CME Group

STOCK INDEXES

Nikkei 225 Spread Opportunities

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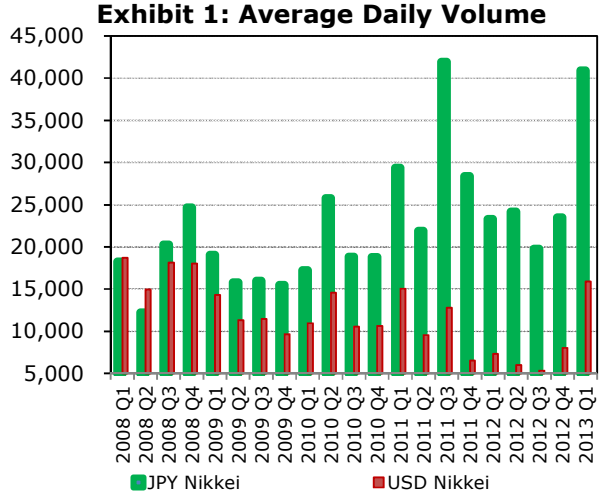
Financial Research & Product Development

Among many success stories within the CME Group family of stock index contracts is the phenomenal growth of not one, but two, futures contracts based on the Nikkei 225 Index. The original U.S. dollar (USD) denominated contract has been listed for trading for nearly 25 years. But the Nikkei 225 futures complex grew tremendously subsequent to the introduction of a companion futures contract denominated in Japanese yen (JPY) in 2004.

Prior to the availability of the JPY denominated contract, the USD contract was posting average daily volume (ADV) of approximately 4,000 contracts. By the 1st quarter of 2013, ADV in the two contracts combined grew to 57,000 contracts.

Exhibit 1: Average Daily Volume



A significant driving force behind this volume growth is found in the spread opportunities between the USD and JPY denominated contracts. And the key determinant in the relative value of the spread is the correlation between the Nikkei 225 index and the JPY/USD exchange rate. Thus, the spread between USD and JPY Nikkei 225 futures is often referred to as a "correlation trade." This article discusses the relative valuation of the two versions of the Nikkei 225 futures and mechanics associated with the correlation trade between the two.

Contract Terms

A useful starting point is to review the contracts' specifications, as depicted in Exhibit 2. The most obvious difference between the two contracts (USD Nikkei and JPY Nikkei) is found in their respective contract multipliers. The USD-Nikkei is sized at $5 x the Index while the JPY-Nikkei is valued at 500 JPY x the Index.

There are other subtle differences between the two contracts. *E.g.,* serial contract months are listed for trading in JPY-Nikkei while the USD-Nikkei contract is only offered in the March quarterly cycle of March, June, September and December. Further, the USD-Nikkei is traded via open outcry and on the CME Globex® electronic trading system while the JPY-Nikkei contract is offered exclusively on Globex.

Exhibit 2: Nikkei Futures Contract Features

	USD Nikkei Futures	JPY Nikkei Futures
Contract Multiplier	USD 5	JPY 500
Minimum Price Fluctuation	5 index points	
Final Settlement	Cash-settled to SOQ of the Nikkei 225 Index on 2nd Friday of the contract expiry month	
Last Trading Day	3:15 pm Chicago time on day preceding final settlement, usually Thursday prior to 2nd Friday of contract month	
Contract Months	4 Quarterlies	5 Quarterlies & 3 Serials
Trading Venue	CME Globex and Open Outcry	CME Globex only
Position limits	5,000 contracts	

The two contracts are "synced" to expire on the 2nd Friday of the contract month. Both contracts settle to the Special Opening Quotation (SOQ) of the Nikkei 225 Index.

Relative Pricing of USD and JPY

Though the chief difference between the two contracts is the currency in which they are denominated, this does not guarantee that market prices of the two will be identical. In fact, this feature gives rise to systematic price differentials between the two contracts. The persistence of these differentials suggests that they reflect something more fundamental than transitory order flow imbalances.

To understand, consider the following question: if the JPY/USD exchange rate and the Nikkei 225

Index stock were correlated, would market participants prefer to be paid in USD or in JPY?

