EMPIRICAL INVESTIGATION OF HERDING BEHAVIOR IN EAST ASIAN STOCK MARKETS TOWARD THE U.S. MARKET

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ABSTRACT

This paper examines the s*hift of dominance of the American stock market. We also observe herding behavior changes of major Asia Pacific regions towards the American market in the wake of major events that affected financial markets. Events examined include the Asian financial crisis, Internet bubble, September 11 attacks, SARS outbreak, and global financial crisis. Evidence shows the American stock market still held the leading position over the East Asian markets in the wake of these major events. We define the continuing bull (and continuing bear) of the American stock market as the dummy variable of herding behavior. We compare the difference in stock returns before and after structural breaks by investigation into the stock markets in Hong Kong, Taiwan, and Japan. Finally, we propose suitable investment strategies related to herding behavior in the East Asian stock markets toward the American stock market. The examination of out-of-sample profitability revealed the proposed investment strategies contributed to significantly positive average portfolio returns, whether in continuing bull or continuing bear markets.*

JEL: C32, G15

KEYWORDS: Continuing Bull, Continuing Bear, Herding Behavior, Investment Strategy

INTRODUCTION

Trade ties the United States' economy inextricably to markets and economies of the rest of the world. Traded goods and services imply huge tides of financial transaction flow across global borders. U.S. companies and individuals directly invest making themselves the world's largest direct investor in foreign economies. The U.S. also receives more investment from outside its borders than any other nation and has become a world financial capital. The U.S. stock index movement often affects global stock markets.

Asia is one of the world's major emerging markets. Its effect on global economic growth is increasing due to rapid growth of the technology industry. Some major events impacted the Asian financial markets during the late 20th and early 21st century. These include the Asian financial crisis in 1997, the Internet bubble in 2000, the September 11 attacks in 2001, the SARS pandemic in 2003, and global financial crisis in 2008. What kind of impact and influence did these periods bring to Asian stock markets? Will the interrelationships among Asian stock markets change? After the five major events, can we see investment opportunities?

Yang et al. (2007) indicated that the bigger the securities company, the more accurate analysts' earnings forecast. And the more accurate were forecasts made by analysts who analyzed foreign capital. This leads to the idea of examining the stock market in light of foreign capital. Currently, the Pacific area is the mainstream in Asian finance. Our analysis focusses on the interrelationship of stock markets among Pacific countries. Chiao and Wang (2008) investigated clustering patterns of order prices in the Taiwan stock market. They found that investors were front running others' orders to capitalize on opportunities created by integer-price clustering. Their findings led us to wonder if this clustering pattern (or herding

behavior) or a lead-lag relationship (i.e., a dominant market and its followers) existed in Pacific stock markets. Given the existence of a lead-lag relationship, a major dummy variable could then be designed (i.e., the continuing bull (c-bull) and continuing bear (c-bear)) to investigate potential herding behavior and implicated investment manners, with the aim to locate appropriate investment strategies.

Granger's (1969) employed the causality test to analyze lead-lag relationships among Pacific stock markets. However, the exclusive use of causality tests implies neglect of the long-term relationship among variables (Lee, 2005). This paper adopts Lee's (2005) research methodology by first confirming causality among Pacific stock markets. To increase model interpretation, co-integration analysis was employed to verify the co-integration relation of stock indices among different countries. To increase model interpretation, the co-integration test was employed to verify the co-integration relation of stock indices among different countries. Vector Autoregression (VAR) was utilized if there was no sign of co-integration. Furthermore, since the coverage period of the current study was longer, the occurrence of major events in the given period might lead to a structural break in the stock market. Therefore, a structural test was employed to locate the timing of potential structural breaks and to analyze difference (if any) of herding behavior before and after specific timing. Finally, the feature and major contribution of the current study, integrating the dummy variable (i.e., the c-bull and c-bear), casual relation and VAR analysis, consisted in creating a new thought combing the herding behavior and investment strategies so as to draft new investment strategies.

We discuss investment strategy and try to examine if the U.S. stock market still holds the leading place over the East Asian stock markets. Given the U.S. stock market was the leading indicator, c-bull (or c-bear) in the U.S. market would trigger the same phenomenon in countries with lagging indicators. If countries with lagging indicators did not follow the c-bull (or c-bear) in the U.S. market, then herding behavior did not appear. We first use the c-bull (and c-bear) in the U.S. stock market and the herding behavior in Asia Pacific stock markets to draft relevant investment strategies (i.e., buying and selling). Next, we examine if the aforementioned major events led to structural break. Based on structural breaks, we draft investment strategies. We hope to provide investors or investment institutions with new thoughts.

The remainder of the paper is organized as follows: The next section briefly reviews previous research on the U.S. stock market towards the Asian stock markets and herding behavior in stock markets. The following section describes the data and the methodology of Cointegration test, VAR modeling and regression analysis and proposes investment strategies. Next, empirical results based on VAR and regression analysis of continuing bull (continuing bear) are presented. Finally, the paper closes with some concluding comments.

LITERATURE REVIEW

Some studies have suggested the U.S. stock market is a major market that affects the stock markets in other countries (Caporale et al., 2006; Hsin, 2004; Lee et al., 2004). Whether the American stock market still holds the leading place in the wake of the aforementioned five major events is unknown. Therefore, we examine if the American stock market is challenged by other stock markets due to five major events. The following is a brief introduction to the previous research on American and Asian stock markets.

