# The Effect of Macroeconomic Variables on the Relationship between Futures Trading Activity and Cash Market Volatility

Hsuan-Po Chien

Professor of Banking and Insurance

Tatung Institute of Commerce and Technology

Yung-Chang Wang

Professor of Finance

Tatung Institute of Commerce and Technology

Tong-Wei Lin

Department of Finance

Feng Chia University

## Abstract

Financial markets are confronted with increasing challenge in financial liberalization and internationalization around the world. The Taiwan stock market is highly volatile in recent years. This article explores the effect of macroeconomic variables on the relationship between index futures trading and cash index jump volatility for the Taiwan Stock Market. The data cover the period from September 1997 to December 2006 on the daily and monthly bases. Stock prices, term structure of interest rates, OTC index, industrial production index, inflation rates, and trading activity in the MSCI Taiwan stock index futures and Taiwan stock index futures markets in terms of the trading volume and open interest. The regression analysis, unit-root tests, and Granger causality tests are used to conduct the empirical study.

With the macroeconomic variables included, the OTC index volatility turns to be statistically insignificant, while the industrial production index volatility is significantly linked to the cash index jump volatility. It is noted that trading activity of the Taiwan Stock Index Futures is more significant in explaining cash jump volatility than the MSCI Taiwan Stock Index Futures.

Keywords: volatility, macroeconomic variables, Granger causality

# I Introduction

In January 1997, Chicago Mercantile Exchange (CME) launched the Dow Jones Taiwan stock index futures and Singapore International Monetary Exchange (SIMEX) also launched MSCI (Morgan Stanley Capital International) Taiwan stock index futures. Later this year, Taiwan Futures Exchange (TAIFEX) was established and introduced the local TAIMEX futures in the following year. This marked a momentous milestone for the financial markets in Taiwan. The underlying indices for the TAIMEX futures include the overall listed companies in the Taiwan Stock Exchange. MSCI stock index futures include partial listed companies, 87 stocks. It accounts for 86% of the total market value. Thus, the market chart for MSCI Taiwan stock index futures is similar to TAIMEX stock index futures.

In regard with high volatility in Taiwan stock market trends these years, much research has been done on the relationships among the diverse financial markets. However, it’s unable to clearly identify the mechanism to delivering the information because of the different underlying assets in the market. In recent years, owing to the rapid development in the international financial market, the same underlying assets introduce in the different markets. For instance, in the SIMEX and TAIFEX, the same underlying asset, TAIMEX, is provided as a better research opportunity for mechanism information delivery.

We concern the impact of the stock index future on the spot price volatility. In addition, we understand the spot market volatility is also influenced by the other factors. The correlation between macroeconomics variable and stock price has been concerned by most scholars. Thus, we explore the effect of the stock index futures on spot stock price volatility. Also, futures trading volume, macroeconomics variable, and OTC index are taken into account.

The data cover the period from September 1997 to December 2006 on the daily and monthly bases. Stock prices, term structure of interest rates, OTC index, industrial production index, inflation rates, and trading activity in the MSCI Taiwan stock index futures and Taiwan stock index futures markets in terms of trading volume and open interest. This study explores Taiwan Stock prices volatility in terms of jump volatility. Instead of interest, we apply term structure of interest rates. Spot market volatility model is based on OTC index

## II Literature Review

Aggarwal (1988) selectes different sample periods to do the further research. Regression Analysis is used to group the data: OTC and Index. The result reveals that stock price volatility increases after the stock index futures listed in the market. However, this phenomenon that market volatility increase is global even without index futures trading. Compared with OTC, Index relatively decreass in returns volatility and price volatility while it increases in trading volume.

Darrat and Rahman (1995) examine whether stock price volatility would increase because of the futures trading. The research period was from May of 1982 to June of 1991. Granger Casualty is conducted. The evidence shows that futures trading activity, inflation volatility, and risk premium volatility would not result in spot stock price volatility. Term structure of interest rates and OTC index volatility would result in spot stock price volatility.

Reyes (1996) studies on the Weekly Rate of Return regarding with France CAC40 stock index/ index futures and Denmark KFX stock index/ index futures. E-GARCH

Model is used to examine the effect of Denmark and France index futures trading on the stock index volatility. The evidence reveals that the index futures trading in the two European markets would change the distribution of stock market returns, not increase the stock price volatility. The evidence shows that futures trading would restrain the stock volatility. During the period of initializing the trading the futures, the stock markets performe high volatility and asymmetry in these two countries.

