E C O N O M I C S B U L L E T I N

The impact of foreign trading information on emerging futures markets: a study of Taiwan's unique data set

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Abstract

Using a unique dataset from the Taiwan Futures Exchange, this paper investigates whether trading imbalances by foreign investors affect emerging Taiwan futures market in terms of returns and volatility. First, this evidence demonstrates a positive relation between contemporaneous futures returns and net purchases by foreign investors when other market factor effects are controlled. Second, this failure to detect price reversals is inconsistent with the price pressure hypothesis. Third, foreign investors do not exhibit positive feedback trading patterns. Fourth, a bi-directional Granger-causality relationship exists between futures volatility and foreign trading flows. As found for other stock or foreign exchange markets, our empirical results demonstrate that foreign trading flows do have impacts on the return and volatility of developing futures market, suggesting that trading by foreign investors may enhance the information flow of the local futures market.

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1. Introduction

Does foreign trading activity affect local financial market returns and volatility? This issue has attracted considerable attention in developing markets, and has also proven a fertile area for empirical research among financial economists.[1] The impact of foreign trading on developing markets is a controversial issue among market regulators and financial commentators. For example, it is frequently argued that foreign trading can have a destabilizing effect on local financial markets owing to the faster pace of transactions and inherent uncertainties associated with trading by foreign investors (e.g., Khan and Reinhart, 1995; Grabel, 1995; Aitken, 1996; Singh, 1997; Wang and Shen, 1999). Particularly, foreign outflows cause price overreaction and price contagion. Nevertheless, another perspective is that trading is merely the process by which information is incorporated into asset prices. Ross (1989), Lamoureux and Lastrapes (1990), Blume, Easley, and O'Hara (1994), and Antoniou and Holmes (1995) proposed that it is the volatility of asset price, rather than just the simple change in asset price, that is correlated with the information flow rate. Therefore, even increased volatility may not damage markets. The increased volatility could result from increased information flow, which could increase market efficiency.

However, it is also proposed that trades by informed foreign investors investing based on fundamentals positively affect on the market by improving market microstructure, mitigating the influence of noise trading, and tending to stabilize emerging financial markets (Holmes and Wong, 2001). Merton (1987) demonstrated that foreign participation broadens the base of investors in the local market, thus improving liquidity, increasing risk sharing, and lowering the risk premium of stocks. The increased risk sharing, sometimes termed the "base broadening" effect, is an important theoretical reason for the benefits of market liberalization (Clark and Berko, 1997). Kwan and Reyes (1997), Bekaert and Harvey (1997), Choe, Kho and Stulz (1999), Holmes and Wong (2001), Kassimatis (2002) showed that volatility in emerging stock markets declines following foreign investment liberalization. Although the empirical results exhibit no consistency in terms of this issue, foreign investment in local financial markets continues to increase all around the world.

Additionally, the relation between foreign trading flows and local market returns has also received increased attention. There is a growing body of research that studies two phenomena associated with foreign trading in the emerging markets. The first phenomena of interest focuses on the effect of foreign trading flows on returns. Tesar and Werner (1995a, b), Bohn and Tesar (1996), and Brennan and Cao (1997), Choe, Kho, and Stulz (1999) found positive, contemporaneous correlations between international portfolio inflows and stock returns in emerging markets. Brennan and Cao (1997) argued that the contemporaneous correlations may be attributed to international investors updating their forecasts more frequently than local investors in response to the public release of market information. Yu and Lai (1999) and Lin and Ma (2002) also found that trades by foreign investors influence the Taiwanese stock market.

The second phenomena of interest is whether foreign investors are positive feedback traders. That is, are the trades of foreign investors affected by past returns? Investors who buy when prices have increased and sell when they have fallen are

[1] See McKinnon (1973), Grabel (1995), Tesar and Werner (1995a, b), Bohn and Tesar (1996), Aitken (1996), Singh (1997), Kwan and Reyes (1997), Brennan and Cao (1997), Bekaert and Harvey (1997), Stulz (1997), Choe, Kho and Stulz (1999), Wang and Shen (1999), Bekaert and Harvey (2000), Holmes and Wong (2001), Froot, O'Connell, Seasholes (2001), Kassimatis (2002).

