Co-movement of Correlations, News, and Measuring Intentional Herd Behavior in Financial Markets

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Limits of financial theories based on rationality.

- Financial theories based on efficient-market can partially or narrowly explain the variations in financial markets(summers, 1986).
- Especially, information-flow paradigm cannot investigate exactly why we frequently observe high volatility in financial markets even in the absence of any significant information or news including macroeconomic announcements.

Herd behavior

- Herding is another important issue in financial Economics, because it can cause <u>bubble like</u> <u>phenomenon</u> and <u>systematic risk</u> in financial markets(Bikhchandani, Hirschleifer and Welch, 1992; Kodres and Pristsker, 1998; Dhaene et al., 2012).
- Various type of studies for analyzing herd behavior have been made actively(Banerjee, 1992; Avery and Zemsky, 1998; Graham, 1999; DeBondt and Forbes, 1999; Hirshleifer and Teoh, 2003; Sias, 2004; Avgouleas, 2009; etc.).

What is Herding?: General definition

- ✓ A group of market participants who trade in the same direction during the same time(Nofsinger and Sias, 1999)
- ✓ Investors who ignore their initial assessment and trade by following the trend in the previous trade(Avery and Zemsky, 1998)
- ✓ A behavior converge to the average(Hirshleifer and Teoh, 2003)
- > Why is herding occurred?
 - The reasons behind this behavior are diverse.
 - ✓ Informational Cascades(Bikhchandani et al., 1992)
 - ✓ Imperfect information(Calvo and Mendoza, 2000; Puckett and Yan, 2007)
 - ✓ Reputation(Trueman, 1994, Swank and Visser, 2008;)
 - ✓ Compensation schemes(Scharfstein and Stein, 1990; Roll, 1992; Brennan, 1993; Rajan, 1994;)

**** First Method**

What is Herding?: <u>in the Market</u>

- Herding is often used to describe as an investment strategy to follow the <u>market consensus</u> or imitate the activities of financial gurus(Chen, 2013).
- The volatility of a stock market index is determined by the volatilities of the index components as well as the <u>dependence structure</u> among them.
 - ✓ Index volatility will be affected by higher individual volatility and/or stronger positive interdependences.
 - ✓ Thus, stronger positive dependence structure is a sign of less diversification and a higher degree of herd behavior.



Spurious herding and Intentional herding.

• Bikhchandani and Sharma(2000) distinguished between "spurious" and "intentional" herding.

EMH	Pure Spurious	✓	Spurious herding, known as "unintentional herding" is referred to all
Asym. Info.	1		investors reacting identically to the same piece of news identically. Spurious
			herding may reflect the reaction of investors to commonly known public
•			information.
Info.		✓	Intentional herding is purely imitative actions with neglecting their own
Cascalle			private information. They want to avoid being alone with <u>bad consequence</u> ,
Keynes Beauty	♥ Pure		especially when information about the stock is very scarce. Pure "intentional
Contest	Intentional		herding" rarely exists, since the investors cannot be purely irrational.

• To distinguish "spurious" and "intentional" herding empirically is very difficult, but it is great challenge because "intentional herding" can make systematic risk and bubble like phenomenon in financial market.

> Herding: rational and irrational point of view.

- <u>In rational view</u>, herding can be a rational choice under certain circumstances such as principalagent problem, greater cost, less sophisticated investors(Devenow and Welch, 1996; Khan et al., 2011; Blasco, 2012)
- <u>In irrational view</u>, herd behavior is to cause the correlation in trades across individuals and therefore systematic mistake by entire populations(Bikhchandani, Hirschleifer and Welch, 1992)





Source : goybiscuits.com

Literature Review: Herding Measures

Herding measure: Cross-Sectional Standard Deviation(CSSD)

• Christie and Huang(1995) herding measure CSSD is the <u>most commonly used in</u> measuring herding. But it has certain drawbacks.

$$CSSD_t = \left(\frac{\sum_{i=1}^{n} (r_{i,t} - \bar{r}_t)^2}{n-1}\right)^{1/2}$$

 \checkmark $r_{i,t}$ is the observed stock return on firm *i* at time *t*, \bar{r}_t is the cross sectional average of the *N* returns in the aggregate market portfolio at time *t*. Thus, CSSD captures the particular asset return closeness to the realized average.

$$CSSD_t = \alpha + \beta^L D_t{}^L + \beta^U D_t{}^U + \varepsilon_t$$

- $\checkmark D_t^L$ and D_t^U are dummy variables that denotes extreme lower and upper tail respectively.
- ✓ Christie and Huang(1995) essentially employs one fraction of the total return(at the firm level) to capture herding toward the market consensus. In other words, it tests for one specific form of herding and ignores herding in other contexts.

