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Herding Behavior during the Subprime Mortgage Crisis: Evidence from Six Asia-Pacific Stock Markets

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Abstract

This study examines herding behavior in six Asia-Pacific stock markets, namely, Taiwan, China, South Korea, Singapore, Hong Kong, and Japan, during a period of turmoil, particularly the latest subprime mortgage crisis. We find no evidence of herding in the stock markets of Singapore and Hong Kong, and only partial evidence of herding in the stock markets of South Korea and Japan. However, we document significant evidence of herding in the stock markets of Taiwan and China. This result suggests that herding is more pronounced in developing nations, where markets are dominated by individual investors and where daily price limits are observed. Furthermore, we empirically verify and visually corroborate the comparative co-movement behavior between markets with respect to the "home bias reflection hypothesis" and the degree of market openness. Finally, we find apparent herding behavior in a rising market state and during post-crisis period.

Keywords: herding behavior, Asia-Pacific stock market, financial crisis

1. Introduction

Herding is defined as an investment strategy of mimicking actions of other investors or the market in general. According to Bikhchandani and Sharma (2001), there are three motivations of herding. First, others may know something about the return on the investment and their actions reveal this information. Second, the incentives provided by the compensation scheme and terms of employment may be such that imitation is rewarded. A third motivation for imitation is that individuals may have an intrinsic preference for conformity. Herding behavior is believed to be a crucial element of how financial markets perform. The reliance on collective information rather than private information may cause asset prices to deviate from their fundamental values, thus make assets incorrectly priced. The consequences of this behavior are the shift into or out of financial assets by investors and perhaps lead to the formation of bubbles (Hirshleifer and Teoh, 2003). Moreover, the associated behavioral effects on assets price movements may increase their correlations. Thus, to achieve the degree of diversification, investors need a larger selection of securities.

Herding could be segregated into rational and irrational herding (Bikhchandani and Sharma, 2001). For rational herding, independent individuals decide to take similar actions induced by the movement of fundamentals. The irrational herding, by contrast, refers to as where trading decisions are driven by sentiment. Such behaviour results in market prices failing to reflect fundamental information, with mispricing potentially leading to crashes on financial markets. Also, Baddeley et al. (2007) argue that in the real world herding behaviour may be the outcome of interactions between instinctive or emotional and rational responses. In this study, we focus on exploring the comovement of herding behaviour and, more specifically, testing for the presence of both the sentiment and fundamental-driven factors just mentioned.

Empirical investigations of herding behavior in financial markets have branched into two aspects (Chiang and Zheng, 2010). The first path of literature focuses on co-movement behavior based on the measure of dynamic correlation (Boyer et al., 2006; Cai et al., 2009; Chiang et al., 2007; Economou et al., 2011). These studies document that there are greater co-movements during periods of high volatility and suggest that crises that spread through the asset holdings of international investors are mainly due to contagion rather than to the changes in fundamentals. The second path of literature focuses on the cross-sectional correlation dispersion in stock returns in response to excessive changes in market conditions (Chang et al., 2000; Demirer and Kutan, 2006; Hwang and Salmon, 2004; Tan et al., 2008; Zhou and Lai, 2009), i.e., herding would lead security returns that are not significantly different from the overall market return (Note 1). These studies find that herding behavior is more common in emerging markets than in advanced markets.

Motivated by these empirical studies, we use two different methods to provide further insight on the herding behavior. First, we utilize the cross-sectional absolute deviation of returns (CSAD) proposed by Chang et al. (2000) to detect herding behavior within six Asia-Pacific stock markets (i.e., Taiwan, China, South Korea, Singapore, Hong Kong, and Japan) during the pre- and post-subprime mortgage crisis. Next, accounting to CSAD model results, we apply the dynamic conditional correlation threshold GARCH (DCC-TGARCH) to examine herding behavior (co-movement behavior) across markets.

We select six Asia-Pacific stock markets for several reasons. First, Asia-Pacific financial markets differ substantially from those of global economies in terms of interdependence during financial crises. Rodriguez (2007) finds evidence of changing dependence during periods of turmoil. Increased tail dependence and asymmetry characterize the Asian countries, while symmetry and tail independence describe the Latin American countries. This asymmetry dependence may affect cross-sectional dispersion in stock returns in Asian countries and thus have implications for asset-pricing models. Second, there are differences in market structures, such as the relative share of institutional versus individual investors, the quality and level of information disclosure (Note 2), and the degree of market regulations, as manifested in part by the presence of daily price limits (Note 3). These differences affect investor behavior in Asia-Pacific markets. Opaque information disclosure and government regulation make investors inclined to make decisions according to macroeconomic information (see Lao and Singh, 2011). This may be the reason to herd in emerging markets. Calvo and Mendoza (2000) provide a model of herding activity that implies that asymmetric information can lead to emerging market investors to engage in herding. Third, there are conflicting evidences on herd behavior in the Asia-Pacific stock markets. Chang et al. (2000) find significant evidence of herding in South Korea and Taiwan, and partial evidence in Japan. However, there is no evidence of herding in Hong Kong. Focusing on stocks in Hong Kong, Zhou and Lai (2009) document that herding activity in the market of Hong Kong tends to be more prevalent among small stocks, and that investors are more likely to herd when selling rather than buying stocks. Demirer and Kutan (2006) investigate whether investors in Chinese markets, in making their investment decisions, are following market consensus rather than private information during periods of market stress. Their study reveals no evidence of herding, suggesting that investors in Chinese stock markets rationally make their investment choices. In a recent study on Chinese stock markets, Tan et al. (2008) report that herding occurs under both rising and falling market conditions, and is especially strong among A-share investors. Kim and Nofsinger (2005) study institutional herding in Japan using annual turnover data and find that the behavior of institutional herding depends on the economic condition and the regulatory environment. Chiang and Zheng (2010) find evidence of herding in Asian markets (including those of China, Singapore, South Korea, and Taiwan etc.). Accordingly, the evidence from the studies cited above shows mixed results.

Given the conflicting evidence on herding behavior in Asia-Pacific stock markets, we reexamine the earlier studies in three significant aspects. First, we examine whether herding behavior exists across both developing and developed financial markets (Note 4), including the Taiwan, China, South Korea, Singapore, Hong Kong, and Japan. Second, we test the herding behavior of these Asian financial markets during the pre- and post-crisis periods. The tendency to herd may be stronger during periods of abnormal information flows and volatility, i.e., periods of high market stress, when investors seek the comfort of the consensus opinion (see Gleason et al., 2004) (Note 5). Third, we further examine whether herding exhibits asymmetric effects associated with different market returns. The evidence suggests that investors may react to news during up markets differently from news during down markets. Finally, we examine whether cross-market information occurs in markets where herding behavior exists.

Our results indicate that herding, which is detected by the CSAD model, is more pronounced in developing nations dominated by individual investors and where daily price limits are observed (Note 6). The narrower the range of daily price is, the more convergent the cross-sectional dispersion in stock returns is. Combining the CSAD model and the DCC-TGARCH results, the international investment behavior of market participants is influenced by the "home bias reflection hypothesis (Note 7)." Herding behavior tends to be manifested more when investors possess a high degree of familiarity with the market. Next, consistent with results of prior studies (Chang et al., 2000), we find apparent herding behavior when markets are rising. Finally, investors would be more likely to ignore their private information and go with the market consensus during post-crisis period.

The rest of this study is organized as follows. Section 2 presents the methodology used to detect herding behavior. Section 3 describes data and market investors. Section 4 discusses the empirical results. Section 5 concludes the study.

2. Methodology

2.1 Detecting Herding Behavior within an Individual Market

We build on the methodology used in Chang et al. (2000). The herding test facilitates the detection of herding over the entire distribution of market return with the following specification:

$$CSAD_t = \alpha + \gamma_1|R_{m,t}| + \gamma_2(R_{m,t})^2 + \varepsilon_t \tag{1}$$

The left-hand-side variable, $CSAD_t$, is a measure of return dispersion, which is measured by the cross-sectional absolute deviation:

$$CSAD_t = \frac{1}{N}\sum_{k=1}^{N}|R_{k,t} - R_{m,t}| \tag{2}$$

where $R_{k,t}$ is the return of stock k during time period t; $R_{m,t}$ is the equal-weighted average return of market portfolio during the same time period t; N is the number of stocks included in a market portfolio during time period t. The main idea in this methodology is based on the argument that herding behavior would keep security returns from deviating far from the overall market return. Rational asset pricing models imply a linear relation between the dispersion in individual asset returns and the return on the market portfolio (Note 8). As the absolute value of the market return increases, so should the dispersion in individual asset returns. If investors suppress their own beliefs and make investment decisions based solely on the collective actions of the market, the correlation among asset returns is likely to increase, and the corresponding dispersion among returns is likely to decrease, or at least increase at a less-than-proportional rate with the market return. For this reason, a nonlinear market return, $R_{m,t}^2$, is included in the test equation, and a significantly negative coefficient γ_2 in the empirical test would be consistent with the occurrence of herding behavior (Note 9). As the market experiences large price swings, investors tend to ignore their private information and herd around the information emerging from the consensus of all market constituents. Stock returns under these conditions tend to converge, causing the return dispersion to either decrease or increase at a decreasing rate.

