“The Impact of the Development of Trading Systems on Bid-Ask Spreads”

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The impact of the trading systems development on bid-ask spreads

Abstract

Following the closure, on 30 June 2005, of the open outcry system on the Singapore Exchange (SGX), trading in MSCI Taiwan futures on the SGX has since taken place under the electronic system only. Prior to the change, however, a hybrid form of trading existed, with open outcry and electronic trading occurring side-by-side within the SGX. This study sets out to investigate the development of the SGX trading system and its impact on bid-ask spreads at the different stages of full open outcry trading, simultaneous open outcry and electronic trading, and electronic trading only.

Our results show that liquidity, as measured by daily bid-ask spreads, is lower under the electronic trading system than it was under open outcry trading. We find that there was no appreciable difference in daily bid-ask spreads under the electronic trading system, either prior to, or after, the closure of the open outcry pit. Furthermore, when the two systems were running side-by-side, daily bid-ask spreads were lower under the electronic trading system than under open outcry trading. Based upon measures of bid-ask spreads, we find that, in terms of liquidity, the electronic trading system has an advantage over open outcry trading.

Keywords: bid-ask spreads, futures, trading system.
JEL Classification: G13.

Introduction

The primary aim of this paper is to undertake an investigation into daily bid-ask spreads during the development of distinct types of trading systems within the futures markets. The open outcry system of trading on the Singapore Exchange (SGX) was closed on June 30, 2005, with all trading in MSCI Taiwan futures subsequently taking place under the electronic system only. However, prior to this significant change, two distinct periods of development were experienced by market participants trading in MSCI Taiwan index futures contracts within the SGX.

The first of these periods (from January 9, 1997 until June 25, 2000) involved trading during regular hours only under the open outcry system only[1]. The second period (from June 26, 2000 to June 30, 2005) involved simultaneous trading under both the open outcry and electronic trading systems that were fungible, with the SGX permitting market participants to choose between the floor trading and electronic trading systems for most futures contracts during regular trading hours[2].

The open outcry and electronic trading systems compared in this study have given rise to considerable analysis of this particular issue over the past decade, with most of this analysis having used bid-ask spreads to determine whether the electronic trading system is actually more efficient. The related works reported within the literature can be divided into two major categories, the first of which compares bid-ask spreads on the different exchanges where simultaneous trading of contracts occurs under both the open outcry and electronic trading systems. Pirrong (1996) provided evidence to show that under such conditions, the spreads of futures contracts were no wider within the open outcry market (London International Financial Futures and Options Exchange, LIFFE) than within the electronic trading market (Deutsche Terminborse, DTB)[3]. However, the findings of Frino et al. (1998) suggested that within the LIFFE, bid-ask spreads were in fact wider than those found in the DTB. Shyy and Lee (1995) had, nevertheless, earlier demonstrated the reverse; that bid-ask spreads were narrower in the open outcry market.

The second category contrasts bid-ask spreads where contracts are traded under both open outcry and electronic trading systems on a single exchange. Coppejans and Domowitz (1999) evaluated the bid-ask spreads of such a market, the GLOBEX overnight trading system, in both absolute terms and relative to a liquid benchmark, the floor market of the Chicago Mercantile Exchange (CME)[4]. They found that the bid-ask spreads in the S&P 500 futures markets were almost the same under both trading mechanisms.

Aitken et al. (2004) also examined the transfer of trading from an open outcry trading system to an

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[1] Ever since November 10, 1997, MSCI Taiwan index futures have been tradable after the market close on the electronic trading system.

[2] The SGX approved an additional electronic trading session for its MSCI Taiwan index futures contracts, with the new session beginning on June 26, 2000 and running side-by-side with open outcry trading from 8:45 am to 12:45 pm (Singapore Time).

[3] The estimation results of Kofman and Moser (1997) also indicated that the effective bid-ask spreads were virtually identical for both exchanges.

[4] Coppejans and Domowitz (1999) studied electronic trading in Deutschemark (DM), Japanese Yen (JY), and Swiss Frank (SF) futures markets in the S&P 500.

electronic trading system in the stock index futures markets of three exchanges, and went on to present evidence to suggest that there was a reduction in bid-ask spreads following the introduction of electronic trading[1]. Their study provided support for the proposition that, as compared to open outcry markets, electronic trading facilitated high levels of liquidity through a reduction in bid-ask spreads. Copeland et al. (2004) nevertheless offered contra-dictory conclusions to the findings of Aitken et al. (2004).

