Migration of Trading and the Introduction of Single Stock Futures on the Underlying U.S. Stocks*

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Abstract

This study investigates where liquidity and informed trading takes place following the introduction of single stock futures (SSF) contracts on the OneChicago futures exchange. Specifically, we analyze the size and composition of proportional spreads for two sets of stocks, those that have single stock futures contracts and a matched control sample that does not have such contracts. We find that, after controlling for changes in spread determinants, the average proportional spreads, on average, decrease significantly after SSF are introduced. For NYSE stocks, while the average daily trading volume in the cash market is reduced by 389,000 shares, we find a corresponding increase in the average percentage of the adverse selection component in the spread of the cash asset. This pattern indicates a migration of liquidity trading to the SSF market as fund managers appear to adjust their portfolio positions in the secondary SSF market rather than in the primary stock market.

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I. Introduction

For regulators it is important to know where liquidity and informed traders execute their transactions to improve regulation of financial markets in general and of primary and derivate markets in particular. Our aim is to investigate whether the introduction of SSF contracts on individual stocks in the U.S. securities market has had an impact on liquidity and where informed trading takes place. Our investigation is motivated by the recent introduction and increasing volume turnover in SSF contracts and the increasing number of SSF contracts listed on the OneChicago futures exchange, which is a joint venture of the Chicago Board Options Exchange (CBOE), the CME Group (CME) and the Interactive Brokers (IB) Exchange Corporation.

Our analysis is based on a sample of 199 SSF listed stocks. We carefully construct a matched sample of non-SSF listed stocks based on Huang-Stoll (1996) matching score approach. Our empirical analysis is divided into three parts. First, similar to Jegadeesh and Subrahmanyam (1993), we analyze the behavior of bid-ask spreads because spreads are a major component of the costs of trading in capital market transactions, a widely used indicator of market quality and liquidity. We use univariate tests to examine the average daily proportional spreads, the average daily trading and the average daily return variance pre and post the introduction of SSF contracts. The results show that the proportional bid-ask spread for both SSF and the matched sample of non-SSF stocks decreases significantly. We also find that for SSF stocks the average daily trading volume decreases significantly whereas for the matched non-SSF stocks we find no evidence of a significant change.

Second, we perform a multivariate pooled cross-sectional analysis with the proportional spread as dependent variable and a dummy variable to indicate pre- and post-SSF trading periods. After controlling various determinants of spread, our results indicate that for NASDAQ stocks, the average proportional spreads for the underlying SSF stocks are reduced by approximately 22.6%, which is economically significant, while for NYSE stocks, we do not find any corresponding reduction in spread.

Finally, we extend the analysis to investigate whether the reduction in average daily trading volume can be explained by migration of informed or liquidity traders. We measure the migration of trading by estimating the percentage of the asymmetric information cost component of the bid-ask spread based on an improved version of the Huang and Stoll (1997) model. Our results suggest that liquidity rather than informed traders migrate from the primary stock market to the secondary SSF market. However, since only 5% of reduction in the trading volume of the stock market is explained by the introduction of the SSF market, we conjecture that some day traders leave the market as the market becomes more transparent and efficient when single stock futures are introduced.

Our study contributes to the existing line of research that focuses on the effects of futures trading on the market quality of the underlying asset (Jegadeesh and Subrahmanyam, 1993; Hegde and McDermott, 2004; Ang and Cheng, 2005a, 2005b; Chau, Holmes and Paudyal, 2008; Shastri, Thirumalai and Zutter, 2008). In contrast to two closely related studies on SSF contracts, Ang and Cheng (2005b) and Shastri et al (2008), we study the research problem with a different angle. Ang and Cheng (2005b) and Shastri et al (2008) investigate, respectively, the impact of SSF trading on the market efficiency of the underlying stocks (e.g. volatility) and the extent to which price discovery occurs in the futures market. Our paper examines the change in liquidity and migration of informed trading. While both volatility and liquidity are valid measures to make inferences about the degree to which SSF trading contributes to underlying asset market efficiency, our study focuses on liquidity and informed trading primarily because the emergence of futures trading influences the trading strategies and behavior of traders, portfolio managers, hedgers, arbitrageurs and speculators, alike, which in turn will be reflected in the bid-ask spreads. This study also extends the previous literature by examining to what degree the attributes of stocks have an important bearing on the stock's liquidity.

Our study is related to research concerned with identifying where and how informed trading takes place. Since informed traders can trade either in the cash or the derivatives market, the derivatives market might be more attractive due to lower commission, greater financial leverage and the ability of avoiding the short-sale constraints on stocks. Arguably, the cash market might be preferred if the derivatives market is illiquid and attracts a high transaction costs. Existing empirical studies have shown that informed trading is more likely to take place in futures markets than in cash markets because the former has lower trading costs.[1]

The remainder of this paper is structured as follows. Section II presents an overview of institutional features of SSF contracts. Section III provides a review of the relevant literature and discusses the hypotheses tested. Section IV describes the empirical methodology and the dataset. Section V presents and discusses our empirical results and analysis of the changes in spread. Section VI concludes the paper.

[1] For example, Fleming, Ostdiek and Whaley (1996) examine the price discovery process in the S&P 500 index futures, index options and the stock index. They find that futures tend to lead both stock and options market since trading futures is far less costly than trading an equivalent stock portfolio or index option.

II. Background of Single Stock Futures Contract

A. Development and Liquidity of Single-Stock Futures Contracts

For over a decade, SSF contracts have been traded on several exchanges around the world including the London International Financial Futures and Options Exchange (LIFFE) in Europe, the Sydney Futures Exchange (SFE) in Australia, the Hong Kong Exchange and Clearing Ltd (HKEX) in Hong Kong and others. In late 2000, U.S. Congress passed legislation to lift the 20-year ban on trading of SSF. As a consequence OneChicago and the NASDAQ/LIFFE (NQLX) exchanges started trading SSF on November 8, 2002. The two exchanges developed differently. NQLX, which used a market maker system, ceased operation in December 2004. In contrast, OneChicago, which uses a lead market maker (LMM) system, was more successful and steadily increased the number of listed stocks to 491 by December 2007 and has become the dominant market for SSF contracts on U.S. stocks. Each SSF contract is written on 100 underlying shares and the contracts follow the quarterly expiry cycle of March, June, September and December.

