ELECTRONIC TRADING, LIQUIDITY AND INFORMATION EFFICIENCY: EVIDENCE FROM THE MONTREAL EXCHANGE

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ABSTRACT

Electronic Trading, Liquidity and Information Efficiency: Evidence from the Montreal Exchange

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This paper studies the deviation spread of the Equity Index S&P/TSX 60 Futures Contract SXF's daily price from the Cost of Carry Model before and after the contract is launched on the electronic trading platform in the Montreal Exchange. The relative stability of the deviation spread after the introduction of electronic trading shows strong market efficiency improvement. Besides this, after examining the relationship of the deviation spread with the trading volume and some other information sources generated on the trading venue before and after the introduction of the electronic trading, it is found that electronic trading greatly mitigates these information sources' adverse impacts on the spread's stability. This empirical evidence suggests that the information efficiency facilitated by the electronic trading may not conflict with the liquidity enhancement in the public exchange organization.

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TABLE OF CONTENTS

INTRODUCTION

As one of the technological innovations adopted by the security exchanges, electronic trading has become ubiquitous in recent years. The Chicago Mercantile Exchange pioneers the electronic trading mechanism transformation. After five years of planning, negotiation and development, the CME® Globex® electronic trading platform was launched on June 25, 1992. The Chicago Board of Trade began its after hour electronic trading sessions on 1994. Recently, the share of trades undertaken electronically has increased from a 20% share of all trades on both exchanges in 2001 to 53% on the CME and 56% on the CBOT during the first nine months of 2004. In Canada, the Montreal Exchange began its transfer to the electronic trading platform in 2000. Electronic trading outside the North America derivatives exchanges is also gaining acceptance. European financial exchanges made a full transition in the late 1990s. In London, the LME launched a new version of its electronic trading system, LME Select, in December 2003 while the IPE issued a directive to giving more priority to screen-based trading from November 2004. To explore the new potential brokerage profits, the investment bankers are also about to launch their over-the-counter products on their own electronic platform. Barclay Capital is one of those who have succeeded in this approach. It looks like that electronic trading will be an irreversible trend to be followed by the exchange organizations all over the world.

Besides its cost reduction efficiency, the recent rise of electronic markets in both private and public security exchange organizations is coupled with the issue of the exchanges' mergers motivated by the 'side-by-side' trading. More exchanges would like to acquire an electronic link with a derivative option market to facilitate the "side-by-side" trading. The so called "side-by-side" trading is the type of trading strategy which profits through trading simultaneously on two securities, one of which is usually an option contract matched by the other which is not necessarily a derivative product. For example, to catch up the fall of the stock price, one trader could straddle two options, throw in a futures contract to hedge an option, or short a stock to trade against an option.

In fact, the main motivation for this type of trading technique is to earn the forward basis spread change between two certain time points, no matter whether the trading vehicles would be two option contracts, or one option contract hedged with one futures contract, or one option contract traded against its corresponding spot position. However, the factors which influence the changing basis spread are very complex. As commented by Black (1986), it is sometimes hard to distinguish whether such a trade is based on illiquidity or real information, as the liquidity trading on "noise" could be arbitrary and mixed with the informational trading.

As claimed by some electronic markets' owners, the networking enhancement is eased by the digital technology, so the traders can pick up the trades more easily on both sides. However, under the traditional wisdom, especially in the old open outcry trading mechanism, the liquidity and the information efficiency are two trading targets which could hardly be conciliated. The reason is that if overall informational transparency is improved by the electronic screen trading, the "abnormal" spread profits would soon be detected and traded away, which means that it is hard to profit through the "side-by-side" trading if the market is liquid, since profiting from the informational trading has to be completed through the liquidity trading on illiquidity as commented by Black (1986). Moreover, as the futures contract is the derivative contract constructed directly on the forward basis spread, why do side-by-side traders not use the futures and spot contracts to pick up the spread directly but engage in two trades on the different sides with a more complicated option contract involved? What is exactly the role of electronic markets behind this scenario?

To start understanding the issue, the basis spread indicated directly by the Equity Index S&P/TSX 60's Futures Contract's daily price (traded as the Futures Contract SXF in the Montreal Exchange) from the Cost of Carry Model before and after the introduction of the electronic trading mode in the Montreal Exchange is studied. From the perspective of market efficiency, the basis spread is compared with the theoretical spread inducted from the Cost of Carry Model, a basis estimation model based on the publicly revealed information. As implied by the principles of market efficiency, if the market is more efficient after the introduction of electronic trading, the basis spread should not deviate further away from the public information shared and known by every market participant.

The empirical evidence collected finds that the deviation spread of the Equity Index S&P/TSX 60's Futures Contract SXF's daily price from the Cost of Carry Model's estimation is narrowed. And as to the issue of liquidity, electronic trading mitigates the various informational sources' adverse effects from the trading venue, such as the daily trading volume's adverse impact on the spread's stability.

As documented in Clyman, Allen and Jaycobs (1997), one explanation for the above liquidity improvement in the futures market accompanied with narrowing spreads can be the arbitrage trading across the spot and futures market. Moreover, the narrowing of the trading spread can be explained by increasing competition, which may result from the detected arbitrage opportunities digested by the market accordingly.

What is interesting is that this type of arbitrage trading across two markets is not as riskless as assumed by the theory. One limitation for this type of arbitrage is its inability to adjust the underpricing of futures contracts as to the market limitations for borrowing and shorting the spot position. In addition, as arbitrage trading has to be carried out in two markets, the arbitragers in the traditional sense would always not be able to liquidate their holdings on one of the two sides. It is exactly the risky part which deserves more attention. Since the electronic trading speeds up both the digestion and revelation of the market information no matter inside or outside the trading venue, how will the arbitragers capture the arbitrage opportunities in the new and quick trading mechanism?

Different from the futures contract, a party involved in an option contract owns a right to choose rather than bears the obligations to hold. So it could be easier to execute the arbitrage trading by using an option on one side. From Switzer, Varson and Zghidi (2000), it can be expected that if option trading is more efficient for the investors to pick up the spread than the use of futures contracts, the trading volume of the futures contracts will decrease, and its performance would hurt the overall market efficiency; however, if option trading is a trading vehicle which provides the same easy availability of the spread trading for the investors, the trading volume and efficiency of futures contracts will grow accordingly.

What needs attention is that for public exchanges, there is an open organization as the electronic trading market for futures contracts with the estimation basis which can be directly induced from the publicly revealed information accessible to every participant. So in this type of market organization, there still exists a benchmark spread or price, which is totally different from the situation where no benchmark, no integrated market evaluation nor any index the market could refer to, especially as in some scenarios with some exotic over-the-counter derivative products.

The paper proceeds as follows: Section II provides the literature review; Section III and IV present the description of the data and research methodology; Section V, VI and VII discuss the results and the related implications.

LITERATURE REVIEW

Black (1971) characterizes a liquid market as having the following properties:

(1) There are always bid and ask prices for the investor who wants to buy or sell small amounts of stocks immediately.

(2) The difference between the bid and ask (the spread) is always small.

(3) An investor who is buying or selling a large amount of stock, in the absence of special information, can expect to do so over a long period of time at a price not very different, on average, from the current market price.

(4) An investor can buy or sell a large block of stocks immediately, but at a premium or discount that depends on the size of the block. The larger the block, the larger the premium or discount.

In the automated stock exchange proposed in Black (1971), if the trader traded on private informational reasons, and their trading volume executed all in one time was large enough to exert its influence on the market price, the market mechanism should not let him profit. The market's controlling power to constrain the profitability of informational trading is to impose the premium on the size of the informational trades. Therefore, the price movement reacting to the large trading volume size, which was caused by the informational shock revealed on the automated exchange trading venue, should not be regarded as the characteristics of illiquidity, but a function to protect the market efficiency. Thus, in Black's design of the automated stock exchange, the loss of the informational traders on its volume size is justifiable, and not an issue of liquidity due to its market efficiency role. For the liquidation trader, Black suggested making use of the futures contract to arrange a liquidation transaction at a certain point of time in the future for the spot position held by the trader at the present to solve the problem.

On the spot market, in Kyle (1985), instead of assuming a competitive rational expectation model, an imperfect competition model is built to account for the private informational advantage of the informed insider, as the informed trader has an incentive to restrict the quantity he trades due to the informational trading size discount as described in Black (1971 a, b). The informed trader would more act as "a textbook monopolist". Given the market microstructure related to private information like this, prices would always move less than they would in the corresponding competitive model. The anticipation of the price impact, which would follow information revealed on the informational trading size, always keeps the insiders away from revealing the information on the trading venue and pressures them to hide their trades among the noisy trades. This ex post informational problem is commonly called the Moral Hazard issue in the informational trading literature.

In its theoretical model, Kyle (1989) structures the continuous exchange trading sessions as the sequential auction equilibrium between the informed traders and the uninformed noise traders. He shows that the informed traders can take advantage of the uninformed noisy traders for the information which is privately produced, and the uninformed traders who lose money consistently pay for the private information which informed traders acquires. As stated in Kyle (1984), "if a willingness on the part of some participants to make expected losses is not present, then there is no reason for the market to exist." Hence, as long as the information production is costly and more accessible to large traders than to small investors, a moral hazard problem will definitely exist and there is no way to avoid the tradeoff problem between the market informational efficiency and liquidity for the exchange governors.

On the derivative market, things developed not so simple either. The market seems forever hard to be complete as designed. The derivative user's strategies, such as program trading, portfolio insurance or arbitrage, exaggerated both the derivative and its underlying securities' volatility, even though theoretically it can be assumed that a derivative security can be replicated by a dynamic trading strategy with a risk-free asset and other securities. The liquidity crisis was intensified by the sequential derivative trading strategies following the information shock, such as what happened to Long Term Capital Management (LTCM). This even made the press question the validity of the derivative market as an ideal liquidation place to lock the future cash inflows as suggested by Black (1971)'s trading strategy.