Thus, as a result of such conflicting findings from a number of the prior empirical studies, it remains unclear as to whether one particular type of trading system dominates the other, and this is essentially because, in their overall evaluation of the mechanisms for electronic trading vis-à-vis open outcry trading, the prior studies in this area have invariably suffered from either, or both, of the following defects: (i) they have failed to control for the differences in the contract definitions; and/or (ii) there was no attempt made to control for the differences in the sampling period.

Despite a considerable number of studies having already been carried out in this area, very little attention has been paid to trading systems in the transition stage, where there is the simultaneous occurrence of both open outcry trading and electronic trading within the same exchange[2]. In contrast to the prior studies, we aim to fully examine changes in the daily bid-ask spreads resulting from the changes in the trading mechanisms during the three distinct periods of development.

We examine the evolution of the futures trading systems from open outcry trading to electronic trading, with a particular focus on the period when electronic trading was taking place alongside with open outcry trading. The concurrent trading of MSCI Taiwan index futures on both the electronic and open outcry markets of the SGX provides us with a unique platform for examining daily bid-ask spreads during such a stage of side-by-side trading.

The design of our study has distinct advantages over those of many of the prior studies, since we focus on MSCI Taiwan futures traded on the SGX under alternative trading mechanisms. Our comparison is based upon the same index and contract sizes and there are no differences that might possibly have some impact on the customer base. For this reason, the main objectives of this paper are: (i) to examine the daily bid-ask spreads prior to, and after, the changes in the trading system; and (ii) to compare empirically the relative liquidity levels of the identical SGX futures contracts traded side-by-side under both trading systems (electronic trading and open outcry trading) during regular trading hours.

1. Data and methodology

1.1. Data. In order to determine the impact on bid-ask spreads stemming from the development of the trading system, we divided the futures data into three distinct periods: (i) full open outcry trading; (ii) side-by-side trading (both open outcry and electronic); and (iii) full electronic trading (Figure 1). The basic notion behind this classification was an attempt to determine whether there were any discernible changes in bid-ask spreads across these three distinct time periods.

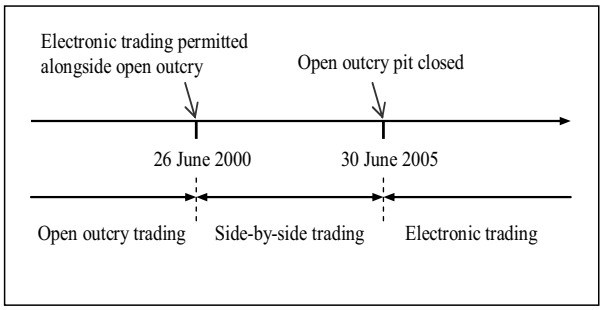

Fig. 1. Development of the MSCI Taiwan futures trading systems

Table 1. Trading hours on the MSCI Taiwan index

	Open outcry trading	Electronic trading
50 days before 26 June 2000		
Monday-Friday	8:45 am – 1:15 pm	2:45 pm – 7:00 pm [b]
Saturday	8:45 am – 12:15 pm	Closed
50 days after 26 June 2000		
Monday-Friday	8:45 am – 12:45 pm	8:45 am – 12:45 pm ¶ 4:00 pm – 7:00 pm [b]
Saturday	8:45 am – 12:15 pm	Closed
50 days before 1 July 2005		
Monday-Friday	8:45 am – 1:45pm	8:45 am – 1:50pm ¶ 4:00 pm – 7:00 pm [b]
50 days after 1 July 2005		
Monday-Friday	Closed	8:45 am – 1:50pm

Notes: [a] The 50 day period excludes those contracts that were rolled over to the next nearby contract three trading days prior to expiration. [b] Trades executed during this session are for T+1 settlement in Singapore time.

[1] The three futures exchanges were the London International Financial Futures and Options Exchange (LIFFE), the Sydney Futures Exchange (SFE), and the Hong Kong Futures Exchange (HKFE).

[2] See, for example, Gwilym and Buckle (1996), Frino et al. (1998), Wang (1999) and Tse and Zabotina (2001).

We obtained transaction data on MSCI Taiwan Index futures from the SGX for the 50-day periods prior to, and after, each of the dates when changes in the trading system occurred. Details of the trading hours for MSCI Taiwan Index futures during our sample period are provided in Table 1. Since nearby futures contracts are generally the most actively traded, we used the data on these nearby contracts. Furthermore, in order to avoid any abrupt price change from the prior expiration date, the contracts were rolled over to the next nearby contract three trading days before expiration[1].