We also construct a $CSAD_t$ measure from a market index: TAIEX (Taiwan), CSI 300 (China), KOSPI 200 (South Korean), STI (Singapore), and HIS (Hong Kong), which all use value-weighted method; Nikkei 225 (Japan) uses price-weighted method. The market index is easily observed by investors and consists of high-capitalization stocks. Lo and MacKinlay (1990) find that returns on large portfolios (high capitalization) predict future returns on small (low capitalization) portfolios, but not vice versa. This is attributed either to the slower adjustment of small stocks to market-wide news (Brennan et al., 1998; Chordia and Swaminathan, 2000) or to differences in the quality of firm-specific and cash-flow information (Yu and Wu, 2001).

2.2 Detecting Co-Movement Behaviors between Markets

In section 2.1, the methodology can only examine herding behavior within one market. However, the second purpose of the study is to investigate co-movement behaviors between markets. We further test the cross-market information transmission using the dynamic conditional correlation threshold GARCH (DCC-TGARCH) introduced by Engle (2002) via the Eq. (3)-Eq. (9).

$$R_{i,t} = \mu_i + \beta_{1i}R_{i,t-1} + (\beta_{1j} + \lambda_{1j}D)R_{j,t-1} + \varepsilon_{i,t} \tag{3}$$

$$R_{j,t} = \mu_j + \beta_{2j}R_{j,t-1} + (\beta_{2i} + \lambda_{2i}D)R_{i,t-1} + \varepsilon_{j,t} \tag{4}$$

$$\sigma_{i,t}^2 = \alpha_{i,0} + \alpha_{i,1}\varepsilon_{i,t-1}^2 + \alpha_{i,2}\sigma_{i,t-1}^2 + (\delta_{i,1} + \gamma_{i,1}D)S_{i,t-1}\varepsilon_{i,t-1}^2 + (\delta_{j,2} + \gamma_{j,2}D)S_{j,t-1}\varepsilon_{j,t-1}^2 \tag{5}$$

$$\sigma_{j,t}^2 = \alpha_{j,0} + \alpha_{j,1}\varepsilon_{j,t-1}^2 + \alpha_{j,2}\sigma_{j,t-1}^2 + (\delta_{j,1} + \gamma_{j,1}D)S_{j,t-1}\varepsilon_{j,t-1}^2 + (\delta_{i,2} + \gamma_{i,2}D)S_{i,t-1}\varepsilon_{i,t-1}^2 \tag{6}$$

$$\sigma_{ij,t} = \rho_{ij,t}\sigma_{i,t}\sigma_{j,t} \tag{7}$$

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}q_{jj,t}}} \tag{8}$$

$$q_{ij,t} = \bar{\rho}_{ij} + \omega(z_{i,t-1}z_{j,t-1} - \bar{\rho}_{ij}) + \kappa(q_{ij,t-1} - \bar{\rho}_{ij}) \tag{9}$$

where the subscripts i and j denote markets i and j, respectively. $R_{i(j),t}$ and $R_{i(j),t-1}$ refer to continually compounded returns at time t and t-1. $\varepsilon_{i(j),t}$ denotes a new shock at time t. $S_{i(j),t-1}$ stands for the dummy variable with a value of unity if $\varepsilon_{i(j),t-1}<0$ and zero otherwise. D equals unity for the post-crisis period and zero otherwise. $\bar{\rho}_{ij}$ is the constant unconditional correlation between i and j market returns and $z_{i,t-1} = \varepsilon_{i,t-1}/\sigma_{i,t-1}$ and $z_{j,t-1} = \varepsilon_{j,t-1}/\sigma_{j,t-1}$ are the standardized residuals of i and j market returns, respectively.

Eq. (3) and Eq. (4) describe the first-order autoregressive process for stock returns, with $R_{i(j),t-1}$ capturing the autocorrelation. $DR_{i(j),t-1}$ are used to investigate whether the cross-market return correlations are affected by the subprime crisis at time t-1. Eq. (5) and Eq. (6) express the process of conditional variance and describe the conditional variance process to respond asymmetrically to rise and fall in stock prices. Specifically, positive return shocks have an impact of $\alpha_{i(j),1}$, while negative return shocks have an impact of $\alpha_{i(j),1}+\delta_{i(j),1}$. Coefficient $\delta_{i(j),1}>0$ indicates the process of leverage effects in the conditional variance. Moreover, $\gamma_{i(j),1}$ and $\gamma_{i(j),2}$ indicate whether the asymmetric and cross-market volatility change via subprime mortgage crisis. Finally, Eq. (7) describes the process of time-varying covariance. Moreover, $\rho_{ij,t}$, the dynamic conditional correlation between i and j market returns, is calculated by using Eq. (8) and Eq. (9) developed by Engle (2002).

Eq. (9) shows the dynamic process of the conditional correlation. Coefficients ω and κ capture the effects of previous shocks and previous conditional correlation on the current conditional correlation. If $\omega + \kappa < 1$, the correlation between the financial assets will revert to the long-run unconditional level after a shock.

3. Data and Market Investors

3.1 Data

We collect daily data on stock prices for all constituents included in the six Asia-Pacific market indexes: TAIEX, CSI 300, KOSPI 200, STI, HIS, and Nikkei 225 over the period from January 1, 2006 to August 31, 2009. In addition to Griffin et al. (2003) conclude that the nature of herding is not universal and differs across exchanges and countries, rational and irrational herding motivations represent collective movements in the market towards some position and the news of these key equity indexes are frequent released by the media. As a result, many global investors views the change of these key equity indexes as reference points. We use key equity indexes (CSI 300, KOSPI 200, STI, HIS, and Nikkei 225) as Hwang and Salmon (2004) and Blasco and Ferreruela (2008) have examined cross-market herding behaviors. The stock return is calculated using continually compounding returns. Christie and Huang (1995) find that herding behavior is a very short-lived phenomenon. Hwang and Salmon (2009) show that noise in financial markets may be highly persistent and slow moving over time. They take the growth of a “bubble” for example, so they use monthly data to detect the beta herding-sentiment relationship in the financial market. However, our measure focuses on the cross-sectional variability of returns (risk-return relationship) rather than on the betas used by Hwang and Salmon (2009). The beta measures the systematic risk for a particular asset, and the beta of a firm is likely to change if a firm changes its operation policy, change of which takes time. Since we measure herding behavior (Note 10) and not sentiment, we restrict our attention to daily data. The data are gathered from the Taiwan Economic Journal (TEJ) and the Datastream Database.

Our daily data are from January 1, 2006 to August 31, 2009. We have 907 daily return observations for Taiwan, 891 for China, 909 for South Korea, 919 for Singapore, 902 for Hong Kong, and 901 for Japan. We use August 1, 2007 as the cut-off point (Note 11) because the subprime mortgage credit crisis began in the United States in 2006 and became a global financial crisis in August 2007. We compare the differences between the entire time period and two sub-periods (January 1, 2006-July 31, 2007; August 1, 2007-August 31, 2009).

3.2 The Investor and Market Characteristics

Since Tan et al. (2008) find that the apparent difference in herding behavior may be due to the different characteristics of Chinese A and B markets, it is of interest to consider whether investor and market characteristics as well as behavioral tendencies affect return dispersions in six Asia-Pacific financial markets.

Taiwan stock market is dominated by domestic individual investors, rather than institutional and foreign investors. In 2009 there are about 72% domestic individual investors. Meanwhile, Taiwan stock market has more government regulation and central bank intervention.

In China, the legal framework and the rule of law are weak, and there are few alternatives for investors. Investors facing only a few alternatives and heavy government involvement, such as regulation and central bank intervention, tend to speculate in the stock market, causing significant market volatility (Green, 2003). About two-thirds of outstanding shares are not publicly tradable. In addition, the A-share market of China is dominated by domestic individual investors (China Securities and Futures Statistical Yearbook, 2009). One of the biggest problems facing traders is lack of transparency.