Antoniou, Holme and Prestley (1998) explore the effect of the stock index futures trading on the spot market volatility in the American S&P500, the British FTSE-100, the SWISS MI, the German DAX100, the Japanese NIKKEI225, and the Spanish IBEX35. The results reveale :(1) Spot market volatility increased after the S&P500 stock index futures traded in the American market;(2)Spot market volatility doesn't significantly increase after the stock futures traded in the UK, Japan, and Span;(3) The spot market volatility significantly decreases after the stock index futures traded in Germany and Switzerland. It shows the phenomenon that the decrease of futures trading and the stock information asymmetry.

Rahman (2001) applies GARCH(1,1) to examine the effect of the launch of the Dow Jones Industry index futures and futures option on the Down Jones industry index 30 constituent stocks intraday return volatility. The empirical study shows that the Dow Jones Industry index constituent stocks conditional volatility doesn't result in structural change after the futures option traded in the market.

Shenbagaraman (2003) explores the effect of the trading of the futures and options on the Indian spot market volatility. GARCH(1,1) Model iss conducted in the research. The empirical research shows that there was no significant influence after the trading of the futures and options. However, the effect of GARCH disappears after the trading of the futures. That means the trading of the derivatives increases the effectiveness of the stock market. All the information would influence the stock price.

Illueca and Lafuenta(2003) analyzes the intraday relationship between the spot price volatility and the futures trading volume in the Spanish stock market. Regression Analysis and GARCH Model are conducted to examine whether the futures trading volume would influence the spot price volatility. The result shows that there is no significant correlation between the stock index spot price volatility and the futures trading volume.

Chatrath, Song and Adrangi (2003) explore the relationship between holding the S&P500 index future contracts and the spot market volatility by the institutional traders, large speculators, the small traders, and the spreaders. The volatility is measured by the intraday price change, intraday high and low price change, and the interval extreme-value. The empirical result reveals that the holding futures contracts for the institutional traders would increase while the spot price volatility increased. However, the evidence reveals that there's no significant relation between the other type of trading and the spot price volatility.

Boyer and Popiela(2004) examine whether the introduction in the market of the S&P500 index futures would influence the S7P500 index spot price volatility. The research method developed by Ronen(1997) is used to examine to the effect of the futures trading on the spot price volatility. Also, the method developed by Lynch and Mendenhall(1997) is used to examine irregular trading activity. The result reveals that there's no significant increase in the spot price volatility after trading S&P500 stock index futures in the market.

Calado, Garcia and Pereira(2005) studies on the eight stocks in the Portuguese stock market to analyzes the effect of the options and futures trading on the stock market volatility. The result shows that there's no significant difference between the underlying stock variance and ß after trading the derivatives in the market. It means that the derivatives doesn't significantly affect the Capital market.

Robbani and Bhuyan(2005) tests the effect of the futures and options trading on the 30 constituent stocks volatility and trading volume in the Dow Jones Industry Index. The method, GARCH(1,1), is used. The result shows that the derivatives trading significantly increases the stock market volatility. The 23 stocks trading volume significantly increases.

Wang (2006) conducts GARCH and Granger Causality to examine the correlation between the futures contract on the different expiration date volatility and the spot index volatility in terms of TAIMEX, trading volume, TAIMEX near month period and near season period contract index, and trading volume. The result shows that : (1) There's high volatility persistence in these three markets;(2) the volatility persistence didn't significantly decline in these three markets when the trading volume included conditional mean equation ; (3) The spot trading growth rate would decrease the capability to explain the price volatility when the futures trading growth rate included the conditional variance equation of the spot index return;(4)There's no significant correlation between the growth rate of spot trading and the futures market volatility;(5) The most important influential factor for the market volatility is the growth rate of near moth contract trading; (6)Index futures exists the one –way influence in volatility spillover; (7) In near month period, and near season period futures contracts, there's two-way influence in volatility spillover.

Chien (2006) examines the lead and lag relationships among Taiwan stock index, futures, and options markets, using the Granger-causality test and forecast error variance decomposition in the context of the VAR model. Evidence reveals that (1)Taiwan stock index futures lead spot, spot leads call option, call option leads put option in the total periods, Means that the future markets price discovery. (2)Contemporaneous relationship exists between call option and put option in the front year. (3)The put option is affected by spot and call option. The spot is affected by the futures market in the rear year. (4)Compared the front year with the rear year thought the option market got more mature than before, but it was still not play the master rote of price discovery. The future market leads spot, spot leads call option and call option leads put option.