1.2. Methodology. Several methods are available for the calculation of bid-ask spread[2], with one particular measure, which does not impose bid and ask data, being the auto-covariance spread estimator proposed by Roll (1984) and Schultz (2000). Their estimates work well with intraday data and are similar to measured effective spreads[3]. Since no information on bid and ask spreads is provided by the SGX for the period when only electronic trading occurred, we use a modification of the Roll (1984) estimator, as suggested by Schultz (2000), to measure the daily bid-ask spreads:

$$Adjusted\ Roll\ Spread_t = \frac{2\sqrt{-\operatorname{cov}(\Delta P_j, \Delta P_{j-1})}}{1 - \frac{7}{8(n-1)}} \quad (1)$$

where P_j is the price of transaction j on day t; cov is the serial covariance of the price change calculated from intraday prices; and n represents the number of observations on day t.

According to a number of prior studies, bid-ask spreads are largely determined by trading volume and price volatility[4]; thus, we specify our model to control for changes in both trading volume and price volatility across the different periods of development of the trading system. Trading volume ($VOLUME_{i,t}$) is the daily volume of trades for trading system i on day t ; and price volatility ($VOLATILITY_{i,t}$) is the intraday price volatility for trading system i on day t. We estimate the following equation as a means of assessing the impact of bid-ask spreads under the different trading systems:

$$Adjusted\ Roll\ Spread = \beta_0 + \beta_1 D_i + \beta_2 \sqrt{VOLUME_{i,t}} + \beta_3 VOLATILITY_{i,t} + \beta_4 D_i \times VOLATILITY_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where i = 1, 2, 3, 4 denote the different trading mechanism periods; and D_i is a dummy variable. A description of the dummy variables is provided in Table 2.

Table 2. Description of the dummy variables

D_i	D = 0		D = 1	
	Trading mechanism	50-day Periods	Trading mechanism	50-day Periods
i = 1	Open outcry only	prior to June 26, 2000	Open outcry (side-by-side stage)	after June 26, 2000
i = 2	Open outcry (side-by-side stage)	prior to July 1, 2005	Electronic only	after July 1, 2005
i = 3	Electronic (side-by-side stage)	prior to July 1, 2005	Electronic only	after July 1, 2005
i = 4	Open outcry (side-by-side stage)	prior to July 1, 2005	Electronic (side-by-side stage)	prior to July 1, 2005

We use the square root of trading volume so as to ensure that the results are not dominated by outliers (McInish and Wood, 1992). The interactive term between D_i and price volatility is included as a means of capturing the incremental effect of D_i on the daily bid-ask spreads of price volatility, after controlling for changes in both trading volume and price volatility[5]. This analysis enables us to isolate the impact of the changes in the trading system after controlling for changes in the determinants of daily bid-ask spreads that are likely to be driven by market conditions.

2. Empirical results

The descriptive statistics for the daily adjusted Roll bid-ask spreads, price volatility and trading volume over the daily intervals are presented in Panels A, B, and C of Table 3. These tables provide details of the diverse transaction mechanisms for the respective

[1] SGX futures are traded on a monthly cycle. The consequence of rolling over too early is that it would result in the use of less liquid contracts. We therefore rolled over to the next nearest contract 3 days prior to the expiration of the current contract.

[2] See, for example, Stoll (1989), George et al. (1991), McInish and Wood (1992).

[3] In contrast to the studies of Roll (1984) and Schultz (2000), which measured the accuracy of the effective spread estimates, our study focuses on whether the bid-ask spread is affected by the development of the trading systems. Thus, there is no attempt in the present study to identify any other methods that might provide greater accuracy in the measurement of bid-ask spreads.

[4] See, for example, Ho and Stoll (1983), Glosten and Milgrom (1985), McInish and Wood (1992) and Prucyk (2005).

[5] We also examined variance inflation factors (VIF) as a measure of collinearity; all of the results were within the acceptable range, with the exception of the interactive term between *Di* and trading volume. Hence, this interactive term was removed.

stages of full open outcry trading, side-by-side trading and full electronic trading. Preliminary analysis of the data on the effects after the change in the trading system shows that there was a reduction in both daily adjusted Roll bid-ask spreads and price volatility, whilst also revealing an increase in trading volume.

