Index Arbitrage In China

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Financial professionals and scholars generally agree that the two most important transaction types found in global stock futures markets are arbitrage and calendar spreads[1]. Of these, arbitrage is the more important, especially in newly developing futures markets such as China and India. It is also widely agreed that sustaining a meaningful volume of daily arbitrage transactions is required for the successful growth of futures exchanges. Yet very little is written in detail about the important practical elements of implementing these crucial trades, knowledge of which regulators, investors and exchange officials must have as they seek to develop and participate in efficient equity markets.

The function of continuous stock index arbitrage between futures and their underlying assets is to exert necessary pricing pressure that causes futures prices to revert to their economic fair value. Lack of a central fair value price both reduces liquidity in futures and stock markets and erodes the corresponding willingness of individuals and institutions to participate. Without a fairly priced index futures market, institutional investors, both domestic and foreign, have few means to hedge their diversified stock portfolios when risks are perceived to be high. Typically, the only alternative is to

liquidate assets in times of risk: normally an very expensive process. Experience reveals that the absence of hedging instruments especially limits foreign investments and can lead to significant outflows of capital in times of distress. Especially in newly developing futures markets, it is therefore important for regulators and exchanges to create and sustain trading rules, tax levels, margins and other conditions conducive to arbitrage

Also affected by a lack of efficient arbitrage is the ability of managers to develop and offer dependable product innovations based upon derivatives[2]. The presence of financial instruments effective for hedging and for new product development can not only encourage needed foreign capital flows but also stabilise foreign capital already invested in developing economies. These facts explain the desire in emerging markets to rapidly develop derivative markets in parallel with domestic stock markets.

China's government, for example, has recognised this issue and accelerated the growth of its stock index futures market listed on the China Financial Futures Exchange (CFFEX). In May 2011 Zhu Yuchen, President of the CFFEX, cited a resolution contained in the third round of China-US Strategic Economic Dialogue to create and encourage a QFII (Qualified Foreign Institutional Investor) presence in the China stock index futures market. The Chinese government and the city of Shanghai also seek a common goal of making Shanghai a premier global financial centre by 2020. Obtaining that goal will require attention to be focused on the health of the city's financial futures market and so to measures supporting the pursuit of successful index arbitrage activities. With the size of China's stock market second only to that of the US, investors should reasonably expect China's stock index futures market to follow shortly.

Using recent CSI 300 futures data, this article seeks to explore specific details of stock index arbitrage in China's new CSI 300 stock index futures market. Knowledge of the requirements for successful arbitrage in this market can suggest to regulators and exchanges the steps necessary for making market improvements that can attract and retain foreign and domestic professional investors. Meanwhile, knowledge of the practical means for identifying and implementing profitable arbitrage can encourage the professional growth of an essential activity that improves market liquidity and stability. Finally, the understanding that index arbitrage is serving to keep futures

prices near to their economic fair value can also provide investors and hedgers with the assurance they need to increase comfortably their participation in China's rapidly developing stock market.

FORWARD AND REVERSE FUTURES ARBITRAGE

When the price of a stock index futures contract far exceeds that of its underlying index, an opportunity arises to capture by arbitrage a return in excess of the current short-term interest rate. One means to capture this excess is through the purchase of a replicating portfolio of index stocks and the simultaneous sale of an equivalent currency value in futures contracts. Done properly, the resulting net position in both stocks and futures is neutral with respect to changes in market. A decline in the value of the stocks will be offset by a profit in the short futures position and vice versa, thereby resulting in an arbitrage position indifferent to market price fluctuations. The rate of return on this cash-like position can be calculated in advance of execution and compared by an arbitrageur with the interest rate matched to the maturity of the futures contract. If the rate implied by establishing the arbitrage exceeds the current market rate, an opportunity to capture excess return arises.

Provided all costs of establishing the two legs of the arbitrage are covered, the transaction can be implemented with the assistance of a futures broker. While the arbitrage position can be held to the expiration of the futures contract, typically less than a month in duration, the transaction can also be unwound at any time that the pricing spread between the two legs is favourable. Alert arbitrageurs frequently unwind such positions earlier than the expiration and look to redeploy their capital in other arbitrage opportunities.

