Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Structural changes in foreign investors’ trading behavior and the corresponding impact on Taiwan’s stock market

Cho-Min Lina, Yen-Hsien Leeb,∗, Chien-Liang Chiuc

a Department of Accounting, Providence University, 200 Chungchi Road, Shalu, Taichung Hsien 433, Taiwan, ROC
b Department of Finance, Chung Yuan Christian University, 200 Chung Pei Road, Chung-Li, Tao-Yuan 32023, Taiwan, ROC
c Department of Banking & Finance, Tamkang University, 151 Ying-Chuan Road, Tamsui, Taipei County 25137, Taiwan, ROC

ARTICLE INFO

Article history:
Received 20 November 2007
Received in revised form 17 June 2008
Accepted 9 July 2008
Available online 31 July 2008

JEL classification:
C22
F21
G14

Keywords:
Structural change
Expected and unexpected net purchases of foreign investors
GARCH–ARJI model

ABSTRACT

This study investigates the impact of the expected and unexpected trading behavior of foreign investors on return volatilities during structural change periods. And the jump intensity model pinpoints crucial events that have influenced the stock market. The empirical results find that there has been a stabilizing effect of foreign investment on Taiwan’s stock market as restrictions on foreign trading have been gradually relaxed, as opposed to there being a complete relaxation of the restrictions imposed on Qualified Foreign Institutional Investors (QFIIs).

© 2008 Elsevier B.V. All rights reserved.

1. Introduction

Taiwan, South Korea, India, and the People’s Republic of China (PRC) are four Asian countries that have opened their markets to Qualified Foreign Institutional Investor (QFII). Thus, foreign investors play a crucial role in Asian stock markets. In spite of this, few studies have identified the correlation that exists between foreign investment and stock returns. Choe et al. (1999) and Kim and Wei (2002) studied the influence of foreign investors on the South Korean stock market over a brief period,

∗ Corresponding author at: Department of Finance, Chung Yuan Christian University, 200 Chung Pei Road, Chung-Li, Tao-Yuan 32023, Taiwan, ROC. Tel.: +886 3 265 5711 x13615.
E-mail addresses: cmlin@pu.edu.tw (C.-M. Lin), yh@cycu.edu.tw (Y.-H. Lee), 100730@mail.tku.edu.tw (C.-L. Chiu).

0275-5319/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.ribaf.2008.07.003
i.e. from 2 December 1996 to 27 December 1997, during the Asian financial crisis, but no consistent conclusions were reached. Hamao and Mei (2001) carried out similar studies for the 1974–1992 and, despite the longer time span, failed to yet again identify the effect of foreign investors. When compared to the cases of South Korea and Japan, fewer studies have been made to study the case of Taiwan.

Foreign investors were first introduced to Taiwan in 1983, and subsequent key milestones included the establishment of the QFII in 1991, the inclusion of the Taiwan Stock Exchange (TSE) index as one of the emergent market indexes by Morgan Stanley Capital International (MSCI) in 1996, and the relaxation of restrictions on QFII investors in 2003. Figs. 1 and 2 indicate that the share of stocks held by foreign investors and the total market value of foreign investors has increased along with the gradual relaxation of foreign trading limits. Kim et al. (2005) suggests the increased importance of foreign volume as an information variable; therefore, foreign investors are regarded as the market leaders, so that foreign trading behavior often has a significant influence on emerging stock markets, as in the case of foreign investors in the Thai stock market during the Asian financial crisis in 1997. From the government’s point of view, the introduction of foreign investors is aimed at stabilizing the domestic stock market. However, the trading behavior of foreign investors can sometimes be unreasonable, i.e. they might engage in positive feedback trading by buying stocks as stock prices increase and selling as prices fall, thus giving rise to huge volatilities in the emerging stock markets. Furthermore, this study purposes to understand whether the trading behavior of foreign investors impact on volatility of Taiwanese stock market.