Table 3. Descriptive statistics

Panel A: Open outcry only						
	Adj. Roll Bid-ask spreads		Price volatility		Trading volume	
	Open outcry		Open outcry		Open outcry	
50 days before 6/26/00						
Mean	0.1475		2.4353		9163	
Median	0.1383		2.2109		8726	
Std. dev.	0.0522		1.2142		2529.931	
Panel B: Side-by-side trading						
	Adj. Roll Bid-ask spreads[a]		Price volatility[a]		Trading volume[a]	
	Open outcry electronic		Open outcry electronic		Open outcry electronic	
50 days after 6/26/00						
Mean	0.1347	N/A[b]	1.8411	1.6931	9546	574
Median	0.1296	N/A[b]	1.6057	1.5436	9079	350
Std. dev.	0.1191	N/A[b]	0.8993	0.9805	2621.457	759.343
50 days before 7/1/05						
Mean	0.0731	0.0353	0.6989	0.6960	10799	9664
Median	0.0736	0.0302	0.5254	0.5493	9650	9536
Std. dev.	0.0075	0.0176	0.4210	0.4350	5650.764	6109.065
Panel C: Electronic only						
	Adj. Roll Bid-ask spreads		Price volatility		Trading volume	
	Electronic		Electronic		Electronic	
50 days after 7/1/05						
Mean	0.0301		0.6756		19866	
Median	0.0302		0.5162		18772	
Std. dev.	0.0030		0.3626		7201.561	

Notes: [a] Adj. Roll bid-ask spreads, price volatility, and trading volume are calculated over daily intervals and means, medians, and standard deviations reported. [b] In the initial period of electronic trading (starting on June 26, 2000), trading volume was very low with infrequent transactions; the data necessary for the calculations are therefore unavailable.

The results presented in Table 4 also provide new evidence on daily bid-ask spreads during the period of side-by-side trading in the single futures market. Table 4 provides some evidence to show that after the closure of open outcry trading, both mean and median daily price volatility were slightly lower; however, the *t* statistics were not significant.

Table 4. Differences in means t-tests

Trading system[a]	Adj. Roll Bid-ask spreads[b]	Price volatility[b]	Trading volume[b]
O vs. O(S)	−0.385	2.508**	−0.619
O(S) vs. E	40.269**	0.012	−7.368**
E(S) vs. E	−0.180	0.088	−7.538**
O(S) vs. E(S)	22.366**	−0.306	0.546

Notes: [a] O refers to open outcry trading only; E refers to electronic trading only; O(S) refers to open outcry trading at the side-by-side stage; and E(S) refers to electronic trading at the side-by-side stage. [b] ** indicates significance at the 1% level; * indicates significance at the 5% level.

There was a discernible decline in average daily price volatility following the introduction of electronic trading, with the *t*-tests comparing the means of the two stages (open outcry trading only and open outcry trading during the side-by-side stage) indicating that the change in price volatility was statistically significant at the 0.01 level.

Nevertheless, following the subsequent launch of full electronic trading, we did not find that open outcry contracts were the perfect complement to liquid and robust open outcry markets. There is, however, a possibility that this result was driven by systematic changes in price volatility and trading volume, since Panel B and Panel C also reveal statistically significant differences in both of these variables. This suggests, therefore, that the results may be driven by extraneous variables, as opposed to the trading mechanism effect on bid-ask spreads.

Table 5. Determinants of daily bid-ask spreads (time series data)

	April 6,2000 – October 4, 2000		April 4, 2005 – October 6, 2005		April 4, 2005 – October 6, 2005	
	Open outcry only vs. open outcry (side-by-side trading)		Open outcry (side-by-side trading) vs. electronic only		Electronic (side-by-side trading) vs. electronic only	
	$i = 1$		$i = 2$		$i = 3$	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Constant	0.1789	2.2233	0.0651	23.8132**	0.0341	8.2222**
D_i	0.0265	0.6210	-0.0435	-17.0319**	-0.0022	-0.5657
Sqrt (VOLUME)	0.0070	0.5799	0.0015	0.7069	0.0001	0.1074
VOLATILITY	-0.0051	-0.5562	0.0002	2.3999*	-0.0001	-0.5894
D_i*VOLATILITY	-0.0076	-0.4014	-0.0006	-0.1924	0.0042	0.9552

Table 5 (cont). Determinants of daily bid-ask spreads (time series data)

	April 6,2000 – October 4, 2000	April 4, 2005 – October 6, 2005	April 4, 2005 – October 6, 2005
	Open outcry only vs. open outcry (side-by-side trading)	Open outcry (side-by-side trading) vs. electronic only	Electronic (side-by-side trading) vs. electronic only
Adj. R^2	-0.034	0.932	-0.028
F-statistic	0.194	338.749**	0.355
No.of Obs.	100	100	100

Note: ** indicates significance at the 1% level; * indicates significance at the 5% level.

