Efficiency of Single-Stock Futures: An Intraday Analysis

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Abstract

Using intraday bid ask quotes of Single-Stock Futures (SSF) contracts and the underlying stocks, we examine the pricing and informational efficiency of SSF traded on the Hong Kong Exchange. Both the SSFs and the stocks are traded on electronic platforms. The market microstructure and the data obviate the problems of stale and non-executable prices as well as uncertain bid-ask bounce of the thinly traded futures contracts. Nominal price comparisons show that over 80% of SSF quotes are inferior to stock quotes. Over 99% of the observed futures spreads are above one stock tick compared to only 2% of those for stocks. After adjusting for the cost-of-carry, however, SSF are fairly priced. Given higher stock trading costs, non-members should even find the futures attractively priced. Thus the absence of competitive market maker does not bias prices so as to discourage trading. SSF quotes also account for one-third of price discovery despite their low volume.

Keywords: Single-stock futures; Transaction costs; Price discovery; Arbitrage

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1. Introduction

Single-stock futures or SSFs are futures contracts on individual stocks. They were once touted as revolutionary, intended to attract both retail and institutional investors. There are two significant advantages of trading SSF over stocks. They have lower margin requirements than stocks, and thus provide a cheaper way to participate in equities. Because there is no uptick rule for SSF, investors can establish a short position on downticks. Short sellers can also benefit from eliminating the costs and inefficiencies associated with the stock loan process. Yet since their launch in 2002 in the U.S., SSFs have been thinly traded, representing less than 0.1% of the volume of the underlying stocks. SSFs introduced in 1995 in Hong Kong are also inactive. That there is one single market maker for the entire SSF market in Hong Kong raises concern that futures prices could move significantly from fair values in a direction to discourage participation.

There is limited research on SSF markets since SSFs trade on only a few exchanges. Ang and Cheng (2005a) examine selection of stock futures contracts for listing in the U.S. Ang and Cheng (2005b) find that fewer unexplained large stock returns for SSF firms post-listing, suggesting that SSF trading improves market efficiency. Dutt and Wein (2003) argue that current margin rates are too high for many SSF contracts and may restrict liquidity. In the Australian stock futures markets, Dennis and Sim (1999) and Lee and Tong (1998) find the introduction of SSF does not significantly change the volatility of the stocks underlying the share futures. None of these authors use transaction or quote-level data. Fung and Mok (2005) use transaction data to examine the efficiency of the SSF market during the Hong Kong financial crisis, but their research is plagued by the problems of thin trading.

Both SSF and stocks in Hong Kong are traded on electronic platforms. Bid and ask quotes displayed on trading screens are firm commitments of participants and are potentially executable. We use complete records of intraday bid-ask quote data directly retrieved from the trading screen over August 2001 through June 2003 to examine the pricing and informational efficiency of SSF contracts relative to the underlying stocks. The specific market microstructure and the quote data let us overcome the infrequent trading problem and uncertain bid-ask price bounces in thinly traded securities.

We find that over 99% of the observed futures spreads are above one stock tick compared to only 2% for stock spreads. Nominal price comparisons show that over 80% of SSF quotes are inferior to stock quotes; specifically, the best bid (ask) of a stock is often above (below) that of the SSF. After adjusting for the cost-of-carry, however, SSF are fairly priced. Exchange non-members in particular should even find the futures attractively priced after factoring in the higher stock trading cost. These results imply that the absence of a competitive market maker does not biase prices so as to discourage trading.

We use the Hasbrouck (1995) and Gonzalo and Granger (1995) two common factor models to investigate the price discovery process between SSFs and the underlying stocks. Despite extremely low volume, SSF quotes account for one-third of price discovery. So why are SSF contracts inactive? The absence of incentives for brokerage firms to promote SSFs and the "winner takes most" equilibrium of Chowdhry and Nanda (1991) may explain the thin trading.

The remainder of this paper is organized as follows: Section 2 reviews the market structure of the SSFs in the U.S. and other countries. Section 3 describes the data and the market structure of Hong Kong SSFs. Section 4 summarizes and interprets the empirical results. Section 5 concludes the paper and provides some policy recommendations.

2. Review of U.S. Single-Stock Futures

Since its launch in late 2002 as a joint venture of Chicago's three major traditional exchanges–the Chicago Mercantile Exchange, the Chicago Board Options Exchange, and the Chicago Board of Trade–OneChicago has posted trading volume that is disappointing to many futures veterans. OneChicago was launched at the same time as the Euronext.Liffe and Nasdaq-owned joint venture, NQLX, which also traded SSFs. Nasdaq pulled out of NQLX in 2003, and Euronext.Liffe followed suit a year later. NQLX halted trading in all its security futures products in December 2004 because of low volume (See "NQLX is Out of the SSF Biz," 2004, and McKay, 2005).