Chang (2002) found volatile exchange rate movement during the Asian financial crisis led global investors to re-evaluate the importance of currency exposure in Asian stock markets. Ho and Wan (2002) found that intervention is significant in the case of Hong Kong and Singapore due to the Asian financial crisis in 1997. The authors find the hypothesis of covariance stationary cannot be rejected after the effects of the financial crisis have been properly filtered. Hsin (2004) revealed the existence of significant international transmission effects among major world markets, both in terms of returns and volatility, and mostly in a positive direction. The U.S. market, as expected, is the leading market in the sense that it has the most pervasive and significant impact on all markets across continents. Lee et al. (2004) discovered, in the 1980s and early 1990s, the NASDAQ's success helped prompt Singapore, Japan, Taiwan, and South Korea to set up or formalize their own second board markets.

Michayluk and Neuhauser (2006) found the stock market decline in 1997 was preceded by new information that affected the fundamental values of U.S. firms. They provided a detailed description of U.S. stock returns surrounding the Asian financial crisis. The results were indicative of investor overreaction in times of market crisis. Caporale et al. (2006) examined international transmission of the Asian financial crisis in 1997 and estimated for US, European, Japanese and South East Asian daily stock market returns. He found the phenomenon of volatility spillovers existed in all cases. Liu and Hsu (2006) examined the relationship between the financial development and the source of growth for Taiwan, South Korea, and Japan economies. They found that stock market development had positive effects on Taiwan's economic growth. The Taiwanese economy suffered less from the Asian financial crisis.

Herding behavior is used to describe the interaction between investors trading in 1990. Herd behavior is a common phenomenon in human society. It refers to members of other groups of people adopting behaviors and opinion tendencies. This behavior is considered to be characteristic of less mature rational investors, because the use of their own information and knowledge will lead to higher costs. So they try to imitate or follow the successful financial activities master investors.

Scharfstein and Stein (1990) consider reputation-based issues. In some cases, managers ignore their private information, while imitating other managers' investment decisions. If this occurs, the market will exhibit herding behavior characteristics. Whether rational or irrational, the results likely to lead to herding behavior. Irrational investors focus on psychological factors but ignore their beliefs and show blind compliance to follow other investors. Due to a lack of information in the market, investors follow the consensus and mimic the decisions of others. In contrast, rational investors focus on principal-agent problems. Managers ignore their own private information completely, not just to imitate the behavior of others, but to maintain their reputation in the market. When investors have a common view of preference or aversion on certain characteristics of the stock or investment program, investors may have the same investment decision and the herding phenomenon is formed (Del Guercio, 1996; Falkensetin, 1996; Wermer, 1999).

Herding behavior rebacked in the stock market according to Christie and Huang (1995). They used the cross-sectional standard discrete level to describe herding behavior. Chang et al. (2000) revised the cross-sectional absolute deviation (CSAD) pricing model to view different markets among market participants as to whether investment behavior has a tendency to herd. Researchers also used CSAD to analyze stock returns, Gleason et al. (2004), Tan et al. (2008), and Chiang and Zheng (2010). Saastamoinen (2008) and Chiang et al. (2010) used the quantile regression model to observe herding behavior. We have a different explanation of herding behavior from the analysis mentioned above. This study incorporates the relevant continuing bull and continuing bear markets as a dummy variable of herding behavior from the leading market of US to identify suitable investment strategies for East Asia stock markets.

DATA AND METHODOLOGY

We use daily stock indices and returns from the Taiwan Economic Journal database. The data are available for eight markets including the Dow Jones Industrial Average (Dow Jones), NASDAQ Composite (NASDAQ), TaiEx Stock Index (TaiEx), Nikkei Stock Average (Nikkei), Hang Seng Index (HSI), KOSPI Composite Index (KOSPI), Shenzhen Composite (Shenzhen), and SSE Composite Index (SSEI), from January 1995 to December 2009. In terms of out-of-sample information, five markets daily data for stock indices, including the TaiEx, Dow Jones, Nikkei, HSI, and KOSPI were used during the sample period from 2010 to 2013.

Andrews (1993), Andrews and Ploberger (1994) proposed the use of various tests to analyze structural breaks. These tests include the Quandt-Andrews breakpoint test as well as others analyses such as Wald, Lagrange multiplier, and Likelihood ratio-like Tests. The underlying principle is consistent in that each observation is examined by the Chow test, whose F statistic decides if structural breaks occurred in each observation. If the F-statistic is smaller than the threshold, then the time series has stationary series of

structural breaks. By contrast, if the F-statistic is larger than the threshold, then the time series is the unit root series without structural break.

Traditional econometric models were built upon a priori theory meaning that before the lead-lag relationship could be confirmed regression analysis was conducted with the hypothesis that one variable was the explanatory variable of another variable. The empirical results, thus, were not convincing. Sims (1980) proposed the use of Vector Autoregression (VAR) model to solve problems concerning structural models. In VAR, a set of variables (called endogenous variables) formed a set of regression models. Each endogenous variable was put into time series analysis, and variables in each regression were added to defer items taken as explanatory variables. Since causality among variables and a priori theory were not needed in the VAR model, the model could be used to analyze the interrelationship among various variables. VAR could be illustrated in equation (1):

$$Y_t = \alpha + \sum_{s=1}^{m} \beta_s Y_{t-s} + \mu_t \quad (1)$$

where Y_t stands for the linear stochastic process with covariance stationary collected in a n×1 vector, α is constant matrix, β_s (s=1…,m) is the coefficient matrix in a given deferred period, Y_{t-s} (s=1…,m) is the deferred item of endogenous variable at time *m*, μ_t is the disturbance and meets $e(t) \sim N(0, \sigma_\mu^2)$, signifying the white noise in a n×1 vector.