In Korea, foreign institutional investors hold nearly 38% of the total market capitalization in 2009 while individual investors hold approximately 62%. The Tokyo Stock Exchange (TSE) is a single-price, two-way, transaction-based continuous auction market with price-movement limits and binding-trading procedures intended to suppress rapid and large price movements (Bremer and Hiraki, 1999). The institutional investors and foreign investors account for more than 70% of trading in the TSE (Kamesaka et al., 2003), and they tend to be more knowledgeable and sophisticated than individual investors are. The foreign institutional investors hold more than 18% of the total market capitalization, while domestic institutional investors hold approximately 52%. Although Japan opened its stock markets to foreign investors much earlier than Korea did, the current percentage of foreign ownership in Japanese stock markets is much smaller than that in Korean stock markets. This phenomenon could be a result of the belief of foreign investors that they can beat the market more easily in Korea than in Japan.

Stock markets of Korea and Japan are dominated by institutional investors, but the nature and development of institutional investors between the two stock markets are also different. Japanese banks (the biggest institutional investors) in general have a close relationship with industrial firms through mutual stock ownership. In other words, Japanese banks own stocks not to generate high investment returns but to develop business relationship and to have control. In Korea, however, banks are not important institutional investors. Major Korean institutional investors, such as mutual funds, insurance companies, and the National Pension Fund, usually invest in stocks for the purpose of managing their assets. The different investment purposes of Japanese and Korean institutional investors could lead one to think that the return generated by Korean institutional investors would be better than that generated by their Japanese counterparts. Table 1 lists the percent of investors' composition for Asia-Pacific stock markets.

Compared with above mentioned four stock markets, markets of Singapore and Hong Kong enjoy less government regulation and central bank intervention. Moreover, the institutional investors share the largest trading activities in these two developed financial markets. The Hong Kong market is dominated by foreign institutional investors (Cash market transaction survey (Note 12), 2009-2010).

Table 1. Percent of investors' composition for Asia-Pacific stock markets

Market	Taiwan		China		South Korea		Hong Kong		Japan	
year	Individuals	Institutions	Individuals	Institutions	Individuals	Institutions	Individuals	Institutions	Individuals	Institutions
2006	72.8	27.2	84.4	15.6	51.3	48.7	31.2	68.8	28.2	71.8
2007	69.4	30.6	84.2	15.8	52.3	47.7	29.3	70.7	23.6	76.4
2008	63.9	36.1	84.3	15.7	59.4	40.6	29.1	70.9	21.3	78.7
2009	72.1	27.9	84.1	15.9	62.1	37.9	25.2	74.8	28.5	71.5

Notes: The data is retrieved from the Stock Exchange of each market. Singapore Stock Exchange does not support the figure. According to Maru, the percent of individual and institution inventors in Singapore stock market is about 30 and 70, respectively.

4. Empirical Results

4.1 Descriptive Statistics

In Table 2, we report descriptive statistics for daily market portfolio returns, calculated as equal-weighted average and original market index, and the corresponding CSAD for the markets of Taiwan, China, South Korea, Singapore, Hong Kong, and Japan. In general, after the financial crisis, the two class market portfolio returns of six equity markets ($R_{m,t}$) are characterized by higher standard deviations relative to those before the crisis. We find that both equal-weighted average and original market index returns are negatively skewed during the three periods for the six equity markets, except for Singapore market index return in the post-crisis period. In general, return during the post-crisis period is more extremely negative than that during the pre-crisis period. The mean and median of daily CSAD during the post-crisis period, like market return, show higher dispersion relative to that during the pre-crisis period. This implies that the cross-sectional dispersion in stock returns (risk) diverge during the post-crisis period. According to the coefficient of variation (Note 13) (CoV) of daily CSAD, only Taiwan and China have the smaller CoV during post-crisis period than that during pre-crisis period. This indicates that the volatility per unit of risk reduces during the post-crisis period. For example, in Taiwan, the CoV during the pre-crisis period is 21.87% (0.0035/0.0160) reducing to 21.81% (0.0041/0.0188) during the post-crisis period.

Table 2. Summary statistics of returns ($R_{m,t}$) and cross-sectional absolute deviations ($CSAD_t$) for six Asia-Pacific stock markets

Market	Sample period (number of observations)	Equal-weighted calculation						Market index calculation					
		$CSAD_t$			$R_{m,t}$			$CSAD_t$			$R_{m,t}$		
		Mean	Median	S.D	Mean	Median	S.D	Mean	Median	S.D	Mean	Median	S.D
Taiwan	01/01/06-08/31/09 (907)	0.0176	0.0169	0.0041	0.0002	0.0019	0.0159	0.0183	0.0174	0.0045	0.0001	0.0011	0.0161
	01/01/06-07/31/07(389)	0.0160	0.0155	0.0035	0.0015	0.0026	0.0099	0.0165	0.0157	0.0038	0.0009	0.0013	0.0101
	08/01/07-08/31/09(518)	0.0188	0.0181	0.0041	-0.0008	0.0012	0.0191	0.0197	0.0188	0.0046	-0.0006	0.0009	0.0194
China	01/01/06-08/31/09 (891)	0.0203	0.0194	0.0054	0.0014	0.0049	0.0248	0.0206	0.0196	0.0057	0.0013	0.0034	0.0236
	01/01/06-07/31/07(380)	0.0202	0.0189	0.0062	0.0042	0.0057	0.0199	0.0204	0.0192	0.0064	0.0041	0.0049	0.0190
	08/01/07-08/31/09(511)	0.0204	0.0196	0.0048	-0.0007	0.0023	0.0277	0.0208	0.0199	0.0051	-0.0009	0.0017	0.0263
South Korea	01/01/06-08/31/09 (909)	0.0199	0.0187	0.0062	0.0003	0.0022	0.0188	0.0203	0.0189	0.0069	0.0002	0.0013	0.0180
	01/01/06-07/31/07(392)	0.0171	0.0161	0.0038	0.0014	0.0027	0.0120	0.0173	0.0163	0.0039	0.0008	0.0019	0.0113
	08/01/07-08/31/09(517)	0.0220	0.0203	0.0067	-0.0006	0.0013	0.0226	0.0226	0.0207	0.0077	-0.0003	0.0009	0.0218
Singapore	01/01/06-08/31/09 (919)	0.0150	0.0135	0.0058	0.0001	0.0009	0.0132	0.0156	0.0141	0.0063	0.0001	0.0009	0.0165
	01/01/06-07/31/07(395)	0.0125	0.0121	0.0029	0.0011	0.0023	0.0090	0.0128	0.0124	0.0029	0.0011	0.0016	0.0098
	08/01/07-08/31/09(524)	0.0169	0.0152	0.0067	-0.0007	-0.0004	0.0157	0.0177	0.0160	0.0073	-0.0006	-0.0008	0.0201
Hong Kong	01/01/06-08/31/09 (902)	0.0147	0.0134	0.0060	0.0005	0.0018	0.0228	0.0149	0.0135	0.0061	0.0003	0.0012	0.0219
	01/01/06-07/31/07(389)	0.0111	0.0105	0.0032	0.0017	0.0022	0.0113	0.0113	0.0107	0.0033	0.0011	0.0015	0.0099
	08/01/07-08/31/09(513)	0.0174	0.0157	0.0061	-0.0004	0.0017	0.0285	0.0177	0.0162	0.0063	-0.0003	0.0007	0.0277
Japan	01/01/06-08/31/09 (901)	0.0149	0.0136	0.0055	-0.0006	0.0008	0.0201	0.0150	0.0138	0.0056	-0.0005	0.0003	0.0195
	01/01/06-07/31/07(390)	0.0113	0.0109	0.0024	0.0001	0.0009	0.0118	0.0114	0.0109	0.0025	0.0001	0.0004	0.0114
	08/01/07-08/31/09(511)	0.0177	0.0162	0.0056	-0.0011	0.0002	0.0247	0.0178	0.0164	0.0057	-0.0010	-0.0001	0.0239

Notes: This table reports the daily mean, median, and standard deviation of the returns ($R_{m,t}$) and the cross-sectional absolute deviations ($CSAD_t$) over the sample period for the six markets in our sample.

4.2 Evidence of Herding and Asymmetric Effects of Market Return

Table 3 provides results of the empirical specification in Eq. (1) estimated for the whole period and two sub-periods for each of the six markets. In Panel A, the majority coefficients on the linear term of $|R_{m,t}|$ are significantly positive. These results confirm the prediction that $CSAD_t$ increase with $|R_{m,t}|$. Furthermore, in six markets, except for China, the coefficient γ_1 in the up market is higher than that in the down market. This suggests that the dispersions in security returns are wider in an up-market day than in a down-market day. This finding appears to be consistent with the directional asymmetry documented by McQueen et al. (1996) and Chang et al. (2000), i.e., stocks in the United States react quickly to negative macroeconomic news than to positive news.

