DOES FOREIGN INVESTMENT WORSEN THE DOMESTIC STOCK MARKET DURING A FINANCIAL CRISIS? EVIDENCE FROM TAIWAN

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ABSTRACT

Foreign portfolio investment is a major means by which emerging stock markets accumulate capital. However, the high mobility of foreign funds is a concern for local investors and policymakers in emerging countries because it may induce high stock price volatility. In this study, we utilized a risk-based approach to investigate whether the stocks most favored by foreign investors are riskier than those least favored by foreign investors. We distinguished our sample stocks into foreign most-favored and foreign least-favored groups and classified our data periods into a financial crisis period and an aftermath period. We then estimated the 1% VaRs and expected maximum losses through a GARCH–extreme value theory–copula methodology for the foreign most-favored and least-favored groups. The empirical results indicated that the foreign most-favored group had lower 1% VaRs than the foreign least-favored group during both the financial crisis and its aftermath. However, the foreign most-favored group had higher expected maximum losses than the foreign least-favored group. Thus, although stocks favored by foreign investors may not be riskier in general, investing in these stocks could still occasion disaster in an extreme event.

JEL: G01, G11, G15

KEYWORDS: Foreign Portfolio Investment; Multivariate Copula; GARCH; Extreme Value Theory

INTRODUCTION

Since the burgeoning epidemic of financial liberalization in the 1990s, foreign portfolio investment has become a major funding source for emerging stock markets. Although stock market openness can help emerging markets accumulate capital rapidly, the instability of foreign funds may be a serious concern for domestic investors and policymakers as the Asian financial crisis in 1997 has demonstrated how foreign portfolio investment can destroy a domestic stock market. Therefore, a risk-based approach to evaluating the impacts of foreign investment on the domestic stock market is essential. Previous studies have tended to investigate the impacts of foreign investment from the angle of stock market volatility (e.g. Holmes and Wong, 2001, Kassimatis, 2002, Huang, Lin, Yu, and Hoe, 2006, Kuo and Chen 2006, and Lai, Lou, Shiu, 2008). However, such studies addressed only whether foreign capital destabilizes the domestic stock market, but supplied no rigorous figures as to the extent of losses. We supply this gap by evaluating how foreign investment affects the domestic stock market, analyzing the 1% Value-at-Risk (VaR) and expected maximum losses through a GARCH–Extreme Value Theory (EVT)–Copula methodology.

Over the past two decades, due to the extraordinary trading losses of several financial institutions, a significant number of quantitative methodologies for evaluating investment risk have emerged. Of these, the Value-at-Risk (VaR) is one of the most well known. Introduced in 1994 when JP Morgan launched its RiskMetrics service, the VaR uses a simple number to demonstrate under a given level of

confidence, such as 95% or 99%, how the loss of a portfolio investment can worsen over a target horizon. Due to its ease of application, financial regulators (e.g. Basel I and II Accords) also use the VaR as the preferred benchmark for regulating capital requirements for financial institutions. The VaR can be estimated in several ways, such as through historical data or simulations. Traditionally, the VaR has been estimated based on an asset return normality distribution assumption. However, empirical studies have documented that most asset return distributions are fat-tailed. Recently, several techniques have been developed to handle asset return distributions beyond the leptokurtic. Among these, the GARCH–EVT–Copula VaR methodology is one of the latest and most powerful. According to Hsu, Huang and Chiou (2012), the GARCH–EVT–Copula setting for evaluating VaR is more accurate than the conventional Monte Carlo simulation methodology. Specifically, the GARCH–EVT–Copula VaR model combines three models: the GARCH, the extreme value theory (EVT), and the copula, and evaluates the portfolio VaR in four steps: First, the GARCH (1,1) model extracts independent and identically distributed (iid) random variables, to be applied in the extreme value theory (EVT). Second, we use the EVT to model return distribution tails. The fat tail appearance is commonly observed in finance return data. To precisely model the return distribution, we use a semi-parametric approach, in which the return distribution center is modeled via empirical distribution without parameter, and the distribution tails are modeled via the EVT generalized Pareto distribution with parameter. As studies by Ho, Burridge, Cadle, and Theobald (2000), Neftci (2000), Da Silva and Mendes (2003), Bali (2007), and Hsu, Huang, and Chiou (2012) have shown, EVT offers better estimations in modeling distribution tails. Third, we use the multivariate copula function to model dependences among return distributions. A benefit of using copula models is their flexibility. Copula models have relatively fewer restrictions and may be applied to any type of data distribution. Fourth, we use the copula dependence parameters to run copula simulations and to estimate VaRs and expected maximum losses.