Although claimed to serve as the risk management tools, derivative products never seem effective to reduce the riskiness, especially for the uninformed traders. The uninformed traders often have to adjust their holding position passively, and the information they can get is often delayed, and even badly twisted. Even though they can dynamically hedge the risk by the derivative security, they cannot effectively hedge away the price risk following the information shock. They can seldom catch up with the speed of the price adjustments both in the spot market and the derivative market, nor can they always have the freedom to stop chasing the price movements. One of the reasons is that when they adjust positions, all the others would do the same, which further expands the volatility.

In fact, the main issue here is that facing the information shock, there exists neither the basis to converge heterogeneous opinions, nor the effective mechanism to disseminate the irrational herding behavior. The deep reason is that within the traditional trading mechanism system, the information production or revelation is costly. More importantly, the relation-based open outcry mode widely used in that period helped the traders in the market to hide the information in order to get trades liquidated. This results in the monopolistic power of the informed trader, which the information revelation strategy to get orders executed even more unprofitable and unnecessary.

So in such an imperfect competitive market, everyone in the market would prefer to hide their private information as their monopolistic power, and expect that the others would behave irrationally so that they can extract more profits by their acquired information. Berkman and Hayes (2000) show the empirical evidence of the role of the floor brokers in the trading venue. They find that floor brokers have valuable information advantage over off-floor traders. The floor brokers help the traders to liquidate their trades by using limit orders as to the limit orders' option-like characteristics. In other words, based on the private information, the informed traders expect the price movement at the next round, and use the limit order book to wait for the right timing to pick it up. The open outcry agents just help the informed traders to "auction" the offers to the uninformed traders, while the uninformed traders bid against each other. The uninformed winners of the offer pay the most. Reversely, the informed traders, who are helped by the open outcry floor broker, extract out the most profits as they can. This type of the Winner's Curse problem is the essence of the intensified liquidity crisis following the information shock.

Nevertheless, Grossman (1988) reconfirms the positive function of the derivative products, whose ability to reveal the strategic trading information is indispensable for the relative stability across the spot and futures market. In this paper, Grossman stresses the information content of the price impact following the strategic moves taken by the traders, and rechecks the liquidity issue across the derivatives' and its underlying securities' market. As the introduction of futures and options products is closely associated with the trading strategies which are used for spot/futures arbitrage, hedging or portfolio insurance, the price of the traded derivatives not only reflects the demand intensity of its underlying security products and their related derivative products, but also signals the timing for the contrarian traders to arbitrage and profit from the price impact induced by the demand change. Since the strategic trading information revealed serves as the trigger to arbitrage back the pricing deviation, this paper theoretically justifies the price impact caused by the hidden information implied in the trade quotes from the derivative strategy users.

For a solution, Grossman (1988) recommends that each exchange could set up a system where stop-loss orders and other limit orders could be sent to a central computer where all the orders' information could be aggregated and the results could then be made to the public continuously. As many specialists have already used an "electronic book", it is proposed to link the books across different stock markets and to publicly display the size of all the limit orders for the derivative products contingent on various indices. If the trading information was revealed across the spot and futures/options market by electronic books, the resulting contrarian trades could then ease the tradeoff issue between the information efficiency and the liquidity.

However, the problem with Grossman's proposal is his reliance on the intermediary agents' assistance to execute the contrarian trading and to pull back the market's sense of pricing rationality. As will be mentioned in the later part of this section, the drawback with Grossman's design is that the stop-loss order and the other limit orders, the sources of the desired trading information, do not function as efficiently as they have performed under the open outcry mode. The main reason is that the electronic trading network substantially accelerates the trading quotes' update. When facing the information shocks, the orders may even not be able to get executed when they are submitted as the stop-loss orders or as any other type of the limit orders. Therefore, the aggregation of the strategic moves by inducting them from the price moves across the spot and future market may not even be plausible, although the overall transparency of the market is greatly improved.

In fact, as to the informational efficiency, several studies have appeared to examine the efficiency dilemma between the liquidity and information transparency. Akerlof (1970) asserts that the information efficiency in the trading mechanism is not possible because of Gresham's Law, that is, "Bad money drives out good if they exchange for the same price." Leland and Pyle (1977) point out that there is something intrinsic in intermediation which could be applied to solve moral hazard problems. Following his hypothesis, two streams of literature are developed to solve the dilemma problem through the function of the financial intermediary. Campbell and Karcaw (1980) examine the signaling role of financial intermediaries to ease the asymmetric information conflicts by purchasing the assets in the assets market. But they also notice that the initial endowments of the signaling intermediaries set the constraints to their intervention capability, and they may not have enough resources to prove the reliability of their information to the whole market. Gordon and Pennacchi (1990) suggest that the financial intermediaries can act as the agents to split the cashflows of the risky assets, and can create the riskless liquidity securities for the uninformed investors to diversify and avoid the risk. Unfortunately, the cases referred to in these papers do not relate to public exchange organizations.

In the past few years, globalization, rapidly changing technology, and mounting competition change the environment dramatically. Macey and O'Hara (1999) find that the cost of the information acquisition and production has been lowered substantially. More specifically, the information production in the public exchange becomes less dependent on the listed corporations, and more and more information is generated out of the exchange system and much easier to be accessed. So the public exchange operates much more independently of the listed firms than before.

Even within the organizations of the public exchanges, things are different now. Locke and Venkatesh (1997) show that futures contracts' transactions tend to occur directly between the customers to eliminate the leakage and save the transaction costs. Manaster and Mann (1996) demonstrate that the market environment for market makers is now more competitive than before, so the market makers always adopt active inventory management strategies rather than the inventory neutral strategies as assumed in earlier studies.

As to the investors, Deli and Varma (2002) find that the main reason for investors to use derivatives, especially equity derivatives, is for the purpose of saving transaction costs and of enhancing liquidity. Langowski, Park, and Switzer (1997) suggest using the treasury futures and futures options to save the cost for hedging the mortgage backed securities. For the trading opportunity, Roll et al. (2005) document the mutual causal relationship between the arbitrage trading and the market liquidity. In addition to the acknowledged case that the liquidity can facilitate the arbitrage, it is found that the shocks to the absolute basis predict the stock market liquidity. Liquidity shocks forecast future shifts in the long-term basis, suggesting that liquidity affects arbitrageurs more in less active longer-term futures contracts. Since the informational trading first induces the expansion of the deviations of the futures' pricing from its theoretical Cost of Carry Model price based on its spot position, it precedes the improvement of the market liquidity provided by arbitrage trading. Therefore, in the situation studied by the paper, the enhanced liquidity can be the result of the up-to-date information revelation and transparency, rather than its constraints.

As a new entity born in the new environment, the electronic trading market shows a number of novel characteristics which have never happened before in the old open outcry mode. Hasbrouck (2005) studies the use of the limit order book in the Island Electronic Communication Network (ECN). He finds that different from the option like characteristics as documented in Berkman and Hayes (2000), the limit book is used by the investors as the bargaining tool rather than for the best execution. After the bargaining process, the investors always withdraw their limit orders, and tend to use the market order instead for the execution.

Gilbert and Rijken (2006) study the impact from the usage of limit order book by screen trading on the depth of the LIFFE FTSE 100's futures market. They find that with screen trading, the digestion of the large order does not depend on the volume size per se, but against the opposite trading sides existing in the order book. However, they do not find the evidence that the new way of order digestion may improve the market depth. This suggests the adverse selection dilemma that the screen trader would have to face in order to protect their private information.

Clyman, Allen and Jaycobs (1997) examine the source of the liquidity in FINEX's (The financial instruments division of the New York Cotton Exchange) U.S. Dollar Index Futures Contract. They find that volume is not the decisive factor for the market's liquidity. Rather, the main source of liquidity is borrowed from the underlying markets channeled by arbitrage trading.

METHODOLOGY

The Equity Indices' Futures Contract market provides a platform for the traders, who believe in their ability to predict or who hold a confident view in their valuation of the futures price of the equity index, to take the risk, express their forecast estimates, and get an adequate price. It should not be used as a trading venue for the insiders to take advantage over both the uninformed and the spot traders, nor to claim the excessive profit margin which they do not deserve. Therefore, a relatively stable spread based on public information between the futures price and spot price is very important for the overall efficiency across the futures and spot market.

In this paper, the deviation spread of the Equity Index S&P/TSX 60 Futures Contract SXF's daily price from the Cost of Carry Model, a futures pricing model based on public information, is examined before and after the contract is launched on the electronic trading platform in the Montreal Exchange. The empirical study is carried to test whether the deviation spread narrows after introducing the electronic trading mode on the contract, as well as whether it becomes much less affected by the trading volume revealed on the futures contracts' trading venue. The relative stable daily spread shows strong market efficiency improvement after the introduction of the electronic trading, and the relative stability of the spread still holds even on the account of the trading volume's impact, which is always the source of the illiquidity based on its asymmetric information nature. This paper also tries to examine the relationship of the deviation spread with the trading volume and some other information sources generated on the trading venue before and after the introduction of the electronic trading. After decomposing their contributions respectively to the deviation spread and extracting out each component's change related to the impact brought by the electronic trading, it is found that electronic trading greatly mitigates these information sources' adverse impacts on the spread's stability. This empirical evidence shows that the information efficiency facilitated by the electronic trading may not conflict with the liquidity enhancement in the public exchange organization.

The Cost of Carry Model

The Cost of Carry Model is a futures' pricing model based on arbitrage strategy and public information available across the spot and futures market. Rational pricing of a futures contract should represent the current price of the underlying asset adjusted for the opportunity cost that arises from delayed settlement. In practice, the numerical difference between a spot and a futures price is referred to as the basis. So it is evident that the key of futures products' pricing is to estimate the adequate basis by its opportunity costs.