The arbitrage position just described is generally termed a forward arbitrage. To establish a reverse arbitrage, the arbitrageur borrows stock to sell in the open market (so-called short selling) and simultaneously purchases stock index futures with equivalent currency value. Once again the resulting position will ideally be neutral with respect to changing market prices. By choosing to execute this transaction at a proper price spread between futures and stock, a return in excess of a matched-to-expiry interest rate can be captured. If market price fluctuations are favourable, the reverse arbitrage can be unwound at a date prior to the futures' expiration—with the added benefit of capturing a higher rate of return than originally planned.

Whether forward or reverse arbitrage positions will potentially yield an attractive return can be known at any time during the trading day by means of a basic calculation using current market data. By watching shifting market prices and knowing all relevant costs, an arbitrageur can determine at any given time during a trading day whether or not to execute an arbitrage transaction. For this purpose the critical value to calculate is the interest rate implied by the forward or reverse arbitrage. This implied rate simply requires knowledge of the theoretical fair value for the futures contract.

The theoretical fair value for the CSI 300 futures contract with expiry in n days is given by:

$$FV = Io \times [1 + (r - d) \times n/365]$$

where

- Io = level of the CSI 300 index stated in index points
- r = interest rate for borrowed funds matched to the contract expiration date
- d = dividend yield on the CSI 300 calculated to the contract expiration date
- n = number of days to the contract expiration date
- t = n/365

If the current quoted futures price is Fo then all quantities in this formula are known except the interest rate implied by Fo. This interest rate, r*, implied by Fo is given by

$$r^* = d + (365/n) \times [(Fo/Io) - 1]$$

In a cost-free environment, excess return from a forward arbitrage is available whenever r* exceeds r. Similarly, when r* is significantly below r, reverse arbitrage becomes profitable. In either type of arbitrage the source of the return is the price spread between the futures quoted price and its fair value at the time. This forward arbitrage spread is

$$Fo - FV = Io \times [(r^* - r) \times n/365]$$

In an environment where there is a cost, C, this spread must be adjusted by subtracting that cost. With this adjustment the implied interest rate can be written as

$$r^* = r + [(Fo - FV - C)/(Io \times t)]$$

STOCK INDEX ARBITRAGE IN CHINA

The market conditions that allow for some forms of efficient forward stock index arbitrage are present today in China, while conditions to support reverse arbitrage require regulatory encouragement. Because of the structure of the domestic China market, the arbitrage that does occur differs in form and size from that most frequently found in more mature markets and represents a creative adaption to the local regulatory and investment environment.

Technically there are three possible forms of stock index arbitrage in the China market. These are:

1. Stock baskets vs. futures
2. ETFs vs. stock baskets
3. ETFs vs. futures

Stock Baskets Vs. Futures

Several complications confront the arbitrageur of stock baskets vs. CSI 300 futures, making execution difficult. First, the 300 securities in the CSI 300 index are traded on two different stock exchanges. Two hundred and eight of the stocks in the index are listed on the Shanghai Exchange, while 92 are traded on the Shenzhen Stock Exchange. Thus acquiring a basket of stocks that fully replicates the index requires the simultaneous execution of separate stock baskets on two different exchanges.

Even if trading platforms permitted automated executions of stock baskets, the potential for mismatched basket completion times would be risky. This obstacle alone significantly inhibits arbitrage. Then there is the matter of co-ordinating the futures executions so as to have three simultaneous executions as an arbitrage is set up or unwound. Such structural characteristics present formidable challenges for arbitrageurs.

Next is the issue of transaction size. The size of a forward arbitrage will be limited by the ease of obtaining shares in the least liquid stocks in the index. Too large a stock basket will raise the offer prices in the least liquid stocks, driving up transaction costs and degrading arbitrage returns. If a fully replicating basket is used then to limit these impact costs, the size of the arbitrage position must be limited to a small number of futures contracts. Also, adding to the difficulty of reverse arbitrage is China's

undeveloped market for securities lending. Reverse arbitrage positions require the arbitrageur to borrow shares from a stock holder and this is simply not practical at this time.

All of these factors suggest strongly that stock baskets vs. futures arbitrage is not feasible in the China market at this time.