In this study, we estimate the 1% VaR and the expected maximum loss of stocks listed on the Taiwan Stock Exchange (TWSE) using the GARCH–EVT–Copula model suggested by Hsu, Huang, and Chiou (2012). Since Taiwan fully opened its stock market at the end of 2000, foreign capital has accumulated tremendously in the TWSE. In early 2001, the aggregate market value of foreign investment was about 40 billion US dollars, while on November 3rd 2007, that figure had jumped up to around 240 billion US dollars, during a period in which the aggregate value of the entire TWSE had increased only 2.5 times. Due to specific preferences and asymmetric information, however, foreign investors tend to invest only in certain types of stocks—such as large firms and stocks with high book-to-market ratios, lower betas, higher weights in the MSCI, or lower rates of stock returns—rather than in the entire market (Lin and Swanson, 2003, Chen, Lin, Huang, and Wang, 2009, and Chao and Chen, 2012). To thoroughly examine the impact of foreign investors, we follow the classification by Hsu (2013) in selecting the 50 stocks with the highest foreign ownership as the foreign most-favored group and the 50 with the lowest foreign ownership as the foreign least-favored group, comparing their portfolio VaRs in both the financial crisis period (December 2007–June 2009) and its aftermath (July 2009–December 2011).

This study contributes to the literature by providing a VaR-based analysis of the impacts of foreign investment. Although the impact of foreign investment on domestic stock markets has been widely discussed in the literature, most studies have emphasized stock returns or volatilities, but none has probed the issue via the VaR. The recent financial crisis has raised concerns as to whether foreign investment worsens domestic stock markets during financial crisis. Our study applied the sophisticated GARCH–EVT–Copula model to evaluate the VaRs of the foreign most-favored and least-favored groups during both the financial crisis and its aftermath. The empirical results will help investors and policymakers understand whether foreign-favored stocks are riskier, especially during a financial crisis.

The empirical results indicate that the VaRs of the foreign most-favored group are smaller than those of the foreign least-favored group in both the financial crisis period and its aftermath, implying that foreign investment flows were relatively stable and did not shift away during the financial crisis period. However, the higher maximum expected losses in the foreign most-favored group also indicate that investors in those stocks may suffer more from extreme events. Therefore, domestic investors may do well to invest with caution in stocks belonging to the foreign most-favored group.

The remainder of this paper is organized as follows. The next section reviews the related literature. The third section describes the empirical models, and the fourth section presents the data used. The main empirical results are reported in the fifth section, while the sixth section summarizes the study and offers conclusions.

LITERATURE REVIEW

Whether foreign investment destabilizes a domestic stock market has been a subject widely discussed in the literature, but no consensus has emerged in that regard. Huang, Lin, Yu, and Hoe (2006) studied the volatility–volume relationship before and after the full liberalization of the TWSE and found that the unexpected volume of foreign investment was associated with a positive volatility–volume relationship during the full liberalization period. Lai, Lou, and Shiu (2008) employed the GJR–GARCH model to investigate the impact of foreign investors' trades on TWSE stock volatility between January 2000 and September 2006 and concluded that foreign investment improved the efficiency of the domestic stock market but also increased volatility because of the process of stock price adjustment. Chen, Huang, and Chen (2011) adopted the EGARCH process to investigate how foreign investors affected the TWSE after the removal of the ceiling on foreign ownership of stocks listed on the TWSE. They found that after the market was fully opened, stock price volatility in the electronics industry increased.

Although foreign investment has apparently tended to increase stock market volatility, several studies have argued the contrary. Using the asymmetric GARCH model, Holmes and Wong (2001) examined whether stock market volatility increased after stock market openness in South-East Asian countries and indicated that those markets had not been destabilized. Kassimatis (2003) studied the relationship between stock market volatility and financial liberalization in six emerging countries using the EGARCH model and indicated that volatility fell after market liberalization. Lin, Lee, and Chiu (2010) employed the AutoRegressive Jump Intensity (ARJI) model to examine how foreign investors impacted the TWSE and demonstrated that foreign investment did not destabilize the TWSE after its full liberalization. Hsu and Huang (2010) utilized the GJE–GARCH model to examine how foreign investment affected stock market volatility in 21 industries of the TWSE and disclosed that in general, foreign investment tended to stabilize the TWSE after full stock market openness.

Some studies have emphasized foreign investors' investment preferences and trading strategies. Lin and Swanson (2003) studied 60 large firms listed on the TWSE and found that foreign investors preferred large-size, high book-to-market, and high-tech stocks and that those investors adopted momentum strategies. Chen, Lin, Huang and Wang (2009) investigated the investment preferences of foreign institutional investors across various industries in the Taiwanese stock market and concluded that company size was a key factor in foreign investors' investment preferences, and that those investors utilized momentum strategies in determining their investment preferences.

