

Detailed Topix Quanto vs Topix Daily Hedge Index Comparison (terms as at October '16)

This document aims to explain the difference between an investment that mitigates currency exposure between the underlying asset to which the investment is linked and the currency of the investment itself by way of a Quanto and then by way of a daily hedging mechanism ("Daily Hedge"). It will then go on to discuss the pricing differential between a Quanto product and Daily Hedge product, the reasoning for that differential and then will provide historical time series data illustrating the relative performance of each, in differing market conditions.

We will base this analysis on one structure:

6 Year EIS Note

GBP

Topix

Downside Risk: Embedded short 65% EKIP

(European style at the money put option, knock in at 65% of initial index)

Upside Performance: Embedded long X% Participation in an ATM call with 13 averaging observations at maturity

Quanto Structure:

Provides a perfect currency hedge for an international investment. The payoff for such a structure would be, assuming no contingent capital preservation barrier has been breached.

$$£1 + Participation * (Index Final / Index Initial - 1)$$

Clearly here the currency movement between the JPY and GBP is not relevant to the formulaic payoff and therefore the investor. The investment has no JPYGBP currency exposure.

Daily Hedge Structure:

Provides a quasi-hedge that mitigates much of the currency exposure, but not completely, without incurring the associated costs of a Quanto option, (see later discussion below). The payoff formula for the investment product would be, assuming no contingent capital preservation barrier has been breached.

$$£1 + Participation * (Hedged Index Final / Hedged Index Initial - 1)$$

The formula for the Hedged Index is outlined in the Appendix, but is explained below in simpler terms.

The process involves an international equity index (in this case the Japanese Topix index) where each day, a one-day forward FX trade to sell JPY versus buying GBP is executed. Importantly the notional amount of the FX forward will be equal to the notional value of the index at the beginning of that day. In this regard, should the index go up or down in value the following day, that change in value of the index will be exposed to the fluctuation in the JPYGBP exchange rate the following day also. This is best explained by way of several scenarios, albeit we have made the FX and market moves relatively extreme in order to illustrate more clearly.

Day 1

Hedged Index day 1 = £100

JPYGBP hedge put on for £100 equivalent

Day 2

Scenario 1

Underlying Index Unchanged

JPYGBP currency depreciates by 10%

Underlying index in GBP terms depreciates by 10%

JPYGBP currency hedge yields 10% gain

Hedged Index day 2 = £100

Scenario 2

Underlying Index Appreciates by 10%

JPY currency depreciates by 10% (Asset | FX have exhibited -100% correlation)

Underlying index in GBP terms depreciates by 1% (i.e. $100 * 110% * 90%$)

JPYGBP currency hedge yields 10% gain

Hedged Index day 2 = £109

Quanto Index day 2 = £110

Scenario 3

Underlying Index depreciates by 10%

JPY currency depreciates by 10% (Asset | FX have exhibited +100% correlation)

Underlying index in GBP terms depreciates by 19% (i.e. $100 * 90% * 90%$)

JPYGBP currency hedge yields 10% gain

Hedged Index day 2 = £91

Quanto Index day 2 = £90

Scenario 4

Underlying Index depreciates by 10%

JPY currency appreciates by 10% (Asset | FX have exhibited -100% correlation)

Underlying index in GBP terms depreciates by 1% (i.e. $100 * 90% * 110%$)

JPYGBP currency hedge loses 10%

Hedged Index day 2 = £89

Quanto Index day 2 = £90

Scenario 5

Underlying Index appreciates by 10%

JPY currency appreciates by 10% (Asset | FX have exhibited +100% correlation)

Underlying index in GBP terms appreciates by 21% (i.e. $100 * 110% * 110%$)

JPYGBP currency hedge loses 10%

Hedged Index day 2 = £111

Quanto Index day 2 = £110

Hopefully one can see that where the underlying asset and FX exhibit negative correlation, the Daily Hedge index will underperform the Quanto and vice versa. Obviously the magnitude of that under or over-performance will also be driven by the magnitude of the asset price move and that of the FX. Put more succinctly, the more volatile the underlying asset and underlying FX, the greater the moves and therefore the greater the probability of under or over-performance.

Quanto versus Daily Hedge Pricing

For the structure outlined at the outset, we solved for the upside participation in any rally in the Topix index.

- (1) The Quanto version would deliver you approximately 125% participation whereas**
- (2) The Daily Hedge version would deliver approximately 180% participation.**

This is obviously a significant difference in participation, which raises the obvious question, why?

