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Time-varying market wide herding behavior:spot equities herd futures index in Taiwan

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ABSTRACT

The paper explores the herding relationship between spot market and futures market by using two different herding measurements. Heavily traded constituents stocks of Taiwan electronic sector index and finance sector index are used to test the existence of herding. We also examine whether herding behavior has asymmetric reactions for up (bull) markets and down (bear) markets. Daily and 15-minute returns data covering Taiwan spot market and Taiwan futures market are analyzed. The results partly support the information cascade theory and rational asset pricing theory. Investors do herd temporarily but also trade rationally in a long period. Furthermore, daily and 15-minute data demonstrate the investors' tendency toward herding is higher during market downstream.

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Introduction

Facing complicated and uncertain financial market conditions, investors have to collect available information and make investment decision. Under extreme market situations, such as financial panic, investors may not have enough time to collect information or investors do not know how to filtrate valuable information from many disorderly data. The investor behavior under extreme market conditions is an important and interesting research topic.

Prevalent evidences suggest that herding behavior exists in financial markets during extreme market situations. Banerjee (1992) defines herding behavior as 'everyone doing what everyone else is doing, even when their private information suggests doing something quite different'. As Prechter (2001) noted, most people get virtually all of their ideas about financial markets from other people, through newspapers, televisions, tipsters and analyst, without checking a thing. Due to the spur on indecisive psychological reasons, irrational investing decisions are probably easier to happen especially during periods of extreme market movements. Gleason, Mathur and Peterson (2004) define herding as a common irrational behavior that investor follows others' trading strategies or to receive others' investing suggestions. Weiner (2006) defines herd as investors' trade in the same direction. Prechter and Parker (2007) view the herding behavior from the socionomic theory of finance; their main augment is 'in finance, uncertainty about valuations by other homogeneous agents includes unconscious, non-rational herding, which follows endogenously regulated fluctuations in social mood, which in turn determine financial fluctuations'. Cipriani and Guarino (2009) study herd behavior in a laboratory market with financial market professional. When the event uncertainty situation happens, the proportion of herding decision is increases.

Present empirical studies about herding behavior can be classified into two main topics. One focuses on the herding behaviors of a variety of market participants. Among them, the investment behavior of fund managers is obviously the major issue. Lakonishok, Shleifer and Vishny (1992) established the LSV measurement and find weak evidence of American pension fund managers trading in herds but slightly stronger evidence in small stocks. The LSV measurement is used widely, Wermers (1999) 、Wylie (2005) and Agudo, Sarto and Vicente (2008) adopt the LSV measurement to detect herding behavior in different markets. Researches concerning about the herding among market participants, fund mangers and financial analysts, lie outside the focus of this paper. This study aims to study the herding behavior among individual investors that is the market wide herding.

The topic we want to discuss is the empirical examinations of market wide herding. Christie and Huang (1995) find a higher level of dispersion around the market return during large price movements by using daily and monthly returns on US equities. The findings reject the existence of herding. Chang, Cheng and Khorana (2000) develop a non-linear model to identify herding and use monthly data of several capital markets. They find herding in the South Korea and Taiwan markets, but do not find herding evidence in the USA, Hong Kong and Japan markets. Gleason et al. (2004) use intraday (15- minute) US Exchange Traded Funds (ETF) data and adopt Christie and Huang (1995) and Chang et al. (2000) models to examine herding. They find no evidence of herding. Using hourly and daily returns on Australian equities, Henker, Henker and Mitsios (2006) find neither market wide nor industry sector herding occurs in daily and hourly data. Weiner (2006) looks at speculative behavior in the international oil futures markets, and his evidence is mixed.

Blasco and Ferreuela (2008) examine seven developed stock markets (Germany, United Kingdom, United States, Mexico, Japan, Spain and France) using 10 or 11 of their most heavily traded stocks to test the existence of herding. The results indicate only the Spain market exhibit a significant herding tendency. Daily data show speculators as a group does not herd; however, some subgroups of speculators do herd. Chiang and Zheng(2010) expand Chang et al.(2000) model and verify the

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herding behavior exist in several countries and herding are more significant during downward market situation.

From the literatures mentioned above, we can conclude that whether herding behavior exists in different markets or sectors is still unsolved. Not only the sampled markets ranging from developed to developing capital markets, the data frequency of these studies are also quite different. We notice that intraday data and sector data plays more important role in recent studies.

Most of these papers also examine whether investors react asymmetric to good news and bad news. The logic underlying such a subject is that investors are more likely to herd in times of potential wealth losses. The empirical findings of Christie and Huang (1995) do not support the asymmetry in dispersion between up and down markets. Chang et al. (2000) show that the herding measure is higher when the market is declining than it is advancing. Henker et al. (2006) find mixed support for the asymmetric reaction. The daily data shows a stronger herding in down-market and hourly data do not show any asymmetry.