Although researchers have seemingly paid a great deal of attention to how foreign investment affects the TWSE, existing studies evince the following shortcomings: First, the current literature provides only a comparison of foreign investment impacts before and after full stock market openness. However, the recent financial crisis has raised concerns as to whether foreign investment worsens a

domestic stock market during a financial crisis, making study of this issue necessary. Second, according to Hsu (2013), most studies have investigated foreign investment impacts using the entirety of TWSE data. However, empirical data have supported that foreign investors invest only in stocks with certain characteristics, and not the entire market. Therefore, a study examining only the stocks most favored and least favored by foreign investors may be more appropriate in evaluating the impacts of foreign investment.

METHDOLOGY

The return of each stock is defined as the continuously compounded change of the closing price from date t-1 to date t. Mathematically this change can be presented as:

$$r_{i,t} = LN(\frac{p_{i,t}}{p_{i,t-1}}) \quad (1)$$

In this study, we adopt the GARCH–EVT–Copula model as suggested by Hsu, Huang and Chiou (2012) and Huang and Hsu (2012).

The GARCH Application

Since the conventional empirical distribution will not adequately grasp fat tail appearances, we plan to calibrate EVT to model the distribution tails. An important assumption of the EVT is that the data need to be independent and identically distributed (iid) random variables. To validate the EVT assumption, we employ the GARCH (1,1) model to filter the original return series and extract the iid data. The GARCH (1,1) model is presented as:

$$r_{i,t} = \mu_i + \varepsilon_{i,t} \quad (2)$$

$$\varepsilon_{i,t} = z_{i,t}\sigma_{i,t} \quad (3)$$

$$z_{i,t} \sim iid, f[E(z_{i,t}) = 0 \; and \; V(z_{i,t}) = 0] \quad (4)$$

, and $\sigma_{i,t}^2 = \omega + \eta_i \varepsilon_{i,t-1}^2 + \tau_i \sigma_{t-1}^2$ (5)

, where $r_{i,t}$ is the actual return from the sample, and the necessary conditions are that ω>0, 1≥η≥0, 1≥τ ≥ 0, and $\eta + \tau$ <1. Using information for the previous trading date, we can derive the conditional expected return μ_i and the conditional volatility $\sigma_{i,t}$, and extract the independent, identically distributed sequence $z_{i,t}$.

Extreme Value Theory (EVT)

Due to the fat-tailed appearance of return distributions, the conventional approach of using an empirical distribution to model return data may be inappropriate. In this study, we use a semi-parametric approach to model the return distribution. This methodology employs a non-parametric empirical distribution to model the center of the return distribution and a parametric generalized Pareto distribution from extreme value theory to model the distribution tails. Thus, the marginal distribution of Z_i is defined as follows, with the superscripts *l* and *r* denoting left and right tails:

$$F_i(\widehat{z_i}) = \begin{cases} \frac{k_l}{n}\left[\widehat{\xi_l^l}\frac{v_i^l - z_i}{\beta_i^l}\right]^{\frac{-1}{\xi_i^l}}, for\ z_i < v_i^l \\ \varphi(\widehat{z_i}), for\ v_i^l < z_i < v_i^r \\ 1 - \frac{k_r}{n}\left[\widehat{\xi_l^r}\frac{z_i - v_i^r}{\beta_i^r}\right]^{\frac{-1}{\xi_i^r}}, for\ z_i > v_i^r \end{cases} \quad (6)$$

, where β is the scale parameter, and ξ is the shape parameter, indicating that the distribution has a truncated tail when $\xi<0$; the distribution has a thin tail when $\xi = 0$, and the distribution has a fat tail when $\xi>0$. n is the number of observations, and k represents the number of observations beyond threshold v. Selecting an appropriate threshold v is important as it represents a trade-off between bias and variance. In this study, we set the v at 5% for both upper and lower tails as suggested by Neftci (2000).

Copulas

A copula function is a joint distribution that links univariate marginal distribution functions of asset returns into a multivariate distribution function. Based on Sklar's theorem, as long as marginal distribution functions are continuous, a unique copula exists. A benefit of using copula functions is that they have few assumptions and restrictions. This flexibility has given rise to the broad application of copula functions in the field of finance.

The general term of the copula function can be derived as follows. Let F be an n-dimensional joint distribution function, and $Z= (z_1, z_2, ..., z_n)^T$ be a vector of n random variables with marginal distributions $F_1, F_2,\ldots, Fn$, in which case a joint distribution function is defined as(see Cherubini, Luciano, and Vecchiato, 2004, and Nelsen, 2006, for detailed derivations):
:

$$F_{1,2,\ldots,n}(z_1, z_2, \ldots, z_n) = p(Z_1 \le z_1, Z_2 \le z_2, \ldots, Z_n \le z_n), \text{for all } z_1, z_2, \ldots, z_n \in \mathbb{R}^n \quad (7)$$

According to Sklar's (1959) theorem, as long as the marginal distributions F1, F2, …, Fn are continuous, there will be a unique copula C as follows:

$$F(z_1, z_2, \ldots, z_n) = C\big(F_1(z_1), F_2(z_2), \ldots, F_n(z_n)\big) \quad (8)$$

In this study, we specify two popular copula functions: the Gaussian copula and the t copula.