Since the moving trend of a stock index was generally stochastic and might be non-stationary, the direct use of regression analysis among stock indices might lead to spurious regression. To avoid the occurrence of spurious regression, the current study first examined whether the stock indices of different countries were stationary; that is, to examine if root unit existed in variables. Therefore, Said & Dickey's (1984) Augmented Dickey-Fuller unit root test was employed to analyze the stationarity of variables. The results showed the stock indices of different countries were non-stationary. Portfolio return was significant at the 1% level, which denied the null hypothesis of non-stationarity. That is, variables become stationary after first-order difference (i.e., I(1)). Thus, in this study, the stock index information of different countries refers to the portfolio return.

With differencing, long-term information of data might be destroyed and not able to show proper behavioral influence in a model. To retain the long-term stationary relationship of data we apply cointegration so as to increase model interpretation. This study uses the cointegration test to verify the relationships among different countries. If cointegration exists, vector error correction model (VECM) was employed for verification. Vector autoregression (VAR) was utilized if there was no sign of cointegration. Further, maximum-likelihood (Johansen, 1988), trace test (Johansen & Juselius, 1990), and multivariate cointegration analysis (Hsu & Lee, 2005; Lee, 2005) are employed to examine if cointegration relations exists among stock indices of different countries.

After identifying the lead-lag relationship of stock markets among different countries via causality tests, the variable dummy of continuing bull (c-bull) and continuing bear (c-bear) of the portfolio return of leading stock market is defined as an independent variable, while the portfolio returns of other stock markets are defined as dependent variables. The $y_{i,t}$ portfolio return is defined as the dependent variable and could be expressed in Equation 2:

$$y_{i,t} = \alpha_1 + \beta_1 y_{i,t-1} + l_p \sum_{p=2}^{6} pda_{t-1} + m_q \sum_{q=2}^{6} qdb_{t-1} + e_t \quad (2)$$

where da (db) is the dummy variable to the portfolio return of herding behavior towards the portfolio of the leading stock market, p and q refer to the days of c-bull and c-bear of the portfolio of the leading stock market, $y_{i,t}$ is defined as portfolios of non-leading stock markets for i market at time t, β_1 is the coefficient of y_i for time t-1, and l_p/m_q respectively represent the coefficient of determination of the c-bull and c-bear for p days and q days, α_1 is constant. Without considering transaction costs and short selling restrictions, the proposed investment strategies in this study are as follows:

In times of c-bull market, if the coefficient of determination l_p is significant and larger than 0, investors

are advised to buy the stock of the lagging stock market with the c-bull of the leading market for p+1 days. If l_{p+1} is insignificant, investors are advised to sell the stock of the lagging stock market with the c-bull of the leading market for p+2 days. If l_p and l_{p+1} are both significant, investors are recommended to hold the stock without selling. In times of a c-bull market, if $l_{p\ is}$ smaller than 0 or l_p is insignificant, and buying or selling strategies are not recommended.

In times of a c-bear market, if the coefficient of determination m_q is significant and smaller than 0, short selling of the lagging stock with the c-bear of the leading stock market for q+1 days is suggested. If m_{q+1} is insignificant, investors are encouraged to buy the stock of the lagging market with the c-bear of the leading market for q+2 days. If m_q and m_{q+1} are significant, investors are recommended to hold the stock without purchasing. In times of a c-bear market, if m_q is insignificant or m_q is larger than 0, buying/selling strategies are not recommended.

This paper uses causality test to analyze the lead-lag relationship among Pacific stock markets. To find possible structural breaks, we perform the structural tests on Pacific stock markets with causality tests and VAR analysis. The major feature and contribution of the study consists in the adding of dummy variables (i.e., c-bull and c-bear) to integrate herding behavior and draft new investment strategies. The profitability of investment strategies is also a focus of the paper. To examine the profitability of proposed investment strategies, the current article, without considering transaction costs and short selling restrictions, examines out-of-sample profitability of weighted price indices among different countries with the sample period from Jan. 1st 2010 to Dec. 31st 2013. A paired-sample t-test is used to examine if there are any significant differences in portfolio returns between investment strategies and weighted price indices. The calculation of average portfolio returns of investment strategy combinations is illustrated in equation (3):

$$\bar{R_J} = \left[\prod_{i=1}^{T}(1 + R_{i,j})\right]^{1/T} - 1 \qquad (3)$$

where T is the number of portfolio, Ri,j is the portfolio return of investment strategy of i, and j denotes the lagging stock market.

RESULTS AND DISCUSSION

Summary Statistics

Table 1 presents summary statistics of stock index daily returns. Panel A shows summary statistics of the average index daily returns of eight stock markets for the full sample. Summary statistics of average index daily returns of five markets data for out-of-sample are shown in Panel B. Table 1 reveals Mainland China having the highest average daily returns but the Japan, South Korea, and Taiwan showing negative returns over the 1995 to 2009 sample period. By the end of 2012, Prime Minister Shinzo Abe task the big push, Abe Economics, trying to loosen monetary policy, introducing massive economic stimulus measures and structural reforms in this market, reversing years of Japan's economic predicament. Japan shows higher average daily returns, while Hong Kong and Taiwan still shown negative average returns over the out-of-sample period.

The run chart of stock indices of different countries in the wake of major financial events is illustrated in Figure 1. The results show that stock markets in the U.S. and Mainland China were not affected by the Asian financial crisis (see the Dow Jones in Chart A and the NASDAQ, SSEI, and ShenZhen in Chart A). The Japan and Taiwan, the Nikkei and TaiEx in Chart A were influenced to a certain extent, and that the South Korea and Hong Kong were severely affected, with a considerable amount of collapse (see KOSPI in Chart B and HSI in Chart A). While the Internet bubble did not lead to an obvious drop in the Dow Jones, and the NASDAQ suffered from a severe falls, leading to sharp drops in the stock markets in Hong Kong, Taiwan, and Japan. South Korea was affected to some extent, but Mainland China was not impacted greatly.

