

Arbitrage Models and Opportunities Comparison: Evidence from UK, US and Hong Kong Index Future Markets

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Abstract

Chinese government will launch first of Chinese financial future product on the middle of 2010 which named by China Stock Index 300 Future. According to other emerging markets experiences of development, there are a lot of arbitrage opportunities existing in the market at the beginning of the future product launched, then investor will try to catch the relative opportunities for get the abnormal return. In this paper we are going to empirical analysis the currently modern arbitrage models in developed and developing markets by mathematical derivation, and also going to compare the arbitrage opportunities in relative markets. After the empirical research, this paper will conclude which model is suitable for use in emerging market like Mainland China and Hong Kong, and how to accurate calculate transaction cost and dividend. In additional, the paper will also conclude the arbitrage opportunities in UK, US and Hong Kong index future markets.

Key Words: Index Futures, Arbitrage Models, Spread opportunities, Comparisons

1. Introduction

Stock index future arbitrage current operates by the price relationship between spot and future contract or between future contracts. When this price relationship departs from the balanced then the arbitrage or spread opportunities will be exist. Investor can get earn by sell over estimation price product and buy undervalue product, and close both position when the price of two product return back to the balanced level. A large number of arbitrage actions can make arbitrage opportunity disappear. Arbitrage exchange is one of the basic exchange strategies in future market.

Basically former researchers researched arbitrage and mispricing field almost on the theory of cost of carry, they are Modest and Sundaresan (1983), Cornell and French (1983a, 1983b), Figlewski (1984a, 1984b), Arditti et al.(1986), Cornell (1985), Newey and West (1987), MacKinlay and Ramaswamy (1988), Saunders and Mahajan (1988), John J. Merrick (1988), Bhatt and Cakici (1990), Chung (1991), Klemkosky and Lee (1991), Yadav and Pope

(1990,1991), and Lim (1992), Brenner et al. (1989b, 1990b). And some researcher proposed the accrual mispricing theory, they are Sloan (1996), who is the first proposed accrual mispricing theory, Subramanyam proposed and document the mispricing between cross markets, Collines and Hribar (2000a) proved the overpricing and abnormal return and Xie (2001) proposed that the market has one more kinds of accrual mispricings as discretionary accruals and consequentially overpricing.

The definition of stock index future is that buy or sell one of stock index future contract and sell or buy another contract or underlying asset, finally close two position at same time for earn low risk return by market price goes out of balance. There are four main kinds of arbitrage strategy that inter-period arbitrage, exchange arbitrage, cross contract arbitrage and spot-future arbitrage. Normally one exchange may list many contracts but the contracts are not refers to the same stock market, for example S&P 500 and NASDAQ-100 contracts in Chicago Merchandise Exchange (CME), its sample stocks are not completely same with the spot market. And some index future contracts listed in two or three different exchanges, for example NIKKEI 225 index future is listed on Singapore International Financial Exchange (SIFE) on September 1986, Osaka Stock Exchange on September 1988 and September 1990 on CME. Otherwise, Xinhua FTSE A50 index future has listed in SIFE, the sample stocks of A50 are the top 50 value of Shanghai and Shengzheng stocks, hence it has high correlation relation between China Stock Index Future 300 contract, then it can be a better product of cross market arbitrage.

Stock index future has more operation convenience which compare with commodity futures. The arbitrage of commodity future because it exist spot transaction, delivery and saving and so on cost and process, especially there has higher risk in process of delivery. Generally only investor who is work on spot product and trade then join commodity spot-future arbitrage. Stock index because of it delivery by cash on expiry so there has no exist delivery cost, it trade on market very active compare with commodity futures.

2. Methodology

2.1 Spread Interval Construction

In the process of stock index arbitrage, unless needs to consider about the theoretical price of future contract, it is necessary that consider the cost during the whole process of trade which are including the tax, trade commission and so on. So there always has a non-arbitrage interval between spot and future contract. If future price is in such interval the spread trade must be loss. So the spread opportunity appear depend on future price whether in non-arbitrage interval or not. Moreover, the limit of security loan and short sell also are the risk factors. In the stock index future spread field, normally one time trade is including spot and future at same time, because spot index is not single security so that investor must instead it by relative stock portfolio. However, there often has exchange block to reduce exchange efficiency.

