INFLUENCE OF EXTERNAL FACTORS ON THE TAIWAN STOCK EXCHANGE

Chin-Wen Huang, Western Connecticut State University

ABSTRACT

Due to the small market size and the low trading volume, emerging markets are, in general, shallow and easily affected by external factors such as the capital flows from foreign portfolio investment and the stock market fluctuations of their major trading partners. This study attempts to investigate how foreign portfolio investment and the trading partner's equity market affect the local stock market and whether such impacts are persistent through time. Adopting the GARCH-EVT-Copula approach, this study takes the Taiwan Stock Exchange as an example to examine (1) the time varying dependencies between the changes in the Taiwan Stock Exchange Capitalization Weighted Stock Index and the changes in foreign portfolio investment volume, and (2) the time varying dependencies between the changes in Taiwan Stock Exchange Capitalization Weighted Stock Index and the changes of the China A-Shares market aggregation index. The empirical results indicated that although foreign portfolio investment started as a strong force in moving the market, it became less influential during the financial crisis period. The stock movements from an emerging market's top trading partner, however, become more influential as the international trading volume between the two increased and did not weaken even during the financial crisis period.

JEL: G01, G11, G15

KEYWORDS: Foreign Portfolio Investment; GARCH; EVT; Copula

INTRODUCTION

With the shallow market and relatively low trading volumes, stock markets in emerging economies are easily disturbed and manipulated by external factors such as the shifts of foreign portfolio investment flows and the stock market fluctuations from their major trading partners. From emerging markets' point of view, foreign portfolio investment is a doubled-edged sword. On the one side, when foreign capital pours into the emerging stock markets, it provides the capital to support local economic development and, therefore, boosts economic growth. On the other side, since the flow of foreign hot money is unstable in nature, once it flees from the emerging markets, it will tamp down the domestic stock market and cause economic turmoil. As to the dependence between the emerging markets and the markets of their major trading partners, the literature has observed that stock markets tend to integrate with their trading partners. However, the intensity and the persistence of such linkages are not yet well documented, especially during the periods of economic downturns.

To efficiently examine how foreign portfolio investment and the stock market fluctuations of one's top trading partner affect the movements of an emerging stock market, it is important to select a market that is closely monitored by foreign investors and, over time, has attracted a significant amount of foreign investment. This same country has also to be one of those whose economic growth relies heavily on the international trade. To fulfill the criteria above, this study chose the Taiwan Stock Exchange (TWSE) as the sample market for analysis. Taiwan is a country known for its rapid economic growth over the past several decades, and it is the country's international trade that drives such phenomenal growth. During 1990s, Taiwan initiated its stock market openness policy by allowing qualified foreign institutional investors (QFII) to buy shares at the TWSE with strict holding volume restrictions. As the economy grew, Taiwan gradually released its foreign ownership restrictions. On October 2, 2003, Taiwan, finally, fully abolished the restrictions on foreign investors in its stock markets. Around the same time, Taiwan also opened its domestic manufactories to make direct investment in China, establishing that trading partnership. Since then, the TWSE has been affected by both foreign portfolio investment and the Chinese stock markets.

The TWSE is an ideal market that qualifies for this analysis for several reasons. First, the advanced information and communication technology industries in Taiwan have kept Taiwan on foreign investors' radar screen as one of their favorite hot money destinations. In fact, Taiwan produces over ninety percent of the world's motherboards and notebook PCs. According to Hsu (2013) and Hsu and Huang (2010), when Taiwan fully opened its stock market in the early 2000s, a significant amount of foreign capital flooded into Taiwan. As of July 2007, the value of foreign investment on TWSE had risen to more than 600 percent of its original level, while during the same period the entire Taiwan stock market aggregation value had only doubled. Second, with significant foreign exchange reserves, Taiwan stabilized its currency exchange rates, letting them fluctuated within 10 percent over the period studied. Such low variations in exchange rates made the current analysis less disturbed by exchange rate fluctuations. Third, as China's economy grows, and Taiwan opens its domestic companies to invest in China, China has become the top trading partner of Taiwan. According to globalEDGE™, China supplanted the U.S. as Taiwan's top trading partner in 2003. As of 2012, China accounts for 27.1 percent of the total international trade of Taiwan and the Greater China Region (China and Hong Kong) accounts for 40 percent of Taiwan's entire international trade.

This study intends to use the time varying GARCH-EVT-Copula model to investigate how external factors, such as foreign portfolio investment and market movements from a country's major trading partners, affect the returns of an emerging stock market. There are three steps involved in the setting of the time-varying GARCH-EVT-Copula modeling. First, the GARCH model is adopted to filter the original time series data to extract the independent and identically distributed (iid) random variables to fulfill the requirements of the extreme value theory (EVT). Second, the semi-parametric approach is applied to model the return distributions of the data, in which the center of the distribution is modeled by non-parametric empirical distribution and the tails are modeled with the EVT as the fat tail phenomena are commonly observed in financial data. Third, the Student t, the Gumbel, and the Clayton copula models are adopted to evaluate dependencies in general terms, upper tails and lower tails, respectively. In this article, two sets of time varying dependencies between October 2003 and December 2010 were analyzed. The first set is the time varying dependencies between the changes of the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) and the changes of foreign portfolio investment volume; the second set is the time varying dependencies between the changes of TAIEX and the changes of the China A-Shares market aggregation index. The empirical findings suggest that TWSE and foreign portfolio investment have positive and increasing dependencies after the market fully opened in 2003 but dropped during the financial crisis period and remained comparatively low between 2008 and 2010. The dependencies between the TWSE and the China A-Share indices, however, demonstrate a persistent upward trend regardless the states of the economy. The remainder of this paper is organized as follows. Section 2 reviews the literature. Section 3 describes the empirical models. Section 4 presents the data used. The main empirical results are reported in Section 5. Section 6 summarizes the study and offers conclusions.