Gaussian Copula

Due to its easily application, the Gaussian copula is the most popular copula function in the copula family. Mathematically, the multivariate Gaussian copula can be written as:

$$C\left(F_1(z_{1,t}), F_2(z_{2,t}), \ldots, F_n(z_{n,t})\right) = \Phi_\Omega\left(\Phi^{-1}(z_{1,t}), \Phi^{-1}(z_{2,t}), \ldots \Phi^{-1}(z_{n,t})\right) \quad (9)$$

$$\Phi_\Omega\left(\Phi^{-1}(z_{1,t}), \Phi^{-1}(z_{2,t}), \ldots \Phi^{-1}(z_{n,t})\right) = \frac{\frac{1}{\sqrt{2\pi^n \Omega}}\exp\left(\frac{-1}{2}Z^T\Omega^{-1}Z\right)}{\prod_{j=1}^n \frac{1}{\sqrt{2\pi}}\exp\left(\frac{-1}{2}z_j^2\right)} \quad (10)$$

, where Φ denotes a univariate standard normal distribution function, Φ_Ω is the joint distribution of the multivariate standard normal distribution functions, and Ω is the correlation coefficient matrix. The Ω is estimated via the maximum likelihood estimation (MLE) method as $\widehat{\Omega} = \frac{1}{T}\sum_{t=1}^T \rho_t \rho_t'$.

t Copula

The t copula is based on the t distribution, which is symmetric for fatter tails but shorter than the standard normal distribution. The multivariate t copula describes dependences that include both distribution center and tails. It is defined as:

$$C^{t}_{v,\Omega}\left(F_1(z_{1,t}), F_2(z_{2,t}), \dots, F_n(z_{n,t})\right) = t_{v,\Omega}\left(t_v^{-1}(z_{1,t}), t_v^{-1}(z_{2,t}) \dots, t_v^{-1}(z_{n,t})\right) \quad (11)$$

$$t_{v,\Omega}\left(t_v^{-1}(z_{1,t}), t_v^{-1}(z_{2,t}) \dots, t_v^{-1}(z_{n,t})\right) = \int_{-\infty}^{t_v^{-1}(z_1)} \int_{-\infty}^{t_v^{-1}(z_2)} \dots \int_{-\infty}^{t_v^{-1}(z_n)} \frac{\Gamma\left(\frac{v+n}{2}\right)\frac{1}{\sqrt{|\Omega|}}}{\Gamma\left(\frac{v}{2}\right)(v\pi)^{\frac{n}{2}}}\left(1+\frac{1}{v}z^{T}\Omega^{-1}z\right)^{-\frac{v+n}{2}} dz_1 dz_2 \dots dz_n \quad (12)$$

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

$$\widehat{\Omega} = (cov(Z) - \frac{2v^2}{(v-2)^2(v-4)}\hat{\rho}\hat{\rho}')\frac{v-2}{2} \quad (13)$$

The Value-at-Risk (VaR) model

The VaR is a risk assessment technique that provides information concerning the likelihood of expected losses over a target horizon at a given level of confidence β. Mathematically, the VaR can be defined as:

$$VaR(r_p)_\beta^h = inf\{r_p \in R | P(L \leq \widehat{VaR}) = \alpha\} \quad (14)$$

, where L is a sequence number, $r_{p,t}$, $r_{p,t-1}$, $r_{p,t-2}$, $r_{p,t-3}$, …$r_{p,t-h}$, denoting the portfolio return at times *t*, *t*-1, *t*-2, ..., *t*-*h*, respectively; α is a small percentage close to 0 (usually 1% or 5%); and *h* is the target horizon as the differential period between time *t* and time *t*+*h*. In this study, we define the α as 1% and the target horizon, *h*, as 1 day. We adopt the above GARCH–EVT Gaussian copula and the GARCH–EVT-t copula methodologies to simulate 10,000 returns for every single date and estimate the 1% VaRs and the expected maximum losses accordingly.

DATA

The data studied in this paper are the daily returns of the 50 foreign most-favored and 50 foreign least-favored stocks traded on the TWSE for the period of December 3rd, 2007, to December 31st, 2011. Data were retrieved from the Taiwan Economic Journal (TEJ), a comprehensive financial database containing the detailed financial and corporate data for the major Asian markets. To examine how the two groups perform during different states of the economy, based on the report of the National Bureau of Economic Research (NBER), we split the full sample into two periods: a recession period from December 1st, 2007, to June 30th, 2009, and its aftermath, from July 1st, 2009, to December 31th, 2011.