In Panel A, the parameter estimates of γ_2, $\gamma^{up}{}_2$ and $\gamma^{down}{}_2$ for Singapore are significantly positive, providing anti-herding phenomenon in the CSAD-return’relationship. For Hong Kong, these parameter estimates are statistically insignificant, providing no evidence of any non-linearity in the CSAD-return relationship. Then, we turn our attention to South Korea and Japan. The parameter estimates of the non-linear term for these two markets indicate asymmetric reaction to market return during the whole period. Specifically, the $\gamma^{up}{}_2$ coefficients are negative and statistically significant, while the $\gamma^{down}{}_2$ coefficients are positive and statistically insignificant. The result implies that herding behavior is present in the two markets examined when markets are rising. In the other two emerging financial markets, Taiwan and China, the coefficients γ_2,$\gamma^{up}{}_2$ and $\gamma^{down}{}_2$ are negative and statistically significant, suggesting that herding behavior exists in both markets during the whole period.

Since the direction of the market return may affect investor behavior, we examine possible asymmetries in herd behavior conditional on whether the market is rising or falling. In Panel A, the absolute value of $\gamma^{up}{}_2$ in the up market for all the six markets is higher than that in the down market ($\gamma^{down}{}_2$) during the whole period. The results for China (Taiwan) are consistent with those documented by Tan et al., 2008 (Chang et al., 2000). During down markets, when news is bad, investors would be evaluating a relatively large set of investment opportunities vis-à-vis the bad news. As such, their actions may be spread out over time, leading to a lack of herding. On the other hand, during up markets, investors have the simpler task of evaluating the effects of news on a smaller set of stocks in their portfolios. They can act quickly on the news by following the aggregate market in adjusting their portfolios, thereby creating the possibility of herding. To understand asymmetric reactions of herding behavior to pre- and post-financial crisis, we also test the equality of the herding coefficient in both up and down markets ($\gamma^{up}{}_2$ -$\gamma^{down}{}_2$). The results suggest that in the manifestation of herding behavior, asymmetric reactions to the direction of the market returns exist in the South Korean and Japanese stock markets, but no asymmetry exists in the other markets examined.

In panels B and C, to further investigate herding behavior during the period of turmoil, we contrast the magnitude and significance level of $\gamma^{up}{}_2$ between the two sub-periods and find that the corresponding dispersion among returns decreases in the post-crisis period, except for returns in Singapore. Meanwhile, the magnitude and significance level of $\gamma^{down}{}_2$ in post-crisis period show that the corresponding dispersion decreases in Taiwan, Korea, Singapore, and Japan. The magnitudes of $\gamma^{up}{}_2$ and $\gamma^{down}{}_2$ in the pre- and post-crisis periods show evidence that herding behavior is higher during post-crisis period and up market than in other market conditions. This implies that investors depend more on collective information in post-crisis period and when market is rising. This finding appears to be consistent with that of Glaser and Weber (2005). They use questionnaire data to analyze the expectations of individual investors before and after the September 11 attacks. Somewhat surprisingly, they find that the stock return forecasts of individual investors are higher and the differences of opinion lower after the terrorist attacks.

Noticeably, we find statistically insignificance on both $\gamma^{up}{}_2$ and $\gamma^{down}{}_2$ coefficients for Japan market during the post-crisis periods. This finding is in contrast to the results reported in Korea market during the post-crisis periods, where partial evidence of herding in rising market exists. Since Japan market is dominated by domestic institutional investors (Japanese banks), their investment strategy aim at the long-run business relationship with industrial firms. The finding supports that the investment purposes of institutional investors could affect financial market stability.

Table 3. Estimates of herding behavior in six Asia-Pacific stock markets during the whole sample period and two subsample periods

Panel A: The whole sample period (1/1/2006 to 8/31/2009)

Market	Model A				Model B				Model C				
	α	γ_1	γ_2	$Adj\text{-}R^2$	α	$\gamma^{up}{}_1$	$\gamma^{up}{}_2$	$Adj\text{-}R^2$	α	$\gamma^{down}{}_1$	$\gamma^{down}{}_2$	$Adj\text{-}R^2$	$\gamma_2^{up}\text{-}\gamma_2^{down}$
Taiwan	0.0147***	0.3724***	-5.0972***	0.2408	0.0145***	0.3871***	-6.4331***	0.2056	0.0149***	0.3794***	-4.9200***	0.2710	-1.5130
China	0.0173***	0.2105***	-1.5200***	0.1348	0.0168***	0.2150***	-2.9683***	0.0688	0.0180***	0.2684***	-1.8760***	0.2439	-1.0923
South Korea	0.0160***	0.2998***	0.0018	0.4448	0.0159***	0.3482***	-1.1670**	0.3374	0.0160***	0.2686***	0.6265	0.5410	-1.7935***
Singapore	0.0115***	0.3159***	2.6239***	0.4662	0.0113***	0.3299***	3.8364***	0.5485	0.0119***	0.2762***	2.3052**	0.3943	1.5311
Hong Kong	0.0110***	0.2417***	-0.1583	0.4084	0.0111***	0.2713***	-0.2101	0.4138	0.0106***	0.2225***	-0.1667	0.4299	-0.0433
Japan	0.0117***	0.2373***	-0.1609	0.3643	0.0116***	0.2784***	-0.5222*	0.3468	0.0117***	0.1959***	0.3012	0.3938	-0.8235*

Panel B: The pre-crisis period (1/1/2006 to 7/31/2007)

Country	Model A				Model B				Model C				
	α	γ_1	γ_2	$Adj\text{-}R^2$	α	$\gamma^{up}{}_1$	$\gamma^{up}{}_2$	$Adj\text{-}R^2$	α	$\gamma^{down}{}_1$	$\gamma^{down}{}_2$	$Adj\text{-}R^2$	$\gamma_2^{up}\text{-}\gamma_2^{down}$
Taiwan	0.0139***	0.3402***	-3.4378**	0.2164	0.0139***	0.3683***	-5.3717	0.1584	0.0137***	0.3391***	-3.2148	0.2828	-2.1569
China	0.0165***	0.2878***	-1.6113**	0.2012	0.0162***	0.2649***	-2.13354	0.1406	0.0168***	0.4431***	-3.6588***	0.2775	1.5253
South Korea	0.0158***	0.0396	6.2020***	0.2438	0.0155***	0.1858*	0.1178	0.1068	0.0157***	-0.0559	9.2011***	0.4447	-9.0832**
Singapore	0.0112***	0.1252**	4.9364**	0.2716	0.0113***	0.1195	7.0124	0.1893	0.0112***	0.0477	7.0331***	0.4295	-0.0207
Hong Kong	0.0094***	0.1714***	1.6189	0.2470	0.0098***	0.0651	8.0466***	0.2852	0.0094***	0.1310*	1.5928	0.2351	6.4537
Japan	0.0107***	0.0010	3.8795***	0.1438	0.0110***	-0.0205	4.7891**	0.1040	0.0104***	0.0163	3.4945**	0.1853	1.2946

Panel C: The post-crisis period (8/1/2007 to 8/31/2009)

Country	Model A				Model B				Model C				
	α	γ_1	γ_2	$Adj\text{-}R^2$	α	$\gamma^{up}{}_1$	$\gamma^{up}{}_2$	$Adj\text{-}R^2$	α	$\gamma^{down}{}_1$	$\gamma^{down}{}_2$	$Adj\text{-}R^2$	$\gamma_2^{up}\text{-}\gamma_2^{down}$
Taiwan	0.0160***	0.3137***	-4.4950***	0.1767	0.0156***	0.3364***	-5.9091***	0.1714	0.0164***	0.3119***	-4.1937***	0.1818	-1.7153
China	0.0180***	0.1460***	-0.9680**	0.0984	0.0178***	0.1119***	-1.8529***	0.0312	0.0186***	0.1928***	-1.0336*	0.2556	-0.8192
South Korea	0.0175***	0.2945***	-0.1612	0.4648	0.0174***	0.3570***	-1.5183***	0.3690	0.0175***	0.2531***	0.5856	0.5479	-2.1039***
Singapore	0.0125***	0.3408***	1.8200*	0.4662	0.0122***	0.3882***	2.1314	0.5803	0.0129***	0.2778***	2.0099	0.3706	0.1214
Hong Kong	0.0140***	0.1393***	0.4892**	0.3348	0.0145***	0.1551***	0.5550	0.3532	0.0133***	0.1387***	0.3371	0.3477	0.2178
Japan	0.0143***	0.1877***	0.0223	0.3466	0.0144***	0.2279***	-0.3562	0.3265	0.0143***	0.1444***	0.5280	0.3828	-0.8843*

