THE STRUCTURAL CHANGE OF MUTUAL FUND HERDING IN CHINA STOCK MARKET

Wanbin Pan*, Jun Shan

Abstract

This paper examines the structural change of mutual fund herding in china stock market, an important investment behavior of institutional investors. A self-normalization based Kolmogorov-Smirnov test is employed to test the change point of herding from 2002 to 2011, the results suggest that there really be structural change points in mutual fund herding. The mutual fund herding changed at December 2004, June 2007 and December 2008. The structural change of the mutual fund herding can be explained by the financial environment of China stock market**.

Keywords: Institutional Investors, Herding, Change Point

JEL Code: R53

** University of Science and Technology of China, Management School*
Tel: (86)551-63600567
*** The Project was supported by the National Natural Science Foundation of China (Grant No. 71301158) and the Humanities and Social Sciences Foundation of the Ministry of Education of China (Grant No. 13YJCZH134)*

1 Introduction

The rise of institutional investors is one of major changes in the global financial system in recent years. Institutional investors are changing the structure and behavior of financial markets, their trading behavior has an increasing and far-reaching impact on the stock market stability. As the most important institutional investors, the mutual fund has become a pivotal force of Chinese capital market, and their investment behavior has an increasingly important impact on the capital market. As a representative of the rational investors in Chinese stock market, the fund is generally considering the use of professional analysis for investment, improve market efficiency and promote the healthy development of the market. Deep research on the funds' investment behavior can help understand their impact on market deeply, regulate their behavior and promote the steady development of financial market.

The herding of fund is particularly noteworthy phenomenon. The term herding behavior refers to, in the case of asymmetric information, the conduct of an individual who relinquished their own beliefs and better judgment, to follow the decisions of the collective, even when they appear In error (Christie and Huang, 1995). Investors herd in certain time when they take the same investment strategies and share an aversion to stocks with certain characteristics. When in "herds", many institutional investors ignore their own private information and analysis, buy or sell the same stocks blindly. This results in the fluctuation of stock price, triggering market systemic risk, and undermines the stability of the market. Because herding behavior is random and blind, it has an important influence on the efficiency and stability of the market, and is closely related with the financial crisis. Therefore, academia and government regulators pay increasing attention on the herding behavior.

Testing of the existence of herding behavior is not a new subject. There have been a vast and growing number of studies from both theoretical and empirical perspective, but few results about how herding behavior changes. However, the financial market is changing all the time. With the rapid development of information technology, linkage between the different financial markets continues to enhances, information disseminates faster and faster, and there is a trend of global financial integration. As the important players in the financial markets, how do institutional investors react to the valid information and adjust their investment strategies? Does the change mode have a relationship with the change of financial market environment? This paper focuses on whether the fund herding behavior is changing and where the change point is. Financial environment change on the time is conducted to explain the change of the fund herding's behavior. Especially when the market is in the extreme situation, herding behavior is enhanced or weakened, and the impact on the market stability.

A self-normalization based Kolmogorov-Smirnov test is employed to test the fund herding's change point. Change point refers to the sudden change at some unknown time in the time series model, the time

is the so-called change point. The common change point includes mean change point, the probability change point and the model change point. In the financial analysis, it is necessary to test the stability of the financial time series by examining the presence of change point. Study on the mean change point of financial time series aims to identify and verify existence, location, number and gap of the change point. Then we can generally get the structure of the financial time series. It has important significance on the study of financial time series with a segmented structure. Change point theory for financial data processing has broad application prospects.

The remainder of this paper is structured as follows: the next section summarizes the results of the main literature, while Section 3 goes to describe the methodologies in the study. Then, we report estimation results in Section 4, the change point of fund herding behavior in Chinese market. Finally, Section 5 contains a summary of the research, draws some conclusions based on results and the financial environment in Chinese market.

2 Literature review

The presence of herding behavior can be traced back to the study of Lakonishok et al.(1992). They put forward the indicator (LSV) to portray herding behavior. By analyzing the performance of 769 American stock funds, they found no obvious herding behavior, but minor herding behavior on the small stock trading. Wermers(1999) use the LSV model to study the American mutual funds in the period 1976-1994,and find that the herding behavior between the mutual funds is high than the pension funds, and herding behavior in the market of small stock between growth mutual funds is observed. Heish et al.(2011) argue that, by analyzing Asian stock market in the period 1996-2004, the presence of herding behavior can be confirmed in Asian emerging markets. Chiang et al.(2010) confirm the presence of herding behavior in developed markets (with the exception of the U.S.) and in Asian markets. They also find that the degree of herding behavior is especially high during periods of financial crisis in America, and the period of increasing in Asian market. Hwang and Salmon（2001）argue that the investment behavior is affected by the financial crisis in Asian and Russia. The degree of herding behavior is high before the crisis while the financial market is relative calm, but reduced significantly after the crisis.