Figure 1 illustrates the trends of the standardized aggregate market values of the foreign most-favored group, the foreign least-favored group, and the standardized TWSE aggregate capitalization over the sample period. As shown in Figure 1, the stocks least favored by foreign investors experienced a significant price slump during the recession period and a surge in prices during the expansion period.

The stocks most favored by foreign investors seemed to be rather slow in following changes similar to those of the TWSE. The volatility of the foreign least-favored group was higher than that of the foreign most-favored group.

Figure 1: The Trends of the Standardized Aggregate Market Values

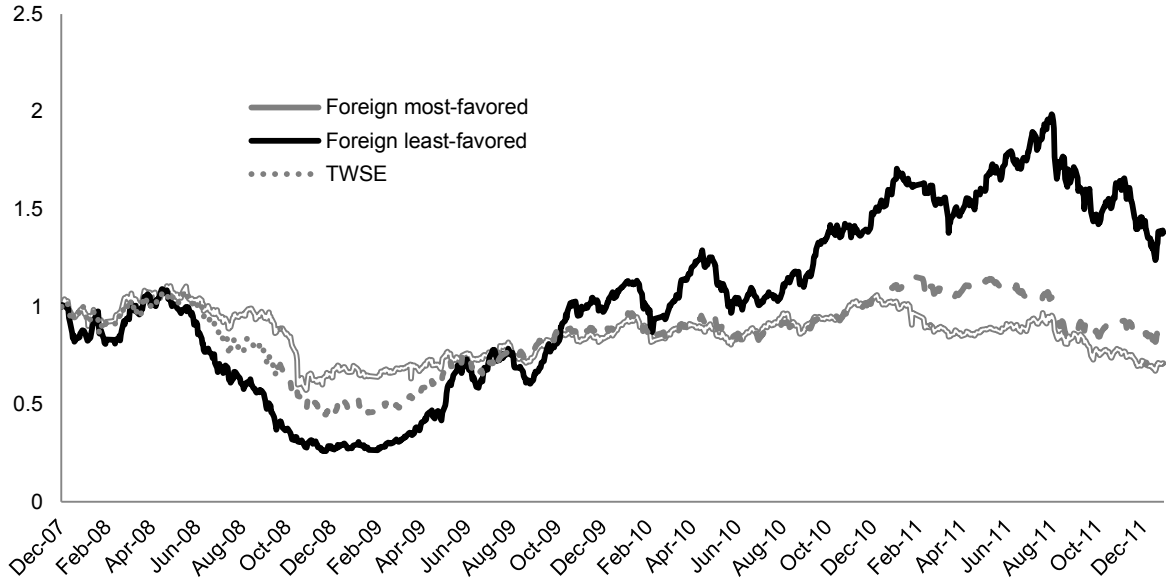

Table 1: The Compositions of Most-Favored and Least-Favored Portfolios

Most Favored Stocks		Least Favored Stocks	
Industry	**Number of Companies**	**Industry**	**Number of Companies**
Automobile	2	Banking and Securities	7
Biotech	1	Biotech	2
Cement	1	Chemicals	2
Construction	3	Construction	3
Electrical Appliances	2	Electrical Appliances	4
Electronics	17	Electronics	14
Entertainment	1	Glass and Ceramics	1
Financial Services	1	Information Services	1
Food	3	Machinery	2
Plastics	2	Natural Gas Utility	1
Retail	1	Networking	1
Rubber	2	Packaging & Container	1
Textile	11	Pulp and Paper	1
Wire and Cable	3	Retail	1
		Steel	1
		Textile	3
		Tourism	1
		Transportation	1
		Wire and Cable	3
Total	50		50

The compositions of industries in both groups are reported. Foreign investors tended to focus their investment in certain industries, such as electronics and related industries. The foreign least-favored group consisted of a relatively wide range of industries. The trends of the standardized aggregate values of the foreign most-favored group, the foreign least-favored group and the TWSE are presented. The values of all three groups dropped during the financial crisis period and rebounded in its aftermath. Of the three lines, that of the foreign most-favored group seems to follow a path most similar to that of the TWSE, while the pattern of the foreign least-favored group varies considerably.

Table 1 summarizes the nature of the industries of the stocks in each group. Based on the numbers reported in Table 1, foreign investors tended to focus their investment in certain industries, such as electronics and related industries. The foreign least-favored group consisted of a relatively wide range of industries. Table 2 provides a summary of the statistics.