Literature Review: Herding Measures

Herding measure: Cross-Sectional Standard Deviation(CSSD)



- ✓ Relationship between CSSD (left) / CSAD (right) and daily DJIA returns (2010. 1. 4 ~ 2013. 5. 31)
- ✓ Horizontal full line denotes 5% quantile, dotted line denotes 1% quantile of CSSD / CSAD.

Literature Review: Herding Measures

Herding measure: Lakonishok, Shleifer and Vishny method(LSV)

• LSV measure(Lakonishok et al., 1992) provides important insights into fund manager behavior and many empirical studies employ the LSV measure, however, it has also certain drawbacks.

$$H(i) = \left| \frac{B(i)}{B(i) + S(i)} - p(t) \right| - AF(i)$$

- ✓ B(i) is the number of money managers who are net buyers, S(i) is the number of money managers who are net sellers(i.e. decreasing their holdings), p(t) is the expected proportion of money managers buying in that quarter relative to the number of active, and the adjustment factor, AF(i), is the expected value of |B/(B+S)-p| under the null hypothesis of no herding.
- ✓ It is not informative of the intensity of herding behavior since it does not consider the volume of trading and also it cannot reveal whether herding is followed the same fund over time(Bikhchandani and Sharma, 2000).
- ✓ Furthermore, this measure critically does not account for the quantity of stock investors buy or sell(Hwang and Salmon, 2001)

Literature Review: Herding Measures

**** Second Method**

- Herding measure: Patterson and Sharma method(PS)
 - Herding intensity(Patterson and Sharma, 2006)

$$x(i, j, t) = \frac{\left(r_i + \frac{1}{2}\right) - np_i(1 - p_i)}{\sqrt{n}}$$

 \checkmark r_i is the real number of sequences of type i (upward, downward or zero tick), n is the real number of trades executed in security j during the trading day t, p_i is the probability of finding a sequence of type i.

$$\sigma^{2}(i, j, t) = p_{i}(1 - p_{i}) - 3p_{i}^{2}(1 - p_{i})^{2}$$

$$H(i,j,t) = \frac{x(i,j,t)}{\sqrt{\sigma^2(i,j,t)}} \sim N(0,1)$$

 \checkmark x(i, j, t) is asymptotically normally distributed with zero mean and variance

[Table] Data, Period and its source

Variables	Period	Source
DJIA market index	2010.1.4 ~ 2013.5.31	Google/Yahoo Finance
DJIA components(30) price	2010.1.4 ~ 2013.5.31	Google/Yahoo Finance
Number of Economic News	2010.1.4 ~ 2013.5.31	Dow Jones FACTIVA

[Table] Data Summary

Variables	Mean	Standard Dev.	Skewness	ADF
DJIA market returns	0.0433	1.0127	-0.4333	Stationary
Number of Economic News	156.4779	33.3687	0.1072	Stationary
Ln(Number of Econ. News)	5.0291	0.2217	-0.4213	Stationary

* Note : 5% criterion for ADF test

In	troduction	Literature Review	Data	Framework and Methodology	
	Data				
	[Table] DJIA index co	omponents history(2010. 02	1. 04 ~ 2013. 05. 31)		
	Date Added		Replaced by		
	2012. 09. 24	Kraft Foods(KFT)		United Health Group(UNH)	

[Table] News Summary

Source	Dow Jones Institutional News, The Wall Street Journal
Company/Industry	All Companies/All Industries
Region	United States
Subject	 Commodity/Financial Market News Corporate/Industrial News Economic News

[Table] News Summary, by sources

Variables	Mean	Standard Dev.	Skewness	ADF
Dow Jones Institutional News	66.0105	32.7505	0.1693	Stationary
The Wall Street Journal	84.9138	12.2853	-0.3073	Stationary

* Note : 5% criterion for ADF test



Framework and Methodology

Main Considerations for New Herding Measure : First Factor

- Cross-Sectional Dynamic Conditional Correlation, market versus components
 - Strong positive interdependence is a sign of less diversification and higher degree of herd behavior.
 - Several recent empirical literatures have employed the DCC measure to investigate financial contagion effects as a possible herd behavior between the global markets during crisis periods(Bekaert and Harvey, 2000; Corsetti, Pericoli, and Sbracia, 2005; Boyer et al., 2006; Chiang et al., 2007; Jeon and Moffett, 2010).
 - Dehaene et al.(2012) employed time-varying correlation to examine option market herding.
 - ✓ Strong interdependence in the market is occurred by market news or herding.
 - ✓ DCC can directly and intuitively capture the cross-sectional correlation
 - ✓ DCC is independent of time series volatility problem
 - ✓ DCC can capture the dynamic herd behavior.