termed as positive feedback or momentum traders. Numerous studies such as Dornbusch and Park (1995), Choe, Kho and Stulz (1999), Froot, O'Connell and Seasholes (2001), Grinblatt and Keloharju (2000), Karolyi (2002), Kim and Wei (2002), and Dahlquist and Robertsson (2004) find that foreign investors exhibit positive feedback trading patterns in equity markets. In addition, the price pressure hypothesis would suggest that increased flows temporarily induce high returns which are reversed afterwards. Clark and Berko (1996) and Dahlquist and Robertsson (2004) evaluate price pressure by foreign investors in the Mexican and Swedish stock markets, respectively. Both studies do not find the existence of price pressure hypothesis for the Mexican and Swedish stock markets. That is, no evidence shows that stock returns are negatively related to past net foreign flows. Nevertheless, little attention has been paid to the price pressure hypothesis and positive feedback trading by foreign investors in emerging futures markets. Consequently, this study tests the hypotheses of price pressure and positive feedback trading in Taiwan futures markets.

Taiwan stock market has become an increasingly popular investment destination in Asia stock markets, especially since the introduction of Taiwan Stock Index (TSI) into the Morgan-Stanley Emerging Market Free Index, World Free Index and Fareast Free index. Furthermore, Taiwan Futures Exchange (TAIFEX) was built on July 21, 1998 and has been growing fast. Especially, the Taiwan Stock Index Futures contract (TX) is the sixth largest one of Asian index futures contracts in 2004.[2] Nevertheless, the Taiwan futures market was not active during earlier periods. To increase the width and depth of the Taiwan futures market, government authorities permitted the opening up of Taiwan futures markets to foreign investments (FI)[3]on November 1, 1999. Previous studies on the influence of foreign investments on local stock and foreign exchange markets have been conducted,[4] but little empirical work has been done to study whether and how foreign trading affects returns and volatility in emerging futures markets. Consequently, this work will address a gap in the literature. Additionally, the Taiwanese experience presented in this study may act as a guide for other developing futures markets, which are in a quandary over the possible influence of trades by foreign investors on local markets.

Taking advantage of a unique dataset from TAIFEX, the purpose of this study is to investigate the impact of trading imbalances[5] by foreign investors on price behavior in terms of returns and volatility in Taiwan futures markets. This investigation uses two different methodologies to enhance the robustness of the results. First, this work adopts the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model which enables us to study the effects of foreign trading on the futures markets. Second, the VAR model is employed to examine the dynamic interaction between returns (or volatility) and trading flows by foreign investors. In the VAR framework, we can test the price pressure hypothesis and explore whether foreign investors are feedback traders in futures markets. This study includes a distinct feature to help ensure that the effects of foreign investments are made more robust. This paper hypothesizes that market factors other than trading information by foreign investors may affect futures return and volatility, so the effect

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[2] The statistic is provides by Trade Data Global Service.

[3] Foreign investments in this study refer to foreign portfolio investments. Investments of qualified foreign institutional investors (QFII) serve as a proxy for foreign investments. QFII include foreign banks, insurance companies, fund management institutions, securities firms, and other investment institutions meeting the qualifications set by the Taiwan Securities and Futures Commission (SFC).

[4] For example, Brennan and Cao (1997), Bekaert and Harvey (1997), Stulz (1997), Choe, Kho and Stulz (1999), Yu and Lai (1999), Holmes and Wong (2001), Wang and Shen (1999), Froot, O'Connell, Seasholes (2001), Kassimatis (2002) etc.

[5] Trading imbalances denote the difference between long and short positions in futures market.

of additional market factors is controlled. Consequently, the spot return[6] serves as a proxy for additional market factors for catching the systematic economic effects, so that the impact of trading information by foreign investors on futures returns and volatility can be properly studied without contamination.

The remainder of this paper is organized as follows. Section 2 describes the data used. Section 3 outlines the empirical methodology. Section 4 presents the empirical results and discussion. Finally, section 5 provides concluding remarks.