Table 2: Summary Statistics

Foreign Favored Group						**Foreign Un-Favored Group**					
Stock Code	Mean (%)	Std Dev	Skewness	Kurtosis	J-B test p-value	Stock Code	Mean (%)	Std Dev	Skewness	Kurtosis	J-B test p-value
1440	-0.0015	0.0281	-0.0656	3.386	0.03**	1213	0.0046	0.0284	0.3206	3.732	0.00***
1445	0.0017	0.0214	0.1435	5.243	0.00***	1231	0.0132	0.0239	0.1235	4.518	0.00***
1473	0.0006	0.0199	0.3031	5.006	0.00***	1235	0.0024	0.0241	0.3251	5.154	0.00***
1513	-0.0030	0.0234	-0.1061	4.873	0.00***	1307	0.0064	0.0219	0.2481	4.560	0.00***
1527	-0.0045	0.0210	0.1984	5.749	0.00***	1321	-0.0007	0.0249	0.1074	4.562	0.00***
1530	-0.0040	0.0212	0.0297	5.299	0.00***	1418	-0.0003	0.0322	0.1216	3.082	0.25
1533	-0.0059	0.0286	0.1656	3.722	0.00***	1419	0.0057	0.0313	0.0445	3.200	0.36
1608	-0.0031	0.0239	-0.1831	4.663	0.00***	1423	-0.0021	0.0228	-0.2595	5.153	0.00***
1609	-0.0015	0.0219	-0.2913	4.998	0.00***	1444	0.0048	0.0279	0.0084	3.689	0.00***
1618	-0.0023	0.0294	0.1230	3.689	0.00***	1446	0.0025	0.0246	0.2205	4.768	0.00***
1713	-0.0012	0.0243	-0.0603	4.426	0.00***	1452	0.0015	0.0230	0.1230	4.882	0.00***
1726	0.0017	0.0151	-0.0917	8.005	0.00***	1454	0.0020	0.0220	0.0241	4.788	0.00***
1733	0.0011	0.0216	0.0109	5.200	0.00***	1456	-0.0077	0.0377	-0.0187	2.380	0.00***
1909	-0.0019	0.0212	0.0259	5.332	0.00***	1457	-0.0002	0.0263	0.1604	4.022	0.00***
2025	-0.0080	0.0310	0.0482	3.362	0.05*	1463	0.0028	0.0281	0.1517	3.779	0.00***
2340	-0.0084	0.0310	-0.0233	3.216	0.35	1467	-0.0041	0.0244	0.0008	4.754	0.00***
2353	-0.0039	0.0255	-0.0585	3.759	0.00***	1512	0.0005	0.0247	0.1815	4.352	0.00***
2355	-0.0014	0.0212	0.0341	5.165	0.00***	1526	-0.0020	0.0284	0.2238	3.970	0.00***
2362	0.0026	0.0291	0.0199	3.285	0.17	1611	0.0044	0.0259	0.1377	4.043	0.00***
2367	-0.0079	0.0305	-0.0671	3.206	0.28	1613	-0.0049	0.0278	0.1654	3.822	0.00***
2375	-0.0114	0.0326	0.0260	3.143	0.61	1616	-0.0082	0.0249	-0.1898	4.555	0.00***
2412	0.0049	0.0118	0.5308	9.203	0.00***	1734	-0.0004	0.0238	0.3325	4.808	0.00***
2428	0.0006	0.0249	0.0548	4.115	0.00***	2104	-0.0004	0.0238	-0.2012	4.716	0.00***
2430	0.0096	0.0272	0.0849	4.159	0.00***	2107	0.0023	0.0279	-0.1032	3.665	0.00***
2441	-0.0018	0.0219	-0.0279	5.210	0.00***	2201	0.0053	0.0294	0.0808	3.412	0.02**
2442	-0.0098	0.0334	0.1605	3.028	0.11	2206	-0.0019	0.0285	-0.0831	3.585	0.00***
2474	-0.0003	0.0329	-0.0872	2.916	0.45	2313	-0.0028	0.0321	0.0151	3.131	0.68
2488	-0.0064	0.0169	0.0697	6.700	0.00***	2314	-0.0100	0.0302	-0.0496	3.417	0.02**
2514	-0.0036	0.0268	0.0682	4.081	0.00***	2345	0.0000	0.0279	-0.1024	3.899	0.00***
2545	0.0041	0.0366	-0.0173	2.635	0.06*	2401	-0.0138	0.0287	-0.2593	3.525	0.00***
2606	-0.0032	0.0235	-0.0307	4.876	0.00***	2413	-0.0087	0.0301	0.0513	3.508	0.00***
2705	0.0012	0.0310	-0.0588	3.334	0.07*	2419	0.0031	0.0293	-0.0426	3.499	0.00***
2836	-0.0047	0.0248	0.0266	4.565	0.00***	2421	0.0063	0.0218	0.3956	4.812	0.00***
2837	-0.0121	0.0315	0.0653	3.378	0.03**	2427	0.0050	0.0289	0.1190	3.731	0.00***
2841	0.0011	0.0289	0.0601	3.497	0.00***	2457	0.0043	0.0294	-0.0976	3.430	0.00***
2845	-0.0010	0.0266	0.1294	3.969	0.00***	2458	-0.0085	0.0334	-0.1257	3.036	0.25
2849	-0.0015	0.0311	-0.0709	3.446	0.00***	2462	0.0062	0.0252	0.0454	4.103	0.00***
2851	-0.0001	0.0196	-0.0775	5.952	0.00***	2471	0.0049	0.0322	0.0129	3.220	0.35
2881	0.0036	0.0247	-0.0423	4.457	0.00***	2483	-0.0028	0.0217	0.1393	4.920	0.00***
3044	-0.0166	0.0326	0.0418	2.919	0.75	2489	-0.0394	0.0288	-0.0928	3.735	0.00***
4104	0.0056	0.0251	-0.0588	4.123	0.00***	2506	0.0277	0.0283	-0.0371	3.887	0.00***
5203	-0.0580	0.0230	0.1148	4.431	0.00***	2509	-0.0588	0.0323	-0.0991	3.180	0.22
5388	0.0333	0.0293	-0.0083	3.283	0.18	2537	0.0695	0.0313	0.0599	3.561	0.00***
9905	0.0846	0.0239	0.2028	4.527	0.00***	2901	0.0219	0.0218	0.3588	5.147	0.00***
9908	0.0335	0.0157	0.0951	7.270	0.00***	3027	-0.0714	0.0268	0.0728	3.885	0.00***
9914	0.0325	0.0207	-0.0721	5.244	0.00***	3035	-0.0791	0.0322	-0.1258	3.176	0.14
9924	0.0058	0.0185	0.3404	6.187	0.00***	3036	0.0506	0.0264	-0.0866	3.900	0.00***
9933	0.0810	0.0200	0.0069	5.340	0.00***	9930	0.0483	0.0147	-0.3029	8.418	0.00***
9934	0.0435	0.0249	0.0855	4.133	0.00***	9941	0.1113	0.0204	0.3031	5.447	0.00***
9937	0.0419	0.0164	0.2303	6.749	0.00***	9943	0.0601	0.0234	0.2071	4.614	0.00***