Framework and Methodology

Main Considerations for New Herding Measure : First Factor

- Cross-Sectional Dynamic Conditional Correlation, market versus components
 - ✓ Set AR(1,1)-DCC(1,1) GARCH(1,1) model.
 - ✓ Set 31 mean equations and variance equations in multivariate GARCH(1,1) model for 1 Dow Jones Industrial Average index returns $R_{m,t}$ and 30 index components returns $R_{j,t}$ (j = 1, ..., 30)
 - ✓ Estimate Dynamic Conditional Correlation(DCC) $\rho_{m,j,t}$ (*j* = 1, ..., 30)

$$\begin{bmatrix} \rho_{m,1,1} & \rho_{m,2,1} & \dots & \rho_{m,j-1,1} & \rho_{m,j,1} \\ \rho_{m,1,2} & \rho_{m,2,2} & \dots & \rho_{m,j-1,2} & \rho_{m,j,2} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \rho_{m,1,t-1} & \rho_{m,2,t-1} & \dots & \rho_{m,j-1,t-1} & \rho_{m,j,t-1} \\ \rho_{m,1,t} & \rho_{m,2,t} & \dots & \rho_{m,j-1,t} & \rho_{m,j,t} \end{bmatrix}$$

Framework and Methodology

Main Considerations for New Herding Measure : First Factor

- Cross-Sectional Dynamic Conditional Correlation, market versus components
 - ✓ Cross-Sectional DCC can be calculated as:

$$\rho_{t} = \sum_{j=1}^{N} \omega_{j,t} \ \rho_{m,j,t} \qquad \qquad \omega_{j,t} = \frac{p_{j,t} s_{j,t}}{\sum_{j=1}^{N} p_{j,t} s_{j,t}}$$

 $\rho_{m,j,t}$: DCC between market index *m* and index component *j* at time *t*. *j* = 1, 2, ..., N

- *N* : total number of index components and
- *T* : total number of trading days.
- $\omega_{j,t}$: weight of index component *j* at time *t*.
- $p_{j,t}$: close price of stock j at time t
- $s_{j,t}$: the outstanding shares of stock j at time t

Framework and Methodology

Main Considerations for New Herding Measure : First Factor

Cross-Sectional Dynamic Conditional Correlation, market versus components



► Cross-sectional DCC well explain the conditional variance of market index returns.

Framework and Methodology

- Main Considerations for New Herding Measure : Second Factor
 - Persistency and intensity of autocorrelation toward the same direction
 - ✓ We can assume that if financial market follow efficient market hypothesis(Fama, 1970), stock price will follow a random walk (independent) and its returns has zero mean. Thus, the probability assignable to each type of return sequences(above the zero, below the zero) should be the same.
 - ✓ If investors trade to the same direction with market consensus during same periods (herding), we can observe significant autocorrelation toward the same direction.
 - ✓ If herd behavior in the market is stronger and persisted, autocorrelation in index returns will also be stronger and long lasted toward the same direction. Thus, it can make <u>bubble</u> <u>like phenomenon.</u>

Framework and Methodology

Main Considerations for New Herding Measure : Second Factor

- Persistency and intensity of autocorrelation toward the same direction
 - [Herding versus "Intensity of Autocorrelation"]: Positive Feedback Trading, a special case of herd behavior, can makes positive return autocorrelation and it makes potential for mispricing and excess volatility (Sentana and Wadhwani, 1992; LeBaron, 1992; Campbell *et al.*, 1993; Sias and Starks, 1997; Cooper, 1999; Koutmos and Saidi, 2001).
 - [Herding versus "Persistency of Autocorrelation"] : Patterson and Sharma(2005) investigate the herd behavior at intraday level using bootstrapped runs test which is based on the information cascade models of Bikhchandani et. al.(1992).

$$\begin{cases} if \ r_{i,1} \neq 0, & T_{i,1} = 1 \\ if \ r_{i,t} > 0 \ \begin{cases} if \ r_{i,t-1} \leq 0, & T_{i,t} = 1 \\ if \ r_{i,t-1} > 0, & T_{i,t} = 1 \\ if \ r_{i,t} < 0 \ \begin{cases} if \ r_{i,t-1} \geq 0, & T_{i,t} = T_{i,t-1} + 1 \\ if \ r_{i,t-1} \geq 0, & T_{i,t} = 1 \\ if \ r_{i,t-1} < 0, & T_{i,t} = 1 \\ if \ r_{i,t} = 0, & T_{i,t} = 1 \\ T_{i,t} = 0 \\ \end{cases}$$

Framework and Methodology

Main Considerations for New Herding Measure : Second Factor

• Persistency and intensity of autocorrelation toward the same direction



Framework and Methodology

Main Considerations for New Herding Measure : Second Factor

- Persistency and intensity of autocorrelation toward the same direction
 - ✓ **Cumulative returns.** If return sequences lasted toward same direction for a long time, Cumulative returns at time *t* is bigger than observed returns at time *t*. For example,