If herding exists only within a temporary period, this phenomenon can be explained by the information cascade theory. Zhou and Lai (2009) test herd behavior in a transparent and order-driven market using intraday data and find that herding tends to be more prevalent in economic downturns and that the existence of informational cascades, especially when more informed investors trade with noise traders. Henker et al. (2006) purpose that the daily or monthly data frequency may preclude the discovery of herding that occurs within the trading day. Banerjee (1992), Bikhchandani, Hirshleifer and Welch et al. (1992) and Avery and Zemsky (1998) purpose information cascade theory, and this theory can explain temporary herding. An information cascade arises when decisions are made by each investor sequentially, but investors begin to ignore their private information and in favor of observing actions of previous investors. As investors are unsure of the quality of their information, the actions of other investors are observed and investors may follow others' action. Furthermore Bikhchandani et al. (1992) and Bikhchandani, Hirshleifer and Welch (1998) illustrate that cascades are delicate. Cascades imply that prices reflect only a narrow information set, so the arrival of new information can lead investors to re-evaluate their choices and cause the cascade to collapse. This suggests that herds can quickly reverse their decisions, which imply that herd can only exist in a temporary period. Under information cascade theory, herd should not persist for a long period.

While many researches ─ like stock investors, mutual fund managers and futures investors ─ have been largely done to examine herding in single market, spot or futures, there is much less researches focus on the herding relationship between futures and spot markets, that is, whether spot herd futures. Based on financial theory, futures price equals to the expected future spot price. Some recent studies support this statement. Rajaguru and Pattnayak(2007) show the Hang Seng Stock Average exists a lead-lag relationship between spot and futures; Lien and Tse (1999) study the Nikkei index and argue that futures price provide signal for the spot price in the future. Chan (1992) analyzes transaction data on the Standard and Poor's(S&P) 500 and Major Market Index (MMI). Chan suggests that futures price leads the spot index and futures market is the main source of market wide information of spot market. Being a leading indicator for spot markets, futures may be followed by spot market; in other word, a herding relationship may exist between spot and futures markets.

This paper aims to shed light on the question of whether there exists a herding relationship between spot market and futures market. Such a study presents an empirical test of the market efficiency. If the investors are temporary irrational, herding behavior will exist as information cascade theory expects.

These are three improvements over the previous studies in the study. First, the contribution comes from the Taiwan data, one of the Pacific financial markets. In contrast, data in previous studies such as Christie and Huang (1995)、Gleason et al. (2004) and Henker et al. (2006) all test the herding in developed financial markets. This paper can amend this gap in previous studies.

Second, tick-by-tick transaction data are used in this study to calculate 15-minute return data during the trading periods, whereas previous studies use daily or monthly data. Given the speed of trading and information disseminate in futures and spot market, studies with low frequency data can fail to capture the temporary herding that is evident only in intraday data. Therefore, results from daily and 15-minutes data in this study can complement those previous studies to examine whether herding is robust to the frequency of data.

Finally, this study examines herding behavior cross two different markets, spot and futures. In contrast, data in previous studies such as Christie and Huang (1995)、Gleason et al. (2004) and Henker et al. (2006) focus only on single market. The use of two related markets can help us to identify whether herd can propagate from one market to another.

The purpose of this study is to examine if spot market herds futures markets and further investigate whether herding behavior has different reactions in up markets and down markets by using daily and intraday data of Taiwan market.

The remainder of the paper is organized as follows. The second section provides an overview of the characteristics of Taiwan futures market. The third section explains the methodology and hypothesis. The empirical results are provided in the fourth section. The last section concludes the paper.

Characteristics of Taiwan Futures Markets

We all know that emerging countries are playing an increasing important role on the international stage either in political and economical ways. And the present study will exploit one of the Four Asian Tigers ─ Taiwan to examine whether herding exists cross spot and futures markets. Trading activities in Taiwan's futures markets are actively since 1998 when Taiwan Futures Exchange (TAIFEX) was established. On 2002, the total annual number of futures contracts which have been struck a bargain is about 4,132,000; on 2010, the annual number has raised to nearly 25,332,000. During the nine years, the trade number has six-time growth. The trend is obviously upward. TAIFEX opened for business and launched its first product: the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) futures on 21, July, 1998. On 21, July, 1999, its first anniversary, TAIFEX introduced two more products: the Taiwan Stock Exchange Electronic Sector Index (TE) futures and the Taiwan Stock Exchange Finance Sector Index (TF) futures and the underlying indexes of these two futures contracts are Taiwan Stock Exchange Electronic Sector Index and Taiwan Stock Exchange Finance Sector Index. Taiwan Stock Exchange Electronic Sector Index is composed of 317 constituent stocks and Taiwan Stock Exchange Finance Sector Index is composed of 35 constituent stocks. Taiwan futures market becomes an important financial market and this is the account why we choose Taiwan market to be our study object.

The composition of Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) futures is dominated by electronic sector and finance sector which have a 68.1% industrial weight of TAIEX futures as shown in Table1.

Therefore, we would like to examine if constituent stocks of electronic sector index and constituent stocks of finance sector index will herd electronic sector index futures and finance sector index futures respectively.

All of the futures products have 5 delivery months including spot month, the next calendar month, and the next three quarterly months. Trading hours are 8:45am-1:45pm Monday through Friday of the regular trading days of the Taiwan Stock Exchange. Daily price limit is set to be +/- 7% of previous day's settlement price. As for the spot markets, the trading hours are 9:00am-1:30pm Monday through Friday of the regular trading days. Daily price limit is set to be +/- 7% of previous day's settlement price which is same as futures market.