While both exchanges are electronic, OneChicago uses a lead market-maker system, and NQLX uses a central limit order book with a market-maker overlay. OneChicago guarantees a two-sided market by obliging lead market-makers to make markets, while NQLX gives market makers incentives to make markets through its fee structure.

In Hong Kong, a single market maker is designated for the entire SSF market. Even though the market maker provides firm bid and offer prices subject to maximum spread limits, a single market maker raises suspicions that in the absence of competition on the futures price could deviate significantly from its fair value and in a direction to discourage participation.

Initially, SSFs were thought to have distinct advantages in margins, taxes, and short selling rules in the U.S. security markets. Many investors note that the 20% margin rate is high for a futures product, although it is lower than the 50% margin rate on securities. Because nearly all institutional traders in the securities world trade with a margin of 15% or better, the margin advantage for SSFs is insignificant. The broad-based index futures are marked to market and receive a beneficial 60/40 treatment (i.e., 60% of gains on futures are treated as long-term gains and 40% as short-term). Investors are subject to ordinary income rules, so there is no tax consequence until an investor closes out a position. The result is that broad-based index futures are taxed until more favorable rules are passed (Mehta, 2002). When the Bush administration tax cuts reduced the rate for dividends and capital gains to 15%, SSFs became disadvantaged.

Because there is no uptick rule for SSFs, shorting a SSF is as convenient as acquiring a position. Because investors may opt to trade SSFs instead of borrowing a stock to short, brokerage firms may not have any incentive to promote SSFs. Some analysts have also suggested that the contracts act too much like an option, a more common investment for betting on a stock's prospects.

SSFs offered on a number of exchanges including Sweden, South Africa, Spain, Australia, and Hong Kong have never done well. SSFs introduced at Euronext.Liffe in Swiss/U.K., on the MEFF in Spain and the NSE in India built up some presence in the market, although they have still not accumulated the kind of liquidity that signals a successful contract. These three exchanges benefit from a simpler legal and regulatory structure. In the U.S. markets, both OneChicago and NQLX have argued that regulation by the Commodity Futures Trading Commission (CFTC) and the Securities and Exchange Commission (SEC), which share oversight, has kept the product from generating the interest that had been expected.

3. Data and Market Structure of Hong Kong Single-Stock Futures

The market capitalization of the Hong Kong stock market was US$456 billion in 2002, making it 12^{th} in the world and second only to Japan in Asia. The Hong Kong Exchange (HKEx) is the only organized stock exchange in Hong Kong. Both stocks and all kinds of futures trade on an electronic trading platform–the Hong Kong Futures Automatic Trading System (HKATS)–and are regulated by the same government agency, the Securities and Futures Commission (SFC). The markets are transparent, with an open limit order book. There are no taxes on capital gains and no uptick rules for both stocks and futures.

SSFs are cash settled following Asian-style settlement procedures. The settlement price is set equal to the average of the middle quotes taken every five minutes during the trading day. As for OneChicago, a designated market maker is used for each SSF in order to enhance liquidity. The market makers provide firm bid and offer prices subject to maximum spread limits and enjoy in return a waiver of the exchange trading fee associated with stock futures trading.

The futures trade during the same hours as the underlying stocks. The markets open at 10:00 am and close at 4:00 pm with a midday break from 12:30 to 2:00 pm. An SSF contract is standardized as one board lot (100 shares) of the underlying stocks. There are 33 SSFs trading on the Hong Kong Exchange; the underlying stocks are the component stocks of the Hang Seng Index (HSI), the benchmark of the Hong Kong stock market, which is a value-weighted index based on 33 stocks of the largest companies in Hong Kong. We exclude five SSFs (China Petroleum & Chemical, Hong Kong Exchanges and Clearing Ltd., PetroChina Co. Ltd., Huaneng Power International, and Bank of China Hong Kong Ltd) from our analysis because of an insufficient trading history. Hence the sample numbers 28 SSFs and their underlying stocks.

We use a complete record of bid-ask quotes of the futures and the underlying stocks from August 2001 through June 2003. The data, directly retrieved by HKEx from the electronic trading system, represent firmly committed quotes of market participants and are potentially executable. Use of these data allows us to overcome the problems of thin trading and the bid-ask price bounce in transactions prices. The bid-ask stock quotes are taken from snapshots of the trading screen every 30 seconds throughout the trading sessions. A quote is revised if it is different from the previous one. Bid and ask quotes are perfectly synchronous since they are retrieved at the same time. The quote of a stock future is refreshed when there is a change in the quote; the previous quote remains effective until it is revised. Hence, the futures quotes are continuous up to a second.

Hong Kong Interbank Offer Rates (HIBORs) come from Datastream. Four rates are collected for the study: 1-day, 1-week, 1-month, and 2-month rates. Interest rates used for holding (or discounting) time period are interpolated from the two adjacent interest rates. Dividend information is obtained from HKEx. The data provide the per-share cash dividend, announcement date, ex-date, and payment date.