Looking back to the scenarios we ran for the Daily Hedge, we illustrated how the scenarios where the underlying asset and FX exhibit negative correlation, the Hedge Index will underperform the Quanto index. If you look at this another way, one could hopefully see that if as a bank you were providing a Quanto payoff version and one was looking to hedge oneself with the underlying and FX hedges, where the correlation each day was negative or expected to be negative, as a trader you would naturally lose money. Obviously the size of those losses would be driven by how frequently the correlation was negative and how big the FX and asset moves were each day. Put more simply, the more negatively correlated the Topix|JPYGBP are and the more volatile the Topix and JPYGBP are, the greater the expected losses, for the bank hedging the product. The current indicative implied levels used by banks for the pricing of Topix Quanto options are the following.

Topix|JPYGBP: ~ -60%

Topix ATM 6 year Implied: ~ 20%

JPYGBP ATM : ~ 15.90%

In order for the bank to price in the expected hedging losses incurred, the one year forward is effectively increased by the following “Quanto adjustment factor”:

$$-1 * (\text{Correlation} * \text{FX Vol} * \text{Asset Vol}) \rightarrow 1.91\%$$

As one can see, this is quite a significant amount and when you extrapolate that out to a 6-year maturity as is the structure we outlined above, the pricing impact, given an approximate delta in the structure of ~120% is getting towards 10%. There-in lays the pricing differential between the Quanto option and the Daily Hedge.

The next question to therefore ask, is, if as an investor you trade the Daily Hedge version, where in effect you are taking the intra-day Topix|JPYGBP risk, would you not significantly underperform the Quanto index? There are two elements to consider in answering this question theoretically:

- 1) The implied levels banks price into the Quanto Asset|FX correlation, JPYGBP volatility and Topix volatility are evidently implied and invariably these levels are rich compared to the actual realized levels (consider current 6 year implied volatility priced in equity options, versus current realized levels)
- 2) The duration of the trade versus your expected holding period. Whilst the Quanto hedging costs priced into the example product are those expected for 6 years, which you pay for up-front, your holding period may be shorter.

In summary then, one could take the view that the implied levels used to compute the Quanto cost are in fact inflated and as an investor you'd be prepared to take the risk back on yourself via the Daily Hedge version, with a view to receiving enhanced participation, which will result in better adjusted returns, assuming that any underperformance of the hedged version (if any), is offset by the greater level of participation in the investment itself.

The analysis in Appendix 2 looks at a number of historical scenarios and compares the performance of the Quanto index to that of the Daily Hedge.

Appendix 1

The level of the FX Hedged Index as of each Exchange Business Day t following the Strike Date shall be determined in accordance with the following formula:

$$\text{FX Hedged Index Level}_t = \text{FX Hedged Index Level}_{t-1} \times \left[1 + \left(\frac{\text{Underlying Closing Level}_t}{\text{Underlying Closing Level}_{t-1}} - 1 \right) \times \frac{\text{FX}_t}{\text{FX}_{t-1}} \right]$$

where:

FX Hedged Index Level_t means the FX Hedged Index Level in respect of Exchange Business Day t

FX Hedged Index Level_{t-1} means the FX Hedged Index Level in respect of Exchange Business Day t-1

FX Hedged Index Level₀ means the FX Hedged Index Initial Level (as defined below)

Underlying Closing Level_t means the official closing price or level for the underlying on Exchange Business Day t

Underlying Closing Level_{t-1} means the official closing price or level for the underlying on Exchange Business Day t-1

Underlying Closing Level₀ means the Strike Level

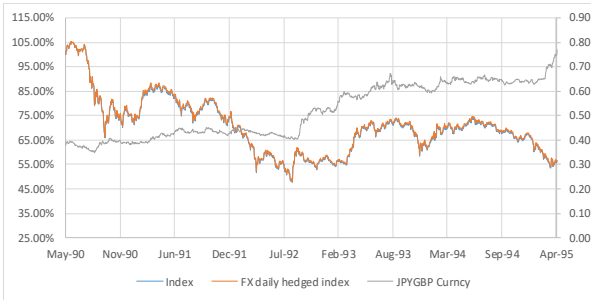
FX_t means the Exchange Rate in respect of Exchange Business Day t

FX_{t-1} means the Exchange Rate in respect of Exchange Business Day t-1

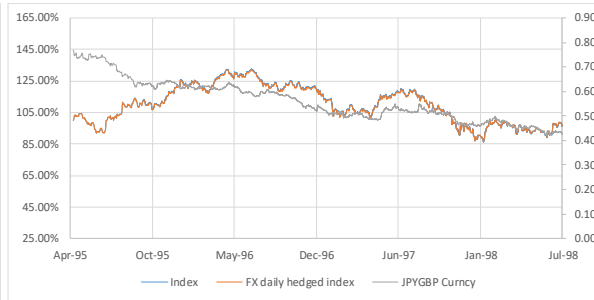
FX₀ means the Exchange Rate in respect of the Strike Date

Exchange Rate means the average of the mid JPY/GBP Currency exchange rate quoted on Bloomberg Page JPYGBP Curncy (or such other page or service that may replace Bloomberg Page JPYGBP Curncy for the purpose of displaying the mid JPY/GBP exchange rate or any other page or service as the Calculation Agent may select for this purpose which displays such exchange rate) at 7:00 a.m. (London time) on any relevant date as determined by the Calculation Agent (expressed as the number of units of the GBP (or part thereof) for which one unit of JPY can be exchanged) PROVIDED THAT if any such Exchange Rate cannot be determined as specified above it shall be determined by the Calculation Agent at such time(s) and by reference to such source(s) as it deems appropriate.