2. DATA

This study analyzes the data on foreign traders' positions in Taiwan Stock Index Futures contract (TX). The unique data consist of daily records of long and short positions by foreign investors, and are obtained from the TAIFEX. The reason for our interest in the TX index futures market is that it is the most active Taiwanese futures contract in TAIFEX. Other futures contracts, such as electronic and financial sector index futures, are not studied here owing to thin trading by foreign investors. Consistent with prior research, the nearby futures contract is used to construct futures returns. The daily trading imbalances by foreign investment (FI) in TX nearby futures market is used as a proxy for the daily net trading inflow of foreign investment, as proposed by Froot, Scharfstein and Stein (2001). The futures and spot prices are retrieved from the Taiwan Economic Journal (TEJ)[7] database. The study period is from January 1, 2001 to December 31, 2003. The spot returns, R_S, futures returns, R_F, and changes in qualified foreign institutional investor' (QFII) net trading inflow, FI, are obtained by taking the natural logarithmic difference of the levels, respectively. That is, $R_{st} = S_t - S_{t-1}$, $R_{Ft} = F_t - F_{t-1}$, and $FI_t = QFII_t - QFII_{t-1}$ where F_t denotes the natural logarithm of the futures price, S_t represents the natural logarithm of the underlying spot price (TSI), and $QFII_t$ is the natural logarithm of the daily net trading inflow of QFII.

Panel A of Table 1 lists summary statistics of the daily futures returns, spot returns, and change in net trading inflow of foreign investors. The futures and spot indexes have positive average returns. The changes in the average trading imbalances of foreign trading are negative, indicating that foreign investors are net sellers for index futures contracts during the sample period. This implies that foreign investors may use futures markets for hedging purpose. The Jarque-Bera statistics are statistically significant at the 5% level, indicating that none of the three series are normally distributed. The Ljung-Box statistics, denoted by Q (12), show that the null hypothesis is rejected at the 5% significance level for the series of changes in the net trading inflow of foreign investors, but not for both the series of futures and spot return. This evidence indicates that the first moment autocorrelations are present in the series of changes in the net trading inflow of foreign investors. Additionally, this study examines the dependence on the squared returns and changes series using Ljung-Box statistics, denoted by Q^2 (12). The Q^2 (12) statistics are statistically significant at the 5% level for all three series during the study period, indicating that the three series are characterized by the second moment dependence, namely the ARCH effect. Consequently, this paper employs the GARCH-type process (Engle, 1982; Bollerslev, 1986; Bollerslev et al., 1992) to model futures price volatility. Panel

[6] Taiwan Stock Exchange Value-Weighted Stock Index (TSI)

[7] TEJ is a private data-source company. TEJ provides the most comprehensive and reliable economic and financial data base.

B of Table 1 shows that the unit root hypothesis in each series can be rejected at the 1% and 5% levels of significance, suggesting that the three series exhibit stationarity.

<Insert Table 1 about here>

3. Methodology

3.1 GARCH model considering market factors

To improve the study robustness, two commonly used models, the GARCH-based and VAR-based models, are employed to examine the relationship between price behavior and the daily foreign trading imbalances in the TX. First, the change in the variance of asset returns over time is well documented in the financial literature. This type of behavior has been modeled very successfully using the autoregressive conditional heteroscedasticity (ARCH) model proposed by Engle (1982) or its generalized version, the GARCH model[8] proposed by Bollerslev (1986). Therefore, this study applies the GARCH model to investigate the influence of daily foreign trading information on the futures price behavior in terms of returns and volatility. To properly investigate the impact of daily net foreign trading inflow on futures price while avoiding contamination, futures index returns behavior is adjusted for exposition to other market factors, which may affect futures markets. Following Bologna and Cavallo (2002), spot returns serve as a proxy for market factors in this study. The adjustment is obtained by including spot return as an exogenous explanatory variable in specifying for the futures returns series. The AR (p)-GARCH (1, 1) model is specified as follows.

$$R_{F,t} = \theta_0 + \sum_{i=1}^{p} \theta_{F,i} R_{F,t-i} + \sum_{i=0}^{m} \theta_{S,i} R_{S,t-i} + \sum_{i=0}^{n} \theta_{FI,i} FI_{t-i} + \varepsilon_t \quad (1)$$

$$\varepsilon_t | \Omega_{t-1} \sim N(0, h_t)$$

$$h_t = \omega_0 + \omega_1 \varepsilon_{t-1}^2 + \omega_2 h_{t-1} + \sum_{i=0}^{k} \lambda_{FI,i} FI_{t-i} \quad (2)$$