Methodology and Hypothesis

Methodology

During periods of normal information flow and normal market volatility, the returns on the individual stock should reflect the investors' reactions to information relevant to the individual stock. However, rational asset pricing models and herding behavior propose distinct predictions regarding the behavior of the dispersion of returns during periods of markets stress. Rational asset pricing models predict that during extreme futures market movements, the differing sensitivities of individual securities to the futures market return will result in an increase in dispersion. Being a leading indicator for spot markets, spot market may follow the futures markets. The existence of market wide herding during periods of abnormal information flows, investors who tend to herd might be expected to act opposite on their information about individual stock and instead rely on the returns on the futures market to form their investment decisions. As a result, periods of market stress are particularly well suited to examining herding behavior.

Christie and Huang (1995) propose that individuals are more likely to suppress their own beliefs during extreme market movements and tend to follow the market consensus. During periods of high market stress, spot market investors who seek to herd would observe the returns on the related futures and seek to follow these market returns. Under this scenario, we would expect the returns of constituent stocks of each sector index futures to converge towards those of the sector futures. Thus, herding would result in a smaller difference between the returns on the constituent stocks of sector index futures and sector index futures. We use two alternative measures of dispersion to identify the herding between constituent stocks of sector index and sector index futures. Herding would be evidenced by a lower cross-sectional standard deviation (CSSD), and a lower cross-sectional average deviation (CSAD) during periods of market stress.

The cross-sectional standard deviation (CSSD) method is used by Christie and Huang (1995) and can be expressed as

$$CSSD_t = \sqrt{\frac{\sum_{i=1}^{N}\left(R_{i,t} - R_{m,t}\right)^2}{N-1}} \qquad (1)$$

Where *Ri,t* is the daily (intraday) return on *constituent stocks* i of sector index during time period t; *Rm,t* is the daily (intraday) return on the s*ector index futures* during the same time period; N is the number of constituent stock of each sectors in this study.

The approach taken by Christie and Huang (1995) is to argue that herding will be more prevalent during periods of market stress, which is defined in terms of extreme returns on the sector index futures. Consider the following equation:

$$CSSD_t = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t \qquad (2)$$

Where D_t^U = 1, if the return on the *sector index futures* for time period *t* lies in the extreme upper tail of the returns distribution, D_t^U = 0, otherwise. And D_t^L = 1, if the return on the *sector index futures* for time period *t* lies in the extreme lower tail of the returns distribution, D_t^L = 0, otherwise.

The α coefficient denotes the average dispersion of the sample excluding the regions covered by the two dummy variable. The percentage of the upper or lower tail of the sector index futures return distribution can be set up as we want, and the present study uses 5%, to establish the market movement periods as our definition of extreme market movement.

The theory of herding behavior and the model of rational CAPM have distinct view concerning the dispersion level of return during periods of extreme market situations. The theory of herding behavior believes that CSSD will be smaller during periods of market stress. Thus, statistically significant negative values for β1 and β2 would indicate the presence of herding. Whereas, the model of rational CAPM argues that CSSD won't have significant change during periods of market stress arising from the fact that individual asset has different sensitivity to the market return. So, β1 and β2 be zero, or not significantly negative, would indicate that rational CAPM model is fit.

An alternative measure of dispersion is provided by Chang et al. (2000) who define the cross-sectional absolute deviation (CSAD) as

$$CSAD_t = \frac{1}{N}\sum_{i=1}^{N}\left|R_{i,t} - R_{m,t}\right| \qquad (3)$$

Chang et al. (2000) argue that the model in Eqs. (2) requires defining what is meant by market stress. They propose that under normal conditions, the conditional CAPM specifies a linear relationship between CSAD and market returns; however, if herding occurs during periods of market stress, then a nonlinear relationship will also exist. This nonlinear relationship can be modeled as follows:

$$CSAD_t = \alpha + \gamma_1\left|R_{m,t}\right| + \gamma_2 R_{m,t}^2 + \varepsilon_t \qquad (4)$$

If herding is present, γ_2 then will be significantly negative, implying that the deviation of returns on the constituent stocks of sector index from the returns on the sector index futures declines during periods of stress. According to Gleason et al. (2004), this nonlinear component would also be observed for CSSD if herding is present during periods of market stress. That is, the dependent variables in Eqs. (2) and Eqs. (4) could be swapped:

$$CSAD_t = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t \qquad (5)$$

$$CSSD_t = \alpha + \gamma_1\left|R_{m,t}\right| + \gamma_2 R_{m,t}^2 + \varepsilon_t \qquad (6)$$

Herding hypothesis

Herding is information dissemination even though the disseminating information may not be true; therefore, herding may be a common phenomenon during extreme market situation. Imaging a situation that traders with less and unsure information do not know the value of new information and need to make decision in a short period, they will herd the trading of leading sector index futures. Along with the time processing, the true value of new information will reveal and traders do not need to herd.

This means that herding may not extend for a long time such as one trading day or one month; instead, herding may exist only in a short time period. Information cascade theory suggests that herds can quickly reverse their decisions, which imply that herd can only exist in a short period.