LITERATURE REVIEW

In this section, two strands of literature regarding Taiwan Stock Exchange (TWSE) will be reviewed: (1) foreign portfolio investment, and (2) the equity market integration among trading partners.

Foreign Portfolio Investment

The issue of how foreign investments affect the TWSE has been widely studied in the literature. Earlier studies, such as that of Lin and Shiu (2003), tended to focus on foreign investors' investment preference and investment strategies. Their research investigated foreign investors' investment preference between 1996 and 2000 and suggested that due to informational asymmetry, foreign investors seem to prefer to invest in firms with certain characteristics, such as large size, low book-to-market ratios, high export ratios, and high beta. Lin and Swanson (2003) examined foreign investors' trading behavior and investment performance with 60 large-size firms listed on the TWSE. The empirical results indicated foreign investors utilized momentum strategies of buying past winners and selling past losers. After the TWSE was fully opened in 2003, the emphasis in the literature turned to the relationship between trading volume and market volatilities. Lin, Lee, and Chiu (2009) analyzed how foreign investors' expected and unexpected trading

behaviors affected return volatilities in the TWSE during structural change periods using the AutoRegressive Jump Intensity (ARJI) model introduced by Chan and Maheu (2002). This study revealed that foreign investment tends to stabilize as the foreign ownership limitation was gradually abolished.

Since the financial crisis of 2008, the focus of research moved into the investigation of the intensity of cross-market linkages and how foreign investors' trading behaviors affected the riskiness of emerging stock markets. Hsu, Huang, and Ntoko (2013) studied foreign investment behaviors by adopting the GARCH-EVT-Copula approach to estimate the 1 percent VaR on stocks that are most-favored by foreign investors and stocks that are least-favored by foreign investors. The empirical results concluded that compared to the foreign least-favored stocks, the foreign most-favored stocks demonstrated lower 1 percent VaRs but higher maximum losses, indicating that the foreign most-favored stocks may not be riskier but could cause disaster in extreme events. Lien, Tseng, and Wu (2013) studied the impact of financial liberalization on the TWSE and indicated that the gradual opening of the stock market let Taiwan benefit from foreign capital and protect it from the damages of the 1997 Asian financial crisis. The same study also concluded that foreign investment contributed to a significant amount of the growth of the TWSE and helped it stabilize. Liao, Chou, and Chiu (2013) investigated trading behavior of foreign institutional investors and suggested that the trading decisions of foreign institutional investors exhibit a cognitive bias-anchoring effect. Furthermore, this study indicated that foreign investors' momentum strategies are influenced by the consequence of prior ownership.

Equity Market Integration among Trading Partners

From the point of seeking international diversification, investors should not invest in the markets that show a high degree of dependence or are cointegrated with each other. Some studies were devoted to the analysis of the movements between Taiwan's equity market and the equity markets of Taiwan's major trading partners. For example, Chang and Nieh (2001) adopted the cointegration analysis to study the equity market transmission between the Taiwan market and the stock markets from its trading partners and concluded that markets are cointegrated, and that the counties in the region tend to exhibit greater influence than the countries not in the region. Johansson and Ljungwall (2009) employed the MGARCH model to examine the spillover effects among China, Taiwan and Hong Kong. The empirical results demonstrated that there was no long-run relationship among the three markets, and the three markets tended to be independent from one another. However, in the short run, evidence showed that the mean spillover effect of Taiwan spills over to China and Hong Kong, and Taiwan is affected by the volatility spillover effect from Hong Kong, indicating the three markets are related to one another. Chiou, Hsu, and Huang (2013) revealed that due to the intensive trading and direct investment among the countries in the Greater China Region, local investors would be better off to diversify their portfolios by including assets from other regions.

Although existing studies have investigated the impacts of foreign investment on the Taiwan Stock Exchange or the dependence between the Taiwan Stock Exchange and its major trading partners, these studies tended to adopt static models to estimate the relationships between assets or indices, while it is widely accepted that time-varying models are more suitable in describing the dynamics among the assets returns. To fill this gap, this study applied the time varying GARCH-EVT-Copula models to capture (1) the dynamic dependencies between the changes of the TAIEX and the changes of foreign portfolio investment volume, and (2) the time varying dependencies between the changes of TAIEX and the changes of the China A-Shares market aggregation index. The results of this study will have important implications for both policymakers and investors in the region.

METHODOLOGY

Let the daily return for the index i on date t, denoted as $r_{i,t}$. The continuously compounded change of the index i from date $t-1$ to date t can be calculated as

$r_{i,t} = LN\left(\frac{I_{i,t}}{I_{i,t-1,}}\right)$.

This study adopted the GARCH-EVT-Copula framework suggested by Hsu, Huang, and Chiou (2012) along with the rolling window approach introduced by Hsu, Huang and Ntoko (2013) to capture the time varying dependencies. For each index or data series, the data from t_1 to t_{250} are used to estimate the dependence on t_{250}, t_2 to t_{251} are gathered to estimate the dependence on t_{251}, and t_3 to t_{252} are adopted to form the dependence on t_{252}, and so on. Therefore, with the rolling window approach, a sequence of time varying dependencies was derived.

The Garch Application

The literature has documented that asset returns usually exhibit the fat-tailed distribution. To better fit the return data, it is essential to incorporate the Extreme Value Theory (EVT) to estimate the tail distributions. However, EVT treatment requires data to be independent and identically distributed (iid) random variables, which have seldom been observed empirically in return series. To cope with this problem, the GARCH (1,1) model is applied to filter the original data to extract the independent and identically distributed (iid) random variables. According to Hsu, Huang, and Chiou (2012), a standard GARCH model can be defined as:

$$r_{i,t} = \mu_i + \varepsilon_{i,t} \quad (1)$$

$$\varepsilon_{i,t} = z_{i,t}\sigma_{i,t} \quad (2)$$

$$z_{i,t} \sim iid, f[E(z_{i,t}) = 0 \; and \; V(z_{i,t}) = 0] \quad (3)$$

, and $\sigma_{i,t}^2 = \omega + \eta_i \varepsilon_{i,t-1}^2 + \tau_i \sigma_{t-1}^2$ (4)

, where $\omega > 0$, $1 \geq \eta \geq 0$, $1 \geq \tau \geq 0$, and $\eta + \tau < 1$. Given the information on date $t-1$, μ_i denotes the conditional expected return and $\sigma_{i,t}$ stands for the conditional volatility of return i on date t. The extracted independent, identically distributed sequence, $z_{i,t}$, follows the Gaussian distribution, and $f(.)$ is the density function of $z_{i,t}$.

