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The Impact of the QFIIs Deregulation on Normal and Abnormal Information Transmission Between the Stock and Exchange rates in Taiwan

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Abstract

This investigation adopts the Correlated Bivariate Poisson GARCH with Jump and Diffusion Volatility Spillover (CBP-GARCH-JDSV) model to determine whether the Qualified Foreign Institutional Investors (QFIIs) deregulation in Taiwanese stock markets influences normal and abnormal information transmission between stock and exchange rates. Empirical results demonstrated that the diffusion and jump process have significantly correlations and interacted with stock and exchange rates markets following the QFIIs deregulation. Finally, normal information transmission changed bi-directionally across markets and abnormal information supports the asset approach to determining exchange rates. Additionally, estimation results suggest that information transmissions are affected by removal of investment restrictions.

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1. Introduction

Based on the asset approach for determining exchange rates adjustment to equate supply and demand for financial assets such as stocks (Kanas, 2000). When stock prices (domestic wealth) decrease, foreign investor capital flows out of the market and a current depreciation (an increase in the exchange rates) is necessary to balance asset supply and demand. Stiglitz (1998), Radelet and Sachs (1998) also noted that emerging markets are particularly susceptible to affected by foreign investors. Furthermore, the importance of such mechanisms has likely increased as a result of the removal of barriers to capital movement. As the Taiwanese stock market has removed all restrictions on Qualified Foreign Institutional Investors (QFIIs[1]) investors in October 2003, the actions of foreign investors[2] have become a matter of interest for individual investors and are also worthy in-depth investigation.

Previous research[3] regarding the relationship between stock returns and exchange rates change has focused on the first moment of the relevant distributions, and ignored the second moment; furthermore, Kanas (2000) Caporale and Pittis and Spagnolo (2002) indicated an explicit relationship of volatility exists between stock returns and exchange rates changes. In examining the volatility spillover between the stock and exchange rates markets, Kanas (2000) identified volatility spillovers from stock prices to the exchange rates for five of six countries analyzed—Germany was the exception. Caporale and Pittis and Spagnolo (2002) observed that stock prices lead exchange rates negatively in Japan and South Korea and positively affected the exchange rates in Indonesia and Thailand (during the pre-crisis periods); moreover, in Indonesia and Thailand after the onset of the East Asian crisis, spillover effects were bi-directional. Maheu and McCurdy (2004) developed a jump-diffusion model that has two components: a diffusion process captures continual fluctuations in asset prices, due to liquidity or strategic trading (normal information transmission); a jump process that represents occasional large changes in prices that can result from abnormal information. These studies discuss transmission effects for normal information (s volatility spillovers) and ignore abnormal information (jump spillovers). This study examines issues of information transmission effects that are classified as normal and abnormal[4] in the stock and exchange rates markets in Taiwan.

Despite the considerable amount of research that analyzes the linkages and

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[1] Qualified Foreign Institutional Investors (QFIIs) here refers to foreign professional investment institutions, which can be further classified into five categories: insurance companies, banks, securities, fund management organizations, and other investment units—e.g., mutual funds, retirement funds, government funds, mercy funds, etc.

[2] Foreign investors comprised 0.1% of total investment in the Taiwan stock market in 1990, at which time individual domestic investors dominated the market accounting for 96.7% of total investment. The share of foreign investors had increased to 8% by 2003, with that of domestic individual investors decreasing to 79%, indicating a major change.

[3] Booth and Rotenberg (1990); Smith (1992); Bodnar and Gentry (1993); Correia, Perman and Rees (1993); Ajayi and Mougoue (1996).