To measure this time varying market wide herding, we define two sets of models. For daily data are model (7) and (8)

$$CSAD_t = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t \qquad (7)$$

$$CSSD_t = \alpha + \gamma_1 \left| R_{m,t} \right| + \gamma_2 R_{m,t}^2 + \varepsilon_t \qquad (8)$$

For 15-minute data are model (9) and (10).

$$CSAD_t = \alpha + \theta_1 D_t^U + \theta_2 D_t^L + \varepsilon_t \qquad (9)$$

$$CSSD_t = \alpha + \eta_1 \left| R_{m,t} \right| + \eta_2 R_{m,t}^2 + \varepsilon_t \qquad (10)$$

Hypothesis 1: If herding behavior exists for a long period, then β_1, β_2 and γ_2 will be significantly negative when using daily data.

Hypothesis 2: If herding behavior exists for a short period, then θ_1, θ_2 and η_2 will be significantly negative when using intraday data.

Asymmetric reaction hypothesis

To ground on Chang et al. (2000), markets' reactions towards good news and bad news would appear to be diverse; consequently, allowing for the possibility that the degree of herding may be asymmetric in up markets and down markets. Chang et al. (2000) estimate the model for periods when the market return is positive (up market) and when it is negative (down market) and coefficient value of γ_2 in Eqs. (8) or η_2 in Eqs. (10) be different in up market and down market. And they find that CSAD is higher in up market, relative to down market days. It's because investors are more fear of the extreme movements in down market, then investors are easier to follow the herd under down market.

The present study examines the degree of herding while the futures market is going up and down, investigating whether the herding level has an asymmetric reaction. If there has an asymmetric reaction, then β_1 / θ_1 (γ_2 / η_2 in up market) and β_2 / θ_2 (γ_2 / η_2 in down market) will have significant difference.

Hypothesis 3: If H_0: $\beta_1 - \beta_2 = 0$ or $\theta_1 - \theta_2 = 0$ (γ_2 in up market- γ_2 in down market=0 or η_2 in up market- η_2 in down market=0) is rejected,then the degree of herding appears to be asymmetric during up market and down market.

Data

We obtain tick by tick data from the Taiwan economic journal (TEJ) database for the period 3 July 2006 to 29 June 2007. Owing to Taiwan Stock Exchange Electronic Sector Index is composed of 317 constituent stocks and Taiwan Stock Exchange Finance Sector Index is composed of 35 constituent stocks, this study adopts top 10 trading volume constituent stocks to measure herding behavior between spot market and futures market. The top 10 trading volume constituent stocks of electronic sector index comprise 54.5% of total trading value of electronic sector index, and these top 10 stocks are considered as highly representative. Top 10 trading volume constituent stocks of electronic sector index include stocks issued by Taiwan Semiconductor、Hong Hai Precision Industry、Au Optronic、High Tech Computer、MediaTek、AsusTek Computer、Chi Mei Optronic、United Microelectronics、Taiwanese Telecom, and Delta Electronic. Even though these 10 companies are classified in the same sector, their products cover different products such as liquid crystal display, software, semiconductor, and telecommunication and so on.

Top 10 trading volume constituent stocks of finance sector index include stocks issued by Cathy Holding、Fubon Holding、Mega Holding、Chinatrust Holding、Yuanta Holding、First Holding、Hua Nan Holding、China Development Holding、Taiwan Cooperative Bank and Shin Kong Holding. The top 10 constituent stocks of finance sector comprise 77.1% of total trading value of finance sector index. These 10 companies are doing similar business.

The intraday data are the returns calculated every 15 min. Each item has 19 intraday observations in one day period from 9:00 a.m. to 13:30 p.m. Since there is 247 trading days during sample period, a total of 4,693 intraday returns and 247 daily returns are calculated for each items. Millions of trading data in each day will be filtered to set up the data for empirical analysis.

Results

Descriptive statistics of data

Table 2 summarizes some important statistic values of daily and 15-minute data of constituent stocks, CSSD, and CSAD for electronic sector and finance sector. The statistics show that the magnitude of the dispersion measures is higher for the daily data than for the intraday data based on CSSD and CSAD. The daily and intraday CSAD dispersion measure displays a lower mean and less variability than the daily and intraday CSSD dispersion measure in both electronic sector and finance sector. Both daily and 15-minute data show that the electronic sector index futures display higher level of mean and standard deviation than that of finance sector index futures.

Herding test using daily data

Herding test of electronic sector Model A in Table 3 summarizes the regression results for Equations (7) and (8) of electronic sector for returns calculated daily. The results reported in this model use the 5% criterion, 5% of the TE futures returns observations are in the upper and in the lower tails of the TE futures returns. The regressions in Model A show that β1 and β2 coefficients for the regressions are not significantly different from zero This result is contrary to what we would expect if herding behavior was present.

We turn our attention to the operational versions of the Chang et al. (2000) model. The results for this model are reported in Model B Table 3. We see that γ_2 is not significantly negative at 1% significant level when CSSD or CSAD is treated as the dependent variable. This result points to the absence of herding in electronic sector during periods of high market stress.

Herding test of finance sector We next analyze the herding behavior in finance sector in Table 4. Model A summarize the regression results for Equations (7) and (8) for finance sector and returns are calculated daily. The β_1 coefficients for these regressions are significantly positive, indicating that dispersion actually increases during up market. The nonlinear model shows that γ_2 is positive and not significantly different from zero at 1% significant level. This result also supports the absence of herding in finance sector during periods of high market stress. Hypothesis 1 is rejected; herding does not exist when daily data are observed.

