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# The market microstructure and relative performance of Taiwan stock index futures: a comparison of the Singapore exchange and the Taiwan futures exchange ☆

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**Abstract**

This study proposes to examine the relative performance of Taiwan Futures Exchange (TAIFEX) and Singapore Exchange Derivatives Trading Limited (SGX-DT) of the Taiwan Stock Index Futures markets by analyzing the intraday patterns of bid–ask spreads and by comparing the execution costs and depth of these two markets. The TAIFEX is an electronic call market, while the SGX-DT operates as a traditional open outcry continuous trading system. The empirical comparison of execution costs and depth of these two markets shows that, although the explicit transaction cost is higher for TAIFEX compared to SGX-DT, the quoted and effective spreads are relatively lower for TAIFEX. The results for information asymmetry components also suggest that the traditional open outcry continuous trading system is more vulnerable to asymmetric information. The market depth regressions results indicate that the electronic call market mechanism of TAIFEX is deeper than the traditional open outcry mechanism of SGX-DT. As the explicit transaction costs are higher for TAIFEX, the above results imply that the better performance of TAIFEX in comparison with SGX-DT is due to the differences in their market structures. This can partly explain why trading volume has gradually moved from the SGX-DT to the TAIFEX.


*JEL classification:* G14; G15

*Keywords:* Bid–ask spread; Intraday pattern; Depth; Screen versus Floor trading; Information asymmetry components

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## 1. Introduction

Optimal stock market design has long been a pertinent issue for both academics and practitioners. Studies have increasingly focused on the impact that market structures has on market quality. Understanding this impact may help to identify the market design that will produce the desirable characteristics of an efficient market.

Futures markets have traditionally used a centralized "open-outcry" system designed to facilitate trading between customers and floor traders. However, a majority of futures exchanges have introduced various forms of electronic trading because of the rapid growth in trading volume and an increased demand for a more efficient trading environment. Advances in technological innovations made that change to electronic trading a reality. The concept of efficiency is the locus for such a transition from futures pit to electronic trading systems.

However, efficiencies of a market can be gauged in many different ways. For example, trading costs are considered to be a popular measure of market efficiency. In addition to explicit transaction costs such as transaction fees and taxes, implicit costs, which include among others bid–ask spread, are also important overheads borne by market participants. Liquidity constitutes another important measure of market performance since a liquid market should ensure price resilience, deeper quote size, and narrower spread.

The purpose of this study is to examine and compare the relative market performance of the Taiwan stock index futures traded on the Taiwan Futures Exchange (TAIFEX) and the Singapore Exchange Derivatives Trading Limited (SGX-DT). The SGX-DT maintains a floor trading system in which dealers trade continuously through open outcry. The TAIFEX makes use of an electronic screen-based trading system.

There has long been an effort to locate the forces which determine the success of exchange-traded futures contracts. Holder et al. (1999) attempt to examine the key factors of success in the context where competing exchanges offer essentially equivalent futures and futures option contracts. They do not find sufficient evidence to prove that the trading structure (electronic or open-outcry) influences the competitive outcome significantly. Weber (1999), on the other hand, compares the trading mechanisms of floor markets with screen-based markets. Using a simple simulation model, he shows that order matching leads to faster completion of the desired trades and to a reduction of about $\frac{1}{3}$rd in transactions costs.

Venkataraman and Madhavan (2001) compare the execution costs of similar stocks in an automated trading structure (the Paris Bourse) and a floor-based trading structure (the NYSE). They conclude that the execution costs are higher in Paris than in New York. Gwilym and Thomas (1998) examine the bond futures contracts at LIFFE by comparing the bid–ask spreads during open-outcry trading with those during electronic trading. Their results indicate that spreads are appreciably wider during screen trading hours.

This study compares the trading costs and liquidity of TAIFEX and SGX-DT Taiwan index futures markets. The differences in execution costs and depth are examined to see which trading system provides better performance. Because the instruments traded are effectively identical, this approach of comparing market performance offers an advantage over the traditional approach of testing markets that trade different assets. In other words, this study is a controlled experiment of two trading system characteristics: (a) continuous open-outcry, and (b) electronic call auction.

The paper is organized in five sections. Following this brief introduction, Section 2 describes the characteristics of different market mechanisms and Section 3 presents the data and methodology. The results of the analysis of relative performance between the TAIFEX and the SGX-DT are presented in Section 4. The final section provides a summary with a few concluding observations.

## 2. Trading mechanism and transaction costs of TAIFEX and SGX-DT

### 2.1. Trading mechanism of TAIFEX and SGX-DT

Futures contracts on the Taiwan stock index began trading on the SGX-DT on January 9, 1997, and on the Taiwan Futures Exchange TAIFEX on July 21, 1998. The SGX-DT uses a floor trading system in which dealers trade continuously through open outcry from 8:45 AM to 1:45 PM. Every trader in the pit is an auctioneer, with each one announcing his or her own bids and offers. If a trader finds a bid or ask attractive, he/she simply hits the bid or takes the ask. When there are more traders with the same offer or ask, the buyer or seller can choose with whom they wish to trade.

Once a trade is executed, price information is immediately communicated to the pit observers, who in turn report the transactions over a worldwide electronic communication system. All transactions, including spreads, must be done through open outcry accompanied by hand-signals in the designated pit. Only members of the exchange can participate in the trading pit activities.