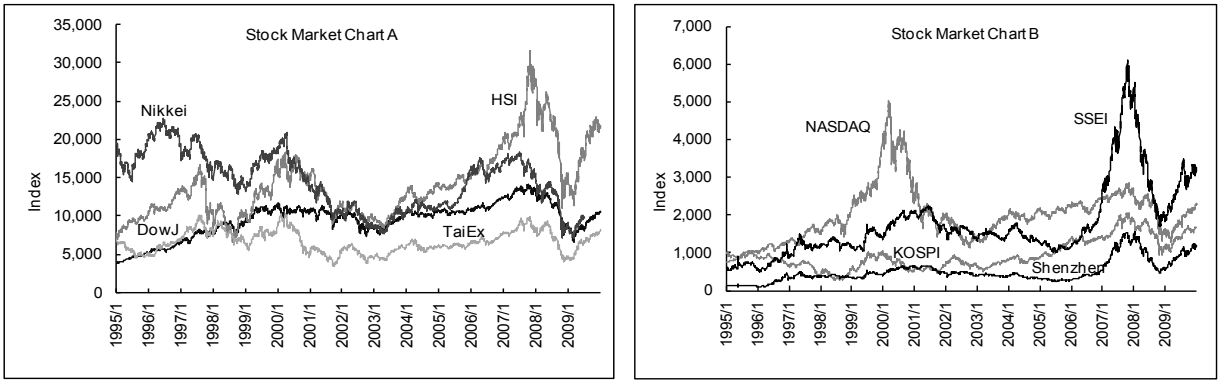
Table 1: Summary Statistics for Indices Return Using Closing Prices

	DowJ	Nikkei	HSI	KOSPI	TaiEx	NASDAQ	SSEI	Shenzhen
Panel A: statistics for the period of January 1995 to December 2009								
mean	0.02%	-0.03%	0.01%	-0.00%	-0.01%	0.01%	0.03%	0.04%
Std. Dev.	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
min	-8.20%	-12.11%	-14.73%	-12.80%	-6.98%	-16.66%	-17.91%	-18.88%
max	10.51%	13.23%	17.25%	11.28%	6.52%	16.66%	26.99%	24.91%
n	3,816	3,688	3,712	3,907	3,904	3,806	3,642	3,634
Panel B: statistics for the period of January 2010 to December 2013								
mean	0.04%	0.03%	-0.00%	0.01%	-0.00%	-	-	-
Std. Dev.	0.01	0.02	0.01	0.01	0.01	-	-	-
min	-5.71%	-42.15%	-5.83%	-6.42%	-5.74%	-	-	-
max	4.15%	44.93%	5.52%	4.90%	4.46%	-	-	-
n	1,006	984	986	994	994	-	-	-

This table shows summary statistics of indices returns using closing prices for the full sample and out-of-sample period. Panel A shows descriptive statistics of indices daily returns on indexes such as the Dow Jones Industrial Average (Dow Jones), NASDAQ Composite (NASDAQ), TaiEx Stock Index (TaiEx), Nikkei Stock Average (Nikkei), Hang Seng Index (HSI), KOSPI Composite Index (KOSPI), Shenzhen Composite (Shenzhen), and SSE Composite Index (SSEI). The data covers the period of 1995-2009. Panel B summarizes descriptive statistics of indices daily returns such as the Dow Jones, TaiEx, Nikkei, HSI, and KOSPI for the out-of-sample period of 2010-2013. The mean of average index returns are computed using the equation of $\bar{R}_J = \left[\prod_{i=1}^{T}(1 + R_{i,j})\right]^{1/T} - 1$.

The September 11 attacks seriously damaged Wall Street and led to a sharp drop in the Dow Jones Industrial average. The NASDAQ was not significantly affected, probably because NASDAQ had not recovered from the Internet bubble at that time. The Taiwan, Tokyo, and Hong Kong markets were slightly affected, but South Korea and Mainland China were barely influenced. SARS started in February 2003, becoming a pandemic in April, severely impacting the global economy and financial markets. Although SARS did not strike Japan, its tourism received considerable impact. Finally, the announcement of the bankruptcy of Lehman Brothers Holdings Inc. (the fourth largest investment bank in the U.S.) in September 2008 and the acquisition of Merrill Lynch (the third largest investment bank) by Bank of America led to a domino effect in the global stock markets, starting the global financial crisis.

Figure 1**:** Stock Market Chart of Major Events



This figure the daily stock indices of the U.S stock market and Asian stock markets

Cointegration Test and Causality Test

To examine the stationary of stock index series, we employ the augmented Dickey-Fuller (ADF) unit root test to analyze original stock index data. The results show the P-value is insignificant whether in (intercept, intercept and trend) or in (no intercept, and no trend), suggesting that stock indices had unit root. After the analysis of first order differences, we employ the ADF unit root test again, and find the P-value is significant whether in (intercept, intercept and trend) or in (no intercept, and no trend), indicating a stationary time series after the difference. However, the time series of stock indices would expel inferred long-term information of data after differencing. Therefore, a cointegration test is employed to

examine if a cointegration relationship exists in stock indices among different countries. The results indicate the absence of cointegration. Further, we use a Vector Autoregression (VAR) model to analyze consequent impulse response and variance decomposition. Before the VAR analysis, we examine country-specific data via a causality test. The results reveal the Dow Jones holds the leading position and others showed signs of lagging behind. Pacific stock markets are affected by the U.S. stock market. Mainland China, Shenzhen and SSEI are also influenced by the Dow Jones and NASDAQ, suggesting that the U.S. stock market, connected with the world, is still influential in the stock markets of Mainland China. The fact that the Dow Jones holds the leading position in stock markets also implies that herding behavior existed in the Pacific stock markets toward the Dow Jones. This paper, therefore, aimed to identify possible effects of the U.S. stock market (continuing bull (c-bull) and continuing bear (c-bear)) on Pacific stock markets and to uncover suitable investment strategies based on the analysis.