4. Empirical Results and Interpretation

SSFs were thinly traded during our sample period, August 2001 through June 2003. The trading volume of each SSF is less than 0.1% the volume of the underlying stock. There were a total of only 5,812 trades. The number of trades in the spot month contracts amounted to 53% of the total; the next month's contracts represented 31.3%. We focus on the best bid and ask price quotes of these contracts and their underlying stocks.

4.1. SSF volume and short-selling

We would expect conditions that trigger short selling in the stock market to induce more trading in stock futures. Therefore, SSF volume should be positively related to the short-selling volume of the underlying stock. This conjecture is supported by an OLS regression result with daily data:

$$\textit{Futures Volume}_{ij} = 0.399 + 5.67\mathrm{e}^{-8}\textit{Short-Selling Volume}_{i} + 1.44\mathrm{e}^{-8}\textit{Net Volume}_{i}$$

where *Futures Volume*$_{ij}$ is the volume of futures on stock *i* on day *j*, and *Short-Selling Volume*$_{ij}$ and *Net Volume*$_{ij}$ correspond to the underlying stock of the particular futures contract. Net volume, defined as total volume minus the short-selling volume, is incorporated in the regression to control for the positive relationship between total volume and short sales volume. Stock volumes are measured daily and in dollars. Coefficients are all significant and positive at any conventional confidence levels. These results support our conjecture that factors prompting short selling in the stock market will induce more trading in the stock futures market.

4.2. Comparison of margin rates

The average daily margin rate of the 28 SSFs is 9.9%, ranging from 5.8% to 18.6%. We obtained the margin rate by dividing the initial margin by the value of the shares underlying each contract at the closing. This is much lower than the minimum margin rate of 30%, which is stipulated by the Securities and Futures Commission of Hong Kong, for the corresponding stocks. Members and institutional investors must also comply with this 30% margin rate. Given the low margin requirements, the thin trading volume in SSFs is surprising.

4.3. Bid-ask spreads

We focus on the best bid and best ask price quotes of the SSFs (denoted by F_b and F_a) and the underlying stocks (S_b and S_a). The bid-ask spreads are calculated from synchronous stock and futures quotes. To facilitate comparison, we convert the futures spread (in dollars) into the number of ticks for the underlying stock. Note that the minimum tick size of a futures contract is HK$0.001 while the tick size of each stock is different and is specified according to an official spread table. The official minimum spread is positively related to the price level of the stock.

We compare the bid and ask quotes between a futures contract and its underlying stock as follows: (1) Using stock quotes that are refreshed every 30 seconds, we first construct a series of perfectly synchronous pairs of bid and ask stock quotes; and (2) using the continuous series of bid and ask futures quotes, we construct a series of futures quote pairs that are synchronous to the stock quote pairs.

For space reasons, we do not report individual results for the 28 SSFs and stocks (they are available on request). Table 1 reports the distribution of spreads measured in ticks for SSFs and stocks. We see that only 0.87% of the SSF spreads are one tick or less (that is, more than 99% are over one tick); while 97.9% of the stock spreads are one tick. Hence, spread costs for SSF trading are higher than for the stocks.

4.4. Differences in quoted prices

We compare the best bid (ask) price of SSF and the synchronous best bid (ask) price of the underlying stock. We would expect that thin trading in the SSF may imply lower best bids for the SSF than the underlying stock and higher best asks. Traders who want to take a bearish position may thus prefer shorting stocks to shorting the futures; similarly, a bullish trader would prefer buying stock to going long futures. This may be why traders prefer stock to an SSF.

Table 2 examines the distribution of the difference between SSF and stock best price quotes. Although we use the means to describe the results here, the median values are almost same. The best bid of the stock, S_b, is higher than the best bid of the SSF for 74.2% of all observations; the best ask of the futures is higher than the best ask of the stock, S_a, for 81.5% of all observations. Both differences are significant.

Thus, if traders want to take a bearish position, they may be better off shorting stocks than shorting the SSFs. Similarly, a long stock position may be better than a long futures position, although (as we will see) trading costs for stocks are higher than for futures. Tables 3, 4, and 5 calculate the cost-of-carry fair futures bid and ask prices implied by the synchronous stock prices, factoring in the round-trip transaction cost differential and the ex-post dividend payment, D, for further comparisons.