[4] Normal and abnormal information transmissions are examined by diffusion volatility and jump intensity spillovers.

interactions between stock and exchange rates markets, no attempt has been made to investigate the likelihood that quality of information may be a crucial determinant of information transmission in stock and exchange rates markets. This study applied the Correlated Bivariate Poisson-GARCH model proposed by Chan (2003) extended with a Jump and Diffusion Volatility Spillover (CBP-GARCH-JDSV) model to examine the relationships between stock and exchange rates markets during the pre- and post-QFII periods. This analysis will provide a detailed description of information transfer and market integration; furthermore, this study attempted to determine whether the QFIIs deregulation changed normal and abnormal information transmissions in the stock and exchange rates market in Taiwan.

The article is organized as follows. Section II describes data and the econometric model. Empirical results are reported in Section III and IV. Final section contains our conclusions.

2. Data and CBP-GARCH-JDSV model

The study period was Jan. 1, 2000, to Dec. 31, 2005. The daily Taiwan stock index (TAIEX) and foreign exchange (FX) transaction data were collected and transformed into daily returns[5], yielding 1528 observations. As the Taiwanese stock market has removed all restrictions on the QFIIs in October 2003, this study divided the sample into the pre- and post-QFII periods to examine the influence of foreign investment on stock and exchange rates markets in Taiwan. The daily TAIEX index and FX transaction data were obtained from the Taiwan Economic Journal (TEJ).

To capture the diffusion volatility and jump intensity spillover effects between TAIEX and FX markets, this study investigated this issue using adapted CBP-GARCH model. For the purpose to examine the discrepancy of spillover effects after the impact of releasing foreign investing restriction, we set D_t denote the dummy variable which takes on value of 1 after this event and o otherwise. Let $r_{i,t}$ be the return at time t for the index *i*, (i = T, F where T and F denotes TAIEX and FX markets), Φ_{t-1} the information set at time t-1, then, the CBP-GARCH-JDSV model is described as follows:

$$r_t = \mu + \varepsilon_t + J_t \qquad \varepsilon_t \mid \Phi_{t-1} \sim N(0, \tilde{H}_t) \tag{1}$$

$$\sigma^2_{T,t} = \omega_T + \alpha_T \varepsilon^2_{T,t-1} + \beta_T \sigma^2_{T,t-1} + (\alpha_{TF} + \alpha_{TF1} D_t)\varepsilon^2_{F,t-1} \tag{2}$$

$$\sigma^2_{F,t} = \omega_F + \alpha_F \varepsilon^2_{F,t-1} + \beta_F \sigma^2_{F,t-1} + (\alpha_{FT} + \alpha_{FT1} D_t)\varepsilon^2_{T,t-1} \tag{3}$$

$$\sigma_{TF,t} = (\rho_{TF} + \rho_{TF1} D_t)\sigma_{F,t}\sigma_{T,t} \tag{4}$$

where R_t is a 2×1 vector of returns consisting of a constant mean μ, a error term ε_t, and a jump component J_t. The error term has a bivariate normal distribution with

[5] Granger Huange and Yang (2000) argued that daily (as opposed to monthly) data are more appropriate for capturing the effect of capital movement.

zero mean and conditional covariance matrix $\tilde{H}_t$, which has the form of constant correlation GARCH instead of the BEKK form used by Chan (2003). The coefficients α_{TF} and α_{FT} capture the volatility spillover effects. For example, if α_{TF} (α_{TF}) is significant, then the volatility of FX (TAIEX) share indices will spill over to TAIEX (FX) share markets, and vice versa. It implies that normal information transmission effects between TAIEX and FX share markets are supportive. Moreover, parameters α_{TF1} and α_{FT1} are specified to examine the impact of releasing investing restriction for the issue of information transmission, and the term ρ_{TF1} is set to investigate the discrepancy of correlation after the removal of investing restriction.