[Insert Figure 1 here]

Figure 1 shows that SSF have quickly gained popularity. The liquidity of SSF has increased significantly since their introduction and continues to increase as contracts on more stocks are introduced. The increase in the number of stocks on which contracts are listed might initially be explained by the intense competition between OneChicago and NQLX in order to become the dominant SSF exchange. The total average daily trading volume for all SSF contracts on OneChicago has steadily increased and stands at 32,166 contracts in 2007, with futures on stocks of General Electric, AT&T, Johnson & Johnson, Apple Computer and Kraft being the most actively traded in December 2007. The trading volume peaks on contract expiry months. These months are also the expiration months of the S&P 500 index futures contracts as well as other equity option contracts. This evidence is therefore consistent with our conjecture that market participants actively use SSF contracts for investing and hedging purposes due to the advantages offered by SSF. For this reason, it is expected that this market activity will have a considerable impact on the liquidity of the underlying stocks.

B. Advantages and Disadvantages of Single Stock Futures Contracts

In 2002, a panel of finance experts[2] highlighted that SSF could enhance the welfare of investors and lower the costs of trading in several ways. First, SSF provide opportunities to substantially leverage individual stock transactions through lower margin requirements of 20% of the position's total value compared to the margin requirement of 50% in the cash market. As an inexpensive alternative to an outright stock transaction, SSF reduce capital constraint problems. Second, SSF enable investors to avoid short-sale restrictions and costly regulations that are imposed on the cash market. Investors are better off because they can sell short on a downtick (no up-tick rule) in the futures market[3] and there is no restriction on the number of futures contracts that can be shorted. New information would be readily reflected in the futures prices and improves the price discovery process.[4] Third, SSF are also a less costly alternative for investors to hedge stock options positions or underlying equity positions against short-term adverse price movements. They enable investors to create cost-effective hedging strategies and significantly reduce trading expenses, timing risk and basis risk that arise from simultaneously entering multiple markets to hedge.

[2] University of Chicago's VSB Finance Roundtable 26th September 2002.
[3] The SEC has eliminated the uptick rule on July 6, 2007 and there is an ongoing discussion about a reintroduction of the rule.
[4] Shastri et al (2008) find support for the argument that the price discovery process of the underlying stocks improves significantly after the introduction of SSF contracts on OneChicago.

However, the introduction of SSF may affect the liquidity of the underlying stocks and thus influence the portfolio choice of institutions and hedge fund managers. In addition, SSF are also a hedging vehicle for broad-based index investments or fund holdings because they are designed to separate a stock's specific risk from the overall markets risk. As such, fund managers can use SSF to remove the exposure to the undesirable downside risk of certain stocks which are the constituents of an existing index or fund investment.

The debate of whether SSF improve market efficiency remains unsolved. On one hand, Ang and Cheng (2005b) show that SSF trading increases market efficiency. Using a news event approach they find that the number of unexplained large stock returns decreases for firms after SSF are introduced and is smaller in comparison to firms without SSF. This reduction also increases with the level of trading of SSF. On the other hand, McBride Johnson (2005) argues "that stock futures, […], may simply be a failed product" or put differently, that SSF might just be a redundant innovation. Their view is supported by the initially low level of contract trading volume. With the benefit of hindsight this pronouncement may have been premature as shown by the strongly growing trading volume of SSF after 2004 in Figure 1. In summary, the overall demand for SSF is expected to change the liquidity in both the futures and the underlying spot market. This may subsequently affect the degree to which SSF contribute to price discovery and hence market efficiency.

III. Theory and Hypotheses

A. Migration of Trading

The Shad-Johnson Accord prohibited the trading of SSF in the U.S. financial markets. Both theoretical and empirical studies that analyzed the effect of introducing futures contracts focused on investigating futures contracts that are linked to a basket of securities or an index.

Information asymmetry costs and inventory carrying costs are expected to play a major role in explaining the variation in the spreads of the underlying stocks following the introduction of futures contracts. Some authors (Gorton and Pennacchi (1991); and Subrahmanyam (1991)) claim that markets in stock index futures are more attractive for uninformed traders with well-diversified portfolios because the degree of asymmetric information in futures markets is significantly lower than in markets for individual stocks. Therefore, informed traders who possess security-specific information will trade in individual stock markets, while uninformed traders will trade in index futures markets in order to reduce the adverse selection costs. If uninformed traders shift to lower-cost markets following the introduction of index futures markets, the spreads of the underlying stocks are expected to widen because there is a greater proportion of informed traders in the underlying stock market. Market makers therefore require to be compensated for bearing the risk of dealing with informed traders through a wider spread. On the one hand, if index futures markets provide market makers with lower opportunity costs for hedging their inventory risk, the spreads of the underlying stocks could be expected to narrow. Gorton, Pennacchi and Subrahmanyam predict that if uninformed traders do indeed shift to lower-cost futures markets, the liquidity of the underlying stocks may worsen. As such, they predict that the bid-ask spreads of the underlying stocks should subsequently increase because there is a greater proportion of informed traders in the stock market. On the other hand, Silber (1985) predicts that the spreads in the stock market should decrease, as market makers can hedge their inventory risk at a lower cost. Under this hypothesis, market makers are able to execute stock transactions more aggressively without being too concerned about the balance of their inventory level because there are no short-sale constraints and the margin requirement is lower in the futures market.

Empirical studies investigating the behavior of spreads following the introduction of index futures contracts offer mixed results. Jegadeesh and Subrahmanyam (1993) show that, after controlling for three determinants of spread (price level, return variance and trading volume), the average proportional spread increases significantly for the S&P 500 index stocks and marginally for the non-S&P 500 index stocks following the introduction of the index futures contracts. They interpret this finding as evidence that uninformed traders migrate to futures markets after the advent of index futures contracts rather than the alternate explanation that trading of index futures contracts allows specialists to better hedge their inventory risk. In contrast, Hegde and McDermott (2004) show that while the liquidity of the Dow Jones Industrial Average (DJIA) 30 stocks appears to increase after the introduction of the DIAMONDS futures contract as both the quoted and effective spreads decrease significantly, both standardized volume and depth also decrease significantly. After controlling for changes in price level, trading volume and return volatility, they show that the market liquidity of the stocks included in the DJIA 30 index significantly improves following the introduction of the exchange-traded funds. They interpret this finding as a result of a reduction in the asymmetric information costs of trading.

In the presence of asymmetric information, one possible strategy for the informed trader is to execute trades indirectly in the SSF market rather than the cash market for cost reasons. Therefore, we would expect some informed traders to migrate to the SSF market to utilize their informational advantage. This argument leads to our first hypothesis:

H_1: The introduction of SSF contracts on the underlying stocks results in a migration of informed trading from the primary stock market to the secondary SSF market.