*Table 2 reports the mean, standard deviation (Std. Dev), skewness, kurtosis, and Jarque-Bera (J-B) test results for the daily returns from each stock in both the foreign most-favored and least-favored groups. The name of each stock is reported via its 4-digit TWSE stock code. The significance of the Jarque-Bera test results are presented using asterisks, where ***, **, and * indicate significance at the 1%, 5% and 10% levels respectively.*

As with most financial data, the returns of most stocks in the foreign most-favored and least-favored groups are not normally distributed. Their non-zero skewness and high kurtosis indicated that the return distribution tails tended to be fat, and the 0 p-value of the Jarque-Bera test results confirmed that the return distributions were beyond the leptokurtic. There were several exceptions in which the Jarque-Bera test failed to reject the normality of return distribution hypothesis. According to Hsu (2013), a possible explanation is the TWSE's 7% price movement constraint, which reduces the range of price movement and thus influences stock returns toward normal distribution.

Table 3 presents the average returns of the foreign most-favored and least-favored groups for the full sample period, the financial crisis period and its aftermath. In panel A, the daily average returns are reported, revealing that among the three periods, the foreign least-favored group consistently yielded the highest daily average return. For the full sample period, the foreign most-favored group shows a negative average return at -0.013%, while the foreign least-favored group has a positive average return at 0.004%. When we go deeper to compare the average returns during different economic states, we find that both groups get negative average returns during the financial crisis period and positive average returns during the aftermath.

Table 3: Average Returns and the Results of the Mann–Whitney U Test

	The Foreign Most-Favored group	The Foreign Least-Favored group
Panel A: Average Daily Returns		
Full Sample Period	0.0046% (0.0155)	-0.0123% (0.0156)
Expansion Period	-0.0235% (0.0189)	-0.0365% (0.0195)
Recession Period	0.0239% (0.0127)	0.00043% (0.0123)
Panel B: Average Annually Returns		
Full Sample	13.59% (0.3749)	8.00% (0.3601)
Expansion Period	-35.44% (0.2341)	-39.453% (0.2052)
Recession Period	26.82% (0.2696)	20.82% (0.2910)
***Panel C: The* Mann–Whitney U Test**		
	Test result	P-value
Full Sample	1	0.0004***
Expansion Period	1	0.017**
Recession Period	1	0.0000***

*The daily average returns, the annually average returns and the results of the Mann–Whitney U Test from the foreign most-favored and least-favored groups during the three different sample periods are presented, and the standard deviations are presented in the corresponding parenthesis . In Panel C, the Mann–Whitney U test are calculated based on the annualized returns, and the significance of the test results are presented using asterisks, where ***, **, and * indicate significance at the 1%, 5% and 10% levels respectively.*

To reduce disturbances caused by daily return volatility, we annualized the returns by adding up the daily returns using a 252-day rolling window (e.g. the annual return on date t_{252} is the summation of the daily returns from date t_1 to t_{252}, and the annual return on date t_{253} is the summation of the daily returns from date t_2 to t_{253}). The average annual returns from the two groups are reported in Panel B. The results show that the foreign least-favored group still consistently outperformed the foreign most-favored group.