There are lots of studies on the presence of herding behavior in Chinese stock markets. For instance, Tan et al. (2008) find evidence of herding behavior of China A-share and B-share stocks. Moreover, the herding behavior in Chinese stock markets varies when market conditions changes. Yao et al. (2014) find that herding behavior becomes weaker over the sample period.

There are lots literatures conducting various methods on testing for change points for a sequence of independent and identically distributed (idd) random variables. The test statistics developed for change point detection in the iid. context work well (Brodsky and Darkhovskay (1993)). However, they may not work in the time series data. Because of the temporal dependence in the data, the statistics need take some modification.

In the case of testing for a change point, the commonly used ways contain the Kolmogorov-Smirnov test, lag-window test, etc. The traditional Kolmogorov-Smirnov test statistic involves a consistent long-run variance estimator, which uses estimator of the spectral density of 0 to make the limiting null distribution free of nuisance parameters. The lag-window type long-run variance estimator requires the choice of a bandwidth parameter and it is difficult to select in practice. The power function is very sensitive to the bandwidth parameter used in finite samples. The choice of a bandwidth is a difficult task in practice, so the applicability of the method reduces a lot. In the lag-window test, the choice of a bandwidth may lead to a non-monotonic power function. The power function can be non-monotonic in the sense that it can decrease and even reach a zero values as the alternative value considered becomes further away from the null value. However, the test is good when its power function should monotonically increase when the alternative value is more far from the null hypothesis.

For the test statistics, the non-monotonic of power function brings a difficult problem. The theoretical and empirical studies have shown that a data-dependent bandwidth parameter will result in a non-monotonic power function. The parameter is set up in the null hypothesis but biased strictly in the alternative hypothesis (Perron (2006)). Shao(2010) provides a more direct way to construct the confidence band using the self-normalized approach bypassing the delicate issue of computing asymptotic variances. It improves the application of the self-normalized approach to test for change points. Shao and Zhang(2010) propose a new test statistic to test for a change point in the mean, which does not involve estimate of $\sigma 2$ directly. Its asymptotic null distribution is pivotal and the (approximate) critical values are tabulated through simulations. The test is simple to implement yet powerful in the sense that it is consistent and achieves$\sqrt{n}$power.A wonderful feature of the SN-based test is that its empirical power seems to be monotonic. Compared to the traditional Kolmogorov-Smirnovtest, the SN-based test has a moderate power loss but better size. It has more wide applicability than former because it can be used to test for a change point in the small samples. The SN-based test provides a new perspective to test for change point in the financial time series.

3 Methodology

3.1 Herding behavior measure

Our measure of herding for a given stock in a given half year, HM_{it}, is defined as

$$\mathrm{HM_{it}} = |p_{it} - E(p_{it})| - AF(i,t) \quad (1)$$

Where, $p_{it} = \frac{Nbuy_{it}}{Nbuy_{it}+Nsell_{it}}$, $\mathrm{E}(p_{it}) = \frac{\sum_{i=1}^{n_t} Nbuy_{it}}{\sum_{i=1}^{n_t} Nbuy_{it}+\sum_{i=1}^{n_t} Nsell_{it}}$

$Nbuy_{it}$ is the number of funds who increase their holdings in the stock i in the half year t (net buyers),$Nsell_{it}$ is the number of the funds who increase their holdings in the stock i in the half year t (net sellers),$\mathrm{E}(p_{it})$ is the expected proportion funds buying in that half year relative to the number active, and *AF(i)* is an adjustment factor. *AF* accounts for the fact that under the null hypothesis of no herding, the absolute value of $p_{it} - \mathrm{E}(p_{it})$is great than zero. *AF* is, therefore, the expected value of $|p_{it} - \mathrm{E}(p_{it})|$ under the null hypothesis of no herding. Since $Nbuy_{it}$ follows a binomial distribution with probability p of success, we calculate AF with the given p and the number of funds active in that stock in that half year using the Monte Carlo simulation.

It shows the presence of herding behavior while HM_{it} is not zero significantly. Then degree of herding behavior is stronger with a bigger HM_{it}.