ETFs Vs. Stock Baskets

There are numerous ETFs based upon portfolios of China stocks and they all follow the creation and redemption process common to ETFs found elsewhere. When ETF shares are priced below the value of the underlying securities the ETF shares can be purchased by an arbitrageur and submitted to the ETF Trust holding the stocks for redemption in return for the underlying stock portfolio. The portfolio can then be sold in the secondary market to realise an arbitrage profit. When the ETF shares are priced above the value of the underlying securities, a portfolio of underlying stocks can be purchased and submitted to the ETF Trust, leading to the subsequent creation of ETF shares which can then be sold in the secondary market to realise a profit. This in-kind creation and redemption mechanism for ETFs allows for an arbitrage that can often be pursued on a daily basis in the China market.

ETF vs. stock basket arbitrage, while typically subject to minimum creation and redemption sizes, is designed to be effective in maintaining a constant convergence between the ETF price and the stocks comprising the underlying index. This particular form of arbitrage does not require the existence of a securities lending industry to supply stock baskets; nor does it involve futures contracts. Because this arbitrage requires only a simple two-way exchange of stocks and ETF shares it has no direct effect on maintaining futures at their fair value.

For futures to seek their fair value a third type of arbitrage is necessary, namely that of ETF shares against index futures.

Figure 1

US And China Requirements For Stock-Futures-ETF Arbitrage

Arbitrage Requirement	S&P 500	CSI 300
Stock Portfolio Trading	Efficient	None
Short Sales	Permitted	Not Approved
Securities Lending	Efficient	Underdeveloped
Stock Liquidity	High	Moderate
Futures Liquidity	High	Moderate

ETFs Vs. CSI 300 Futures

The third and final form of stock index arbitrage proves the most promising in the China market as the use of ETFs against futures solves some of the more difficult problems confronted in the other two forms of arbitrage. By combining two or more ETFs to replicate the CSI 300 index, the need to transact 300 stocks at once on two different stock exchanges (stock portfolio trading) is removed. Execution needs to take place in only a limited number of ETFs. A skilled futures broker can normally facilitate the required simultaneous futures and ETF executions to establish a forward arbitrage position. Reverse arbitrage, however, is still very difficult to establish in China, being inhibited by the lack of a developed securities lending market and a regulatory prohibition against short sales. Given these conditions it is clear why ETF-futures forward arbitrage in China presently takes the form of ETFs vs. futures.

Among the ETFs listed in the mainland China stock markets, none completely replicates the CSI 300 index. There are, however, two ETFs that, when properly combined, provide a very close approximation to the index. The first is the ETF 180 covering 180 of the large capitalisation A-listed CSI 300 stocks traded on the Shanghai exchange. The second is the SI 100 ETF, covering 100 A-listed large capitalisation stocks listed on the Shenzhen Exchange. Together these two ETFs cover 93% of the 300 stocks in the CSI 300 index.

Using historical pricing data on the CSI 300 index and these two ETFs, we found the portfolio that minimised the tracking error between the index and ETFs required 77% of investable funds to be placed in ETF 180 shares and the balance in SI 100 ETFs. Arbitrageurs will want to complete such an analysis periodically with an emphasis on the most recent data to guide portfolio construction.

The statistical correlations, R-square and tracking error for this portfolio of two ETFs appear in Figure 2. The weighted ETF portfolio price vs. CSI 300 index is plotted in Figure 3 and displays an exceptionally good fit.

Figure 2

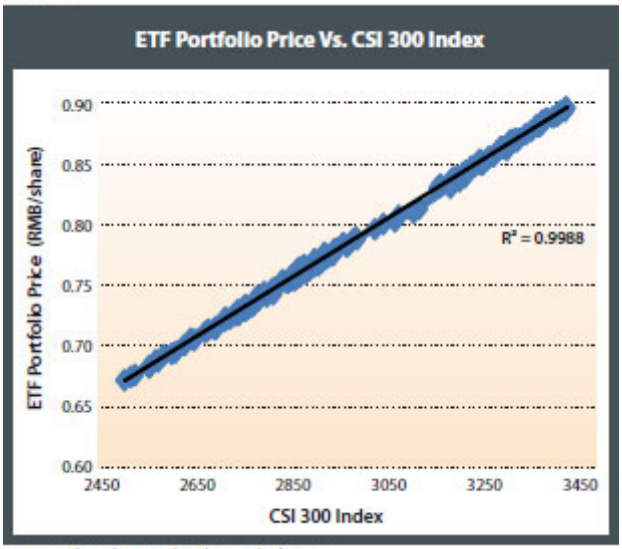
ETF Portfolio Statistics

CORRELATIONS			
	CSI 300	ETF SI 100	ETF 180
CSI 300	1.000	0.963	0.989
ETF SI 100	0.963	1.000	0.923
ETF 180	0.989	0.923	1.000