\footnote{Other studies associated with the Asian financial crisis may not have used the same period as that used by Choe et al. (1999).}
In order to ascertain the role and function of foreign investors, this study investigates whether foreign investors cause volatility in Taiwan’s stock market. Theoretically, the relaxation of the limits on foreign investment should enlarge and stabilize the stock market scale, helping both strengthen the local stock market and enhancing market efficiency. However, it is frequently claimed that large capital flows associated with foreign investors often give rise to significant stock price and exchange rate volatility and thus lead to abnormal price fluctuations. Scholes (1972), Kraus and Stoll (1972), Shleifer and Summers (1990), Bekaert and Harvey (1997), Bekaert et al. (2002), and Wang and Shen (1999) all concluded that the trading behavior of foreign investors was often the cause of stock market instability. Besides, positive feedback trading and trading on the part of a herd of foreign investors often gives rise to increased stock market volatility as asset prices become detached from their fundamentals, as proposed by DeLong et al. (1990). Although positive feedback trading on the part of foreign investors occurs frequently, no consistent conclusion has been reached in determining whether foreign investors play a dominant role in stock market volatility. Choe et al. (1999) and Kim and Wei (2002) found that foreign investors exhibit a tendency to buy when prices increase and to sell when prices fall in South Korea, but they did not prove that this tendency was the main cause of the stock market volatility. Aggarwal and Chen (1990), Lakonishock et al. (1992), Tesar and Werner (1994, 1995), Bohn and Tesar (1995), Bohn and Tesar (1996), Choe et al. (1999), Grinblatt and Keloharju (2000), and Hamao and Mei (2001) all concluded that foreign investors were not the main cause of stock market instability. Wang (2007) indicated the relationship between trading of foreign investor is often negatively related to volatility in Indonesia and Thailand. Hence, the cause–effect relationship between foreign investors and stock return volatility is not clear from previous studies, and it is this that provides the motivation for this study.

Most of the earlier studies claimed that foreign trading behavior had only a linear impact on Taiwan’s stock market and Kim and Mei (2001) and Chang and Kim (2001) indicated that the potential source of jumps innovation to returns result from the impacts of various unexpected shocks, such as the announcements of earnings, market crashes, political issues and financial crisis. For this reason, this study has adopted the structural change model proposed by Bai and Perron (2003) to verify whether there exist structural changes in terms of Taiwan’s foreign investors’ trading behavior. Besides, this study has investigated the impact of the expected and unexpected trading behavior of foreign investors obtained via ARMA model on return volatilities and has also pinpointed crucial events that influence the stock market via GARCH model with autoregressive conditional jump intensity (GARCH–ARJI) during structural change periods.

We contribute to the literature in various ways. First, we discover two structural change points in relation to the net purchases of foreign investors in Taiwan. Second, we investigate the impact of the expected and unexpected trading behavior of foreign investors on Taiwan’s stock return volatility based on these two switching points and the corresponding three sub-periods. Third, we find that political shocks influence Taiwan’s stock market. Thus, we believe that our approach is methodologically solid and appropriate for providing a better understanding of the effects of foreign investment on the Taiwanese stock market.

This remainder of this paper is organized as follows. Section 2 describes the data and methodology. This is followed by Section 3 that presents the empirical results. Finally, Section 4 summarizes the key results and presents the conclusions.

2. Data and methodology

2.1. Data

The sample period runs from 1 August 1995 to 31 December 2005. Daily TAIEX transactions data are collected and transformed into daily returns, yielding 2610 observations.\(^2\) Both the daily TAIEX index and the net purchases of foreign investors are obtained from the Taiwan Economic Journal (TEJ) database.

\(^2\) We define the logarithmic return on time \(t\) as \(R_t = (\ln P_t - \ln P_{t-1}) \times 100.\)
2.2. Methodology

This study follows the autoregressive conditional jump intensity model by Chan and Maheu (2002), which postulates that the jump intensity obeys an ARMA process and incorporates the GARCH effect of returns series. Given the set of returns at time \( t - 1 \) and the two stochastic innovations, \( \varepsilon_{1,t} \) and \( \varepsilon_{2,t} \), the time-series model of returns can be expressed as follows:

\[
R_t = \mu_0 + \sum_{i=1}^{p} \phi_i R_{t-i} + \varepsilon_{1,t} + \varepsilon_{2,t}
\]  

(1)

where \( \varepsilon_{1,t} \) is a mean-zero innovation with a normal stochastic process, and is assumed to be

\[
\varepsilon_{1,t} = \sqrt{h_t} z_t, \quad z_t \sim \text{NID}(0, 1)
\]

and \( \varepsilon_{2,t} \) denotes a jump innovation assigned to be a conditional zero-mean value, and conditionally mean zero. \( \varepsilon_{1,t} \) is contemporaneously independent of \( \varepsilon_{2,t} \). \( E_t \) and \( U_t \) denote expected and unexpected net purchases of foreign investors, respectively.

From Eq. (1) it is realized that this equation shows that the returns series includes a normal stochastic process and a jump stochastic process that is characterized by a Poisson distribution with a time-varying conditional intensity parameter, \( \lambda_t \). The Poisson distribution with parameter \( \lambda_t \) that is conditional upon \( \Omega_{t-1} \) is assumed to describe the arrival of a discrete number of jumps, where \( n_t \in \{0, 1, 2, \ldots \} \) over the interval \([t-1, t]\). The conditional density of \( n_t \) is as follows:

\[
P(n_t = j|\Omega_{t-1}) = \frac{e^{-\lambda_t} \lambda_t^j}{j!}, \quad j = 0, 1, 2, \ldots
\]  

(3)

