Do Foreign Institutional Traders Have Private Information for the Market Index? The Aspect of Market Microstructure

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ABSTRACT

We investigate whether foreign institutional investors possess private information in index futures trading based upon six-year market index futures transaction data on the Taiwan Futures Exchange (TAIFEX). According to the French and Roll (1986) ‘decomposition of price formation’, our empirical results rule out the possibility that volatility dynamics are driven by public information and mispricing, since the findings indicate that private information proxied by information-related intraday patterns of volatility and bid-ask spread would be the major cause of price variations. A test of the information hypothesis of Schlag and Stoll (2005) provides further support for the existence of private information in foreign institutional trading. Finally, when calculating the cumulative return for foreign institutional traders from detailed account-by-account trading data, the conclusions drawn from our empirical analysis remain unchanged.

**Keywords**: Foreign institutional investors; Market index futures; Private information.

**JEL Classification**: G10; G14

1. INTRODUCTION

Foreign institutional investors, particularly those trading in individual stocks, invariably possess firm-specific information which is not available to the general public; as such, they are invariably regarded within the extant related literature as better informed and more sophisticated traders than individual investors.[[2]](#footnote-2) For example, using daily data on the 16 largest Finnish stocks, Grinblatt and Keloharju (2000) found that over a two-year period, more stocks that performed well over the next 120 trading days were bought by foreign investors and domestic financial enterprises than domestic individual investors. Seasholes (2000) also found evidence in Taiwan of foreign institutional investors buying (selling) individual stocks just prior to positive (negative) earnings announcements, whilst domestic investors were found to trade in the opposite direction.

However, when it comes to an index market, there may be a reduced likelihood of informed traders possessing market-wide information, as compared to firm- specific information. Pan and Poteshman (2006) could find no evidence of informed trading in three broad index option markets, essentially because investors tend to use index options primarily for hedging purposes, as opposed to speculation.[[3]](#footnote-3) Furthermore, the market index usually reflects market-wide information, such as macroeconomic news, which is commonly viewed as public information. In cases where each trader within the same market has access to the same public information set, it seems far less certain that foreign institutional investors would be in possession of private information at the market level.[[4]](#footnote-4)

Given the inherent ambiguity of any claim that foreign institutional investors must surely have access to private information relating to the index futures market, we set out in this study with the overall aim of providing new evidence on the informational role of trading by this particular group of investors.[[5]](#footnote-5) We adopt a comprehensive dataset of stock market index futures from the stock index futures traded on the Taiwan Futures Exchange (TAIFEX) over the years 2003 to 2008.[[6]](#footnote-6) Participation in the TAIFEX by foreign institutional investors increased from 4 per cent to 24 per cent during our sample period, the most significant increase in trading growth rate among all types of traders.[[7]](#footnote-7) Such a rapid increase in participation by foreign institutional investors provides us with a valuable opportunity to investigate the influence of foreign institutional trading on market variations in the TAIFEX, and also enables us to tackle the interesting question of whether foreign institutional investors possess private information on an index market.

Our study involves several analytical stages, the first of which is similar in spirit to the analysis carried out by French and Roll (1986), since it provides a preliminary picture of the role of foreign institutional investors with regard to price formation on the TAIFEX. We follow Ito et al. (1998) to test the flow of public information by observing whether there was any increase in the number of daily news reports within our sample period or whether any specific patterns are revealed. We hand-collected all news reports from the *Economic Daily News*, one of the major financial newspapers in Taiwan, to measure public information flows. If the public information flow remained unchanged across our sample period, then the probability of public information as the main cause of price variations would be minimized.

In the second stage, in order to further distinguish between private information and pricing errors, we follow the same steps used in the French and Roll (1986) approach for the estimation of the contribution of mispricing to price variations. If the mispricing in price variations falls, or remains constant, whilst transactions by foreign institutional traders and price variations continue to increase over the same period, then the empirical results would tend to provide support for the argument that foreign institutional trading contains private information on market index futures. Since the French and Roll (1986) conclusions are widely used in the related empirical literature on price formation in the stock market, we attempt to fill the current gap in the literature by applying their argument to the index futures market, where the findings remain unclear.[[8]](#footnote-8)

In the third stage, we examine intraday foreign institutional transactions in a further attempt to verify the existence of private information. Some of the earlier studies have provided empirical evidence of a U-shaped pattern embodied in intraday volatility;[[9]](#footnote-9) for example, Easley and O’Hara (1992) demonstrated a decline in information asymmetry over the entire trading period, whilst Foster and Viswanathan (1993) tracked the intraday volatility U-shape to determine whether the existence of private information in trading was responsible for the volatility smile.

Ito et al. (1998) demonstrated that the introduction of lunch-hour trading in the Tokyo FX market revealed more information, ultimately highlighting the presence of a volatility U-shape. They concluded that the results provided support for the predictions of a private-information model, which implied that the information content of trading can be identified by the shape of the intraday volatility.[[10]](#footnote-10) We therefore link U-shaped volatility to private information by comparing the changes, over time, in the volatility U-shapes during a trading day.

In addition to changes in the volatility shapes, the bid-ask spread may be another important microstructure measure for examining private information.[[11]](#footnote-11) Madhavan, Richardson and Roomans (1997) suggested that the U-shaped intraday spread was induced by a combination of a reduction in information asymmetry and an increase in the order process component during the trading day.[[12]](#footnote-12) Nevertheless, whilst Madhavan et al. (1997) argued that within a hybrid market such as the NYSE informed trading may be concentrated in early morning trading hours, other studies have reported comparable results when extending the focus to a pure limit-order market.

For example, Brockman and Chung (1999) and Chan (2000) studied the bid-ask components on the Hong Kong Stock Exchange, De Jong, Nijman and Roell (1996) examined the bid-ask component on the Paris Bourse, and with particular focus on adverse selection costs, Ahn, Cai, Hamao and Ho (2002) reported that the bid-ask spread also exhibited a U-shaped pattern in the Tokyo Stock Exchange. Although differing from, but not contradictory to, Madhavan et al. (1997), the Ahn et al. (2002) study concluded that the evidence of an increase in information asymmetry around the end of the trading day suggested that transactions during this period generally conveyed private information.

Fourth, we use the Schlag and Stoll (2005) model to undertake a regression analysis to test for the presence of private information in foreign institutional trading. As argued by Schlag and Stoll (2005), informed trading will have a permanent impact on the market prices of the underlying assets, whereas the price impact of uninformed trading is only temporary in nature. If a number of foreign institutional investors possess private information relating to the Taiwan stock index futures market, then foreign institutional trading will have a permanent price impact, thereby providing support for the ‘information hypothesis’.

Finally, we evaluate the dollar trading profit of foreign institutional traders using detail account-by-account trading data in each period to determine if foreign institutional traders are the ultimate winner in the TAIEX index futures market. Empirical results show that the monthly average dollar profit that a foreign institutional trader can make for a single trade during the period of September 2007 through December 2008 is about 3,018 in New Taiwan Dollar, thereby providing support for the existence of private information in foreign institutional trading.

Our major findings are summarized as follows. Firstly, we show that public information has no causal effects on price variations in the index futures market; indeed, we find that public information flow is quite stable throughout the sample period, whereas price volatility varies across different periods. Secondly, we test the role of mispricing in price volatility and find that the changes in mispricing cannot fully explain the price variations, a result which indicates that the private information possessed by foreign institutional traders has a dominant effect on price formation in the TAIFEX.

Thirdly, we test the intraday volatility and bid-ask spread patterns to identify the influence of foreign institutional trades during a trading day and find that the information-related U-shapes of intraday volatility and bid-ask spreads tend to flatten out with an increase in foreign institutional trading in the late morning session; we apply several robustness tests on the intraday U-shapes of both volatility and bid-ask spread. Finally, we show that foreign institutional trading provides support for the ‘information hypothesis’ only in the most recent period, since the same effect is not discernible in the earlier periods. Moreover, we find that foreign institutional trading is also more profitable in the recent period than the earlier periods. All of these findings provide support for the prior results leading us to conclude that foreign institutional investors do indeed possess private information on the index market.

The remainder of this study is organized as follows. A review of the empirical works in the related literature is provided in Section 2, followed in Section 3 by a description of the data and the analytical approach adopted for this study. The empirical results and tests for the robustness of the results are reported in Section 4. Finally, the conclusions drawn from this study are presented in Section 5.

