V7

The Impact of Electronic Trading on the Relative Informational Efficiency of Index Futures Market

Joseph K.W. Fung
Associate Professor
Department of Finance and Decision Sciences
Hong Kong Baptist University
Hong Kong

Li Jiang
Assistant Professor
Department of Accounting
Polytechnic University of Hong Kong
Hong Kong

Kam C. Chan*
Leon and Ruby Mai Page Professor of Finance
Gordon Ford College of Business
Western Kentucky University
Bowling Green, KY 42101

Dec, 2003

*Contact author. Johnny.Chan@wku.edu (e-mail); 1-270.745.2955 (phone); 1-270.745.5284 (fax).

The Impact of Electronic-Trading on the Relative Informational Efficiency of Index Futures Market

Abstract

This study examines the impact of migration to electronic trading on the relative informational efficiency between an index futures contract and the underlying cash index. The recent move to electronic trading of the Hong Kong Hang Seng Index futures contract provides an opportunity to study how the change affects the effective bid and ask spread in the futures market and the dynamic relationship between the futures and the underlying cash index. Our findings suggest that the migration reduced the effective spread of futures contract. In addition, the information flow from futures to the cash index is strengthened while the instantaneous feedback between futures and cash markets is weakened after the migration. The instantaneous feedback and futures to cash feedback information flow are strengthened in a falling market. However, consistent with the literature, a trading migration from floor to electronic trading reduces the release of lumpy information, which tends to reduce the feedback from futures to cash market.

The Impact of Electronic-Trading on the Relative Informational Efficiency of Index Futures Market

1. Introduction

Against the backdrop of recent and rapid growth of electronic trading[1] worldwide, this study provides an empirical evaluation of the impact of a migration of floor to electronic trading (hereafter, trading migration) on the informational efficiency of the futures market. Several studies have compared the relative size of informational flow and liquidity for a particular security with parallel trading in both floor and electronic system (Martens, 1998; and Franke and Hess, 2000). This study focuses on the impact of a trading migration on the relative informational efficiency between index futures and the underlying cash index.

Contrasting the results obtained by Stoll and Whaley (1990), Grunbichler, Longstaff, and Schwartz (1994) commented that screen trading "seems" to enhance the relative informational efficiency of the market. However, such comparison as being made by Grunbichler et al (1994) may not be valid as they were comparing two trading systems in two distinctively different markets and over highly varied time horizon. A recent study by Taylor, van Dijk, Franses, and Lucas (2000) directly tests the impact of electronic trading on the index-futures dynamic behavior by using data surrounding the recent change to electronic trading of equity stocks in the London Stock Exchange.

The current study examines the impact of the recent migration of the Hong Kong Hang Seng Index futures contract to electronic trading on the effective bid and ask spread of the

---

[1] For example, stock trading on the Australian Stock Exchange (ASX) switched to electronic trading since October 1991 with the introduction of the Stock Exchange Automated Trading System (SEATS); while stock trading on the London Stock Exchange switched to screen-based electronic trading on October 20, 1997 with the introduction of SETS, an electronic trading system. For derivatives trading, the Share Price Index (SPI) futures trade on the Sydney Futures Exchange (SFE) switched to electronic trading in September 1999.

futures price as well as the index-futures dynamic relationship. Our study complements Taylor et al (2000) in several aspects. Taylor et al studied the effect of the change in the trading mechanism in the cash market while the current study investigates the impact of the change in the trading mechanism for the futures market. In Taylor et al, the futures was traded on the floor via open outcry when the cash market switched to electronic trading. In the current study, the Hong Kong cash market adopts electronic trading of stocks throughout the sample period while the futures market switched to electronic trading.

Despite the fact that electronic trading together with an open limit order book increases the speed of information dissemination and enhances market transparency (O'Hara, 1995), it is uncertain whether electronic trading improves the informational lead of the underlying instrument (in our case, it is futures). Execution risk is important in conducting arbitrage (Kumar and Seppi, 1994). The improved operational and informational efficiency in futures trading is supposed to foster the alignment between the two markets and enhances integration. Therefore, the trading migration to electronic trading in futures market should lubricate the feedback mechanism and will effectively reduce the extent of any instantaneous feedback (lead-lag) between cash and futures markets.

On the other hand, it has been generally argued that, in an electronic trading environment, large orders in a floor-trading environment may actually decrease[2] because unfilled limit orders are free options in a screen-based electronic trading environment. Thus, electronic trading reduces the attractiveness to traders of using futures to reveal lumpy information (i.e., information that leads large price movements). If lumpy information is not released through futures trading, the informational lead of futures over cash should decline. However, trading

[2] See for example, Miller (1997).

futures may still be a preferred mean to convey less lumpy information if electronic trading reduces the trading cost for small orders. If these conjectures are correct, then the futures lead over the cash index should be strengthened with the migration of the futures contract to electronic trading after controlling for lumpy information release.