ETF PORTFOLIO VS. CSI 300 INDEX	
Correlation	99.94%
R-square	99.88%
Tracking Error	0.188%

Source: China Financial Futures Exchange, Bloomberg and authors' calculations

Figure 3



Source: Bloomberg and authors' calculations

ARBITRAGE COSTS

To enumerate the costs of stock index arbitrage, first consider a forward arbitrage in which the two legs of the transaction are a future and a basket of stocks that replicate the index underlying the contract. The primary direct and indirect costs for arbitrageurs typically include:

Index Changes

It is possible that during the life of an index arbitrage position, index components may change due to in- and out-migrations of securities as specified from time to time by the index provider. Adding to these can be capital changes such as stock splits, reverse splits, stock dividends, spinoffs, mergers and more. All these changes have the potential of adding to the drift of a stock portfolio's value away from the index underlying the future. Any drift away from the index will create a cost that must be

estimated and covered by an arbitrageur. A useful measure of this cost is the tracking error, normally defined as the standard deviation of differences between portfolio and index returns.

Because we have constructed a replicating portfolio of two ETFs, any pricing uncertainty due to changing CSI 300 index composition is already included in the measured tracking error (0.188%). At the setup for the arbitrage the cost associated with this tracking error is estimated by the arbitrageur. We have used the tracking error in Figure 2 in our subsequent calculations.

Timely Execution

To avoid unwanted execution costs, all the stocks in an index portfolio should ideally be executed at exactly the same time. Such timely execution is often not possible. However, the resulting costs can be minimised in markets which support computerised trading platforms for stock baskets. In such markets the stock portfolio is delivered for execution electronically in a single computer file at the same time that futures orders are placed. This procedure normally limits any unwanted costs due to non-simultaneous trade executions. The risk of trading the stocks and futures at different times is that the realised spread between the two is less than that required for profitable arbitrage.

Because the presence in China of electronic markets for both futures and ETFs allows for nearly simultaneous executions by brokers, we take the associated cost of untimely executions to be negligible.

Bid/Ask Spreads

In many global stock markets a quoted index price is calculated and posted based upon the last traded prices for the individual index securities, whereas the arbitrageur requires all stocks to be valued at the bid or offer for reverse and forward arbitrage respectively. For the arbitrageur, then, the difference between the posted index level and the level corresponding to all bid or all offer prices must be estimated. The difference from last quotations then becomes a cost to cover before profitable arbitrage can be undertaken. Similarly, the bid and offer price for the futures contract must be accounted for as the arbitrage is set up and later unwound. However the magnitude of the futures bid-offer spread is typically quite small.

The weighted bid-offer spread on the ETFs used to construct our tracking portfolio was found to be 0.1329% of market value. For CSI 300 futures the bid-offer spread was calculated at 0.0017% of market value. An arbitrageur could expect to pay half the full bid-offer spread on setup and half on unwind for the transaction for a combined cost for ETFs and futures of 0.1346%. A provision for covering this should be undertaken upon entering any arbitrage.

Commission And Impact Costs

Because stock execution commissions are typically far above those for futures contracts, frequently by a ratio of ten to one or more, a significant fraction of the total costs for index arbitrage is in commissions. Also, for portfolios beyond a certain size, an impact cost may result when the normal supply of shares available for purchase or sale is exceeded. In such cases, the stock market prices move to accommodate the excess share volumes. Arbitrageurs are aware of this effect and normally design the size of arbitrage portfolios to minimise this outcome.

Brokerage commissions for China arbitrage transactions typically range from 0.10% to 0.30% of trade value. We assume that arbitrage positions are carefully chosen in size so as to avoid introducing any impact charges. This conforms to the standard practice among arbitrageurs who are willing to carry several arbitrage positions of smaller size rather than one large one having impact costs to cover.

Unwind At Expiry

Futures converge at expiry to a final settlement price which in some markets may not be the final closing price of the index. Such a structural contract specification introduces yet another element of uncertainty into the cost of arbitrage. Typically in such markets arbitrageurs will not wait until expiration to unwind their positions, choosing instead to unwind when a profitable opportunity arises.