The jump component enters the mean equation with an expected value of zero which is achieved by subtracting the expected values from the series of random jumps. In a bivariate framework, the jump component is defined as:

$$J_t = \left[\sum_{i=1}^{n_{Tt}} Y_{Tt,i} - E_{t-1}\left(\sum_{i=1}^{n_{Tt}} Y_{Tt,i}\right) \quad \sum_{j=1}^{n_{Ft}} Y_{Ft,j} - E_{t-1}\left(\sum_{i=1}^{n_{Ft}} Y_{Ft,i}\right) \right]' \tag{5}$$

where $Y_{Tt,i} \sim N(\theta_T, \delta_T^2)$ and $Y_{Ft,i} \sim N(\theta_F, \delta_F^2)$, and J_t has a bivariate normal distribution with zero mean and variance matrix. The normal disturbance and the jump components are assumed to be independent. Two constructed by the independent Poisson variables namely n_{Tt}^*, n_{Ft}^*, and n_{ct}^*. Each one of these variables has a probability density function given by $P(n_{it}^* = j \mid \Phi_{t-1}) = e^{-\lambda_i}\lambda_i^j / j!$. The expected values and variances of n_{it}^* are each equal to λ_i, which is also referred to as the expected number of jumps or the jump intensity. The time varying jump intensities are defined as

$$\lambda_{T,t} = \lambda_T + \eta_T^2 r_{T,t-1}^2 + (\eta_{TF}^2 + \eta_{TF1}^2 D_t) r_{F,t-1}^2 \tag{6}$$

$$\lambda_{F,t} = \lambda_F + \eta_F^2 r_{F,t-1}^2 + (\eta_{FT}^2 + \eta_{FT1}^2 D_t) r_{T,t-1}^2 \tag{7}$$

$$\lambda_{c,t} = \lambda_c + \eta_{cT}^2 r_{T,t-1}^2 + \eta_{cF}^2 r_{F,t-1}^2 \tag{8}$$

The jump intensities are assumed to be related to the market conditions which are reflected in $r^2_{i,t-1}$ as an approximation of last period's volatility. Similar, the covariance $\lambda_{c,t}$ is governed by the variations in last period volatilities from both series. In the above specification, the coefficients η_{TF} and η_{FT} capture the jump intensity spillover effects. If η_{FT} (η_{TF}) is significant, then the jump intensity of TAIEX (FX) share markets will spill over to FX (TAIEX) share markets, and vice versa. It indicates that abnormal information transmission effects come into existence. Furthermore, parameters η_{TF1} and η_{FT1} measure the impact of releasing investing restriction to the jump intensity spillover effects between TAIEX and FX share markets in Taiwan. Combining the GARCH model with the CBP function, the probability density function for R_t given I jumps in index a and j jumps in index b is defined by

$$f(R_t \mid n_{Tt} = i, n_{Ft} = j, \Phi_{t-1}) = \left|H_{ij,t}\right|^{-0.5} \exp(-u'_{ij,t} H_{ij,t}^{-1} u_{ij,t}) \Big/ \left(2\pi\right)^{0.5T} \quad (9)$$

where $u_{ij,t} = \left[r_{T,t} - \mu_T - i\theta_T + (\lambda_T + \lambda_c)\theta_T \quad r_{F,t} - \mu_F - i\theta_F + (\lambda_F + \lambda_c)\theta_F \right]'$, and $H_{ij,t}$ is the covariance matrix of the returns given i jumps in index a and j jumps in index b. Under the normal disturbance, ε_t, is independent of the jump component, $H_{ij,t}$, is the summation of the covariance matrix for the normal disturbance and the jump component. The covariance matrix for the jump component $\Delta_{ij,t}$ is derived from the assumption that the correlation between the jump size is constant across contemporaneous equations and zero across time:

$$\mathrm{Corr}(Y_{Tt}, Y_{Ft}) = \rho_{JFT} \text{ and } \mathrm{Corr}(Y_{Tt}, Y_{Ft}) = 0 \text{ where } t \neq s \quad (10)$$