Extreme Value Theory (EVT)

After the original data are extracted to become iid variables, a semi-parametric approach is then used to model the return distributions. Thus, the center of the distribution is modeled with the empirical distribution and the tails are modeled with generalized Pareto. The marginal distribution of Z_i can be expressed as follows:

$$F_i(\hat{z}_\iota) = \begin{cases} \frac{k_l}{n}\left[\hat{\xi}_\iota^l \frac{v_i^l - z_i}{\beta_i^l}\right]^{\frac{-1}{\xi_i^l}}, for\ z_i < v_i^l \\ \varphi(\hat{z}_\iota), for\ v_i^l < z_i < v_i^r \\ 1 - \frac{k_r}{n}\left[\hat{\xi}_\iota^r \frac{z_i - v_i^r}{\beta_i^r}\right]^{\frac{-1}{\xi_i^r}}, for\ z_i > v_i^r \end{cases} \quad (5)$$

, where l and r represent the lower and upper tails, respectively. Also, n is the number of observations and k represents the number of observations beyond threshold v. This study defines the upper and the lower 5 percent of the data as the extreme values as suggested by Neftci (2000). Therefore, the first equation describes the marginal distribution of the data below the 5th percentile; the second equation is the marginal

distribution of the central part, representing the data from the 5th percentile to the 95th percentile; and the third equation models the marginal distribution of the data above the 95th percentile. Also, β is the scale parameter and ξ is the shape parameter. When $\xi>0$, a fat tail is observed, when $\xi = 0$, a thin tail is resulted and when $\xi<0$, the tail is finite (truncated tail).

Copulas

A bivariate copula *C* is a function that connects two univariate marginal distributions into a multivariate distribution function. According to Sklar (1959), as long as the two marginal distribution functions are continuous, a unique copula exists. The flexibility of copula modeling comes from the copulas being measured independently from marginal distributions. Therefore, neither the marginal distributions nor the copulas are restricted by certain assumptions. Such high flexibility makes the copula functions popular in modeling dependencies between asset returns. According Cherubini, Luciano, and Vecchiato (2004), McNeil, Frey, and Embrechts (2005), and Nelsen (2006), the derivation of a copula model can be illustrated as follows. In a bivariate case, let F be an 2-dimensional joint distribution function, and let $Z= (z_1, z_2)^T$ be a vector of two random variables with marginal distributions F_1 and F_2 and a joint distribution function:

$$F_{1,2}(z_1, z_2) = p(Z_1 \leq z_1, Z_2 \leq z_2), \text{for all } z_1, z_2 \in \mathbb{R}^n \quad (6)$$

By Sklar Theorem, as long as the marginal distributions F_1 and F_2 are continuous, there will be a unique copula *C* which is a bivariate distribution function with all uniform (0,1) marginal distributions. That is,

$$F(z_1, z_2) = C\left(F_1(z_1), F_2(z_2)\right) \quad (7)$$

In this study, three copula functions are adopted to examine the dependence between the indices: the t copula, the Gumbel copula and the Clayton copula.

The t Copula

The t copula is derived from the t distribution, which defines the data with symmetric fatter tails. It calibrates dependencies for both the distribution center and the tails. The bivariate t copula is defined as:

$$C^t_{v,\Omega}\left(F_1(z_{1,t}), F_2(z_{2,t})\right) = t_{v,\Omega}\left(t_v^{-1}(z_{1,t}), t_v^{-1}(z_{2,t})\right) \quad (8)$$

$$t_{v,\Omega}\left(t_v^{-1}(z_{1,t}), t_v^{-1}(z_{2,t})\right) = \int_{-\infty}^{t_v^{-1}(z_1)} \int_{-\infty}^{t_v^{-1}(z_2)} \frac{\Gamma\left(\frac{\upsilon+2}{2}\right)\frac{1}{\sqrt{|\Omega|}}}{\Gamma\left(\frac{\upsilon}{2}\right)(\upsilon\pi)} \left(1 + \frac{1}{v} z^T \Omega^{-1} z\right)^{-\frac{v+2}{2}} dz_1 dz_2$$

, where $t_{v,\Omega}$ represents the bivariate joint t distribution, $t_v^{-1}$is the inverse of the distribution of a univariate t distribution, and v is the degrees of freedom. The correlation coefficients exist when $v>2$ and Ω is the correlation coefficient matrix. By defining $\rho = \left(t_v^{-1}(z_{1,t}), t_v^{-1}(z_{2,t})\right)$, Ω can be estimated using the maximum likelihood estimation (MLE) method.

The Gumbel Copula

The Gumbel copula is applied in estimating upper tail dependencies. According to Embrechts, Frey, and McNeil (2005), the Gumbel copula can be defined as:

$$c(z_1, z_2) = \exp\left\{\{-[(-\ln(z_1)^\delta) + (-\ln(z_2)^\delta)]^{\frac{1}{\delta}}\right\}, \delta \geq 1 \quad (9)$$

The dependence between z_1 and z_2 are presented in the value of δ. When $\delta=1$, there is no upper tail dependence between z_1 and z_2. When δ increases, the upper tail dependence between z_1 and z_2 increases. When δ approaches its maximum, the upper tail dependence between z_1 and z_2 will be the perfect upper tail dependence. To provide a better judgment of δ, empirical work tends to normalize δ with the following equation: $\lambda_g = 2 - 2^{\frac{1}{\delta}}$.