2. LITERATURE REVIEW

We briefly introduce different branches of the prior empirical works of relevance to the present study. Some studies within the extant related literature indicate that foreign institutional investors appear to have private information regarding stock market index futures. For instance, Chang, Hsieh and Lai (2009) found that foreign institutional investors had greater predictive power with regard to near-the-money and middle-horizon equity index options, whilst Chang, Hsieh and Wang (2010) subsequently demonstrated that specific combinations of trades executed by foreign institutional investors involving both index options and futures were capable of predicting future index volatility.

Although these studies suggest that foreign institutional trading has both price and volatility impacts on the index market, Stoll and Schlag (2005) indicated that significant price impacts could be either informed or uninformed, which implies that testing the price/volatility impacts of foreign institutional trading may not sufficiently answer the question of whether foreign institutional investors have private information on the index market. Interestingly, whilst Barber et al., (2009) noted that making profits from trading is commonly viewed as an indicator of the possession of private information relating to the market, Hao, Chou, Ho and Weng (2015) showed that foreign institutional investors may accrue profits from futures index trading, not through any informational advantage, but by making the market, thereby suggesting that foreign institutional trading does not necessarily equate to informed trading.

The seminal work of French and Roll (1986) on the closure of the NYSE provides us with a starting framework for our analysis. Other relevant studies include Barclay, Litzenberger and Warner (1990), Amihud and Mendelson (1991), Ito and Lin (1992) and Ito et al. (1998), all of which examined information flows in the Tokyo Stock Exchange, a pure limit-order market similar to the TAIFEX. By investigating the changes in weekend or lunch volatility in the Tokyo Exchange, they linked trading to the associated process of information dissemination. Hsieh and Kleidon (1996) simultaneously measured spread and volatility patterns across different trading centers to evaluate models of asymmetric information, which is also of relevance to the discussion here.

A further string of related empirical works focuses particularly on whether foreign institutional traders have an informational advantage over their local competitors within the same market, although the current empirical findings are not conclusive. For example, several studies have found that trading by foreign investors tends to lead price movements,[[13]](#footnote-13) which implies that foreign institutional investors have a clear informational advantage. Conversely, however, Choe, Kho and Stulz (2005) and Dvorak (2005) respectively found no evidence of better-informed foreign investors in Korea or Indonesia. Similarly, at the market level, Griffin, Nardari and Stulz (2004) showed that after controlling for the contemporaneous relationship between flows and returns, foreign investors were generally incapable of timing the market at the daily frequency.

Nevertheless, in the above-related studies, the focus has invariably been placed on the stock market, which is essentially projecting complex information sources, including inside information. By focusing on the index futures market, our study may help to shed new light on the understanding of foreign institutional trading in the derivatives markets. Our findings may be of particular importance to emerging markets, since participation by foreign institutional traders has deepened significantly in these markets, and indeed, such participation may play an increasingly influential role in the developing markets.

3. DATA AND METHODOLOGY

**3.1 Data Description**

Our transaction dataset comprises of a detailed history of the order flows in TAIEX futures (hereafter, TXF) covering the period from 1 January 2003 to 31 December 2008. For each order, the dataset reports the date and time of arrival of the order, its direction (buy or sell), the quantity demanded or offered, and, most importantly for our purposes, the identification of the traders, as the trader code enables us to identify foreign institutional trading. The TXF is the major index futures contract on the TAIFEX and also the most actively-traded product. Its underlying index, the Taiwan Stock Exchange Capitalization Weighted Index, is a value-weighted index of all individual stocks traded on the Taiwan Stock Exchange.[[14]](#footnote-14)

There was rapid growth in the daily average volume of foreign institutional trading on the TAIFEX between 2003 and 2008, much greater than that of any other traders in the market. The increase in foreign institutional trading can be separated into three periods: (i) January 2003 to December 2005; (ii) January 2006 to August 2007; and (iii) September 2007 to December 2008. In Period 1, although the growth in the overall market was relatively steady, the volume of foreign institutional trading continued to advance.

Turning to Period 2, with effect from 1 January 2006, the TAIFEX applied a permanent reduction in the trading tax rate, from 0.025 to 0.01 percent for index futures trading; this 60 per cent reduction in fees was designed to stimulate market participation and induce more trading activity, and indeed, the growth in foreign institutional trading became more rapid thereafter. This phenomenon is consistent with the findings of Chordia et al. (2011), who noted that the reduction in transaction costs made a significant contribution to the trading volume uptrend in the NYSE between 1993 and 2008.

The Period 2 regime ended in August 2007, immediately prior to the start of the 2007-2008 global financial crisis period. The separation is self-evident, because the financial crisis comprehensively affected the market and brought about structural changes to trading. As shown in Figure 1, from Period 1 to Period 3, daily trading by foreign institutional investors increased from 3,783 to 89,426 trades, representing almost a twenty-four-fold increase. Over the same time horizons, the growth in trading by domestic institutions and individuals was only about six-fold from Period 1 to Period 2 and about two-fold from Period 2 to Period 3.

<Figure 1 is inserted about here>

The respective percentages of trading by foreign institutional investors in Periods 1, 2 and 3 were 3.74 percent, 11.22 percent and 24.46 percent, whilst the respective percentages for trading by domestic institutions over the same periods were 18.91 percent, 33.42 percent and 31.66 percent, and those for individual traders were 77.36 percent, 55.54 percent and 43.88 percent. Neither domestic institutional trading nor individual trading reveals any monotonic uptrend, whereas the uptrend in foreign institutional trading across the three different periods represents very distinct low, medium and high regimes of foreign institutional trading on the TAIFEX.

**3.2 Changes in Public Information Flows and Price Variations**

We begin by examining the changes in the public information set over the sample period, referring to the seminal work of Ito et al. (1998) to carry out the comparison. Market news reports published by the *Economic Daily News*, a major Taiwanese financial newspaper, are used to analyze the impact of the changes in public information across different regimes within our sample period. We measure the changes in the public information flow based upon the total number of daily news items as a proxy for the public information set. In specific terms, an increase (reduction) in the total number of daily news items indicates a larger (smaller) public information flow; if the number of daily news items is constant, then the public information flow is unchanged.

After examining the changes in the public information set, we calculate and examine the price variations in the index futures market, and adopt different intraday frequencies to measure the price variations in order to ensure a thorough comparison. Once again to ensure the thoroughness of our examination, realized volatility is calculated based upon one-minute, five-minute, ten-minute and 15-minute returns,[[15]](#footnote-15) and in order to avoid biases attributable to the use of high-frequency data, we calculate all intraday returns by the mid-point of the bid and ask prices in each of the time intervals and define the return as the log-difference of the mid-price between the time intervals.

We measure the intraday price volatility levels for all available returns within a trading day and carry out comparisons between these volatility levels across different periods based upon daily observations. If the price variation is found to be solely driven by the variation in public information, then the changes in price volatility should correspond with the variations in public information.

**3.3 Private Information and Mispricing Errors**

We determine whether price variations are caused solely by public information based upon the method described in Section 2.2, with a negative result implying that an increase in foreign institutional trading incorporates more private information into the market prices; a rejection of such potential causality does, however, also include the possibility of mispricing. Since distinguishing between private information and mispricing errors requires additional evidence, we refer to two seminal works which can help to differentiate between private information and mispricing errors. French and Roll (1986) denoted an upper bound for the mispricing error component of the return in a given period, *t*, as:

, (1)

where *Vl* is the return variance over the long holding period; *Vs* is the cumulated variance over short sub-intervals; *V*(*Rt*) is the return variance in period *t*; and *V*(*Et*) is the concurrent proportion of variance attributable to mispricing. Appendix B provides a detailed description of the French and Roll (1986) variance decomposition.

Although the French and Roll (1986) method is insightful, Ito et al. (1998) subsequently argued that there were shortcomings in their method of distinguishing between mispricing and private information. Specifically, the French-Roll assumption requires that the private information effects are permanent, whereas mispricing effects are temporary; however, among certain classes of private information, the price effects may also be temporary, and thus, mispricing will also be persistent in such cases. Since the interpretation of the level of the bound is difficult, Ito et al. (1998) argued that addressing the ways in which trading changes the bound can better exploit the information content of trading in the regime shift.

We follow the spirit of the French and Roll (1986) and Ito et al. (1998) studies in the next stage of our analysis to examine the impact of mispricing using Equation (1). We adopt several measures to meticulously calculate the variance ratios on a daily basis, including five-minute variance over one-minute variance, ten-minute variance over one-minute variance, 15-minute variance over one-minute variance, and 15-minute variance over five-minute variance. We then carry out comparisons of the deviations in the variance ratios (i.e., the bound) across different periods.