Therefore, the covariance matrix for the jump component can be presented as:

$$\Delta_{ij,t} = \begin{bmatrix} i\delta_T^2 & (\rho_{JTF} + \rho_{JTF1} D_t)\sqrt{ij}\delta_T\delta_F \\ (\rho_{JTF} + \rho_{JTF1} D_t)\sqrt{ij}\delta_T\delta_F & j\delta_F^2 \end{bmatrix} \quad (11)$$

where parameter ρ_{JTF1} measures the discrepancy of jump correlation before and after the event. Although jumps are unobservable, an ex post filter can be constructed as:

$$P\left(n_{Tt} = i, n_{Ft} = j \mid \Phi_t\right) = f\left(r_t \mid n_{Tt} = i, n_{Ft} = j, \Phi_{t-1}\right) \Big/ P\left(r_t \mid \Phi_{t-1}\right) \times P\left(n_{Tt} = i, n_{Ft} = j \mid \Phi_{t-1}\right) \quad (12)$$

where the conditional density of returns is defined by

$$P(r_t \mid \Phi_{t-1}) = \sum_{i=0}^{\infty} \sum_{j=0}^{\infty} f(r_t \mid n_{Tt} = i, n_{Ft} = j, \Phi_{t-1}) P\left(n_{Tt} = i, n_{Ft} = j \mid \Phi_{t-1}\right) \quad (13)$$

Finally, the log likelihood function is simply the sum of the log conditional densities:

$$\ln L = \sum_{t=1}^{T} \ln P(r_t \mid \Phi_{t-1}) \quad (14)$$

Since the information matrix is not block diagonal, evaluation of the full likelihood is required. To estimate the CBP-GARCH-JDSV model, a truncation point must be selected for the probability function is Eq.(13). We choose a truncation point, which is sufficiently large so that the likelihood function and parameter estimates stabilize to a set of converged values. Finally, the BFGS numerically algorithm in WinRats 6.0 was used to maximize Eq. (14).

3. Empirical results

Table 1 presents descriptive statistics during two periods, the statistics show that the average return of TAIEX displays lower than FX during the pre-event period, whereas FX higher during the post-QFII period. Both max and min values reduce during the post-QFII periods than during the pre-QFII periods, attributing volume of the QFII investment increase during the post-QFII, improving domestic investment environment and stabilizing effect to the QFIIs deregulation on the Taiwanese stock market[6]. TAIEX (FX) is positively (negatively) skewed and both returns have a fat tail compared with the normal distribution and which is consistent with the presence of GARCH effects; furthermore, the JB statistics are signification. Augmented Dickey-Fuller (ADF), Phillips and Perron (P-P) and Kwiatkowski et al. (KPSS) unit root tests with respect to the TAIEX and FX. The results are stationary for returns of TAIEX and FX.

Table 1. Descriptive statistics of daily return

Index	Mean	Std.	Min	Max	Skewness	Kurtosis	JB
Panel A: pre-QFII period							
TAIEX	-0.038	1.935	-12.778	6.172	-0.266***	2.928***	351.929***
FX	0.008	0.289	-2.848	3.207	0.959***	45.106***	81018.235***
Panel B: post-QFII period							
TAIEX	0.020	1.159	-6.912	5.419	-0.537***	5.458***	738.696***
FX	-0.005	0.307	-1.062	1.376	0.093***	1.571***	59.766***

Note： *、** and *** denote significantly at the 10%、5% and 1% level.

Table 2 presents the CBP-GARCH-JDSV model results[7]. At the 5% level, the α_T and β_T (α_F and β_F) parameters are significant. The $\alpha_T+\beta_T$ ($\alpha_F+\beta_F$) is 0.9875 (0.7397), indicating a strong GARCH effect and persistence of conditional variance. Both jump intensity and size parameters are significant, that is, the two markets exhibit jump behaviors. Therefore, Poisson jump components play a critical role in modeling these stock and exchange rates markets.