The literature above is about the effect of the derivatives trading on stock volatility. The conclusions of these studies are different owing to the different research methods and data. There are different opinions on theory. Some thinks the derivatives provide diverse ways to investment and hedge. It's helpful to stabilize the spot price and segregate risk, which causes the spot price volatility decrease. Some think the investors transfer the spot market capital to the derivatives market , which results in the spot market volatility increase. The spot market volatility exits not only because of the futures transaction, but also includes many macroeconomics factors in the market. Thus, this study aims to focus on the test of Taiwan index futures and MSCI Taiwan index futures to the spot market volatility. Macroeconomics variables will be used to detect the factor that influences the spot market volatility.

The macroeconomics variables we apply include industry production index, term structure of interest rate, inflation rate, and default risk premium. Industry production index reflects the macroeconomic prospect and influences the business profit that is the resource of cash flow operation. Apparently, there's close relation between stock return and industry production index. Through yield curve, term structure of interest rates mean the relationship between the different expiry dates maturity bond yield curve and expiry date. Yield curve slope is the period spread. Yield curve goes up which means the economic rebound. while the downward of the slope means depression. Based on the change, we can predict the stock market and judge the economic trend. Default risk premium is the spread of bond ratings, which can foresee the macroeconomic environment status. Consumer price index is measured by inflation rate. TAIMEX, trading volume, Taiwan index futures, MSCI Taiwan index futures , and the macroeconomic data above are used to explore the effect of the futures trading and macroeconomic variables on stock market volatility. For the first time, the two variables term structure of interest rates and OTC index, are used in the study on the Taiwan stock market.

The egression analysis, unit root test, LM-ARCH Test, and Granger casualty test which usually appear in econometrics textbooks are conducted in the research.

## III Results and Explanations

### 3.1 Data and Variables

A total of 109 monthly data of MSCI Taiwan stock index cited from Taiwan Economic Journal Database(TEJ). The samples selects ranging from March 1997 to December 2006；A total of 90 monthly data of Taiwan stock index future selects ranging from July 1998 to December 2006. Macroeconomic variables volatility and OTC index volatility are measured by 12 month moving average standard error. The stock return is obtained by taking the first difference of the logarithmic form of the original data.

The stock index used in this paper is the stock volume-weighted index constructed by the Taiwan Securities Exchange (TSE), while the OTC index is the volume-weighted stock index constructed by the Over-the-Counter Trading Center. This paper applies jump volatility proposed by Becketti and Sellon (1989) to capture volatility in the Taiwan volume-weighted stock index. A range is constructed for all the observations in the sample and those outside the range are called outliers or jumps. More specifically, If an observation is larger than that indicated in Equation 3-1 or smaller than that indicated in Equation 3-2, it is called an outlier. The frequency of jumps is obtained by having the total hours of jumps for the Taiwan volume-weighted stock index in a month be divided by the total hours of trading in the month.

Upper adjacent value = $V_U + 1.5\ V_Q$ (3-1)

Lower adjacent value = $V_L - 1.5\ V_Q$ (3-2)

$V_Q = (V_U - V_L)$ (3-3)

where $V_U$ is the 75th percentile and $V_L$ is the 25th percentile.

The term structure of interest rates is derived from the yield curve based on the default-free zero coupon bond. The industrial production index is constructed by selecting 657 items from the 2,091 items in the monthly industrial dynamic survey and comparing their total production with that computed in 2001. The inflation rate is the percentage change in the consumer price index (CPI). The futures the trading volume is represented by the modes of the TAIFEX index futures contract and the MSCI Taiwan index futures contract. The open interest in the futures contract is represented by the monthly average of TAIFEX index futures the open interest and MSCI Taiwan index futures the open interest. The symbols for the variables used in this paper are summarized in Table 3-1.

Tables A3-1 and A3-2 in the appendix document the descriptive statistics for the two samples (MSCI and TAIFEX). They include mean, median, maximum, minimum, standard deviation, skewness, kurtosis, and Jarque-Bera test statistics.

Table 3-1 Symbols for the Variables

| Variables | Symbols |
|---|---|
| Jump volatility in the Taiwan Volume-Weighted Stock Index (the cash market) | VJ |
| Jump volatility in the OTC index | VC |
| Volatility in the term structure | VS |
| Volatility in the industrial production index | VP |
| Volatility in the inflation rate | VF |
| Trading volume of the MSCI or TAIFEX index futures | FA |
| Open interest in the MSCI or TAIFEX index futures | FB |

## 3.2 The Unit-Root Test

It is found from the ADF test that, for the MSCI monthly data, VJ, VS, and VP are stationary, that is, they are all I(0) time series, while VC, VF, FA, and FB turn to be stationary after first-differencing, that is, they are all I(1) time series. The results from the ADF test for the MSCI monthly data are reported in Tables 3-2 and 3-3.