The TAIFEX futures contracts are traded by the Electronic Trading System (ETS) from 8:45 AM to 1:45 PM. This system is similar to the auction system with automatic order matching in which traders communicate exclusively through computers without revealing their names. Order entry and execution of trade begins with the submission of a limit order. Orders accumulate in the central limit order book 15 min prior to the opening. Once opened, the system calculates the opening price at which the maximum number of bids and asks can be matched. Thereafter, the system matches orders automatically every ten seconds until 5 min before closing, with priorities given to price and time. Thereafter the orders accumulate until the closing and are then matched to generate the closing price. Large orders exceeding the limit order of the quote will be split up over more quotes according to the price and time of entering the system.

The order-and-trade information is disseminated to the public on a real-time basis using an electronic screen. The ETS displays the last traded price, the best five bid and ask prices unmatched in the last trade, and the number of shares demanded or offered at each of the five bid and ask quotes at every 10-s interval.

### 2.2. Transaction rules and transaction costs of the TAIFEX and the SGX-DT

Transaction rules and trading costs are vital factors that affect market liquidity and market performance. Both the implicit costs in trading, such as bid–ask spread, and the explicit costs, such as transaction fees and taxes, add to the considerable expenditures of the market participants. There are three major explicit costs in trading futures contracts: (1) the commissions charged for selling and buying back futures contracts; (2) the transaction tax paid for trading futures contracts; and (3) the opportunity costs of futures margins. In addition, differences in the exchange's concept of minimum price change, daily price change limits, and margins have important implications for investors.

Table 1 summarizes the main features and major explicit costs of the two futures contracts. The brokerage commissions are similar for both the contracts. The daily price limit of TAIFEX futures is 7 percent of the previous settlement price. For SGX-DT futures, there are three price limits. The initial price limit is 7 percent of the previous day's settlement price, and trading at or within the price limit of 7 percent is allowed for the next 10 min. Once the 10 min period has elapsed, the intermediate price limit of 10 percent comes into effect. When the intermediate price limit of 10 percent becomes a reality, a further 10-min cooling-off period is allowed. Once all

Table 1
Main features of Taiwan stock index futures contracts

| | SGX-DT futures | TAIFEX futures |
|---|---|---|
| 1. Location | Singapore | Taiwan |
| 2. Underlying asset | MSCI Taiwan index | Taiwan capitalization weighted index |
| 3. Contract size | SGX-DT multiplied by US$100 | TAIFEX multiplied by NT$200 |
| 4. Trading hours | 08:45–13:45<br>16:00–19:00 | 8:45–13:45 Taiwan time (Taiwan and Singapore have the same time zone) |
| 5. Method of trading | Open outcry | Electronic call auction |
| 6. Tick size | $0.1 \times$ US$100 = US$10 (currently about NT$330) | $1 \times$ NT$200 = NT$200 |
| 7. Settlement procedure | Cash settlement | Cash settlement |
| 8. Price limit | Initial price limit: 7% of the previous day's settlement price (lasts for 10 min)<br>Intermediate price limit: 10% of the previous day's settlement price (lasts for 10 min)<br>Final daily price limit: 15% of the previous day's settlement price | 7% of the previous settlement price |
| 9. Margin | US$2,375 (approximately 9 percent of transaction value) | NT$120,000 (approximately 10 percent of transaction value) |
| 10. Exchange tax | None | 0.025 percent of contract value |
| 11. Commission | Approximately 0.1 percent of transaction value | Approximately 0.1 percent of transaction value |
| 12. Average daily volume | 12,127 | 9,004 |

these time frames have elapsed, the final price limit of 15 percent comes into effect and subsequently, the final price limit is applied for the rest of the trading day.

The exchanges also differ in their margin requirements as is evident from item 9 in Table 1. The initial margins are currently about 9 percent for the SGX-DT futures, and 10 percent for the TAIFEX futures. Currently there are no tax requirements at the SGX-DT. However, the TAIFEX levies taxes at the rate of 0.025 percent of the contract value. The higher transaction costs and more stringent restrictions imposed by the TAIFEX result in the lower volume exchanged in this market.

The average daily volume during the sample period is 12,127 for SGX-DT and 9,004 for TAIFEX. However, the growth rate of TAIFEX volume is higher than that of SGX-DT, with an average eight-fold increase from September 1998 to September 2001. The volume of SGX-DT futures has only doubled during the same period.

In addition to the transaction rules and transaction costs, the composition of the indices traded on the two exchanges have further implications for market liquidity. The underlying index of the TAIFEX futures contract is the Taiwan capitalization weighted index, which is a value-weighted index of all common stocks (currently about 600) listed on the Taiwan Stock Exchange. The SGX-DT futures contract, however, uses as its underlying index the MSCI Taiwan index, which is composed of the 77 most liquid and most highly capitalized stocks of the Taiwan stock exchange. Therefore, it is more likely to be characterized by smaller information asymmetry and lower hedging and arbitrage costs and thus should be more liquid.