VAR, Impulse Response, and Variance Decomposition

Once no cointegration relationship among stock indices, VAR could be directly utilized to analyze consequent impulse response and variance decomposition. The impulse response of Pacific stock markets reveals that, in addition to the influence from itself, Pacific stock markets are affected by U.S. stock markets (in particular, the Dow Jones). The relationships among Shenzhen and other Pacific stock markets are weak (SSEI does not affect Shenzhen, either). The portfolio return of the SSEI is affected not only from internal effects but also by the Shenzhen. However, the SSEI isn't highly affected by other Pacific markets.

In addition, the variance decomposition of Pacific stock markets allow for a better understanding of the relationship of portfolio returns among Pacific stock markets. Variance decomposition of Taiwan, Hong Kong, Japan, and South Korea stock markets reveal that these four stock markets are affected by Dow Jones and from within. Other stock markets had relatively lower effects on these four countries. Therefore, this paper focuses on the influence of the Dow Jones and from within. Variance decomposition of stock index returns of the Dow Jones reveals that influence from within reached 99.36%, uninfluenced by Pacific stock markets. The NASDAQ only contributes a minimum influence of 0.03%. Variance decomposition of the NASDAQ shows influence from the Dow Jones reached 56.4%, while the influence from within is 42.97%. Pacific stock markets had little influence on the NASDAQ, and thus may be not considered. The variance decomposition of portfolio returns of the Shenzhen suggests the influence from within reached 96.58%, followed by that from Hong Kong (1.98%). Portfolio returns of others barely had any influence on the Shenzhen. Variance decomposition of portfolio returns of the SSEI suggested the influence from itself is only 16.47%. The biggest influence comes from the Shenzhen (79.19%), followed by HSI (2.20%). Portfolio returns of others Pacific stock markets barely had any influence on SSEI.

Regression Analysis of Herding Behavior

Tests show the Dow Jones holds a leading position over the TaiEx, Nikkei, HSI, KOSPI, Shenzhen, and SSEI. VAR analysis reveals that Shenzhen and SSEI are less influenced by the Dow Jones. Although the Dow Jones holds a leading position over Shenzhen and SSEI, its influence on the Shenzhen and SSEI is small. Therefore, we did not include stock markets in China with regard to investment strategy discussions.

The regression analysis of the sample period is listed in Table 2, in which daily returns of the TaiEx, Nikkei, HSI and KOSPI are the dependent variable, while the c-bull/c-bear of the Dow Jones for 2 to 6 days are the independent variables. The regression aims to examine if the c-bull and c-bear market of the Dow Jones for 2 to 6 days affected the TaiEx, Nikkei, HSI and KOSPI. That is to observe if herding behavior in the Pacific stock markets existed towards the c-bull and c-bear of the Dow Jones for 2 to 6 days.

In Table 2, regression analysis of the c-bull and c-bear of the Dow Jones for 2 to 6 days on the TaiEx, Nikkei, HSI and KOSPI reveal that all coefficients l_2 are significant at the 1% level. The c-bull of the

Dow Jones for 3 to 5 days on the TaiEx and KOSPI are insignificant. The coefficients l_3 of the c-bull of the Dow Jones for 3 days on the Nikkei and HSI are significant at the 5% and 1% level, respectively. However, the c-bull for 4 to 6 days does not yield a significant effect except for 4 days on the HSI. The results imply that TaiEx and KOSPI investors do not follow herding behavior after a 3-day c-bull of the Dow Jones. Investors, thus, are advised to sell their stock after a 3-day c-bull of the Dow Jones. Investors in the Nikkei do not follow herding behavior after a 4-day c-bull of Dow Jones, they are advised to sell their stock after the 4-day c-bull. Investors in the HIS are advised to sell their stock after the 5-day c-bull.

Table 2**:** Regression Analysis of Herding Behavior for Full Sample Period

$y_{i,t}$	TaiExR	NikkeiR	HSIR	KOSPIR
$y_{i,t-1}$	0.0158	-0.0750	-0.069	-0.0033
	(0.76)	(-2.73)**	(-1.60)	(-0.13)
$da2_{t-1}$	0.0031	0.0039	0.0056	0.0037
	(3.75)***	(4.70)***	(6.16)***	(3.69)***
$da3_{t-1}$	0.0019	0.0031	0.0037	0.0023
	(1.74)	(2.93)**	(3.45)***	(1.88)
$da4_{t-1}$	0.0023	0.0013	0.0058	0.0032
	(1.84)	(0.89)	(4.25)***	(1.94)
$da5_{t-1}$	0.0021	0.0044	0.0037	0.0008
	(1.14)	(2.29)*	(2.06)*	(0.30)
$da6_{t-1}$	0.0005	-0.0023	0.0005	-0.0001
	(0.21)	(-1.02)	(0.22)	(-0.03)
$db2_{t-1}$	-0.0023**	-0.0042***	-0.0032**	-0.0037**
	(-2.62)	(-4.63)	(-3.15)	(-3.22)
$db3_{t-1}$	-0.0037	-0.0058	-0.0074	-0.0068
	(-2.94)**	(-4.55)***	(-4.99)***	(-4.02)***
$db4_{t-1}$	-0.0041	-0.0063	-0.0083	-0.0083
	(-1.65)	(-3.03)**	(-2.82)**	(-3.13)**
$db5_{t-1}$	-0.0053	-0.0029	0.0036	0.0014
	(-1.73)	(-0.69)	(0.88)	(0.29)
$db6_{t-1}$	-0.00646	-0.0151	-0.00865	-0.0166
	(-1.11)	(-2.24)*	(-1.22)	(-2.76)**
Intercept	-0.0002	0.0001	-0.0002	0.0000
	(-0.55)	(0.31)	(-0.51)	(0.09)
N	3,110	3,139	3,133	3,159