The conditional jump intensity \( \lambda_t \) is the expected number of jumps conditional upon the information set \( \Omega_{t-1} \), which is parameterized as

\[
\lambda_t = \lambda_0 + \rho \lambda_{t-1} + \gamma \zeta_{t-1}
\]  

(4)

\( \lambda_t \) is related to the conditional jump intensity and \( \zeta_{t-1} \) which is defined as

\[
\zeta_{t-1} = E[n_{t-1}|\Omega_{t-1}] - \lambda_{t-1} = \sum_{j=0}^{\infty} j P(n_{t-1} = j|\Omega_{t-1}) - \lambda_{t-1}
\]  

(5)

where \( P(n_{t-1} = j|\Omega_{t-1}) \), called the filter, is the ex post inference on \( n_{t-1} \) given the information set \( \Omega_{t-1} \), and \( E[n_{t-1}|\Omega_{t-1}] \) is the ex post judgment of the expected number of jumps from \( t - 2 \) to \( t - 1 \) and \( \lambda_{t-1} \) is the conditional expectation of \( n - 1 \) given the information set \( \Omega_{t-2} \). Therefore, \( \zeta_{t-1} \) represents the change in the conditional forecast of \( n_{t-1} \) by the econometrician as the information set is updated. From this definition, \( \zeta_t \) is a martingale difference sequence with respect to information set \( \Omega_{t-1} \). Therefore \( E[\zeta_t] = 0 \) and \( \text{Cov}(\zeta_t, \zeta_{t-i}) = 0, i > 0 \). Consequently, the intensity residuals in a specified model should not exhibit any autocorrelation.

Hence, the GARCH–ARJI model can be rewritten as follows:

\[
\lambda_t = \lambda_0 + (\rho - \gamma) \lambda_{t-1} + \gamma E[n_{t-j}|\Omega_{t-j}]
\]  

(6)

where \( \lambda_t > 0 \), and \( \lambda_0 > 0 \), \( \rho \geq \gamma \), \( \gamma \geq 0 \).

The jump size, \( \pi_{t,k} \), is assumed to be independently drawn from a normal distribution. The jump-size distribution is

\[
\pi_{t,k} \sim \text{NID}(\theta, \epsilon^2)
\]  

(7)

and the jump component influencing returns from \( t - 1 \) to \( t \) is

\[
J_t = \sum_{k=1}^{n_t} \pi_{t,k}
\]  

(8)
Therefore, the jump innovation associated with period \( t \) is expressed as
\[
\varepsilon_{2,t} = J_t - E[J_t|\Omega_{t-1}] = \sum_{k=1}^{n_t} \pi_{t,k} - \theta \lambda_t
\]  
(9)

The conditional variance of returns is decomposed into two components: a smoothly developing conditional variance component related to the diffusion of past news impacts and the conditional variance component associated with the heterogeneous information arrival process which generates jumps. The conditional variance of returns is
\[
\text{Var}(R_t|\Omega_{t-1}) = \text{Var}(\varepsilon_{1,t-1}|\Omega_{t-1}) + \text{Var}(\varepsilon_{2,t-1}|\Omega_{t-1}) = h_t + (\theta^2 + \delta^2) \lambda_t
\]  
(10)

The likelihood function is constructed as follows. The conditional density of returns is normal distributed and \( j \) jumps are normally distributed as
\[
f(R_t|n_t = j, \Omega_{t-1}) = (2\pi h_t + j\delta^2)^{-1/2} \exp\left(-\frac{(R_t - \mu - \sum_{i=1}^{p} \phi_i R_{t-i} + \theta \lambda_t - \theta j)^2}{2(h_t + j\delta^2)}\right)
\]  
(11)

Furthermore, Maheu and McCurdy (2004) propose and provide an ex post distribution for the number of jumps, \( n_t \). The filter is contracted as
\[
P(n_t = j|\Omega_{t}) = \frac{f(R_t|n_t = j, \Omega_{t-1})P(n_t = j|\Omega_{t-1})}{f(R_t|\Omega_{t-1})}
\]  
(12)

After integrating out all jumps during a 1-unit interval, the conditional probability density function may be expressed as
\[
f(R_t|\Omega_{t-1}) = \sum_{j=0}^{\infty} f(R_t|n_t = j, \Omega_{t-1})P(n_t = j|\Omega_{t-1})
\]  
(13)

Therefore, the likelihood function can be expressed as
\[
L(\Psi) = \sum_{t=1}^{T} \log f(R_t|\Omega_{t-1}; \Psi)
\]  
(14)

where \( \Psi = (\mu, \phi, \omega, \alpha, \beta, \theta, \delta, \lambda, \rho, \gamma) \).

3. Empirical results

3.1. Structural change

While the breakpoints have to be pinpointed using the Chow test, some of the change points can hardly be precisely identified in advance as the breakpoint is unknown or there is more than one breakpoint. For this reason, this study has adopted the pure structural change model proposed by Bai and Perron (2003) to determine whether there exists structural change in the net purchases of foreign investors as well as the corresponding structural change periods.