Because CSI 300 futures are not designed to converge at expiration to the closing level of the index, there is a risk of loss if futures positions are held to expiry. Accordingly arbitrageurs normally unwind their full positions prior to the last trading day. Here we assume any unwind will cover an uncertainty in convergence. Based upon observations for nine futures contracts (Figure 4) the average magnitude of this uncertainty is approximately 0.27%.

For a larger view, please click on the image above.

Government, Regulatory And Exchange Fees

In most countries where stock and futures markets are found, associated fees are imposed by governments, regulators and exchanges. All these must be carefully noted by the arbitrageur and factored into the cost of establishing and unwinding a position. These fees are not always charged on both purchases and sales so the rules for cost calculations must be understood in detail.

China brokers are required to a collect a securities transaction tax, a transfer fee and a stamp tax, all to be included in their "commission" charges. The typical brokerage commissions we use already include these extra costs.

Short Sales

When reverse arbitrage is executed, shares are sold short and futures purchased. Full short sale execution of a stock basket containing several hundred securities will normally require far more time than a purchase. Sometimes not all issues in a basket can be borrowed and sold short, adding further to the uncertainty of capturing a futures spread versus its underlying index.

Without a developed securities lending market in China, market reverse arbitrage is not presently possible in the country. For calculation purposes, however, we can approximate the influence of short sales on arbitrage returns by assuming that 85% of the interest on short sale proceeds is retained by the lender of the securities. The balance of interest (the rebate) is made available to the arbitrageur.

Dividends

Further uncertainty arises from the uncertain future payment amounts of corporate dividends paid by firms in the index. Estimates of these payments over the intended arbitrage holding period can be made based upon historical records. However, dividend payment uncertainty remains, as it is normal to have increases and decreases from historical dividends when company fortunes change. In the US market, heavy dividend payment periods occur in January-February, April-May, July-August and October-November, requiring a careful historical estimate of forward dividend yield prior to index arbitrage execution.

Dividends in the China market are typically small and infrequent. Because there is insufficient reliable data to estimate the uncertainty of dividend yields in ETFs, we assume this uncertainty is minimal and so it does not enter into our present cost

calculations.

A summary of anticipated primary costs for China ETF vs. futures arbitrage appears in Figure 5.

Figure 5

Arbitrage Costs—ETF Portfolio Vs. CSI 300 Futures

Type of Arbitrage Costs*	% of Traded Value
Tracking Error	0.1880%
Bid / Ask Spreads	0.1346%
Commission Range—ETFs	0.10% to 0.30%
Commission Range—Futures	0.005% to 0.010%
Commission Range—Total	0.105% to 0.310%
Short Sales	15% Rebate

Source: Bloomberg and authors' calculations
*Government, regulatory and exchange fees included in commissions

Zero Arbitrage Band And Return Calculations

The result of these costs is the establishment of forward and reverse arbitrage thresholds that must be exceeded if profitable arbitrage is to occur. These thresholds are above and below the futures fair value and form a zero arbitrage band inside of which no profitable arbitrage takes place. We call the difference between fair value and the upper (lower) threshold the forward (reverse) arbitrage band. The width of the full zero arbitrage band is the sum of the widths of the forward and reverse arbitrage bands. Because the costs of forward and reverse arbitrage often differ, the sizes of those bands will also differ. In all futures markets a contract priced above the upper threshold presents a profitable opportunity for forward arbitrage while a future priced below the lower threshold makes reverse arbitrage attractive.

With a clear knowledge of costs, the upper and lower thresholds for zero profit arbitrage can be calculated along with the resulting width of the forward, reverse and zero arbitrage bands.

On 21 December 2010, for the CSI 300 future expiring 21 January 2011 (ticker IF1101), futures prices required to cover all costs for forward and reverse arbitrage were calculated. The widths of the upper and lower zero profit thresholds were determined as a percentage of the futures fair value. The width of the zero arbitrage band was the sum of the widths for forward and reverse arbitrage bands.

A forward arbitrage using the data in Figure 5 would have produced attractive returns in Figure 6 between 7.09% and 11.91% net of all costs. Reverse arbitrage was notably unattractive.