4.5. Deviations from fair values

Table 3 summarizes the differences between actual and fair futures quotes implied by synchronous stock quotes in terms of the cost-of-carry relationship, factoring in ex-post dividend payments. Tables 4 and 5 present results for different trading cost assumptions. The fair futures bid and ask prices (F_b^* and F_a^*) are based on the best bid and ask prices of the underlying stock, respectively. That is,

$$F_b^* = (S_b - D)\left(1 + \frac{r}{365}\right)^{T-t} + C_1 \tag{1a}$$

$$F_a^* = (S_b - D)\left(1 + \frac{r}{365}\right)^{T-t} + C_1 \tag{1b}$$

where r is the annual interest rate, T is the time to maturity, and C_1 is the per-share difference in round-trip transaction cost between trading stock and futures.

The results in Table 3, which assumes a zero cost of trading, are consistent with the simple price comparison in Table 2. Panel 1a shows that the actual futures bid is below its fair value 85.5% of the time. The underpricing of the bid (relative to the fair bid price) amounts to about 40 basis points of the fair value. Similarly, Panel 2a indicates that the futures ask is above its fair value 82% of the time, with a difference of 40 basis points.

Table 4 shows that the round-trip trading cost for stock is 26 basis points and 82 basis points (relative to the stock mid-quote) above that for futures, according to member's and non-member's positions, respectively.

In Tables 5 and 6, we examine how actual trading costs for members and non-members will affect the results. Taking members' trading costs into account, Table 5 shows that mispricing occurs substantially less often. Only 53.5% of the observations show underpricing for the bid futures price, and only 51.2% of observations show overpricing of the ask futures price. The extent of the difference is also reduced, to 22 and 23 basis points, respectively.

Table 6 shows the results after considering non-members' trading costs. Because non-members have to pay trading commissions, the bid futures price becomes overpriced by 40 basis points, and overpricing occurs for only 16.4% of the observations. The actual ask futures price is, on average, below its fair value by 38 basis points, and overpricing occurs only 17% of the time. This indicates non-members should prefer SSFs to the underlying stocks.

4.6. Arbitrage opportunities

To see whether there is any potential arbitrage opportunity in using SSFs, we analyze the potential asymmetry between overpricing and underpricing. We would expect both high magnitude and more frequent underpricing in SSF than overpricing because of the costs and problems associated with short stock-buy futures arbitrage. Fung and Draper (1999) and Draper and Fung (2003) find these results in the Hong Kong Hang Seng Index futures contracts. Hence, findings for single-stock futures are largely expected to be consistent with those for the index.

Table 7 presents these results for the three different transaction cost categories (zero, members, and non-members). We also separate the results into overpricing and underpricing in each panel, where e^+ and e^- represent over- and underpricing of the futures contract relative to F^U and F^L, the upper and lower no-arbitrage bounds:

$$e^+ = \frac{F^b - F^U(S^a)}{F^U(S^a)};\ F^b > F^U \text{ and } e^- = \frac{F^L(S^b) - F^a}{F^L(S^b)};\ F^a < F^L \tag{2a}$$

$$F^U = (S^a - D)(1 + \frac{r}{365})^{T-t} + C_2 \text{ and } F^L = (S^b - D)(1 + \frac{r}{365})^{T-t} - C_2 \tag{2b}$$

where C_2 is the total round trip cost for establishing and closing of an arbitrage portfolio.

Table 7 shows there is mispricing observed in 6.3% of cases under the zero trading cost assumption: 2.9% from overpricing and 3.4% from underpricing. Occasions of mispricing decline to 3.3% and 1.2% after factoring in trading costs of members and non-members. Underpricing occurs more often than overpricing. The latter result can be explained by the cost, risk, and inconvenience of short-selling in the cash stock market.

4.7. Price discovery between single-stock futures and stocks

Price discovery is the process by which information is incorporated into prices. Authors such as Koutmos and Tucker (1996) and Wahab and Lashgari (1993) in the U.S. and So and Tse (2004) in the Hong Kong markets have documented that stock index and index futures prices are cointegrated, with a common factor or implicit efficient price. These results would be expected with convergence between the futures and the underlying asset, and arbitrage prevents the two prices from diverging.

We examine the price discovery process between the SSFs and the underlying stocks by exploring the common factor in the cointegrating relationship. We use the Gonzalo and Granger (1995) and Hasbrouck (1995) common-factor models, widely used in the literature. They are discussed in detail by Baillie et al. (2002), de Jong (2002), Harris, McInish, and Wood (2002), Hasbrouck (2002; 2003), and Lehmann (2002).

The Gonzalo and Granger (1995) and Hasbrouck (1995) models are estimated from a bivariate cointegrated series, $Y_t = (F_t, S_t)'$, modeled by the vector error correction model (VECM):

$$\Delta Y_t = \alpha(F_{t-1} - S_{t-1}) + \text{ lagged terms of } \Delta Y_t + \varepsilon_t \quad (3)$$

where α is the error correction coefficient vector, F_t and S_t are logarithms of the SSF and stock midquotes, and ε_t is the innovation vector. The midquotes are the averages of the bid and ask prices at the end of each minute. Gonzalo and Granger and Hasbrouck transform the VECM (3) into the

Stock and Watson (1988) common-factor model, decomposing Y_t into a common factor and a temporary component.