The paper offers an empirical analysis on the extent to which information intensity and the lumpiness in the release of the information affect the integration of futures and cash markets and the informational lead of the futures under the two distinct market microstructures. Finally, the study also controls for the impact of (up and down) market conditions on the dynamic relationships.

Our study uses a tick-by-tick transaction and bid/ask quote records for the index futures as well as a high frequency record of the stock index quotes over a period of 16 months surrounding the trading migration from floor trading to electronic trading. We first use Geweke's (1982) approach to investigate how and whether the change in market microstructure affects the relationship between lumpiness and intensity of information and the dynamic feedback mechanism between cash and futures markets. Then, we partitioned the feedback relation between futures and cash markets into instantaneous feedback between futures and cash markets and from futures market to cash market. Our new approach permits a direct examination of how the electronic trading system affects the inter-market information flow. Our results suggest that the effective spread becomes smaller after the trading migration. In addition, the information flow from futures to the cash index is strengthened while the instantaneous feedback between futures and cash markets is weakened after the migration of futures trading to the electronic platform. The instantaneous feedback and from futures to cash feedback information flow are strengthened in a falling market. However, consistent with the literature, a trading migration from floor to electronic trading reduces the release of lumpy information as inferred from a substantial reduction in average deal size after the change. The disincentive to release lumpy information through futures trading reduces the feedback from futures to cash market.

The paper is organized as follows: section 2 reviews the literature and motivates the study; section 3 describes the data and methodology for the test; section 4 summarizes and interprets the results; and section 5 concludes.

2. A brief literature review

We separate the literature into two sub-sections. The first sub-section discusses the general findings of the impact of electronic trading on the transaction costs, liquidity, and the dynamic relationship between cash and futures markets. The second sub-section summarizes the importance of incorporating information intensity and lumpiness.

General

In a frictionless market, index futures and the stock basket underlying the index should be perfect substitute for each other. However, in reality, the lower transaction cost as well as the convenience in taking market actions through trading futures make it a preferred instrument over the stock basket for speculators as well as portfolio managers in altering their market exposure. Fleming, Ostdiek, and Whaley (1996) rightfully argue that, in general, instruments with lower trading costs play a more important information discovery role compared to their higher cost substitutes. Therefore, it is expected that changes in index futures price lead changes in the underlying cash index, and numerous studies have provided supporting evidence on the conjecture[3]. The level of market friction is affected by the market microstructure where the

[3] See Sutcliffe (1997) for a comprehensive summary of empirical studies.

instruments are being traded. Electronic trading together with an open limit order book provides a high level of market transparency and facilitates almost instantaneous execution of trades onscreen. Moreover, electronic trading reduces the marginal cost of trade execution that can help reduce the effective spreads in the market. Tse and Zabotina (2001) also provide empirical evidence in the FTSE 100 index futures to support the role of trading migration in reducing effective spread.

There are primarily two strands of literature regarding the trading migration of open outcry trading system to an electronic screen-based trading system. The first strand deals with the impact of such trading system switching on the transaction costs and liquidity of the underlying assets. While there are several proxies for transaction costs and liquidity, the common proxy is the bid-ask spread. If electronic trading reduces transaction efficiency and enhances market transparency (which promotes competition among traders), then the bid and ask spread should be reduced after electronic trading. Empirical findings are generally in sync with such conjecture. For example, Pirrong (1996) documented that the bid-ask spread in the Bund futures in the electronic market are not greater than the open outcry market. Similarly, Blennerhassett and Bowman (1998) and Frino et al (1998) also find that the spreads are lower after switching to electronic screen-based market in Germany and New Zealand respectively. Taylor et al (2000) find that the average of the spread of the FTSE-100 stocks declined by 30% following the introduction of the electronic trading system (i.e., SETS) on the London Stock Exchange. Previous studies have included control variables such as market activity. However, the intensity and lumpiness of information are not explicitly considered.

The second strand of the literature focuses more on the lead-lag relationship between cash and futures prices after the trading migration of outcry system to electronic system. In essence, these studies examine the impact of such trading migration on the dynamic relationship between cash and futures market. For example, Grunbichler, Longstaff and Schwartz (1994) find, in the German market, that the DAX futures' lead over the cash price is longer[4] and by as much as 20 minutes after the trading migration. The DAX futures are traded on screen-based electronic trading system while the underlying stocks are traded via open outcry. However, despite screen trading of the stocks on the Australian Stock Exchange, Frino and West (1999) find that the floor-traded SPI futures lead the underlying index by as much as 25 minutes. Fung and Jiang (1999) examined the Hong Kong markets that share similar institutional setting as the Australian markets but found that the futures lead by only five minutes. Nevertheless, it is difficult to make solid inferences about how differences in market microstructures might have affected the dynamic relationships since it is impossible to control for the unique characteristics and regulatory structure of different national markets.