The Clayton Copula

The lower tail dependence can be estimated by the Clayton copula. The mathematical form of the Clayton copula is defined as:

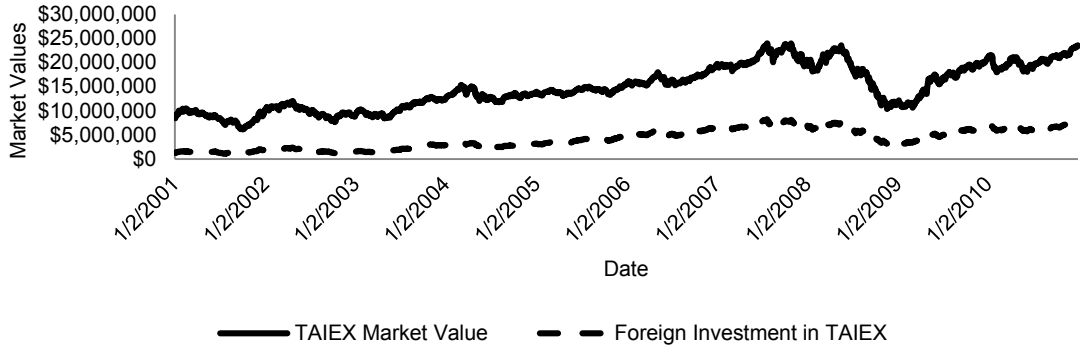
$$c(z_1, z_2) = \max\left[\left({z_1}^{-\delta} + {z_2}^{-\delta} - 1\right)^{\frac{-1}{\delta}}, 0\right], 0 < \delta \leq \infty \quad (10)$$

Like the Gumbel copula, the Clayton copula presents the estimation of the dependence between z_1 and z_2 with δ. When $\delta=0$, there is no lower tail dependence between z_1 and z_2. When δ is increases, the lower tail dependence between z_1 and z_2 increases. When δ approaches its maximum, the lower tail dependence between z_1 and z_2 will be the perfect lower tail dependence. The δ can be normalized through the following equation: $\lambda_c = 2^{\frac{1}{\delta}}$.

DATA

The data used in this study were the daily Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX), the daily China A-Shares index and the daily foreign investment value in TAIEX. The data of TAIEX and the daily foreign investment value in TAIEX were retrieved from Taiwan Economic Journal (TEJ), a database providing the data for the major financial markets in Asia. TAIEX, with the base value set at 100 as of 1966, covers all listed stocks on TWSE. China A-Shares index daily data were downloaded from Morgan Stanley Capital International Inc. (MSCI). It is one of the most widely quoted Asian market indices. The market value of TAIEX, on December 31, 2010, was 786 billion USD. Figure 1 presents the market value of TAIEX and the amount of foreign investment in TAIEX from January 2001 to December 2010. The unit for both series is millions of New Taiwan Dollar. Figure 2 presents the standardized market values of TAIEX and the foreign investment in TAIEX, with the base set at January 2, 2001. As presented in Figure 1 and Figure 2, foreign investment has increased significantly since 2003 and reached a peak in 2007, at more than 600 percent of the January 2, 2001 value. During the same period, however, the total market value of the TAIEX had increased less than three-fold of its original value of January 2, 2001.

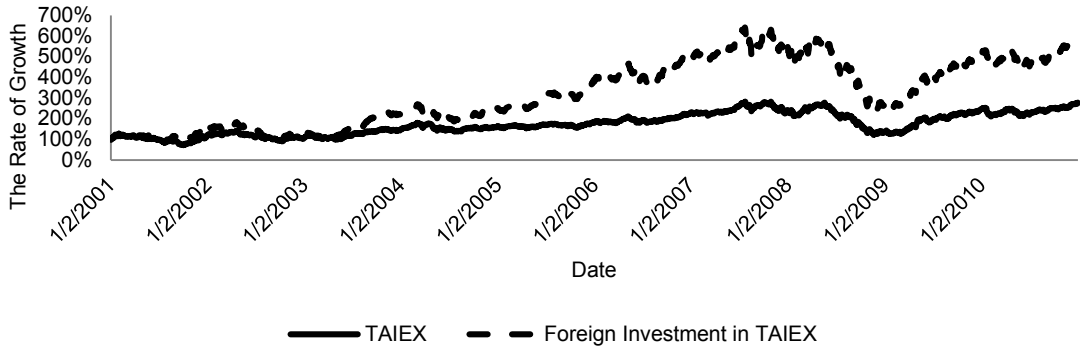
Figure 1: The Market Values of the TAIEX and the Foreign Investment in TAIEX



TAIEX, with the base value set at 100 as of 1966, covers all the listed stocks on TWSE. The unit of both series is in millions of the New Taiwan Dollar.

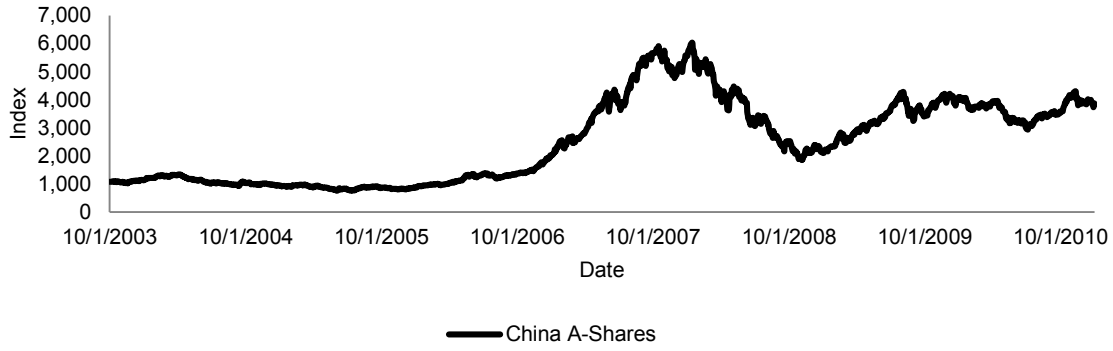
Both TAIEX and foreign investment values went down in 2008 due to the occurrence of the subprime financial crisis and increased again in 2009 as the market rebounded. Figure 3 demonstrates the path of China A-Shares index for the period 2003 – 2010. According to Figure 3, China A-Shares didn't move very much until late 2006. The index value rose sharply between mid-2006 to mid-2007. It went down in 2008 and rebounded in 2009.