There are forward and backward spread limits:

(1) Forward Spread and Upper limit:

When future price is overestimation, we can get model by forward spread strategy with transaction cost. Set the primary margin is k, assume that the spread opportunity appear at time t, and stop spread at time T, so there has spread forward opportunity when as follows equation establish:

$$F(t, T) \geq \frac{[(1+c_{PL})e^{r_b(T-t)}+c_{FS} \times c_{FL}] \times (S_t \times D_t) e^{\mu P(T-t)}}{1-c_{FS}e^{r_b(T-t)}-k(e^{r_b(T-t)}-1)} \quad (1)$$

Where c_{PL} is spot buying cost (calculate by percentage), c_{PS} is spot selling cost (calculate by percentage), c_{FL} is the amount cost of future buying cost, c_{FS} is amount cost of future selling, D_t is amount dividend during the spread period (calculate by points), μ is instantaneously expectant return, r_b is the cost of borrow funds, S_t is spot index. And where $c_{PL} = c_1 + c_2 + c_3$, $c_{FS} = (c_1 | c_4 | c_3) e^{-r_b(T-t)}$, $c_{FL} = c_{F1} + c_{F2} + c_{F3}$, $c_{FS} = c_{F1} + c_{F2} + c_{F3}$, c_1 is the commission of trade spot portfolio which calculate by percentage, c_2 is the impact cost of buy spot portfolio, c_3 is the tax payment of trade spot portfolio, c_4 is sell spot impact cost, c_{F1} is the commission of trade future contract, c_{F2} is the impact cost of buy future contract, c_{F3} is the tax payment of trade future contract, c_{F4} is impact cost of sell future contact and r is risk free rate.

Because investor cannot directly buy spot index, so it needs construct spot portfolio for instead of spot index, so here exist follow error, the spread equation should to add follow error δ then get completely forward spread equation:

$$F(t, T) \geq \frac{[(1+c_{PL})e^{r_b(T-t)}+c_{FS} \times c_{FL}] \times (S_t \times D_t) e^{\mu P(T-t)}}{1-c_{FS}e^{r_b(T-t)}-k(e^{r_b(T-t)}-1)} + \delta \quad (2)$$

(2) Backward spread and lower limit:

When future price is undervalue, we can get model by back spread strategy with transaction cost. Set the primary margin is k, assume that the spread opportunity appear at time t, and stop spread at time T, so there has spread forward opportunity when as follows equation establish:

$$F(t, T) \leq \frac{[(1+c_{PS})e^{r_b(T-t)}+c_{FS} \times c_{PL}] \times (S_t \times D_t) e^{\mu P(T-t)}}{1-c_{FS}e^{r_b(T-t)}-k(e^{r_b(T-t)}-1)} - \delta \quad (3)$$

And the follow error can calculate by:

$$\delta = \mu + Z_{\alpha=0.1} \times \sigma$$

Where μ is the absolutely mean value of observation sample, σ is standard deviation and 90% significant level.

Arbitrage interval depends on stock index future mispricing, and the price difference between future and spot constructed the theoretical profit interval. However, real market is an un-perfect market so than the arbitrage earn always reduce by transaction cost, following error, funds

borrow and lend cost and so on, some time there cost can make spread loss. Hence in real spread implement investor must mind the cost change every time, and only the price difference between spot and future is higher than transaction cost then spread can get earn or it will be loss.

Arbitrage cost calculation is that calculate the parameters which can impact future price, and substitute into the price model and get the transaction cost of spread. The funds borrow and lend cost, fixed trade cost and margin are known before spread, and cash dividend and impact cost needs to estimate and adjust during the process of spread.

In the cost of carry model, the cost of carry difference comes from risk free rate and dividend rate, so when risk free rate is higher than dividend rate, the future price will higher than spot price, and the future price will lower than spot price if risk free rate less than dividend rate.

The cost carry model:

$$F_t = S_t(1 + r_f)^{T-t} - D(t, T)$$

$$F_t = S_t e^{(r_f - d)(T-t)}$$

Where F is the theoretical price at time t , S is the spot index price at time t , r_f is risk free risk, $D(t, T)$ is cash dividend from time t to T . Then the dividend can calculate by:

$$D(t, T) = \sum_i^N \left[\left(\frac{S_{i,t} d_i w_i}{P_{i,t}} \right) e^{r(T-t)} \right] \quad (4)$$

Where d_i is dividend payment after tax of stock i , w_i is the weight of stock i , $P_{i,t}$ is stock i price at time t .

During the spread, the spot position because dividend payment so that the value is spot position involved the value of the cash dividend, and the value of future on expiry only equal to spot position on expiry. In this case, in forward spread process, the dividend is high means that the spread interval will bigger, the earning of sell future will reduce, and the spread upper limited will lower. In backward spread, sell spot position will lose some part of cash dividend, then dividend higher the spread interval decrease, so the cost of buy future needs decrease and non-arbitrage interval will be low.