Table 3-2 The ADF unit-root test for MSCI in levels

| Variable | Level | | | | | |
|---|---|---|---|---|---|---|
| | None | | Intercept | | Intercept and Trend | |
| | Statistics | AIC | Statistics | AIC | Statistics | AIC |
| VJ | -1.5112(1) | -3.3574 | -5.0765(1)*** | -3.5402 | -8.6034(0)*** | -3.59164 |
| VS | -1.7780(1)* | -12.5454 | -2.8683(1)* | -12.5764 | -2.9174(1) | -12.5621 |
| VC | -1.7259(1)* | 4.7323 | -2.9388(1)** | 4.6985 | -3.8878(1)*** | 4.6597 |
| VF | -0.8228(0) | -13.7031 | -1.8202(0) | -13.7114 | -2.3833(0) | -13.7151 |
| VP | -0.4714(0) | 2.5795 | -3.9228(0)*** | 2.4631 | -4.2074(0)*** | 2.4600 |
| FA | 1.5378(1) | -2.0059 | -2.4775(1) | -2.0508 | -5.0430(0)*** | -2.0107 |
| FB | 2.1665(0) | -2.5408 | -1.7585(0) | -2.5576 | -4.4312(1)*** | -2.7135 |

Notes: 1.***、**、* denote significance at the 1%, 5%, and 10% levels.
2.Numbers in the parentheses denote the optimal number of lags.

Table 3-3 The ADF unit-root test for MSCI in First Differences

| Variable | First Difference | | | | | |
|---|---|---|---|---|---|---|
| | None | | Intercept | | Intercept and Trend | |
| | Statistics | AIC | Statistics | AIC | Statistics | AIC |
| VJ | -17.3961(0)*** | -3.35458 | -17.3127(0)*** | -3.33576 | -17.2458(0)*** | -3.31832 |
| VS | -6.9977(0)*** | -12.5344 | -6.96977(0)*** | -12.5185 | -6.85562(0)*** | -12.5008 |
| VC | -5.3286(2)*** | 4.714296 | -5.3255(2)*** | 4.731586 | -5.29389(2)*** | 4.750619 |
| VF | -6.8466(0)*** | -2.05103 | -6.81595(0)*** | -2.03252 | -6.78074(0)*** | -2.01409 |
| VP | -12.4466(0)*** | 2.553333 | -12.3931(0)*** | 2.571629 | -12.3521(0)*** | 2.588685 |
| FA | -14.9919(0)*** | 18.267 | -15.1241(0)*** | 18.26729 | -15.0635(0)*** | 18.28497 |
| FB | -8.61929(1)*** | 20.71552 | -8.28092(2)*** | 20.66088 | -8.7972(2)*** | 20.62437 |

Notes: 1.***、**、* denote significance at the 1%, 5%, and 10% levels.
2.Numbers in the parentheses denote the optimal number of lags.

It is also found from the ADF test that, for the TAIFEX index monthly data, VJ, VS, and VP are stationary, that is, they are all I(0) time series, while VC, VF, FA, and FB turn to be stationary after first-differencing, that is, they are all I(1) time series.

The results from the ADF test for the MSCI monthly data are reported in Tables 3-4 and 3-5.

Table 3-4 The ADF unit-root test for MSCI in levels

| Variable | Level | | | | | |
|---|---|---|---|---|---|---|
| | None | | Intercept | | Intercept and Trend | |
| | Statistics | AIC | Statistics | AIC | Statistics | AIC |
| VJ | -0.9118(5) | -3.59104 | -4.5289(1)*** | -3.67683 | -5.6403(2)*** | -3.7458 |
| VS | -1.5127(1) | -12.5721 | -2.8421(1)* | -12.6145 | -2.8366(1) | -12.5925 |
| VC | -0.9571(3) | 4.648018 | -1.7332(3) | 4.645961 | -4.3835(1)*** | 4.5605 |
| VF | -1.3153(0) | -13.8787 | -1.7032(0) | -13.8809 | -2.2807(0) | -13.8846 |
| VP | -0.4418(1) | 2.710683 | -4.2282(0)*** | 2.552034 | -4.2103(0)*** | 2.5734 |
| FA | 0.2192(0) | 18.86451 | -1.1974(0) | 18.85738 | -2.8764(0) | 18.8042 |
| FB | -0.1401(0) | 19.21617 | -1.3436(0) | 19.20998 | -3.1634(0) | 19.1429 |

Notes: 1.*** 、** 、* denote significance at the 1%, 5%, and 10% levels.
2.Numbers in the parentheses denote the optimal number of lags.