The Cost of Carry Model determines the basis on a no-arbitrage basis. As the law of one price implies, the cashflows of entering into a futures contract on the equity index can be replicated by borrowing the cash on the money market, buying the equity index on its spot market, and then carrying the basket of equities till the expiration date of the futures contract. The opportunity cost of holding the equity index futures contract by using the above replicating strategy is the difference of risk-free rate in the money market to borrow the cash for holding the futures contracts, and the dividend yield when the equity index is held till the expiration of the futures contract. Therefore, the daily basis of the futures contracts can be estimated on two rates: the riskfree interest rate and the dividend yield. If the futures price based on basis estimates is lower than the observed futures price, the cash and carry arbitrage, that is to sell the spot equity index and to buy the futures contract, can be executed. Reversely, if the futures price is underpriced, the reverse cash and carry arbitrage can be executed. As the arbitrage reverses the mispricing of the futures price from its basis estimates, the fair or theoretical value of the futures contract should converge to one price which accords with the Cost of Carry Model.

The Pricing Efficiency Hypothesis

The first hypothesis tested examines whether the average deviation of the Equity Index S&P/TSX 60 Futures Contract SXF's daily price from the Cost of Carry Model has changed after the contract is launched on the electronic trading platform in the Montreal Exchange. If electronic trading supports the law of one price as argued, the deviation spread from the Cost of Carry Model should be narrowed under the electronic trading.

Calculation of the Deviation Spreads from the Cost of Carry Model

As shown in equation (2.1), the Cost of Carry Model estimates the theoretical futures price $\hat{F}_t$ at time t by multiplying the spot price S_t with the estimation of the Cost of Carry $e^{(r-d)(t-T)}$. d is the dividend yield the spot equity index position can accumulate on a day to day basis. r is the riskfree interest rate which the traders are obliged to pay to finance their holding in the spot position one day after another. $t-T$ is the days remaining ahead before a spot position holder sell the holding spot position to get liquidated.

$$\hat{F}_t = S_t e^{(r-d)(t-T)} \qquad (2.1)$$

The dividend yield information is announced on the stock exchange. The daily riskfree interest rate can be interpreted from the Government Treasury Bond's Interest Rate updated by Bank of Canada. And the yield form the equity index and the daily forward interest rate are the premium/discount by which everyone who invest in equity index products will be affected. So based on the availability and commonality (besides the law of one price imposed by arbitrage opportunity), their spread could be assumed as a fair valuation of the opportunity cost to carry the spot equity index position based on the coherent opinions of the publicly revealed information.

As quoted in the public, the equity dividend yield and the government bond interest rate are always the annualized rates. To convert the annualized rate into the continuous compound daily rate, the process from the equation (2.2) is followed. r_d is the daily continuous compound return. r_y is the annualized rate which is collected.

$$r = 1 + r_d = (e^{\ln(1+r_y)})^{\frac{1}{365}} \qquad (2.2)$$

The deviation of futures price's deviation X_t at day t from the Cost of Carry Model is calculated as the difference between the futures price quoted in the equity index futures contract trading venue and the estimated futures price from equation (2.1).

$$X_t = F_t - \hat{F}_t \qquad (2.3)$$

The OLS estimation model for testing the cost of carry model is constructed as follows:

$$X_t = \alpha_0 + \alpha_1 \times DummyET_t + \varepsilon_t \qquad (2.4)$$

$$H_0 : \alpha_1 = 0$$

To verify the impact of electronic trading on the law of one price of the futures contracts, a dummy variable is set to account for the impact from the electronic trading. All the trading days available in data set before the introduction of electronic trading are set as zero, and the days afterwards are set as 1.

The Liquidity Hypothesis

The examination of the impact from the Futures Contract SXF's daily trading volume on the deviation series is constructed as follows:

$$X_t = \beta_0 + \beta_1 * Volume_t + \varepsilon_t \qquad (3.1)$$

To capture the impact of the electronic trading mechanism on the trading volume' effects on the deviation series, the coefficient β_1 in equation (3.1) is broken down into two components as in equation (3.2). By the same notion used in the regression estimation model (2.1), which is used to estimate the pure effects from electronic trading on the futures price's deviation series, β_{vol} can be interpreted as the expected impact of futures contract SXF's daily trading volume on the deviation series when not executed in the electronic trading platform, and β_{vol}^{ET} can be interpreted as the change of the Futures Contract SXF's daily trading volume impact on the deviation series after the introduction of the electronic trading into the trading venue.

$$\beta_1 = \beta_{vol} + \beta_{vol}^{ET} * DummyET \qquad (3.2)$$

Then the regression equation (3.1) can be reconstructed as in (3.3).

$$X_t = \beta_0 + \beta_{vol} * Volume_t + \beta_{vol}^{ET} * DummyET_t * Volume_t + \varepsilon_t \qquad (3.3)$$

$$H_0^{vol} : \beta_{vol} = 0$$

$$H_0^{vol*ET} : \beta_{vol}^{ET} = 0$$

Decomposition

To further quantify the components of the deviation spread contributed by different daily information sources within the trading venue before and after the introduction of electronic trading, the regressors from equation (3.2) are expanded from the following four data sources.

First, to account for the impact from the Cost of Carry Model estimates itself, three series, which are the days to maturity, the unsigned equity index dividend yield daily changes, and the unsigned three month Canadian Government Treasury Bill interest rate daily changes, are included into the regression. Second, the series of unsigned daily price changes of the Equity Index S&P/TSX 60 Futures Contract SXF is included. Third is the series of unsigned daily price changes of the Equity Index S&P/TSX 60's spot position.

The inclusion of the two unsigned spot and future market price change series accounts for the trading information revealed respectively from the spot and futures markets' trading venues. The fourth source of information included is the series of the daily trading volume, which reflects the impacts of the traders' private information on the deviation spread.

Except for the series of days to maturity, each time series of the above regressors is further expanded into nine subseries to account for the timing effects of the informational trading before and after each record's trading day. One of the subseries is the time series from each record's trading day itself (t). Four subseries are to account for the forecasting capacity of the deviation spread from the cost of carry model one day (t+1), two days (t+2), three days (t+3) respectively after each record's trading day, and also its average forecasting capacity between four days and twenty day (t+4,t+20) after the each record's trading day. Another four subseries are to account for the impact from the series which are one day (t-1) , two day (t-2) and three days (t-3) ahead of each record's trading day respectively, and the average impact from the series which is between four days and twenty days (t-20, t-4) ahead on the series of the record itself. In total, 46 subseries are set as described above.

After obtaining the regression results (see Table 7), the average deviation spread attributed to each series (and its consistent subseries) is decomposed into two components to identify the impact of the electronic trading on the deviation spread. The procedure has followed the process as described in equation (4)

$$\bar{S}_i = \beta_i \bar{x}_i$$
$$\bar{S}_i^{ET} = \beta_i^{ET} \bar{x}_i^{ET} \qquad (4)$$

$\bar{S}_i$ is the benchmark component which assumes the non-existence of the electronic trading. $\bar{x}_i$ is the average of each series (subseries). $\bar{S}_i^{ET}$ is the electronic trading component which accounts for the change brought by electronic trading on the deviation spread. $\bar{x}_i^{ET}$ is the average of the each series (subseries) only in the period within which the electronic trading is launched.

Some Details

The reason that the Montreal Exchange is chosen for testing is that the daily trading session of Equity Index Futures Contract SXF opens roughly at the same duration as its underlying spot market: Toronto Stock Exchange, where the contract's spot position is traded. This provides an excellent natural experiment to test the functions of electronic trading on synchronizing the futures and spot market, and its function on facilitating the detection of the arbitrage opportunity across the two markets.

In fact, this feature is very unique both internationally and within the range of the electronic trading, while the other equity index futures contracts in the other derivative exchange worldwide often provide after hour trading with the access to the electronic trading platform. So the impact of closing and opening effects on the pricing, which might be accounted by the after hour trading, can be also minimized in the testing of this paper.

The main attention is given to the impact of electronic trading on the Equity Index Futures Contract SXF based on the Equity Index S&P/TSX 60 index products in the Toronto Stock Exchange. To verify the effects of the Cost of Carry Model on the deviation spread of the daily futures price from the model itself, it is easier to estimate the equity index products than the other commodity futures products, especially in the perspective of the storage cost estimation. On the other hand, compared to the bond futures, it is more advantageous to examine both the private information impact and the public information impact on the equity futures products. Information Transparency is one of the biggest characteristics of the electronic trading. It is better to examine the efficiency pricing of equity futures than the bond futures for its much more plentiful private information with regards to the evaluation of its underlying equity constituents.

Montreal Exchange

The Montréal Exchange (MX), Canada's oldest exchange, is a fully electronic exchange dedicated to the development of the Canadian derivative markets. In 2000, the Montreal Exchange began its transfer to the electronic trading platform. On September 25, 2000, the CGB, the CGF and the OGB were transferred on the Montreal Exchange's new electronic trading platform SAM (Montréal Automated System). On July 16, 2001, the SXO was transferred on SAM. On October 1, 2001, the Exchange ceased trading junior listings. The Exchange completed its automation process with the transfer of stock options on SAM. All derivatives are now traded on SAM, and the Trading Floor is closed. Thus, for the Montreal Exchange, there is no more the open outcry trading on the trading floor, and all the orders are executed on the screen based electronic platform.

Different from the GLOBEX developed in Chicago Mercantile Exchange (CME) in the United States, the electronic trading system in the Montreal Exchange does not allow after hour trading, and can only be accessed by the registered members on both the Montreal Exchange (MX) and the Boston Option Exchange (BOX).

Futures Trading System of the Montreal Exchange is operated on FIFO Basis. Orders are filled according to price and time of the acceptance in the options on futures and futures trading system. The followings are some details:

- When the quantity of the order is increased and if there are other orders at the same price in the central book at the time of the increase, it is treated as a new order. It is preferable to issue a new order for the additional quantity instead of increasing the existing one so that the time priority for the initial quantity is retained.
- When the quantity of the order is decreased, it retains its priority in the system.
- Hidden quantities are time-stamped when they appear in the central order book.
- A stop order is time-stamped when triggered.
- The modification of the account number does not change the order's priority.
- The modification of the validation date does not change the order's priority.

There is no other priority than FIFO on a price/time basis. In all cases, each approved participant is responsible for insuring that, at the same price and time-stamp, it gives priority to client orders over its own professional orders.