Asymmetric reactions to news using daily data

The investors' asymmetric reactions to electronic sector news based on Christie and Huang (1995) is shown in Table 5. The returns are calculated daily. Although the difference between β_1 and β_2 is positive, the results are not significant when using CSSD and CSAD as dependent variable respectively. Herding behavior is more likely to happen during down market, but the evidence is not strong enough to support this hypothesis. Hence, no evidence of asymmetric response is evident when the criterion for extreme is set at 5%. This study does not support the investors of Taiwan electronic sector have asymmetric reactions to the good news or bad news of the electronic sector futures markets based on Christie and Huang (1995) model.

The returns are calculated daily. The coefficient value $\gamma_{2,down}$ is significantly different from zero when CSSD or CSAD is treated as the dependent variable. The difference between $\gamma_{2,up}$ and $\gamma_{2,down}$ is negative but not significantly different from zero. The results reject hypothesis 3 when using Chang et al. (2000) model. The results from Table 5 offer strong evidence to reject the existence of asymmetric reactions in Taiwan electronic sector when using daily data.

We replicate the above analysis for Taiwan finance sector. Table 6 shows that the difference of β_1 -β_2 is significantly greater than zero which means that this study does support investors of Taiwan finance sector have asymmetric reactions to news of finance sector futures. Spot financial equities herd finance sector index futures more when futures index is under extreme downward trend than it is upward trend. The nonlinear model do not show the asymmetric reactions.

Herding test using 15-minute data

Herding test of electronic sector All the models in Table 7 show that constituent stocks of electronic sector and electronic sector futures (TE) do not have a temporary herding relationship. Results in Model A support rational theory. The θ_1 and θ_2 coefficients for these regressions are significantly positive, indicating that dispersion increases during periods of market stress. This result is contrary to what we would expect if herding behavior was present. We turn to the operational versions of the Chang et al. (2000) model. The results are reported in Model B, Table 7. We see that η_2 is significantly positive at 1% significant level, this result points to the absence of herding in electronic sector during periods of high market stress using 15-minute data. The information cascade hypothesis is rejected in Taiwan electronic sector.

Herding test of finance sector We examine the herding in finance sector and support the information cascade theory; there exists a temporary herding in spot finance constituent stocks and finance index futures when the nonlinear model is used.

The θ_1 and θ_2 coefficients in Model A are significantly positive, indicating that dispersion actually increases during up and down market and is contrary to temporary herding behavior.

The Chang et al. (2000) model shows that η_2 is significantly negative at 5% and 1% respectively significant level when CSSD or CSAD is treated as the dependent variable. This result supports the temporary herding in finance sector during periods of high market stress.

The results of the nonlinear model, which indicating temporary herding in Model B, conflict with Model A, where herding behavior is not supported. This inconsistence can be attributed to the nature of the dummy variable regression model, which can not capture the nonlinearity between market return and dispersion measure. Nonlinear model has higher adjusted R square value than dummy variable regression model. Intraday data indicate that temporary herding do exist in Taiwan spot financial equities herd finance sector index futures.

Hypothesis 2 is supported, and this means that temporary herding does exist in finance sector based on nonlinear model.

Asymmetric reactions to news using intraday data

The investors' asymmetric reactions to electronic sector news based on Christie and Huang (1995) is shown in Table 9. The difference between θ_1 and θ_2 is significantly positive. Herding behavior is more likely to happen during down market and the evidence is strong enough. This study does support Taiwan investors have asymmetric reactions to the good news or bad news of the electronic sector futures markets based on Christie and Huang (1995) model.

The asymmetric reactions to news based on Change et al. (2000) are also shown in Table 9. The difference between η_2^{up} and η_2^{dwon} and is significantly positive when CSSD or CSAD is treated as the dependent variable. The results significantly support hypothesis 3 when using Chang et al. (2000) model.

The results from Table 9 offer strong evidence to support the existence of asymmetric reactions in Taiwan electronic sector when using 15-minute data.

We replicate the above analysis for Taiwan finance sector. Table 10 shows that when Christie and Huang (1995) model is used, herding behavior is more likely to happen during down market. The θ_1- θ_2 value is significantly positive when the criterion for extreme is set at 5% which means investors tend to herd in downward futures market. The asymmetric reactions to news based on Change et al. (2000) are also shown in Table 10. Both η_2^{up} and η_2^{dwon} are less than zero, only η_2^{dwon} is significantly less than zero. Lower η_2^{dwon} value shows that investors tend to herd during downward futures market. The difference between η_2^{up} and η_2^{dwon} is not significantly different from zero.

Based on the findings of Table 9 and Table 10, this study supports that investors are more herding during downward market than upward in electronic sector and finance sector using 15-minute data.

Conclusions

Rational asset pricing theory and information cascade theory are all evidenced in this study. Using two different measurements of dispersion for identifying herding behavior, we show that temporary herding exists in spot financial equities herd finance sector index futures; on the other hand, the electronic equities do not herd. The temporary herding phenomena are consistent with the findings of Zhou and Lai (2009). The herding behavior in the finance sector may due to the similarity of these constituent stocks. On the other hand, the main products of constituent stocks of electronic sector are not so similar, this makes the uninformed investors do not follow the trend of electronic sector index futures.