## 3. Data and methodology

### 3.1. Data

Intraday tick data for both the TAIFEX and the SGX-DT Taiwan index futures are taken from the data files compiled by the TAIFEX and the SGX-DT, respectively. The dataset from the TAIFEX includes all transaction prices and volume records with a time stamp recorded to the nearest second. In addition, the dataset contains information on the five best bid and ask quotes as well as order quantity. For the automated trading system, the data are relatively clean. The time stamps indicate the precise time of the transaction and the new quotes. Furthermore, quote and trade information is recorded in correct sequence. However, since the TAIFEX matches orders every 10 s, it also displays the trade prices and bid and ask quotes at 10-s intervals. Therefore, the new orders arriving during the next 10 s will not be displayed until the next run of call arrives.

The transaction data of the SGX-DT contains information on the time to the nearest second, contract type, contract month, trading date, quotation time, price, and type of price (bid, ask, traded or settlement) for all quotes and transactions. The data provided are potentially far more informative than those used in many previous U.S. studies, because ‘time and sales’ data from U.S. futures exchanges, such as the Chicago Mercantile Exchange (CME) and the Chicago Board of Trade (CBOT), contain only information of bid quotes exceeding or ask quotes below the previously recorded transaction price. Moreover, trades are only recorded if they involve a change in price from the last trade. As a result, estimating the bid–ask spread in these markets is problematic. On the other hand, as trading rules for the SGX-DT require all bids and offers to be announced to the floor prior to trade execution, trades generally do not occur at prices inside the best bid and ask quotes.

The data for nearby futures contracts has been used in this study since they are usually the most actively traded contracts. To avoid thin markets and expiration effects, however, we roll over to the next nearest contract when it emerges as the most active contract. The sample period adopted in this study is from January 1, 2001 to September 30, 2001 and the trading day is divided into 15-min intervals.

### 3.2. Measures of execution costs

Since the quotes and transactions are denominated in U.S. dollars for SGX-DT and in New Taiwan dollars for TAIFEX, the percentage spread measures are calculated to compare execution costs across markets.[1] The first measure of execution cost is the quoted spread. Because the spread refers to a round-trip transaction, that is, two trades, we seek to measure execution costs per trade. The percentage quoted half-spread is used and calculated as

$$QS_{it} = 100(A_{it} - B_{it})/2M_{it}, \tag{1}$$

where $A_{it}$ is the ask price for index futures $i$ at time $t$, $B_{it}$ is the bid price for index futures $i$ at time $t$, and $M_{it}$ is the mid-point of quoted ask and bid prices. The use of the quoted half-spread as a measure of execution costs assumes that transactions will occur at the time of quotes. However, bid and ask quotes are not necessarily the prices at which trades take place since it is possible to trade inside the quotes, especially if the spread is wide. This will make the quoted spread a biased measure of execution costs.

To overcome this bias, the effective half-spread is calculated. This reflects the difference between the actual trade price and the mid-point of the quoted bid and ask-prices, and it provides a better measure of the actual trading costs. The percentage effective half-spread is computed as

$$ES_{it} = 100D_{it}(P_{it} - M_{it})/M_{it}, \tag{2}$$

where $P_{it}$ is the transaction price for index futures $i$ at time $t$; $M_{it}$ is a proxy of the "true" underlying value of the index futures before the trade; and $D_{it}$ is a binary variable that equals 1 for market buy orders, and $-1$ for market sell orders, using the algorithm suggested in Huang and Stoll (1996).

Glosten and Milgrom (1985) and Copeland and Galai (1983) have shown that the spread includes a component which compensates the dealer's loss to the potentially informed traders. Because of the adverse information possessed by some traders, it is well known that prices move against the dealer after a trade, falling after a dealer

[1] On average, the contract value during the sample period is NT$972,322 for TAIFEX futures and about NT$738,350 for SGX-DT futures. The average dollar effective half-spread is 0.980694 tick, or NT$196 for TAIFEX futures, and 0.63721 tick, or about NT$210 for SGX-DT futures.

purchase and rising after a dealer sale. Consequently a dealer does not, on average, realize the effective spread because he realizes losses when he trades with an informed trader. To gauge the extent of information on trading at SGX-DT and TAIFEX, the effective half-spreads are further decomposed into realized half-spread and an information asymmetry component following Huang and Stoll (1996). The price reversal after trades, which represents the market-making revenue net of losses to better-informed traders, is measured as the realized spread. And the excess of the effective spread over the realized spread is the estimate of the component lost to informed traders. The transaction price of 5 min following the current trade is used as the proxy of the index future's post-trade economic values (Huang and Stoll, 1996). The information asymmetry component ($IA_{it}$) and realized spread ($RS_{it}$) are calculated, respectively as:

$$IA_{it} = 100D_{it}(P_{it+\tau} - M_{it})/M_{it}, \tag{3}$$

$$RS_{it} = 100D_{it}(P_{it} - P_{it+\tau})/M_{it}, \tag{4}$$

where $P_{it+\tau}$ is the trade price at least 5 min after the trade at time $t$.

As we observed earlier, the TAIFEX matches and displays orders every 10 s. The newly arrived orders during the next 10-s interval will not be displayed until the next run of call. As a result, the estimates of the quoted spreads and effective spreads become biased. To overcome this problem, this study employs the Thompson–Waller (1988) measure of spreads that are not dependent on observing bid and ask quotes. Thompson and Waller (T–W) estimate the bid-ask spread as the average absolute tick-to-tick price change over a time interval. That means, if during an observation interval $t$ there are $n$ price changes observed, the estimated spread over this interval is

$$TWS_t = \sum_{j=1}^{n} |P_{j+1} - P_j|. \tag{5}$$

To be comparable with the other spreads estimates described above, this study computes the T–W's estimates of spreads by percentage spreads.