The Contract SXF is the equity index futures contract based on Standard & Poor's Canada 60 Index listed in Toronto Stock Exchange. On January 29, 2001, the Contract SXF was transferred on the electronic trading platform SAM in the Montreal Exchange. A detailed description is provided in Exhibit 1.

DATA

The data used in this paper is the daily trading data of the Contract SXF traded on the Montreal Exchange. The daily futures price quotes of the Contract SXF are collected from the DataStream database. The daily spot price quotes of the Equity Index S&P/TSX 60, the index's 12 month dividend yields, and the three month Canadian Treasury Bond interest rate series are collected from the Bloomberg terminals from September 7, 1999 to June 5, 2006.

The daily price for each day is the last settlement price. The settlement price is the price at which a contract is settled at the end of the trading day. With stocks this is the last trade of the day. However, with other instruments such as commodity futures the last trade of the day does not always have to be the settlement price. This is important because all margin determinations are based on the settlement price. If the settlement price brings the traders equity below margin requirements, the trader will get a margin call.

Although most of the time the settlement price will equal the last trade, this is not always the case. The exchanges therefore have a settlement committee for each commodity traded. Immediately after closing, the settlement committee meets to ensure that the last trade fairly represents the value for that commodity. Usually it does; however, if it doesn't, it is the function of the committee to establish a fair settlement price.

With actively traded contracts with relatively stable pricing, the committee usually leaves the last trade as the settlement price. However, the settlement price becomes more difficult for a thinly traded issue which may have last traded 3 or 4 hours before the close. A complicating issue which could arise might be a significant news story which broke shortly before the close of trading and which has a significant impact on the price of that particular commodity. In such situations, it is the function of the settlement committee to use whatever information is available to try to determine a price for that commodity which fairly represents its value in light of the changed circumstances. The high and low are always taken from traded prices.

On the other hand, the daily settlement day may be fair to decide the margin calls for the locals, but for the research, especially as to the interpretation of the data results, it may impose the bias on our data results. Nevertheless, the main attention in this paper does not rest on the day trading opportunities, but hopes to carry out an objective overall review of the technological changes brought by electronic trading on the market efficiency.

ESTIMATION RESULTS

On the pricing efficiency hypothesis, both the futures contract SXF's signed deviation spread and the unsigned deviation spread are narrowed after the electronic trading. From Table 4, it can be seen that the coefficients for the electronic trading dummy variables are negative on both the signed deviation series and the unsigned series. Also from Figure 1, it can be seen that the extremes cases have been largely reduced after the introduction of the electronic trading, especially those around the maturity dates.

On the liquidity hypothesis from Table 5, it can be seen that if there is no electronic trading system, the futures contract SXF's trading volume would increase the futures daily price's deviation from the Cost of Carry Model. However, the intensity of the Equity Index Futures Contract SXF's trading volume's pressure on the futures price's deviation is much mitigated in the electronic trading mode. And the change of the intensity after the introduction of the electronic trading is not only statistically significant, but also balances off the expected intensity of the situation without the consideration of electronic trading.

On the Cost of Carry Model, according to the component decomposition (see Table 8), the negative effects from days to maturity on the spread are decreased under the environment of electronic trading by 1.01938 points. Without the electronic trading, its components would be expected to deduct the positive deviation spread by 1.22871 points. After the introduction of electronic trading, the weight of days to maturity on the deviation spread from the Cost of Carry Model is substantially subdued. Its negative effects on the deviation spread are substantially reduced.

The weight of components which the dividend yield contributes to the total deviation spread from the Cost of Carry Model is largely reduced by 2.5659 points. And more interestingly, the greatest change to the dividend yield components brought by the electronic trading is the component related to average dividend yield change between 4 and 20 trading days ahead of each record's trading day, which is 2.07499 points and its sign is negative. Similarly, the weight of components which the Three Month Government Treasury Bill Rate contributes to the total deviation spread from Cost of Carry Model is also reduced. Among its components brought by the electronic trading to the effects of the Treasury Bill Rates on the deviation, the biggest one, which is 0.46898 points, relates to the impact from the average change of the Three Month Government Treasury Bill Rate 4 and 20 trading days after each record's trading day. Combining the three components from the Cost of Carry Model (days to maturity, dividend yield, and the Three Month Government Treasury Bill Rate), the sum is reduced by 1.0087 points.

When reexamining electronic trading's influence on the daily trading volume's impact over the Cost of Carry Model deviation spread, the results accord with the preliminary liquidity hypothesis test listed in Table 5. The electronic trading decreases the daily trading volume's impact on the deviation spread by -2.60772 points.

On the Asymmetric Pricing Information across the equity index futures and spot market, after combining the components contributed by the spot and futures price changes, it can be found that the sum is increased by 1.01484 points following the launch of the electronic trading. This evidence implies that in the electronic trading environment, the deviation spread from the Cost of Carry Model increases with the magnitude of price change across the spot and futures market. Moreover, the biggest changes brought by the electronic trading on the spot and futures market both come from the average price changes fours days before the records' trading day, but not from those of the days ahead.

More interestingly, the electronic trading substantially enlarges the regression error from the assumed estimation model by 0.98366 points. This implies that the information outside the trading data across the spot and futures market or some new and unknown variables may take more significant roles than before to account for the deviation spread change after the introduction of electronic trading. And as the sign of the component of these unknown information sources related to the changes caused by electronic trading mode is positive, it suggests that in the electronic trading environment, the information related to these unknown factors outside the trading venues tends to help the traders to profit from the deviation spread from the Cost of Carry Model across the spot and futures markets.

DISCUSSION

Information brought by the equity index futures contract's trading volume not only reveals the private information held by the trades' initiators, but also the asymmetric information across the spot and futures market. As the futures price's deviations from the Cost of Carry Model are narrowed, the profits for a trade's initiator to trade on the private asymmetric information by the vehicles of the futures contracts would be lower. However, from Table 6, the average daily trading volume of Equity Index Futures Contract SXF in the Montreal Exchange rises from daily average of 4566 contracts in the before-electronic-trading period (from September,1999 to January 26th,2001) to 6498 contracts on average in the after-electronic-trading period (from January 29th,2001 to June, 2006). And from Figure 4, an increasing trend can also be detected. Moreover, on March 13th, 2006, the volume reaches the highest peak of 92907 contracts. And the deviation on that day is 2.8940 points, which is not the highest deviation error, and even lower than the previous day deviation which is 3.2693 points. And although the daily trading volume revealed in Figure 3 around the maturity dates increases in the settings of the electronic trading, it can be seen in Figure 1 that the deviation spread of the Futures Contract SXF's daily price from the Cost of Carry Model, as mentioned in the previous section about the estimation results, greatly narrows around the maturity dates. Then the question is why the trading volume will increase even though the possible profiting range seems to be not so big as before?

From the weights of the components contributed respectively by the Cost of Carry Model, the Trading Volume, the Asymmetric Pricing Information across the spot and futures market, and the Information outside the Trading Venue (or there would be some unknown exogenous estimation variables), it can be seen that if the deviation spread is assumed to be one of the profiting sources of arbitrage trading across the equity index spot and futures market, the nexus of the battle over exerting the profits seems to be changed after the introduction of electronic trading.

As shown by the weights of the components, before the introduction of electronic trading, the trading volume impact is the biggest component which contributes to the deviation spread from the Cost of Carry estimates. This suggests that the traders may trade on the volume to take advantage of each other, which will normally lead to the illiquidity. However, after the introduction of the electronic trading mode, the trading volume's impacts from the equity index futures market are not the main components which contribute to the deviation spreads, but the biggest components which contribute to the narrowing of the deviation spread following the introduction of the electronic trading mode. As the asymmetric pricing information across the spot and futures market, or perhaps the information source outside the trading venue takes a much more active role in deciding the deviation spread, the situation now looks like that the traders' attention is directed away from each other's trading direction. Instead, the traders more intend to base their own evaluation on different sources of information they could collect.

Actually, the changed pattern of the information flows throughout the trading venue following the organizational restructuring imposed by the electronic trading mechanism may be the main reason to explain for the above results. In old open outcry mode, dealers know each other. The relationship based dealers' network often facilitated club-like contracting linkage between the trading agents on the trading venue. So it was relatively easy for the traders in the market to achieve the highest profits through hiding the real information content of each quote. However, now under the electronic trading mode, every quote is labeled by unrevealed ID set by the system, sequenced by the universal trading rules, and indexed by time and price. Every trade submitted into the system is sequenced by its time and price stamp, and has to be executed one by one. This breaks the relationship based dealer's network, and in turn increase the competition intensity. It is not so easy to hide among the noise traders and to obtain the best execution for the informational traders as before. To get the best execution, the traders have to trade actively and submit the orders as early as possible.

Thus, the electronic trading mode appears to possess some unique advantages the open outcry mode have never had before. First, the electronic trading mode solves the cost problem associated with the intermediary agents within the trading venue. As mentioned in Campell and Karcaw (1980), the capability of the financial intermediaries to continuously produce the relatively reliable information is often constrained by their initial budget constraints. Evidently, in the electronic trading environment, the cost of the information production is lower than that in the open outcry mode. The easiness of information production is actually the inherent advantage of the electronic screen trading.

Hasbrouck (2005) points out that the traders in the environment of electronic trading prefer to use the limit order book as the signaling tool for bargaining.

Second, the electronic market permits the trading information to be revealed instantaneously, which greatly enhances the synchronization of the equity index's spot and futures market without the wealth endowments constraints, which would otherwise prevent the arbitrage trading from converging the heterogeneous opinions following the information shock and from helping the market to retrieve its rationality. As shown by the empirical results in this paper, the trading volume does not influence the price process of the equity index futures price relative to its spot position, which relieves the burden of the uninformed investors to "synchronize" their position with the large trader's position in the derivatives to avoid the large trader's manipulation as the situation described in Jarrow (1992, 1994).