Taylor et al (2000) directly tests the impact of electronic trading on the index-futures dynamic behavior by using data surrounding the recent change to electronic trading of equity stocks in the London Stock Exchange. They control for the market microstructure problem by focusing their test on the dynamic relationship surrounding the introduction of SETS in the London Stock Exchange. Their results suggest that both futures and the cash index react faster to past pricing errors in the post-SETS period. Moreover, the speed of adjustment in stocks catches up with that of the futures after electronic trading of the stocks.

In this paper, we examine two aspects of the impact of electronic trading. First, we examine how the trading migration to electronic trading may affect futures market transaction costs and liquidity as proxy by futures price bid-ask spread. In particular, we control for futures

[4] For example, Stoll and Whaley (1990) find that the S&P 500 index futures lead the cash index by about 5 minutes.

market activity, information intensity and information lumpiness of the futures market. Second, we investigate the impact of the electronic trading on the dynamic relationship between the Hang Seng Index futures and the cash index. The screen-based trading system for the underlying stocks remains unchanged during the study period. This fact makes the results of the study complements that of Taylor et al (2000).

Information intensity and lumpiness

Admati and Pfleiderer (1988) argue that the volume of trading is positively related to the amount of information arrived in the market. On the other hand, Easley and O'Hara (1987) theoretically show that informed traders tend to increase the size of their trade. The inherent leverage provided by futures trading makes it a preferred outlet for revealing substantial market views; and that implies that futures leads the cash stocks to a greater extent when information intensity rises. These are in line with the argument of Garbade and Silber (1983) and the findings of Schwartz and Laatsch (1991) that the strength of the lead-lag relation depends on the relative volume between the two markets.

However, Miller (1997) argues that liquidity for large order is lower in an electronic than in a floor-trading environment. Traders would also be reluctant to place large limit orders on the trading screen since unfilled limit orders provides free options for other traders in the market. These problems reduce the attractiveness of using futures to reveal lumpy information when they are most abundant under volatile market activity. Hence, besides information intensity, we also need to consider information lumpiness.

Frank and Hess (2000) argue that floor trading is preferred to electronic trading when information intensity is high; therefore, the floor trading system should capture a larger volume share in volatile market situation. They test the hypothesis by examining the Bund futures contracts traded on both London International Financial Futures Exchange (LIFFE) and Deutsche Terminborse (DTB) for the period 1991 to 1995. DTB adopts an electronic trading system while LIFFE uses open outcry for the study period. Consistent with their conjecture, they find that the volume share traded through the electronic system is inversely related to the level of information intensity.

3. Hypothesis, Methodology, and Data

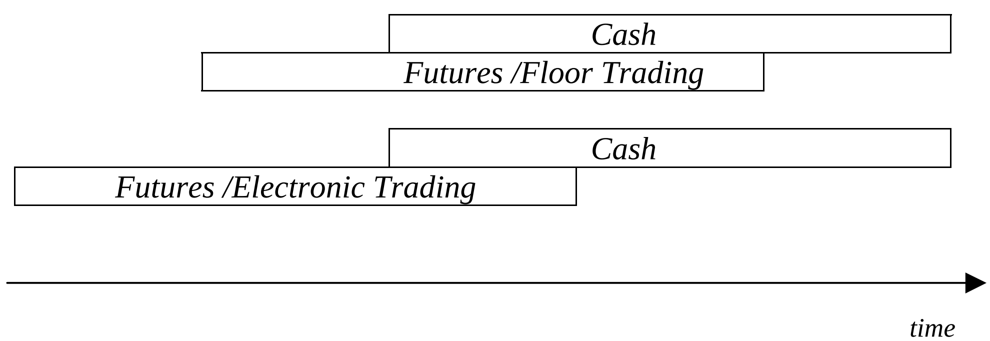
Hypotheses

Similar to the literature on the impact of electronic trading on transaction costs and liquidity, we argue that the bid-ask spread (as a proxy for transaction costs and liquidity) will be smaller after the trading migration. We also contend that if lumpy information is not released through futures trading, the informational lead of futures over cash should also decline after controlling for lumpy information release. However, trading futures may still be a preferred mean to convey less lumpy information if electronic trading reduces the trading cost for small order. If these conjectures are correct, then the futures lead over the cash index during times of high information intensity is reduced after electronic trading. In these investigations, we control for market activity, information intensity and information lumpiness.

Specifically, our paper tries to determine (1) whether the change to electronic trading of the futures market reduces the bid and ask spread in the futures price after controlling for market activity, information intensity and information lumpiness; (2) whether the change to electronic trading of the futures contract magnifies its lead over the cash index; (3) whether the change increases the level of integration between the futures and the cash stock markets as measured by the instantaneous feedback between cash and futures markets; and finally (4) whether the lead of futures over the cash index is affected by market activities, information intensity and lumpy information releases after electronic trading.

How the trading migration from floor to electronic trading affects feedback measures depends on the initial relation between futures and cash markets. It is commonly found that futures market tends to lead cash market. Therefore, a further increase in the speed of futures market to incorporate information would imply: 1) a reduction in instantaneous feedback between futures and cash markets; and 2) an increase in the feedback from futures market to cash market.