Table 1 reveals the results of the structural change tests for foreign trading, where the tests for Sup FT(\( k \)), UD max, and WD max reveal that there exist structural changes in foreign trading at the 1% significance level. Moreover, while applying the sequential tests, e.g. Sup FT(\( n + 1|n \)), and the BIC tests to determine the number of breaks and break points (dates), it is found that both tests identify two break points in the net purchases of foreign investors, namely, 1168 (12 October 1998) and 2301.

\[3\] The Sup FT(\( k \)) test which is the null hypothesis of no structural break versus the alternative of a fixed number of breaks \( k \). UD max test and WD max test of the null hypothesis of no structural break versus the alternative of an unknown number of breaks given some upper bound, UD max test, an equal weighted version, and WD max test. The sup FT(\( l+1|l \)) test, which is a sequential test of the null hypothesis of \( l \) breaks versus the alternative of \( l+1 \) breaks.
Table 1
Structural change test for QFIIs

|                | Sup FT(1) | Sup FT(2) | Sup FT(3) | Sup FT(4) | Sup FT(5) |
|----------------|-----------|-----------|-----------|-----------|-----------|
| 17.2815***     | 23.4113***| 17.3866***| 13.3047***| 10.3359***|
| UD max         | 23.4113***| 30.7398***|
| WD max         |           |           |           |           |
| Sup FT(2|1) | Sup FT(3|2) | Sup FT(4|3) |       |
| 22.471***      | 7.3502    | 5.2666    |

Number of breaks chosen by BIC

|               | Dates of breaks 1 | Dates of breaks 2 |
|---------------|-------------------|-------------------|
|               | 1168 (12 October 1998) | 2301 (12 March 2003) |

Notes: *** denote significance at the 1% level.

Table 2
ARMA(1,1) model for net purchases of foreign investors

| Periods       | Coefficients\textsuperscript{a} | Coefficients\textsuperscript{a} | Coefficients\textsuperscript{a} |
|---------------|----------------------------------|----------------------------------|----------------------------------|
|               | t value\textsuperscript{a}       | t value\textsuperscript{a}       | t value\textsuperscript{a}       |
| 31 August 1994–12 October 1998 |                                 |                                 |                                 |
| CONSTANT      | 10.0870***                      | 4183.5095                        | 10.1096***                      |
| AR(1)         | 0.6850***                       | 14.8061                          | 0.7248***                       |
| MA(1)         | −0.3268***                      | −5.4445                          | −0.3320***                      |
| AIC           | 643.9394                        | 2850.1844                        | 2834.4122                       |
| SBC           | 659.1260                        | 2865.2796                        | 2848.0740                       |
| Q(10)         | 8.0184                          | 9.1455                           | 16.0762                         |

Notes: *** denote significance at the 1% level. \(Q\) denote the Ljung–Box \(Q\) statistics.
\textsuperscript{a} Parameters.

(12 March 2003), which can be further divided into three sub-periods, namely, 31 August 1994–12 October 1998, 13 October 1998–12 March 2003 and 13 March 2003–31 December 2005. The first period includes the introduction of the QFII system in 1991, the inclusion of the TSE index as one of the emergent market indexes in the MSCI in 1996, as well as allowing overseas Chinese and foreigners to invest in the TSE. The second period includes the gradual relaxation of the QFII limit in 2001, and the third period includes the removal of the remaining limits imposed on QFII.

Next, the net purchases of foreign investors are further divided into those that are expected and those that are unexpected and their corresponding influences on the TSE return volatilities are analyzed during each sub-period after identifying the break points for foreign trading. The ARMA\((p, q)\) model is utilized to divide the foreign trading behavior into that which is expected and unexpected based on the minimum of the AIC and SBC criteria, where the estimation coefficients of the ARMA\((p, q)\) model have to be significant and the Ljung–Box \(Q\) statistics exhibit no serial correlation. Based on these criteria, ARMA\((1, 1)\) is the most appropriate model\textsuperscript{4} for interpreting the net purchases of foreign investors, as Table 2 reveals.