If the changes in the deviations in the variance ratios correspond with the changes in the price volatility levels across different periods, then the results would suggest that mispricing plays an important role in price formation and is inconsistent with the null hypothesis of ‘no-private-information’.[[16]](#footnote-16) The changes in volatility in different trading sessions within a trading day can further distinguish between private information and mispricing; we therefore separate whole day trading hours into three trading sessions, early morning (8:45 am to 10:15 am), late morning (10:15 am to 12:15 pm) and lunch (12:15 pm to 1:45 pm) sessions and test the volatility shapes during these sessions for each day across different periods.

The extant literature reports that information asymmetry during trading hours contributes to the U-shaped intraday pattern of volatility; accordingly, if we observe changes in volatility between different trading sessions, then the change in the pattern is more likely to be attributable to the shift in the trade submissions of foreign traders; in more specific terms, we calculate the proportion of trade submissions by foreign traders in the early morning, late morning and lunch sessions. If the distribution, over time, between the three sessions remains unchanged, then the intraday volatility U-shapes should also be unchanged, essentially because there is no shift in private information between the different trading sessions.

If the proportion of trade submissions were to shift to the late morning session, then the U-shape would be flattened out; conversely, if the proportion of trade submissions were to shift to the early morning or lunch session, then the U-shape would be deepened. By carrying out this exercise, we generate predictions on the ways in which intraday volatility responds to the different trading regimes. If we can verify the predictions, then we can identify the existence of private information among foreign institutional investors in the index futures market.

In addition to the U-shape pattern of volatility, the prior related studies have also argued that intraday bid-ask spread has a U-shaped pattern similar to intraday volatility (see for example, Mclnish and Wood, 1992). Given that the U-shaped pattern in intraday spread can be attributed to the existence of information asymmetry, the additional prediction of private information relates to the changes between the different regimes in the U-shaped pattern of the bid-ask spread.

**3.4 Robustness Tests for Exogenous Controls**

The natural experiment in the TAIFEX is not a pure regime shift with increasing foreign institutional trades, essentially because concurrent growth occurs in trading volume among domestic institutional traders. In order to strengthen our earlier results, we exclude the potential effects arising from domestic institutional trading, since such trading may also involve private information. We therefore identify two periods, 2004 and 2005, to carry out additional comparisons.

We choose these two years because they are the only years in our full sample period during which there was declining trading volume growth. Interestingly, in these two years, only the daily average volume of foreign institutional trading exhibited growth, from 4,700 contracts to 5,600 contracts, whilst the trading volume of domestic institutions was relatively unchanged. This difference provides us with an opportunity to test the private information of foreign institutional trader by comparing the changes in the intraday volatility or bid-ask spread U-shapes between 2004 and 2005 so as to determine whether our findings are consistent with those in Section 2.3.

We also carry out a similar comparison between 2006 and 2007, a period during which foreign institutional traders were the only trader group with an increase in trading volume (8.55 per cent to 13.78 per cent) as compared to a slight reduction in the trading volume of domestic institutional traders (26.09 per cent to 24.17 per cent). This separation once again provides us with an opportunity to exclude the impact of domestic institutional traders since it is less likely that decreasing domestic institutional trading would carry more private information into the market.

**3.5 Examination of the ‘Information Hypothesis’**

Our analysis directly investigates the information source of price formation in the market by decomposing the causes of price volatility into three elements (public information, private information and mispricing) to determine whether the possession of private information is associated with foreign institutional investors. To further assess the price impacts of foreign institutional trading, we adopt the Schlag and Stoll (2005) model to estimate the following regression:

(2)

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where *Rt* represents index futures return; and *Buyt* (*Sellt*) are the buy (sell) orders of foreign institutions at time *t*. Without any loss of generality, we control for *Buy/Sell* orders and returns with four lags, with the variables being calculated on the basis of 15-minute intraday intervals.

It should be noted that the coefficients *δ* and *η* are similar to the Kyle (1985) lambda measure of price impact. Based on the current lambda and the lambda coefficients on lagged orders, Schlag and Stoll (2005) proposed two hypotheses, the ‘information’ and ‘liquidity’ hypotheses, on the relationship between price change and signed volume. The expected signs of the coefficients on current and one-lag *Buy/Sell* orders under the two hypotheses are specified as follows:

*Information Hypothesis*  
For *BUY*: Lag 0 is positive; Lag 1 is zero.   
For *SELL*: Lag 0 is negative; Lag 1 is zero.

*Liquidity Hypothesis*  
For *BUY*: Lag 0 is positive; Lag 1 is negative.   
For SELL: Lag 0 is negative; Lag 1 is positive.

If the information hypothesis is supported, then the price impact is informed; conversely, if the liquidity hypothesis is supported, then the liquidity demand, as opposed to private information, is the likely causal factor of the price impact. We carry out regressions for each period in order to identify the information content of the price impact under different regimes.

4. EMPIRICAL RESULTS

**4.1 Are Market Variations Caused Solely by Public Information?**

We first of all examine the number of news reports appearing across the three periods in one of the major Taiwanese newspapers, the *Economic Daily News*. Our news report statistics are hand-collected and compiled by investigating the daily news reports across the whole sample period, including only news reports relating to market-wide information. The average daily numbers of news reports in the Taiwan market over the sample period are shown in Table 1, with Panel A showing that during Periods 1, 2 and 3, the daily average remained unchanged, and the standard deviation in the number of news reports was statistically unchanged across all periods. The only slight increase in the median number of daily news reports was from Period 2 to Period 3.

<Table 1 is inserted about here>

Since it is already well recognized that the US market directly affects the Taiwan market, we also count the number of news reports on the US market; the statistics are reported in Panel B of Table 1, from which we can see that the patterns in the number of news articles are similar to those in Panel A. In order to obtain a complete picture of public information flows, we combine the numbers of news articles relating to the Taiwan and US markets and report the statistics in Panel C, from which we can see that no significant changes are discernible between each period in the means, medians and standard deviations; hence, the results clearly indicate that the flow of public information remained unchanged throughout the sample period.

As previously noted, if price variations in the market are solely driven by public information, then the price volatility dynamics should mimic the pattern of volatility in public information. A brief illustration of the one-minute and ten-minute time plots of realized intraday volatility, with trend curves, is provided in Figure 2, which clearly reveals an increase in volatility in the later part of the sample period, whilst the mid-sample period is found to have the lowest volatility. It therefore appears that the stable public information flows have no explanatory power with regard to the price variations in the TAIFEX futures index.

<Figure 2 is inserted about here>

We next examine the market volatility dynamics over the three different regimes, estimating such volatility using five different realized volatility levels, with the results being reported in Table 2. With the one exception of one-minute realized volatility, all of the remaining volatility measures reveal very similar patterns. In specific terms, a slight reduction is discernible in volatility between Period 1 and Period 2, as compared to a dramatic increase between Period 2 and Period 3.

<Table 2 is inserted about here>

Although no significant changes are discernible in one-minute realized volatility between Period 1 and Period 2, changes similar to those of the other measures are discernible between Period 2 and Period 3. Given the unchanged public information flows between each period, the increases in volatility imply that private information on the TAIFEX is the likely cause of the major price variations over the same time periods.

**4.2 Does Mispricing or Private Information Cause the Variation?**

The findings in Table 2 do not exclude the possibility that the price variations may be caused primarily by mispricing, as opposed to private information. A simple way of identifying the causes of price variations is to test the changes in mispricing. If the changes in mispricing are inconsistent with the changes in price volatility, it is less likely that the price variations arise solely as a result of the pricing errors in the market. We calculate a variance ratio deviation as the bound of the mispricing and examine the differences between each period based upon Equation (1); the results are reported in Table 3.

<Table 3 is inserted about here>

As Table 3 clearly shows, there were reductions in each of the variance ratio deviations between Period 1 and Period 2, with this declining pattern being similar to the pattern found in Table 2. The changes between Period 2 and Period 3 are, however, found to be inconsistent with the corresponding changes in volatility levels. There were continuing reductions in the deviations in the 5:1 variance ratio between Period 2 and Period 3, whereas the deviations in the other variance ratios were generally found to be unchanged over the same time horizon.

Since public information remained unchanged and volatility increased between Period 2 and Period 3, the declining or unchanged pricing errors in Table 3 rule out the possibility that the increase in volatility was caused by mispricing. This finding provides evidence of the existence of private information in the index futures market, essentially because the increase in the market volatility between Period 2 and Period 3 is most likely caused by private information. However, we still obtain ambiguous results on the comparison between Period 1 and Period 2 as a result of the reductions in the bounds of both mispricing and price volatility. In order to more precisely assess the private information within the market, we extend our investigation by adding evidence of intraday dynamics in volatility shapes and bid-ask spread shapes.