This table shows the regression estimates of the equation: $y_{i,t} = \alpha_1 + \beta_1 y_{i,t-1} + l_p \sum_{p=2}^{6} pda_{t-1} + m_q \sum_{q=2}^{6} qdb_{t-1} + e_t$ *Estimates were made using ordinary least squares regressions of the four East Asian stock markets. The variable* $y_{i,t}$ *denotes the dependent variable of stock index daily returns of the TaiEx Stock Index (TaiExR), Nikkei Stock Average (NikkeiR), Hang Seng Index (HSIR), and KOSPI Composite Index (KOSPIR) for full sample period. The independent variables (1)* $y_{i,t-1}$*; (2)* $da2_{t-1}$*~*$da6_{t-1}$*, denote the dummy variable of continuing bull of Dow Jones Industrial Average (Dow Jones) for 2 to 6 days; and (3)* $db2_{t-1}$*~*$db6_{t-1}$*, denote the dummy variable of continuing bear of Dow Jones for 2 to 6 days. N is the number of observations. The figures in each column are the regression coefficient. The t-statistics are in parentheses. ***, **, * indicate significance at the 1, 5, and 10 percent levels respectively.*

In terms of the c-bear of the Dow Jones for 2 to 4 days, the coefficient $m_{2/3/4}$ of the portfolio returns of the Nikkei, HSI, and KOSPI are significant at either the 1% or 5% level. The c-bear of the Dow Jones for 2 to 3 days, the coefficient $m_{2/3}$ of the portfolio returns of the TaiEx is significant at the 5% level. The coefficient m6 of the portfolio returns of the KOSPI in the c-bear for 6 days are significant at 5% level. The results indicated that although investors do not follow herding behavior after a 5-day c-bear of the Dow Jones, the c-bear for 6-day would affect investors in the Nikkei and KOSPI. The effect of the c-bear of the Dow Jones is significant in the first two days. The c-bear for 4 to 6 days does not yield significant effect.

Regression Analysis on Herding Behavior after Structural Breaks

This section focuses on structural breaks result from the impact of major financial events (collected in the sample period from 1995 to 2009) on stock markets. The results of structural analysis, with the portfolio returns of the TaiEx, Nikkei, HSI, and KOSPI being separate dependent variables and the portfolio return of the Dow Jones being the independent variable, indicated that to Taiwan, structural breaks occurred in the wake of the September 11 attacks. Japan experienced a structural break during the outbreak of SARS.

Since Hong Kong was caught in the Asian financial crisis in 1998, the structural analysis of the HSI reveals that certain structural breaks occurred during the financial crisis. However, a structural break was not found in the KOSPI. According to the structural break test, the TaiEx, Nikkei, and HSI all experienced certain structural breaks, except for KOSPI. Regression analysis on structural breaks before and after the major financial events is examined to determine if major financial events led to changes in herding behavior and investment strategies. As we learned the c-bull of the Dow Jones for 2 days significantly affected the portfolio return of the TaiEx over the full sample period. The results in Table 3 show that before the September 11 attacks, the 2-day c-bull of the Dow Jones significantly affected TaiEx portfolio returns at the 10% level, while the c-bull for 3 to 6 days insignificantly affected the TaiEx. In the wake of September 11, however, the c-bull of the Dow Jones for 2 days and 4 days significantly affected TaiEx portfolio returns at the 1% and 10% levels, suggesting the TaiEx stock market shows herding behavior towards the c-bull of the American stock market in the wake of September 11.

The c-bear of the Dow Jones for 2 days and 3 days significantly affected the portfolio return of the TaiEx. Before the September 11 attacks, the c-bear of the Dow Jones for 3 days and 6 days significantly affected TaiEx portfolio returns at 10% and 1% level, while other conditions did not yield significant effects. However, in the wake of September 11, the c-bear of the Dow Jones for 2 days and 6 days significantly affected TaiEx portfolio returns at the 1% and 5% levels respectively, indicating that herding behavior in the TaiEx towards the c-bear strengthened in the wake of the September 11 attacks. Therefore, in the wake of September 11, investment strategies of the September 11 attacks should be adjusted to short selling with the c-bear for 2 days, and investors should buy the stock back the next day for liquidation. Given the c-bear for 6 days, short selling is suggested when the stock market opens and investors are advised to buy the stock back the next day for liquidation.