3.2. Descriptive statistics

Table 3 presents the descriptive statistics for the full period and each sub-period for the daily returns of the TAIEX, where the averages of the stock index returns are not significantly different from 0 and where the return of the third period is positive. The second period is significantly different from 0 and is positively skewed, and the kurtosis is significantly larger than 3, implying that the stock index return has a fat tail compared with the normal distribution. The statistics of the Jarque–Bera test are all significant, indicating that the respective distributions are clearly non-normal. Furthermore, there

\textsuperscript{4} To estimate the expected and unexpected values of the net purchases of foreign investors, this study estimates the ARIMA\((p, q)\) model first, where the unexpected values are obtained by subtracting the expected values from the real values.
Table 3
Descriptive statistics of daily returns

| Periods                      | Mean  | S.D.  | Skewness | Kurtosis | Jarque–Bera | Q (10) | Q2 (10) |
|------------------------------|-------|-------|----------|----------|-------------|--------|---------|
| 31 August 1994–31 December 2005 | −0.0023 | 1.5527 | −0.0818*** | 4.9127*** | 460.9435*** | 23.6991*** | 510.2603*** |
| 31 August 1994–12 October 1998 | −0.0011 | 1.4011 | −0.2762*** | 5.4936*** | 317.1843*** | 16.5596* | 142.6154*** |
| 13 October 1998–12 March 2003 | −0.0404 | 1.8550 | 0.0961*** | 3.7694*** | 29.6896*** | 15.6919 | 123.0820*** |
| 13 March 2003–31 December 2005 | 0.0589  | 1.2216 | −0.3764*** | 6.8437*** | 449.3506*** | 7.8677  | 127.4661*** |

Notes: * and *** denote significance at the 10% and 1% levels, respectively. Q and Q2 denote the Ljung–Box Q and Q2 statistics, respectively.

Fig. 3. Price and returns of the TSE index.

is a return volatility clustering phenomenon on the right-hand side of Fig. 3, suggesting that large volatilities follow larger volatilities and small volatilities follow smaller volatilities.

3.3. GARCH–ARJI models

Both the GARCH model and the GARCH–ARJI model are appropriate based on the Ljung–Box Q and Ljung–Box Q2 statistics, which exhibit no serial correlation in the standard residuals or in the squared standard residuals. Moreover, LR statistics, AIC criteria, SC criteria, and HQC criteria are used to determine the most appropriate model from the GARCH and the GARCH–ARJI models. Based on the significance of the LR statistics as well as the minimum AIC criteria, SC criteria, and HQC criteria in Table 4, the GARCH–ARJI model is a plausible model compared to the GARCH model. Thus, the GARCH–ARJI model is used to investigate the impact of the expected and unexpected trading behavior of foreign investors on stock return volatility during each sub-period.

As shown in Table 5, the estimated results of the models all meet the conditions that the parameters \( \omega \), \( \alpha \), and \( \beta \) of the conditional variance equation have to be positive and that the sum of \( \alpha \) and \( \beta \) has to be less than 1. The values of the persistence of the return volatility for each sub-period are 0.8324 (0.0497 + 0.7827), 0.8994 (0.0612 + 0.8793), and 0.9826 (0.0178 + 0.9648), respectively, where the stock volatility persistence in the third sub-period is the most significant.

---

5 The Augmented Dickey Fuller, Phillips-Perron and Kwiatkowski–Phillips–Schmidt–Shin unit root tests reveal that the stock returns of the full period as well as each sub-period are all stationary. Besides, the number of jumps used in this study is 10, as proposed by Ball and Torous (1985).

6 The output of GARCH model can be obtained from the authors.

7 The LR statistic tests for GARCH and GARCH–ARJI model.
Table 4  
Model selection criteria

| Periods                          | 31 August 1994–12 October 1998 | 13 October 1998–12 March 2003 | 13 March 2003–31 December 2005 |
|----------------------------------|---------------------------------|-------------------------------|-------------------------------|
|                                  | GARCH  | ARJI | GARCH  | ARJI | GARCH  | ARJI |
| Q(10)                            | 12.2151 | 10.4010 | 6.4099 | 6.1477 | 3.6045 | 2.9726 |
| Q^2(10)                          | 5.9920  | 3.9900  | 14.3496 | 17.7165 | 12.2965 | 3.0149 |
| AIC                              | 3.4003  | 3.3037  | 4.0630  | 3.9790  | 3.1195  | 3.0149 |
| SC                               | 3.4427  | 3.3763  | 4.0560  | 4.0536  | 3.1943  | 3.1271 |
| HQC                              | 3.4120  | 3.3238  | 4.0184  | 3.9997  | 3.1410  | 3.0471 |
| LR                               | 112.6797*** | 30.8666*** | 73.3472*** | 73.3472*** | 73.3472*** | 73.3472*** |

Notes: *** denote significance at the 1% level. Q and Q^2 denote the Ljung–Box Q and Q^2 statistics, respectively. LR denotes the likelihood ratio statistic, AIC denotes the Akaike information criterion, SC denotes the Schwarz criterion, and HQC denotes the Hannan-Quinn criterion.