Assume the JPY/USD exchange rate is positively correlated with the Nikkei 225. As such, one might prefer to buy JPY Nikkei futures vs. USD Nikkei futures. This is intuitive to the extent that if the Nikkei 225 advances, profits on the long position would tend to be bolstered by an advancing JPY vs the USD. But if the Nikkei 225 should decline, losses are mitigated by a decline in the JPY vs. the USD. Thus, the JPY Nikkei futures contract should trade at a premium vs. the USD Nikkei futures contract. [1]

Positive Correlation between Nikkei 225 & JPY/USD exchange rate	➔	**JPY Nikkei > USD-Nikkei futures contract**
Negative Correlation between Nikkei 225 & JPY/USD exchange rate	➔	**JPY Nikkei < USD-Nikkei futures contract**

The reverse would apply if the JPY/USD exchange rate was negatively correlated with the Nikkei 225. As such, one would prefer a long JPY Nikkei position over a long USD Nikkei position. This makes sense to the extent that if the Nikkei 225 advances, profits on a long position in JPY-Nikkei are compromised by a declining JPY. Or, if the Nikkei 225 should decline, losses on a long JPY Nikkei futures position are magnified by an advancing JPY. Thus, USD Nikkei futures should trade at a premium vs. JPY Nikkei futures.

Anatomy of the Spread

Consider the following trade: sell or short one USD Nikkei futures at $I_{\$}$ and buy or go long Δ number of JPY denominated contracts at a price of $I_{¥}$. Let $\bar{I}$ denote the Final Settlement Price of Nikkei 225 futures and $\bar{E}$ denote the spot JPY/USD exchange rate on the expiration date of Nikkei 225 futures. [2] At contract expiration, the position's profit/loss (PL), expressed in USD, may be denoted as follows.

$$PL = -5\,(\bar{I} - I_{\$}) + \Delta \cdot 500\,\bar{E}\,(\bar{I} - I_{¥})$$

Now assume the spread ratio Δ equals 1 / (100 x E), where E is the spot JPY/USD exchange rate at the time the trade originally is executed. [3] The P/L is now reduced as follows.

$$\begin{aligned} PL &= -5\,(\bar{I} - I_{\$}) + 5\,\frac{\bar{E}}{E}\,(\bar{I} - I_{Y}) \\ &= 5\left(\frac{\bar{E}}{E} - 1\right)(\bar{I} - I_{¥}) + 5\,(I_{\$} - I_{¥}) \\ &= 5\left(\frac{\bar{E} - E}{E}\right)(\bar{I} - I_{¥}) + 5\,(I_{\$} - I_{¥}) \end{aligned}$$

Finally, suppose that when we enter into the spread, USD Nikkei and JPY Nikkei futures are both fairly valued, not merely with respect to their own dynamics, but also with respect to the dynamics of the JPY/USD exchange rate. If so, then the expected PL should be zero. Rearranging terms gives us the following equation.

$$\frac{I_{¥} - I_{\$}}{I_{v}} = E\left[\left(\frac{\bar{E} - E}{E}\right)\left(\frac{\bar{I} - I_{¥}}{I_{¥}}\right)\right]$$

The left side of the equation depicted the premium, in percentage terms, of JPY Nikkei futures relative to USD Nikkei futures. The right side represents the covariance between the dynamics of the JPY/USD exchange rate and Nikkei 225 Index. This quick-and-dirty calculation formalizes our earlier hunch - if the JPY/USD exchange rate and the Nikkei 225 Index are positively correlated, the JPY-denominated index futures contract should be valued at a premium over the USD-denominated contract.

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[1] It is important to recognize that when one may establish a long or short futures position on a leveraged basis by posting collateral as the initial margin. That collateral may be held in the form of USD denominated cash or securities; JPY denominated cash or securities; or, in other currencies. Thus, a USD domiciled trader may establish a long in JPY-Nikkei futures without actually holding or posting any Japanese yen. Subsequently, however, any profits or losses which accrue in the JPY-Nikkei futures position are denominated in JPY.

[2] The Japanese yen vs. U.S. dollar exchange rate is typically quoted in terms of yen per 1 dollar and this is commonly referred to as the USD-JPY rate. For the convenience of USD based traders, however, we quote in "American terms" of U.S. dollars per 1 Japanese yen. This is referred to as the JPY-USD rate. This further sets the stage for a discussion of how one might use CME JPY/USD futures, quoted in dollars per yen, as a hedge.

[3] This spread ratio is designed to ensure that the value of the contract multipliers of the two index futures contracts are identical.

Though this formula is already remarkably compact, we can make it yet more so if we adopt the following notation. Let T denote the time to futures expiration, σ_E and σ_I denote the annualized volatility of the exchange rate and the Nikkei index, respectively, and ρ denote the correlation between the exchange rate and the index. Then the premium of JPY vs. USD Nikkei 225 futures – or the *quanto* spread – may be represented as follows.

$$\frac{I_{¥} - I_{\$}}{I_{¥}} = \rho\, \sigma_E\, \sigma_I\, T$$

Determinants of the Premium

This equation spotlights the three principal determinants of the price premium between the two index futures contracts, and the relationship among these determinants.