Trading not only takes place for information-based reasons. For example, fund managers have to adjust their holdings in certain positions because their retail clients decide to change their investment strategy or because clients enter or exit a fund. To change portfolio holdings quickly and cost-effectively fund managers could use derivative securities. Traditionally, the options market would have been the only derivative market that allowed for the direct adjustments of holdings in a specific security. However, the cost of this strategy is not low and also suffers from the low levels of liquidity of many of these option contracts. Index managers are in a better position because they can also trade in the index futures contract. Although this is a cost-effective strategy, the size of the contract might be a problem. In contrast, the creation of the SSF market allows fund managers to execute liquidity-motivated trades directly in the futures contract, which underlies a specific stock. This has the advantage that the cost of such a transaction is substantially lower and that both long and short orders are easily executed. This leads to the second hypothesis:

H_2: The introduction of SSF contracts on the underlying stocks results in a migration of liquidity trading from the primary stock market to the secondary SSF market.

IV. Data and Research Method

A. Description of Data

Our univariate and multivariate analyses use daily data from the beginning of July 2002 to the end of 2006. Due to data limitations, our spread decomposition analysis uses intraday TAQ data with a shorter sample period, which spans from the beginning of July 2002 to the end of 2004. During the sample period from the beginning of July 2002 to the end of 2006, 231 firms were listed for SSF trading. Due to data limitations, 32 firms were removed from the sample.[5] This left us with a sample of 199 firms, consisting of 152 firms trading on the NYSE and 47 firms trading on NASDAQ. The information on trading dates, open interest and trading volume for each SSF contract trading on OneChicago were collected from the OneChicago and the Securities Industry Research Centre of Asia-Pacific (SIRCA).

To generate the control variables, we collect stock returns, trading volume, and closing price for each stock from the Center for Research in Security Prices (CRSP) database. Finally, closing bid-ask prices for each stock and intraday quote and transaction data are obtained from the TAQ database.

A list with an equal number of matching non-SSF traded stocks is created from S&P 500 index stocks because most of the SSF stocks are constituents of the S&P 500 index. To select a set of matching non-SSF traded stocks, we employ the following criteria. First, we compile a list of matching candidate firms that belong to the same industry sector as each SSF-listed firm using the 2-digit Global Industry Classification Standard (GICS) code. Second, the candidate firms must be traded on

[5] Due to misreported bid-ask spread, mismatched CRSP EX and SIC codes and missing information on the SSF listing date. Furthermore, two stocks were removed (Google and Dreamworks Animation SKG Inc.) as their corresponding SSF contracts began trading shortly after the IPO leaving an insufficient pre-event sample period to construct the event study.

the same exchange (NYSE or NASDAQ) as the SSF-listed firm.[6] Then, based on the list, we compute the following matching score for each matching candidate firm:

$$\sum_{j=1}^{3}\left(\frac{y_j^{SSF}-y_j^{NSSF}}{(y_j^{SSF}-y_j^{NSSF})/2}\right)^2$$

where y_j is the matching variable. Three matching variables were used to generate the score: the average daily trading volume, the average daily proportional bid-ask spread, and the firm size (an average of the daily market capitalization) based on the six month period prior to the SSF introduction. For each SSF-listed stock, we select the matching non-SSF-listed stock with the lowest matching score.[7]

B. Research Methodology

We consider the introduction of the SSF contract as an event. An estimation period of six-month pre (-131; -6) and six-month post (+6; +131) the SSF introduction is adopted with an excluded 10-day period around the event (-5, +5). We expect migration of informed trading beginning within a few days as the underlying stocks are actively traded stocks. Excluding the ten trading days around the SSF introduction is considered appropriate because futures contracts on some stocks only started trading a few days after they were listed.

The empirical analysis is divided into three parts. First, we perform a univariate analysis to examine the change in the mean percentage spreads in the pre and post futures period for the underlying SSF-listed stocks and matching non-SSF listed stocks. Second, we pool our sample into a cross-sectional time-series panel and

[6] In addition, all candidate matching firms must have at least 100 valid observations in a six month sample. We remove candidate matching firms with missing bid and ask quotes, that have declared bankruptcy or are delisted through our sample period (6 months prior and 6 months after initiation of SSF trading).

[7] We have also considered other matching variables such as firm size and volume turnover and we obtain a similar set of matching firms without SSF.

examine the change in spread after controlling for trading characteristics: namely, the price level, trading volume and return variance. A dummy variable is included in order to detect the change in the average daily proportional spread as a result of the trading of the SSF.

(1) $$LNSPRD_{it} = a_0 + a_1 LNPRC_{it} + a_2 LNVOL_{it} + a_3 LNVAR_{it} + bDSSF_i + e_{it}$$

where i = 1, …, 199 denotes the stocks and t = 0 the pre-SSF period and t = 1 the post-SSF period. $LNSPRD_{it}$, $LNPRC_{it}$, $LNVOL_{it}$ and $LNVAR_{it}$ are the natural logarithms of the average daily proportional spread, average daily closing price level, average daily volume and average daily return variance, respectively for security i in period t. The $DSSF_i$ dummy equals 0 in the pre-SSF period, and 1 in the post-SSF period. The model in equation (1) utilizes Stoll's (1978) result that price, volume and return volatility explain a large proportion of cross-sectional and time-series variations in the bid-ask spread. We do not consider the effective spread measure because it fails to capture how the spread changes when the daily closing price is used. Price level is defined as the average of the quoted bid and ask prices. Price has a negative influence on depth, which is in turn negatively related to spreads.[8] More intuitively, price is negatively related to the proportional spread. Volume is the total number of shares traded during a day in the pre- and post-SSF periods. Theoretically and empirically, trading volume increases with depth and hence reduces spreads because high volume implies market makers have more flexibility to offset inventory imbalances. Return variance is measured by using individual daily returns in the pre- and post-SSF periods. Microstructure studies indicate that large return volatility causes higher spreads because of high inventory and adverse selection risk. Therefore,

[8] To a certain extent, relative spread controls, in part, the impact of the price level. The remaining effect is due to minimum price variation and discreteness of the quoted bid-ask spread. Harris (1994) highlights the natural presence of negative correlation between relative spread and stock price due to this market friction.

the spreads need to be larger so that market makers can be compensated for the risks incurred by providing liquidity to the market. The dummy variable *DSSF* captures the change in the average spread as a result of the trading of SSF.

The model (1) is similar to Jegadeesh and Subrahmanyam (1993) except daily data is used to compute the average values. Natural logarithm transformations are used for all variables except the dummy. After controlling for the determinants of the spread, we expect that any residual variation between the pre and the post futures trading periods can be attributed to the introduction of the SSF contracts.