Where Eq. (1) is termed the conditional mean equation, and Eq. (2) is known as the conditional variance equation. $R_{F,t}$ is regressed on its AR (p) process to eliminate the serially correlated residuals in Eq. (1). Ω_{t-1} denotes the information set available up to time t. Additionally, h_t represents the conditional variance term at time t. Moreover, FI_t and its lagged terms are incorporated into both the mean and conditional variance equations. Furthermore, parameters $\theta_{FI,i}$ and $\lambda_{FI,i}$ represent the impact of foreign investment on futures market returns and volatility, respectively. If increased net foreign trading flow changes positively impacts market returns, the coefficients $\theta_{FI,i}$ will be statistically significant and positive. That is, market performance is good (poor) when foreign investors buy (sell) more. Similarly, if changes in the daily net foreign trading inflows affect market volatility, the coefficients $\lambda_{FI,i}$ will be statistically significant. A negative $\lambda_{FI,i}$ parameter indicates that market volatility increases with decreasing net trading inflow of foreign investors. That is, market volatility increase when foreign investors take more short positions than long positions in the futures market. Additionally, if the coefficients of

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[8] The standard GARCH (p,q) model indicates that the conditional variance of returns is a linear function of lagged conditional variance term and past squared error terms.

the lagged *FI* are significantly negative and the contemporaneous coefficient of *FI* is significantly positive in Eq. (1), we can accept the price pressure hypothesis.

3.2 VAR model considering market factors

Second, following Froot, O'Connell, and Seasholes (2001) and Wang and Shen (1999), this study employs a bivariate vector autoregression (VAR) model to examine the dynamic interaction between futures returns (or volatility) and foreign trading flows. That is, this work can learn more regarding the Granger causality between price behavior and changes in the daily net foreign trading inflow using a VAR model. Particularly, we can test the price pressure hypothesis and study whether foreign investors are feedback traders in futures markets. Following Chiang and Wang (2002), this study employs the volatility estimator of Garman and Klass (1980) to measure daily futures price volatility. Garman and Klass (1980) contend that the high-low volatility estimator disregards the joint effects of opening and closing prices, and then develops a volatility estimator (GK volatility estimator) that considers high (H), low (L), opening (O), and closing (C) prices. Consequently, the following GK volatility estimator is used to measure daily futures price volatility owing to the high-low-open-close data providing more information.

$$\sigma^2_{GK,t} = 0.511(a-b)^2 - 0.019\left[c(a+b) - 2ab\right] - 0.383c^2 \tag{3}$$

Where $a = \ln(H/O)$, $b = \ln(L/O)$, and $c = \ln(C/O)$.

This study employs a technique similar to that of Easley, O'Hara, and Srinivas (1998) and Chiang and Wang (2002) to filter out the market factors effects on futures return and volatility before performing the VAR model. This approach enables the impact of the net foreign trading inflow on futures price behavior to be examined without contamination. The following regression equations are performed, respectively.

$$R_{F,t} = \eta_0 + \eta_1 R_{S,t} + e_t \tag{4}$$

$$\sigma^2_{GK,t} = \xi_0 + \xi_1 R_{S,t} + v_t \tag{5}$$

Where $R_{S,t}$ denotes the spot returns and serves as a proxy for additional market factors for catching the economic systematic effects in this work. Furthermore, $R_{F,t}$ and $\sigma^2_{GK,t}$ represent the futures returns and GK volatility estimator of futures price volatility at time t, respectively. Moreover, the residuals $\hat{e}_t$ and $\hat{v}_t$ from Eqs. (4) and (5) act as measures of futures returns and volatility that are free of additional market factors effects, respectively.