In order to ensure the validity of our test for the impact of the development of the trading systems on bid-ask spreads, it is necessary to implement controls for changes in both price volatility and trading volume during each developmental stage. Table 5 presents the results of the regression on daily adjusted Roll bid-ask spreads against the dummy variables, trading volume, price volatility and interactive variables.

The realized spreads in the same trading systems were not significantly different, either prior to, or after, the launch of side-by-side trading (see i = 1 and i = 3, where the *t*-values are 0.621 and –0.565). On the other hand, the *F*-statistics indicate that the model was significant for contracts in open outcry trading (side-by-side) vis-à-vis electronic trading only, whilst the adjusted R^2 statistic was 0.932, thereby indicating that these models have reasonable explanatory power.

Our results reveal that after controlling for certain variables, such as price volatility and trading volume, within the regression framework (see i = 2), daily bid-ask spreads were tighter for electronic trading. By contrast, as regards the period of open outcry trading only vis-à-vis the period of open outcry trading during the side-by-side stage, the results indicate that after controlling for other variables, the launch of the electronic trading system (which began on June 26, 2000) had no statistically significant impact on daily bid-ask spreads in the open outcry market. The coefficients on the interactive term were inconsistent in sign and had no appreciable significance across the three regression models.

Table 5 also indicates that after controlling for the determinants of daily bid-ask spreads, the coefficients of price volatility were positive and significant for open outcry trading during the side-by-side stage vis-à-vis electronic trading only. This finding is also consistent with the prior examination of the stock markets undertaken by McInish and Wood (1992).

In contrast to Table 4, the results reported in Table 5 for open outcry trading during the period of side-by-side trading vis-à-vis the period of electronic trading only, do not conflict with those reported for the side-by-side period of open outcry and electronic trading. These results suggest that the spreads for electronic trading were lower than the corresponding spreads for open outcry trading, even after controlling for variations in spread that may be attributable to other related variables.

There is also no evidence to suggest that the introduction of electronic trading system had any obvious association with the decline in daily bid-ask spreads during the period of full electronic trading. Therefore, there exists only weak evidence of a negative relationship between electronic trading during the side-by-side period and the full electronic trading period.

Interestingly, using a multiple cross-sectional regression model to investigate the trading mechanisms during the side-by-side period of open outcry and electronic trading, after controlling for price volatility and trading volume, the coefficient in D_i was negative and statistically significant (Table 6). This indicates that when open outcry trading and electronic trading existed in parallel within the same futures index, there was an increase in daily bid-ask spreads for floor-based trading.

Regardless of the stage of development, after controlling for price volatility and trading volume, we find that electronic trading resulted in upgrading overall market liquidity by reducing daily bid-ask spreads.

Table 6. Determinants of daily bid-ask spreads (cross sectional data)

	April 4, 2005 – June 30, 2005 Open outcry (side-by-side) with electronic trading *i* = 4	
	Coefficient	t-statistic
Constant	0.0666	14.3911**
D_i	-0.0408	-12.2375**
Sqrt(VOLUME)	0.0025	0.0924
VOLATILITY	0.0001	1.3483*
D_i *VOLATILITY	-0.0006	-0.1374
Adj. R^2		0.822
F-statistic		109.518**
No. of Obs.		100

Note: ** indicates significance at the 1% level; * indicates significance at the 5% level.

Conclusions

This study has assessed the impact of the development of trading systems on overall daily bid-ask spreads, with the SGX offering an ideal environment for such analysis, having passed through three distinct stages of systemic change; a full open outcry trading system, a simultaneous open outcry and electronic trading system, and a full electronic trading system. Our study has focused on the MSCI Taiwan futures traded on the SGX under these three alternative trading mechanisms.

The futures contracts examined here were based upon the same index and contract sizes; furthermore, there were no differences that might affect their customer base. We find from the results that daily bid-ask spreads were higher under the open outcry trading system both prior to, and after, the launch of electronic trading. We also find that there were no significant differences in daily bid-ask spreads under the electronic trading system, either prior to, or after, the closure of the open outcry pit.

Finally, we also find that daily bid-ask spreads under the electronic trading system were lower than those under the open outcry trading system during the period when the electronic trading system was running alongside the traditional open outcry trading pit. These lower spreads seem to suggest that an electronic trading system has greater liquidity than that of an open outcry trading system.

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