There is extensive evidence to show that the bid–ask spread in the financial market is not constant, but varies through time. To understand further the intraday pattern of execution costs and information asymmetric costs, this study also calculates the intraday execution costs. To do so, we break the trading day into twenty 15-min intervals and compare the execution costs and information asymmetry costs between the TAIFEX and SGX-DT during each trading interval.

### 3.3. Measures of depth

It is commonly held that prices in deep markets move relatively little in response to large volumes. Therefore, to test each market's depth, the two-step procedure model presented by Pirrong (1996) is used in this study. In the first step, volume is decomposed into expected and unexpected components because volume shocks may have effects on prices different from those caused by anticipated changes in volume.

The expected and unexpected volumes during a time interval are estimated using the following regression equation:

$$V_{it} = \alpha + \sum_{j=1}^{p} \beta_j V_{it-j} + \sum_{k=1}^{q} \gamma_k |\Delta P_{it-k}| + \lambda \sigma_{it-1} + \varepsilon_{it}, \tag{6}$$

where $V_{it}$ represents the trading volume for index futures $i$ in interval $t$. In the absence of public access to the actual intraday volume data of the SGX-DT, the number of recorded transactions is used as a proxy for trading volume for both markets. In addition, $\sigma_{it-1}$ is a measure of lagged volatility, which is defined as the difference between the highest price and the lowest price from the previous 15-min interval. This term, plus the lagged absolute price changes, captures the effect of expected price volatility on volume. The fitted values from this equation serve as estimates for expected volume in a second volatility/depth equation, and the residuals from the volume equation are used to measure unexpected volume in the second step.

In the second step, market depth is determined by estimating the following price volatility model:

$$|\Delta P_{it}| = \theta + \phi EVOL_{it} + \varphi UVOL_{it} + \kappa UVOL_{it}^{+} + \mu \sigma_{it-1} + \xi_{it}, \tag{7}$$

where $EVOL_{it}$ is the expected volume measured by the fitted value from (6), $UVOL_{it}$ represents the unexpected volume in interval $t$, $UVOL_{it}^{+} = \varepsilon_{it}$ if $\varepsilon_{it} > 0$, $UVOL_{it}^{+} = 0$ if $\varepsilon_{it} \leqslant 0$, and $\xi_{it}$ is an error term. The magnitude of absolute price changes is also affected by the volatility of the underlying price series and therefore, $\sigma_{it-1}$ is included in the depth regressions. This variable effectively functions as a proxy for volatility to the extent that there are persistent time-varying components in price variances. The coefficients on the volume terms, $EVOL_{it}$, $UVOL_{it}$ and $UVOL_{it}^{+}$ are measures of market depth. Positive unexpected volume is included to determine whether the effects of volume shocks on price volatility are asymmetric, as documented by Bessimbinder and Seguin (1993).

Since the expected volume and unexpected volume variables in the volatility equation are generated regressors, an instrumental variable approach is used to estimate the market depth regressions to reflect this fact.

## 4. Empirical results and analysis

In this section, the differences in market performance measures between the TAIFEX and the SGX-DT are examined. Possible explanations for these empirical results are also provided.

The available data points to the fact that the explicit trading costs and market restrictions do affect investors' willingness to trade on a specific market to the extent of influencing the market performance. In addition, the composition of the indices traded on the two exchanges also has implications on the market liquidity. Since the explicit transaction costs are larger for the TAIFEX futures, and there are more trading restrictions for foreign investors in TAIFEX futures contracts, these will affect the market performance of the TAIFEX, leading to a tendency for investors to trade on the SGX-DT. Moreover, given the broader index of the TAIFEX futures contract, it is more likely to be characterized by greater information asymmetry, and higher hedging and arbitrage costs, and thus should be less liquid. However, if the performance of the TAIFEX is relatively better than the SGX-DT, then one can conclude that it is due to the differences in market structure between the TAIFEX and the SGX-DT.

### 4.1. Implicit trading costs

The quoted and effective half-spread on TAIFEX and SGX-DT are examined in this section. Figs. 1 and 2 show the intraday patterns of the percentage quoted and effective half-spreads of these two markets. Overall, the size of quoted spreads is larger than that of effective spreads for the TAIFEX futures. This suggests that the quoted spreads of the TAIFEX are overestimated since the TAIFEX will not display the newly arrived orders during the 10-s interval. This results in trades taking place between displayed quoted prices for TAIFEX futures. In both measures, the spreads are smaller on the TAIFEX than on the SGX-DT, and all of the differences in effective spreads are statistically significant at 5% level.[2] This is an important finding because the explicit transaction cost is considered to be higher for the TAIFEX than for the SGX-DT. This may suggest that the electronic call market mechanism of the TAIFEX is more efficient than the open-outcry mechanism of the SGX-DT.

It can be seen from Figs. 1 and 2 that both the quoted and effective spreads exhibit U-shaped intraday patterns for the TAIFEX. This finding is consistent with the observations of Brock and Kleidon (1992), McInish and Wood (1992), and Lee et al. (1993). The SGX-DT data shows that the size of quoted spreads is similar to that of the effective spreads,[3] and both the quoted and effective spreads are quite constant over the trading day with the exception of being slightly higher during the opening and cash closing intervals.