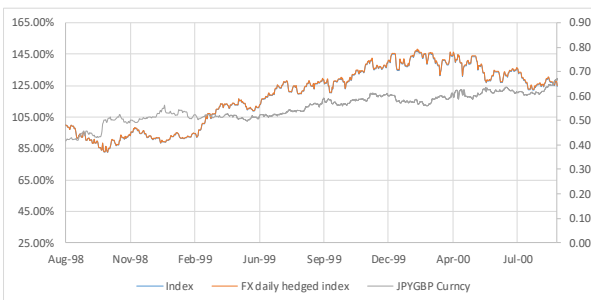
Appendix 2



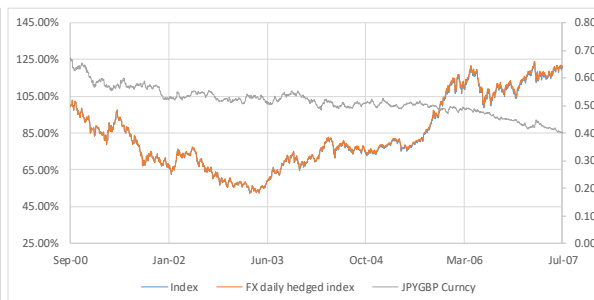
Index Final
 Daily hedge 56.5%
 Quanto 56.1%



Index Final
 Daily hedge 91.8%
 Quanto 91.4%



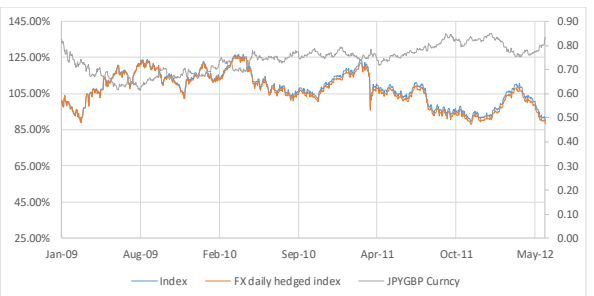
Index Final
 Daily hedge 124.9%
 Quanto 124.5%



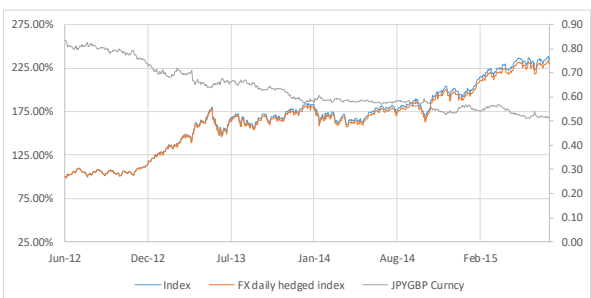
Index Final
 Daily hedge 121.1%
 Quanto 120.4%



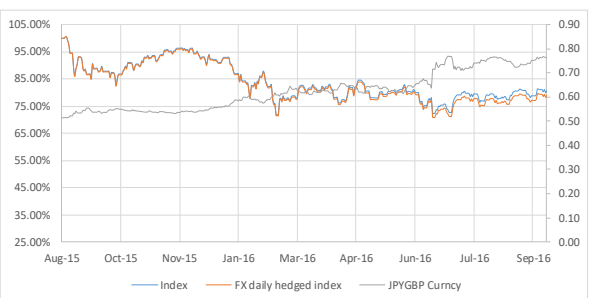
Index Final
 Daily hedge 43.7%
 Quanto 46.1%



Index Final
 Daily hedge 88.3%
 Quanto 90.1%



Index Final
 Daily hedge 229.9%
 Quanto 234.8%



Index Final
 Daily hedge 79.0%
 Quanto 80.7%

Appendix 3

ADR or Composite Structures:

In this investment, investors have full currency exposure between the JPYGBP exchange rate at inception and the JPYGBP exchange rate at maturity or when the investment is unwound. The payoff of such an investment would be as follows, assuming any capital preservation barrier has not been breached.

$$\text{£1} + \text{Participation} * [(\text{Index Final} * \text{JPYGBP Final}) / \text{Index Initial} * \text{JPYGBP Initial}] - 1$$

One can see from the formula, that if the JPYGBP exchange rate weakens (goes down) whilst the index level is unchanged, the numerator will be smaller than the denominator and hence your payoff will be less than £1.

Hence the investor has full currency exposure within the investment.

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