For a longer period, no evidence of herding is found in both finance sector and electronic sector. Information cascade theory explains the temporary herding and rational asset pricing theory describes no herding in long period. The findings based on Taiwan data are different from previous findings such as Christie and Huang (1995), Gleason et al. (2004) and Henker et al. (2006). Intraday data can capture the temporary herding which may not be proved by long period data, daily or monthly. Investors tend to herd in the short-run and turn to rational the long run. Taiwan market data offers a precious complement to previous studies which mainly focusing on developed financial markets.

Investors tend to herd in downward market. Daily data of finance sector and 15-minute data of electronic sector and finance sector show that investors tend to herd in downward market. This finding is similar to previous studies such as Chang et al. (2000)、Henker et al. (2006)、Zhou and Lai (2009) and Chiang and Zheng(2010). Investors are more likely to herd in time of potential wealth loss.

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Table 1: Industry Category and Individual Weight in Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX)

Industry category	% weight in TAIEX	Industry category	% weight in TAIEX
Electronic	54.8%	Food	1.10%
Finance and Insurance	13.3%	Electric Machinery	0.87%
Plastic	8.13%	Trading and Consumer's Goods	0.86%
Fuel and Electricity	4.30%	Rubber	0.84%
Iron and Steel	3.18%	Automobile	0.77%
Shipping and Transportation	2.54%	Electrical and Cable	0.50%
Textile	1.71%	Glass and Ceramic	0.39%
Other	1.69%	Biotechnology and Medical Care	0.31%
Cement	1.53%	Paper and Pulp	0.309%
Building Material and Construction	1.50%	Tourism	0.22
Chemical	1.14%		

Source: Taiwan Futures Exchange

Table 2: Daily and 15-minute statistics of constituent stocks and Taiwan sector index futures

Items	Daily Mean Return (%)	Daily Standard Deviation (%)	Daily Minimum (%)	Daily Maximum (%)	15-minutes Mean Return	15- minutes Standard Deviation (%)	15-minutes Minimum (%)	15-minutes Maximum (%)
Taiwan electronic sector index futures	0.13	1.11	-4.22	3.74	6.8E-03	0.244	-2.903	3.046
Constituents								
Taiwan Semiconductor	8.92E-2	1.50	-4.24	5.02	4.7E-03	0.353	-5.634	3.198
Hong Hai Industry	0.184	1.94	-5.87	6.67	1.1E-04	0.424	-4.348	3.571
Au Optronic	9.3E-2	1.49	-3.92	5.27	4.9E-03	0.352	-3.26	3.226
HighTech Computer	-8.7E-2	2.84	-7.00	7.00	-3.5E-05	0.566	-5.276	4.116
MediaTek	0.254	2.16	-6.58	7.00	1.5E-04	0.459	-2.874	3.237
AsusTek Computer	9.47E-2	1.57	-4.59	6.40	5.5E-05	0.366	-4.849	5.897
Chi Mei Optronic	4.7E-2	1.69	-5.76	7.00	2.5E-03	0.38	-3.753	3.407
United Microelectronics	1.89E-2	1.39	-4.11	6.89	1.1E-03	0.359	-2.466	6.921
Taiwanese Telecommunication	0.55	2.88	-4.38	4.75	1.7E-04	0.465	-4.728	3.765
Delta Electronic	0.157	1.88	-5.53	6.94	8.3E-03	0.442	-2.959	4.206
Electronic index CSSD	1.634	0.62	0.392	3.90	0.358	0.254	0.000	5.55
Electronic index CSAD	1.18	0.42	0.323	2.82	0.25	0.157	0.000	2.684
Taiwan Finance sector index futures	3.73E-2	1.09	-3.43	4.38	1.9E-03	0.233	-3.052	2.011
Constituents								
Cathy Holding	5.1E-2	1.50	-4.43	6.61	2.6E-03	0.331	-4.09	2.887
Fubon Holding	4.2E-2	1.66	-4.36	6.92	2.2E-03	0.393	-6.283	6.704
Mega Holding	-1.75E-2	1.40	-5.84	6.80	-8.2E-04	0.351	-5.192	4.286
Chinatrust Holding	1.1E-2	1.63	-4.57	6.21	2.2E-05	0.394	-5.385	3.52
Yuanta Holding	0.11	1.98	-5.84	6.90	5.9E-03	0.481	-4.605	4.13
First Holding	-1.4E-2	1.00	-3.39	2.60	-5.8E-04	0.283	-6.941	1.923
Hua Nan Holding	5.1E-3	1.31	-6.89	6.92	4.3E-04	0.349	-6.054	5.012
China Development Holding	4.3E-2	1.33	-3.50	6.67	2.4E-03	0.352	-2.749	2.49
Taiwan Cooperative Bank	3.6E-2	1.27	-3.54	5.53	3.4E-05	0.307	-1.987	3.132
Shin Kong Holding	4.0E-2	1.79	-5.90	6.91	2.1E-03	0.399	-6.49	2.662
Finance index CSSD	1.156	0.51	0.345	4.10	0.317	0.21	0.000	3.743
Finance index CSAD	0.860	0.36	0.258	2.77	0.236	0.146	0.000	2.272

Note: The table reports the intraday and daily return statistics. CSSD refers to the cross-sectional standard deviation method of Christie and Huang (1995). CSAD refers to the cross-sectional absolute deviation method of Chang et al. (2000).The data covers from 3, July, 2006 to 29, June, 2007.