3.2 Self-normalization based Kolmogorov-Smirnov test

This paper applicates SN-based Kolmogorov-Smirnov test proposed by Shao and Zhang (2010) to test change points in the fund herding behavior. Suppose we test for a change point in the mean of a univariate time series, the null hypothesis and alternative hypothesis are the followings,

$$H_0: E(X_1) = \cdots = E(X_n) = \mu$$

versus

$$H_1: E(X_1) = \cdots = E(X_{k^*}) \neq E(X_{k^*+1}) = \cdots = E(X_n),\ 1 \leq k^* < n \text{is unknown}$$

A commonly used test statistics is defined as

$$T_n(\lfloor nr \rfloor) = n^{-1/2} \sum_{t=1}^{\lfloor nr \rfloor} (X_t - \overline{X}_t)\,, r \in [0,1]$$

Let $S_{t_1,t_2} = \sum_{j=t_1}^{t_2} X_j$ if $t_1 \leq t_2$ and 0 otherwise. The normalization process $V_n(\cdot)$ is defined as follows. For k=1,…, n-1, let

$$V_n(k) = n^{-2}\left[\sum_{t=1}^{k}\left\{S_{1,t} - (t/k)S_{1,k}\right\}^2 + \sum_{t=k+1}^{n}\left\{S_{t,n} - (n-t+1)/(n-k)S_{k+1,n}\right\}^2\right]$$

The SN-based Kolmogorov-Simrov test statistics and the point position can simplified as

$$G_n = \frac{T_n(k)'T_n(k)}{V_n(k)}$$

$$\hat{k} = \underset{k=1,\cdots,n-1}{argmax} \frac{T_n(k)'T_n(k)}{V_n(k)}$$

4 Empirical results

4.1 Data

Based on the LSV model, we calculate the herding effect using the fund holding data over the June 2002 to June 2011 period. Data are obtained from CSMAR data base. According to some rules of the "Law of the Securities Investment Fund" and the "Information Disclosure Rules of Securities Investment Fund", mutual funds will disclose the "details of the top ten

holding stocks ordered by the ratio of the market capitalization to the total net asset of the fund" in the quarter reports, and disclose the all the holding stocks in the mid-year report and annual report. Therefore, the research interval is half year, and we use the fund holding data in mid-year report and annual report. The research period covers the bull and financial crisis stage.

4.2 Change point of herding behavior based on K-S test

Table 1 provides the herding behavior per six months and the t-test results based on the mid-year reports and annual reports. The herding behavior per year is provided in table 2.

Table 1. The Herding of mutual fund per Six Months

Year	First half	T-test	Second half	T-test
2002	4.491***	3.673	1.524**	1.985
2003	-0.504	-0.532	-1.459***	-2.651
2004	4.944***	6.116	-0.240	-0.416
2005	4.185***	5.904	0.538	1.075
2006	3.972***	7.821	5.491***	9.861
2007	1.527***	3.269	-0.620	-1.599
2008	1.305***	2.932	1.036**	2.438
2009	-0.225	-0.59	1.852***	4.653
2010	2.343***	6.907	3.225 ***	10.322
2011	-0.137	-0.521	——	——

Note: T-Statistics in the third and fifth column.
(*), significance at 10%; (**), significance at 5%; (***), Significance at 1%.

Table 2. The Herding of mutual fund per Year

	Hmit	T-test
2002	2.638***	3.967
2003	-1.043**	-2.021
2004	2.352***	4.681
2005	2.233***	5.222
2006	4.757***	12.565
2007	0.245	0.821
2008	1.168***	3.800
2009	0.883***	3.182
2010	2.831***	12.309
2011	-0.137	-0.521

Note: T-Statistics in the third column.
(*), significance at 10%; (**), significance at 5%; (***), Significance at 1%.

As in table 1 and table 2, the herding of mutual funds changed during the period 2002-2011. It is stronger in the period 2002-2006 and year 2010, but weaker in the period 2008-2010. whether the investment behaviors of funds have changes? Where are the change points? And whether they have a correlation with the financial market environment? We can't tell based on the t-test ratios. Moreover, we have only 19 herding behavior data, which are calculated every six months from 2002 to the first half of 2011. The time series sample is too short that we can't test it based on the traditional Kolmogorov-Smirnov test. In the further study, a self-normalization based Kolmogorov-Smirnov test is employed to test the change points of the mutual fund herding.