Table 3-5 The ADF unit-root test for MSCI in First Differences

| Variable | First Difference | | | | | |
|---|---|---|---|---|---|---|
| | None | | Intercept | | Intercept and Trend | |
| | Statistics | AIC | Statistics | AIC | Statistics | AIC |
| | First Difference | | | | | |
| Variable | None | | Variable | | None | |
| | Statistics | | Statistics | | Statistics | |
| VJ | -7.5810(4)*** | -3.6042 | -7.5584(4) *** | -3.5836 | -5.1021(11) *** | -3.6241 |
| VS | -4.9830(0)*** | -12.568 | -4.9543(0) *** | -12.546 | -4.9151(0) *** | -12.5237 |
| VC | -5.0569(2)*** | 4.6358 | -5.0265(2) *** | 4.6591 | -5.0425(2) *** | 4.6775 |
| VF | -5.3601(3)*** | -2.0908 | -5.3285(3) *** | -2.0674 | -5.2946(3) *** | -2.0439 |
| VP | -11.3318(0)*** | 2.6902 | -11.2668(0) *** | 2.7129 | -11.2080(0) *** | 2.7348 |
| FA | -3.1652(7) *** | 18.8472 | -3.4710(7) *** | 18.8453 | -3.4394(7) *** | 18.8698 |
| FB | -11.2177(0) *** | 19.1873 | -11.2724(0) *** | 19.1971 | -11.2028(0) *** | 19.2198 |

Notes: 1.*** 、** 、* denote significance at the 1%, 5%, and 10% levels.
2.Numbers in the parentheses denote the optimal number of lags.

## 3.3 The ARCH Effect

The ARCH-LM test is employed to examine whether each of the variables is heterscedastic. The results are reported in Table 3-6. Evidence indicates that, either for MSCI or for TAIFEX index futures, the jump volatility in the cash market (VJ) displays no ARCH effects, which implies that the variable is homoscedastic.

Table 3-6 The ARCH-LM Test

| | VJ(MSCI) | | VJ(TAIFEX) | |
|---|---|---|---|---|
| Order | F-statistic | P-Value | F-statistic | P-Value |
| 1 | 0.7555 | 0.3867 | 0.3034 | 0.5831 |
| 5 | 0.6360 | 0.6727 | 0.3851 | 0.8576 |
| 10 | 0.5236 | 0.8692 | 0.2823 | 0.9831 |
| 15 | 0.3601 | 0.9850 | 0.5199 | 0.9195 |
| 20 | 0.5256 | 0.9455 | 0.4770 | 0.9635 |

Notes: 1.*** 、** 、* denote significance at the 1%, 5%, and 10% levels.

## 3.4 Regression Analysis

Equation 3-1 is specified with jump volatility in the cash market (VJ) as the explained variable and the lagged jump volatility in the OTC index (VC), volatility in the term structure (VS), volatility in the industrial production index (VP), volatility in the inflation rate (VF), and the MSCI or TAIFEX trading volume (FA) as explanatory variables.

$$VJ_t = \alpha_0 + \alpha_1(L)VJ_t + \alpha_2(L)VS_t + \alpha_3(L)VP_t + \alpha_4(L)DVC_t + \alpha_5(L)DVF_t + \alpha_6(L)DFA_t \quad (3\text{-}1)$$

where all the variables are stationary, L denotes the lag operation, and D denotes the first -difference operation. The final predicting error (FPE) is utilized to select the optimal number of lags.

If the MSCI or TAIFEX trading volume is substituted by the open interest, the regression model is constructed as Equation 3-2.

$$VJ_t = \alpha_0 + \alpha_1(L)VJ_t + \alpha_2(L)VS_t + \alpha_3(L)VP_t + \alpha_4(L)DVC_t + \alpha_5(L)DVF_t + \alpha_6(L)DFB_t \quad (3\text{-}2)$$

The results from estimating Equation 3-1 are documented in Tables 3-7 and 3-9, while those from estimating Equation 3-2 are documented in Tables in 3-8 and 3-10.

It is found from Tables 3-7 and 3-8 that the jump volatility in the cash market (VJ) is positively associated with the own variable lagged by two months as well as negatively associated with the industrial production index (VP) lagged by one month, while the jump volatility in the cash market has no association with MSCI trading activity. Tables 3-9 and 3-10 indicate that the jump volatility in the cash market is positively associated with the own variable lagged by two months, negatively associated with the industrial production index lagged by one month, and positively associated with the TAIFEX trading volume and the open interest lagged by one month. It is justified to find that the TAIFEX index futures is more closely correlated with the cash market than the MSCI Taiwan index futures since the former is composed of all the listed companies in the Taiwan Securities Exchange.