For the quoted spreads, the markets show little difference during the opening and cash closing intervals. However, there are significant differences in the effective spreads between these two markets. This suggests that the wide difference in the execution costs between the TAIFEX and the SGX-DT arises from the different market mechanism employed in these two markets.

The lowest spread appears in both the markets at the futures closing interval. Chan et al. (1995) and Tse (1999) also found a sharp decline in spreads immediately before the close. They attribute the lower spreads in the last interval of trading to the

[2] For the sake of brevity, the statistical results are not shown here. However, they are available upon request from the author.

[3] The percentage of trades taking place between quoted prices for the SGX-DT futures is only 0.74%, suggesting that it is rare for orders to receive price improvement, and that the SGX may be a one-tick market. In fact, the average quoted spread is 1.4 ticks for the SGX-DT futures, and the percentage of quoted spreads larger than one tick for the SGX-DT futures is 30%. This suggests that the SGX-DT is not a one-tick market and therefore, we may not attribute the higher spread on the SGX-DT to its large tick size.

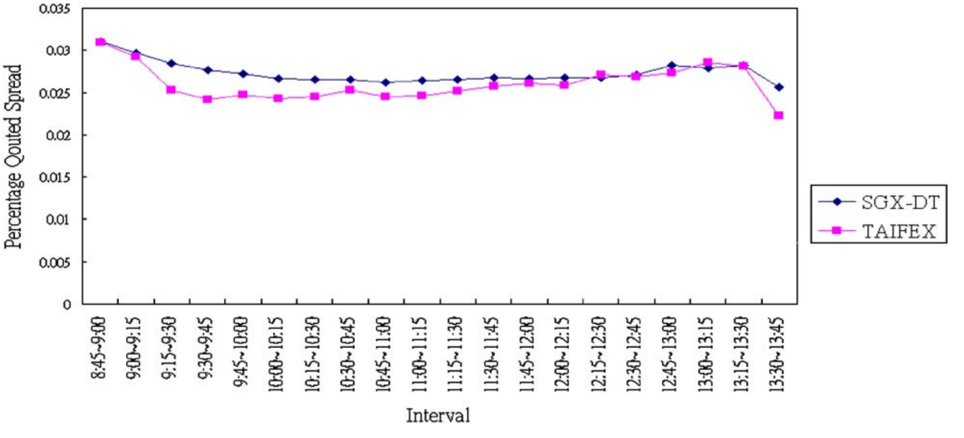


Fig. 1. The percentage quoted spread of TAIFEX and SGX-DT Taiwan stock index futures.

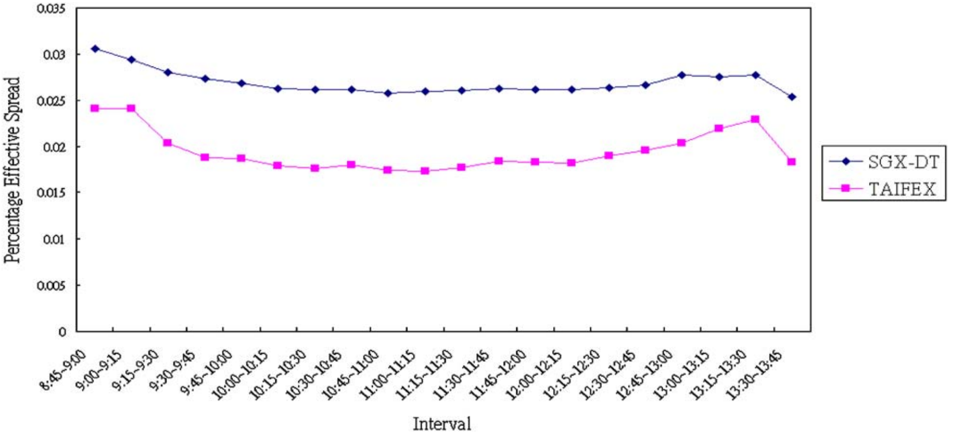


Fig. 2. The percentage effective spread of TAIFEX and SGX-DT Taiwan stock index futures.

short-term speculative behavior of scalpers and day traders. Because of their extremely short-term speculative trading behavior, scalpers try to avoid holding overnight inventory especially near the close. Day traders are also eager to close out their positions before the market closes. Thus, the spread of futures will decline sharply at the close.