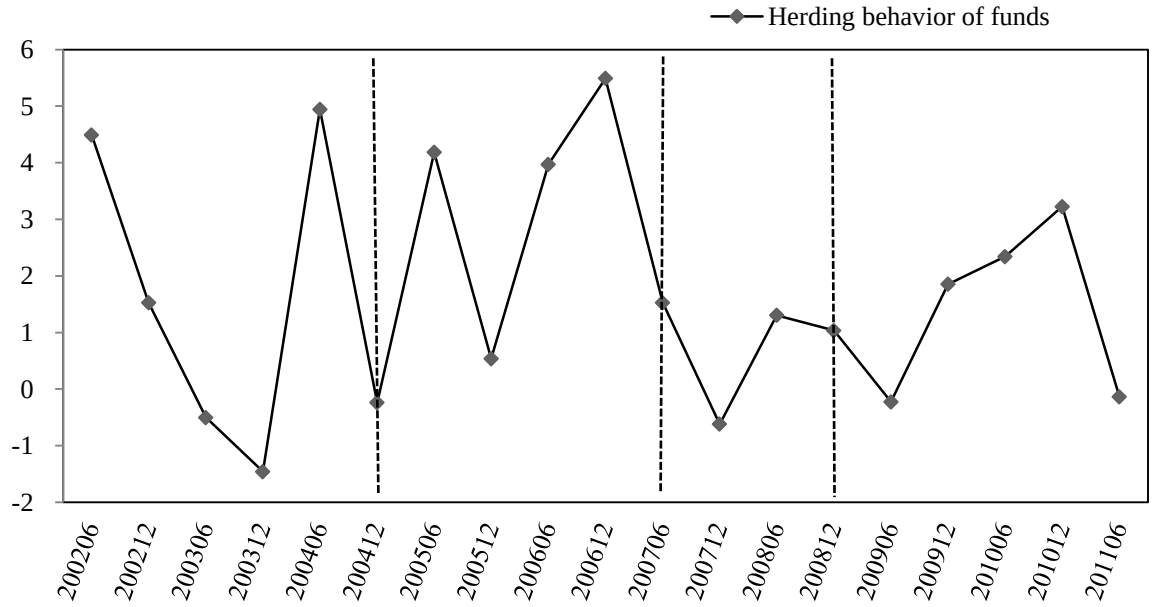
First, we calculate the Gn-statistics of all the time series employing the self-normalization based Kolmogorov-Smirnov test. According to the Gn-statistics, we can get the position of the first mean change point. Then, after splitting the series by the first mean change point into two parts, we can find the mean change points in the left and right parts. After calculating the Gn-statistics of the left and right series, we can get the positions of the second and third mean change points.

We find three change points. Table 3 presents the three change points and the Gn-statistics.

Table 3. A self-normalization based Kolmogorov-Smirnov test of herding

Change point	Gn
December 2004	854.8363
June 2007	1644.991
December 2008	780.8668

Figure 1. The herding series of funds and the positions of the change points



The results of SN-based Kolmogorov-Smirnov test show the presence of mean change points in the mutual fund herding. The first change point is at the end of 2004, the second is at the middle of 2007, and the third one is at the end of 2008.

In order to understand the fund herding behavior in different financial environment, we use the change points to segment the sample into four parts, and calculate the mean herding behavior in the four periods. Table 4 presents the result of the herding behavior in the four periods.

Table 4. The average herding of mutual fund in four periods

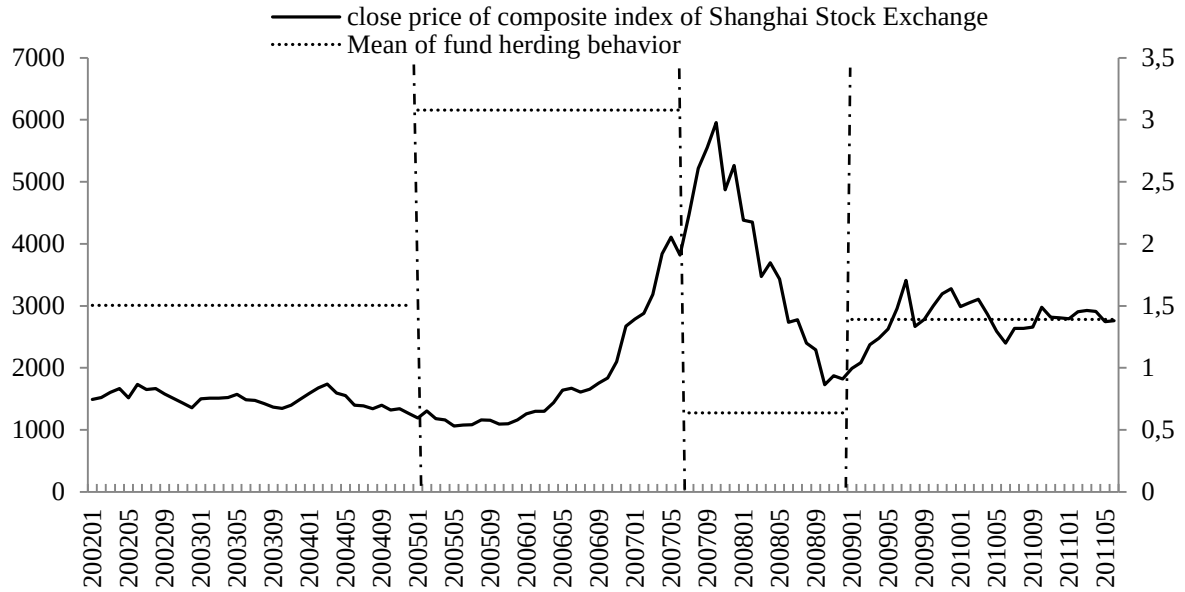
Period	HM	T-ratio
January 2002～December 2004	1.505	4.6029
January 2005～June 2007	3.078	12.6264
June 2007～December 2008	0.632	2.5800
January 2009～June 2011	1.391	9.4239