Finally, we use Huang and Stoll's (1997) spread decomposition model (HS) with the corrections proposed by Henker and Wang (2006) to estimate the change of the asymmetric information parameter for the NYSE listed stocks in our sample. A significant reduction of this parameter would imply a migration of informed trading to the SSF market supporting H_1. NASDAQ listed stocks are excluded from this analysis because NASDAQ does not have monopolistic market makers. A spread cost component analysis based on inside quotes from a group of heterogeneous broker-dealers would lead to spurious results if applied to a trade indicator spread cost decomposition model that assumes the presence of a monopolistic market maker. These broker-dealers adjust their quotes depending on order flow and their individual firm's stock inventory levels and not the aggregate inventory level of all market makers. This gives us a total of 76 NYSE-listed stocks in the sample.[9] HS's spread decomposition model is used because it measures the level of asymmetric information as a percentage of the spread and thus its value is not affected by the declining spread

[9] All trades labeled as errors or out-of-order and all trades with non-standard settlement arrangements are excluded. We also exclude non-firm quotes and quotes with an associated depth of zero. A further price reversal filter captures rare recording errors.

over our sample period.[10] HS's spread decomposition model is based on the induced serial correlation in trade flows:

$$E(x_{t-1} \mid x_{t-2}) = (1 - 2\pi)x_{t-2} \quad (2)$$

where x_t is the trade indicator variable and π is the probability of a trade reversal. Given (2), the change in the quote midpoint, ΔM_t, is modeled with the average spread specification of the model proposed by Henker and Wang (2006) as

$$\Delta M_t = (\alpha + \beta)\frac{\bar{S}}{2}x_{t-1} - \alpha(1-2\pi)\frac{\bar{S}}{2}x_{t-2} + \varepsilon_t \quad (3)$$

$\bar{S}$ is the average spread from the relevant sample period (pre-SSF versus post-SSF). α is the percentage adverse selection cost component of the spread. β is the percentage inventory holding cost component of the spread. Henker and Wang (2006) show that the constant average spread specification of the model in equation (3) is free from the biases inherent in the original specification of the model with time varying spreads. We use GMM with two moment conditions based on the normalizing equations from (2) and (3). With three parameters to be estimated, the model is exactly identified.

V. Results and Discussion

A. Univariate Analysis

Panel A in Table 1 presents the summary statistics of the average daily proportional spreads, trading volume and return variances of SSF stocks and matching non-SSF stocks prior to and after the SSF introduction.

[Insert Table 1 here]

[10] Other models such as Madhavan, Richardson and Roomans (1997) model the level of asymmetric information based on the permanent price impact of the order flow innovation. With spread decreasing over time, a reduction in price impact is inadequate to conclude that informed traders migrate to the futures market.

The combined and the corresponding subsamples all exhibit some positive skewness in the cross-sectional daily proportional spreads because the means exceed the medians. Note that the decreases in the average proportional spreads are statistically significant. Without controlling for any factors, the average daily proportional spread for the combined sample of all SSF and matching non-SSF stocks, on average, is lower in the post-SSF period than in the pre-SSF period. The average proportional spread for the combined cross-section of stocks decreases by 24.2% using mean values and by 8.1% using median values. When we separate SSF and matching non-SSF stocks, we observe that the reduction in spread is larger for SSF stocks with a decrease of 27.9% versus 20.8% for the matching non-SSF stocks. Using median values instead we do not observe any change for the matching non-SSF stocks but a 5.6% decrease in proportional spreads for the sample of SSF stocks. The results of our preliminary test are different from those of Jegadeesh and Subrahmanyam (1993) who examined a period with minimum price increments of 1/8 compared to 1/100 of a dollar for our sample. They find that, without controlling for any determinants of bid-ask spreads, the quoted proportional spreads of stocks in the subsequent 6 months is higher than that in the 6 months preceding the introduction of the S&P 500 index futures.

To gain further insights into the difference in the shift in average proportional spreads between the SSF stocks listed on the NYSE and those listed on NASDAQ, the same univariate tests were applied to these two groups of stocks. Our motivation is based on Affleck-Graves, Hedge and Miller (1994) who suggest that while the trading structures have a significant effect on the adverse selection costs, the differences in the characteristics of firms listed on each market have also a significant impact on the inventory cost component.[11] This test is important because it provides an insight into how institutions with different trading mechanisms affect the transmission of information and hence, affects agents' abilities to learn private information subsequent to the trading of SSF.

The results in Panel B of Table 1 indicate that the spreads of the SSF stocks listed on NASDAQ in both sub-periods are generally lower than those of the SSF stocks listed on the NYSE. These results hold for both mean and median values and are inconsistent with prior findings. However, a possible explanation for this finding is that we only investigate relatively small sub-samples of shares listed on the NYSE or NASDAQ. This could particularly affect the results for the forty-seven NASDAQ listed SSF stocks, since most of these stocks are large and very liquid. Note, however, that the differences in medians between these two sub-samples are relatively small. The results from the difference in means tests show that the proportional spreads for the NYSE and NASDAQ stocks are significantly lower in the post-SSF trading period.

Although the preliminary tests generally indicate that the average spread is lower in the post-SSF trading period, it would be premature to draw the conclusion that the introduction of the SSF causes the narrowing of the bid-ask spreads from these results. Benston and Hagerman (1974), and Stoll (1978) have shown that the changes in return volatility, volume and price are all determinants of the bid-ask spread. Hence, any residual variation in the spreads should only be attributed to the introduction of the SSF market after controlling for these factors.

[11] Our investigation also adds empirical evidence to studies (such as Huang and Stoll (1996), Affleck-Graves, Hedge and Miller (1994) that focus on the difference in the adverse selection costs between the two exchanges, in that the introduction of SSF adds a novel change in the market environment which affects spreads and spread cost components.

We continue the univariate analysis by investigating pre- and post-SSF statistics for changes in the average daily trading volume, and the average daily return variance. We omit price for two reasons. As discussed in Jegadeesh and Subrahmanyam (1993), there is no reason to believe that the introduction of SSF will have an impact on the stock price levels. Stock prices should reflect the expected future benefits of stocks. Second, during the period of investigation stock prices generally increased due to the recovery of the U.S. economy after the technology bubble had burst and the financial market instability after the September 2001 attacks.