2.2 Calendar Spread

Stock index Calendar spread basic on the different contract price prediction, so it is a risk free spread, sometimes it is speculation. But the whole of this spread the double opposite process and care about the basis of two contract price trend, so it is just arbitrage but speculation, because speculation has only single process. Compare with future-future spread and single position trade, future-future spread has some features of low risk, low transaction cost. Because one contact loss can get back by another contact earn, so exchange and brokerage has a rule that the margin of future-future spread is lower than single trade. Normally there are the same margin between arbitrage and hedge. Future-future spread can divide by calendar spread, inter-market spread and inter-product spread. In the article will discuss calendar spread and inter-market spread. Because of investor trade two different contracts has the same underlying,

normally two contracts have stable price basis, once the basic get more change then spread opportunity will be appeared. Inter-market spread is actually that trade the price basis between two contracts. According to the process of direction, it has three kinds of spread paths are bull spread, bear spread and butterfly spread.

Bull spread is mean that when stock price go up, because index future and spot has deep relation, so someone of index and index future has same up trend, but different expiry day contract has different price movement, in this case investor will buy the contract which has high speed price to go up and sell contract which has low price to go up. If see from the price basis, bull market investor think about the market is blooming and far contract and near contract will has bigger price basis. Bull market spread investor think that far future contract price should be higher than near contract, and current time far contract price is undervalue. So investor will sell near index future and buy far contract at same time.

Bear market spread is mean that when the market trend go down, so someone of index and index future has same up trend, but different expiry day contract has different price movement, and the speed of movement also are different then get opportunity of spread. In this case investor sell higher speed price down contract and buy low speed price down contract. Bear market investor think about far contract will drop more than near contract. Meanwhile bear spread is mean that the price basis will change to small, far contract current price is overvalue then sell far contract and at same time buy near contract.

Butterfly spread are two opposite direction contracts and share the same middle contract, means trade three contracts at the same time, it get earn by the price basis between another two contracts. When investor think about the middle contract will has price basis change with another two contracts then they will choose butterfly spread. Once judged middle contract price undervalue or overvalue with another two contracts, then butterfly spread can get risk free earn.

2.2.1 Pricing Analysis

According to the cost of carry model:

$$F(S, t, T) = S(t) \times (1 + r(T - t)) - D(t, T) \quad (5)$$

Then theoretical price basis is:

$$\Delta F = S(t) \times r \times (T_2 - T_1) - D(t, T_2) + D(t, T_1) \quad (6)$$

Where T_2 is the expiry day of far contract, T_1 is the expiry day of near contract, $D(t, T_2)$ is dividend pay from t to T_2 , normally dividend rate is lower than interest rate.

Because of transaction cost is exist so there has bull market spread opportunity when have as follows equation:

$$F(S, t, T_2) - F(S, t, T_1) \geq \Delta F + 4C \quad (7)$$

Where C is single transaction cost of trade future contract. At this time the strategy is that sells near contract and buy far contract.

In bear spread, there has opportunity when has as follows equation:

$$F(S, t, T_1) - F(S, t, T_2) \geq \Delta F + 4C \tag{8}$$

At this time the strategy should be sell far contract and buy near contract.

Both function (7) and (8) can get earn only when the price basis recovery to the rational level.

2.3 Inter-Market Spread

Inter-market spread is that investor spread similar contracts by opposite direction in different exchange. Investor process inter-market spread more care about the price basis vary to big or small. If one contract have stronger price trend than another contract, we can call it mighty contract, once mighty contract have stronger price go up or down than another contract than investor can get earn from inter-market spread. There are some risks may impact inter-market spread which likes Price prediction exist error between two market future contracts, and maybe there has two, similar contract in two exchanges but the regulation has some different can cause risks, Foreign currency rate vary. Currency rate is the one of core component of spread transaction cost, if sometime currency rate has instantaneous big vary can make spread loss, and Expiry day difference.

According to the cost of carry, the local and foreign stock index future price consider without non-continuously rate and dividend rate:

$$F = S(1 + R)^T \tag{9}$$

$$F^* = S^*(1 + R^*)^{T^*} \tag{10}$$

When in the situation of non-arbitrage opportunity:

$$\pi = S(1 + R)^T - \left(\frac{S}{E}\right) \times (1 + R^*)^{T^*} \times (1 + R_F)^{(T-T^*)} \times FE$$

$$= F - \left(\frac{S}{E}\right) \times (1 + R^*)^{T^*} \times (1 + R_F)^{(T-T^*)} \times FE = 0$$

Where S is local spot index and multiply by 1point; S^* is Foreign spot price multiply by 1 point; F is Local future price multiply by 1 point; F^* is Foreign future price multiply by 1 point; R is Local interest rate; R^* is Foreign interest rate; T is Local future contract expiry day; T^* is Foreign future expiry day; R_F is Forward rate from T^* to T; E is Spot rate; FE is Forward rate and X^* is The volume of trade local future contract.