**4.3 Intraday Volatility and Bid-Ask Spread** **U-shapes**

As discussed in Section 2.3, our primary aim is to examine the order submissions of foreign institutional traders in an attempt to determine whether changes occurred in the distribution of the quotes between the three different intraday trading sessions, the early morning, late morning and lunch sessions. We calculate the daily percentage of the quotes submitted by foreign institutional traders in the late morning session for each trading day within each sample period and then carry out difference tests between the periods, and report the results in Table 4; the higher the daily percentage of quotes in the late morning session, the lower the daily percentage of quotes in the early morning and lunch sessions.

<Table 4 is inserted about here>

The results in Table 4 show that, over time, the order submissions of foreign institutions are relatively more concentrated in the late morning session. The respective average (median) daily percentage of submissions in Periods 1, 2 and 3 are around 30 per cent (30 per cent), 32 per cent (31 per cent) and 33 per cent (32 per cent). A monotonic increase is discernible across the periods, although only the difference between Period 2 and Period 3 is found to be statistically significant.[[17]](#footnote-17) The findings in Table 4 indicate that if foreign institutional traders carry more private information into the late morning session, as compared to the early morning and lunch sessions, intraday volatility and bid-ask U-shapes should flatten out over time.

In order to capture the intraday volatility and bid-ask spread patterns, we calculate the early morning-to-late morning (E-L) volatility and bid-ask spread ratios and lunch-to-late morning (L-L) volatility and bid-ask spread ratios. If the intraday volatility or bid-ask spread has a U-shape, then both the E-L and L-L ratios should be greater than 1. We adopt one-minute and five-minute realized volatility for the volatility analysis and use quoted spread (*QSpr*) and percentage spread (*PSpr*) for the bid-ask spread analysis.[[18]](#footnote-18)

The respective results on the intraday volatility and the bid-ask spreads are reported in Tables 5 and 6, with Table 5 showing that the intraday volatility in Period 1 has a distinct U-shape, consistent with the findings reported within the prior literature. Interestingly, in Periods 2 and 3, the volatility U-shape is obviously flattened out, with at least one of the E-L and L-L ratios reducing between the two periods, and the changes being statistically significant. We also plot the U-shapes for each period in Figure 3, which provides a clearer illustration of the erosion of the U-shape over time.

<Table 5 and Figure 3 are inserted about here>

Table 6 shows very similar patterns for QSPR and PSPR. Again, a distinct bid-ask spread U-shape is discernible in Period 1, but the shape flattens out in Periods 2 and 3. Figure 4 also graphically illustrates this flattening out over time.

<Table 6 and Figure 4 are inserted about here>

In summary, the findings on the changes in the intraday shapes of volatility and bid-ask spread provide clear evidence of a shift in private information not only between Period 2 and Period 3, but also between Period 1 and Period 2. The changes in the shapes are obviously associated with the changes in the order submissions of foreign institutional traders.

**4.4 Excluding the Potential Effect of Domestic Institutional Trading**

In Sections 3.1 to 3.3 we showed that private information drives market volatility on the TAIFEX, and that the source of the private information is more likely related to foreign institutional traders. Across our full sample period, foreign institutional traders are found to bring more private information into the market; however, domestic institutional trading may also increase at the same time, although the increase in the proportion of overall trading is less than that for foreign institutional trading.

In order to exclude the potential influence of domestic institutional traders, we carry out additional comparisons with volatility and bid-ask spread, the results of which are respectively reported in Tables 7 and 8. The comparisons with the intraday volatility U-shape are presented in Table 7, from which we can see that, after controlling for domestic institutional trading, we continue to observe the flattening out of the volatility U-shape from 2004 to 2005 and from 2006 to 2007.

<Table 7 is inserted about here>

The results of the comparisons with the bid-ask spread, which are presented in Table 8, provide clear evidence of a flattened out intraday bid-ask spread U-shape.[[19]](#footnote-19) As noted earlier, from 2004 to 2005 and from 2006 to 2007, domestic institutional traders were less able to cause market-wide changes, largely because their trading in these periods was relatively unchanged.

<Table 8 is inserted about here>

Nevertheless, both Tables 7 and 8 reveal the continuing occurrence of a shift in the private information in the market and the flattening out of the intraday U-shapes of both volatility and the bid-ask spread. The results suggest that, as compared to domestic institutional traders, foreign institutional traders are more likely to cause price variance as a result of their possession of private information.

**4.5 Testing the Price Impact of Foreign Institutional Trading**

We have so far provided evidence to show that the private information possessed by foreign institutional investors gives rise to changes in price variations in the index futures market; however, the question remains as to whether foreign institutions – which represent a relatively small trading group (responsible for only 15 to 25 percent of the total market) – can actually create a market-wide change. We therefore carry out a further regression analysis using the Schlag and Stoll (2005) model to specify the price impact of foreign institutional trading.

Pan and Poteshman (2006) argued that if specific investors wished to trade on their information advantage, they should choose to trade through leverage in order to maximize their trading gains. Thus, in our analysis using the Schlag and Stoll (2005) model, we expect to find that the signed trading volume of foreign institutional investors, in a period where they have the highest participation rate, will be the most informative and have the greatest impact on market movements. Table 9 presents the regression results on the three time periods.

<Table 9 is inserted about here>

As expected, the information hypothesis is supported only by the Period 3 results, whilst the Period 2 results are consistent with the liquidity hypothesis, and the Period 1 results provide only partial support for the liquidity hypothesis. In summary, the information effect in Period 3 implies that foreign institutional trading became more informative from Period 1 to Period 3. Thus, with the accompanied increase in the trading proportion of foreign institutional traders, the regression analyses using the Schlag and Stoll (2005) model provide clear support for our earlier findings.

**4.6 Trading Performance of Foreign institutional Investors**

So far, we have presented empirical evidence to specify the relation between the production of private information on the TAIFEX and foreign institutional trading. Another line of investigation would be to evaluate the trading performance for foreign institutions in different periods on the TAIFEX.

By precisely tracing position changes for all foreign institutional trading accounts for 1,484 trading days on the TAIFEX, we evaluate the dollar trading performance of foreign institutional traders. We compute, for each month, the average dollar profit that a trader can make for a single trade. The reason we propose the monthly frequency for performance evaluation is in conjunction with the fact that futures contracts are settled monthly. We report monthly-average dollar trading profit of foreign institutional traders for each period. To avoid extreme evaluation resulted from sparse trading of specific traders, only the traders who execute at least five round-trip transactions in each month and trade for more than four months in each period are included in the computation. The means and standard errors of monthly single-contract-profit are shown in Table 10.

We find that, on monthly basis, by trading a single futures contract, foreign institutional investors can earn $2,382 NTD, $2,494 NTD, and $3,018 in period 1, 2, and 3, respectively. We test the difference of the trading profit between periods. Interestingly, when the trading profit from period 1 to period 2 is statically indifferent, the trading profit of period 3 is significantly higher than that of period 2. The reported results indicate that foreign institutional trading tend to be more profitable over time. This is supportive to our finding in Table 9, which suggest that foreign institutional trading is more informative in the recent period.

**[Insert Table 10 Here]**

5. CONCLUSIONS

Our primary aim in this study is to extend the line of research on the private information possessed by foreign institutional traders in the Taiwan index futures market. Our analyses and findings are summarized as follows. Firstly, we test the relationship between the flow of public information and intraday volatility levels and show that public information is not the cause of price variations in the index futures market. We find that public information flows are quite stable throughout the sample period, whereas there are variations in price volatility across different periods. This suggests that either private information or mispricing contributes to price formation. Secondly, we test the role of mispricing in price volatility and find that the changes in mispricing cannot fully explain the price variations. This result provides support for the argument that private information affects price formation on the TAIFEX.

Thirdly, we test the intraday volatility and bid-ask spread patterns in order to identify the influence, over time, of foreign institutional trades, and find that the information-related U-shapes of intraday volatility levels and bid-ask spreads are flattened out with the increase in foreign institutional trades in the late morning session (10:15 am to 12:15 pm). This finding further confirms the existence of private information among foreign institutional investors. Finally, we not only test the price impact of foreign institutional traders by implementing the Schlag and Stoll (2005) model but also calculate the actual trading profit for foreign institutional traders from detailed account-by-account transaction data, with the results showing that foreign institutional trading is the most informative during periods with the highest proportion of foreign institutional trading on the TAIFEX, thereby suggesting that, over time, foreign institutional trading does carry more private information.