Third, even without detecting hidden asymmetric information, the spread pricing between the equity index's spot and futures price based on the Cost of Carry Model is a "fair" game to compensate and protect the uninformed traders both on the spot and futures side. The estimation of Cost of Carry Basis itself is a fair valuation, which justifies the deserved gains accumulated by the spot or future position based on the publicly revealed information.

In fact, as the spot equity index position is the underlying security for the equity index derivative products, the demand for the equity index derivatives may corner the spot daily price if all these equity products' derivatives have to be underwritten on the underlying spot position. A relative stable spread between the equity index spot and futures price creates the possibility to cover the written equity index derivative products by using futures contracts in addition to the spot position. This possibility in turn relieves the burden of the spot market to bear the demand pressure from the derivative markets. For example, to write a call option by the futures contracts, the underwriter may long the futures contract. These two positions in the derivative market swap the position with each other, which would almost impose no demand pressure on the spot market. If the writer of the position holds different opinions from the buyer, she may not cover the position, or could short the futures price later, while still maintaining the portfolio holdings on a neutral estimation basis. This is also the reason why the trading volume of futures contracts which could be used to write the option products will not influence the spread between the spot and futures prices in the electronic trading mode so much as in the open outcry mode, as the profits for underwriting the option contract on the futures position can be the risks shared by the futures and option traders respectively, and may avoid the friction with the spot position holder. In this situation, the information production from one side of the market will no longer compel the traders on the opposite side to provide the liquidity by holding the same components of the portfolio purely on the spot market to cover the position. Therefore, as the friction caused by the information production can be largely smoothed, the heterogeneous opinions in the market can compensate each other to serve as the sources for the volatility in an acceptable range without cornering the market to the extremes.

IMPLICATIONS

Over the past ten years, the nature of the competitive and regulatory environment around the exchanges has changed dramatically. As pointed out by Macey & O'Hara(1999), liquidity will be the nexus of competition of the exchanges to survive.

When public exchanges were not privatized and listed as they are now, the traditional solution was to impose the fraternal regulations on trading locals, such as the specialists and market makers as for the solution. One issue of the fraternal regulations is discretionary account management. To improve the liquidity only on the trading locals, the Exchange always encourages the specialists, the market makers and all the registered dealers to trade on their own account. However, within the trading venues of the public exchange, there is no effective control mechanism for the fair dealing. This creates a big dilemma for the trading venue governance. Nowadays more and more public exchange organizations evolve into profitable corporate entities. By betting their liquidity heavily on the market makers and the specialists, the exchanges lose their own independence, which on the other hand, further weakens the exchanges' governance power.

The liquidity improvement found in an electronic trading environment across the spot and futures market provides an alternative way to look at the liquidity issue in the public exchange organization. Following the information transparency enhancement facilitated by the electronic trading mechanism, the liquidity of the derivative products' market can be provided not only from the specialists or market makers, but also from the investors in the underlying security market, and also from the ordinary independent traders who can trade across the spot and futures market if certain profitable or protective conditions apply. This implies that more attentions should be given to the potential investors beyond the trading locals. Using the technology innovations to expand the scope of information revelation, opening up the local trading venue, facilitating the arbitrage/contrarian trading, providing the trading vehicles for the trading strategies with different combinations of the trading products, and building up the bridges to the underlying market are all the possible measures which could be taken to achieve the liquidity advantages.

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APPENDICES

Exhibit 1: Contract Specifications of Equity Index S&P/TSX 60 Futures Contract SXF in the Montreal Exchange

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Exhibit 1: Contract Specifications of Futures Contract SXF

Trading Unit

Size: C$200 X the futures value

Contract Months

March, June, September and December.

Price Quotation

Quoted in index points, expressed to two decimals.

Last Trading Day/Expiration

Trading ceases on the trading day prior to the Final Settlement Day (the 3rd Friday of the contract month, providing it be a business day; if not, the 1st preceding day).

Contract Type

Cash settlement. The final settlement price is the Official Opening Level of the underlying index on the Final Settlement Day.

Price Fluctuation

0.10 index points = C$20 per contract

Reporting Limit

1,000 net long or short in all contract months combined.

Price Limits

A trading halt will be invoked in conjunction with the triggering of "circuit breaker" in the underlying stocks.

Trading Hours (Montréal time)

9:30 a.m. to 4:15 p.m.

Sources : Montreal Exchange
www.m-x.ca

Figure 1: Signed Deviation Spreads of the Equity Index S&P/TSX 60 Futures Contract SXF's Daily Price from the Cost of Carry Model from September 7th, 1999 to June 5th, 2006

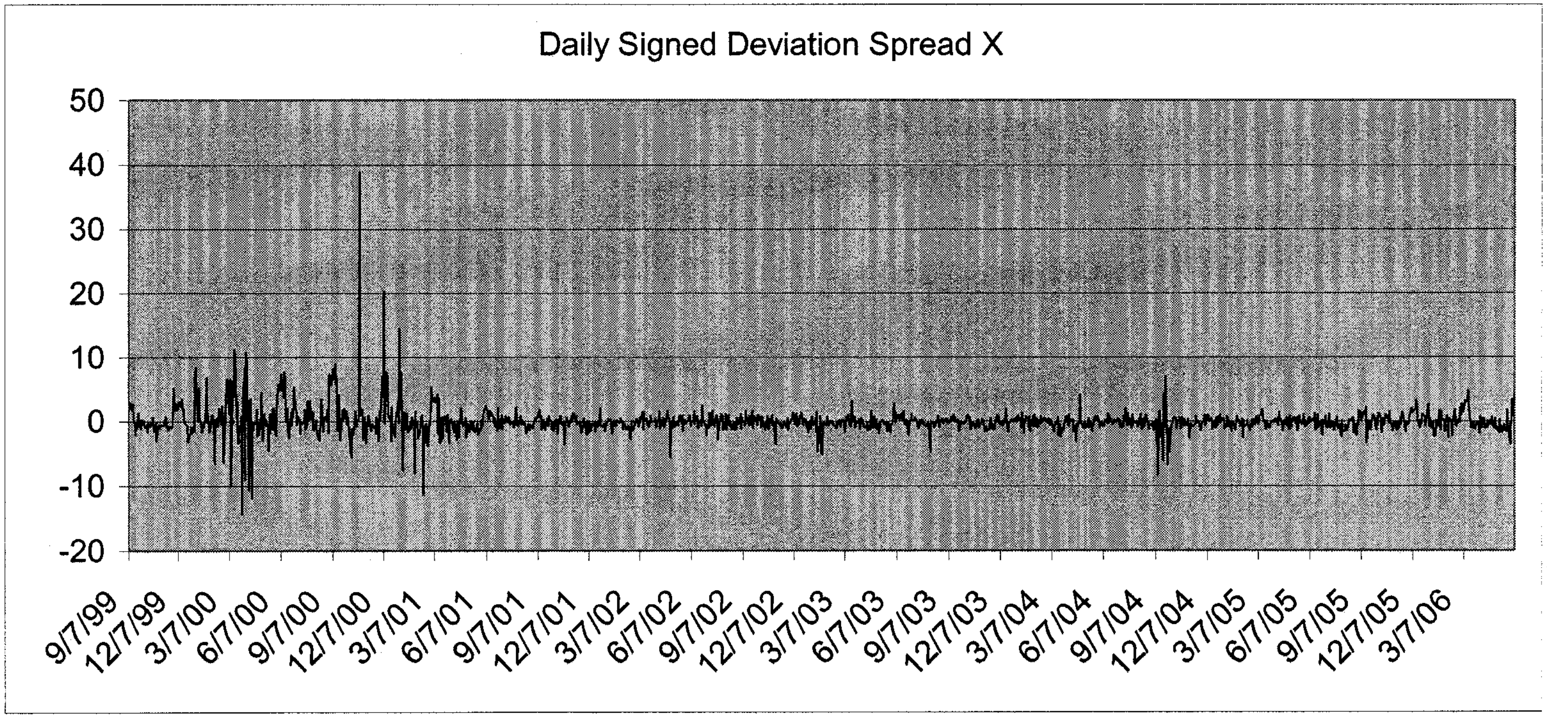

Figure 2 : Signed Deviation Spreads of the Equity Index S&P/TSX 60 Futures Contract SXF's Daily Price from the Cost of Carry Model from September 7^{th}, 1999 to June 5^{th}, 2006 with the range of (-5, +5) points.