Figure 2: The Growth of the Market Values in TAIEX and Foreign Investment



This figure presents the standardized market values of TAIEX and the foreign investment in TAIEX, with the base set as of January 2nd, 2001.

Figure 3: The China A-Shares Index from 2003 – 2010



China A-Shares didn't move very much until late 2006. The index value rose sharply between mid-2006 to mid-2007. It went down in 2008 and rebounded in 2009.

In this study, the daily data from October 2, 2003 to December 31, 2010 were studied. The summary statistics of the daily return series of the TAIEX index, the China A-Share index, and the daily change of foreign investment volume are reported in Table 1. The high kurtosis and non-zero skewness of the data along with the results from the Jerque-Bera (JB) test indicate that the data are not normally distributed, which provides the justification for adopting the GARCH-EVT-Copula models, as discussed in Section 3 of this paper, in evaluating assets dependencies.

Table 1: the Summary Statistics of the Daily Returns of TAIEX Index and China A-Shares, and the Daily Change of Foreign Investment Volume in TAIEX

	TAIEX	China A-Shares	Foreign Investment in TAIEX
Mean (%)	0.0494	0.0852	0.0718
Std. Dev.	0.0142	0.0187	0.0155
Skewnes	-0.1445	-0.2538	-0.2722
Kurtosis	7.3338	5.8632	5.3608
Jarque-Bera (p-value)	0.0000***	0.0000***	0.0000***

*TAIEX represents Taiwan Stock Exchange Capitalization Weighted Stock Index. ***, **, and * indicate significance of JB Test at the 1%, 5% and 10% levels, respectively.*

EMPIRICAL RESULTS

Adopting the rolling window technique, 250 observations prior to time *t* were used to estimate the dependence for time *t*. In this paper, over 1500 dependencies for each copula model were derived. Since it is difficult to illustrate the 1500+ daily dependencies for each model in the paper, Table 2 presents the dependencies between the TAIEX and the foreign investment volume in TAIEX in the monthly frequency instead. Figure 4 graphs the daily dependencies between the TAIEX and the foreign investment volume in TAIEX. According to Table 2 and Figure 4, the dependencies between the TAIEX and the foreign investment increased from 2004 to the middle of 2007. It then dropped sharply in 2008 and the dependencies stayed low between 2008 and 2010. The empirical results from t copula revealed that TAIEX tended to move in a similar direction with foreign portfolio investment prior to the financial crisis in 2008. However, during the financial crisis period, the impact from foreign investment was weakened. According to Table 2, the results from Gumbel and Clayton copulas, which are the measures of tail dependence, show that upper tail dependencies are generally stronger than the lower tail dependencies, indicating the TAIEX and foreign investment moved in similar directions on bull market days, but had different investment decisions on bear market days. Possible explanations behind the decreased dependencies during the bear market are the changes of the domestic investors' herding behaviors and government interventions, which are frequently observed in the emerging markets during a crisis period.