For the average daily trading volume, we find that the average daily trading volume decreases significantly for the SSF stocks. We observe a smaller statistically insignificant decrease in the average daily trading volume for the matching non-SSF stocks. In panel B of Table 1 we report the results for the NYSE-listed and NASDAQ-listed stocks. The results show that the trading volume for NASDAQ-listed stocks decreases more than for NYSE-listed stocks. Our results are consistent with the theoretical predictions of Gorton and Pennacchi (1991), and Subrahmanyam (1991). They predict that trading volume in the underlying stocks and other stocks decreases following the introduction of stock index futures. They claim that this is the result of the migration of uninformed traders to the futures market and the substitutability between the use of the cash and futures markets when forming diversified portfolios.

For the average daily return variance for the combined, SSF and matching non-SSF stock samples, we find that the average daily return variance decreases for all three samples and the corresponding differences in means tests are statistically significant. Our results are in line with Ang and Cheng (2005b) who find that the unexplained volatility of the underlying stocks decreases following the introduction of SSF. We also compare our results to results that are based on the introduction of futures contracts on a basket of securities, such as an index futures contract. Our results support Edwards's (1988) claim that the stock market volatility declined subsequent to the introduction of S&P 500 index futures contracts. However, our results are in contrast to Jegadeesh and Subrahmanyam (1993). They document an increase in the volatility of stocks post introduction of index futures trading, without controlling for any factors.

We further investigate the change in the average daily return variance by separating the sample into stocks listed on the NYSE and NASDAQ (Panel B). On a relative basis, the reduction in variance by 26.5% for NYSE listed SSF stocks is significantly larger than the reduction by 12.5% for the corresponding matching NYSE listed non-SSF stocks. However, for NASDAQ stocks the variance reduction of 51.2% is significantly larger for the matching non-SSF stocks than the reduction of 42.4% for the corresponding SSF stocks. The observed reduction in the variance implies a decrease in inventory risk, but the decrease in volume and the increase in price level produce a mixed effect on the fixed-cost component of the average spreads. The fall in volume increases the fixed-cost component while the increase in price level has the opposite effect.

B. Multivariate Analysis and Discussion of Results

1. Multivariate Analysis based on daily data

Table 2 presents the results of the regressions explaining the relation between the spread and the explanatory variables for the combined stocks, the SSF stocks and the matching non-SSF stocks including the dummy variable.[12] The *t*-statistics of all the

[12] Regression (1) was estimated separately for each sub-period in order to check for stability of slope coefficients. We found that the slope coefficient on volume significantly increased in magnitude and the slope coefficient on variance showed a slight increase in the post SSF period regression for the SSF stocks.

parameter estimates are computed using the White (1980) heteroskedasticity-consistent standard errors and covariance terms.[13]

[Insert Table 2 here]

The sign and magnitude of all the estimated slope coefficients in the regression are consistent with our expectations and the results in Stoll (1978), Jegadeesh and Subrahmanyam (1993), and Chordia, Roll and Subrahmanyam (2000). Also, the estimated slope coefficients on the price, volume and return variance do not change significantly. This suggests that the dummy variable explains the variation in spread between the pre- and post-SSF period.

Our results show that the average proportional spread for the combined non-SSF and SSF sample is significantly lower in the post-SSF trading period. The estimate for the slope coefficient on the dummy variable for the SSF stocks is -0.1458 which is significant at the 90% level. The estimated slope coefficient on the same dummy for the matching non-SSF stocks is insignificant with a *t*-statistic of 1.09. The magnitude of both estimated coefficients indicates that the decrease in the average proportional spread in the post-SSF trading period is significantly larger for the SSF stocks than for the matching non-SSF stocks. These findings therefore show that, after controlling for price, volume and return variance, the proportional spread decreased following the introduction of the SSF contracts. In comparison to the liquidity of the matching non-SSF stocks, the liquidity of the underlying SSF stocks is more strongly affected by the introduction of SSF trading.

We re-estimate model (1) after dividing the sample into NYSE-listed and NASDAQ-listed stocks. For NYSE stocks, the estimated coefficients of the dummy

[13] One notable concern in this analysis is potential measurement error in the proportional spread. Since the average of the proportional spreads over a 6-month period is used, any rounding error should be largely cancelled-out. Moreover, because the proportional spread is used in the regression as the dependent variable, the OLS estimates will be unbiased provided any measurement error is uncorrelated with the independent variables in the model.

variable *DSSF* are not significantly different from zero for both SSF and matching non-SSF stocks. Interestingly, for NASDAQ stocks, the estimated coefficient for SSF listed stocks is -0.2257 and it is strongly significant with a *t*-statistic of -3.43, while for matching non-SSF stocks, the coefficient is insignificantly different from zero. The point estimate of $DSSF_i$ in the regression for the SSF stocks listed on NASDAQ indicates that, after controlling for other factors, the average proportional spreads for the SSF stocks decreased on average by 22.6% subsequent to the introduction of SSF. This effect is stronger than the effect we estimated in the univariate analysis. It is also significantly higher than the estimated increase of 3% in spread reported in Jegadeesh and Subrahmanyam (1993) when they examine the effects of the introduction of S&P500 index futures on all of the index constituent stocks. In addition, it is important to note that, the change in the average proportional spreads in the pre- and post-SSF trading periods for the SSF stocks is not only statistically significant, it is also economically significant. Therefore, even though the underlying stocks are heavily traded stocks with high trading volumes and tight spreads, the decrease in the average proportional spread is substantial. For example, in the pre-SSF period, if a stock that was priced at $30 has a proportional spread of 0.5%, the spread related cost of purchasing 1,000 shares is $150. In the post-SSF period, all else constant, the cost of executing the same trade is $119.69. Thus, the decrease is about $30.31, which is a significant amount given the dollar size of the transaction costs.

Our results suggest that the introduction of SSF decrease spreads and thus increase the pricing efficiency for stocks listed on NASDAQ. This evidence on the liquidity of stocks is consistent with the finding of Ang and Cheng (2005b).

2. Migration of Informed and/or Liquidity Traders

Table 3 presents summary statistics of the GMM estimates of the adverse selection parameters, α, on our sub-sample of NYSE-listed stocks from the Huang and Stoll spread decomposition model with constant spread. The use of Henker and Wang's (2006) corrected specification significantly reduces the number of negative α estimates. After removing sample firms with negative α's (1 for the SSF sample and 7 for the matching non-SSF sample), the range of adverse selection cost estimates, α, is around 11-15% of the spread. When we compare both mean and median α estimates across the two sample periods, the adverse selection costs for SSF stocks increase while the corresponding costs for non-SSF stocks decrease.