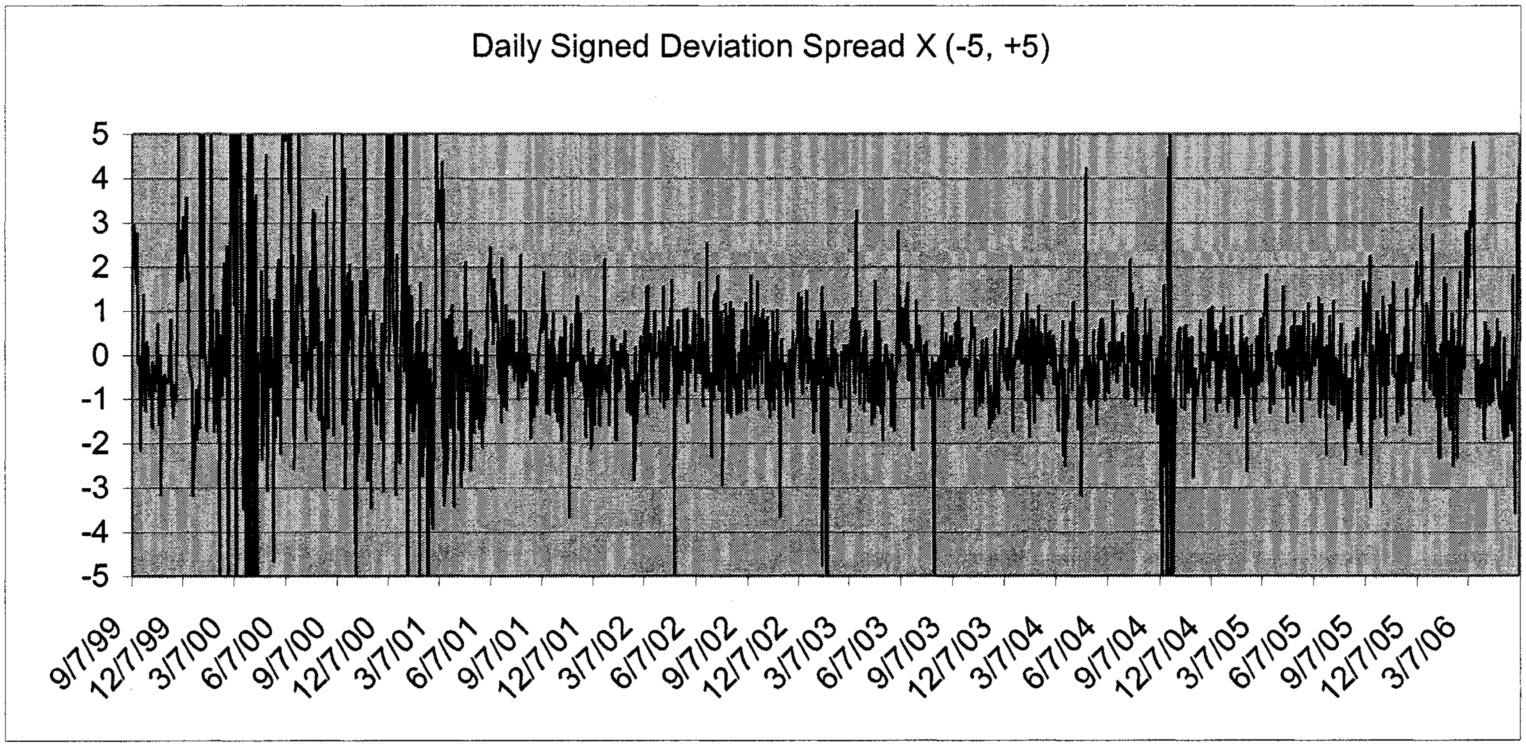

Figure 3 : The Daily Trading Volume of the Equity Index S&P/TSX 60 Futures Contract SXF in Montreal Exchange from September 7th, 1999 to June 5th, 2006

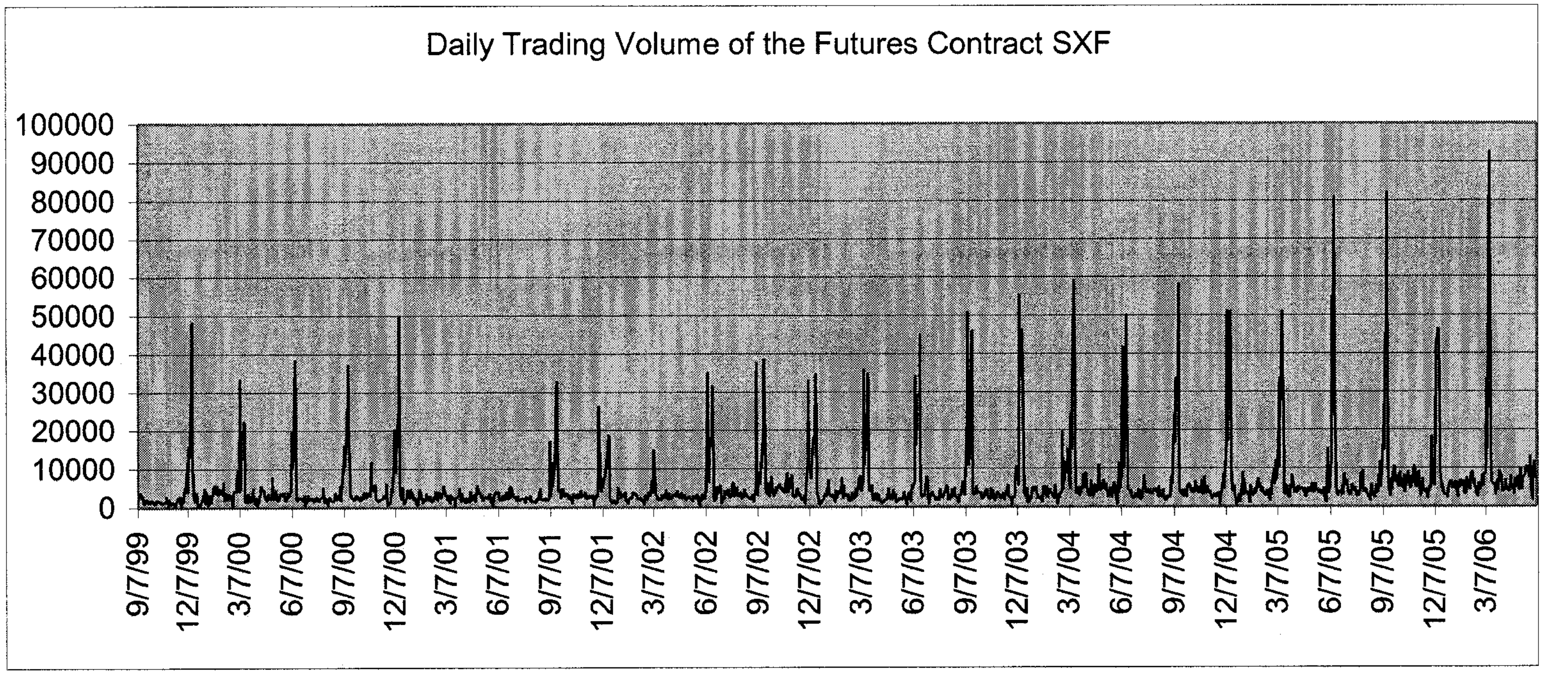

Figure 4: : The Daily Trading Volume of the Equity Index S&P/TSX 60 Futures Contract SXF in Montreal Exchange from September 7th, 1999 to June 5th, 2006 when the trading volume is lower than 10000 contracts

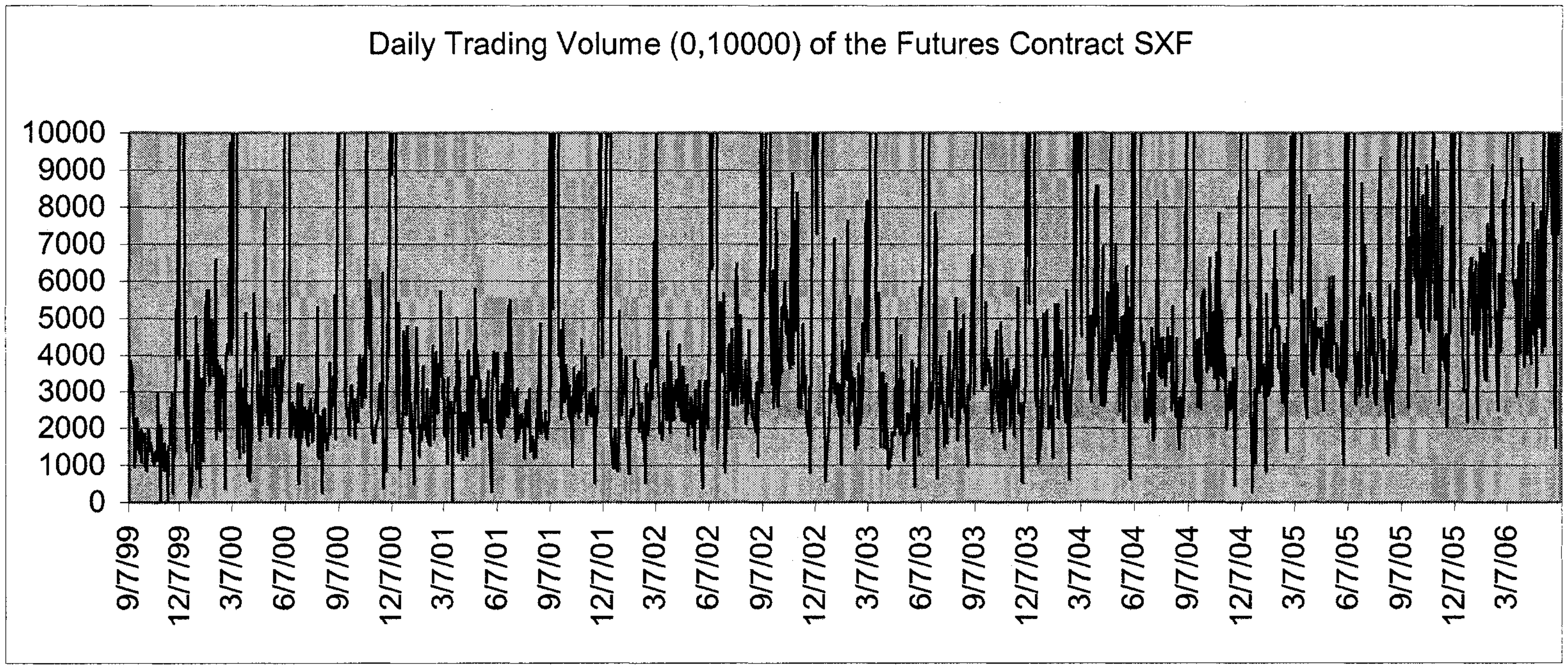

Table 1: Statistics for the Daily Settlement Price and the Daily Return of the Equity Index S&P/TSX 60 Futures Contract SXF in the Montreal Exchange before and after Launching the Contract on the Electronic Platform on January 29th, 2001

Table 1 : Statistics for the daily settlement price and the daily return of the equity Index S&P/TSX 60 futures contract SXF in the Montreal Exchange before and after launching the contract on the electronic platform on January 29th, 2001

	The Daily Futures Contract SXF Settlement Price		
	09/07/1999 - 06/05/2006	09/07/1999 - 01/26/2001	01/29/2001 - 06/05/2006
N^0	1678	341	1337
Mean	490.8145	549.1323	475.9407
Median	470.05	548	457
Maximum	704.45	704.45	704.40
Minimum	318.6	396.5	318.6
Standard Deviation	91.6593	78.4356	88.8295
Skewness	0.5611*	-0.0668	0.8298*
Kurtosis	-0.5873*	-0.7524*	-0.0547
Jarque-Bera	112.1795*	8.2979	153.6074*