The common factor or efficient price represents the permanent price movement caused by information. The Gonzalo-Granger (1995) model decomposes the common factor into a linear combination of the price innovations. The common-factor coefficients can be considered the contribution of each market to price discovery. Hasbrouck (1995) defines a market's contribution to price discovery as its information share, or the proportion of the common factor innovation variance that can be attributed to that market. The higher the common-factor coefficient in the Gonzalo-Granger model or the higher the information share in the Hasbrouck model, the more a market contributes to the price discovery process.

Results of the information shares depend on the order in which the variables are represented in the VECM, if the innovations ε_t are cross-market correlated; i.e, the covariance matrix of ε_t is not diagonal. The upper bound of the information share for a given market is obtained when that market is the first variable in the model, the lower bound when the market is the last variable. Like most researchers, we use the midpoint of the lower and upper bounds to interpret the results. The Gonzalo and Granger model does not decompose the covariance matrix of ε_t, and the result do not depend on the ordering of the variables.

We use 10 lagged terms in the VECM; results for 5 and 15 lags are similar to the results in Table 8. The average common-factor coefficient of F_t is 0.334 and that of S_t is 0.666. Both coefficients are significantly different from zero at any conventional levels according to the Gonzalo-Granger Q-statistic. The average information share of F_t is 0.370 and S_t is 0.630. Thus both models indicate that SSFs contribute less to price discovery than the underlying stocks. Yet when we factor in the trading volume figures, a better than one-third price discovery contribution of the SSFs (obtained with less than a 0.1% share of the trading volume) indicates that the electronically traded SSF market with a single designated market maker is very efficient in providing price discovery. While the SSF market does not dominate the price discovery process, it is very likely that it would if comparable trading volumes were reached.

5. Conclusions

We use bid and ask quote intraday data of the Hong Kong Single-Stock Futures (SSFs) for a two-year period to investigate the pricing and informational efficiency between SSFs and their underlying stocks. SSFs and stocks are traded on the same electronic platform and regulated by the same government agency, but SSF volume represents less than 0.1% of the volume of the underlying stocks.

The futures quotes are found to be inferior to the corresponding stock quotes and spreads are wider. Comparisons between the actual futures quotes and the fair futures quotes implied by synchronous stock quotes, however, show that the futures are fairly priced. And after factoring in the higher stock trading costs (including trading commissions), non-members should find futures prices attractive. The SSF market is also highly informationally efficient. The futures quotes provide about one-third of price discovery despite their extremely low volume.

If the SSF market is both cost-effective and informationally efficient, and offers lower margins and more benefits of short selling, how can we explain why the SSF contracts are not actively traded?

Admati and Pfleiderer (1988) show that both informed traders and uninformed traders want to trade in a market with high liquidity. Chowdhry and Nanda (1991) show that if a financial product trades in several locations simultaneously, a natural clustering of liquidity in a particular market results in a “winner takes most” equilibrium. This equilibrium may make the stock markets dominate the SSFs.

One issue is that brokerage firms may have no incentive to promote SSFs because SSFs take money away from their stock lending businesses. Many investors, particularly retail investors, are still not familiar with SSFs. Exchanges should implement programs to offer brokerage firms benefits if they want to promote SSFs. Moreover, instead of considering that SSFs can be created synthetically using options, investors should understand that SSFs create a new investment opportunity for options trades, e.g., turning a traditional debit position into a credit position (see Crask, 2003).

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Table 1
Distribution of Spreads (in ticks) for Futures and Stock

No. of Ticks	Spot and Next Month Futures		Stocks	
	No. of Observations	% of Total	No. of Observations	% of Total
≤ 1	1361	0.87%	153132	97.91%
1 < x ≤ 2	46812	29.93%	2640	1.69%
2 < x ≤ 3	53444	34.17%	450	0.29%
3 < x ≤ 4	26562	16.98%	114	0.07%
4 < x ≤ 5	15092	9.65%	31	0.02%
5 < x ≤ 6	9201	5.88%	16	0.01%
6 < x ≤ 7	1365	0.87%	5	0.00%
7 < x ≤ 8	596	0.38%	2	0.00%
8 < x ≤ 9	673	0.43%	1	0.00%
9 < x ≤ 10	619	0.40%	0	0.00%
10 < x ≤ 11	326	0.21%	1	0.00%
11 < x ≤ 12	108	0.07%	0	0.00%
12 < x ≤ 13	55	0.04%	1	0.00%
13 < x ≤ 14	27	0.02%	0	0.00%
14 < x ≤ 15	19	0.01%	0	0.00%
15 < x ≤ 16	16	0.01%	0	0.00%
16 < x ≤ 17	13	0.01%	0	0.00%
17 < x ≤ 18	30	0.02%	0	0.00%
18 < x ≤ 19	9	0.01%	0	0.00%
19 < x ≤ 20	17	0.01%	0	0.00%
≥ 20	48	0.03%	0	0.00%
Total	156393	100.00%	156393	100.00%

The minimum bid ask spread for a stock is 1 tick. For comparison purpose, the futures (dollar) spread is divided by the tick-size of the underlying stock. The bid and ask spreads are calculated from synchronous stock and futures quotes.