During the pre-QFII period, the diffusion process ρ_{TF} [8] had a significant correlation and negative interactions with TAIEX and FX markets, and the jump process ρ_{JTF} was not significant correlation. Whereas the diffusion and jump (ρ_{TF1} and ρ_{JTF1}) were significant correlation and negative interactions with TAIEX and FX markets during the post-QFII period. Thus, this analytical finding is consistent with the belief that stock and exchange rates markets had integration when foreign investment limits are eliminated.

This study examines whether deregulation changes the information transmission

[6] Aggarwal and Chen (1990), Tesar and Werner (1994, 1995), Bohn and Tesar (1996), Choe et al. (1999), Grinblatt and Keloharju (2000), and Hamao and Mei (2001).

[7] Diagnostic test results for the standardized and squared standardized residuals. The Ljung-Box Q and Q^2 statistics of both order 20 and 40 indicate that the residuals are not linear dependencies, suggesting that model is specified correctly.

[8] The result support Kanas (2000), in which there are contemporaneous relationships between stock returns and exchange rates changes.

mechanisms. We applied the likelihood ratio to test the hypothesis $\alpha_{TF} = \alpha_{FT} = \eta_{TF} = \eta_{FT} = 0$ and $\alpha_{TF1} = \alpha_{FT1} = \eta_{TF1} = \eta_{FT1} = 0$ that diffusion volatility and jump intensity spillover effects exist between the TAIEX and FX during the pre-QFII and post-QFII periods. The null hypotheses are rejected; therefore, information is transmitted between two markets during the two periods.

In term of normal information transmissions, the likelihood ratio is again used to test the hypothesis ($\alpha_{TF} = \alpha_{FT} = 0, \alpha_{TF1} = \alpha_{FT1} = 0$) that is rejected significantly, that diffusion volatility spillover effects exist, indicating the existence of normal information transmissions in the TAIEX and FX market. Therefore, further analytical results demonstrate that the volatility spillover parameters (α_{FT}) are statistically significant, suggesting the presence of unidirectional normal information transmissions from the TAIEX to FX markets pre-QFII period; this analytical finding indicates that the volatility of stock returns is a determinant for the volatility of the exchange rates. However, α_{TF1} [9] and α_{FT1} are statistically and negatively significant, implying the existence of bi-directional normal information transmissions between TAIEX and FX markets during post-QFII period. Thus, the QFIIs deregulation generates a diffusion volatility spillover effect that reinforces cross-markets.

Table 2. CBP-GARCH-JDSV model estimation results

TAIEX			FX		
Variable	Coefficient	Standard Error	Variable	Coefficient	Standard Error
μ_T	0.0115	0.0295	μ_F	0.0045	0.0033
ω_T	0.0209***	0.0017	ω_F	0.0022***	0.0001
α_T	0.0340***	0.0016	α_F	0.2166***	0.0198
β_T	0.9535***	0.0017	β_F	0.5231***	0.0146
θ_T	-1.5650***	0.3868	θ_F	0.0613***	0.0178
δ_T	2.6719***	0.5346	δ_F	0.4208***	0.0119
λ_T	0.0160***	0.0020	λ_F	0.0363***	0.0128
η_T	-0.0111	0.0118	η_F	0.0065	0.1629
ρ_{TF}	-0.1549***	0.0292	ρ_{TF1}	-0.1424***	0.0468
ρ_{JTF}	0.0554	0.2771	ρ_{JTF1}	-0.0014***	0.0000
η_{CT}	-0.0482**	0.0195	η_{CF}	-0.1837**	0.0772
λ_C	0.0043	0.0066			
α_{TF}	-0.0092	0.0128	α_{FT}	-0.0001***	0.0000

[9] Aggarwal and Chen (1990), Tesar and Werner (1994, 1995), Bohn and Tesar (1996), Choe et al. (1999), Grinblatt and Keloharju (2000), and Hamao and Mei (2001) determined that foreign investors are not the primary cause of stock instability, namely, foreign investors do not cause stock volatility. The elimination of foreign investment limits expanded market scale and stabilized the market. Foreign professional capital managers exert their influence on domestic stock market and thereby strengthen Taiwan's stock market and enhance its efficiency. The analytical results obtained in this study are supportive of Kanas (2000), in which contemporaneous relationships exist between stock returns and exchange rates changes.