Framework and Methodology

Main Considerations for New Herding Measure : Second Factor

• Persistency and intensity of autocorrelation toward the same direction



Framework and Methodology

Main Considerations for New Herding Measure : Third Factor

- Number of economic news as a proxy of market information: intentional herding The number of news significantly positively related on returns volatility and interdependence between market and its components. But, strong correlation which is occurred by News impact is "spurious herding".
 - ✓ Hwang and Salmon(2001) and Blasco and Ferreruela(2008) both tried to distinguish "spurious" and "intentional" herding using the ideas of "cross-sectional variance of beta" and "comparison between CSSD and artificially created CSSD" respectively. However, these two methods indirectly classify the intentional herd behavior without direct impact of public information.
 - New York Times front-page headlines, the number of daily Dow Jones or the Wall Street Journal stories and dividend announcements are directly related on regularities in financial market or market activities such as absolute value of returns, absolute value of firm specific returns. (Penman, 1987; Thompson et al., 1987; Atkins and Basu, 1991; Berry and Howe, 1993; Mitchell and Mulherin, 1994)

Framework and Methodology

Main Considerations for New Herding Measure : Third Factor

• Number of economic news as a proxy of market information: intentional herding

Date	04/01/2010 40 04/01/2010	1. Derivative Securities	16. National Government Debt/Bond Markets
	04/01/2010 to 04/01/2010	2. Routine Market/Financial News	17. Treasury Bond Prices/Commentary
		3. Energy Prices	18. Foreign Exchange News
	Dow Jones Institutional News, The Wall Street Journal	4. Crude Oil Markets	19. Tables
Source		5. Crude Spot Market Commentary	20. Corporate Debt Instruments
		6. Commodity/Financial Market News	21. Debt/Bond Markets
Author	All Authors	7. Commodity Markets	22. Central Bank Intervention
Autnor		8. Energy Markets	23. Acquisitions/Mergers/Takeovers
Company	All Companies	9. Commentaries/Opinions	24. Regulation/Government Policy
		10. Interest Rates	25. Selection of Top Stories/Trends/Analysis
Industry	All Industries	11. Economic News	26. Equity Markets
		12. Money Markets	27. Cash Commodities Commentaries
Region	United States	13. Energy Commentary	28. Page-One Stories
		14. Crude Oil/Natural Gas Product Markets	29. Industry Profile
Language	English	15. Analyst Comments/Recommendations	30. Equity Derivatives
Results Found	1123	Tatal 100 autient 1st 20th autient k	$a = \frac{650}{2}$

► Total 100 subject, 1st~30th subject has 65% of news

Framework and Methodology

Main Considerations for New Herding Measure : Third Factor

• Number of economic news as a proxy of market information: intentional herding



Framework and Methodology

- Main Considerations for New Herding Measure : Third Factor
 - Number of economic news as a proxy of market information: intentional herding



► The number of DJIA news significantly positively related on returns volatility

Framework and Methodology

New Herding Measure for Financial Markets

• Strong Correlation between index and its components : Dynamic Conditional Correlation

$$\rho_t = \sum_{j=1}^N \omega_{j,t} \, \rho_{m,j,t}$$

• Strong Correlation between index and its components : Dynamic Conditional Correlation

$$\begin{cases} if \ r_{i,1} \neq 0, & T_{i,1} = 1 \\ if \ r_{i,t} > 0 \begin{cases} if \ r_{i,t-1} \leq 0, & T_{i,t} = 1 \\ if \ r_{i,t-1} > 0, & T_{i,t} = 1 \\ if \ r_{i,t} < 0 \begin{cases} if \ r_{i,t-1} > 0, & T_{i,t} = T_{i,t-1} + 1 \\ if \ r_{i,t-1} < 0, & T_{i,t} = 1 \\ if \ r_{i,t} = 0, & T_{i,t} = 1 \\ T_{i,t} = T_{i,t-1} + 1 \\ T_{i,t} = 0 \end{cases}$$

• Number of economic news as a proxy of market information: intentional herding

Data

Framework and Methodology

> New Herding Measure for Financial Markets

$$H_{t} = \left[\left\{ \frac{\rho_{t}}{\sigma(\rho_{t})} + \frac{T_{m,t}}{\sigma(T_{m,t})} \right\} - \frac{N_{t}}{\sigma(N_{t})} \right] + \left\{ \left(\frac{\bar{\rho}_{t}}{\sigma(\rho_{t})} + \frac{\bar{T}_{m,t}}{\sigma(T_{m,t})} \right) - \frac{\bar{N}_{t}}{\sigma(N_{t})} \right) \right\}$$
Variation term
Market level term



Framework and Methodology

New Herding Measure for Financial Markets



Framework and Methodology

New Herding Measure for Financial Markets



Framework and Methodology

New Herding Measure for Financial Markets



****** Correlation[Herding vs Volatility] : CSSD=0.2766, Our New Measure=0.3627