Table 2
Summary Statistics of Difference between the Stock and Futures Quotes

Panel 1: Best bid stock quote – Best bid futures quote

		N	Mean	Std Dev	Min	Med	Max	% of times that Stk Bid > Fut Bid
Panel 1a								
Overall		214209	0.0829 (<.0001)#	0.2438	-1.3500	0.0400	7.0000	74.23%
Panel 1b								
	Mean		0.0817	0.1555	-0.3609	0.0416	1.5448	75.88%
	Std Dev		0.0811	0.1949	0.3835	0.0171	2.0346	12.23%
	Min		0.0296	0.0211	-1.3500	0.0000	0.2000	45.76%
	Med		0.0551	0.0852	-0.2000	0.0400	0.7000	74.23%
	Max		0.3691	0.8505	-0.0450	0.0900	7.0000	95.73%

Panel 2: Best ask futures quote – Best ask stock quote

		N	Mean	Std Dev	Min	Med	Max	% of times that Fut Ask > Stk Ask
Panel 2a								
Overall		215250	0.0513 (<.0001)#	0.2731	-3.4500	0.0600	9.4000	81.54%
Panel 2b								
	Mean		0.0343	0.1711	-0.8022	0.0574	1.6019	80.51%
	Std Dev		0.0661	0.2070	0.9846	0.0205	2.4136	9.03%
	Min		-0.2619	0.0189	-3.4500	0.0300	0.1000	57.24%
	Med		0.0425	0.0894	-0.3800	0.0500	0.6500	80.29%
	Max		0.1076	0.8286	-0.0550	0.1000	9.4000	97.70%

Panel 1a and 2a show the overall results for the entire sample of 28 stock futures and their underlying stocks.
Panel 1b and 2b provide summary statistics of the corresponding statistics for the 28 different stocks.
Numbers in parentheses denote the *p*-value of a *t*-test on the null hypothesis that the mean is equal to zero.

Table 3
Summary Statistics of Difference between Futures Quotes and Fair Value at Zero Cost

Panel 1: (Best bid futures quote F_b – Futures fair value F_b^*) / Futures fair value F_b^*
(Futures fair value based on stock bid quote)

	N	Mean	Std Dev	Min	Med	Max	% of times that Fair Bid > Fut Bid
Panel 1a							
Overall	199280	-0.00398 (<.0001) #	0.00628	-0.39582	-0.00276	0.10376	85.53%
Panel 1b							
	Mean	-0.0049	0.0049	-0.0665	-0.0045	0.0217	0.8589
	Std Dev	0.0045	0.0027	0.0939	0.0040	0.0241	0.0812
	Min	-0.0199	0.0019	-0.3958	-0.0168	0.0059	0.7118
	Med	-0.0034	0.0041	-0.0374	-0.0031	0.0151	0.8553
	Max	-0.0011	0.0136	-0.0103	-0.0010	0.1038	0.9890

Panel 2: (Best ask futures quote F_a – Futures fair value F_a^*) / Futures fair value F_a^*
(Futures fair value based on stock ask quote)

	N	Mean	Std Dev	Min	Med	Max	% of times that Fut Ask > Fair Ask
Panel 2a							
Overall	200299	0.00399 (<.0001) #	0.00622	-0.03771	0.00261	0.15485	81.91%
Panel 2b							
	Mean	0.0050	0.0052	-0.0150	0.0046	0.0561	0.8293
	Std Dev	0.0044	0.0025	0.0080	0.0043	0.0334	0.1137
	Min	0.0004	0.0017	-0.0377	0.0003	0.0103	0.5566
	Med	0.0037	0.0048	-0.0128	0.0032	0.0497	0.8573
	Max	0.0182	0.0119	-0.0061	0.0169	0.1548	0.9890

Note: $F_b^* = (S^b - D)(1+\frac{r}{365})^{T-t} - C_1$

$$F_a^* = (S^a - D)(1+\frac{r}{365})^{T-t} + C_1$$

C_1 = Stock Trading Cost (Round-trip) - Futures Trading Cost (Round-trip)

Panel 1a and 2a show the overall results for the entire sample of 28 stock futures and their underlying stocks.
Panel 1b and 2b provide summary statistics of the corresponding statistics for the 28 different stocks.
The number in parentheses denote the *p*-value of a *t*-test on the null hypothesis that the mean is equal to zero.