Is it conceivable that instantaneous feedback between futures and cash market becomes weaker? The following char illustrates our arguments. The overlapping area indicates the instantaneous feedback between futures and cash markets, which is reduced after the trading migration to electronic screen-based trading in the futures market.



To summarize, we have the following hypotheses regarding the impact of electronic trading:

- Hypothesis 1: the bid-ask spread is reduced after electronic trading.

- Hypothesis 2: the trading migration to electronic trading from floor trading reduces the instantaneous feedback relation between cash and futures markets.
- Hypothesis 3: the trading migration to electronic trading strengthens the feedback from futures market to cash market.
- Hypothesis 4: instantaneous feedback (between the futures and cash index) is positively related to trading intensity (volume and volatility)
- Hypothesis 5: conditional on the release of lumpy information, the futures lead over the cash index is reduced after electronic trading

Methodology

To examine Hypothesis 1, we use the following regression model:

$$Spread_t = \alpha_0 + \alpha_1 D_t + \alpha_2 R_t + \alpha_3 SIZE_t + \alpha_4 (D_t \cdot SIZE_t) + \alpha_5 \sigma_t + \alpha_6 VOLUME_t + \upsilon'_t \quad (1)$$

where D_t = period dummy variable which is one after the migration from open outcry trading to electronic screen-based trading in the futures market.

R_t = daily futures return

σ_t = intradaily futures market volatility

$Spread_{,t}$ = effective bid-ask spread of futures market as measured by average of daily bid-ask spread

$SIZE_t$ = daily average deal size of futures

υ'_t = random error term.

The futures market volume and intradaily volatility proxy market intensity. The daily average deal size is used as a proxy for information lumpiness. We expect that α_1 is negative in Equation (1). That is, after controlling for market activity, information intensity, and information lumpiness, the electronic trading reduces the effective bid-ask spread (reduces futures market transaction costs and enhances futures market liquidity).

To examine Hypotheses 2 to 5, we need to calculate the dynamic relationships (both instantaneous feedback and futures to cash feedback) between futures and cash markets in a daily basis. Following Kawaller, Koch and Koch (1993), we use Geweke (1982) feedback measures to quantify the strength of dynamic relation between futures and cash markets. Geweke feedback measures have an advantage of representing cardinal measures of the inter-dependence between two time series. Let S_t and F_t denote the logarithms of cash and futures prices, respectively. We consider a vector autoregression model with error-correction (VECM). We have the following equations:

$$S_t = \mu_1 + \sum_{i=1}^{P} a_i S_{t-i} + \sum_{i=1}^{Q} b_i F_{t-i} + \varepsilon_{St} \tag{2}$$

$$F_t = \mu_2 + \sum_{i=1}^{Q} c_i S_{t-i} + \sum_{i=1}^{P} d_i F_{t-i} + \varepsilon_{Ft} \tag{3}$$

where the variance/covariance matrix of $(\varepsilon_{St} \varepsilon_{Ft})$ is

$$Y = \text{cov}\begin{bmatrix} \varepsilon_{St} \\ \varepsilon_{Ft} \end{bmatrix} = \begin{bmatrix} \sigma_{\varepsilon S}^2 & \sigma_{SF} \\ \sigma_{FS} & \sigma_{\varepsilon F}^2 \end{bmatrix}.$$

If there is no inter-temporal relationship between cash and futures prices, then Equations (2) and (3) are reduced to

$$S_t = \mu_1^{'} + \sum_{i=1}^{P} a_i^{'} S_{t-i} + u_{St} \tag{4}$$

$$F_t = \mu_2^{'} + \sum_{i=1}^{P} d_i^{'} F_{t-i} + u_{Ft} \quad (5)$$

with $\text{var}(u_{St}) = \sigma_{uS}^2$ and $\text{var}(u_{Ft}) = \sigma_{uF}^2$. Geweke (1982) feedback measures are:

$$G_{in} = \ln(\hat{\sigma}_{uS}^2 \cdot \hat{\sigma}_{uF}^2 / |\hat{Y}|)$$

$$G_{F \Rightarrow S} = \ln(\hat{\sigma}_{uS}^2 / \hat{\sigma}_{\varepsilon S}^2)$$

$$G_{S \Rightarrow F} = \ln(\hat{\sigma}_{uF}^2 / \hat{\sigma}_{\varepsilon F}^2)$$

$$G = G_{in} + G_{FS} + G_{SF}$$

Following Geweke (1982), the instantaneous feedback between futures and cash markets is measured by G_{in}. G_{FS}, G_{SF}, and G measure the feedback from futures market to cash market (or the extent futures leads cash market), from cash market to futures market (or the extent cash leads futures market), and total feedback between cash and futures markets respectively. We use the intradily data in estimating various Geweke measures in daily basis. Based on the daily Geweke feedback measures, we conduct the following cross-sectional regression analyses:

$$G_{in,t} = \beta_0 + \beta_1 D_t + \beta_2 R_t + \beta_3 SIZE_t + \beta_4 (D_t \cdot SIZE_t) + \beta_5 \sigma_t + \beta_6 VOLUME_t + \upsilon_t \quad (6)$$

$$G_{FS,t} = \gamma_0 + \gamma_1 D_t + \gamma_2 R_t + \gamma_3 SIZE_t + \gamma_4 (D_t \cdot SIZE_t) + \gamma_5 \sigma_t + \gamma_6 VOLUME_t + \xi_t \quad (7)$$

where D_t = period dummy variable which is one after the migration from open outcry trading to electronic screen-based trading in the futures market.