	The Futures Contract SXF Daily Return(%)		
	09/07/1999 - 06/05/2006	09/07/1999 - 01/26/2001	01/29/2001 - 06/05/2006
N^0	1677	340	1337
Mean	0.0275	0.0806	0.0140
Median	0.0458	0.1812	0.0376
Maximum	5.7589	5.7589	4.3937
Minimum	-7.2729	-7.2729	-6.2904
Standard Deviation	1.1630	1.7612	0.9533
Skewness	-0.3316*	-0.3133	-0.3588*
Kurtosis	3.4768*	1.1929*	2.7863*
Jarque-Bera	875.3729*	25.7205*	461.1713*

*indicates statistically significant at .01 level

Table 2: Statistics for the Daily Close Price and the Daily Return for the Equity Index S&P/TSX 60 traded in Toronto Stock Exchange before and after Launching the Equity Index Futures Contract SXF on the Electronic Platform in the Montreal Exchange on January 29th, 2001

Table 2 : Statistics for the daily close price and the daily return for the equity index S&P/TSX 60 traded in Toronto Stock Exchange before and after launching the equity index futures contract SXF on the electronic platform in the Montreal Exchange on January 29th, 2001

	The Daily Spot Price		
	09/07/1999 - 06/05/2006	09/07/1999 - 01/26/2001	01/29/2001 - 06/05/2006
N^0	1678	341	1337
Mean	489.6801	545.4275	475.4618
Median	469.88	545.47	456.14
Maximum	702.80	695.69	702.80
Minimum	319.25	394.95	319.25
Standard Deviation	90.7803	77.3764	88.4608
Skewness	0.5581*	-0.0554	0.8212*
Kurtosis	-0.5801*	-0.7257*	-0.0751
Jarque-Bera	110.6476*	7.6563	150.5940*

	The Daily Spot Return(%)		
	09/07/1999 - 06/05/2006	09/07/1999 - 01/26/2001	01/29/2001 - 06/05/2006
N^0	1677	340	1337
Mean	0.0273	0.0799	0.0140
Median	0.0644	0.1802	0.0544
Maximum	4.5143	4.5143	1.7740
Minimum	-11.6984	-11.6984	-8.0792
Standard Deviation	1.1655	1.7767	0.9499
Skewness	-0.8027*	-0.8493*	-0.5624*
Kurtosis	8.8717*	5.3503*	5.3871*
Jarque-Bera	5679.7488*	446.3990*	1687.1960*

*indicates statistically significant at .01 level

Table 3: Deviation Spreads of the Equity Index S&P/TSX 60 Futures Contract SXF's Daily Price from the Cost of Carry Model in the Montreal Exchange, from September 7,1999 to June 5,2006 and Pre- vs. Post- Electronic Trading Period (before and after January 29th,2001)

Table 3 : Deviation Spreads from the Cost of Carry Model from September 7,1999 to June 5,2006 and pre- vs. post- electronic trading period[a] (before and after January 29th,2001)

	Signed Deviation Spread		
	09/07/1999 - 06/05/2006	09/07/1999 - 01/26/2001	01/29/2001 - 06/05/2006
N^0	1678	341	1337
$N^0_{<0}$	946	161	785
Mean	0.0425	0.9255	-(0.1827)
Median	0.7034	0.1081	-(0.1748)
Maximum	38.9365	38.9365	7.0993
Minimum	-(14.4604)	-(14.4604)	-11.4432
Standard Deviation	2.2081	4.1121	1.2519
Skewness	4.1746*	2.6987*	-(0.8307)*
Kurtosis	67.6317*	23.2207*	10.9035*
t-Statistics	0.78868	4.15619*	-(5.33592)*
t-Statistics difference between periods[b]			-4.9188
Degree of freedom			1676
p-value			-1.3586E-06

	Unsigned Deviation Spread		
	09/07/1999 - 06/05/2006	09/07/1999 - 01/26/2001	01/29/2001 - 06/05/2006
Mean	1.1778	2.4607	0.8506
Median	0.7034	1.3921	0.6227
Maximum	38.9365	38.9365	11.4432
Minimum	0.0016	0.0016	0.0021
Standard Deviation	1.8680	3.4198	0.9362
Skewness	7.6845*	4.8077*	3.7259*
Kurtosis	113.5624*	40.1951*	24.1889*
t-Statistics	25.82901*	13.28742*	33.22201*
t-Statistics difference between periods[b]			4.5500
Degree of Freedom			1676
p-value			7.4688E-06

[a] the deviation spread from the Carry of Cost Model is defined in equation $X_t=(F_{(t,T)} - F^e_{(t,T)})$, where $F_{(t,T)}$ is the actual index futures price, P_t is the index spot price, $F^e_{(t-T)} = P_t e^{(r-d)(t-T)}$, r is the 3 month treasury bond rate of interest, and d is the yearly (12 month) dividend yield on the index; the Pre-Electronic Trading period is 09/07/1999 - 01/26/2001, and the Post-Electronic period is 01/29/2001 - 06/05/2006

[b] the t-statistics measure the difference between the average deviation spread before and after the electronic trading

*indicates statistically significant at .01 level

Table 4 : Regression Results of the Impact of Electronic Trading on the Deviation Spread of the Futures Contract SXF's Daily Price from the Cost of Carry Model in the Montreal Exchange

Table 4 : Daily futures deviation spreads' regression results from September 7,1999 to June 5, 2006

Panel A

Dependent Variable is the signed deviation spread series:

$$X_t = a_0 + a_1 dum_t + \varepsilon_t$$

where dummy variables are equal to 1 after January 29,2001 (the beginning of SXF contract's electronic trading) and 0 otherwise.

	Parameter	t-statistic	
a_0	0.9255	7.9004*	
a_1	-1.1082	-8.4442*	$R^2 = 0.0408$

Panel B

Dependent Variable is the unsigned deviation spread series:

$$| X_t | = a_0 + a_1 dum_t + \varepsilon_t$$

where dummy variables are equal to 1 after January 29,2001 (the beginning of SXF contract's electronic trading) and 0 otherwise.

	Parameter	t-statistic	
a_0	2.4607	25.9290*	
a_1	-1.6101	-15.1440*	$R^2 = 0.1204$

*indicates statistically significant at .01 level

Table 5: Regression Results of Futures Contract SXF's Daily Trading Volume's Effects on the Deviation Spread from the Cost of Carry Model before and after the Introduction of Electronic Trading in the Montreal Exchange from September 7,1999 to June 5, 2006

Table 5 : Regression results of futures trading volume effects on the deviation spread from the cost of carry model before and after the introduction of electronic trading from September 7,1999 to June 5, 2006

Dependent variable is the signed daily deviation spread series:

$$X_t = \beta_0 + \beta_{vol} * VOL_t + \beta^{ET}_{vol} * VOL_t * DummyET_t + \varepsilon_t$$

	Parameter	t-statistic
β_0	-0.27223	-4.3731*
β_{vol}	0.000215	14.4437*
β^{ET}_{vol}	-0.00019	-12.7457*

*indicates statistically significant at .01 level

R^2=0.1117

Dependent variable is the unsigned daily deviation spread series:

$$| X_t | = \beta_0 + \beta_{vol} * VOL_t + \beta^{ET}_{vol} * VOL_t * DummyET_t + \varepsilon_t$$

	Parameter	t-statistic
β_0	1.008354	19.5555*
β_{vol}	0.000206	16.7024*
β^{ET}_{vol}	-0.00021	-16.7741*

R^2=0.1484

*indicates statistically significant at .01 level

Table 6: Statistics for the Daily Trading Volume of the Equity Index S&P/TSX 60 Futures Contract SXF in the Montreal Exchange before and after the Contract was launched on the Electronic Platform on January 29th, 2001

Table 6 : Statistics for the daily trading volume of the Equity Index S&P/TSX 60 Futures Contract SXF in the Montreal Exchange before and after launching the contract on the electronic platform on January 29th, 2001

	The Daily Futures Contract SXF's Trading Volume		
	09/07/1999 - 06/05/2006	09/07/1999 - 01/26/2001	01/29/2001 - 06/05/2006
N	1678	341	1337
Mean	6105	4566	6498
Median	3507	2710	3690
Maximum	92907	50083	92907
Minimum	0	0	0
Standard Deviation	8738.3878	6515.0128	9180.8516
Skewness	4.2630*	4.0373*	4.1871*
Kurtosis	22.7945*	19.1222*	21.6802*
t-Statistics	28.6204*	12.9411*	25.8567*
t-Statistics difference between periods[b]			4.4661
Degree of Freedom			1676
p-value			8.4986E-06

*indicates statistically significant at .01 level

Table 7 : Multivariate Regression Statistics for Different Information Sources' Impacts on the Unsigned Deviation Spread from the Cost of Carry Model before and after Launching the Equity Index S&P/TSX 60 Futures Contract SXF on the Electronic Platform in the Montreal Exchange on January 29th, 2001

Table 7 : Multivariate Regression Results

Dependent variable is the unsigned daily deviation spread of futures contract SXF's price from the cost of carry model