Table 4
Summary Statistics of Differential Trading Cost between Stock and Futures (C_1)
for all 28 Stock Futures Contracts

C_1 = (Round-trip Stock Trading Cost – Round-trip Futures Trading Cost) / Stock Mid Quote

Panel 1 Trading cost differential from members' position						
	N	**Mean**	**Std Dev**	**Min**	**Med**	**Max**
	158484	0.2603%	0.0649%	-0.3282%	0.2531%	0.7630%
Panel 2 Trading cost differential from non-members' position						
	N	**Mean**	**Std Dev**	**Min**	**Med**	**Max**
	158484	0.8228%	0.8176%	-5.7483%	0.6643%	7.4669%

Table 5
Summary Statistics of Difference between Futures Quotes and Fair Value at Member Cost

Panel 1: (Best bid futures quote F_b – Futures fair value F_b^*) / Futures fair value F_b^*
(Futures fair value based on stock bid quote)

	N	Mean	Std Dev	Min	Med	Max	% of times that Fair Bid > Fut Bid
Panel 1a							
Overall	199280	-0.00140 (<.0001) #	0.00618	-0.39409	-0.00026	0.10649	53.49%
Panel 1b							
	Mean	-0.0022	0.0049	-0.0638	-0.0018	0.0246	0.5662
	Std Dev	0.0042	0.0027	0.0942	0.0039	0.0241	0.2120
	Min	-0.0158	0.0020	-0.3941	-0.0135	0.0083	0.2049
	Med	-0.0009	0.0041	-0.0342	-0.0005	0.0178	0.5451
	Max	0.0015	0.0135	-0.0076	0.0016	0.1065	0.9560

Panel 2: (Best ask futures quote F_a – Futures fair value F_a^*) / Futures fair value F_a^*
(Futures fair value based on stock ask quote)

	N	Mean	Std Dev	Min	Med	Max	% of times that Fut Ask > Fair Ask
Panel 2a							
Overall	200299	0.00140 (<.0001) #	0.00612	-0.04404	0.00009	0.15145	51.23%
Panel 2b							
	Mean	0.0023	0.0053	-0.0178	0.0018	0.0532	0.5557
	Std Dev	0.0042	0.0025	0.0087	0.0040	0.0332	0.2358
	Min	-0.0022	0.0017	-0.0440	-0.0024	0.0079	0.1219
	Med	0.0011	0.0049	-0.0154	0.0007	0.0466	0.5728
	Max	0.0154	0.0117	-0.0086	0.0140	0.1514	0.9709

Note: $F_b^* = (S^b - D)(1+\frac{r}{365})^{T-t} - C_1$

$$F_a^* = (S^a - D)(1+\frac{r}{365})^{T-t} + C_1$$

C_1 = Stock Trading Cost (Round-trip) - Futures Trading Cost (Round-trip)

Panel 1a and 2a show the overall results for the entire sample of 28 stock futures and their underlying stocks.
Panel 1b and 2b provide summary statistics of the corresponding statistics for the 28 different stocks.
The number in parentheses denote the *p*-value of a *t*-test on the null hypothesis that the mean is equal to zero.

Table 6
Summary Statistics of Difference between Futures Quotes and Fair Value at Non-Member Cost

Panel 1: (Best bid futures quote F_b – Futures fair value F_b^*) / Futures fair value F_b^*
(Futures fair value based on stock bid quote)

	N	Mean	Std Dev	Min	Med	Max	% of times that Fair Bid > Fut Bid
Panel 1a							
Overall	199280	0.00405 (<.0001) #	0.00883	-0.38965	0.00434	0.10991	16.38%
Panel 1b							
	Mean	0.0045	0.0068	-0.0610	0.0054	0.0334	0.1852
	Std Dev	0.0050	0.0064	0.0941	0.0058	0.0251	0.1904
	Min	-0.0084	0.0024	-0.3896	-0.0067	0.0124	0.0035
	Med	0.0039	0.0050	-0.0323	0.0047	0.0256	0.1143
	Max	0.0194	0.0373	-0.0097	0.0219	0.1099	0.7463

Panel 2: (Best ask futures quote F_a – Futures fair value F_a^*) / Futures fair value F_a^*
(Futures fair value based on stock ask quote)

	N	Mean	Std Dev	Min	Med	Max	% of times that Fut Ask > Fair Ask
Panel 2a							
Overall	200299	-0.00384 (<.0001) #	0.00897	-0.09311	-0.00447	0.14134	17.09%
Panel 2b							
	Mean	-0.0041	0.0074	-0.0267	-0.0053	0.0499	0.1996
	Std Dev	0.0049	0.0068	0.0193	0.0059	0.0329	0.2002
	Min	-0.0164	0.0028	-0.0931	-0.0229	0.0116	0.0169
	Med	-0.0038	0.0057	-0.0204	-0.0045	0.0427	0.1145
	Max	0.0091	0.0399	-0.0127	0.0067	0.1413	0.7728