Our findings run contrary to the common view that it is far less likely that investors will possess private information relating to index market trading. In conjunction with the findings reported in the prior related literature, the evidence presented in this study demonstrates that foreign institutional investors possess private information, not only with regard to individual stocks, but also index market futures. The results further imply that the informational advantage of foreign institutional traders in the TAIFEX can provide them with trading gains at the expense of local investors.

**Acknowledgement**

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APPENDIX A

**Taxonomy of Private Information**

In order to root the taxonomy in theory, we consider the theoretical setting of Ito et al. (1998). The tenet in their definition of private information is that superior information on temporary price effects qualifies as private information. We begin by considering a canonical two-period trading model in which trading occurs initially at price *P*0 and then again at *P*1, with a terminal payoff, *F*, then being realized at *t* = 2.

Under this framework, the information on the terminal payoff, *F*, can be regarded as ‘fundamental’ private information. In contrast to this fundamental private information, the information which is unrelated to the payoff, *F*, but of relevance to the interim prices, *P*0 and *P*1, can be regarded as ‘semi-fundamental’ private information.

*P*0 and *P*1are assumed to be determined by many arguments beyond the expectation of the payoff, *F*, such as the risk aversion and trading constraints of traders, the supply and demand of the risky asset, along with other features within the trading environment. Given that all of these features affect *P*0 and *P*1, but do not alter the expectations of *F*, superior knowledge of these therefore qualifies as semi-fundamental private information within the index futures market.

APPENDIX B

**Variance Decomposition**

The components of return variance were derived by French and Roll (1986) from an identifying assumption, that mispricing has temporary effects on prices, whereas private information has permanent effects. We begin by decomposing the return in period *t* (that is, *Rt*) into two components, an information component, *It*, and an error component, *Et*:

,

where the error component can be both a pricing error and a measurement error.

Given that the effect of the error component on prices is only temporary, the variance in returns over long holding periods reflects only the information component, whereas the cumulated variance over short intervals includes both components.

Let *Vl* denote the long-term return variance and *Vs* denote the short-term return variance, then 1 –*Vl* / *Vs* (=*V*(*Et*)/*V*(*Rt*)) provides an upper bound on the proportion of variance attributable to mispricing. This deviation is the upper bound, essentially because *V*(*Et*) includes the effect of the bid-ask bounce.

This measure essentially assumes that the components are uncorrelated:

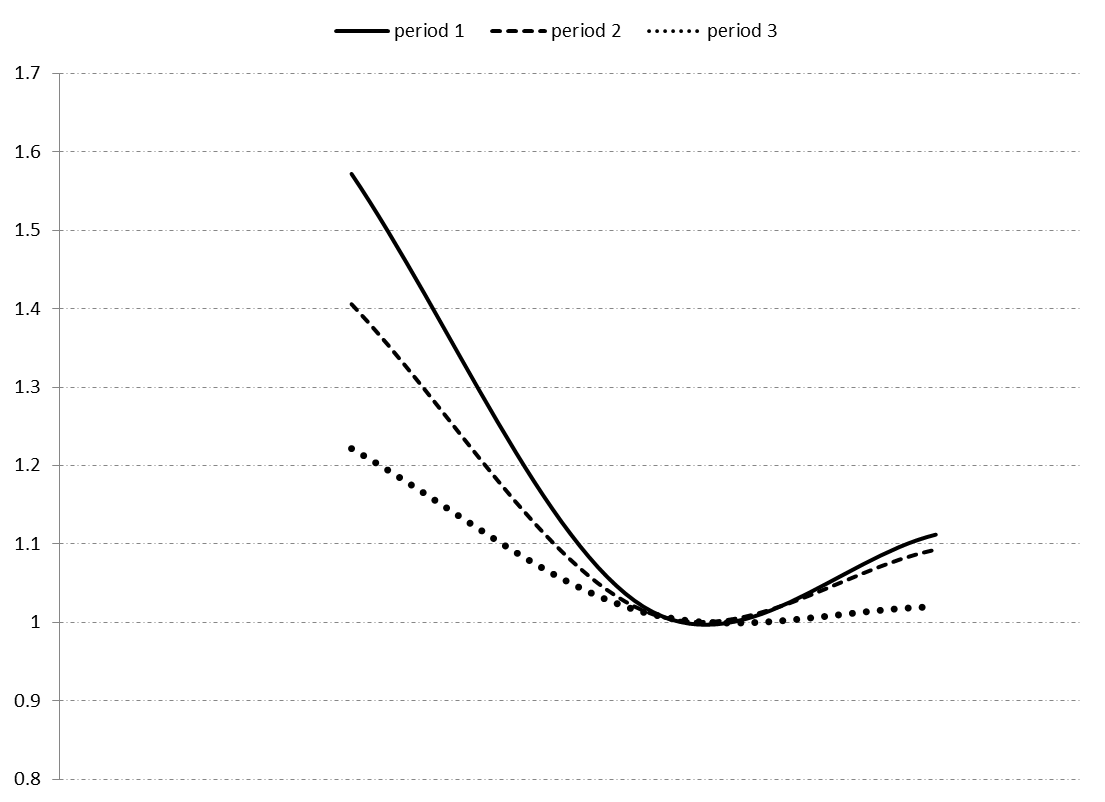
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**Figure 1: The number and Percentage of Trades for Each Investor in Different Periods.** This figure presents the daily average trading volume for foreign institutional investors, domestic institutional investors, and individual investors in different periods. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. Period 1 is from January 2003 to December 2005. Period 2 is from January 2006 to August 2007. Period 3 is from September 2007 to December 2008. The left plot is based on the number of trades (contract), and the right plot is based on the trading percentage.

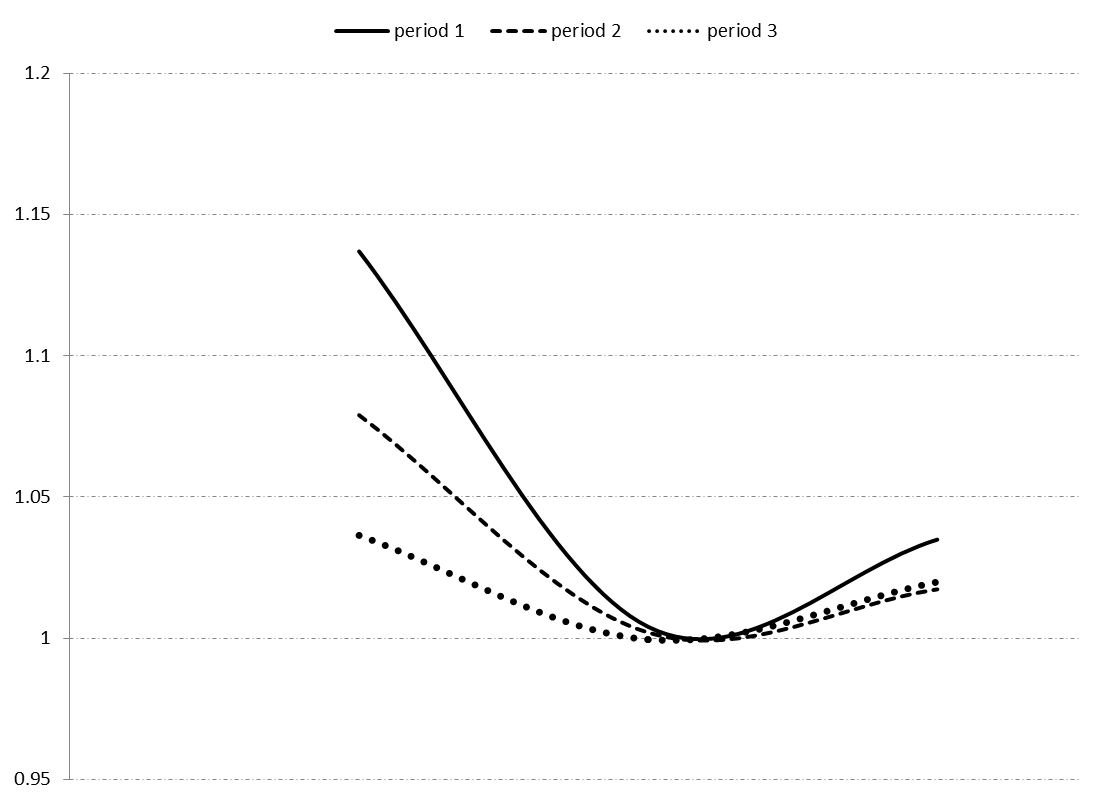
**Figure 2: Intraday Volatility through Time.** This figure presents the time dynamics of return volatilities of the TXF index by two measures: 1-minute return volatility and 10-minute return volatility. The sample period is from January 2003 to December 2008, which includes 1484 trading days. The volatilities are calculated by corresponding intraday returns for each trading day. The returns are calculated as the changes in the log of the bid–ask midpoint. Two solid curves are nonlinear trend lines for return volatilities.