Table 3: Herding test of Taiwan electronic sector using daily data

Model A: $Dispersion_t = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t$ (Criterion=5%)

Dependent variable	α	β_1	β_2	Adjusted R^2
CSSD	0.016 (33.78)***	0.002 (1.132)	0.001 (0.36)	0.001
CSAD	0.012 (39.68)***	0.003 (1.53)	0.00009 (0.07)	0.015

Model B: $Dispersion_t = \alpha + \gamma_1 \left|R_{m,t}\right| + \gamma_2 R_{m,t}{}^2 + \varepsilon_t$

Dependent variable	α	γ_1	γ_2	Adjusted R^2
CSSD	0.017 (18.47)***	-0.107 (-0.689)	7.28 (1.48)	0.012
CSAD	0.011 (20.82)***	0.017 (0.176)	3.02 (1.01)	0.026

Note: t-values in parentheses , *** Indicates significance of the t-values at the 1% level. ** Indicates significance of the t-values at the 5% level.

Table 4: Herding test of Taiwan finance sector using daily data

Model A: $Dispersion_t = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t$ (Criterion=5%)

Dependent variable	α	β_1	β_2	Adjusted R^2
CSSD	0.011 (32.0)***	0.006 (3.72)***	0.001 (0.37)	0.046
CSAD	0.008 (35.33)***	0.005 (5.01)***	0.001 (0.59)	0.086

Model B: $Dispersion_t = \alpha + \gamma_1 \left|R_{m,t}\right| + \gamma_2 R_{m,t}{}^2 + \varepsilon_t$

Dependent variable	α	γ_1	γ_2	Adjusted R^2
CSSD	0.011 (16.68)***	0.054 (0.462)	2.745 (0.764)	0.03
CSAD	0.008 (18.23)***	0.048 (0.621)	2.84 (1.19)	0.072

Note: t-values in parentheses , *** Indicates significance of the t-values at the 1% level. ** Indicates significance of the t-values at the 5% level.

Table 5: Asymmetric reaction test of Taiwan electronic sector using daily data

Christie and Huang's Model : $y_t = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t$ Criterion=5%

	β_1	β_2	$\beta_1 - \beta_2$		β_1	β_2	$\beta_1 - \beta_2$
CSSD	0.002	0.001	0.001 (0.504)	CSAD	0.003	0.0001	0.0029 (1.38)

Chang et al.'s Model :

$$y_t = \alpha + \gamma_{1,up} \left| R_{m,t} \right| + \gamma_{2,up} (R_{m,t})^2 + \varepsilon_t$$

$$y_t = \alpha + \gamma_{1,down} \left| R_{m,t} \right| + \gamma_{2,down} (R_{m,t})^2 + \varepsilon_t$$

	Upward Market		Downward Market		Difference
	$\gamma_{1,up}$	$\gamma_{2,up}$	$\gamma_{1,down}$	$\gamma_{2,down}$	$\gamma_{2,up} - \gamma_{2,down}$
CSSD	0.140 (0.60)	2.505 (0.308)	-0.445 (-2.09)**	14.25 (2.27)**	-11.745 (-1.14)
CSAD	0.141 (0.96)	2.17 (0.42)	-0.221 (-1.85)*	7.25 (2.06) **	-5.08 (-0.85)

Note: The table reports regression results and tests of an asymmetric reaction. Differences in coefficients in this mode are tested with corresponding t-values in parentheses. The asymmetric reactions to news based on Change et al. (2000) are also shown in Table 5.

Table 6: Asymmetric reaction test of Taiwan finance sector using daily data

Christie and Huang's Model : $y_t = \alpha + \beta_1 D_t^U + \beta_2 D_t^L + \varepsilon_t$ Criterion=5%

	β_1	β_2	$\beta_1 - \beta_2$		β_1	β_2	$\beta_1 - \beta_2$
CSSD	0.006 (2.93)***	0.001	0.005	CSAD	0.005 (2.56)**	0.001	0.004

Chang et al.'s Model :

$$y_t = \alpha + \gamma_{1,up} | R_{m,t} | + \gamma_{2,up} (R_{m,t})^2 + \varepsilon_t$$

$$y_t = \alpha + \gamma_{1,down} | R_{m,t} | + \gamma_{2,down} (R_{m,t})^2 + \varepsilon_t$$

	Upward Market		Downward Market		Difference
	$\gamma_{1,up}$	$\gamma_{2,up}$	$\gamma_{1,down}$	$\gamma_{2,down}$	$\gamma_{2,up} - \gamma_{2,down}$
CSSD	0.227 (1.44)	0.742 (0.16)	-0.052 (-0.28)	2.44 (0.41)	-1.698 (-0.225)
CSAD	0.141 (1.28)	2.396 (0.74)	0.026 (0.227)	0.83 (0.23)	1.566 (0.323)

Note: The table reports regression results and tests of an asymmetric reaction.
Differences in coefficients in this mode are tested with a T-test with corresponding t-values in parentheses.