Notes: This table reports the estimated coefficients of the following regression models: Model A is the absolute value of an equally-weighted realized return of all sample securities during the whole period, Model B is in rising market and Model C is in declining market. We use t-statistics based on Newey-West (1987) consistent standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Model A: $CSAD_t = \alpha + \gamma_1|R_{m,t}| + \gamma_2(R_{m,t})^2 + \varepsilon_t$

Model B: $CSAD^{up}_t = \alpha + \gamma^{up}_1|R^{up}_{m,t}| + \gamma^{up}_2(R^{up}_{m,t})^2 + \varepsilon_t$

Model C: $CSAD^{down}_t = \alpha + \gamma^{down}_1|R^{down}_{m,t}| + \gamma_2(R^{down}_{m,t})^2 + \varepsilon_t$

Where $R^{up}_{m,t}$ ($R^{down}_{m,t}$) is the equally weighted portfolio return during period t when the market is up (down). Besides, we apply Joint Wald Test H_0: γ^{up}_2-γ^{down}_2 =0 to check the equality of the herding coefficient in both rising and falling markets.

Since we employ an equally weighted measure, the aggregate results reported in Table 3 may be influenced by the smaller stocks in each market. Examining the relative influence of small versus large stocks is especially important in light of the fact that small stock portfolios may react differently under different conditions relative to large stock portfolios. Hence, we reexamine the non-linearity in the CSAD-return relationship using market index return for each of the six markets in our sample. The results consist of the equally weighted market return in Table 3 except for Japan in an up-market day (please see Appendix A for details). However, the negative coefficients γ_2, γ^{up}_2 and γ^{down}_2 of Taiwan in Table 3 are smaller than that in Appendix A, suggesting that herding is more prevalent in small stocks than in large stocks. This finding is consistent with Zhou and Lai (2009). TAIEX is the composite index that includes all firms listed in Taiwanese stock market, while the other five market indexes are the constitute index that include only the partial representative firms, i.e. the larger firms.

4.3 Cross-Market Information

As mentioned above, the herding behavior appears in four Asia-Pacific markets, excluding Hong Kong and Singapore. In markets of Taiwan and China, herding behavior exists in both up and down markets during the whole period and post-crisis period. In markets of South Korea and Japan, herding behavior only exists in up market during the whole period. Since we find a similar CSAD-return relationship between the markets of Taiwan (South Korea) and China (Japan), it is of interest to examine whether Taiwan (South Korea) investors make their investment decisions based on decisions of investors in China (Japan), and vice versa.

Table 4 lists the estimation results by applying the DCC-TGARCH model. β_{2i} is statistically significant at the 1% level between the markets of South Korea and Japan. Estimation result of $\beta_{2i}< 0$ indicates that the market return in South Korea is affected by that in Japan and shows a reverse relationship between these two countries. Moreover, λ_{2i} is insignificant for those two cases, indicating that the degree of cross-market return correlation does not change after the subprime mortgage crisis. Regarding the conditional variance, the estimates of $\delta_{i,1}$ ($\delta_{j,1}$) are statistically significant and positive at the 5% (1%) level for the markets of Japan (South Korea), suggesting that shocks from bad news cause more volatility than those from good news. The asymmetric volatility effect does not appear in the markets of Taiwan and China. $\delta_{i,2}>0$ ($\delta_{i,2}<0$) is statistically significant at the 1% level, showing that the lagged volatility of China (Japan) increases (decreases) the current volatility of the market of Taiwan (South Korea). Home bias reflection hypothesis indicates that investors' herding have the characteristic of a high degree of familiarity. Therefore, the stock markets of South Korea (Taiwan) and Japan (China) confirm home bias reflection hypothesis. $\delta_{j,2}<0$ is statistically significant at the 1% level, showing that the lagged volatility of the market of Taiwan decreases the current volatility of that of China. The coefficient of $\gamma_{i,1}$ and $\gamma_{j,1}$ are significantly positive, and presents that the asymmetric volatility increases in China and Taiwan after the subprime mortgage crisis. This is consistent with the observation by Yang and You (2003) that the degree of asymmetry is higher after the Asian financial crisis. $\gamma_{i,2}$ is statistically significant at the 1% level. The evidence shows that the volatility of South Korea return, which is affected by Japan, increases after the subprime mortgage crisis.

The effect of mean reversion to the permanent component of the unconditional correlation $\bar{\rho}_{ij}$ is represented by ω and κ. Coefficient ω is found to be statistically significantly positive at the 1% level except for the model of China and Taiwan. κ is also significantly positive. The sum of ω and κ is 0.9997. The condition of $\omega+\kappa<1$ is observed, which implies that dynamic conditional correlation moved around a long-run constant level and displayed a mean-reverting dynamic process. The Ljung-Box test for model specification is performed on standardized residuals, squared standardized residuals, and the cross product of standardized residuals. The results, documented in the last five rows of Table 4, indicate that the DCC-TGARCH specification is appropriate for the data set in the time period. The mean of $\rho_{ij,t}$ is from 0.22 in China and Taiwan, to 0.70 in Japan and South Korea. This means that the "home bias reflection hypothesis" reinforces stronger between South Korea and Japan than that between China and Taiwan. The rationale behind this is that the relatively open of markets can affect the co-movement behaviors between two markets.

To further observe whether the empirical result between Japan and South Korea markets will change via the exchange rate (Note 14), the KOSPI 200 indices are computed by translating into Japanese Yen based on the daily exchange rate. Table 5 lists the estimation results by applying the DCC-TGARCH model after adjusting the exchange rate. β_{1i} is statistically significant at the 5% level. Estimation result of $\beta_{1i}>0$ indicates that the market return in Japan is positive affected by that in South Korea. However, β_{2i} is largely consistent with that shown in Table 4. In conditional variance, the largest difference between Table 4 and Table 5 is $\gamma_{i,2}$. $\gamma_{i,2}>0$ and insignificant show that the lagged volatility of Japan does not increase the current volatility of the market of Korea after the subprime mortgage crisis.

In summary, the market return in South Korea is affected by that in Japan, and after adjusting the exchange rate cross-market return correlation exist bilateral influence. Moreover, volatilities in the markets of China (Japan) and Taiwan (Korea) have bilateral (unidirectional) influence on each other.

Table 4. Maximum likelihood estimates of DCC-TGARCH model

	China vs. Taiwan	Japan vs. South Korea
μ_i	0.0016**	-0.0006
β_{1i}	0.0222	-0.0852*
β_{1j}	0.0133	0.0083
λ_{1j}	-0.0733	0.0853
μ_j	0.0005	0.0000
β_{2j}	-0.0292	0.1200***
β_{2i}	-0.0170	-0.1920***
λ_{2i}	0.0214	0.0738
$\alpha_{i,0}$	0.0000***	0.0000***
$\alpha_{i,1}$	0.1032***	-0.0042
$\alpha_{i,2}$	0.9163***	0.8908***
$\delta_{i,1}$	-0.0592**	0.1123**
$\gamma_{i,1}$	0.0556**	0.0466
$\delta_{j,2}$	-0.0578***	0.0124
$\gamma_{j,2}$	0.0256	0.0159
$\alpha_{j,0}$	0.0000	0.0000***
$\alpha_{j,1}$	0.0474*	-0.0111
$\alpha_{j,2}$	0.9061***	0.8953***
$\delta_{j,1}$	0.0091	0.1787***
$\gamma_{j,1}$	0.0558**	-0.0268
$\delta_{i,2}$	0.0080***	-0.0412***
$\gamma_{i,2}$	-0.0029	0.0447***
ω	0.0090	0.0388***
κ	0.9907***	0.9608***
LogL	4117	4646
$Q_i(20)$	14.06	19.66
$Q_j(20)$	24.22	17.46
$Q_i^2(20)$	14.43	15.49
$Q_j^2(20)$	13.90	18.00
$Q_{ij}(20)$	19.12	19.49