In addition, the jump-size mean \( \theta \) is negative for each sub-period, namely, \(-1.7068 \), \(-1.5731 \) and \(-0.7924 \), respectively. These figures all exhibit significance at the 1% level and imply that the jump behavior incited by abnormal information tends to lead to a negative effect on return. The jump-size variance \( \delta^2 \) exhibits significance in the first sub-period only at the 1% significance level, signifying that the volatility incited by abnormal information in the first sub-period tends to increase the return volatility significantly. The jump parameter \( \lambda_0 \) of the stock return in every period is highly significant, implying that there exists jump behavior for the TSE return whenever there is abnormal information. Furthermore, the jump parameters \( \rho \) and \( \gamma \) for stock returns both exhibit significance with \( p \)-values equal to 0.0 except for \( \gamma \) in the third sub-period, which means that the probability of jumps incited by abnormal information will vary over time, as evidenced in Figs. 4–6. To sum up, the discontinued jump process acts as a crucial factor that influences the stock return, as suggested by Lin and Yeh (1999), Kim and Mei (2001) and Chang and Kim (2001). In other words, previous studies focusing on investigating the effect of foreign investors on stock volatility without considering jump behavior accordingly have given rise to inconsistent or imprecise estimates.

Aside from the above, this study also investigated the impact of the expected and unexpected net purchases of foreign investors on Taiwan’s stock return volatility in each sub-period. This study found that the expected net purchases of foreign investors do not a significant impact on return volatility in the first

Table 5  
The estimated results of the ARJI models

| Periods                          | 31 August 1994–12 October 1998 | 13 October 1998–12 March 2003 | 13 March 2003–31 December 2005 |
|----------------------------------|---------------------------------|-------------------------------|-------------------------------|
|                                  | Coefficients | \( t \) value | Coefficients | \( t \) value | Coefficients | \( t \) value |
| \( \mu_0 \)                      | \(-0.0355 \) | \(-1.1164 \) | \(-0.0428 \) | \(-1.1845 \) | \(0.0456 \) | \(1.2988 \) |
| \( \phi_1 \)                     | \(0.0662***\) | \(2.3252 \) | \(0.0850***\) | \(2.7770 \) | \(0.0612 \) | \(1.5223 \) |
| \( \omega \)                     | \(10.8066 \) | \(1.5157 \) | \(7.5256***\) | \(380.1618 \) | \(0.5372***\) | \(199.7274 \) |
| \( \alpha \)                     | \(0.0497***\) | \(3.7644 \) | \(0.0612***\) | \(9.2582 \) | \(0.0178***\) | \(3.1516 \) |
| \( \beta \)                      | \(0.7827***\) | \(16.1024 \) | \(0.8382***\) | \(103.0832 \) | \(0.9648***\) | \(104.5928 \) |
| \( \gamma \)                     | \(-1.0552 \) | \(-1.4927 \) | \(-0.7225***\) | \(-369.4269 \) | \(-0.0519***\) | \(-99.9221 \) |
| \( \varphi \)                    | \(2.2250***\) | \(3.2014 \) | \(0.4757 \) | \(0.7496 \) | \(0.0500 \) | \(0.6592 \) |
| \( \delta^2 \)                   | \(1.0578***\) | \(2.5156 \) | \(0.0476 \) | \(0.1592 \) | \(2.2736 \) | \(1.4206 \) |
| \( \lambda_0 \)                  | \(0.0278***\) | \(3.9145 \) | \(0.0311***\) | \(5.0576 \) | \(0.0150***\) | \(1.7922 \) |
| \( \rho \)                       | \(0.8913***\) | \(31.8100 \) | \(0.9200***\) | \(50.7864 \) | \(0.9133***\) | \(11.4879 \) |
| \( \gamma \)                     | \(0.7976***\) | \(5.6661 \) | \(0.7992***\) | \(5.4774 \) | \(1.0307 \) | \(1.3898 \) |

Function value  | \(-1926.0252 \) | \(-2250.1358 \) | \(-1056.7185 \)

Notes: *** denote significance at the 1% level.
Fig. 4. Time-varying jump intensities of the TSE index from 31 March 1994 to 12 October 1998.

Fig. 5. Time-varying jump intensities of the TSE index from 12 October 1998 to 12 March 2003.

Fig. 6. Time-varying jump intensities of the TSE index from 13 March 2003 to 31 December 2005.
Table 6
Event for greater jump

| Periods                  | Events                                              |
|-------------------------|-----------------------------------------------------|
| 2–12 October 1997       | Asian financial crisis                              |
| September–October 2000  | President Lee declared the Two Nations Proposition  |
| 1 May 2000              | The declaration of the Two Nations Proposition      |
| 30 September 2000       | The establishment of the Fourth Nuclear Power Plant Reevaluation Committee |
| 27 October 2000         | The Fourth Nuclear Power Plant to the Executive Yuan |
| 11 September 2001       | Premier C.S. Chang officially declared that the construction of the Fourth Nuclear Power Plant was being stopped |
| March 2003              | 911 terrorist attacks                               |
| 19 March 2004           | The outbreak of SARS                                |
| 20 May 2004             | The 11th Presidential Election campaign in Taiwan   |
|                         | The Taiwan issue prior to the 11th Presidential Inauguration |