To provide a statistically rigorous evaluation, we ran a Mann–Whitney U Test to examine whether the return series of the two groups were statistically different. The results, as reported in panel C, show that at a 5% significance level, the two return series in the three data periods are statistically different.

EMPIRICAL RESULTS

Table 4 reports the results of the VaRs for both the foreign most-favored and foreign least-favored groups over the full sample period, the financial crisis period and the aftermath period. These results indicate that for the financial crisis period, the 1% VaRs from both the Gaussian copula and the student t copula were higher than those from the two copulas during the aftermath period, meaning those stocks experienced significant price drops during the financial turmoil. In general the VaRs derived via the t-copula were higher than those derived via the Gaussian copula. Also, the maximum losses as estimated via the t-copula were higher than those estimated via the Gaussian copula. This difference arises from the fact that the t distribution produces fatter tails than the Gaussian distribution.

Between the foreign most-favored and least-favored groups, the 1% VaRs for the foreign most-favored group were 2.759% and 2.836% for the Gaussian and the t copulas respectively, while for the foreign least-favored group the figures were 2.944% and 3.058%, indicating that the foreign most-favored group was not riskier than the foreign least-favored group. During the financial crisis period, the foreign most-favored group seemed to be safer, as the 1% VaRs from the Gaussian and the t copulas were 3.118% and 3.119%, lower than the 3.344% and 3.420% of the foreign least-favored group. During the aftermath period, the VaRs of the foreign most-favored group were slightly higher, 2.775% from the Gaussian copula and 2.949% from the t copula, than those of the foreign least-favored group, at 2.717% from the Gaussian copula and 2.911% from the t copula. In terms of maximum losses, the foreign most-favored group had higher figures than the foreign least-favored group during the full sample, financial crisis and aftermath periods. To sum up, the results show that although the foreign most-favored group seemed to have lower VaRs, its higher maximum losses indicate that its stock returns tended to have higher volatility and longer distribution tails. Therefore, domestic investors investing in the foreign most-favored group may not be engaging in risky behavior in general, but may experience larger losses if extreme events occur.

Table 4: Results of VaRs and Expected Maximum Losses Estimation

	Full Sample				**Financial Crisis**				**Aftermath**			
	Gaussian		**t**		**Gaussian**		**t**		**Gaussian**		**t**	
	1% VaR	Max Loss	1% VaR	Max Loss	1% VaR	Max Loss	1% VaR	Max Loss	1% VaR	Max Loss	1% VaR	Max Loss
Most favorite	2.759	5.511	2.836	6.079	3.118	6.657	3.119	6.456	2.775	5.347	2.949	5.434
Least Favorite	2.944	5.087	3.058	5.388	3.344	5.673	3.420	5.945	2.717	4.566	2.911	5.144

Table 4 reports the 1% VaRs and the expected maximum losses from the multivariate GARCH–EVT–Gaussian copula and the multivariate GARCH–EVT–t copula models. In general, the foreign most-favored group shows lower 1% VaRs than the foreign least-favored group, but shows higher expected maximum losses than the foreign least-favored group.

CONCLUSION

In this paper, we study whether the stocks that are most favored by foreign investors are riskier than those that are least favored during the financial crisis and its aftermath. We employed a multivariate GARCH–EVT–Copula technique to estimate 1% VaRs and expected maximum losses for the two groups over the financial crisis and aftermath periods using TWSE daily stock data from November 2007 to December 2012.

The main findings are as follows: First, due to the fat-tailed characteristics of the t distribution, the VaRs and the expected maximum losses estimated via the t copula were higher than those estimated

via the Gaussian copula. Second, the foreign most-favored group had a lower 1% VaR under both the Gaussian and t copulas than the foreign least-favored group, indicating that investing in the foreign most-favored group may not be riskier. Third, the higher expected maximum losses in the foreign most-favored group demonstrate that investors may experience higher losses during extreme events. Therefore, in general, we can conclude that foreign portfolio investment does not worsen the domestic stock market during a period of financial crisis.

In the future, we suggest that research should focus on why the foreign most-favored group demonstrated higher expected maximum losses. This may be discovered by comparing the characteristics of the stocks included in the foreign most-favored and least-favored groups and their trading volumes. Furthermore, exchange rate fluctuations and changes of government policies may also merit in-depth consideration.

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