Notes: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. The subscripts *i* and *j* are China (Japan) and Taiwan (South Korea), respectively. $Q_{i(j)}(20)$ and $Q^2_{i(j)}(20)$ are the Ljung-Box test statistics detecting autocorrelation in the standardized residuals and standardized squared residuals of the DCC-TGARCH model up to the twentieth lags. $Q_{i(j)}(20)$ is the Ljung-Box statistics, detecting the cross-product of standardized residuals for market *i* and the market *j* up to the twentieth lags.

$$R_{i,t} = \mu_i + \beta_{1i} R_{i,t-1} + (\beta_{1j} + \lambda_{1j} D) R_{j,t-1} + \varepsilon_{i,t}$$

$$R_{j,t} = \mu_j + \beta_{2j} R_{j,t-1} + (\beta_{2i} + \lambda_{2i} D) R_{i,t-1} + \varepsilon_{j,t}$$

$$\sigma_{i,t}^2 = \alpha_{i,0} + \alpha_{i,1}\varepsilon_{i,t-1}^2 + \alpha_{i,2}\sigma_{i,t-1}^2 + (\delta_{i,1} + \gamma_{i,1} D) S_{i,t-1}\varepsilon_{i,t-1}^2 + (\delta_{j,2} + \gamma_{j,2} D)\varepsilon_{j,t-1}^2$$

$$\sigma_{j,t}^2 = \alpha_{j,0} + \alpha_{j,1}\varepsilon_{j,t-1}^2 + \alpha_{j,2}\sigma_{j,t-1}^2 + (\delta_{j,1} + \gamma_{j,1} D) S_{j,t-1}\varepsilon_{j,t-1}^2 + (\delta_{i,2} + \gamma_{i,2} D)\varepsilon_{i,t-1}^2$$

$$\sigma_{ij,t} = \rho_{ij,t}\sigma_{i,t}\sigma_{j,t}$$

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t} q_{jj,t}}}$$

$$q_{ij,t} = \bar{\rho}_{ij} + \omega(z_{i,t-1} z_{j,t-1} - \bar{\rho}_{ij}) + \kappa(q_{ij,t-1} - \bar{\rho}_{ij})$$

Table 5. Maximum likelihood estimates of DCC-TGARCH model after exchange rate adjustment

	Japan vs. South Korea
μ_i	-0.0003
β_{1i}	-0.1923***
β_{1j}	0.1157**
λ_{1j}	0.0656
μ_j	0.0000
β_{2j}	0.1399***
β_{2i}	-0.2449***
λ_{2i}	0.0800
$\alpha_{i,0}$	0.0000***
$\alpha_{i,1}$	-0.0162
$\alpha_{i,2}$	0.8944***
$\delta_{i,1}$	0.1190***
$\gamma_{i,1}$	0.0361
$\delta_{j,2}$	0.0163
$\gamma_{j,2}$	0.0012
$\alpha_{j,0}$	0.0000***
$\alpha_{j,1}$	0.0055
$\alpha_{j,2}$	0.8883***
$\delta_{j,1}$	0.1473***
$\gamma_{j,1}$	0.0363
$\delta_{i,2}$	-0.0513***
$\gamma_{i,2}$	0.0355
ω	0.0465***
κ	0.9523***
LogL	4371
$Q_i(20)$	21.34
$Q_j(20)$	19.37
$Q_i^2(20)$	18.98
$Q_j^2(20)$	22.85
$Q_{ij}(20)$	22.34

Notes: *,** and *** denote significance at the 10% ,5% and 1% levels, respectively. The subscripts *i* and *j* are China (Japan) and Taiwan (South Korea), respectively. $Q_{i(j)}(20)$ and $Q^2_{i(j)}(20)$ are the Ljung-Box test statistics detecting autocorrelation in the standardized residuals and standardized squared residuals of the DCC-TGARCH model up to the twentieth lags. $Q_{i(j)}(20)$ is the Ljung-Box statistics, detecting the cross-product of standardized residuals for market *i* and the market *j* up to the twentieth lags.

$$R_{i,t} = \mu_i + \beta_{1i} R_{i,t-1} + (\beta_{1j} + \lambda_{1j} D) R_{j,t-1} + \varepsilon_{i,t}$$

$$R_{j,t} = \mu_j + \beta_{2j} R_{j,t-1} + (\beta_{2i} + \lambda_{2i} D) R_{i,t-1} + \varepsilon_{j,t}$$

$$\sigma^2_{i,t} = \alpha_{i,0} + \alpha_{i,1}\varepsilon^2_{i,t-1} + \alpha_{i,2}\sigma^2_{i,t-1} + (\delta_{i,1} + \gamma_{i,1} D) S_{i,t-1}\varepsilon^2_{i,t-1} + (\delta_{j,2} + \gamma_{j,2} D)\varepsilon^2_{j,t-1}$$

$$\sigma^2_{j,t} = \alpha_{j,0} + \alpha_{j,1}\varepsilon^2_{j,t-1} + \alpha_{j,2}\sigma^2_{j,t-1} + (\delta_{j,1} + \gamma_{j,1} D) S_{j,t-1}\varepsilon^2_{j,t-1} + (\delta_{i,2} + \gamma_{i,2} D)\varepsilon^2_{i,t-1}$$

$$\sigma_{ij,t} = \rho_{ij,t}\sigma_{i,t}\sigma_{j,t}$$

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t} q_{jj,t}}}$$

$$q_{ij,t} = \bar{\rho}_{ij} + \omega(z_{i,t-1} z_{j,t-1} - \bar{\rho}_{ij}) + \kappa(q_{ij,t-1} - \bar{\rho}_{ij})$$

5. Conclusions

In this study, we examine the international investment behavior of market participants in six Asia-Pacific stock markets, namely, Taiwan, China, South Korea, Singapore, Hong Kong, and Japan during the pre- and post-crisis periods, specifically with regard to their tendency to manifest herd behavior. Results based on daily data indicate that four Asia-Pacific markets, excluding Hong Kong and Singapore, are characterized by investor herding. There are apparent differences in investor behavior among these four markets. In two emerging financial markets, Taiwan and China, herding behavior exists no matter what the market states are. In the markets of South Korea and Japan, herding behavior is only present when markets are rising.

We also test for potential asymmetries in herding behavior related to market returns and the effect of subprime mortgage crisis. The herding behavior found in South Korea and Japan exhibits asymmetric tendencies, and is only present when markets are rising. We find no such asymmetries among investors in the markets of Taiwan and China when markets are rising and falling. Among these four markets, the cross-sectional dispersion in stock returns shrinks during the post-crisis period. Then, we apply the dynamic conditional correlation threshold

GARCH to further examine cross-market information. We find that Taiwan market return is affected by that of China, and their volatilities have bilateral influence. However, the market return between South Korea and Japan exist bilateral influence, but only unidirectional volatility spillover from Japan to South Korea. Moreover, the cross-market return correlation of these four markets increases after the subprime mortgage crisis.

The findings have some important implications. First, herding is more pronounced in the developing nations that are dominated by individual investors and where daily price limits are observed. During period of extreme price movements, equity return dispersions for the Singapore and Hong Kong markets, the two developed markets with no daily price limits and are dominated by foreign institutional investors, tend to increase and remain unchanged, providing evidence against the presence of any herd behavior. However, for South Korean and Japanese markets, both of which have loose daily price limits and are dominated by institutional investors, we find the presence of herding only during extreme up price movement days. As for the Taiwanese and Chinese markets, the two developing nations with strict daily price limits and are dominated by domestic individual investors, we document the presence of herding during both extreme up and down price movement days. Second, the international investment behavior of market participants is influenced by the "home bias reflection hypothesis" and the degree of market openness. After dynamic correlation analysis, the co-movement behavior between South Korea and Japan is superior over those between Taiwan and China. Third, consistent with results of prior studies, we find apparent herding behavior when markets are rising. Finally, investors are more likely to ignore their private information and go with the market consensus during post-crisis period.

References

Ahearne, A., Griever, W., & Warnock, F. (2004). Information costs and home bias: an analysis of U.S. holdings of foreign equities. *Journal of International Economics, 62*, 313-336. http://dx.doi.org/10.1016/S0022-1996(03)00015-1

Baddeley, M., Pillas, D., Christopoulos, Y., Schultz, W., & Tobler, P. (2007). *Herding and social pressure in trading tasks: a behavioural analysis*. Working paper, University of Cambridg.

Bikhchandani, S., & Sharma, S. (2001). Herd behavior in financial markets: a review. *IMF Staff Papers, 47*, 279-310.