Figure 6

Arbitrage Band And Return Calculations

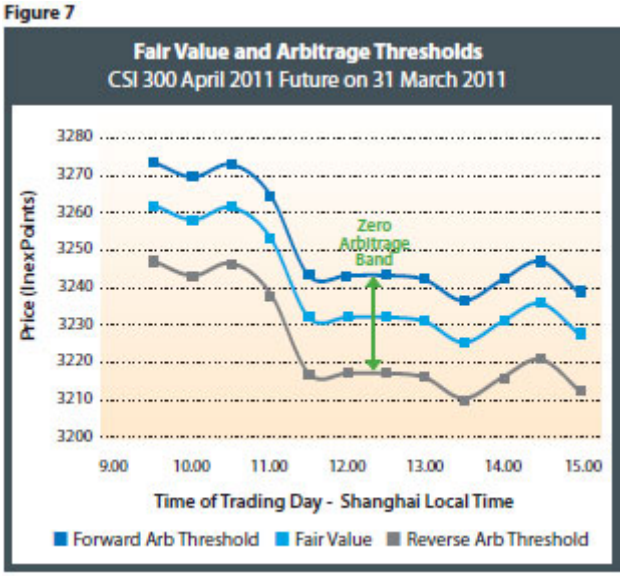
Commission Range (ETFs + Futures)	0.31%	0.11%
ARBITRAGE BANDS		
Width of Forward Arbitrage Band*	0.76%	0.35%
Width of Reverse Arbitrage Band	-1.20%	-0.79%
Total Width of Zero Arbitrage Band	1.96%	1.14%
ARBITRAGE RETURNS		
Forward Arbitrage Returns Net of Costs	7.09%	11.91%
Reverse Arbitrage Returns Net of Costs	-30.29%	-25.47%

Source: Authors' calculations
*Arbitrage bands are measured relative to futures fair value. Data as of 21 Dec 2010.

In mature futures markets with sizable arbitrage volumes, the approximate width of the forward and reverse bands is about plus or minus 0.50% of fair value for a total width of about 1%. The width of the band for CSI 300 futures is expected to be higher, originating from higher commissions in China and tracking error to be covered. Calculations for multiple trade dates and for CSI 300 contracts with differing expiration dates were made to determine the stability of the total width of the zero arbitrage band. The band width findings here were found to be representative.

A zero arbitrage band during the trading day on 31 March 2011 is illustrated in Figure 7 for the CSI 300 April 2011 futures contract. Band widths for forward and reverse arbitrage were calculated using the lower commission range values. On this trade date the April futures closed at 3244.00, above the upper arbitrage threshold (3234.85). Had forward arbitrage taken place at these levels, the resulting 6.91% return net after all costs would have been well above the prevailing matched to maturity SHIBOR rate of 3.21%.

Figure 7



FINAL COMMENTS

In mature global futures markets the maintenance of liquidity and fair pricing in stock index futures depends on having a substantial volume of index arbitrage transactions. Conducted in adequate volume, such transactions create pricing pressure that keeps futures prices near their fair value, in turn creating confidence among retail and institutional investors that investment strategies for hedging and trading can be pursued effectively. Without economically fair conditions arising from arbitrage, investors naturally self-limit their participation in futures and stock markets.

Furthermore, the ability of local stock markets to attract and retain foreign capital is facilitated by liquid hedging instruments, primarily stock index futures. Thus, the growth of both stock and futures markets benefits greatly from having a substantial transaction volume in stock index arbitrage. Index arbitrage is becoming increasingly prevalent in China and its growth coincides with the stated objective of domestic regulators and exchanges to expand the use of CSI 300 index futures by foreign and domestic institutional investors.

Using recent CSI 300 futures data, this article has explored specific details of both forward and reverse index arbitrage. Included in the analysis of these transactions were eight categories of arbitrage costs that together create a zero arbitrage pricing band surrounding a future's fair value. Because arbitrage will not take place inside this band it is in the interest of regulators and exchanges to set overall conditions that prevent the band from becoming excessively large. For CSI 300 futures this zero arbitrage band is presently up to twice as large as that experienced in more mature global futures markets. Whether seeking to execute index arbitrage, or seeking a better understanding of hedging with futures in the China market, the details and calculations provided here offer a useful guide for market regulators and institutional participants.

Footnotes

1. Slivka, R., Xin Li and Yikai Zhang. "Calendar Spreads In China Stock Index Futures", *Journal of Indexes*, May/June 2011, p.51.
2. Slivka, R. and Xin Li. "Hedging And Synthetic Funds Creation In The China Market", *Journal of Indexes*, September/October 2010, p.50.