Hence:

$$F = \left(\frac{S}{E}\right) \times (1 + R^*)^{T^*} \times (1 + R_F)^{(T-T^*)} \times FE \tag{11}$$

Moreover, find the price relationship between foreign and local, according to function (9), (10) can write as:

$$F = \left(\frac{S}{E}\right) \times (1 + R^*)^{T^*} \times (1 + R_F)^{(T-T^*)} \times FE$$

$$= \left(\frac{S}{E} \times \frac{S^*}{S^*}\right) \times (1 + R^*)^{T^*} \times (1 + R_F)^{(T-T^*)} \times FE$$

$$= \frac{S}{ES^*} \times S^* \times (1 + R^*)^T \times (1 + R_F)^{(T-T^*)} \times FE$$

Set $X^* = \frac{S}{ES^*}$ then have:

$$F = X^* \times F^* \times (1 + R_F)^{(T-T^*)} \times FE \tag{12}$$

Function (12) is the non-arbitrage balanced equation, if the right side of this function is not equal to F, and then there has arbitrage opportunity.

1) When $F > X^* \times F^* \times (1 + R_F)^{(T-T^*)} \times FE$:

Sell local future contract, when the expiry day T, needs delivery spot and get F,

Buy foreign index future X^* , for avoid foreign currency value increase, so firstly buy foreign funds by FE, and book a forward contract, and borrow X^*F^*FE by R_F .

When T, earn $X^* \times F^* \times (1 + R_F)^{(T-T^*)} \times FE - F$.

2) When $F < X^* \times F^* \times (1 + R_F)^{(T-T^*)} \times FE$:

Buy local stock index future, when expiry prepare F for delivery spot,

Sell X^* foreign index future, for avoid foreign funds value increase, so sell foreign funds by FE and book forward contract that lend borrow X^*F^*FE by R_F ,

When T, earn $X^* \times F^* \times (1 + R_F)^{(T-T^*)} - F$.

3. Empirical Research

In this section will study the stock index future arbitrage by FTSE100, Hangsheng and NASDAQ markets. Here will use the market data from January 2007 to October 2009, all data resources come from datastream system.

Firstly the details of future contract of FTSE100, Xinhua/FTSE A50 and NASDAQ are as follows table:

Table1. The Details of FTSE100, Hangsheng and NASDAQ future contracts

| | FTSE100 | Xinhua/FTSE A50 | NASDAQ-100 |
|-----------------|--|--|----------------------------------|
| Unit of trading | Contract Valued at £10 per index point | \$1 per index point | \$100 x NASDAQ-100 futures price |
| Delivery months | March, June, September, December | Spot, next calendar month & next two calendar quarter months | March, June, September, December |
| Minimum Price | 0.5 (£5.00) | 5 index point | 0.05 index |

| | | | |
|------------------|---|---|---|
| Fluctuation | | | points=\$5.00 |
| Delivery day | First business day after the Last Trading Day | First business day after the Last Trading Day | First business day after the Last Trading Day |
| Trading hours | 08:00 - 21:00 | 9.15am - 11.35am 1.00pm - 3.05pm | Mon-Fri: 8:30 am -3:15 pm |
| Transaction cost | | | |
| Exchange Fee | \$2.40 | HK\$30.00 | \$ 2.40 |
| Commission Rate | Negotiable | Negotiable | Negotiable |
| Exchange Tax | 0.2% | 0% | 0.5% |

3.1 Spread Interval Estimation

Spread interval construction needs to calculate transaction cost which including the cost of trade spot and future, the cost of borrow money, the tax payment and the impact cost. Otherwise it also needs to set the initial margin level, and risk free rate. According to spread interval function analysis future-spot spread opportunities. First of all we see the historical price trend of FTSE100, Hengsheng and NASDAQ-100 index futures:

Figure 1: The historical price trend of FTSE100 index future

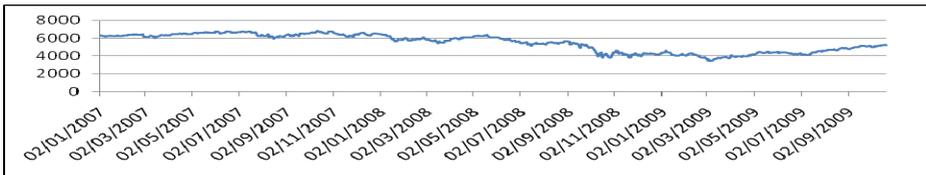


Figure 2: The historical price trend of Hengsheng index future

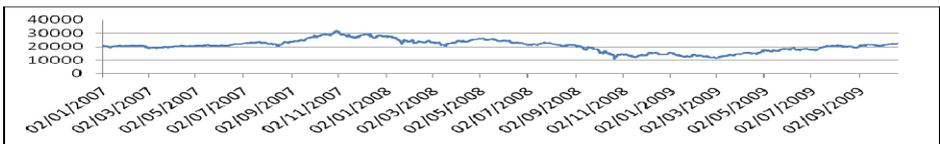
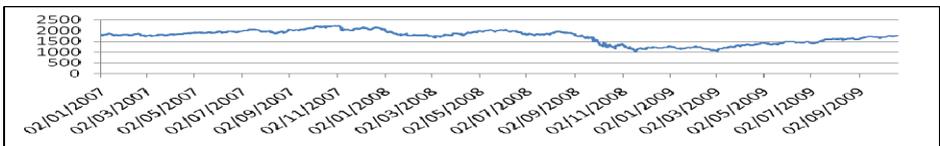


Figure 3: The historical price trend of NASDAQ-100 index future



According to the economical theory, future contract should have same price with spot, however in case of market volatility, the speed of information response and the cost of arbitrage, future price always has difference with spot price. Because of future has low costs, high leverage and cash delivery and so on special features, so future price movement can always

leads spot price.

Figure 4: The basis trend between FTSE100 future and spot

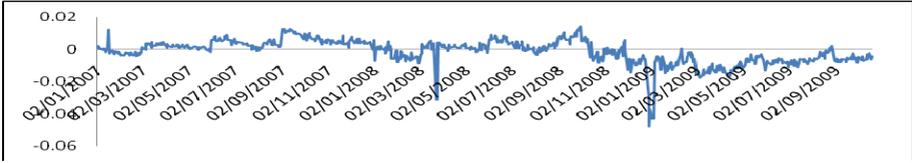


Figure 5: The basis trend between Hengsheng future and spot

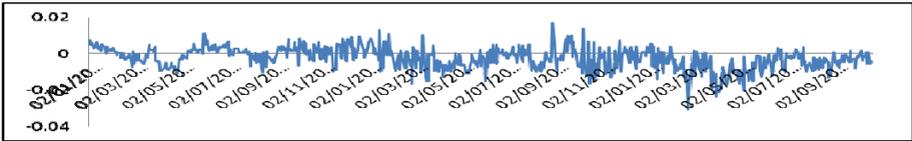
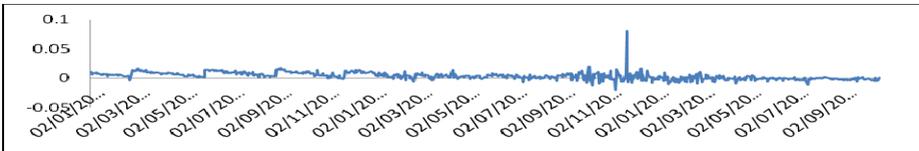


Figure 6: The basis trend between NASDAQ-100 future and spot



From the Figure 4 to 6 we can see, hengsheng index future has biggest basis volatility than other two products, FTSE100 and NASDAQ-100 contacts has stability in some time slices, only hengsheng future cannot see stable in any time slice. So hengsheng future market has more arbitrage opportunities than FTSE100 and NASDAQ-100 future market, of course it is difficult that implement arbitrage in hengsheng than other two markets. In additional, if future contract has long time to expiry, arbitrage activities will more difficult cause lot of speculation funds entre in market with high leverage, so that make market will existed high volatility.

Consider the transaction cost of spread as follows:

Table 2: Transaction cost of FTSE100, Hengshang and NASDAQ100 spots and futures

| | FTSE | | Hengsheng | | NASDAQ | |
|---------------|--------|--------|-----------|--------|--------|--------|
| | Spot | Future | Spot | Future | Spot | Future |
| Commission | 0.05% | 0.02% | 0.09% | 0.03% | 0.25% | 0.12% |
| Tax | 5% | 0.2% | 1% | 0.5% | 3% | 0.2% |
| Impact cost | 0.011% | 0.018% | 0.015 | 0.011 | 0.018 | 0.012 |
| Interest Rate | 0.5% | | 0.2% | | 0.35% | |
| Lend rate | 0.65% | | 0.25 | | 0.5% | |

From the function (1) and (2), we calculate the positive and negative spread interval of three products, the figure (7), (8) and (9) are positive and negative spread opportunities statistic of three products.