1. *Correlation* - If there is no systematic co-movement between exchange rate dynamics and stock index dynamics, then there is no reason to prefer one currency denomination to another.

2. *Volatility* - If the correlation effect is to exert any material impact upon pricing, there must be at least some actual movement in both the exchange rate and the index.

3. *Time* - For either correlation or volatility to manifest themselves requires the passage of time.

Exhibits 3 through 6 illustrates contract spreads for select quarterly expirations. "Theoretical" values indicate what the spread premium would have been, were it evaluated with realized values for index volatility, exchange rate volatility, and correlation.

Note that the general appreciation of JPY vs. USD since mid-2006, combined with a general decline in the Nikkei 225 created a negative spread between JPY and USD Nikkei futures in 2008 and 2009. This spread subsequently moderated in 2010. It changed rather dramatically by late 2012 into 2013 as the JPY declined significantly vs. the USD while the Nikkei rallied.

As our graphics indicate, spread pricing has been generally consistent with theoretical values in terms of direction. Actual values of the spread, however, have deviated from theoretical values frequently and significantly.

Exhibit 3: Mar-09 Nikkei Spreads

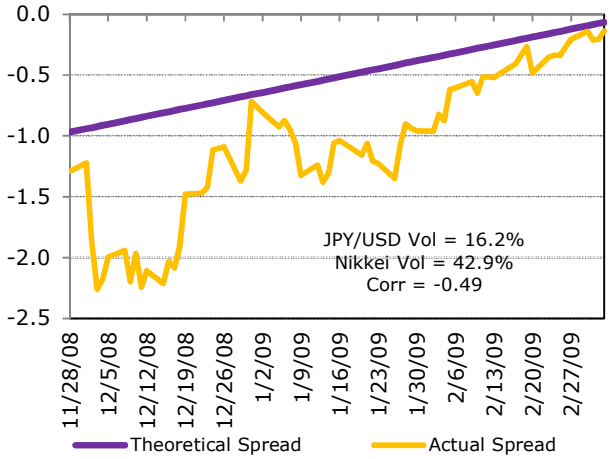


Exhibit 4: Dec-10 Nikkei Spreads

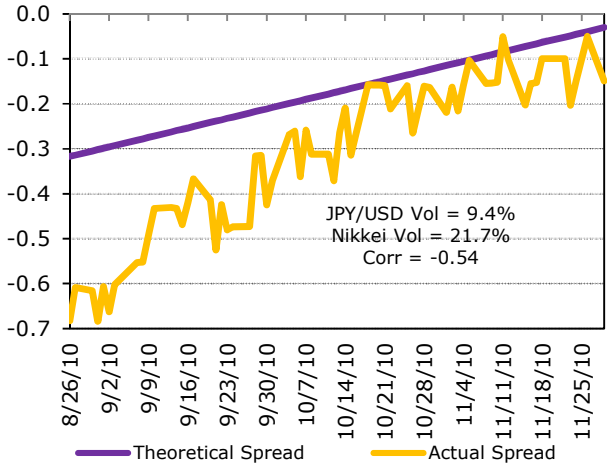


Exhibit 5: Jun-12 Nikkei Spreads

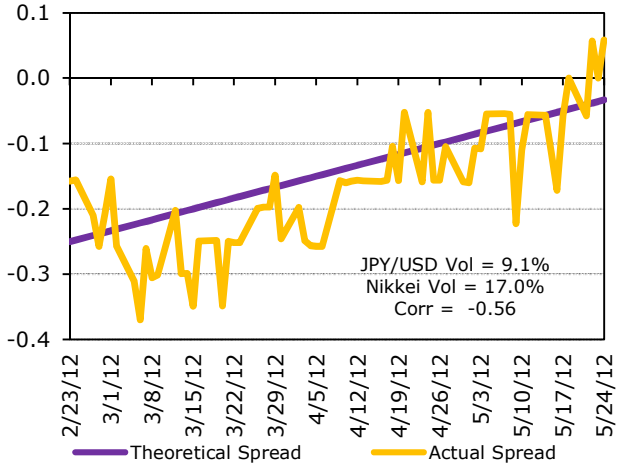
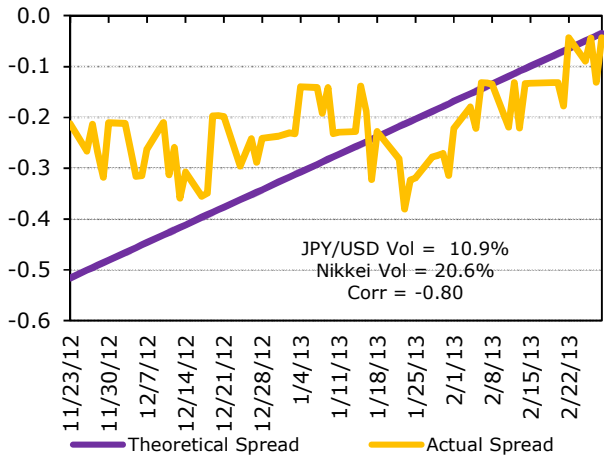