R_t = daily futures return

σ_t = intradaily futures market volatility

$G_{in,t}$ = Geweke feedback measures of instantaneous feedback are based on intradaily feedback relationship from Equations (2) to (5).

$G_{FS,t}$ = Geweke feedback measure from futures to cash that are based on intradaily feedback relationship from Equations (2) to (5).

$SIZE_t$ = daily average deal size of futures

υ_t and ξ_t = random error terms.

Equations (6) and (7) attempt to examine the impact of electronic trading on the dynamic relationship between cash and futures markets after controlling for futures market activity, information intensity, and information lumpiness. Information intensity is proxied by intradaily standard deviation of futures market price changes and trading volume. Information lumpiness is proxied by the average deal size (i.e., daily trading volume divided by number of deals in a day). To mitigate possible time-varying heteroskedasticity in the time series data, we use Hansen's (1982) generalized method of moments (GMM) estimation to get robust standard errors of the coefficients. As the length of residual autocorrelation in regression is unknown, we also use Andrews's (1991) method of automatic bandwidth selection in the GMM estimation.

According to Hypothesis 2, $\beta 1$ should carry a negative sign. If Hypothesis 3 is correct, $\gamma 1$ is positive. For the information intensity (Hypothesis 4), we expect positive signs for $\beta 5$ and $\beta 6$. Regarding to Hypothesis 5, $\gamma 4$ should be negative.

Data

We use minute-by-minute quotes of the Hong Kong Hang Seng Index and the tick-by-tick transaction and the bid and ask quote records of the Hong Kong Hang Seng Index futures for the period September 1, 1999 to February 28, 2001. The data are provided by, respectively, the Hang Seng Index Services Ltd., (H.K.) and the Hong Kong Exchange and Clearing (the Exchange, hereafter). To avoid the potential distortion due to market immaturity and possible unusual trading behavior in anticipation of the event, the data for the entire month of May and June are discarded since the migration of futures to electronic trading takes place on June 6, 2000. Given the buffer surrounding the event, the data provides an eight-month window period before and after the migration. Daily trading summary of the futures contracts is obtained from the Exchange web site. The study focuses on the spot month contract since it maintains the highest liquidity after the migration. The next month contract has higher liquidity than the spot contract only on the expiration day of the latter; hence, the next month contract is substituted for the spot month contract on the last trading day of the month.

Although the index quotes are reported every 15 seconds, the study adopts the minute-by-minute sample. For each index quote, we search for the nearest futures price. A matched pair of the index and index futures is obtained if the stamped times of the futures and of the index quote are apart by no more than 30 seconds. In the absence of a suitable futures price around the index, the futures price adopted in the previous interval is used.

To alleviate the stale price problems associated with the quote data retrieved during the era with floor trading, the study focuses on the change in the effective spreads of the futures contract surrounding the change to electronic trading. The effective spread is defined as the difference between a traded price that is executed at the asked price and the price of the nearest adjacent trade that is executed at the bid price. A trade that is executed at the asked price is hereafter called an ask trade which those executed at the bid price is called a bid trade. The study adopts the following procedures to identify such trades.

In the first pass test, a trade is identified according to the nearest matched pair of bid/ask quotes. The maximum time difference among the stamped time of the trade and the bid/ask quotes is restricted to one minute, and the bid price quote is strictly lower than the asked price quote.

Lee and Ready's (1991) is adopted in cases where an exact matching between traded price and quotes cannot be found. A trade is classified as an ask (a bid) trade if the traded price is above (below) the bid/ask quotes. In cases where the traded price falls exactly on the mid-point, the following tick test is adopted to classify the trade. If the current traded price is above (below) the previous one, the trade is an uptick (downtick) and is classified as an asked (a bid) trade. If the current price is equal to the previous one, then the trade is classified according to the trade before the previous one. A zero-uptick (i.e., the previous trade is traded at an uptick) is classified as an ask trade, and a zero-downtick (i.e., the previous trade is traded at a downtick) is classified as a bid trade. The process stops when there were no changes in the traded price in the last two transactions, and the trade will not be included in the analysis. Moreover, the maximum time difference between the current trade and the oldest transaction (for the purpose of identification) is restricted to five minutes.