Figure 7: FTSE100 spread opportunities statistic

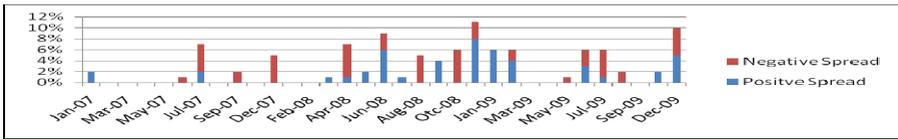


Figure 8: Hengsheng spread opportunities statistic

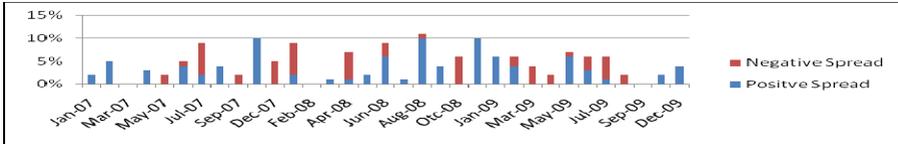
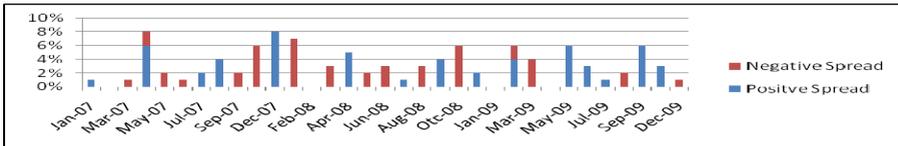


Figure 9: NASDAQ-100 Spread opportunities statistic



The spread opportunity of FTSE100 index future is lower than other products, and the spread interval is lower than other products as well. Positive spread opportunities appeared more than negative spread, there are 540 positive spread opportunities and 127 negative spread opportunities. The highest positive spread probability was 8% on January 2009, and the negative spread probability was 16% December 2009. Hengsheng index future has 475 positive spread opportunities and 257 negative spread opportunities during observe period, and the highest positive spread probability was 9.5% October 2007 and 7% of negative probability on January 2008. NASDAQ-100 index future has 390 positive spread opportunities and 91 negative spread opportunities, and the highest positive spread probability was 8% December 2007 and 7.9% of negative probability on April 2007.

Three kinds of products has same feature that positive spread opportunities more than negative spread opportunities. Average positive opportunities was more than 30% of all of observe samples. However positive and negative spread opportunities are not appeal alternately. The reason may because the expectation of dividend payment or index goes up or down movement. General speaking, there are spot replication, the dividend rate, margin risk and trade strategy components can deep impact arbitrage return.

3.2 Calendar Spread Analysis

Stock index calendar spread consider the volatility of basis between different future contract without consider the single contract price movement. It also has not spread opportunities if the bases varying of two contracts are stable, only when different contract has bigger volatilities then can implement spread strategy.

Figure (10), (11) and (12) are price trend of FTSE 100, NASDAQ-100 and Xinhua/FTSE A50

future contracts, from those figures we can get that both of them price trend are much stable. So this means that the contract bases are stable as well. Otherwise we can see that the far contract price movement always stands on the higher level than nearly contract, and such as that phenomenon are completely suitable for the stock index future price principle.

Figure 10: FTSE spot and future contracts price trend

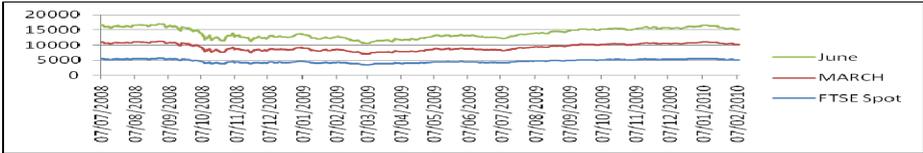


Figure 11: NASDAQ-100 spot and future contracts price trend

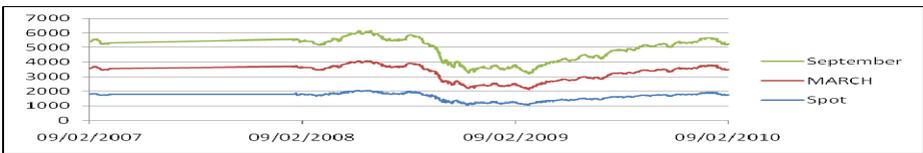
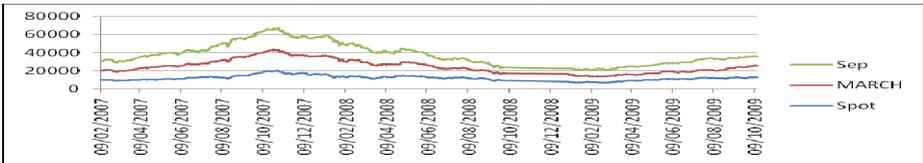


Figure 12: Xinhua/FTSE A50 spot and future contracts price trend



According to the function (6), (7), (8) can get the bull and bear calendar opportunities series, first to calculate the theoretical price basis and then calculate the bull and bear spread opportunities. Finally we can try to draw the basis and spread opportunity Figure to directly see the spread spaces.