### 4.2. Realized spread and information asymmetry

Due to the fact that the higher execution cost could simply reflect compensation for higher private information in trades, the effective spreads in this study are further separated into realized spreads and information asymmetry components. Figs. 3 and 4 show a graphic relationship between these two markets. Fig. 3 shows clearly that

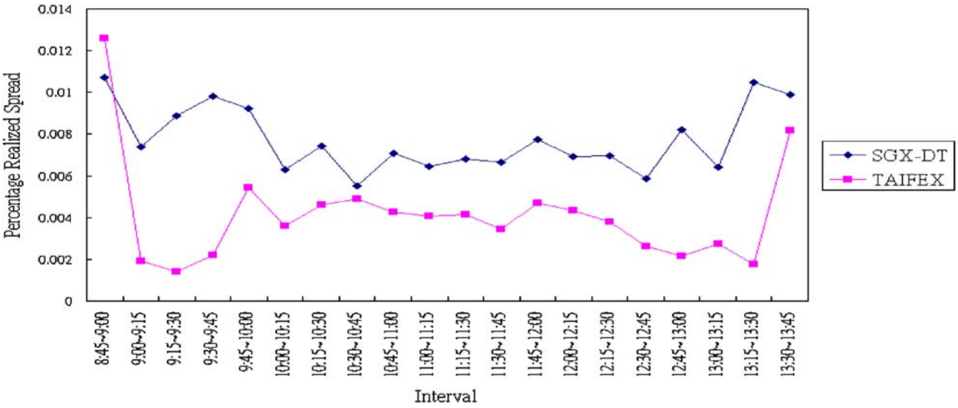


Fig. 3. The percentage realized spread of TAIFEX and SGX-DT Taiwan stock index futures.

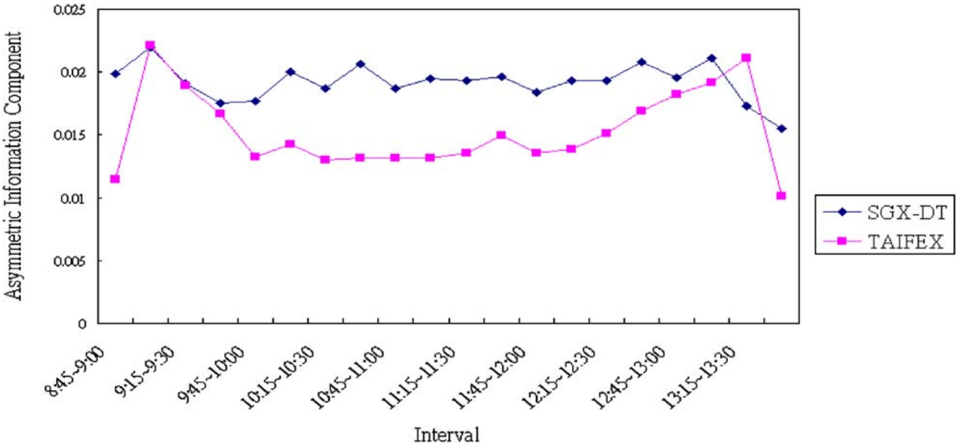


Fig. 4. The asymmetric information component of TAIFEX and SGX-DT Taiwan stock index futures.

the realized spreads in the SGX-DT are higher than in the TAIFEX for all trading intervals except at market opening.[4] This can be explained by the differences in market structures between the TAIFEX and the SGX-DT. The TAIFEX is a batch auction market where the limit orders and quotes are provided by traders, since there is free entry to liquidity supply on the TAIFEX. However, entry to supply liquidity on the SGX-DT is limited due to the restriction imposed on the number of members allowed and the cost of disadvantage that upstairs traders incur to supply liquidity in an open-outcry market. This could lead to lower realized spreads in the TAIFEX.

[4] The Wilcoxon signed rank test shows that all of the differences are statistically significant at the 1% level except for the intervals of 8:45–9:00, 10:30–10:45 and 13:30–13:45. The statistical results can be obtained from the author.

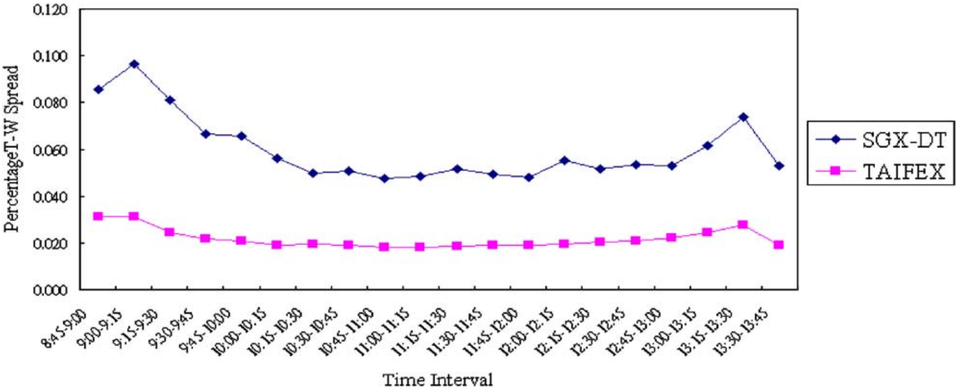


Fig. 5. The percentage T–W spreads of TAIFEX and SGX-DT futures.

Fig. 4 shows that the information asymmetry components in the SGX-DT are higher than in the TAIFEX for all trading intervals except at cash market-closing interval.[5] This implies that the traditional open-outcry mechanism is more vulnerable to asymmetric information than the electronic call market mechanism. For TAIFEX futures, the adverse selection risk is highest at the cash market opening (9:00–9:15 AM) and closing (1:15–1:30 PM) intervals. This indicates that the wide spreads at the cash market open and close are due to greater uncertainty at these times. In addition, the realized half-spread is highest during the futures market opening (8:45–9:00 AM) and closing (1:30–1:45 PM) intervals. Despite this, the information asymmetry components are lowest during these intervals. These results are surprising since the futures traders are considered to have little information about the underlying cash market during the cash market close and should bear more adverse information costs. One possibility is that during these periods, transactions are driven fully by liquidity demands and hedge demands owing to futures market closure.