Table 2: the Dependencies between TAIEX and Foreign Investment in TAIEX

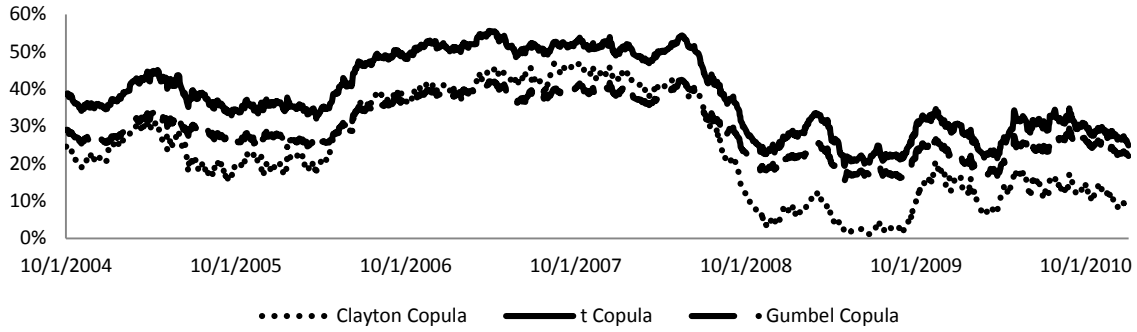
date	clayton copula	t copula	gumbel copula	date	clayton copula	t copula	gumbel copula
10/1/2004	0.2454	0.3861	0.2903	1/2/2008	0.4255	0.4941	0.3861
11/1/2004	0.1964	0.3473	0.2583	2/1/2008	0.4158	0.4939	0.3775
12/1/2004	0.2124	0.3487	0.2550	3/3/2008	0.3875	0.4733	0.3598
1/3/2005	0.2375	0.3567	0.2596	4/1/2008	0.4035	0.4980	0.3846
2/1/2005	0.2661	0.3907	0.2900	5/2/2008	0.4124	0.5216	0.4044
3/1/2005	0.3013	0.4285	0.3222	6/2/2008	0.3928	0.5098	0.3979
4/1/2005	0.3037	0.4453	0.3338	7/1/2008	0.3497	0.4498	0.3409
5/3/2005	0.2739	0.4300	0.3220	8/1/2008	0.2742	0.4073	0.3103
6/1/2005	0.2784	0.4340	0.3261	9/1/2008	0.2127	0.3741	0.2941
7/1/2005	0.2173	0.3886	0.3005	10/1/2008	0.1136	0.2869	0.2274
8/1/2005	0.1843	0.3730	0.2916	11/3/2008	0.0630	0.2455	0.1935
9/2/2005	0.2007	0.3569	0.2726	12/1/2008	0.0395	0.2298	0.1838
10/3/2005	0.1896	0.3416	0.2610	1/5/2009	0.0738	0.2787	0.2161
11/1/2005	0.2253	0.3531	0.2639	2/2/2009	0.0740	0.2851	0.2238
12/1/2005	0.1974	0.3656	0.2797	3/2/2009	0.1221	0.3347	0.2591
1/2/2006	0.2027	0.3626	0.2751	4/1/2009	0.0623	0.2767	0.2067
2/3/2006	0.2188	0.3535	0.2635	5/4/2009	0.0228	0.2090	0.1679
3/1/2006	0.2057	0.3462	0.2591	6/1/2009	0.0220	0.2166	0.1772
4/3/2006	0.2133	0.3502	0.2586	7/1/2009	0.0258	0.2256	0.1848
5/2/2006	0.2726	0.3863	0.2800	8/3/2009	0.0244	0.2182	0.1706
6/1/2006	0.2886	0.4120	0.3057	9/1/2009	0.0220	0.2130	0.1630
7/3/2006	0.3582	0.4635	0.3429	10/1/2009	0.1047	0.3030	0.2349
8/1/2006	0.3878	0.4913	0.3627	11/2/2009	0.1407	0.3137	0.2465
9/1/2006	0.3767	0.4843	0.3590	12/1/2009	0.1756	0.3150	0.2456
10/2/2006	0.3657	0.4817	0.3617	1/4/2010	0.1598	0.3008	0.2207
11/1/2006	0.4085	0.5142	0.3846	2/1/2010	0.1153	0.2554	0.1918
12/1/2006	0.4148	0.5263	0.3942	3/1/2010	0.0643	0.2236	0.1718
1/2/2007	0.3978	0.5055	0.3781	4/1/2010	0.1276	0.2556	0.1949
2/1/2007	0.3927	0.5191	0.3954	5/3/2010	0.1746	0.3259	0.2576
3/1/2007	0.3988	0.5208	0.3947	6/1/2010	0.1304	0.2935	0.2322
4/2/2007	0.4541	0.5546	0.4193	7/1/2010	0.1249	0.3049	0.2422
5/2/2007	0.4384	0.5344	0.4066	8/2/2010	0.1373	0.3199	0.2684
6/1/2007	0.4306	0.4968	0.3680	9/1/2010	0.1525	0.3224	0.2705
7/2/2007	0.4289	0.5201	0.3950	10/1/2010	0.1379	0.2987	0.2608
8/1/2007	0.4110	0.4918	0.3748	11/1/2010	0.1227	0.2887	0.2508
9/3/2007	0.4592	0.5257	0.3990	12/1/2010	0.0964	0.2763	0.2366
10/1/2007	0.4597	0.5237	0.4021				
11/1/2007	0.4418	0.5079	0.3908				
12/3/2007	0.4474	0.5279	0.4094				

The t copula calibrates dependencies for both the distribution center and the tails. The Gumbel copula is applied in estimating upper tail dependencies. The lower tail dependence is estimated by the Clayton copula.

Figure 5 illustrates dependencies between the TAIEX and China A-Shares. Table 3 demonstrates those dependencies in monthly frequency. Unlike dependencies between TAIEX and foreign investment in

TAIEX, which were volatile through time, dependencies between the TAIEX and China A-Shares demonstrated a persistent upward trend through time. Although there was a layback in 2009 as the financial crisis occurred, dependencies rebounded in 2010 and kept going up. In terms of tail dependencies, Table 3 shows upper tail dependencies seemed to be higher than lower tail dependencies during the period studied.

Figure 4: the Dependencies between the TAIEX and the Foreign Portfolio Investment Volume



The dependencies between the taiex and the foreign investment increased from 2004 to mid-2007. it then dropped sharply in 2008. the dependencies stayed low between 2008 and early 2010.

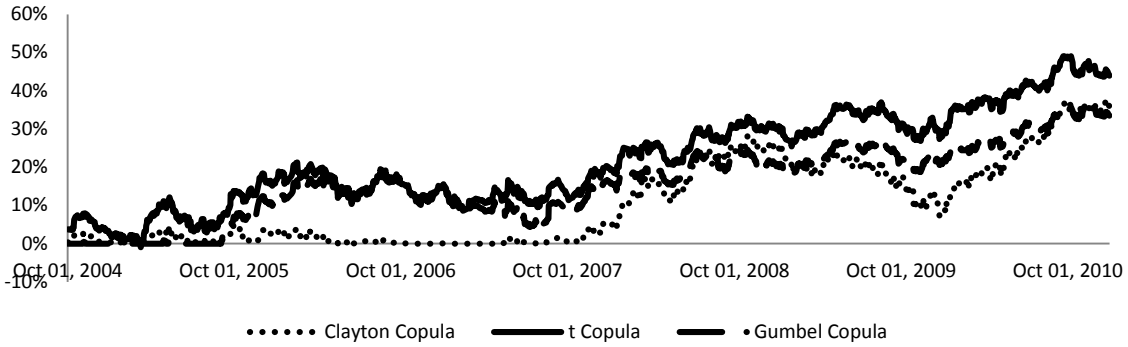
Table 3: the Dependencies between TAIEX and the China A-Shares