Table 3-7 Regression Results from Estimating Equation 3-1 (MSCI trading volume)

| Variable | Coefficient | t-statistics | Variable | Coefficient | t-statistics |
|---|---|---|---|---|---|
| Constant | 0.6677*** | 3.20 | | | |
| VJ(t-1) | 0.1627 | 1.58 | VC(t-1) | 0.0705 | 0.18 |
| VJ(t-2) | 0.2859*** | 2.72 | VC(t-2) | -0.3128 | -0.82 |
| VJ(t-3) | -0.1369 | -1.27 | VF(t-1) | 0.0957 | 0.13 |
| VS(t-1) | 9.1179 | 0.82 | | | |
| VP(t-1) | -0.0535** | -2.11 | FA(t-1) | -0.1051 | -0.04 |
| VP(t-2) | 0.0428 | 1.56 | FA(t-2) | -0.8117 | -0.41 |

Notes: 1.*** 、** 、* denote significance at the 1%, 5%, and 10% levels.
2.$R^2$=0.164 adj. $R^2$= 0.07 F-statistic =1.66

Table 3-8 Regression Results from Estimating Equation 3-2 (MSCI open interest)

| Variable | Coefficient | t-statistics | Variable | Coefficient | t-statistics |
|---|---|---|---|---|---|
| Constant | 0.6649*** | 3.20 | | | |
| VJ(t-1) | 0.1644 | 1.59 | VC(t-1) | 0.0523 | 0.14 |

| | | | | | |
|---|---|---|---|---|---|
| VJ(t-2) | 0.2844*** | 2.72 | VC(t-2) | -0.2991 | -0.81 |
| VJ(t-3) | -0.1401 | -1.31 | | | |
| VS(t-1) | 9.0309 | 0.82 | VF(t-1) | 0.1731 | 0.25 |
| VP(t-1) | -0.0544** | -2.15 | | | |
| VP(t-2) | 0.0444 | 1.64 | FB(t-1) | -0.2515 | -0.08 |

Notes: 1.***、**、* denote significance at the 1%, 5%, and 10% levels.
2.$R^2$=0.162 adj. $R^2$= 0.073 F-statistic =1.82

Table 3-9 Regression Results from Estimating Equation 3-1(TAIFEX trading volume)

| Variable | Coefficient | t-statistics | Variable | Coefficient | t-statistics |
|---|---|---|---|---|---|
| Constant | 0.7553*** | 3.17 | | | |
| VJ(t-1) | 0.0550 | 0.45 | VC(t-1) | -0.2729 | 0.47 |
| VJ(t-2) | 0.2804** | 2.45 | VC(t-2) | 0.0657 | 0.86 |
| VS(t-1) | 6.0411 | 0.13 | VF(t-1) | 0.3598 | 0.64 |
| VS(t-2) | 4.8922 | 0.11 | | | |
| VP(t-1) | -0.0539* | -2.13 | FA(t-1) | 3.9628** | 1.72 |
| VP(t-2) | 0.0267 | 0.99 | FA(t-2) | 0.4577 | 0.20 |

Notes: 1.***、**、* denote significance at the 1%, 5%, and 10% levels.
2.$R^2$=0.220 adj. $R^2$= 0.11 F-statistic =1.95

Table 3-10 Regression Results from Estimating Equation 3-2 (TAIFEX open interest)

| Variable | Coefficient | t-statistics | Variable | Coefficient | t-statistics |
|---|---|---|---|---|---|
| Constant | 0.7450*** | 3.16 | | | |
| VJ(t-1) | 0.0567 | 0.48 | VC(t-1) | -0.2105 | -0.56 |
| VJ(t-2) | 0.2978*** | 2.65 | VC(t-2) | -0.0463 | -0.12 |
| VS(t-1) | -6.9964 | -0.17 | | | |
| VS(t-2) | 14.9809 | 0.37 | VF(t-1) | 0.1718 | 0.22 |
| VP(t-1) | -0.0470* | -1.87 | | | |
| VP(t-2) | 0.0203 | 0.76 | FB(t-1) | 3.9786* | 1.93 |

Notes: 1.***、**、* denote significance at the 1%, 5%, and 10% levels.
2.$R^2$=0.227 adj. $R^2$= 0.126 F-statistic =2.26

## 3.5 The Granger-Causality Test

With the FPE criterion used to select the optimal number of lags, the LR (likelihood Ration) test is employed to perform multi-variate Granger-Causality tests with an attempt to explore the lead-lag relationships between jump volatility in the cash market (VJ), futures trading activity, and macroeconomic variables. The results from the causality test are reported from Tables 3-11 through 3-14.