Figure 13: FTSE 100 bull and bear spread analysis graph

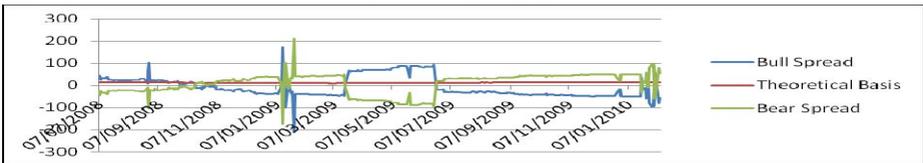


Figure 14: is NASDAQ-100 bull and bear spread analysis graph

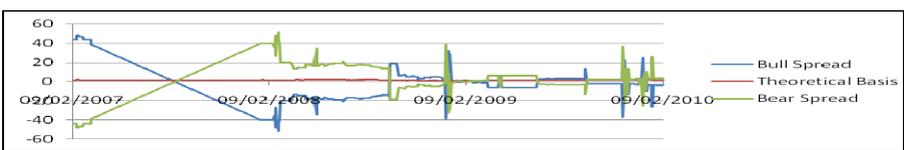
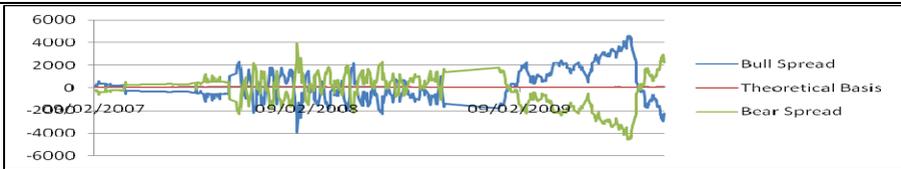


Figure 15: is Xinhua/FTSE A50 bull and bear spread analysis graph



FTSE100 and NASDAQ-100 index future contracts have lower opportunities. From March 2009 to June 2009 FTSE100 had stable spread opportunities, other periods we couldn't see any better chances for spread. NASDAQ-100 had large basis volatility so that spread opportunities have short time existed only, so investor couldn't implement long term spread strategy. Xinhua/FTSE A50 index future contract basis volatility also very big and spread opportunities are abundant. In additional, NASDAQ-100 spread is much more difficult than other two contracts, and Xinhua FTSE A50 is easiest. Normally emerging market is existing much more spread opportunity and developed market is few.

Set the close prices of two contracts are L_1 and L_2 , the price basis between L_1 and L_2 is K , K has mean μ . Now try to eliminate center value then get series M :

$$M = K - \mu \tag{13}$$

The standard deviation of M is σ and make the trade strategies are as follows:

- 1) When $M < -\sigma$, buy far contract and sell current moth contract;
- 2) When $M > \sigma$, buy nearly contract and sell far contract;
- 3) When the above strategy set up, just wait for M return back to deviation interval and make opposite operation;
- 4) When nearly contract on expiry, execute opposite hedge for end the position.

According to above operation, the spread opportunities of FTSE100, NASDAQ-100 and Xinhua/FTSE A50 can express by follows table:

Table 3: Spread opportunities of FTSE100, NASDAQ-100 and Xinhua/FTSE A50

| Contract | Mean of basis | Standard deviation | Percentage of spread opportunity |
|--|---------------|--------------------|----------------------------------|
| FTSE100 March-September | 33.2587 | 82.1938 | 21.45% |
| NASDAQ-100 March-September | 17.6430 | 62.7743 | 14.16% |
| Xinhua/FTSE A50 March-September | 266.4640 | 1358.0257 | 48.31% |
| Percentage of spread opportunity means that the day when has spread chance versus total trade day. | | | |

If we see the history of financial future market development, follow market develop and investor change to mature, stock index future contract price basis will change to be stable and the price difference will reduced as well. In the developed market such as American and British

markets, the price bases between different contracts are very stable, its volatility also very limited, there have little chance to spread or sometimes there completely haven't any chance. Emerging market because it is developing, the speculative trade very activities, a lot of smart money participants market so that the price basis has huge volatility, so it easy to discover spread chance and get return from spread trade. However follows the marker progress, spread opportunity will reduced more such as developed market, the earning space will also reduced, Investor will hard to get earn for spread trade.

3.3 Inter-Market Spread Analysis

In this section we are going to use Morgan Hong Kong spot index future (SGX MSCI Hong Kong) and Hong Kong Hengsheng stock index future for test the inter-marker spread model. The data period is from February 2008 to January 2010.