Early Morning Late Morning Lunch

Standardized Variance Ratio

**Figure 3: Intraday Volatility U-Shapes by Different Periods.** This figure presents the return variance of the TXF index for three intraday trading sessions: early morning (8:45 am–10:15 am), late morning (10:15 am–12:15 pm), and lunch (12:15 am–1:45 pm), Taipei time. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. The return variances are calculated by1-minute returns for each session. The returns are calculated as the changes in the log of the bid–ask midpoint. For cross-period comparison, we standardize each variance by the variance of late morning session for each period (the variance of the late morning session is hence equals 1). The lines are smoothed interpolations of the three variance estimates.



Early Morning Late Morning Lunch

Standardized Bid-Ask Spread

**Figure 4: Intraday Bid-Ask Spread U-shapes by Different Period.** This figure presents the quoted spread of the TXF index price for three intraday trading sessions: early morning, (8:45 am–10:15 am), late morning (10:15 am–12:15 pm), and lunch (12:15 am–1:45 pm), Taipei time. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. The numbers of quoted spreads in this plot are calculated as the mean of all spread value (best ask – best bid) for each session. For cross-period comparison, we standardize the number of spread by the spread of late morning session for each period (the spread of late morning session is hence equals 1). The lines are smoothed interpolations of the three spread estimates.

**Table 1: The Public Information Flow: Daily Number of News reports**

This table reports the public information flow in term of the number of news reports about the market status by the news database, *Economic Daily News*. Panel A reports the news about the Taiwan market, including the stock market and futures market. Because the Taiwan market is affected by the U.S. market, Panel B reports the news about the U.S. market. Panel C aggregates the number of the Taiwan news and the U.S. news. The *t-*test, Wilcoxon test, and *F*-test are used to test means, medians, and, variances across different periods, respectively. \*\* and \* represent a significance level of 5% and 10% for the tests, respectively.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| News source | Period 1  2003.01–2005.12 | | | Period 2  2006.01–2007.08 | | | Period 3  2007.09–2008.12 | | | Mean test  H0: P1=P2 | Median test  H0: P1=P2 | | Variance test  H0: P1=P2 | | Mean test  H0: P2=P3 | Median test  H0: P2=P3 | | Variance test  H0: P2=P3 |
|  | Avg. | Med. | Std. | Avg. | Med. | Std. | Avg. | Med. | Std. |
| *Panel A: News of the Taiwan Market* | | | | | | | | | | | | | | | | | | |
| *Economic Daily News* | 5.44 | 6 | 4.15 | 5.78 | 6 | 4.22 | 5.98 | 7 | 4.12 | -- | | -- | | -- | -- | | \* | -- |
| *Panel B: News of the U.S. Market* | | | | | | | | | | | | | | | | | | |
| *Economic Daily News* | 3.03 | 3 | 2.37 | 2.96 | 3 | 2.48 | 3.11 | 2 | 2.50 | -- | | -- | | -- | -- | | \*\* | -- |
| *Panel C: Two markets combined* | | | | | | | | | | | | | | | | | | |
| *Economic Daily News* | 8.47 | 9 | 5.02 | 8.74 | 9 | 5.53 | 9.09 | 9 | 5.45 | -- | | -- | | -- | -- | | -- | -- |

**Table 2: Intraday Volatility across Different Periods**

This table reports the statistics of intraday volatility by different frequency realized volatility(RV)estimates. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. Volatilities are estimated by intraday returns. The returns are calculated as the changes in the log of the bid–ask midpoint. The units of realized volatilities are multiplied by 103. The *t-*test and Wilcoxon test are used to test means and medians across different periods, respectively. Thestatistics of tests are reported in the last four columns. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Volatility type | Period 1  2003.01–2005.12 | | | | Period 2  2006.01–2007.08 | | | | Period 3  2007.09–2008.12 | | | | Mean test  H0: P1=P2 | Median test  H0: P1=P2 | Mean test  H0: P2=P3 | Median test  H0: P2=P3 |
| Max. | Min. | Avg. | Med. | Max. | Min. | Avg. | Med. | Max. | Min. | Avg. | Med. |
| RV (1-min) | 1.650 | 0.175 | 0.435 | 0.369 | 1.569 | 0.176 | 0.442 | 0.406 | 8.284 | 0.298 | 0.811 | 0.700 | 0.554 | 1.505 | 11.370\*\*\* | 17.089\*\*\* |
| RV (5-min) | 4.652 | 0.356 | 1.071 | 0.956 | 3.764 | 0.422 | 1.001 | 0.903 | 8.270 | 0.715 | 1.844 | 1.634 | –2.373\*\* | –2.335\*\* | 14.922\*\*\* | 16.691\*\*\* |
| RV (10-min) | 6.651 | 0.477 | 1.573 | 1.390 | 5.645 | 0.586 | 1.480 | 1.321 | 8.925 | 1.080 | 2.710 | 2.426 | –2.082\*\* | –1.565 | 15.230\*\*\* | 16.285\*\*\* |
| RV (15-min) | 7.697 | 0.527 | 1.865 | 1.634 | 6.391 | 0.639 | 1.764 | 1.605 | 11.43 | 1.086 | 3.194 | 2.868 | –1.871\* | –1.165 | 14.801\*\*\* | 15.773\*\*\* |

**Table 3: Mispricing across Different Periods**

This table reports the statistics of mispricing errors by different frequencies. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. The mispricing is defined as

where *Vl* is the return variance over the long holding period, and *Vs* is the return variance over short subintervals. The return variances are calculated by corresponding intraday returns for each trading day. The returns are calculated as the changes in the log of the bid–ask midpoint. The *t-*test and Wilcoxon test are used to test means and medians across different periods, respectively. Thestatistics of tests are reported in the last four columns. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deviation Frequency | Period 1  2003.01–2005.12 | | | | Period 2  2006.01–2007.08 | | | | Period 3  2007.09–2008.12 | | | | Mean test  H0: P1 = P2 | Median test  H0: P1 = P2 | Mean test  H0: P2 = P3 | Median test  H0: P2 = P3 |
|  | Max | Min | Ave | Med | Max | Min | Ave | Med | Max | Min | Ave | Med |
| 5-min variance  over 1-min variance | 0.93 | 0.01 | 0.25 | 0.22 | 0.52 | 0.01 | 0.16 | 0.13 | 0.48 | 0.00 | 0.14 | 0.11 | 10.56\*\*\* | 8.41\*\*\* | 1.80\* | 1.84\*\* |
| 10-min variance over 1-min variance | 1.53 | 0.00 | 0.32 | 0.27 | 0.97 | 0.00 | 0.23 | 0.18 | 1.37 | 0.00 | 0.25 | 0.18 | 7.71\*\*\* | 6.66\*\*\* | –1.24 | 0.52 |
| 15-min variance over 1-min variance | 1.71 | 0.00 | 0.32 | 0.23 | 0.90 | 0.01 | 0.24 | 0.19 | 0.90 | 0.01 | 0.24 | 0.18 | 5.33\*\*\* | 3.75\*\*\* | 0.30 | 0.75 |
| 15-min variance over 5-min variance | 0.62 | 0.00 | 0.16 | 0.13 | 0.59 | 0.00 | 0.15 | 0.12 | 0.88 | 0.00 | 0.16 | 0.12 | 1.07 | 1.65\* | –0.96 | –0.22 |

**Table 4: Quotes Distribution among Intraday Intervals across Different Periods**

This table reports the daily percentage of quotes submitted by foreign institutional traders in late morning trading (10:15 am–12:15 pm) session for each trading day of each period. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. The *t-*test and Wilcoxon test are used to test means and medians across different periods, respectively. Thestatistics of tests are reported in the last four columns. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Period 1  2003.01–2005.12 | | | | Period 2  2006.01–2007.08 | | | | Period 3  2007.09–2008.12 | | | | Mean test  H0: P1 = P2 | Median test  H0: P1 = P2 | Mean test  H0: P2 = P3 | Median test  H0: P2 = P3 |
|  | Max | Min | Ave | Med | Max | Min | Ave | Med | Max | Min | Ave | Med |
| Quotes in late morning session (%) | 100 | 0.0 | 30.4 | 30.3 | 73.1 | 4.08 | 31.5 | 31.1 | 100 | 2.68 | 32.9 | 32.2 | –1.45 | –1.38 | –1.99\*\* | –1.92\*\* |