Table 3: Regression Analysis of before and after the Financial Events

$y_{i,t}$	TaiExR(1)	TaiExR(2)	NikkeiR(1)	NikkeiR(2)	HSIR(1)	HSIR(2)
$y_{i,t-1}$	0.0526	-0.0259	-0.0814	-0.076	-0.103	-0.0604
	(1.59)	(-0.96)	(-2.88)**	(-1.57)	(-0.74)	(-1.57)
$da2_{t-1}$	0.0026	0.0036	0.0036	0.0042	0.0056	0.0057
	(2.01)*	(3.46)***	(3.11)**	(3.61)***	(2.51)*	(5.66)***
$da3_{t-1}$	0.002	0.0021	0.0032	0.0032	0.0051	0.0032
	(1.12)	(1.58)	(2.09)*	(2.16)*	(2.30)*	(2.61)**
$da4_{t-1}$	0.0016	0.0032	0.0005	0.0024	0.0041	0.0064
	(0.77)	(2.07)*	(0.24)	(1.41)	(1.72)	(3.90)***
$da5_{t-1}$	0.0008	0.0039	0.0046	0.0041	-0.0012	0.0057
	(0.33)	(1.55)	(1.75)	(1.48)	(-0.38)	(2.70)**
$da6_{t-1}$	-0.0000	0.0024	-0.0027	-0.0007	0.0066	-0.00266
	(-0.01)	(0.80)	(-1.04)	(-0.18)	(1.92)	(-0.89)
$db2_{t-1}$	-0.0002	-0.0041	-0.0031	-0.0056	-0.003	-0.0032
	(-0.13)	(-3.61)***	(-2.82)**	(-3.67)***	(-1.31)	(-2.88)**
$db3_{t-1}$	-0.0046	-0.003	-0.0054	-0.0064	-0.011	-0.0065
	(-2.41)*	(-1.78)	(-3.32)***	(-3.05)**	(-3.32)***	(-3.98)***
$db4_{t-1}$	-0.0043	-0.0038	-0.0041	-0.01	-0.0197	-0.0057
	(-1.16)	(-1.16)	(-1.53)	(-3.11)**	(-1.59)	(-2.57)*
$db5_{t-1}$	-0.0018	-0.0078	0.0018	-0.0099	-0.0037	0.0056
	(-0.51)	(-1.70)	(0.48)	(-1.15)	(-0.88)	(1.14)
$db6_{t-1}$	0.0146	-0.0163	-0.0081	-0.022	0.0315	-0.0129
	(3.47)***	(-2.94)**	(-2.24)*	(-1.78)	(27.49)***	(-2.03)*
Intercept	-0.0008	0.0003	-0.0003	0.0006	-0.0002	-0.0003
	(-1.37)	(0.56)	(-0.59)	(0.96)	(-0.20)	(-0.51)
N	1,375	1,735	1,707	1,432	634	2,499

This table shows the regression estimates of the equation: $y_{i,t} = \alpha_1 + \beta_1 y_{i,t-1} + l_p \sum_{p=2}^{6} pda_{t-1} + m_q \sum_{q=2}^{6} qdb_{t-1} + e_t$. *This table shows two sets results of ordinary least squares regressions of the three East Asian stock markets. The $y_{i,t}$ denotes the dependent variable of stock index daily returns of TaiEx Stock Index (TaiExR(1)), Nikkei Stock Average (NikkeiR(1)), and Hang Seng Index (HSIR(1)) for the sample period before major financial events. The TaiExR(2), NikkeiR(2), and HSIR(2) are over the sample period after major financial events. The independent variables are (1) $y_{i,t-1}$; (2) $da2_{t-1}$~$da6_{t-1}$, denote dummy variable of continuing bull of Dow Jones Industrial Average (Dow Jones) for 2 to 6 days; and (3) $db2_{t-1}$~$db6_{t-1}$, denote dummy variable of continuing bear of Dow Jones for 2 to 6 days. The N is the number of observations. The figures in each column are the regression coefficient. The t-statistics are in parentheses. ***, **, * indicate significance at the 1, 5, and 10 percent levels respectively.*

The regression results of the Nikkei in Table 3 indicated that the c-bull of the Dow Jones for 2 and 3 days significantly affected Nikkei portfolio returns during the full sample period. In terms of its performance before and after the outbreak of SARS, only the Dow Jones c-bull for 2 days significantly affected Nikkei portfolio returns, suggesting that herding behavior towards the Dow Jones c-bull weakened after the SARS event. The Dow Jones c-bear for 2 to 4 days significantly affected the Nikkei. While the Dow Jones c-bear for 2 and 3 days significantly affected the Nikkei before SARS, the c-bear of the Dow Jones for 2 to 4 days contributed to significant effects after SARS, pointing out that herding behavior towards the c-bear of the Dow Jones deepened after the SARS event. The results from the sample period also reveal that the lagging portfolio return of the stock had significantly negative effect on the portfolio return of the Nikkei. While the lagging portfolio return of the stock had significantly negative effect on the portfolio return of the Nikkei before the outbreak of SARS, the lagging portfolio return of the stock, after the outbreak of SARS, did not yield a significantly negative effect. This might suggest that originally, the preceding portfolio return of the stock has significantly negative effect on the portfolio return of the Nikkei Stock Average. However, the Nikkei Stock Average was gradually affected by American stock after SARS, while the preceding portfolio return of the stock contributed little influence.

Based on statements, after the outbreak of SARS, investment strategies of the Nikkei should be adjusted to buying stock after the 2-day Dow Jones c-bull and to selling the stock the next day. Given the c-bear of the Dow Jones for 2 days, short selling is suggested when the stock market opened and investors are advised to buy the stock back for liquidation when the Dow Jones stopped dropping or after the 4-day c-bear.