Note: $F_b^* = (S^b - D)(1+\frac{r}{365})^{T-t} - C_1$

$$F_a^* = (S^a - D)(1+\frac{r}{365})^{T-t} + C_1$$

C_1 = Stock Trading Cost (Round-trip) - Futures Trading Cost (Round-trip)
Panel 1a and 2a show the overall results for the entire sample of 28 stock futures and their underlying stocks.
Panel 1b and 2b provide summary statistics of the corresponding statistics for the 28 different stocks.
The numbers in parentheses denote the *p*-value of a *t*-test on the null hypothesis that the mean is equal to zero.

Table 7
Summary Statistics for Pricing Error (in percentage)

Code	Error	N	n	Mean	Std Dev	Min	Med	Max	% of times that Mispricing Occur
Zero Cost									
Overall	e+	558513	16431	0.00718 (<.0001)	0.00936	0.00000	0.00417	0.14399	2.94%
	e-		18875	0.00672 (<.0001)	0.00811	0.00000	0.00394	0.06006	3.38%
	e		35306	-0.00025 (<.0001)	0.01114	0.06006	-0.00028	0.14399	6.32%
	|e|		35306	0.00693 (<.0001)	0.00872	0.00000	0.00406	0.14399	6.32%
Member Cost									
Overall	e+	558513	8605	0.00822 (<.0001)	0.01047	0.00000	0.00474	0.13998	1.54%
	e-		9701	0.00783 (<.0001)	0.00862	0.00000	0.00499	0.05573	1.74%
	e		18306	-0.00029 (0.0017)	0.01245	-0.05573	-0.00037	0.13998	3.28%
	|e|		18306	0.00801 (<.0001)	0.00954	0.00000	0.00488	0.13998	3.28%
Non-Member Cost									
Overall	e+	558513	3135	0.00990 (<.0001) #	0.01169	0.00004	0.00586	0.13322	0.56%
	e-		3578	0.00861 (<.0001)	0.00898	0.00001	0.00541	0.04827	0.64%
	e		6713	0.00004 (0.8346)	0.01386	-0.04827	-0.00045	0.13322	1.20%
	|e|		6713	0.00921 (<.0001)	0.01036	0.00001	0.00562	0.13322	1.20%

Note:

$$e^{+} = \frac{F^{b} - F^{U}\left(S^{a}\right)}{F^{U}\left(S^{a}\right)};\ F^{b} > F^{U} \text{ and } e^{-} = \frac{F^{L}\left(S^{b}\right) - F^{a}}{F^{L}\left(S^{b}\right)};\ F^{a} < F^{L}$$

$$F^{U} = (S^{a} - D)(1 + \frac{r}{365})^{T-t} + C_{2} \text{ and } F^{L} = (S^{b} - D)(1 + \frac{r}{365})^{T-t} - C_{2}$$

C_2 = Total round trip cost for establishing and closing of an arbitrage portfolio

e^{+} and e^{-} represent over and under-pricing of the futures contract relative to the upper and lower no-arbitrage bounds. Observations falling outside the two categories are discarded from the analysis. The absolute value of the error |*e*| ignores the sign of the error and reveals the absolute magnitude of the mispricing. To check the average of the mispricings we preserve the (negative) sign of to determine whether, on average, the futures are under or overpriced. The distribution of *e* shows how the errors are distributed around the no-arbitrage band. If the mean of e is negative, on average, the futures are underpriced.
All numbers in parentheses denote the *p*-value of a *t*-test on the null hypothesis that the mean is equal to zero.

Table 8
Common Factor Coefficients and Information Shares

	Futures	Stocks
Panel A: Gonzalo-Granger Common Factor Coefficients[a]		
Mean	0.334	0.666
Std Dev	0.106	0.106
Min	0.168	0.447
Med	0.313	0.687
Max	0.553	0.832
Panel B: Hasbrouck Information Shares[b]		
Mean	0.370	0.630
Std Dev	0.044	0.044
Min	0.544	0.544
Med	0.636	0.636
Max	0.707	0.553

This table reports the common factor coefficients of Gonzalo and Granger (1995) and the information shares of Hasbrouck (1995) of the SSFs and the underlying stocks. Minute-by-minute midquotes of the nearby futures contracts and the stocks are used. The midquote is the average of the bid and ask prices.

[a]The common factor coefficients are tested against the null hypothesis of zero using the Gonzalo-Granger Q-statistic, which is distributed as $\chi^2(1)$. The coefficients of the SSFs and stocks are both significant with p-values < 0.001.

[b]The information share is the average of the lower and upper bounds of the information shares.