**Table 5: How does the intraday volatility U-Shape change?**

This table presents the return variance ratio based on three intraday trading sessions: early morning (8:45 am–10:15 am), late morning (10:15 am–12:15 pm), and lunch (12:15 am–1:45 pm), Taipei time. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. The return variances are calculated by 1-minute and 5-minute returns for each session. The returns are calculated as the changes in the log of the bid–ask midpoint. For each period, the left column is the ratio of the variance in the early morning session over the variance in the late morning session (E/L), and the right column is the variance in the lunch session over the variance in the late morning session (L/L). The *t-*test and Wilcoxon test are used to test means and medians across different periods, respectively. Thestatistics of tests are reported in the last four columns. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Period 1  2003.01–2005.12 | | Period 2  2006.01–2007.08 | | Period 3  2007.09–2008.12 | | H0:  P2=P1 | | H0:  P3=P2 | |
|  | | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning | E/L | L/L | E/L | L/L |
| 1-min | Mean | 1.5520 | 1.0920 | 1.3859 | 1.0730 | 1.2017 | 0.9943 | 6.68\*\*\* | 0.88 | 5.03\*\*\* | 3.70\*\*\* |
| Median | 1.4879 | 1.0208 | 1.3549 | 1.0115 | 1.1279 | 0.9538 | 4.54\*\*\* | 0.17 | 8.53\*\*\* | 3.39\*\*\* |
| 5-min | Mean | 1.5436 | 1.1088 | 1.3489 | 1.1217 | 1.1941 | 1.0398 | 6.88\*\*\* | 0.50 | 3.99\*\*\* | 2.82\*\*\* |
| Median | 1.4878 | 1.0249 | 1.3211 | 1.0331 | 1.1451 | 0.9863 | 4.67\*\*\* | 0.64 | 5.40\*\*\* | 2.74\*\*\* |

**Table 6: How does the intraday bid-ask spread U-Shape change?**

This table presents the bid-ask spread ratio based on three intraday trading sessions: early morning (8:45 am–10:15 am), late morning (10:15 am–12:15 pm), and lunch (12:15 am–1:45 pm), Taipei time. The sample period is from January 2003 to December 2008, which includes 1,484 trading days. The spreads are defined by quoted spread (QSPR) and percentage spread (PSPR), calculated as (best ask – best bid) and (best ask – best bid)/midpoint price, respectively. For each period, the left column is the ratio of the mean (median) spread in the early morning session over the mean (median) spread in the late morning session (E/L), and the right column is the mean (median) spread in the lunch session over the mean (median) spread in the late morning session (L/L). The *t-*test and Wilcoxon test are applied to test means and medians across different periods, respectively. Thestatistics of tests are reported in the last four columns. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Period 1  2003.01–2005.12 | | Period 2  2006.01–2007.08 | | Period 3  2007.09–2008.12 | | H0:  P2=P1 | | H0:  P3=P2 | |
|  | | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning | E/L | L/L | E/L | L/L |
| QSPR | Mean | 1.1370 | 1.0349 | 1.0790 | 1.0173 | 1.0364 | 1.0199 | 6.60\*\*\* | 2.19\*\* | 4.50\*\*\* | 0.31 |
| Median | 1.1103 | 1.0123 | 1.0720 | 1.0078 | 1.0234 | 1.0125 | 5.54\*\*\* | 0.98 | 5.49\*\*\* | 0.13 |
| PSPR | Mean | 1.1373 | 1.0353 | 1.0791 | 1.0176 | 1.0358 | 1.0206 | 6.51\*\*\* | 2.15\*\* | 4.49\*\*\* | 0.36 |
| Median | 1.1095 | 1.0110 | 1.0751 | 1.0058 | 1.0210 | 1.0109 | 5.55\*\*\* | 0.96 | 5.49\*\*\* | 0.20 |

**Table 7: Paired years comparisons: Intraday volatility U-shape**

This table presents the return variance ratio based on three intraday trading sessions: early morning (8:45 am–10:15 am), late morning (10:15 am–12:15 pm), and lunch (12:15 am–1:45 pm), Taipei time. Panel A is the comparison of 2004 and 2005. Panel B is the comparison of 2006 and 2007. The return variances are calculated by 1-minute and 5-minute returns for each session. The returns are calculated as the changes in the log of the bid–ask midpoint. For each period, the left column is the ratio of the variance in the early morning session over the variance in the late morning session (E/L), and the right column is the variance in the lunch session over the variance in the late morning session (L/L). The *t*-test and Wilcoxon test are used to test means and medians across different periods, respectively. Thestatistics of tests are reported in the last four columns. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Panel A: Comparison 1* | |  | | | | | |
|  | | 2004 | | 2005 | | H0: no changes between years | |
|  | | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning |
| 1-min | Mean | 1.6229 | 1.0907 | 1.5123 | 1.0339 | 2.82\*\*\* | 1.75\* |
| Median | 1.5722 | 1.0021 | 1.4471 | 0.9700 | 2.72\*\*\* | 1.54 |
| 5-min | Mean | 1.6033 | 1.0935 | 1.5014 | 1.0433 | 2.38\*\* | 1.39 |
| Median | 1.5604 | 0.9817 | 1.4467 | 1.0041 | 2.63\*\*\* | 0.78 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Panel B: Comparison 2* | |  | | | | | |
|  | | 2006 | | 2007 | | H0: no changes between years | |
|  | | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning |
| 1-min | Mean | 1.3727 | 1.0843 | 1.3222 | 1.0412 | 1.46 | 1.69\* |
| Median | 1.3506 | 1.0098 | 1.2919 | 1.0107 | 2.08\*\*\* | 1.24 |
| 5-min | Mean | 1.3198 | 1.1285 | 1.3052 | 1.0903 | 0.37 | 1.02 |
| Median | 1.3076 | 1.0319 | 1.2569 | 1.0307 | 0.63 | 1.12 |

**Table 8: Paired years comparisons: Intraday bid-ask spread U-shape**

This table presents the bid–ask spread ratio based on three intraday trading sessions: early morning (8:45 am–10:15 am), late morning (10:15 am–12:15 pm), and lunch (12:15 am–1:45 pm), Taipei time. Panel A is the comparison of 2004 and 2005. Panel B is the comparison of 2006 and 2007. The spreads are defined by quoted spread (QSPR) and percentage spread (PSPR), calculated as (best ask – best bid) and (best ask – best bid)/midpoint price, respectively. For each period, the left column is the ratio of the mean (median) spread in the early morning session over the mean (median) spread in the late morning session (E/L), and right column is the mean (median) spread in the lunch session over the mean (median) spread in the late morning session (L/L). The *t-*test and Wilcoxon test are used to test means and medians across different periods, respectively. Thestatistics of tests are reported in the last four columns. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Panel A: Comparison 1* | | | | | | | |
|  | | 2004 | | 2005 | | H0: no changes between years | |
|  | | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Early Morning / Late Morning | Early Morning / Late Morning | Early Morning / Late Morning |
| QSPR | Mean | 1.1634 | 1.0471 | 1.0646 | 0.9950 | 5.83\*\*\* | 3.97\*\*\* |
| Median | 1.1257 | 1.0154 | 1.0653 | 0.9835 | 6.77\*\*\* | 3.35\*\*\* |
| PSPR | Mean | 1.1639 | 1.0482 | 1.0646 | 0.9906 | 5.88\*\*\* | 3.94\*\*\* |
| Median | 1.1302 | 1.0125 | 1.0657 | 0.9837 | 6.78\*\*\* | 3.32\*\*\* |
| *Panel B* *Comparison 2* | | | | | | | |
|  | | 2006 | | 2007 | | H0: no changes between years | |
|  | | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Lunch / Late Morning | Early Morning / Late Morning | Early Morning / Late Morning |
| QSPR | Mean | 1.0845 | 1.0270 | 1.0559 | 1.0122 | 2.64\*\*\* | 1.56 |
| Median | 1.0812 | 1.0246 | 1.0534 | 0.9972 | 3.10\*\*\* | 2.02\*\* |
| PSPR | Mean | 1.0845 | 1.0272 | 1.0560 | 1.0128 | 2.59\*\*\* | 1.48 |
| Median | 1.0806 | 1.0229 | 1.0544 | 0.9963 | 3.04\*\*\* | 1.95\* |