This study uses the following bivariate VAR model to investigates the Granger causality between changes in net foreign trading inflow and futures returns (volatility) when market factor effects are eliminated.

$$\hat{e}_t(\hat{v}_t) = \alpha_0 + \sum_{j=1}^{n} \alpha_{1j}\hat{e}_{t-j}(\hat{v}_{t-j}) + \sum_{j=1}^{n} \alpha_{2j} FI_{t-j} + \varepsilon_{1t} \tag{6}$$

$$FI_t = \beta_0 + \sum_{j=1}^{n} \beta_{1j}\hat{e}_{t-j}(\hat{v}_{t-j}) + \sum_{j=1}^{n} \beta_{2j} FI_{t-j} + \varepsilon_{2t} \tag{7}$$

Where $\hat{e}_t(\hat{v}_t)$ and FI_t denote the futures returns (volatility) with market factors effects eliminated and changes in net foreign trading inflow at time t, respectively. The lag length is determined by AIC. The Wald test is conducted to test for the

Granger causality between $\hat{e}_t$ ($\hat{v}_t$) and FI_t. Notably, Newey and West (1987) proposed a more general covariance estimator that is consistent in the presence of both heteroskedasticity and autocorrelation of unknown form.[9] Therefore, all t-statistics are based on the Newey-West (1987) heteroskedasticity and autocorrelation consistent covariance with six lags, corresponding to the sixth root of the sample sizes. If the Wald tests of α_{2j} coefficients are statistically significant and those of β_{1j} coefficients are not, after controlling for the predictive power of lagged returns (volatility), changes in net foreign trading inflow *Granger-cause* futures returns (volatility). That is, changes in the net foreign trading inflow help in predicting futures index returns (volatility) in Taiwan. Additionally, if both α_{2j} and β_{1j} differ significantly from zero, then bi-directional Granger-causality exists between changes in the net foreign trading inflow and futures index returns (volatility). Further, we can study the effect of past returns on current foreign trading flows (*FI*), that is, whether foreign investors are feedback traders. If the Wald tests of β_{1j} coefficients of lagged returns are statistically significant and positive, this indicates that foreign investors are positive feedback traders.

4. Empirical Results

Table 2 lists the parameter estimation results for the AR(6)-GARCH (1, 1) model. The estimation results of the conditional mean function [Eq. (1)] displayed in Panel A of Table 2, demonstrate that the coefficients of the spot return and its lagged terms are statistically positive and significant at the 5% level, indicating that the spot returns contain significant information regarding futures returns. The estimated coefficient on the changes in net foreign trading inflows is statistically positive and significant at the 10% level when controlling other market factors effects. This evidence shows that a positive relation between concurrent futures returns and changes in net foreign trading inflows, suggesting that an increase in net foreign trading inflows contemporaneously and positively impacts on futures market returns. This analytical result resembles the findings for emerging stock markets examined by Tesar and Werner (1995a, b), Bohn and Tesar (1996), Brennan and Cao (1997), and Choe, Kho, and Stulz (1999). However, the estimated coefficient on past changes in net foreign trading inflows is not statistically significant, showing that foreign investors trading may not help in forecasting futures returns. Moreover, there is no evidence that futures returns are negatively related to past foreign trading flows. This failure to detect price reversals is inconsistent with the price pressure hypothesis.

Panel B of Table 2 lists the estimates of the conditional variance function [Eq. (2)]. The coefficient on FI_{t-1} is statistically negative and significant, indicating that futures market volatility is influenced by changes in the net foreign trading inflows. This result shows that futures market volatility increases with decreasing net foreign trading inflows. That is, market volatility increases after foreign investors take more short positions than long positions in the futures market. Table 2 also lists the results of the diagnostic test applied to standardized and squared standardized residuals based on the Ljung-Box Q statistics. Overall, the Ljung-Box Q statistics show that there are no residual linear or nonlinear dependencies, indicating that the AR (6)-GARCH(1,1) model is appropriately specified.

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[9] See Newey and West, 1987, Econometrica 55, pp.703~708.

<Insert Table 2 about here>

Table 3 lists the estimation results of Granger causality between futures returns and changes in daily net foreign trading inflow for VAR model. This evidence indicates that changes in the net foreign trading inflow are not useful in predicting futures returns. The findings resemble those in Panel A of Table 2. Additionally, this study also finds no evidence of positive feedback trading strategies for foreign investors in futures market since the β_{11} coefficient is not statistically significant.