date	clayton copula	t copula	gumbel copula	date	clayton copula	t copula	gumbel copula
10/1/2004	0.0036	0.0373	0.0000	1/2/2008	0.0531	0.1966	0.1609
11/1/2004	0.0208	0.0686	0.0000	2/1/2008	0.1130	0.2508	0.1953
12/1/2004	0.0069	0.0463	0.0000	3/3/2008	0.1262	0.2437	0.1805
1/3/2005	0.0042	0.0262	0.0000	4/1/2008	0.1615	0.2498	0.1864
2/1/2005	0.0017	0.0033	0.0000	5/2/2008	0.1244	0.2201	0.1619
3/1/2005	0.0030	0.0203	0.0000	6/2/2008	0.1338	0.2119	0.1677
4/1/2005	0.0208	0.0731	0.0000	7/1/2008	0.2028	0.2740	0.2220
5/3/2005	0.0358	0.1095	0.0074	8/1/2008	0.2358	0.2932	0.2325
6/1/2005	0.0143	0.0662	0.0000	9/1/2008	0.2256	0.2670	0.1969
7/1/2005	0.0037	0.0403	0.0000	10/1/2008	0.2426	0.3032	0.2328
8/1/2005	0.0045	0.0293	0.0000	11/3/2008	0.2751	0.3262	0.2376
9/2/2005	0.0080	0.0592	0.0000	12/1/2008	0.2500	0.3042	0.2074
10/3/2005	0.0419	0.1337	0.0665	1/1/2009	0.2461	0.2998	0.2028
11/1/2005	0.0081	0.1349	0.0789	2/2/2009	0.2198	0.2668	0.1856
12/1/2005	0.0351	0.1834	0.1235	3/2/2009	0.1982	0.2879	0.2067
1/2/2006	0.0282	0.1671	0.1144	4/1/2009	0.1888	0.2959	0.2119
2/3/2006	0.0237	0.1774	0.1305	5/4/2009	0.2258	0.3386	0.2441
3/1/2006	0.0208	0.1829	0.1468	6/1/2009	0.2214	0.3567	0.2645
4/3/2006	0.0197	0.1871	0.1570	7/1/2009	0.2130	0.3385	0.2482
5/2/2006	0.0099	0.1786	0.1615	8/3/2009	0.1995	0.3503	0.2590
6/1/2006	0.0029	0.1356	0.1385	9/1/2009	0.1697	0.3348	0.2503
7/3/2006	0.0014	0.1323	0.1379	10/1/2009	0.1741	0.3130	0.2205
8/1/2006	0.0052	0.1604	0.1509	11/2/2009	0.1031	0.2713	0.1892
9/1/2006	0.0048	0.1720	0.1633	12/1/2009	0.1159	0.3121	0.2329
10/2/2006	0.0010	0.1557	0.1521	1/4/2010	0.0870	0.2945	0.2186
11/1/2006	0.0000	0.1221	0.1234	2/1/2010	0.1489	0.3499	0.2428
12/1/2006	0.0000	0.1219	0.1252	3/1/2010	0.1481	0.3443	0.2389
1/2/2007	0.0006	0.1552	0.1500	4/1/2010	0.2003	0.3799	0.2711
2/1/2007	0.0001	0.1155	0.1032	5/3/2010	0.2023	0.3680	0.2672
3/1/2007	0.0000	0.1035	0.0920	6/1/2010	0.2209	0.3870	0.2877
4/2/2007	0.0001	0.1089	0.0878	7/1/2010	0.2676	0.4270	0.3183
5/2/2007	0.0027	0.1347	0.1007	8/2/2010	0.2665	0.4065	0.2937
6/1/2007	0.0078	0.1441	0.0924	9/1/2010	0.3361	0.4610	0.3382
7/2/2007	0.0024	0.1135	0.0534	10/1/2010	0.3603	0.4842	0.3503
8/1/2007	0.0002	0.0984	0.0404	11/1/2010	0.3381	0.4430	0.3335
9/3/2007	0.0123	0.1570	0.1053	12/1/2010	0.3491	0.4501	0.3456
10/1/2007	0.0038	0.1235	0.0809				
11/1/2007	0.0074	0.1324	0.0985				
12/3/2007	0.0364	0.1874	0.1540				

The t copula calibrates dependencies for both the distribution center and the tails. The Gumbel copula is applied in estimating upper tail dependencies. The lower tail dependence is estimated by the Clayton copula.

In summary, both foreign investment in TAIEX and the China A-Shares acted as strong forces that affect the movement of TAIEX as a whole. However, the level of the influence from foreign investment has been volatile, whereas the impact from China A-Shares has been more consistent and became stronger as China and Taiwan tightened up their trading partnership. The topic regarding the effect of foreign investment in emerging markets has been heavily studied in the existing literature, for foreign investment has been thought as one of the major sources that create the disturbances in the emerging markets. In this current study, the empirical results provide some additional findings to support this argument. Moreover, the results from this study also indicate that the influential power from the stock market of the major trading partner is an important and persistent source of market mover that authorities should not neglect. Since foreign equity markets are out of the control of a local government, with the existence of the strong and persistent dependencies between the equity markets of the trading partners, a mechanism of close monitoring of the trading partner's equity market should be in place to prevent the avoidable impacts to the local market.

Figure 5: The Dependencies between the TAIEX and the China A-Shares



The dependencies between the TAIEX and the China A-Shares demonstrated a persistent upward trend throughout the time.

CONCLUSION

With small capitalization and a shallow market, emerging markets are known to be easily disturbed by exogenous factors. Foreign portfolio investment, or the hot money, is usual taken as the major external force that impacts the emerging markets. However, whether foreign portfolio investment exhibits a continuing influence on emerging markets has seldom been explored. With China's rising economic power in recent years, more attention needs to be paid to observe the interactions taken within the Greater China. This study adopts the TWSE as the sample emerging market to investigate how foreign portfolio investment and stock movements from an emerging market's top trading partner affect the local emerging stock market, and whether such impacts are consistent through time.