Exhibit 6: Mar-13 Nikkei Spreads



Mechanics of the Spread Trade

Assume we execute a spread trade by purchasing 250 JPY Nikkei futures; and, selling an appropriate number of USD Nikkei futures. Assume there are 3 months until contract expiration and that USD Nikkei futures are trading at a premium of 40 index points over JPY Nikkei futures. Finally, the exchange rate is 100 JPY per USD, or 0.01 in USD per JPY terms. The last of these assumptions implies that the appropriate spread ratio is 1:1. Thus, we might sell 250 USD Nikkei futures.

One day later, both JPY and USD Nikkei futures rally 100 index points, while the spread remains unchanged at 40 index points. The marks to market are as follows.

JPY	**100 pts x ¥500/pt x 250**	**=**	**¥12,500,000**
USD	**100 pts x $5/pt x -250**	**=**	**($125,000)**

If, over the same 1-day interval, JPY has strengthened, then the JPY margin inflow is worth more than the USD margin pay-out. One may lock in this gain via a currency trade, *e.g.,* by selling JPY inflows for USD, covering the USD margin payout, and retaining the residual.

Subsequently, we need to rebalance the spread ratio to account for exchange rate movement. But this adjustment will tend to be small. *E.g.,* a 1% move in the exchange rate would require a 1% change in the spread ratio, which amounts to 2 or 3 contracts in the present instance.

Now recall the spread formula above. It suggests that the cumulative profit or loss on the JPY-USD index spread is simply the accumulation of the daily products of exchange rate and index movements. Against this backdrop, the example above dramatizes that the profitability of the spread trade essentially reflects the outcome of a race between this daily accumulation process, on one hand; and, the convergence of the spread to expiration, on the other.

Exchange Rate Gains/Losses

For many market participants, it may be impractical or infeasible to perform daily currency transactions to crystallize gains/losses on exchange rate movements, per the example above. In such instances, one might be forced to carry one's PL in two different currencies until futures expiration, at which time a single currency trade will occur.

If so, then a slight adjustment to the spread ratio may be desirable. To see why, let's revisit the mathematics of daily PL.

Denote the day's change in Nikkei index futures as δI. Let $r_{¥}$ and $r_{\$}$ denote continuously compounding interest rates for JPY and USD, respectively. Finally, assume no change in the price spread between the USD and JPY Nikkei futures. Now suppose that, instead of instantaneously translating our profit on mark-to-market into dollars, we choose instead to carry the profit until futures expiration. The PL for the day, as realized at contract expiry, may be represented as follows.

$$-5e^{r_{\$}T}\,\delta I + \Delta\,500\,\bar{E}\,e^{r_{¥}T}\,\delta I = 5e^{r_{\$}T}\,\delta I\,x\,\left(100\,\bar{E}\,e^{(r_{¥}-r_{\$})^{T}}\Delta - 1\right)$$

A close look reveals that this requires an adjustment to the spread ratio to account for relative interest rates.

$$\Delta = \frac{1}{100\,E\,e^{(R_{¥}-R_{\$})T}}$$

Where E denotes the current JPY/USD exchange rate. *E.g.,* if we assume that the interest rate differential is 2.75% and, as before, that 3 months remain until futures expiration, then the adjustment

to the spread ratio is roughly 0.7%, representing 1 or 2 contracts for a spread with around 250 contracts on each leg.

Obviously, this does not obviate the need for us to lock in the exchange rate. However, that may be accomplished with CME FX futures. Currency futures generally expire on the Monday prior to the 3rd Wednesday of the contract month, a few days following expiration of Nikkei 225 futures. These few trailing days would allow ample time to consummate the spot foreign exchange transaction entailed in booking the final PL on the spread trade.

Per our example above, a 100-point move for a 250-lot Nikkei futures position generates a mark-to-market variation of ¥12.5 million. This is a convenient number as a standard sized CME Group Japanese Yen futures has a notional size of exactly ¥12.5 million. A 100 point movement in the Nikkei 225 is not uncommon over the course of a single day. Thus, one may conveniently hedge the exposure using currency futures as an alternative to a spot or cash currency transaction.

Concluding Note

Learn more about CME USD and JPY denominated Nikkei 225 futures by checking out our website at www.cmegroup.com.