<Insert Table 3 about here>

Table 4 lists the estimation results of Granger Causality between futures volatility changes in daily net foreign trading inflow for VAR model. Both the α_{21} and β_{11} coefficients differ significantly from zero, indicating the existence of a bi-directional Granger-causality relationship between futures volatility and changes in the daily net foreign trading inflows. Consistent with the findings listed in Panel B of Table 2, this study suggests that changes in the daily net foreign trading inflows influence Taiwan futures market volatility. Nevertheless, a positive coefficient on FI_{t-1} in Table 4 implies that futures market volatility increases with increased changes in the net foreign trading inflows. On the contrary, the negative coefficient on FI_{t-1} in the conditional variance equation of Table 2 demonstrates that futures market volatility increases with decreasing changes in the net foreign trading inflows. Owing to the conflicting results regarding the sign of the coefficient in FI_{t-1} in Panel B of Tables 2 and 4, caution is necessary in interpreting this results. However, this study suggests that reduced changes in net foreign trading inflows in futures market increases futures market volatility since the GARCH model considers inherent characteristics of the time-varying volatility of financial time series, making its fitness more efficient than that of the VAR model.

<Insert Table 4 about here>

5. Conclusion

Despite extensive research regarding the relations between trades by foreign investors and local financial markets, few researchers have examined these relations for emerging futures markets. Consequently, this study tries to address this gap in the literature. We use a unique data set of daily trading imbalance of foreign investors in the Taiwan index futures market to study whether foreign trading affects the futures market in terms of returns and volatility.

First, this evidence shows that there is a positive relation between contemporaneous futures returns and changes in net foreign trading inflows. This analytical result resembles the findings for the emerging stock markets examined by Tesar and Werner (1995a, b), Bohn and Tesar (1996), and Brennan and Cao (1997), Choe, Kho, and Stulz (1999). Second, a failure to find evidence of price reversals rejects the price pressure hypothesis. Third, this study finds that foreign investors are not positive feedback traders in futures markets. Fourth, a bi-directional Granger-causality relationship is found between futures volatility and changes in the daily net foreign trading inflows. Overall, as found for the other stock or foreign exchange markets, our empirical results demonstrate that foreign trading flows do have impacts on the return and volatility of futures market, suggesting that trading by foreign investors may enhance the information flow of the local futures market.

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Table 1

Summary statistics and unit root test for returns and foreign investors' net trading inflow changes

	R_F	FI	R_S
<u>Panel A</u>			
Mean	0.0003	-0.0002	0.0002
Maximum	0.0677	1.0988	0.0561
Minimum	-0.0725	-1.4411	-0.0595
Std. Dev.	0.0193	0.1525	0.0171
Skewness	0.1645	-0.7226	0.1681
Kurtosis	4.5185	25.4205	3.5266
Jarque-Bera (P value)	0.0000***	0.0000***	0.0024***
Ljung-Box Q (12)	11.4121	245.6900***	8.6275
Ljung-Box Q^2 (12)	71.2592***	238.3700***	42.7971***
<u>Panel B</u>	ADF test statistic	ADF test statistic	ADF test statistic
Unit root test	-18.3994***	-13.5202***	-25.6146***

1.The Jarque-Bera statistic tests whether a series is normally distributed under the null hypothesis of normality.
2.Ljung-Box Q (k) statistic tests the joint significance of the autocorrelations of the daily series up to the k-th order.
3.Ljung-Box Q^2 (k) statistic tests the joint significance of the autocorrelations of the squared daily series up to the k-th order.
4.The critical values for ADF test at the 5% and 1% levels are –3.42 and –3.97, respectively. See Mackinnon (1996). H_0 : unit root , H_A : no unit root
5.*** Indicate statistically significant at 5% level.

Table 2

Estimation results of AR (6)-GARCH (1, 1) model

$$R_{F,t} = \theta_0 + \sum_{i=1}^{p} \theta_{F,i} R_{F,t-i} + \sum_{i=0}^{m} \theta_{S,i} R_{S,t-i} + \sum_{i=0}^{n} \theta_{FI,i} FI_{t-i} + \varepsilon_t$$

$$h_t = \omega_0 + \omega_1 \varepsilon_{t-1}^2 + \omega_2 h_{t-1} + \sum_{i=0}^{k} \lambda_{FI,i} FI_{t-i}$$