[Insert Table 3 here]

Table 4 reports results of the mean equality test and the Wilcoxon non-parametric test to check if the change of the adverse selection parameter is statistically significant. Recall our hypothesis that a significant reduction (increase) of the adverse selection parameter implies a migration of informed (liquidity) trading to the SSF market. On average, the estimated α's for SSF stocks listed on the NYSE increased with the introduction of SSF contracts while the corresponding α's for non-SSF stocks decreased (possibly due to an overall increase in liquidity), despite the falling return variance in the corresponding period (see Table 1). We perform the *t*-test on the equality of means of the percentage change of α on our paired sample and we could not reject the null that the percentage change is the same for the two matched samples. Since most mean α's are consistently higher than their corresponding medians, which implies a positive skew to the distribution of α and may reject normality. Thus, for comparison purpose we perform Wilcoxon signed-ranks test statistic. Our result remains unchanged. Overall, we find strong evidence in support of H_2 for the migration of liquidity trading to the SSF market, as the increase in α coincides with a significant reduction in daily trading volume in the underlying stock (see Table 1).

[Insert Table 4 here]

3. Alternative Explanations

If in fact liquidity traders migrate to the SSF market, we would expect that there is some corresponding effect in the trading volumes in both SSF and underlying markets. Our earlier results in Table 1 show that for the SSF stocks average daily trading volumes have decreased significantly. On average, daily trading volume has decreased by approximately 389,000 shares, while the average number of contracts traded on OneChicago per day is 41 contracts over our sample period. Since each contract is written over 100 shares, and given the 20 per cent margin requirement on the SSF contracts, this accounts only for about 5.27 percent of the reported drop in the underlying market.

When a fund manager adjusts a stock position in her portfolio, she could do this by using a position that is just one fifth of the size of the required adjustment size she had to use when simply using stocks to do this. In other words, by making the adjustment using SSF contracts instead, she could increase her adjustment fivefold relative to a direct adjustment in the stock position. A major benefit of this approach is that it significantly reduces the capital costs of the required adjustment in the stock portfolio since only one fifth of the capital is needed to achieve the same level of exposure.

In summary, we see that the migration into the SSF market can only explain roughly 5 per cent of the drop in the daily trading volume of the underlying stock in the NYSE primary market, but it remains an open question what explains the remaining 95 per cent drop in volume. There are two possible explanations. A first explanation is that fund managers use a combination of SSF and option contracts to manage their portfolio and associated risk and return characteristics. A second explanation is that trading activity does not fully migrate from the primary to the secondary derivate market. Instead non-sophisticated traders such as day traders leave the market altogether because the introduction of SSF improves market transparency and efficiency. Day trading becomes less profitable as the market becomes more efficient. If this were the case, the introduction of SSF contracts should reduce the amount of day trading. Therefore, we speculate that the trading volume should decrease disproportionally compared to the trading volume in SSF contracts.

Table 4 presents the average daily trading volumes for the underlying stocks, the corresponding SSF and equity option contracts. Panel A presents the primary and secondary volume statistics for the NYSE-listed stocks. Neither of the mean difference tests for the options is statistically significant. However, both sign and magnitude of the option trading volumes are roughly in line with our expectations. Since each option contract is written on 100 shares the call and put option contract volumes correspond to 15,271 and 4,529 shares. Panel B present the same analysis for NASDAQ-listed stocks. The daily average put option volumes are similar whereas the daily average call option volumes increase by 1,494 contracts which correspond to 149,400 shares. Overall, these results provide little evidence of a migration of trading into the options market. Instead, the results suggest that either some traders trade less frequently or leave the market altogether because the market has become more efficient.

VI. Conclusion

This study examines which traders migrate from the primary to the futures market following the introduction of SSF contracts on the corresponding stocks in the underlying market. In our univariate analysis we find that the proportional bid-ask spreads for both SSF and the matched non-SSF stocks decrease considerably. We also find that for SSF stocks the average daily trading volume decreases significantly. For the matched non-SSF stocks we found no evidence of a significant change. The change in average daily return variance is similar for SSF and non-SSF stocks, but significantly stronger for stocks that are listed on NASDAQ than stocks that trade on the NYSE.

We continue the investigation by estimating a multivariate regression with the proportional spread as dependent variable and a dummy variable to indicate pre- and post-SSF trading periods. Our results indicate that for NASDAQ stocks, the difference between the average spreads for the underlying SSF stocks in the pre- and post-SSF trading periods is approximately 22.6%. This decrease is economically significant. However, we do not find a similar decrease in spread for NYSE stocks.

Finally, given the significant fall in trading volume for NYSE listed stocks after the introduction of the SSF contract, we investigate the migration of trading by employing Huang and Stoll's (1997) spread decomposition model. While our results support the hypothesis that liquidity traders migrate from the primary stock market to the secondary SSF market, the trading volume of the latter market explains only 5% of the reduction in the underlying market. We conjecture that the market becomes more transparent and efficient as day traders leave the market.

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FIGURE 1
Monthly volumes of all SSF trades on the OneChicago futures exchange