### 4.3. Percentage T–W spread

Fig. 5 shows the intraday patterns of the percentage T–W spread of these two markets. It can be seen that the percentage T–W spreads exhibit a U-shaped intraday pattern for both the TAIFEX and SGX-DT futures. The spreads are smaller on the TAIFEX than on the SGX-DT and all of the differences are statistically significant at a 1% level.[6] This finding is consistent with the above findings of quoted and effective spreads, suggesting that the electronic call market mechanism of TAIFEX is more efficient than the open-outcry mechanism of SGX-DT.

[5] Most of the information asymmetry components are significantly smaller on the TAIFEX than on the SGX-DT, except for the intervals of 9:00–9:45, 12:45–13:00 and 13:15–13:30.

[6] The average difference in percentage T–W spreads between these two markets is computed as 0.0383%. In view of the major differences in explicit costs of these two markets (0.025%), the TAIFEX futures are explicitly more attractive to traders and investors. The statistical results can be obtained from the author.

### 4.4. Market depth

The regression results for the depth equation are presented in Table 2. The coefficient on expected volume is positive and significant at the 5% level for only two

Table 2
Estimates of market depth in the TAIFEX and SGX-DT Taiwan stock index futures contracts

| Month | Constant | $\sigma_{t-1}$ | $EVOL_t$ | $UVOL_t$ | $UVOL_t^+$ | $R^2$ |
|---|---|---|---|---|---|---|
| *Panel A: TAIFEX futures* | | | | | | |
| JAN 01 | 25.56 | −0.0139 | −0.0250 | 0.0038 | 0.0921 | 0.1559 |
| | (1.79) | (−0.19) | (−0.61) | (0.22) | (1.74) | |
| FEB 01 | 35.011 | 0.3642 | −0.0124 | 0.0042 | 0.0704 | 0.4239 |
| | (3.32)* | (4.33)* | (−1.17) | (0.32) | (3.79)* | |
| MAR 01 | 7.8510 | 0.2389 | −0.0155 | 0.0093 | 0.0479 | 0.2329 |
| | (1.26) | (5.57)* | (−0.46) | (0.73) | (2.45)* | |
| APR 01 | 18.957 | 0.4078 | −0.0324 | 0.0028 | 0.0853 | 0.3816 |
| | (3.51)* | (8.91)* | (−1.23) | (0.19) | (4.09)* | |
| MAY 01 | 12.943 | 0.0637 | −0.0122 | 0.0368 | 0.0282 | 0.2715 |
| | (3.16)* | (2.52)* | (−0.67) | (4.30)* | (1.92) | |
| JUN 01 | 20.426 | 0.2207 | −0.0232 | 0.0315 | 0.0248 | 0.4043 |
| | (4.75)* | (7.10)* | (−1.62) | (3.25)* | (1.89) | |
| JUL 01 | 7.9038 | 0.0807 | 0.0126 | 0.0347 | 0.0018 | 0.2888 |
| | (1.80) | (3.38)* | (0.79) | (4.16)* | (0.15) | |
| AUG 01 | 18.760 | 0.1731 | −0.0199 | −0.0001 | 0.0467 | 0.2814 |
| | (3.58)* | (3.88)* | (−1.29) | (−0.03) | (3.76)* | |
| SEP 01 | −1.264 | 0.4592 | 0.0094 | 0.0264 | 0.0079 | 0.5141 |
| | (−0.23) | (2.20)* | (0.33) | (2.06)* | (0.43) | |
| *Panel B: SGX-DT futures* | | | | | | |
| JAN 01 | −0.5887 | −0.0424 | 0.0717 | 0.0505 | 0.0270 | 0.0572 |
| | (−0.05) | (−0.52) | (0.97) | (1.97) | (0.72) | |
| FEB 01 | −1.7906 | −0.1500 | 0.0862 | 0.0769 | 0.0188 | 0.1491 |
| | (−0.23) | (−2.86)* | (1.62) | (3.75)* | (0.59) | |
| MAR 01 | 4.4247 | −0.1613 | 0.0237 | 0.0396 | 0.0890 | 0.2056 |
| | (0.99) | (−1.92) | (0.59) | (2.26)* | (3.25)* | |
| APR 01 | 4.9866 | −0.3309 | 0.0376 | 0.0729 | 0.0716 | 0.1494 |
| | (0.85) | (−2.42)* | (0.65) | (2.82)* | (1.80) | |
| MAY 01 | −1.4020 | −0.2207 | 0.0835 | 0.0809 | −0.0245 | 0.2039 |
| | (−0.33) | (−2.54)* | (2.18)* | (6.02)* | (−1.18) | |
| JUN 01 | 0.8617 | −0.1108 | 0.0446 | 0.0481 | 0.0163 | 0.1597 |
| | (0.29) | (−1.71) | (1.56) | (3.66)* | (0.81) | |
| JUL 01 | −0.3133 | −0.1843 | 0.0610 | 0.0487 | 0.0315 | 0.3104 |
| | (−0.09) | (−3.58)* | (2.32)* | (4.58)* | (2.07)* | |
| AUG 01 | 3.9414 | −0.1051 | 0.0236 | 0.0502 | 0.0368 | 0.2182 |
| | (0.82) | (−1.63) | (0.58) | (3.83)* | (1.77) | |
| SEP 01 | 6.4778 | −0.1215 | 0.0127 | 0.0626 | 0.0925 | 0.1799 |
| | (0.54) | (−0.91) | (0.13) | (2.54)* | (2.34)* | |