	Coefficient Estimation without the effects from ET	t Statistics	ET's Impact on the Coefficients	t Statistics
Constant	0.4641727	2.00232**		
Days to Maturity	-0.0272069	-3.75397**	0.0226445	3.06006**
$\mid \Delta DY_{(4,20)} \mid$	22.6013471	0.63787	-22.4933484	-0.61257
$\mid \Delta DY_{(3)} \mid$	-32.3526752	-3.23128**	35.6774423	3.43996**
$\mid \Delta DY_{(2)} \mid$	40.2106808	4.05115**	-42.9222665	-4.17111**
$\mid \Delta DY_{(1)} \mid$	-15.7087018	-1.59550	17.5529971	1.71849**
$\mid \Delta DY \mid$	0.3814153	0.03857	0.3514796	0.03429
$\mid \Delta DY_{(-1)} \mid$	2.9875287	0.29869	-4.3076021	-0.41550
$\mid \Delta DY_{(-2)} \mid$	7.7496544	0.76219	-8.1685742	-0.77618
$\mid \Delta DY_{(-3)} \mid$	4.3789952	0.44437	-3.9164553	-0.38291
$\mid \Delta DY_{(-20,-4)} \mid$	105.0955381	2.13141**	-119.0807836	-2.37647**
$\mid \Delta TB_{(4,20)} \mid$	-25.7065689	-1.78354**	27.959576	0.06864**
$\mid \Delta TB_{(3)} \mid$	0.9973607	0.27048	0.5253166	0.12921
$\mid \Delta TB_{(2)} \mid$	-14.5324927	-3.93174**	13.1569765	3.22424**
$\mid \Delta TB_{(1)} \mid$	-8.6855247	-2.37492**	7.6590011	1.89028**
$\mid \Delta TB \mid$	-2.6309628	-0.72728	3.533883	0.87977
$\mid \Delta TB_{(-1)} \mid$	4.2479128	1.16433	-3.7770592	-0.93367
$\mid \Delta TB_{(-2)} \mid$	4.2801045	1.16751	-2.9425726	0.46871
$\mid \Delta TB_{(-3)} \mid$	2.9016347	0.80501	-4.2661534	0.28594
$\mid \Delta TB_{(-20,-4)} \mid$	11.4709597	0.70060	-9.2532245	0.59110
$\mid \Delta P_{f(4,20)} \mid$	0.005303	0.03679	0.0515769	0.25978
$\mid \Delta P_{f(3)} \mid$	0.042144	2.12398**	-0.0197172	-0.53594
$\mid \Delta P_{f(2)} \mid$	0.0501768	2.50066**	-0.0401657	-1.08049
$\mid \Delta P_{f(1)} \mid$	0.216167	10.78552**	-0.1922493	-5.17690**
$\mid \Delta P_{f} \mid$	0.0356921	1.79039**	-0.0310779	-0.83831
$\mid \Delta P_{f(-1)} \mid$	0.0932515	4.66365**	-0.0802972	-2.16177**
$\mid \Delta P_{f(-2)} \mid$	0.0653177	3.27748**	-0.0416717	-1.12354
$\mid \Delta P_{f(-3)} \mid$	0.0948153	4.91087**	-0.0654773	-1.78584**
$\mid \Delta P_{f(-20,-4)} \mid$	0.7751311	5.69660**	-0.606899	-3.22278**

$\lvert \Delta P_{s(4,20)} \rvert$	-0.2536706	-1.85075**	0.2323527	1.14208
$\lvert \Delta P_{s(3)} \rvert$	0.0111908	0.42300	-0.0394241	-0.95201
$\lvert \Delta P_{s(2)} \rvert$	-0.1643364	-6.05339**	0.156758	3.73864**
$\lvert \Delta P_{s(1)} \rvert$	-0.1064689	-3.92648**	0.1167982	2.79238**
$\lvert \Delta P_{s} \rvert$	0.1458575	5.35117**	-0.1259551	-3.00885**
$\lvert \Delta P_{s(-1)} \rvert$	-0.0973272	-3.55606**	0.0747733	1.78158**
$\lvert \Delta P_{s(-2)} \rvert$	-0.05983	-2.15260**	0.0499755	1.18056
$\lvert \Delta P_{s(-3)} \rvert$	-0.065184	-2.44952**	0.02564	0.61818
$\lvert \Delta P_{s(-20,-4)} \rvert$	-0.9018751	-5.59123**	0.8671418	4.09781**
$Volume_{(4,20)}$	-0.0000433	-0.98373	0.0000245	0.55337
$Volume_{(3)}$	0.0001479	9.01655**	-0.0001533	-8.73152**
$Volume_{(2)}$	-0.0000191	-1.01550	0.0000252	1.24662
$Volume_{(1)}$	0.0000102	0.53634	-0.0000134	-0.65480
Volume	0.000018	0.95554	-0.0000195	-0.96441
$Volume_{(-1)}$	0.0000429	2.21397**	-0.0000433	-2.09075**
$Volume_{(-2)}$	0.0000173	0.91714	-0.0000108	-0.53178
$Volume_{(-3)}$	-0.0000048	-0.28450	0.0000088	0.48511
$Volume_{(-20,-4)}$	0.0002302	3.84918**	-0.0002221	-3.64676**

** indicates statistically insignificant at 0.10 level.

Table 8 : Decomposition of the Unsigned Deviation Spread of the Equity Index S&P/TSX 60 Futures Contract SXF's Daily Price from the Cost of Carry Model in the Montreal Exchange by Different Informational Factors

Table 8 : Decomposition of the unsigned deviation spread from the cost of carry model

MEAN	**1.17785**		
	Overall Decomposition	**Ordinary Component**	**ET Component**
Total	**(0.85065)**	**2.46073**	**-1.61009**
The Cost of Carry Total	**-0.33461**	**0.66626**	**-1.00087**
Days to Maturity	-0.20933	-1.22871	1.01938
$\lvert \Delta DY \rvert$	-0.20866	2.35724	-2.5659
$\lvert \Delta DY_{(4,20)} \rvert$	0.00187	0.39255	-0.39068
$\lvert \Delta DY_{(3)} \rvert$	0.05768	-0.56121	0.61889
$\lvert \Delta DY_{(2)} \rvert$	-0.04708	0.69822	-0.7453
$\lvert \Delta DY_{(1)} \rvert$	0.03203	-0.27274	0.30477
$\lvert \Delta DY \rvert$	0.01274	0.00663	0.00611
$\lvert \Delta DY_{(-1)} \rvert$	-0.02293	0.0519	-0.07483
$\lvert \Delta DY_{(-2)} \rvert$	-0.00728	0.13465	-0.14193
$\lvert \Delta DY_{(-3)} \rvert$	0.00802	0.07595	-0.06793
$\lvert \Delta DY_{(-20,-4)} \rvert$	-0.24369	1.8313	-2.07499
$\lvert \Delta TB \rvert$	0.08338	-0.46227	0.54565
$\lvert \Delta TB_{(4,20)} \rvert$	0.03779	-0.43119	0.46898
$\lvert \Delta TB_{(3)} \rvert$	0.02562	0.01678	0.00884
$\lvert \Delta TB_{(2)} \rvert$	-0.02321	-0.24519	0.22198
$\lvert \Delta TB_{(1)} \rvert$	-0.01737	-0.14694	0.12957
$\lvert \Delta TB \rvert$	0.01527	-0.04451	0.05978
$\lvert \Delta TB_{(-1)} \rvert$	0.00797	0.0719	-0.06393
$\lvert \Delta TB_{(-2)} \rvert$	0.02264	0.07244	-0.0498
$\lvert \Delta TB_{(-3)} \rvert$	-0.02311	0.04913	-0.07224
$\lvert \Delta TB_{(-20,-4)} \rvert$	0.03776	0.1953	-0.15754
Asymmetric Information	**0.73727**	**-0.27757**	**1.01484**
$\lvert \Delta P_f \rvert$	1.17204	4.59474	-3.4227
$\lvert \Delta P_{f(4,20)} \rvert$	0.18795	0.01752	0.17043
$\lvert \Delta P_{f(3)} \rvert$	0.07428	0.13959	-0.06531
$\lvert \Delta P_{f(2)} \rvert$	0.03322	0.16651	-0.13329
$\lvert \Delta P_{f(1)} \rvert$	0.07941	0.71777	-0.63836
$\lvert \Delta P_f \rvert$	0.01535	0.11873	-0.10338
$\lvert \Delta P_{f(-1)} \rvert$	0.043	0.30955	-0.26655
$\lvert \Delta P_{f(-2)} \rvert$	0.07858	0.21706	-0.13848
$\lvert \Delta P_{f(-3)} \rvert$	0.09741	0.31481	-0.2174
$\lvert \Delta P_{f(-20,-4)} \rvert$	0.56282	2.5932	-2.03038

$\lvert \Delta P_s \rvert$	-0.43477	-4.87231	4.43754
$\lvert \Delta P_{s(4,20)} \rvert$	-0.06917	-0.82311	0.75394
$\lvert \Delta P_{s(3)} \rvert$	-0.09159	0.03631	-0.1279
$\lvert \Delta P_{s(2)} \rvert$	-0.0246	-0.53331	0.50871
$\lvert \Delta P_{s(1)} \rvert$	0.03353	-0.34567	0.3792
$\lvert \Delta P_s \rvert$	0.06474	0.47447	-0.40973
$\lvert \Delta P_{s(-1)} \rvert$	-0.07325	-0.31608	0.24283
$\lvert \Delta P_{s(-2)} \rvert$	-0.03203	-0.19446	0.16243
$\lvert \Delta P_{s(-3)} \rvert$	-0.12846	-0.21175	0.08329
$\lvert \Delta P_{s(-20,-4)} \rvert$	-0.11395	-2.95871	2.84476
Private Information	**-0.03107**	**2.57665**	**-2.60772**
Volume	-0.03107	2.57665	-2.60772
$Volume_{(4,20)}$	-0.1229	-0.28264	0.15974
$Volume_{(3)}$	-0.03469	0.95851	-0.9932
$Volume_{(2)}$	0.03946	-0.12357	0.16303
$Volume_{(1)}$	-0.02045	0.06628	-0.08673
Volume	-0.00971	0.11657	-0.12628
$Volume_{(-1)}$	-0.00267	0.2778	-0.28047
$Volume_{(-2)}$	0.04208	0.11165	-0.06957
$Volume_{(-3)}$	0.02549	-0.03127	0.05676
$Volume_{(-20,-4)}$	0.05233	1.48334	-1.43101
Residuals + Approximate Errors - ET	**0.47906**	**-0.50461**	**0.98366**
Residuals + Approximate Errors –Non-ET	**0.80626**		