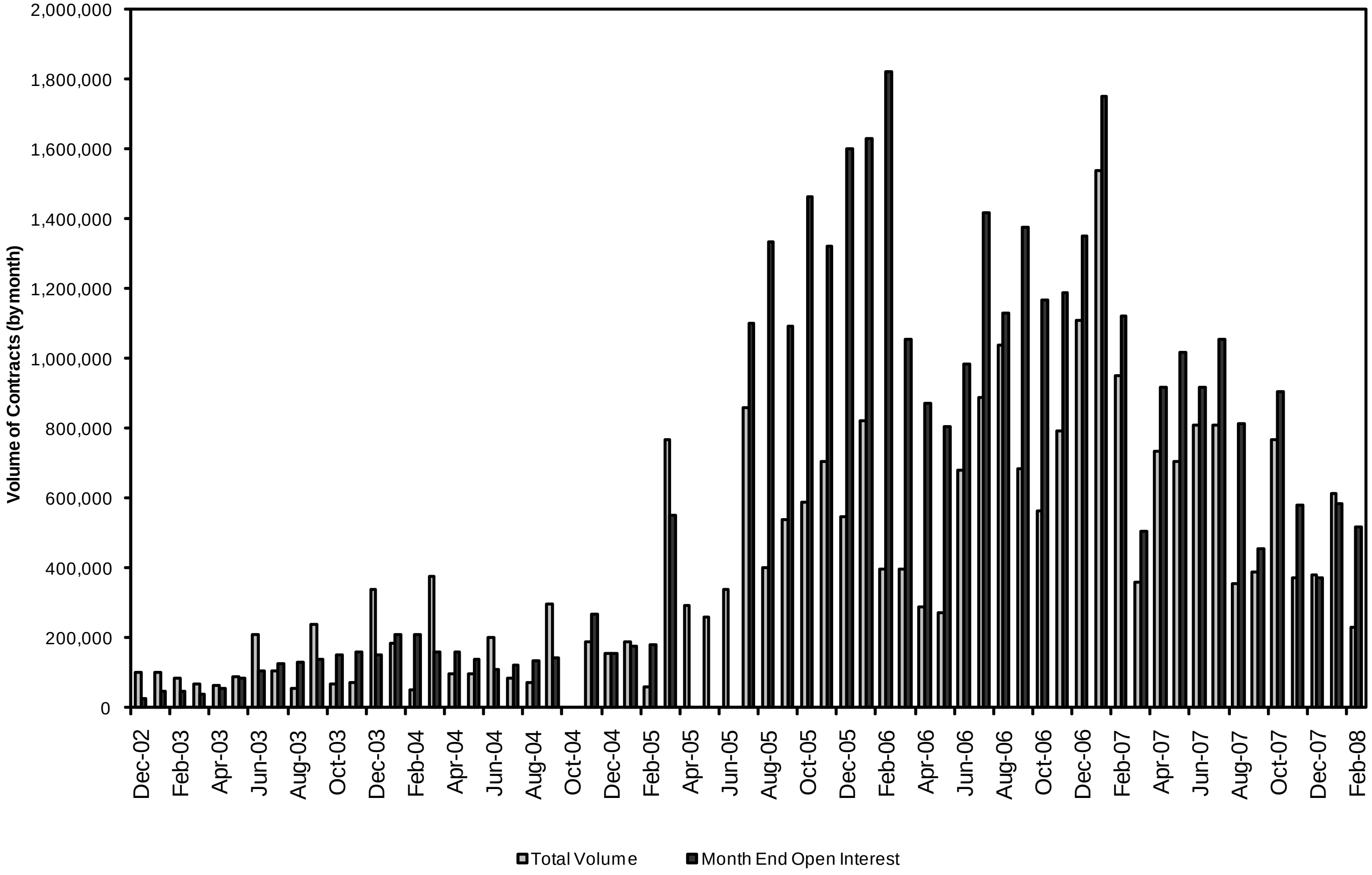

TABLE 1
Descriptive Statistics for SSF and Matching Non-SSF Stocks in the Pre- and Post-SSF Period

This table shows the descriptive statistics for SSF and matching non-SSF stocks in the pre- and post-SSF period at the aggregate and exchange level. [§]The combined stocks consist of 199 SSF stocks and 199 matching non-SSF stocks. [§§] The reported *t*-statistic is the *t*-test for equality of means in the pre- and post-SSF period.

Panel A. Descriptive statistics for combined stocks, SSF stocks and matching non-SSF stocks

		Proportional Spreads (in %)			Average Daily Trading Volume (million shares)			Average Daily Return Variance		
		Combined Stocks[§]	SSF Stocks	Matching non-SSF Stocks	Combined Stocks[§]	SSF Stocks	Matching non-SSF Stocks	Combined Stocks[§]	SSF Stocks	Matching non-SSF Stocks
Pre SSF	Mean	0.219	0.193	0.245	5.567	7.529	3.605	1.07×10^{-3}	9.63×10^{-4}	1.17×10^{-3}
	Median	0.099	0.089	0.105	2.774	3.805	2.328	5.51×10^{-4}	5.66×10^{-4}	5.47×10^{-4}
	SD	0.254	0.199	0.298	5.527	6.962	3.515	1.37×10^{-3}	1.18×10^{-3}	1.52×10^{-3}
Post SSF	Mean	0.166	0.139	0.194	5.180	6.832	3.529	7.20×10^{-4}	6.37×10^{-4}	8.03×10^{-4}
	Median	0.091	0.084	0.105	2.952	3.722	2.499	3.90×10^{-4}	3.28×10^{-4}	4.44×10^{-4}
	SD	0.180	0.129	0.216	5.151	6.376	3.462	1.07×10^{-3}	1.56×10^{-3}	9.76×10^{-4}
Mean difference		-0.053	-0.054	-0.052	-0.387	-0.697	-0.077	-3.46×10^{-4}	-3.3×10^{-4}	-3.66×10^{-4}
t-statistic[§§]		-8.925	-8.35	-5.18	-3.353	-3.351	-0.802	-4.926	-3.402	-3.556

Panel B. Descriptive statistics for NYSE-listed and NASDAQ-listed SSF and matching non-SSF stocks

		Proportional Spreads (in %)				Average Daily Trading Volume (million shares)				Average Daily Return Variance			
		NYSE		NASDAQ		NYSE		NASDAQ		NYSE		NASDAQ	
		SSF	Matching non-SSF	SSF	Matching non-SSF	SSF	Matching non-SSF	SSF	Matching non-SSF	SSF	Matching non-SSF	SSF	Matching non-SSF
Pre SSF	Mean	0.223	0.260	0.098	0.198	4.871	2.728	16.123	6.444	6.75×10^{-4}	7.86×10^{-4}	1.89×10^{-3}	2.41×10^{-3}
	Median	0.093	0.103	0.080	0.119	3.173	1.941	9.178	4.812	3.70×10^{-4}	3.67×10^{-4}	1.76×10^{-3}	2.45×10^{-3}
	SD	0.217	0.303	0.065	0.283	5.110	4.614	19.633	5.499	1.02×10^{-3}	1.22×10^{-3}	1.21×10^{-3}	1.76×10^{-3}
Post SSF	Mean	0.161	0.202	0.066	0.169	4.482	2.843	14.431	5.746	4.96×10^{-4}	6.88×10^{-4}	1.09×10^{-3}	1.17×10^{-3}
	Median	0.091	0.111	0.063	0.089	2.971	2.076	9.123	4.294	2.57×10^{-4}	3.03×10^{-4}	9.09×10^{-4}	9.83×10^{-4}
	SD	0.139	0.204	0.035	0.251	4.141	5.542	16.583	4.877	1.21×10^{-3}	9.96×10^{-4}	8.18×10^{-4}	8.12×10^{-4}
Mean difference		-0.061	-0.058	-0.032	-0.029	-0.389	0.115	-1.692	-0.697	-1.8×10^{-4}	-1.0×10^{-4}	-8.0×10^{-4}	$-1.23\times10-^{3}$
t-statistic[§§]		-7.441	-4.593	-5.288	-3.509	-2.595	1.217	-2.344	-2.833	-1.633	-0.927	-4.373	-5.348

TABLE 2
OLS Regression Results

This table estimates the following model: $LNSPRD_{it} = \alpha_0 + \alpha_1 LNPRC_{it} + \alpha_2 LNVOL_{it} + \alpha_3 LNVAR_{it} + \alpha_4 LNPRC_{it} + \alpha_5 DSSF_i + \varepsilon_{it}$, $i = 1, \ldots, N$ and $t = 0, 1$. $LNSPRD_{it}$ is the natural logarithm of the average daily proportional spread. $LNPRC_{it}$, $LNVOL_{it}$, and $LNVAR_{it}$ are the natural logarithms of the average daily quote midpoint, the average daily trading volume, and the daily return variance, respectively, for security *i* in the pre- and post-SSF periods. The dummy variable DSFF takes a value of 1 in the post-SSF period and 0 in the pre-SSF period. The *t*-statistics are reported in parentheses and computed using the White (1980) heteroskedasticity-consistent standard errors and covariance. ***, ** and * denotes, respectively, significance at the 1%, 5% and 10% level.