Parameter	Coefficient	Standard error
Panel A：Conditional Mean Equation		
θ_0	-1.87E-05	0.0001
$\theta_{F,1}$	-0.5463***	0.0413
$\theta_{F,2}$	-0.3021***	0.0424
$\theta_{F,3}$	-0.2760***	0.0440
$\theta_{F,4}$	-0.2082***	0.0392
$\theta_{F,5}$	-0.1454***	0.0378
$\theta_{F,6}$	-0.1526***	0.0374
$\theta_{S,0}$	1.0544***	0.0102
$\theta_{S,1}$	0.5013***	0.0445
$\theta_{S,2}$	0.3040***	0.0451
$\theta_{S,3}$	0.2903***	0.0487
$\theta_{S,4}$	0.2237***	0.0419
$\theta_{S,5}$	0.1428***	0.0403
$\theta_{S,6}$	0.1628***	0.0402
$\theta_{FI,0}$	0.0021**	0.0012
$\theta_{FI,1}$	0.0015	0.0011
Panel B：Conditional Variance Equation		
ω_0	1.74E-06***	5.96E-07
ω_1	0.1178***	0.0278
ω_2	0.8236***	0.0381
$\lambda_{FI,0}$	-9.54E-07	6.88E-06
$\lambda_{FI,1}$	-2.31E-05***	3.13E-06

Model Diagnostics Test on Standardized Residuals		
Ljung-Box Q (12)	15.186	(0.231)
Ljung-Box Q^2 (12)	6.5614	(0.885)
ARCH (12)	5.8321	(0.924)

1. LB Q (12) and LB Q^2 (12) are the Ljung-Box statistics applied on the standardized and squared standardized residuals, respectively. ARCH (12) is the statistics used to test whether standardized residuals exist ARCH effect up to the order 12.
2. **and *** indicate statistically significant at the 10% and 5% levels, respectively
3. The number in parentheses are the p-values.

Table 3

Estimation results of Granger Causality between futures returns and foreign trading

$$\hat{e}_t = \alpha_0 + \sum_{j=1}^{n} \alpha_{1j} \hat{e}_{t-j} + \sum_{j=1}^{n} \alpha_{2j} FI_{t-j} + \varepsilon_{1t}$$

$$FI_t = \beta_0 + \sum_{j=1}^{n} \beta_{1j} \hat{e}_{t-j} + \sum_{j=1}^{n} \beta_{2j} FI_{t-j} + \varepsilon_{2t}$$

Parameter	Coefficient	Standard error	P-value
α_0	-4.70E-06	0.0001	0.9743
α_{11}	-0.3758***	0.0280	0.0000
α_{21}	3.10E-05	0.0009	0.9725
β_0	-0.0004	0.0030	0.8771
β_{11}	0.8394	0.6943	0.2270
β_{21}	-0.4353***	0.0534	0.0000
Granger Causality			
	$H_0 : \alpha_{21} = 0$	$H_0 : \beta_{11} = 0$	
Wald test	Chi-square stats=0.0012	Chi-square stats=1.4617	

1. **and *** indicate statistically significant at the 10% and 5% levels using Newey-West (1987) heteroskedasticity and autocorrelation standard errors, respectively

Table 4

Estimation results of Granger Causality between futures volatility and foreign trading

$$\hat{v}_t = \alpha_0 + \sum_{j=1}^{n} \alpha_{1j} \hat{v}_{t-j} + \sum_{j=1}^{n} \alpha_{2j} FI_{t-j} + \varepsilon_{1t}$$

$$FI_t = \beta_0 + \sum_{j=1}^{n} \beta_{1j} \hat{v}_{t-j} + \sum_{j=1}^{n} \beta_{2j} FI_{t-j} + \varepsilon_{2t}$$

Parameter	Coefficient	Standard error	P-value
α_0	-1.36E-07	9.59E-06	0.9887
α_{11}	0.2573***	0.0486	0.0000
α_{21}	0.0001***	4.29E-05	0.0049
β_0	-0.0004	0.0030	0.8779
β_{11}	57.498***	28.013	0.0405
β_{21}	-0.4168***	0.0559	0.0000
Granger Causality			
	$H_0 : \alpha_{21} = 0$	$H_0 : \beta_{11} = 0$	
Wald test	Chi-square stats=7.9511***	Chi-square stats=4.2129***	

1. **and *** indicate statistically significant at the 10% and 5% levels using Newey-West (1987) heteroskedasticity and autocorrelation standard errors, respectively