**Table 9: Price Impact Test: Schlag and Stoll (2005) Model**

This table presents the results of the regression estimates using Schlag and Stoll’s (2005) model. The variables are calculated based on 15-minute intraday intervals. The sample period is from January 2003 to December 2008, which includes 29,680 intraday time intervals. The regression model is defined as

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where *Rt*is futures index return at time *t*, *BUYt* is the buy order of foreign institutions at time *t*, and *SELLt* is the sell order of foreign institution at time *t*. For brevity, only the coefficients of current quotes and lagged quotes are reported. The returns are calculated as the changes in the log of the bid–ask midpoint. The *t-test* is applied to test the coefficients; *t*-statistics are in the parentheses. \*\*\*, \*\*, and \* represent a significance level of 1%, 5%, and 10%, respectively.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Intercept | Buyt | Sellt | Buyt-1 | Sellt-1 | Buyt-2 | Sellt-2 | Buyt-3 | Sellt-3 | Buyt-4 | Sellt-4 | Adj *R*2 |
| *Period 1 2003.01–-2005.12* | 49.231\*\* | –0.948\*\*\* | –0.588\*\*\* | –0.397\* | –0.770\*\*\* | 0.459 | –0.271 | 0.126 | 0.030 | 0.449\*\* | 0.203 | 0.68 |
| (2.183) | (–4.610) | (–3.304) | (–1.772) | (4.015) | (2.038) | (1.409) | (0.571) | (–0.158) | (2.231) | (–1.174) |
| *Period 2* *2006.01–-2007.08* | 39.34 | 1.375\*\*\* | –1.672\*\*\* | –0.544\*\*\* | 0.871\*\*\* | 0.024 | –0.010 | –0.324\* | 0.200 | 0.021 | 0.015 | 1.84 |
| (1.268) | (8.441) | (–10.663) | (–3.061) | (5.045) | (0.135) | (–0.579) | (–1.906) | (1.230) | (0.135) | (0.104) |
| *Period 3 2007.09–-2008.12* | –40.85 | 0.907\*\*\* | –1.294\*\*\* | –0.080 | 0.013 | 0.378 | –0.052 | 0.140 | 0.111 | –0.210 | –0.021 | 1.45 |
| (–0.539) | (4.168) | (–5.912) | (–0.339) | (0.055) | (1.617) | (–0.221) | (0.637) | (0.486) | (–1.108) | (–0.104) |

**Table 10: Average dollar profits (NTD) by trading for foreign institutional traders**

This table reports the monthly average trading profits in New Taiwan Dollar (NTD) for all foreign institutional traders. The calculation is conducted by tracing position changes in all foreign institutional accounts for 1,484 trading days from 2003 to 2008 on the TAIFEX. We compute the monthly average dollar profit that a trader can make for a single trade. We show the means and standard errors of a single-contract-profit for all foreign institutional trader in each period. The first column shows the results for period 1, and the second and third column show for period 2 and period 3, respectively. The mean profits in each period are examined by T-test. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Period 1  *2003.01–-2005.12* | Period 2  *2006.01–-2007.08* | Period 3  *2007.09–-2008.12* | *Difference*  H0: First=Second | *Difference*  H0: Second=Third |
| Foreign Institutions  Traders | 2,382 (735) | 2,494 (749) | 3,018 (802) | 112 | 524\*\*\* |

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2. See, for example, Seasholes (2000), Grinblatt and Keloharju (2000), Barber, Lee, Liu and Odean (2009) and Albuquerque, Bauer and Schneider (2009). [↑](#footnote-ref-2)
3. The broad market indices are the S&P 100 (OEX), the S&P 500 (SPX) and the NASDAQ-100 (NDX) indices. [↑](#footnote-ref-3)
4. In this study, we turn to Ito, Lyons and Melvin (1998) for the most accurate definition of the term ‘private information’; they stated that ‘private information’ must satisfy two criteria: (i) it must not be ‘common knowledge’; and (ii) it must be ‘price relevant’. In order to be considered ‘price relevant’, private information can incorporate either the permanent or temporary price effects. Appendix A provides a more detailed taxonomy on private information. [↑](#footnote-ref-4)
5. A wealth of empirical works has contributed to the discussion on the information content of foreign institutional investors by investigating the trading behavior of such investors; the issues have included ‘return predictability’ (Nagel, 2005; Chang, Hsieh and Wang 2009), ‘price impact’ (Stoll, 2000; Chan and Fong, 2000), ‘trading profitability’ (Barber, Lee, Liu and Odean, 2011) and ‘volatility predictability’ (Chang, Hsieh and Wang, 2010). [↑](#footnote-ref-5)
6. The major stock market index in the Taiwan stock exchange is a non-tradable index; an alternative is the stock index futures market, which is highly-correlated with its equity counterpart. The validity of the use of the stock index futures market is supported by the seminal work of Chan (1992), which examined the intraday lead-lag relationship between the returns of the major cash index and the major futures index markets. Chan provided strong evidence of the futures market leading the cash index and weak evidence of the cash index leading the futures market, which suggested that the stock market index futures projects market-wide information. [↑](#footnote-ref-6)
7. Such participation by foreign investors is based on the average daily percentage of foreign institutional trades in the overall market. [↑](#footnote-ref-7)
8. The French and Roll (1986) approach has been widely adopted in various studies to classify the information source within price changes; examples include Fama and French (1988), Berry and Howe (1994) and Chordia, Roll and Subrahmanyam (2008; 2011). [↑](#footnote-ref-8)
9. Examples include Wood, McInbish and Ord (1985), Harris (1986), Admati and Pfleiderer (1988), Foster and Viswanathan (1990), Slezak (1994) and Andersen and Bollerslev (1997). [↑](#footnote-ref-9)
10. In 1972, trading was prohibited in the Tokyo FX exchange during the lunch break (12:00 pm to 1:30 pm); however, due to the migration of trading volume to other exchanges, the committee of the Tokyo FX exchange removed the restriction on 21 December 1994. [↑](#footnote-ref-10)
11. Stoll (1989) showed that the component of adverse information costs in the quoted spread was as high as 43 per cent, thereby indicating that, to a large extent, the bid-ask spread represents the level of information asymmetry in the market. Given that the level of information asymmetry is associated with private information in the market, the time variation in the quoted spread should reflect the changes in informed trading. For example, Glosten (1994) showed that the positive bid-ask spread in the market was attributable to the possibility of trading on private information. [↑](#footnote-ref-11)
12. Mclnish and Wood (1992) reported a U-shaped pattern in the bid-ask spread for NYSE stocks, whilst Madhavan (1992) considered a model in which information asymmetry was gradually resolved during the trading day, with the model predicting a decline in the bid-ask spread throughout the day. [↑](#footnote-ref-12)
13. See, for example, Grinblatt and Keloharju (2000), Seasholes (2000), Froot, O’Connell and Seasholes (2001) and Froot and Ramadorai (2008). [↑](#footnote-ref-13)
14. TAIEX is the abbreviation for the Taiwan Stock Exchange Capitalization Weighted Stock Index, an index constructed by the Taiwan Stock Exchange. In addition to the transaction dataset obtained directly from the TAIFEX, we also use the intraday futures prices dataset obtained from the Taiwan Economic Journal (TEJ). [↑](#footnote-ref-14)
15. Each quote in our original data is time stamped to the second; we report the results based on data with periodicity of one minute, constructed by taking the price closest to each minute. [↑](#footnote-ref-15)
16. The variance in the information component in the price return does not change, essentially because private information does not exist and the public information is unchanged; therefore trading variance cannot possibly increase with a failing (falling…?) or constant proportion due to the error component, because the changes in total variance can only come from mispricing. [↑](#footnote-ref-16)
17. The difference between Period 1 and Period 2 is statistically significant in the one-way test, but only marginally significant in the two-way test. [↑](#footnote-ref-17)
18. For the volatility analysis, we also apply ten-minute and 15-minute realized volatility. The findings are consistent with those using one-minute and five-minute volatility. For the sake of brevity, the results are not reported in the table. [↑](#footnote-ref-18)
19. We compare the distribution of order submissions by foreign institutional traders for the same year pairs before the robustness test in Tables 7 and 8. Similar to the findings in Table 4, the percentage of order submissions in the late morning session was relatively higher in 2005 and 2007. For the sake of brevity, the results are not reported here. [↑](#footnote-ref-19)