4. Results and Discussions

Table 1 Panels A to C present summary statistics of the variables. In Panel A with the full sample from Sep 1, 1999 to Feb 28, 2001 (with May and June 2000 omitted), there were 6,021 deals (median) on a typical trading day. The median daily trading volume of the HSI futures was 14,685 contracts with a volatility of 9.48% as measured by standard deviation of the minute-by-minute futures price changes. The median index return was 0.75% as measured by the daily open-to-close continuously compounded return. Panels B and C show similar statistics with an interesting finding. The number of deals after the implementation of electronic trading increased in terms of mean and median. Panel C has 10,252 (mean) and 9,141 (median) deals per day as compared with 2,744 (mean) and 2,051 (median) in Panel B. Given the trading volumes are similar in both Panels B and C, the average deal size decreased. This is consistent with the literature that, after switching from floor to electronic trading, the releases of lumpy information tend to decrease. On the contrary, the effective spread has a median of 7.26% in the outcry period in Panel B, which is larger median during the electronic trading period in Panel C. However, the market activity, information intensity, and information lumpiness were not controlled in the analysis.

Table 2 presents the effects of electronic trading on the transaction costs and liquidity using GMM estimation of Equation (1). As expected, the coefficient associated with the electronic trading dummy variable is negative and significant at 1% level after controlling for market activity, information intensity, and information lumpiness. The finding is consistent with the literature, i.e., after trading migration to electronic trading, the futures market experiences a decrease in transaction cost and better market liquidity as the bid-ask spread decreases.

Table 3 presents how the Geweke instantaneous feedback and futures to cash market feedback measures related to an electronic trading environment, market activity, information intensity as well as information lumpiness as described in Equations (6) and (7). Again, the results are from GMM estimation. From Table 3 Columns (2) and (3), the electronic trading dummy variable (with electronic trading period = 1) for the instantaneous equation is –1.1016 and significant at 10% level. The futures return variable is also negative and significant at the 10% level. The information intensity variable (as proxied by futures volatility) has a value

0.7719 and significant at 5% level. The information lumpiness variable is not significant. The results suggest that instantaneous feedback is weakened in the electronic trading period after controlling for market activity, information intensity, and information lumpiness. During times of falling futures market (i.e., futures return is negative) and high information intensity, the instantaneous feedback between futures and cash market is stronger. The results in Table 3 support Hypotheses 2 and 4.

In Table 3 Columns (4) and (5), the dependent variable is the Geweke's feedback measure of futures market to cash market. The dummy variable for electronic trading is positive and significant at 5% level. In addition, electronic trading and daily average deal size interaction variable (D_t * $SIZE_t$) carries a negative sign and significant at 10% level. The findings indicate that the information flow from futures market to cash market increases during the electronic trading period. However, after controlled for lumpy information releases, the information flow actually decreases. Again, the results support Hypotheses 3 and 5.

5. Summary

This study has examined the impact of migration to electronic trading on the relative informational efficiency of an index futures contract. The recent move to electronic trading of the Hong Kong Hang Seng Index futures contract provides an opportunity to study how the change affects the effective spread in the futures market and the dynamic relationship between the futures and the underlying cash index. The current study adopts a high frequency data set of the index and the futures surrounding the event to directly investigate how the change affects effective spread and the dynamic relationship. The study examines via Geweke's feedback measures how various market factors affect the dynamic relationships.

The findings suggest that the effective spread of the futures price is reduced following the trading migration of the contract to electronic trading. In addition, the information flow from futures to the cash index is strengthened while the instantaneous feedback between futures and cash markets is weakened after the migration of futures trading to the electronic platform. The instantaneous feedback and futures to cash feedback information flow are strengthened in a falling market. However, consistent with the literature, a trading migration from floor to electronic trading reduces the release of lumpy information, which tends to reduce the feedback from futures to cash market.

Reference

Admati, A.R. and Pfleiderer, P. (1988). A theory of intraday patterns: volume and price variability, *Review of Financial Studies,* 1, 3-40.

Cornell, B., and French, K. (1983). Taxes and the prices of stock index futures, *Journal of Finance,* 38, 675-694.

Engle, R.F., and C.W.J. Granger (1987). Co-integration and error correction: representation, estimation, and testing." *Econometrica*, 55, 251-276.

Easley, D. and O'Hara, M. (1987). Price, trade size, and information in securities markets. *Journal of Financial Economics,* 19, 69-90.

Finucane, T.J. (2000). A direct test of methods for inferring trade direction from intra-day data. *Journal of Financial and Quantitative Analysis*, 35, 553-576.

Frino, A., and West, A. (1999). The lead-lag relationship between stock indices and stock index futures contracts: further Australia evidence. *Abacus*, 35, 333-341.

Fung, J. K. W., and Jiang, L. (1999). Restrictions on short-selling and spot-futures dynamics. *Journal of Business Finance and Accounting,* 26, 227-248.

Fung, J.K.W. and P. Draper (2000). Onscreen trading of stocks and the mispricing of index-futures during financial crisis and government intervention. Working paper, Hong Kong Baptist University.

Fleming, J., Ostdiek, B., and Whaley, R. E. (1996). Trading Costs and the Relative Rates of Price Discovery In Stock, Futures, and Option Markets. *Journal of Futures Markets*, 16, 353-387.