It is found from Table 3-11 that volatility in the industrial production index (VP) Granger-causes jump volatility in the cash market (VJ) at the 5% significance level. Evidence from Table 3-12 indicates that volatility in the industrial production index Granger-causes jump volatility in the cash market at the 10% significance level. MSCI trading activity shows no causality with jump volatility in the cash market from the Granger-Causality test.

Table 3-11 The LR Test (MSCI trading volume)

| Null Hypothesis | $\chi^2$ Statistics | Degree of Freedom |
|---|---|---|
| 1.$\Phi_1(L) = 0$ | 12.94*** | 3 |
| 2.$\Phi_2(L) = 0$ | 0.77 | 1 |
| 3.$\Phi_3(L) = 0$ | 4.93** | 2 |
| 4.$\Phi_4(L) = 0$ | 0.91 | 2 |
| 5.$\Phi_5(L) = 0$ | 0.02 | 1 |
| 6.$\Phi_6(L) = 0$ | 0.19 | 2 |

Notes: 1. The null hypotheses are (1) lagged VJ does not Granger-cause VJ, (2) VS does not Granger-cause VJ, (3) VP does not Granger-cause VJ, (4) VC does not Granger-cause VJ, (5) VF does not Granger-cause VJ, and (6) FA does not Granger-cause VJ.

2. ***、**、* denote significance at the 1%, 5%, and 10% levels.

Table 3-12 The LR test (MSCI open interest)

| Null Hypothesis | $\chi^2$Statistics | Degree of Freedom |
|---|---|---|
| 1.$\Phi_1(L) = 0$ | 12.85*** | 3 |
| 2.$\Phi_2(L) = 0$ | 0.76 | 1 |
| 3.$\Phi_3(L) = 0$ | 5.08* | 2 |
| 4.$\Phi_4(L) = 0$ | 0.90 | 2 |
| 5.$\Phi_5(L) = 0$ | 0.07 | 1 |
| 6.$\Phi_6(L) = 0$ | 0.01 | 1 |

Notes: 1. The null hypotheses are (1) lagged VJ does not Granger-cause VJ, (2) VS does not Granger-cause VJ, (3) VP does not Granger-cause VJ, (4) VC does not Granger-cause VJ, (5) VF does not Granger-cause VJ, and (6) FA does not Granger-cause VJ.

2. ***、**、* denote significance at the 1%, 5%, and 10% levels.

Evidence from Table 3-13 reveals that volatility in the industrial production index (VP) and TAIFEX trading volume (FA) Granger-cause jump volatility in the cash market (VJ) at the 10% significance level. In addition, evidence form Table 3-14 reveals that TAIFEX open interest (FB) Granger-causes jump volatility in the cash market at the 5% significance level. It is found from both tables that, in addition to volatility in the industrial production index, TAIFEX trading activity is causal with jump volatility in the cash market.

Table 3-13 The LR Test (TAIFEX trading volume)

| Null Hypothesis | $\chi^2$Statistics | Degree of Freedom |
|---|---|---|
| 1.$\Phi_1(L) = 0$ | 7.48** | 2 |
| 2.$\Phi_2(L) = 0$ | 0.99 | 2 |
| 3.$\Phi_3(L) = 0$ | 5.38* | 2 |
| 4.$\Phi_4(L) = 0$ | 0.67 | 2 |
| 5.$\Phi_5(L) = 0$ | 0.25 | 1 |
| 6.$\Phi_6(L) = 0$ | 3.42* | 1 |

Notes: 1. The null hypotheses are (1) lagged VJ does not Granger-cause VJ, (2) VS does not Granger-cause VJ, (3) VP does not Granger-cause VJ, (4) VC does not Granger-cause VJ, (5) VF does not Granger-cause VJ, and (6) FA does not Granger-cause VJ.

2. *** 、** 、* denote significance at the 1%, 5%, and 10% levels.

Table 3-14 The LR Test (TAIFEX open interest)

| Null Hypothesis | $\chi^2$Statistics | Degree of Freedom |
|---|---|---|
| 1.$\Phi_1(L) = 0$ | 8.49** | 2 |
| 2.$\Phi_2(L) = 0$ | 0.61 | 2 |
| 3.$\Phi_3(L) = 0$ | 4.30 | 2 |
| 4.$\Phi_4(L) = 0$ | 0.64 | 2 |
| 5.$\Phi_5(L) = 0$ | 0.06 | 1 |
| 6.$\Phi_6(L) = 0$ | 4.16** | 1 |

Notes: 1. The null hypotheses are (1) lagged VJ does not Granger-cause VJ, (2) VS does not Granger-cause VJ, (3) VP does not Granger-cause VJ, (4) VC does not Granger-cause VJ, (5) VF does not Granger-cause VJ, and (6) FA does not Granger-cause VJ.