Blasco, N., & Ferreruela, S. (2008). Testing intentional herding in familiar stocks: an experiment in an international context. *Journal of Behavioral Finance*, *9*, 72-84. http://dx.doi.org/10.1080/15427560802093654

Boyer, B., Kumagai, T., & Yuan, K. (2006). How do crises spread? evidence from accessible and inaccessible stock indices. *Journal of Financ*e, *61*, 957-1003. http://dx.doi.org/10.1111/j.1540-6261.2006.00860.x

Bremer, M., & Hiraki, T. (1999). Volume and individual security returns on the Tokyo Stock Exchange. *Pacific-Basin Finance Journal, 7*, 351-370. http://dx.doi.org/10.1016/S0927-538X(99)00012-8

Brennan, M. J., Chordia, T., & Subrahmanyam, A. (1998). Alternative factor specications, security characteristics, and the cross-section of expected stock returns. *Journal of Financial Economics, 49*, 345-373. http://dx.doi.org/10.1016/S0304-405X(98)00028-2

Cai, Y., Chou, R. Y., & Li, D. (2009). Explaining international stock correlations with CPI fluctuations and market volatility. *Journal of Banking and Finance, 33*, 2026-2035. http://dx.doi.org/10.1016/j.jbankfin.2009.05.013

Calvo, G., & Mendoza, E. (2000). Rational herd behavior and globalization of securities markets. *Journal of International Economics, 51*, 79-113. http://dx.doi.org/10.1016/S0022-1996(99)00038-0

Chang, E. C., Cheng, J. W., & Khorana, A. (2000). An examination of herd behavior in equity markets: an international perspective. *Journal of Banking and Finance, 24*, 1651-1679. http://dx.doi.org/10.1016/S0378-4266(99)00096-5

Chen, Y., Wang, C., & Lin, F. (2008). Do qualified foreign institutional investors herd in Taiwan's securities market? *Emerging Markets Finance and Trade, 44*, 62-74. http://dx.doi.org/10.2753/REE1540-496X440405

Chiang, T. C., & Zheng, D. (2010). An empirical analysis of herd behavior in global stock markets. *Journal of Banking and Finance, 34*, 1911-1921. http://dx.doi.org/10.1016/j.jbankfin.2009.12.014

Chiang, T. C., Jeon, B. N., & Li, H. (2007). Dynamic correlation analysis of financial contagion: Evidence from Asian markets. *Journal of International Money and Finance*, *26*, 1206-1228.

http://dx.doi.org/10.1016/j.jimonfin.2007.06.005

Chordia, T., & Swaminathan, B. (2000). Trading volume and cross-autocorrelations in stock returns. *Journal of Finance*, *55*, 913-936. http://dx.doi.org/10.1111/0022-1082.00231

Christie, W. G., & Huang, R. D. (1995). Following the pied piper: do individual returns herd around the market? *Financial Analysts Journal*, *51*, 31-37. http://dx.doi.org/10.2469/faj.v51.n4.1918

Demirer, R., & Kutan, A. M. (2006). Does herding behavior exist in Chinese stock markets? *Journal of International Financial Markets, Institutions & Money*, *16*, 123-142. http://dx.doi.org/10.1016/j.intfin.2005.01.002

Duchin, R., Ozbas, O., & Sensoy, B. A. (2010). Costly external finance, corporate investment, and the subprime mortgage credit crisis. *Journal of Financial Economics*, *97*, 195-214. http://dx.doi.org/10.1016/j.jfineco.2009.12.004

Economou, F., Kostakis, A., & Philippas, N. (2011). Cross-country effects in herding behaviour: Evidence from four south European markets. *Journal of International Financial Markets, Institutions & Money*, *21*, 443-460. http://dx.doi.org/10.1016/j.intfin.2011.01.005

Engle, R. F. (2002). Dynamic conditional correlation: a simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business and Economic Statistics*, *20*, 339-50. http://dx.doi.org/10.1198/073500102288618487

Glaser, M., & Weber, M. (2005). September 11 and stock return expectations of individual investors. *Review of Finance*, *9*, 243-279. http://dx.doi.org/10.1007/s10679-005-7592-4

Gleason, K. C., Mathur, I., & Peterson, M. A. (2004). Analysis of intraday herding behavior among the sector ETFs. *Journal of Empirical Finance*, *11*, 681-694. http://dx.doi.org/10.1016/j.jempfin.2003.06.003

Green, S. (2003). *China's stock market: eight myths and some reasons to be optimistic*. The Royal Institute of International Affairs, Cambridge University.

Grinblatt, M., Titman, S., & Wermers, R. (1995). Momentum investment strategies, portfolio performance, and herding: A study of mutual fund behavior. *American Economic Review*, *85*, 1088-1105.

Henker, J., Henker, T., & Mitsios, A. (2006). Do investors Herd intraday in Australian equities? *International Journal of Managerial Finance*, *2*, 196-219. http://dx.doi.org/10.1108/17439130610676475

Hirshleifer, D., & Hong, T. S. (2003). Herd behavior and cascading in capital markets: a review and synthesis. *European Financial Management*, *19*, 25-66. http://dx.doi.org/10.1111/1468-036X.00207

Hwang, S., & Salmon, M. (2004). Market stress and herding. *Journal of Empirical Finance*, *11*, 585-616. http://dx.doi.org/10.1016/j.jempfin.2004.04.003

Hwang, S., & Salmon, M. (2009). Sentiment and beta herding. *Working papers*, Warwick University.

Jeon, J., & Moffett, C. M. (2010). Herding by foreign investors and emerging market equity returns: evidence from Korea. *International Review of Economics and Finance*, *19*, 698-710. http://dx.doi.org/10.1016/j.iref.2010.03.001

Kamesaka, A., Nofsinger, J. R., & Kawakita, H. (2003). Investment patterns and performance of investor groups in Japan. *Pacific-Basin Finance Journal*, *11*, 1-22. http://dx.doi.org/10.1016/S0927-538X(02)00095-1

Kim, K. A., & Nofsinger, J. R. (2005). Institutional herding, business groups, and economic regimes: evidence from Japan. *Journal of Business*, *78*, 213-242. http://dx.doi.org/10.1086/426524

Lakonishok, J., Shleifer, A., & Vishny, R. W. (1992). The impact of institutional trading on stock prices. *Journal of Financial Economics*, *32*, 23-43. http://dx.doi.org/10.1016/0304-405X(92)90023-Q

Lao, P., & Singh, H. (2011). Herding behaviour in the Chinese and Indian stock markets. *Journal of Asian Economics*, *22*, 495-506. http://dx.doi.org/10.1016/j.asieco.2011.08.001

Lo, A. W., & Mackinlay, A. C. (1990). Data-snooping biases in tests of financial asset pricing models. *Review of Financial Studies*, *3*, 431-468. http://dx.doi.org/10.1093/rfs/3.3.431

Maru, J. *The Role of institutional investors in the development of Asian stock markets: Singapore, Malaysia, and Thailand (Part1).* Retrieved from http://www.ier.hit-u.ac.jp/COE/Japanese/Newsletter/No.7.english/junko.html

McQueen, G., Pinegar, M. A., & Thorley, S. (1996). Delayed reaction to good news and the cross-autocorrelation of portfolio returns. *Journal of Finance*, *51*, 889-919. http://dx.doi.org/10.1111/j.1540-6261.1996.tb02711.x

Patterson, D. M., & Sharma, V. (2006). Do traders follow each other at the NYSE? Working paper, University of Michigan, Dearborn.

Puckett, A., & Yan, X. (2007). The determinants and impact of short-term institutional herding. Working paper, University of Missouri, Columbia.

Rodriguez, J. C. (2007). Measuring financial contagion: a copula approach. *Journal of Empirical Finance*, *14*, 401-423. http://dx.doi.org/10.1016/j.jempfin.2006.07.002

Sarkissian, S., & Schill, M. (2004). The overseas listing decision: new evidence of proximity preference. *Review of Financial Studies*, *17*, 769-809. http://dx.doi.org/10.1093/rfs/hhg048

Tan, L., Chiang, T. C., Mason, J. R., & Nelling, E. (2008). Herding behavior in Chinese stock markets: an examination of A and B shares. *Pacific-Basin Finance Journal*, *16*, 61-77. http://dx.doi.org/10.1016/j.pacfin.2007.04.004

Wermers, R. (1999). Mutual fund herding and the impact on stock prices. *Journal of Finance*, *54*, 581-622.