$|\Delta P_{it}| = \theta + \phi EVOL_{it} + \varphi UVOL_{it} + \kappa UVOL_{it}^+ + \mu\sigma_{it-1} + \xi_{it}$,
where $EVOL_{it}$ is the expected volume measured by the fitted value from (5), $UVOL_{it}$ represents the unexpected volume in interval $t$, $UVOL_{it}^+ = \varepsilon_t$ if $\varepsilon_t > 0$, $UVOL_{it}^+ = 0$ if $\varepsilon_t \leqslant 0$, $\xi_{it}$ is an error term, and $\sigma_{it-1}$ is the lagged volatility. $T$-statistics are presented in parenthesis.

months (May and July, 2001) on the SGX-DT. For the TAIFEX, there is no coefficient on expected volume, which could be considered as positive and significant. This implies that the expected increases in volume do possess a pronounced effect on prices on both markets, and thus the markets are regarded as deep in this sense. In the case of TAIFEX futures, the coefficient on expected volume for this contract is negative for seven months. In contrast, for the SGX-DT futures, the coefficients on expected volume are all positive, and significantly so for two months. For each month, the coefficient on expected volume from the TAIFEX regression is smaller than that from the SGX-DT regression. This implies that expected increases in volume have a relatively smaller effect on prices on the TAIFEX than on the SGX-DT, and thus the TAIFEX is measured as the deeper market with respect to the expected volume.

The coefficients on the unexpected volume are positive and statistically significant at the 5% level for four months on the TAIFEX and eight months on the SGX-DT. Moreover, all of the coefficients on unexpected volume from the TAIFEX regression are smaller than that from the SGX-DT regression. This suggests that the unexpected increases in volume have comparatively lesser impact on prices on the TAIFEX than on the SGX-DT market.

The coefficients on unexpected positive volume are statistically significant at the 5% level for four months on the TAIFEX and three months on the SGX-DT. It could be presumed thus that an asymmetry of response of prices to volume shocks such as positive volume shocks causes a larger price reaction than negative volume shocks. However, the sum of the unexpected volume coefficients from the SGX-DT regression is larger than that from the TAIFEX regression for all but two months.

The above results indicate that the TAIFEX futures market is deeper than the SGX-DT futures market. Both expected and unexpected volume changes have a smaller impact on price changes on the TAIFEX than on the SGX-DT. Because the TAIFEX market is deeper than the SGX-DT, it implies that traders are more interested in the information that the electronic limit order books offer than those provided by the traditional open outcry. Moreover, the execution costs and market depth can also explain why the SGX-DT has lost its market share to the TAIFEX.[7]

## 5. Conclusion

This study has compared the market performance of two Taiwan stock index futures markets, the TAIFEX and the SGX-DT. The TAIFEX is an electronic call market, while the SGX-DT uses a traditional open outcry continuous trading system. Since these two systems differ in various ways, it is difficult to determine a priori which is more inherently liquid and efficient and thus no conclusions can be drawn from a theoretical discourse alone.

[7] The SGX-DT has historically dominated the volume in this instrument since its inception in January 1997. Lately, however, TAIFEX has significantly closed the gap in volume between the two exchanges. The market share of TAIFEX has improved from 25.77% to 51.53% between 1998 and 2002.

The empirical comparison of execution costs and depth of the stock index futures contracts traded on the electronic TAIFEX and the open outcry SGX-DT shows that, although the explicit transaction cost for the TAIFEX is higher, both the quoted and effective spreads are lower for the TAIFEX compared to the SGX-DT. Moreover, the realized spreads are also lower for the TAIFEX. This observation suggests that the execution costs after controlling for adverse selection are still lower for the TAIFEX. The results of the information asymmetry components, however, lead us to presume that the traditional open-outcry mechanism is more vulnerable to asymmetric information than the electronic call market mechanism, as the information asymmetry components are higher in the SGX-DT than in the TAIFEX for all trading intervals except at the time of cash market closing.

The intraday patterns of the quoted and effective spreads of the TAIFEX futures are U-shaped, whereas the spreads of the SGX-DT futures are quite stable, being only a little higher near the market opening and closing intervals. The effective spreads and percentage T–W spreads of the TAIFEX futures are significantly lower than those of the SGX-DT; this indicates that the wide difference in execution costs between the TAIFEX and SGX-DT futures arises from the different market mechanisms employed by these two markets.

The market depth regression results indicate that the expected and unexpected increases in volume have a less pronounced effect on TAIFEX price volatility and this observation may lead one to assume positively that the electronic call market mechanism of the TAIFEX is deeper than the traditional open-outcry mechanism of the SGX-DT.

Despite the higher percentage of explicit transaction costs for the TAIFEX, the above results show that it performs better than the SGX-DT. These results imply that the TAIFEX's success is due to its market structure. Understanding the nature of these institutional differences may help explain why trading volume has slowly moved from the SGX-DT to the TAIFEX.

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