Table 4: Relative rate of Hong Kong Singapore market

| | Interest rate | Currency rate | Forward rate (1 month) |
|-----------|---------------|---------------|------------------------|
| Hong Kong | 0.001% | 0.1817 | 7.765 |
| Singapore | 0.03% | 5.5032 | 1.4122 |

According to the non-arbitrage function (4.32), the left side is local market (Kong Kong market), and right side is overseas market (Singapore market), when local market closed price is more than overseas market, buy SGX MSCI Hong Kong future contract and sell Hong Kong Heng Sheng future contract. The for the same principle when local closed price is less than overseas market, then buy Hengsheng future contract and sell SGX MSCI Hong Kong future contract. After set up the position and waiting for the future contract go to expiry. The data test by above two contract showed follows results:

Table 5: The earn and loss without consider the transaction cost

| Return | Between 1% - 3% | Between 5% - 8% | Between 8% - 15% |
|-----------|-----------------|-----------------|------------------|
| Earn days | 127 | 81 | 55 |
| Loss days | 73 | 76 | 28 |

Table 6: The Earn and loss with consider the transaction cost

| Return | Between 1% - 3% | Between 5% - 8% | Between 8% - 15% |
|-----------|-----------------|-----------------|------------------|
| Earn days | 1118 | 70 | 48 |
| Loss days | 73 | 76 | 28 |

Table 7: Earn capability comparison without consider the transaction cost

| Return | Between 1% - 3% | | Between 5% - 8% | | Between 8% - 15% | |
|--------------|-----------------|---------|-----------------|---------|------------------|---------|
| Higher price | Hengsheng | MSCI HK | Hengsheng | MSCI HK | Hengsheng | MSCI HK |
| Times | 376 | 120 | 186 | 90 | 83 | 29 |

Table 8: Earn capability comparison with consider the transaction cost

| Return | Between 1% - 3% | | Between 5% - 8% | | Between 8% - 15% | |
|--------------|-----------------|---------|-----------------|---------|------------------|---------|
| Higher price | Hengsheng | MSCI HK | Hengsheng | MSCI HK | Hengsheng | MSCI HK |
| Times | 278 | 101 | 152 | 79 | 51 | 17 |

From the tables we can see the total return is Hong Kong Hengsheng is great than SGX MSCI Hong Kong which means there was a lot spread operate as buy Hengsheng and sell SGX MSCI Hong Kong, and when the return is more the stable of stable is more significant. And also we see if consider with the transaction cost, the capability of earn is reduced.

Many factors are able to impact the inter-market spread, the traditional factors are the future price prediction, the different rule of exchange of two exchanges and currency risk. In real market, Singapore International Finance Exchange launched Xinhua/FTSE A50 stock index future on 5th September 2006, FTSE is the top four index company in the world, and A50 index is including 50 largest Chinese company, a lot of foreign investor proposed A50 is the accurate index of Chinese stock market. According to some of research reports, there has high correlation relation between A50 and China stock index 300, China stock index 300 covered all of A50 stocks. After CSI 300 stock index future launched, it will be the best inter-market spread product team.

4. Conclusion

In this paper we talked about the arbitrage strategy and operation rules, and took empirical research by FTSE100, Hengsheng, NASDAQ-100 and Singapore A50 indices. General speaking, in real market there are spot replication, the dividend forecasting, the margin risk and strategy choose and so on factors can deep impact the efficiency of arbitrage. The spot replication always exists follow error whatever replicate by total replication or optimization methods. And buy ETF also will meet same problem. The follow error can make final price is different between spot and future price so that impact the earning. The follow error comes from transaction cost, underlying stock changes and dividend re-invest and so on reason. In the cost of carry method, dividend can impact future price. In real market if investor instead of dividend by some dividend rate, then the strategy couldn't completely expresses real market situation, because dividend payment is stochastic which means dividend payment time couldn't predict. Example in Hong Kong market, dividend payment often happened during March and April each year. In mainland of China, dividend payment often happened during May, June and July, and few times to get dividend payment on other period. If investor operates adverse strategy which means that buys future and sells spot. In the case if spot price jump up rapidly to make spot margin level is lower than the basic level, or when index drop rapidly, future margin level is lower than basic level, investor will face to margin risk. The worst situation is that invest account have to compulsory closed. In additional, as long as the spread opportunity had

been discovered, investor should to choose a suitable strategy for get return better. The occasion time of open and close position is very important. Otherwise, settlement day and price confirm in different countries also can impact spread return, different countries have different day and price for settlement. For example Hong Kong market confirm settlement price by the average price of last five minters of index, and Mainland of China use average price of second day for confirm the settlement price.

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