Franke, G. and Hess, D. (2000). Information diffusion in electronic and floor trading. *Journal of Empirical Finance,* 7, 455-478.

Frino, Alex, Thomas H. McInish and Martin Toner (1998). The liquidity of automated exchanges: new evidence from German Bund futures, *Journal of International Financial Markets, Institutions and Money*, 8, 225-241.

Garbade, K. D., and Silber, W. L., (1983). Price movements and price discovery in futures and cash markets, *Review of Economics and Statistics*, 65, 289-297.

Granger, C.W.J. (1980). Testing for causality: a personal viewpoint, *Journal of Economic Dynamics and Control,* 2, 329-352.

Grunbichler, A., Longstaff, F. A. and Schwartz, E. S. (1994). Electronic screen trading and the transmission of information: an empirical examination. *Journal of Financial Intermediation,* 3, 166-187.

Harris, L. (1989). The October 1987 S&P 500 stock-futures basis, *The Journal of Finance*, 44, 77-99.

Hasbrouck, J. (1993). Assessing the quality of a security market: a new approach to transaction-cost measurement. *Review of Financial Studies,* 6, 191-212.

Hasbrouck, J. (1995). One security, many markets: determining the contributions to price discovery. *Journal of Finance,* 50, 1175-1199.

Jiang, L. and J.K.W. Fung, and Cheng, L.T.W. (2001). Lead-lag relationship between spot and futures markets under different short-selling regimes. *Financial Review,* 36, 63-88.

Kawaller, I. G., Koch, P. D., and Koch, T. W., (1993). Intraday market behavior and the extent of feedback between S&P 500 futures prices and the S&P 500 index. *Journal of Financial Research,* 16, 107-121.

Kumar, P. and Seppi, D. (1994). Information and index arbitrage. *Journal of Business,* 67, 481-509.

Kleidon, A.W. (1992). Arbitrage, nontrading, and stale prices: October 1987. *Journal of Business*, 65, 483-507.

Kleidon, A.W., and Whaley, R. E. (1992). One market? Stocks, futures, and options during October 1987. *Journal of Finance*, 47, 851-877.

Lee, C.M.C., and Ready, M.J. (1991). Inferring trade direction from intraday data. *Journal of Finance*, 46, 733-746.

Martens, M. (1998). Price discovery in high and low volatility periods: open outcry versus electronic trading. *Journal of International Financial Markets, Institutions and Money*, 8, 243-260.

Miller, M.H. (1997). The futures of futures. *Pacific-Basin Finance Journal,* 5, 131-142.

Miller, M.H., Muthuswamy, J., and Whaley, R.E. (1994). Mean reversion of Standard & Poor's 500 index basis changes: arbitrage-induced or statistical illusion? *Journal of Finance*, 49, 479-513.

Modest, D.M. and Sundaresan, M. (1983). The relationship between spot and futures markets, *Journal of Futures Markets,* 3, 15-42.

Niemeyer, J. (1994). An analysis of the lead-lag relation between the OMX index futures and the OMX cash index. Paper presented to the Seventh Annual European Futures Symposium, Bofnn.

O'Hara, M. (1995), *Market Microstructure Theory*. USA: Blackwell.

Schwarz, T. V., and Laatsch, F. E., (1991). Dynamic efficiency and price leadership in stock index cash and futures markets. *Journal of Futures Markets,* 11, 669-683.

Stoll, H. R., and Whaley, R. E. (1990). The dynamics of stock index and stock index futures returns. *Journal of Financial and Quantitative Analysis*, 25, 441-468.

Sutcliffe, C.M.S. (1997). *Stock index futures: theories and international evidence* (2^{nd} ed.). USA: International Thomson Business Press.

Taylor, N., van Dijk, D., Franses, P.H., and Lucas, A. (2000). SETS, arbitrage activity, and stock price dynamics. *Journal of Banking and Finance*, 24, 1289-1306.

Tse, Y. and T.V. Zabotina (2001). Transaction costs and market quality: open outcry versus electronic trading. *Journal of Futures Markets*, 21, 713-735.

Yadav, P.K. and P.F. Pope (1990). Stock index futures arbitrage: international evidence. *Journal of Futures Markets*, 10, 573-603.

Yadav, P.K. and P.F. Pope (1994). Stock index futures mispricing: profit opportunities or risk premia? *Journal of Banking & Finance*, 18, 921-953.

Table 1. Summary Statistics of the Market activity variables

This Table provides various summary statistics of the market activity variables. Volatility is measured by the standard deviation of the minute-by-minute futures returns for each day during the sample period. Volume stands for the total futures volume for all maturity traded on each day. Number of deals is the total number of futures transactions according to the official report of the exchange. Average deal size is calculated as the total futures volume divided by the total number of deals for the day. Index return (in %) is the open-to-close continuously compounded return for the HSI index.