The time-varying jump intensity ($\lambda_t$) in the stock index returns for each sub-period are not a constant, as presented in Figs. 4–6. Finally, we arranged the events in Table 6. Fig. 4 displays the jump frequency in the first period and there exist greater jumps from 2 October 1997 to 12 October 1998, mainly caused by the Asian financial crisis. Fig. 5 displays the time-varying jump intensities in the second period, there are three major jumps. First, the declaration of the Two Nations Proposition, when former President Lee declared the Two Nations Proposition on 9 July 1999, which gave rise to a large fall in share prices from 8550.27 on the day of the declaration to 6823.52 on 6 August 1999. Second, jump extends from September to October 2000 and has to do with the delay in the construction of the Fourth Nuclear Power Plant. Third, the 911 terrorist attacks against the World Trade Center in New York occurred on 11 September 2001, and caused the stock index to fall to 4176.93.

The third jump had to do with the rhetoric of the Chinese government regarding the Taiwan issue prior to the 11th Presidential Inauguration on 20 May 2004.

The crisis started in October 1997 and caused major upheavals in the currencies of Thailand, Indonesia, Malaysia, and the Philippines. Singapore, South Korea, Taiwan, and Hong Kong were later also affected to varying degrees. The financial market in Russia collapsed from 1997 to mid-1998 and this eventually triggered a major financial crisis.

The stock index was 8777.35 on 29 April 2000. When the Minister of Economic Affairs, Mr. S.Y. Lin, declared the establishment of the Fourth Nuclear Power Plant Reevaluation Committee on 1 May 2000, Taiwan’s stock index slumped to 8638.75 the next day. Minister Lin further submitted the Evaluation Suggestions for the Fourth Nuclear Power Plant to the Executive Yuan on 30 September 2000 and advised calling a halt to the plant’s construction. The Taiwan stock index then slumped to 6185.14. Premier C.S. Chang officially declared that the construction of the Fourth Nuclear Power Plant was being stopped on 27 October 2000 and the stock index fell to 5805.17.

World Health Organization (WHO) announced an outbreak of the severe acute respiratory syndrome (SARS) epidemic in China, Hong Kong, and Vietnam and declared an emergency regarding traveling.
Table 7
Comparison of variances

| Periods                                      | Total conditional variance | Average proportion of the conditional variance explained by the jumps (%) | Average proportion of the conditional variance explained by the diffusion process (%) |
|----------------------------------------------|----------------------------|----------------------------------------------------------------------------|------------------------------------------------------------------|
| 31 August 1994–12 October 1998              | 2.0121                     | 27.86                                                                      | 72.14                                                            |
| 13 October 1998–12 March 2003               | 3.4801                     | 17.79                                                                      | 82.21                                                            |
| 13 March 2003–31 December 2005              | 1.5068                     | 19.67                                                                      | 80.33                                                            |

Kim and Mei (2001) and Chang and Kim (2001) concluded that the market is easily influenced by discontinuous jumps, and Lin and Yeh (1999) confirmed that there exists a discontinuous jump in the TSE. By taking these findings into consideration, this study adopted the model developed by Nimalendran (1994), in which the total variance was estimated by means of $V_t = h_t + \lambda_v (\theta^2 + \delta^2)$.\(^\text{11}\) The variance ratios arising in the jump process as part of the overall jump-diffusion process were used to identify the responsiveness of information.

As revealed in Table 7, the total variances, i.e. the total risk, for the three sub-periods were 2.0121, 3.4801 and 1.5068, respectively, where the level of risk in the second period is the greatest and the slump in the stock market during this period can be accounted for by the declaration of the Two Nations Proposition, the 911 Event, and the suspension of the construction of the Fourth Nuclear Power Plant, implying that Taiwan’s stock market is influenced by political shocks. The variances arising in the jump process in each period accounted for 27.86%, 17.79% and 19.67%, respectively, of the total variance, where the risk caused in the jump process during the first period was the greatest, and may have been due to the poor market information transparency in the first period that accordingly resulted in severe market inefficiency. This study supports the view that unexpected events give rise to the discontinuous jumps proposed by Lin and Yeh (1999), Kim and Mei (2001) and Chang and Kim (2001). Moreover, the time-varying jump intensity of stock returns proposed by Chan and Maheu (2002) has been confirmed in this study.

4. Conclusions

This study has investigated the impact of the expected and unexpected trading behavior of foreign investors on return volatilities during structural change periods as well as also pinpointing crucial events that influence the stock market via the jump intensity model.