			NYSE		Nasdaq	
	SSF stocks	Matching non-SSF stocks	SSF stocks	Matching non-SSF stocks	SSF stocks	Matching non-SSF stocks
LNPRC	-0.3990	-0.3522	-0.3984	-0.3956	-0.7277	-0.5560
	(-5.56)***	(-7.29)***	(-6.33)***	(-7.18)***	(-13.98)***	(-14.98)***
LNVOL	-0.1148	-0.3172	-0.1259	-0.2622	-0.2914	-0.4191
	(-2.14)**	(-9.89)***	(-2.70)***	(-5.89)***	(-8.88)***	(-19.18)***
LNVAR	0.2437	0.3670	0.4325	0.5100	0.1414	0.3408
	(6.12)***	(10.05)***	(11.59)***	(13.24)***	(3.03)***	(7.82)***
DSSF	-0.1458	-0.0754	-0.0786	-0.0998	-0.2257	-0.0120
	(-1.95)*	(-1.09)	(-1.20)	(-1.30)	(-3.43) ***	(-0.19)
Constant	-1.6838	2.0947	-3.5497	2.7557	0.7506	3.2231
	(-1.53)	(3.27)***	(-3.68)***	(3.08)***	(1.05)	(2.47)**
No. of observations	398	398	304	304	94	94
Adjusted R^2	0.21	0.35	0.57	0.44	0.76	0.86

TABLE 3
Summary Statistics for the GMM estimates of the Adverse Selection Parameters α of the Huang and Stoll (1997) (HS) Spread Decomposition Model and Wilcoxon Non-Parametric Test Results

This table presents the summary statistics of the GMM estimates of the adverse selection parameter for the Huang and Stoll (1997) (HS) spread decomposition model with constant spread (α). Panel A reports summary statistics for SSF-listed stocks and Panel B for the matching non-SSF stocks. In Panel C, we report t-test results and Wilcoxon non-parametric test results of the null that the change of adverse selection parameters (before and after the SSF period) for SSF-listed stocks is not different from that for non-SSF-listed stocks. We report the test results for the change in α estimates: $\alpha_{\text{pre-SSF}} - \alpha_{\text{post-SSF}}$. We also report results after excluding negative α estimates in the sample. ***, ** and * denotes, respectively, significance at the 1%, 5% and 10% level.

Panel A: SSF-listed stocks

			After removing negative α	
	Pre-SSF	Post-SSF	Pre-SSF	Post-SSF
Mean	0.1268	0.1437	0.1289	0.1460
Median	0.1193	0.1397	0.1197	0.1408
Std Dev	0.0587	0.0625	0.0562	0.0595
Min	-0.0290	-0.0306	0.0209	0.0218
Max	0.2523	0.2641	0.2523	0.2641
N	76	76	75	75

Panel B: Matching non-SSF-listed stocks

			After removing negative α	
	Pre-SSF	Post-SSF	Pre-SSF	Post-SSF
Mean	0.1219	0.1081	0.1386	0.1220
Median	0.1350	0.1116	0.1529	0.1149
Std Dev	0.0750	0.0746	0.0553	0.0578
Min	-0.0834	-0.1567	0.0064	0.0298
Max	0.2554	0.3011	0.2554	0.3011
N	76	76	69	70

Panel C: Wilcoxon Non-Parametric Test Results

	SSF-listed stocks		Matching non-SSF-listed stocks
$\Delta\alpha = \alpha_{\text{post-SSF}} - \alpha_{\text{pre-SSF}}$	0.0168***		-0.0138**
(*t*-statistic)	(3.35)		(-2.11)
t-test statistic: equality of mean		3.81***	
Wilcoxon signed-ranks test statistic		3.34***	
After removing negative α ($N = 67$)			
$\Delta\alpha = \alpha_{\text{post-SSF}} - \alpha_{\text{pre-SSF}}$	0.0168***		-0.0153***
(*t*-statistic)	(3.11)		(-2.39)
t-test statistic: equality of mean		3.79***	
Wilcoxon signed-ranks test statistic		3.35***	

TABLE 4
Descriptive Statistics of the Average Daily Trading Volume of SSF-listed stocks and the SSF and Option Contracts

This table presents the volume data for the sample of stocks 199 SSF stocks listed on NYSE and NASDAQ. The corresponding SSF, option call and put volumes are also shown. [§]The reported *t*-statistic is the *t*-test for equality of means in the pre- and post-SSF period.

Panel A: NYSE-listed stock

		Daily stock volume (million)	Daily SSF contracts traded	Daily call options volume	Daily put options volume
Pre-SSF	Mean	4.871	–	4485.97	3039.24
	Median	3.173	–	3027.98	2094.94
	SD	5.110	–	5624.22	3043.52
Post-SSF	Mean	4.482	41.19	4638.68	3084.52
	Median	2.971	24.56	3246.14	2199.39
	SD	4.141	45.55	5297.37	3043.56
Mean difference		-0.389		152.71	45.29
t-statistic[§§]		-2.595		-0.480	-0.209

Panel B: NASDAQ-listed stocks

		Daily stock volume (million)	Daily SSF contracts traded	Daily call options volume	Daily put options volume
Pre-SSF	Mean	16.123	–	8423.97	5799.45
	Median	9.178	–	6698.98	4491.38
	SD	19.633	–	6148.71	4826.99
Post-SSF	Mean	14.431	78.93	9918.31	5805.48
	Median	9.123	53.27	7485.68	4299.28
	SD	16.583	131.99	9239.72	4926.73
Mean difference		-1.692		1494.34	6.03
t-statistic[§]		-2.344		-1.300	-0.010