Yang, J. J. W., & You, S. J. (2003). Asymmetric volatility：pre and post financial crisis. *Journal of Management*, *20*, 797-819. http://dx.doi.org/10.1111/0022-1082.00118

Yu, C. H., & Wu, C. (2001). Economic sources of asymmetric cross-correlation among stock returns. *International Review of Economics and Finance*, *10*, 19-40. http://dx.doi.org/10.1016/S1059-0560(00)00069-1

Zhou, R., & Lai, R. (2009). Herding and information based trading. *Journal of Empirical Finance*, *16*, 388-393. http://dx.doi.org/10.1016/j.jempfin.2009.01.004

Notes

Note 1. Apart from examining the herding in whole market, several papers develop alternative measures for detecting institutional investors herding; see, e.g., Grinblatt et al., 1995; Lakonishok et al., 1992; Wermers, 1999.

Note 2. Some authors (Demirer and Kutan, 2006; Henker et al., 2006; Patterson and Sharma, 2006; and Puckett and Yan, 2007) have recently considered other determinants of herding including the proportion of institutional traders, the quality of available information, dispersion of opinion or the presence of uninformed investors, among others.

Note 3. The daily price limits are: 7 percent in Taiwan, 10 percent in China, 15 percent in South Korea, and none in Singapore and Hong Kong. The price limits of stocks in Japan are set according to the differences in base prices.

Note 4. Morgan Stanley Capital International says Taiwan, China, South Korea remain as emerging markets as of Jun 2010. Therefore, these are considered developing markets. On the other hand, Singapore, Hong Kong, and Japan are developed markets.

Note 5. Yet, Hwang and Salmon (2009) examine herding behavior in the US, the UK, and the South Korean stock markets, and they find beta herding when investors believe they know where the market is heading rather than when the market is in crisis.

Note 6. This result differs from that of the study by Chiang and Zheng (2010), but is consistent with that of Chang et al. (2000). Chiang and Zheng (2010) use industry-level data to test the herding behavior, while our study, like that of Chang et al. (2000), uses firm-level data.

Note 7. See Sarkissian and Schill (2004), and Ahearne et al., (2004).

Note 8. The dispersions will increase with the absolute value of market return, since each asset differs in its sensitivity to the market return.

Note 9. A negative coefficient on the squared market return also could be consistent with other interpretations, such as market-timing behavior by investors and deviations from a linear asset pricing model.

Note 10. Gleason et al. (2004) and Tan et al. (2008) point out that herding is a short-term phenomenon.

Note 11. Duchin et al. (2010) mention that “the ongoing financial crisis that began in August 2007 as a result of consumer defaults on subprime mortgages has had dramatic effects on the US financial sector.”

Note 12. Provided by Hong Kong Exchanges and Clearing limited.

Note 13. The coefficient of variation is the standard deviation divided by mean. It is interpreted as the amount of volatility per unit of risk.

Note 14. Taiwan implements a managed-float exchange rate system, while China implements a fixed exchange rate system. Thus, the variance of exchange rate between Taiwan and China is small.

Appendix A. Estimates of herding behavior in six Asia-Pacific markets by market indices methods during the whole sample period and two subsample periods

Panel A: the whole sample period (1/1/2006 to 8/31/2009)

Market	Model A				Model B				Model C				
	α	γ_1	γ_2	*Adj-R*^{2}	α	γ^{up}_1	γ^{up}_2	*Adj-R*^{2}	α	γ^{down}_1	γ^{down}_2	*Adj-R*^{2}	γ_2^{up}-γ_2^{down}
Taiwan	0.0161***	0.2776***	-3.6675***	0.1172	0.0162***	0.2456***	-3.8388***	0.0681	0.0160***	0.3043***	-3.6569***	0.1664	-0.1819
China	0.0176***	0.2416***	-2.0384***	0.1294	0.0174***	0.1976***	-2.7870***	0.0525	0.0179***	0.3297***	-2.6532***	0.2572	-0.1337
South Korea	0.0167***	0.2937***	-0.0268	0.3059	0.0162***	0.3910***	-1.9866***	0.2282	0.0170***	0.2026***	1.6500***	0.4420	-3.6366***
Singapore	0.0114***	0.3191***	1.5628***	0.5354	0.0112***	0.3348***	2.4935***	0.5786	0.0118***	0.2839***	1.1527*	0.5016	1.3407
Hong Kong	0.0113***	0.2400***	0.0632	0.4175	0.0113***	0.2719***	-0.0837	0.4247	0.0111***	0.2214***	0.0600	0.4213	-0.1437
Japan	0.0121***	0.2169***	0.1278	0.3370	0.0122***	0.2414***	-0.0144	0.3140	0.0121***	0.1951***	0.3004	0.3662	-0.3147

Panel B: the pre-crisis period (1/1/2006 to 7/31/2007)

Country	Model A				Model B				Model C				
	α	γ_1	γ_2	*Adj-R*^{2}	α	γ^{up}_1	γ^{up}_2	*Adj-R*^{2}	α	γ^{down}_1	γ^{down}_2	*Adj-R*^{2}	γ_2^{up}-γ_2^{down}
Taiwan	0.0150***	0.2154***	-0.7302	0.1227	0.0149***	0.2358**	-3.0119	0.0730	0.0148***	0.2582***	-1.5202	0.1603	-1.4916
China	0.0170***	0.2946***	-2.0234***	0.1622	0.0170***	0.2335**	-2.0844	0.0861	0.0169***	0.5212***	-4.8128***	0.3181	2.7284
South Korea	0.0155***	0.2366***	-1.6384	0.1301	0.0157***	0.2429**	-2.5452	0.0994	0.0151***	0.2448**	-1.3272	0.1584	-1.2180
Singapore	0.0112***	0.1740***	2.5691	0.2823	0.0107***	0.2879***	-0.2534	0.2771	0.0119***	0.0221	6.4240***	0.3236	-6.6774
Hong Kong	0.0096***	0.2067***	1.0716	0.2140	0.0098***	0.1198	7.9801*	0.2679	0.0098***	0.1466*	1.4635	0.1698	6.5166
Japan	0.0110***	-0.0020	3.6516**	0.0926	0.0113***	-0.0650	6.0015**	0.0801	0.0107***	0.0461	2.1217	0.1057	3.8798

Panel C: the post-crisis period (8/1/2007 to 8 31/2009)

Country	Model A				Model B				Model C				
	α	γ_1	γ_2	*Adj-R*^{2}	α	γ^{up}_1	γ^{up}_2	*Adj-R*^{2}	α	γ^{down}_1	γ^{down}_2	*Adj-R*^{2}	γ_2^{up}-γ_2^{down}
Taiwan	0.0179***	0.2024***	-2.9891***	0.0540	0.0181***	0.1686***	-3.1145***	0.0245	0.0178***	0.2245***	-2.8334**	0.0870	-0.2810
China	0.0180***	0.1998***	-1.7248***	0.1072	0.0182***	0.1176***	-1.9066***	0.0310	0.0185***	0.2422***	-1.5195**	0.2425	-0.3871
South Korea	0.0185***	0.2685***	-0.0027	0.2848	0.0180***	0.3856***	-2.2146**	0.1923	0.0189***	0.1580***	1.9091***	0.4703	-4.1237***
Singapore	0.0124***	0.3190***	1.2711**	0.5166	0.0125***	0.3192***	2.3057**	0.5568	0.0126***	0.2894***	0.8632	0.4845	1.4425
Hong Kong	0.0145***	0.1223***	0.8826***	0.3486	0.0152***	0.1197***	0.9838**	0.3540	0.0136***	0.1386***	0.6189	0.3555	0.3649
Japan	0.0149***	0.1667***	0.3068	0.3247	0.0151***	0.1882***	0.1500	0.2975	0.0146***	0.1478***	0.4892	0.3592	-0.3391

Notes: This table reports the estimated coefficients of the following regression models: Model A is the absolute value of a market index return of all sample securities during the whole period, Model B is in rising market and Model C is in declining market. We use t-statistics based on Newey-West (1987) consistent standard errors. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Model A: $CSAD_t = \alpha + \gamma_1|R_{m,t}| + \gamma_2(R_{m,t})^2 + \varepsilon_t$

Model B: $CSAD^{up}_t = \alpha + \gamma^{up}_1|R^{up}_{m,t}| + \gamma^{up}_2(R^{up}_{m,t})^2 + \varepsilon_t$

Model C: $CSAD^{down}_t = \alpha + \gamma^{down}_1|R^{down}_{m,t}| + \gamma_2(R^{down}_{m,t})^2 + \varepsilon_t$

Where $R^{up}_{m,t}$ ($R^{down}_{m,t}$) is the represent market index return during period t when the market is up (down). Besides, we apply Joint Wald Test H_0: γ^{up}_2-γ^{down}_2 = 0 to check the equality of the herding coefficient in both rising and falling markets.

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