The empirical results reveal that the impact of the expected trading of foreign investors on Taiwan’s stock return volatility increases in accordance with a gradual relaxation of the foreign trading limits and gives rise to a negative effect; therefore, the stabilizing effect of foreign investment on Taiwan’s stock market has already existed in the process of gradually removing the restrictions on foreign trading. Further, we found political shocks influence Taiwan’s stock market. For instance, the declaration of the Two Nations Proposition, the suspension of the construction of the Fourth Nuclear Power Plant, the shooting incident during the 11th Presidential Election and the political rhetoric emanating from China before the Presidential election. Thus, general investors can thus hedge via derivatives in accordance with the trading behavior of foreign investors when being impacted by political events.

References

Aggarwal, R., Chen, S., 1990. The adjustment of stock returns to block trading information. Quart. J. Bus. Econ. 29, 46–56.
Bai, J., Perron, P., 2003. Computation and analysis of multiple structural change models. J. Appl. Econ. 18, 1–22.
Ball, C.A., Torous, W.N., 1985. On jumps in common stock prices and their impact on call option pricing. J. Finan. 40, 155–173.

\(^\text{11}\) The total stock index variance for the three sub-periods was further divided into variances that arise in the jump process ($\lambda_v (\theta^2 + \delta^2)$) as well as other variances that arise in the diffusion process ($h_t$).
Bekaert, G., Harvey, C.R., 1997. Emerging equity market volatility. J. Finan. Econ. 43, 29–77.
Bekaert, G., Harvey, C.R., Lumstadsne, R.L., 2002. The dynamics of emerging market equity flows. J. Int. Money Finan. 21, 295–350.
Bohn, H., Tesar, L.L., 1996. U.S. equity investment in foreign markets: portfolio rebalancing or return chasing? Am. Econ. Rev. 86, 77–81.
Chan, W.H., Maheu, J.M., 2002. Conditional jump dynamics in stock market returns. J. Bus. Econ. Stat. 20, 377–389.
Chang, K.H., Kim, M.J., 2001. Jump and time-varying correlations in daily foreign exchange rates. J. Int. Money Finan. 20, 611–637.
Choe, H., Kho, B.C., Stulz, R.M., 1999. Do foreign investors destabilize stock markets? The Korean experience in 1997. J. Finan. Econ. 54, 227–264.
DeLong, J.B., Shleifer, A., Summers, L.H., Waldmann, R.J., 1990. Positive feedback investment strategies and destabilizing rational speculators. J. Finan. 45, 379–395.
Grinblatt, M., Keloharju, M., 2000. The investment behavior and performance of various investors: a study of Finland’s unique data set. J. Finan. Econ. 55, 43–67.
Hamao, Y., Mei, J.P., 2001. Living with the “Enemy”: an analysis of foreign investment in the Japanese equity market. J. Int. Money Finan. 20, 715–735.
Kim, H.Y., Mei, J.P., 2001. What makes the stock market jump? An analysis of political risk on Hong Kong stock returns. J. Int. Money Finan. 20, 1003–1016.
Kim, J., Kartsaklas, A., Karanasos, M., 2005. The volume–volatility relationship and the opening of the Korean stock market to foreign investors after the financial turmoil in 1997. Asia-Pacific Finan. Markets 12, 245–271.
Kim, W., Wei, S., 2002. Foreign portfolio investors before and during a crisis. J. Int. Econ. 56, 77–96.
Kraus, A., Stoll, H.R., 1972. Parallel trading by institutional investors. J. Finan. Quant. Anal. 7, 569–588.
Lakonishock, J., Shleifer, A., Vishny, R., 1992. The impact of institutional trading on stock prices. J. Finan. Econ. 32, 23–44.
Lin, B.H., Yeh, S.K., 1999. On the discontinuous jump path and conditional heteroskedasticity in Taiwan stock prices. Rev. Securities Futures Markets 11, 61–92.
Maheu, J.M., McCurdy, T.H., 2004. News arrival, jump dynamics, and volatility component for individual stock returns. J. Finan. 59, 755–793.
Nimalendran, M., 1994. Estimating the effects of information surprises and trading on stock returns using a mixed jump-diffusion model. Rev. Finan. Stud. 7, 451–473.
Scholes, M.S., 1972. The market for securities: substitution price-pressure and the effects of information and share price. J. Bus. 45, 179–211.
Shleifer, A., Summers, L.H., 1990. The noise trader approach to finance. J. Econ. Perspect. 4, 19–33.
Tesar, L.L., Werner, I.M., 1994. U.S. equity investment in emerging stock markets. World Bank Econ. Rev. 9, 109–130.
Tesar, L.L., Werner, I.M., 1995. Home bias and high turnover. J. Int. Money Finan. 14, 467–492.
Wang, J., 2007. Foreign equity trading and emerging market volatility: evidence from Indonesia and Thailand. J. Dev. Econ. 84, 798–811.
Wang, L.R., Shen, C.H., 1999. Do foreign investments affect foreign exchange and stock markets—the case of Taiwan. Appl. Econ. 31, 1303–1314.