2. *** 、** 、* denote significance at the 1%, 5%, and 10% levels.

## IV Conclusions

In regard with MSCI Taiwan index futures trading activity, stock volatility is only influenced by industry production index volatility. MSCI Taiwan index futures trading activity doesn't influence the stock market volatility. In regard with Taiwan stock index futures trading activity, spot volatility is influenced by industry production index volatility, Taiwan stock index futures trading volume, and open interest.

In regard with MSCI Taiwan index futures trading activity, there's casualty between industry production index volatility and spot volatility. There's no casualty between MSCI Taiwan stock index futures trading activity and spot volatility. In regard with Taiwan stock index futures trading activity, there's casualty between Taiwan index futures trading volume and open interest to spot volatility.

If the macroeconomic variable are also used and apply the monthly data to evaluate. The result shows that there's no effect of OTC index volatility on spot volatility while there's significant effect of industry production index volatility on spot volatility. In addition, the effect of Taiwan stock index futures trading activity on sot market volatility is much more significant than that of MSCI Taiwan stock index futures trading activity. Although the time for the introduction of Taiwan stock index futures market is short, the spot market has developed well. Furthermore, owing to the overall listed companies are the underlying stocks, Taiwan stock index futures responds to all information better than MSCI Taiwan stock index futures.

# Apendix

Table A3-1 Descriptive Statistics for MSCI

| | Mean | Median | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Probability |
|---|---|---|---|---|---|---|---|---|---|
| VJ | 0.1000 | 0.0983 | 0.23913 | 0.0303 | 0.0408 | 0.8831 | 4.0591 | 15.9066 | 0.0004*** |
| VC | 21.281 | 15.464 | 66.6732 | 4.1900 | 15.307 | 1.3652 | 4.1321 | 32.7627 | 0.0000*** |
| VS | 0.0033 | 0.0030 | 0.0084 | 0.0008 | 0.0018 | 0.9620 | 3.4462 | 14.6267 | 0.0007*** |
| VP | 7.1513 | 7.0394 | 10.0351 | 3.2750 | 1.1338 | -0.0279 | 4.9997 | 15.0075 | 0.0006*** |
| VF | 0.0035 | 0.0034 | 0.0048 | 0.0024 | 0.0007 | 0.2605 | 1.7205 | 7.1573 | 0.0279** |
| FA | 15510 | 14539 | 40685 | 920 | 10878 | 0.3248 | 1.9619 | 5.6237 | 0.0601* |
| FB | 16720 | 11425 | 46329.21 | 1657 | 12922 | 0.6072 | 1.9114 | 9.9734 | 0.0068*** |

Notes: 1.. *** 、** 、* denote significance at the 1%, 5%, and 10% levels.
2. he sample size is 108

Table A3-2 Descriptive Statistics for TAIFEX

| | Mean | Median | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Probability |
|---|---|---|---|---|---|---|---|---|---|
| VJ | 0.9190 | 0.9542 | 1.3424 | 0.3010 | 0.2006 | 0.4797 | 3.2141 | 15.9066 | 0.0004* |
| VC | 21.2811 | 15.4645 | 66.6732 | 4.1900 | 15.3079 | 1.3652 | 4.1321 | 32.7627 | 0.0000*** |
| VS | 0.0032 | 0.0030 | 0.0084 | 0.0008 | 0.0018 | 0.9620 | 3.4462 | 14.6267 | 0.0007*** |
| VP | 7.1513 | 7.0394 | 10.0351 | 3.2750 | 1.1338 | -0.0279 | 4.9997 | 15.0075 | 0.0006*** |
| VF | 0.0034 | 0.0034 | 0.0048 | 0.0024 | 0.0007 | 0.2605 | 1.7205 | 7.1573 | 0.0279** |
| FA | 16720 | 11425 | 46329 | 920 | 12923 | 0.6072 | 1.9114 | 9.9734 | 0.0068*** |
| FB | 15510 | 14539 | 40685 | 1657 | 10879 | 0.3248 | 1.9619 | 5.6237 | 0.0601* |

Notes: 1.. *** 、** 、* denote significance at the 1%, 5%, and 10% levels.
2. he sample size is 108

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