α_{TF1}	-0.1075***	0.0133	α_{FT1}	0.0022*	0.0012
η_{TF}	0.0148	0.0114	η_{FT}	5.2651***	0.6248
η_{TF1}	0.0161	0.0134	η_{FT1}	4.8620***	1.4035
Log-likelihood value			-2478.8717		
Diagnostics on standardized residuals					
Q(10)	12.8639		Q(10)	0.0131	
Q(20)	24.8161		Q(20)	0.0270	
$Q^2(10)$	11.3620		$Q^2(10)$	0.0134	
$Q^2(20)$	19.8013		$Q^2(20)$	0.0274	

Spillover effect test

Items	Pre-QFII period	Post-QFII period
Diffusion and Jump spillover ($\alpha_{TF}=\alpha_{FT}=\eta_{TF}=\eta_{FT}=0$, $\alpha_{TF1}=\alpha_{FT1}=\eta_{TF1}=\eta_{FT1}=0$)	319.0147***	94.5805***
Diffusion spillover ($\alpha_{TF}=\alpha_{FT}=0$, $\alpha_{TF1}=\alpha_{FT1}=0$)	132.3047***	71.6754***
Jump spillover ($\eta_{TF}=\eta_{FT}=0$, $\eta_{TF1}=\eta_{FT1}=0$)	81.1043***	24.9726***

Note：1. * 、** and *** denote significantly at the 10% 、5% and 1% level.
2. Q and Q^2 are Ljung-Box Q test for serial correlation in the standardized residuals and squared standardized residuals, respectively.

For abnormal information transmissions, the likelihood ratio is again applied to test the hypotheses ($\eta_{TF}=\eta_{FT}=0$, $\eta_{TF1}=\eta_{FT1}=0$) that are rejected significantly, indicating that a jump intensity spillover affects the TAIEX and FX market. Therefore, the jump intensity spillover parameters η_{FT} and η_{FT1} are positive and significant[10], indicating that unidirectional abnormal information is transmitted from the TAIEX to the FX during the pre- and post-QFII periods. This study determined that abnormal information is generally supportive of the asset approach to determining exchange rates during the period after the QFIIs deregulation.

4. Conclusion

This study utilized the CBP-GARCH-JDSV model to determine whether the QFIIs deregulation of Taiwan's stock markets changed altered normal and abnormal information transmissions by examining diffusion volatility and jump intensity spillovers between the TAIEX and FX markets.

Overall, analytical results suggest that the diffusion and jump process are significant correlations and interactions with TAIEX and FX markets during the

[10] Scholes (1972), Kraus and Stoll (1972), Shleifer and Summers (1990), Bekaert and Harvey (1997), and Bekaert, Harvey and Lumsdaine (2002) all demonstrated that the transactions of foreign investors caused stock market instability. Large capital flows associated with foreign investors frequently cause significant stock price and exchange rates volatility and, thus, increase abnormal price fluctuation.

post-QFII periods. Short-term dynamic relationships exist between stock and exchange rates markets, and both diffusion volatility and jump intensity spillovers exist in the two markets. After the QFIIs deregulation, normal information transmission changed in the bi-directional between TAIEX and FX and abnormal information generally supported the asset approach for exchange rates determination.

Finally, estimation results demonstrate that information transmissions are influenced by removal of investment restrictions, allowing foreign residents to invest in Taiwan's stock market. These findings are of interest to individual investors, institutions such as pension funds, which diversify their portfolios through international equity investment, and to multinational corporations that have to to manage their exchange rates exposure.

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