Table 7:Herding test of electronic sector index futures using 15-minute data

Model A: $Dispersion_{Es,t} = \alpha + \theta_1 D_t^U + \theta_2 D_t^L + \varepsilon_t$ (Criterion=5%)

	α	θ_1	θ_2	Adjusted R^2
CSSD	0.0032 (94.4)***	0.0029 (19.6)***	0.0017 (11.9)***	0.096
CSAD	0.0023 (105.2)***	0.0022 (22.8)***	0.0014 (15.2)***	0.132

Model B: $Dispersion_{Es,t} = \alpha + \eta_1 \left|R_{m,t}\right| + \eta_2 R_{m,t}^{\ 2} + \varepsilon_t$

	α	η_1	η_2	Adjusted R^2
CSSD	0.0029 (64.4)***	0.317 (11.8)***	18.96 (10.5)***	0.220
CSAD	0.0019 (68.6)***	0.324 (18.7)***	5.82 (5.01)***	0.247

Note: T-values are in parentheses and *** Indicates significance of the t-values at the 1% level

Table 8: Herding test of finance sector index futures using 15-minute data

Model A: $Dispersion_{Fs,t} = \alpha + \theta_1 D_t^U + \theta_2 D_t^L + \varepsilon_t$ (Criterion=5%)

	α	θ_1	θ_2	Adjusted R^2
CSSD	0.0029 (97.57) ***	0.0031 (23.7) ***	0.0023 (17.64) ***	0.149
CSAD	0.0021 (106.62) ***	0.0024 (27.92) ***	0.0019 (21.69) ***	0.202

Model B: $Dispersion_{Fs,t} = \alpha + \eta_1 \left|R_{m,t}\right| + \eta_2 R_{m,t}^{\ 2} + \varepsilon_t$

	α	η_1	η_2	Adjusted R^2
CSSD	0.0024 (58.2) ***	0.5734 (23.1) ***	-3.33 (-1.97)**	0.218
CSAD	0.0017 (66.54) ***	0.478 (29.8)***	-2.92 (-2.68)***	0.315

Note: T-values are in parentheses and ** indicates 5%, *** Indicates significance of the t-values at the 1% level.

Table 9: ***Asymmetric reaction test of electronic sector using 15-minute data***

Model A : $y_{Es,t} = \alpha + \theta_1 D_t^U + \theta_2 D_t^L + \varepsilon_t$ Criterion=5%

	θ_1	θ_2	θ_1-θ_2		θ_1	θ_2	θ_1-θ_2
CSSD	0.0029	0.0017	0.0012	CSAD	0.0022	0.0014	0.0008
	(3.03)***				(3.14)***		

Model B1: Dispersion $CSAD_{Es,t}^{up} = \alpha + \eta_1^{up} \left| R_{Ef,t}^{up} \right| + \eta_2^{up} \left(R_{Ef,t}^{up} \right)^2 + \varepsilon_t$

Model B2: $CSAD_{Es,t}^{down} = \alpha + \eta_1^{down} \left| R_{Ef,t}^{down} \right| + \eta_2^{down} \left(R_{Ef,t}^{down} \right)^2 + \varepsilon_t$

	Up market		Down market		differnece		
	η_1^{up}	η_2^{up}	η_1^{dwon}	η_2^{dwon}	η_1^{up} -η_1^{dwon}	$\eta_2^{up} - \eta_2^{dwon}$	
CSSD	0.211	39.96	0.397	0.78	-0.186	39.18	
(5.22)***	(14.5)***	(10.8)***	(0.34)	(-0.15)	(10.9)***	(0.69)	
CSAD	0.307	13.2	0.327	-0.255	-0.02	13.455	
	(11.7)***	(7.38)***	(13.5)***	(-0.166)	-(0.18)	(5.7)***	

Note: T-values are in parentheses and *** Indicates significance of the t-values at the 1% level.

Table 10: Asymmetric reaction test of finance sector using 15-minute data

Model A : $y_{Fs,t} = \alpha + \theta_1 D_t^U + \theta_2 D_t^L + \varepsilon_t$ Criterion=5%

	θ_1	θ_2	θ_1-θ_2		θ_1	θ_2	θ_1-θ_2
CSSD	0.0031	0.0023	0.0008	CSAD	0.0024	0.0019	0.0005
(2.72)***				(2.50)***			

Model B1: $CSAD_{Fs,t}^{up} = \alpha + \eta_1^{up} \left| R_{Ff,t}^{up} \right| + \eta_2^{up} \left(R_{Ff,t}^{up} \right)^2 + \varepsilon_t$

Model B2: $CSAD_{Fs,t}^{down} = \alpha + \eta_1^{down} \left| R_{Ff,t}^{down} \right| + \eta_2^{down} \left(R_{Ff,t}^{down} \right)^2 + \varepsilon_t$

	Up market		Down market		Difference		
	η_1^{up}	η_2^{up}	η_1^{dwon}	η_2^{dwon}	η_1^{up} -η_1^{dwon}	η_2^{up} -η_2^{dwon}	
CSSD	0.62	-6.36	0.56	-6.79	0.06	0.43	
	(13.2)***	(-1.41)	(16.4)***	(-3.51)***	(0.05)	(0.09)	
CSAD	0.50	-4.10	0.47	-4.39	0.03	0.29	
(16.5)***	(-1.42)	(20.4)***	(-3.44)***	(0.04)	(0.08)	(-1.22)	

Note: T-values are in parentheses and *** Indicates significance of the t-values at the 1% level.