In addition, the results suggest the HSI experienced a structural break during the Asian financial crisis. During the full sample period, the c-bull and c-bear of the Dow Jones for 2 to 4 days significantly affected HIS portfolio returns. Before the Asian financial crisis, only the c-bull of the Dow Jones for 2 and 3 days significantly affected the HSI at the 10% level. However, the c-bull of the Dow Jones for 2 to 4 days all significantly affected HSI, suggesting that herding behavior towards the U.S. stock market deepened after the financial crisis. In terms of the effect of c-bear of the Dow Jones on the HSI, the c-bear for 3 and 6 days significantly affected the HSI before the Asian financial crisis. However, after the Asian financial crisis, the c-bull of the Dow Jones for 2, 3, 4, and 6 days significantly affected the portfolio return of the HSI at 5%, 1%, 10%, and 10% level, respectively. The results imply that the herding behavior towards the Dow Jones deepened after the Asian financial crisis. Therefore, relevant investment strategies after the Asian financial crisis should be adjusted to buying the stock after the c-bull of the Dow Jones for 2 days, and to the selling the stock when the Dow Jones went down or experienced a 5-day c-bull. Short selling of the HSI is advised with c-bear of the Dow Jones for 2 days. Investors are advised to buy the stock back when the Dow Jones stopped dropping or after the 3-day c-bear.

As we have shown, the structural break was not carried against the stock market in South Korea. The regression results showed that, during the sample period, investors are suggested to buy the stock after the c-bull of the Dow Jones for 2 days and sell the stock the next day. Short selling of South Korea stocks is advised after the c-bear of the Dow Jones for 2 days. Investors should buy the stock back when the Dow Jones stopped dropping or after the 4-day c-bear. Short selling of South Korea stocks is advised after the c-bear of the Dow Jones for 6 days and stocks should be bought back for liquidation the next day.

Analysis of Out-of-Sample Investment Strategies

To examine the profitability following the proposed investment strategies, without considering the transaction cost and the short selling restrictions, we examine the out-of-sample profitability of equal weighted price indices among different countries with the sample period of January 1st 2010 to December 31st 2013. We further employ a paired-sample t-test to identify significant differences in portfolio return between investment strategies and stock market indices. According to the aforementioned structural analysis, except for the KOSPI, the TaiEx, Nikkei, and HSI all experienced certain breaks. Regression analysis on the sample period was carried out to perform out-of-sample verification, exclusive of the KOSPI. The results of the paired-sample t-test, presented in Table 4, reveal the proposed investment

strategies contributed to significantly positive average portfolio returns, whether in c-bull or c-bear market.

Table 4**:** Profitability on Out-of-Sample

	TaiExR	NikkeiR	HSIR	KOSPIR
Period：2010/01/01 to 2013/12/31				
Average portfolio return of continuing bull strategies	0.390%	0.584%	0.518%	0.489%
	(4.77)***	(5.01)***	(5.69)***	(5.38)***
Average portfolio return of continuing bear strategies	0.452%	0.364%	0.339%	0.389%
	(4.22)***	(2.79)***	(3.13)***	(3.82)***
Average daily indices return for out-of-sample period	-0.001%	0.034%	-0.001%	0.011%

This table shows the investment profitability of the TaiEx Stock Index, Nikkei Stock Average, Hang Seng Index, and KOSPI Composite Index for the out-of-sample. The results show the calculation of the equation: $\overline{R_j} = \left[\prod_{i=1}^{T}(1 + R_{i,j})\right]^{1/T} - 1$. *This table shows the results of average portfolio return of the TaiEx Stock Index (TaiExR), Nikkei Stock Average (NikkeiR), Hang Seng Index (HSIR), and KOSPI Composite Index (KOSPIR) for the out-of-sample over January 1st 2010 to December 31st 2013. The paired-samples t-statistics are in parentheses. *** indicates significance at the 1 percent levels.*

CONCLUDING COMMENTS

This paper examines the shift of the U.S. stock market and the herding behavior of the major Asian Pacific regions toward the U.S. market. To investigate the lead-lag relationship among the American stock market and the markets in Asia Pacific regions, causality tests and a Vector Autoregression model are employed to examine the interrelationship of stock markets among different countries (i.e., the U.S., Taiwan, Hong Kong, Japan, South Korea, and Mainland China). We use daily stock indices for 8 markets including Dow Jones Industrial Average (Dow Jones), NASDAQ Composite, TaiEx Stock Index, Nikkei Stock Average, Hang Seng Index, KOSPI Composite Index, Shenzhen Composite, and SSE Composite Index. The results suggest that the U.S. stock market still dominates in East Asian economies, even during five major financial events.

After locating the lead-lag relationship of sample markets, dummy variables of continuing bull and continuing bear of the portfolio returns of leading stock markets are defined as independent variables, while portfolio daily returns of other markets are defined as dependent variables. We use regression to investigate the effects of continuing bull and continuing bear of the Dow Jones for 2 to 6 days towards East Asian markets. On the premise of the U.S. stock market as the leading indicator a structural break occurred, revealing that herding behavior in Pacific markets toward the continuing bull or continuing bear is asymmetric. The continuing bear yields larger influence in Pacific markets. According to the findings, we propose suitable investment strategies on herding behavior in East Asian stock markets.

Finally, this study suggests investment strategies to verify out-of-sample profitability of the stock market in each country based on data from January 1st 2010 to December 31st 2013. The results show that proposed investment strategies contributed significantly to positive average portfolio returns in the Taiwan, Japan, Hong Kong, and South Korea market, whether in continuing bull or continuing bear of the Dow Jones.

The contribution of this study is the finding of a major leader and follower relationship among the U.S. market and the East Asian markets. Given the existence of a lead-lag relationship, we design a dummy variable, the continuing bull and continuing bear, to investigate the phenomena of herding behavior and propose suitable investment strategies. However, the stock markets in different countries may have their own characteristics. The results can only be applied to a particular sample and may not be inferred to other countries. Follow-up studies may be able to extend to other stock markets.

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