Using time varying GARCH-EVT-Copula models to estimate the dependence, the empirical results indicate that after Taiwan fully removed restrictions imposed on foreign investors, the dependencies between the TAIEX and the foreign portfolio investment increased. With abundant capital supply contributed by the foreign portfolio investment, the market value of TAIEX was pushed up. Also, the upward trend of the dependencies turned down during 2008-2009. It is interesting to note that the upper tail dependencies from the Gumbel copula are, in general, higher than the lower tail dependencies from the Clayton copula, indicating that the foreign portfolio investment is less influential in bear markets. In terms of the dependencies between TAIEX and China A-shares, according to the three models estimated, the dependencies tended to be stable and upward, even when the financial crisis occurred, indicating that the growing international trade between Taiwan and China has caused strong stock market linkage between the two countries. In summary, the movements from an emerging market's trading partner affect an emerging market's fluctuation more persistently than the impacts caused by the foreign portfolio investment.

There are several areas that merit further investigation. First, future research may focus on finding the determinants that lead the trading partners to have a persistent influence on the domestic stock market, even during periods of financial crisis. The potential factors to be considered include the stage of the economic development of both the host country and its major trading partners, the market scales in both countries, and the interdependence of industries between the countries. Second, the amount of foreign portfolio investment flowing into the local markets depends on the two countries' exchange rate stability, monetary policies, as well as the level of government interventions. Therefore, studies may look into how foreign portfolio investment reacts to the changes of these macroeconomic factors across business cycles.

REFERENCES

Chan W. H. and Maheu, J.M. (2002) "Conditional Jump Dynamics in Stock Market Returns," *Journal of Business and Economic Statistics*, Vol. 20, No. 3, 377-389.

Chang, T. and Nieh, C. (2001) "International Transmission of Stock Price Movements among Taiwan and Its Trading Partners: Hong Kong, Japan and the United States," *Review of Pacific Basin Financial Markets and Policies*, Vol.4, No. 4, 379-401.

Cherubini, U., Luciano, E., and Vecchiato, W. (2004) "*Copula Methods in Finance*." Wiley, Hoboken.

Chiou, W.J., Hsu, C. P., and Huang, C. W. (2013) "Development and International Diversification Benefits of Equity Markets in China, Hong Kong, and Taiwan," *Economic Integration across the Taiwan Strait Global Perspective*, 102-138, Edward Elgar.

Hsu, C. P., (2013) "The Influence of Foreign Portfolio Investment on Domestic Stock Returns: Experience from Taiwan," *International Journal of Business and Finance Research*, Vol. 7, No. 3, 1-11.

Hsu, C. P., and Huang, C. W. (2010) "How Foreign Portfolio Investment Affects Stock Markets in the Host Country: An Empirical Study of Taiwan," *The 2010 Proceedings of the Northeast Business & Economics Association*, October, 298-302.

Hsu, C. P., Huang, C. W., and Chiou, W. J. (2012) "Effectiveness of Copula-Extreme Value Theory in Estimating Value-at-Risk: Empirical Evidence from Asian Emerging Markets," *Review of Quantitative Finance and Accounting*, Vol. 39, 447-468.

Hsu, C. P., Huang, C.W., and Ntoko, A. (2013) "Does Foreign Investment Worsen the Domestic Stock Market during a financial Crisis? Evidence from Taiwan," *International Journal of Business and Finance Research*, Vol. 7, No. 4, 1-12.

Johansson, A.C., and Ljungwall, C. (2009) "Spillover Effects among the Greater China Stock Markets," *World Development*, Vol. 37, No. 4, 839–851.

Liao, L.C., Chou, R.Y., and Chiu, B. (2013) "Finance Anchoring Effect on Foreign Institutional Investors' Momentum Trading Behavior: Evidence from the Taiwan Stock Market," *North American Journal of Economics and Finance*, Vol. 26, 72- 91.

Lien, D., Tseng, M.C., and Wu, S. (2013) "Foreign Investors in Taiwan: Their Roles and Government Perspectives," *Business Horizons*, Vol. 56, No. 6, 749-756.

Lin, C. M., Lee, Y.H., and Chiu, C. L. (2009) "Structural Changes in Foreign Investors' Trading Behavior and the Corresponding Impact on Taiwan's Stock Market, " *Research in International Business and Finance*, Vol. 23, 78-89.

Lin, C. H. and Shiu, C. Y. (2003) "Foreign Ownership in the Taiwan Stock Market: An Empirical Analysis," *Journal of Multinational Financial Management*, Vol. 13, 19- 41.

Lin, A. Y., Swanson, P. (2003) "The Behavior and Performance of Foreign Investors in Emerging Equity Markets: Evidence from Taiwan," *International Review of Finance*, Vol. 4, 189–210.

McNeil, A. J., Frey, R. and Embrechts, P. (2005) "*Quantitative Risk Management: Concepts, Techniques, and Tools*," Princeton University Press, Princeton, NJ.

Neftci, S. (2000) "Value at Risk Calculations, Extreme Events, and Tail Estimation," *Journal of Derivatives*, 7, 23 - 38.

Nelsen, R. (2006) "*An Introduction to Copulas*." Springer-Verlag, New York.

Sklar, A. (1959) "Fonctions de répartition à n dimensions et leurs marges," *Publications de l'Institut de Statistique de L'Université de Paris* 8, 229–231.

ACKNOWLEDGMENTS

The author is grateful to the editor, Mercedes Jalbert, and two anonymous referees for helpful comments on an earlier version of this paper. The usual disclaimer applies.

BIOGRAPHY

Dr. Chin-Wen Huang is Assistant Professor of Finance at Western Connecticut State University. Her research appears in journals such as *Review of Quantitative Finance and Accounting*, *The International Journal of Business and Finance Research*, *American Journal of Business Education*, and *Empirical Economics Letters*. She can be reached at: The Department of Finance, Ancell School of Business, Western Connecticut State University, 181 White Street, Danbury, CT 06810. Email: huangc@wcsu.edu.