Panel A: Full sample (Sep 1, 1999-Feb 28, 2001); N=326 days

	Mean	Std	Min	Med	Max
Number of deals	6,498	4,826	1,048	6,021	26,844
Volume	16,486	6,250	6,572	14,685	41,912
Volatility	10.90	5.26	4.27	9.48	52.73
Avg. deal size	4.47	3.90	0.71	2.70	21.18
Index Return	-5.89	137.94	-507.48	0.75	415.41
Effective spread	7.71	2.71	4.41	7.37	51.74

Panel B: Before electronic trading (Sep 1, 1999-Apr 30, 2000); N=163 days

	Mean	Std	Min	Med	Max
Number of deals	2,744	1,431	1,048	2,051	7,983
Volume	16,416	6,872	6,572	14,736	41,912
Volatility	11.94	5.44	4.27	10.71	52.73
Avg. deal size	7.21	3.88	1.94	7.09	21.18
Index Return	-6.46	154	-507.48	-1.06	391.24
Effective spread	7.71	3.61	4.55	7.26	51.74

Panel C: After electronic trading (July 1, 1999-Feb 28, 2001); N=163 days

	Mean	Std	Min	Med	Max
Number of deals	10,252	4,038	4,158	9,141	26,844
Volume	16,556	5,580	7,715	14,609	35,228
Volatility	9.86	4.88	4.38	8.53	31.50
Avg. deal size	1.72	0.57	0.71	1.57	3.29
Index Return	-5.32	120.24	-295.71	1.91	415.41
Effective spread	7.70	1.27	4.41	7.57	12.96

Table 2. Effects of switching to electronic trading system under different market activity, information intensity, and information lumpiness on effective bid/ask spread

$$Spread_t = \alpha_0 + \alpha_1 D_t + \alpha_2 R_t + \alpha_3 SIZE_t + \alpha_4 (D_t \cdot SIZE_t) + \alpha_5 \sigma_t + \alpha_6 VOLUME_t + \upsilon'_t \quad (1)$$

where D_t = period dummy variable which is one after the migration from open outcry trading to electronic screen-based trading in the futures market.
R_t = daily futures return
σ_t = intradaily futures market volatility
$Spread_{,t}$ = effective bid/ask spread of futures market as measured by average of daily bid/ask spread
$SIZE_t$ = daily average deal size of futures
υ'_t = random error term.

	Effective spread	
	Coeff.	**t-value**
Intercept	5.8384	47.75***
D_t, Trading environment dummy variable (electronic trading = 1; otherwise = 0)	-0.8603	-4.58***
R_t, Daily futures return	-0.0004	-2.55**
$SIZE_t$, average daily deal size	-0.093	-6.40***
D_t * $SIZE_t$	-0.4489	-4.72***
σ_t , intradaily futures market volatility	0.1381	1.25
$VOLUME_t$, Daily futures volume	$3.2*10^{-5}$	4.89***
R-square	0.6524	
N	326	

Table 3. Effects of switching to electronic trading system under different market activity, information intensity, and information lumpiness on instantaneous and futures to cash market information feedback

$$G_{in,t} = \beta_0 + \beta_1 D_t + \beta_2 R_t + \beta_3 SIZE_t + \beta_4 (D_t \cdot SIZE_t) + \beta_5 \sigma_t + \beta_6 VOLUME_t + \upsilon_t \quad (6)$$

$$G_{FS,t} = \gamma_0 + \gamma_1 D_t + \gamma_2 R_t + \gamma_3 SIZE_t + \gamma_4 (D_t \cdot SIZE_t) + \gamma_5 \sigma_t + \gamma_6 VOLUME_t + \xi_t \quad (7)$$

where D_t = period dummy variable which is one after the migration from open outcry trading to electronic screen-based trading in the futures market.
R_t = daily futures return
σ_t = intradaily futures market volatility
$G_{in,t}$ = Geweke feedback measures of instantaneous feedback are based on intradaily feedback relationship from Equations (2) to (5).
$G_{FS,t}$ = Geweke feedback measure from futures to cash that are based on intradaily feedback relationship from Equations (2) to (5).
$SIZE_t$ = daily average deal size of futures
υ_t = random error term.

	Instantaneous feedback		**Feedback from futures to cash market**	
	Coeff. (2)	**t-value (3)**	**Coeff. (4)**	**t-value (5)**
Intercept	21.2201	45.95***	12.9386	29.80***
D_t, Trading environment dummy variable (electronic trading = 1; otherwise = 0)	-1.1016	-1.80*	1.1904	2.24**
R_t, Daily futures return	-0.0014	-1.71*	-0.0019	-2.40**
$SIZE_t$, average daily deal size	-0.0407	-0.80	0.0897	2.03**
D_t * $SIZE_t$	-0.2875	-0.95	-0.4084	-1.94*
σ_t, intradaily futures market volatility	0.7719	2.35**	0.2626	0.65
$VOLUME_t$, Daily futures volume	$3.9*10^{-5}$	1.64	$-1.0*10^{-5}$	-0.57
R-square	0.1463		0.0364	
N	326		326	