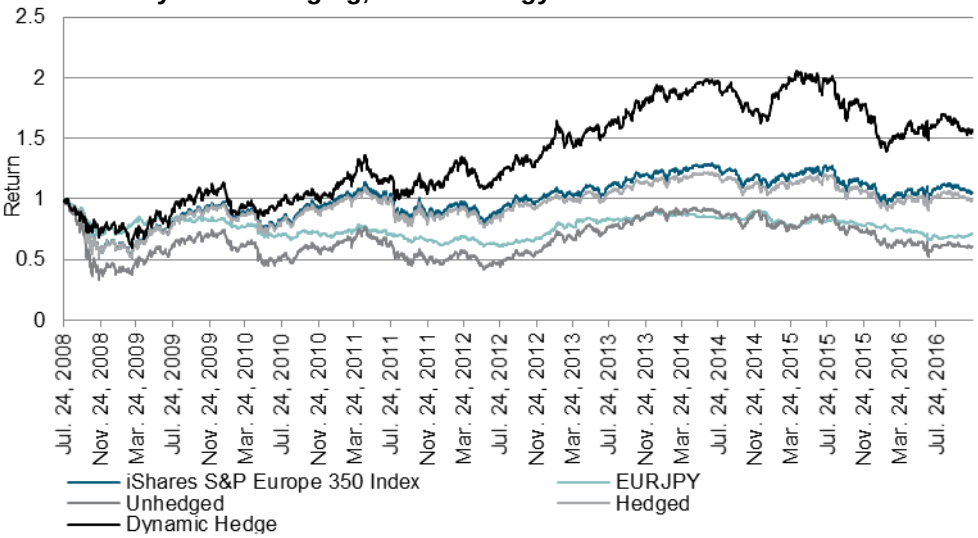

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Exhibit 28: iShares S&P Europe 350 Index Performance

CATEGORY	iSHARES S&P EUROPE 350 INDEX	EURJPY	UNHEDGED	HEDGED	DYNAMIC HEDGE	STATIC
Annualized Return (%)	4.43	-3.19	1.24	3.70	9.14	7.62
Annualized Standard Deviation (%)	27.66	14.02	38.23	27.66	26.70	21.49
Annualized Sharpe Ratio (Rf=0%)	0.16	-0.23	0.03	0.13	0.34	0.35

Source: Bloomberg. Data as of Nov. 22, 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.

Exhibit 29: SPDR S&P 500 ETF Trust Performance

CATEGORY	SPDR S&P 500 ETF TRUST	USDJPY	UNHEDGED	HEDGED	DYNAMIC HEDGE	STATIC
Annualized Return (%)	10.84	0.65	11.49	9.63	13.94	10.47
Annualized Standard Deviation (%)	21.16	10.93	27.38	21.16	21.45	19.55
Annualized Sharpe Ratio (Rf=0%)	0.51	0.06	0.42	0.46	0.65	0.54

Source: Bloomberg. Data as of Nov. 22, 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

This second installment of a two-part empirical study aims to demonstrate how far-reaching the applications of the S&P/JPX JGB VIX may be by exploring potential use cases for Japanese market participants looking for foreign equity exposure. For readers interested in pursuing this particular case further, one potentially fruitful avenue of research may be to model more explicitly the covariance between the yen and foreign equities as a function of relevant common macroeconomic factors.

This second installment of a two-part empirical study aims to demonstrate how far-reaching applications of the volatility index may be by exploring potential use cases of the S&P/JPX JGB VIX for Japanese market participants looking for foreign equity exposure.

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PERFORMANCE DISCLOSURE

The S&P/JPX 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.

The Index returns shown do not represent the results of actual trading of investable assets/securities. S&P Dow Jones Indices LLC maintains the Index and calculates the Index levels and performance shown or discussed, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the Index or investment funds that are intended to track the performance of the Index. The imposition of these fees and charges would cause actual and back-tested performance of the securities/fund to be lower than the Index performance shown. As a simple example, if an index returned 10% on a US $100,000 investment for a 12-month period (or US $10,000) and an actual asset-based fee of 1.5% was imposed at the end of the period on the investment plus accrued interest (or US $1,650), the net return would be 8.35% (or US $8,350) for the year. Over a three year period, an annual 1.5% fee taken at year end with an assumed 10% return per year would result in a cumulative gross return of 33.10%, a total fee of US $5,375, and a cumulative net return of 27.2% (or US $27,200).

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