4.3 The structural change of herding and the financial environment of the stock market

Figure 2 shows strong correlation between the mutual fund herding and the volatility of financial environment. Chinese stock market was bear from 2002 to 2004. Under the background of reduction of State-owned shares, the composite index of Shanghai Stock Exchange falls below 1339 in January 2002. With a series prosperity policies issued by supervision authorities in the second half, including stopping reduction of State-owned shares in domestic market, restricting the seasoned offering rules, etc. The market has an fierce reaction on the policies, and fluctuates strongly. The index falls to about 1300 in May 2004. As a whole the market does not prosper, and the fund herding behavior is only 1.55.

The stock market sees overall rise continually since 2005 because of share reform policies. The composite index of Shanghai Stock Exchange rise over 6000 from 1000, and the fund herding behavior is most significant in this period. The mean herding behavior is 3.078.

Figure 2. The mean of mutual fund herding in four periods and close price of composite index of Shanghai Stock Exchange per month



At end of 2007, the Chinese stock market phases out into bear from bull, financial crisis appear. The international financial market has been affected seriously in 2008. The Lehmann Brothers made an application for bankruptcy protection, Merrill Lynch was acquired by the Bank of America, and the US government was forced to bail out the American International Group (AIG), which is the insurance giant in US. The powerful roles in Wall Street fell, which were sale to survive, taken over by the government, or went bankrupt. Under the background of global financial market integration, Chinese stock market has also been affected. The fund herding behavior decreased significantly from the second half of 2007 to the end of 2008, that the mean is only 0.632. The result shows that the mutual funds are more cautious and rational to invest, therefore, their herding behavior is not obvious relatively.

In order to cope with the negative impact of the financial crisis in 2008, Chinese government reform a series monetary and fiscal policies to revive confidence of the market, including down-regulating benchmark interest rate four times continuously and deposit reserve rate three times, and expanding government expenditure, etc. Although the financial market environment has not been a clear improvement from 2009 to 2011, but the mentality of investors has been gradually stabilized. The mutual fund herding has increased, and the mean is 1.391 in this period.

Overall, the mutual funds have a high degree of herding behavior in the bull market and low in bear market. In the context of the financial crisis, the fund are more cautious and rational, therefore, the degree of their herding behavior reduced greatly compared to other periods.

5 Conclusion

This paper uses SN-based Kolmogorov-Smirnov test, which is applied to test financial time series of lower frequency, to test change points in the mutual fund herding behavior. The SN-based Kolmogorov-Smirnov test does not involve a consistent long-run variance estimator and not require the choice of a bandwidth parameter, which is different from the traditional Kolmogorov-Smirnov test and lag-window test. The spectral density of the statistics in SN-based Kolmogorov-Smirnov test is free of nuisance parameters, and its power function is monotonic. After test the mean of fund herding behavior, we find that the test does not have strict requirements on the structure of time series, therefore, it is more suitable for financial time series samples of smaller size.

This paper studies how the institutional investors change their investment behaviors from a new perspective, which is different from the existing literatures that study the presence of fund herding behavior. We can have a better understand on the behavior of institutional investors and how to change in behavior finance research, especially under different market conditions (particularly the financial crisis). Overall, as the most important institutional investors, the mutual funds' investment behavior is not static, and has a significant correlation with the volatility of financial environment. Herding behavior of the fund is significant in bull and weak in bear. The funds are more cautious and rational after the financial crisis, therefore, their herding behavior is not obvious. The fund did not show an obvious herding behavior in the financial crisis of 2008, and the degree of their herding behavior is even decreased continuously. As the most important institutional investors, mutual funds have an strong information superiority because

of their financial strength, professional researchers to invest, information gathering analysis and other advantages. Mutual funds invest in large scale with long investment cycle, and they pay more attention on value investment and are more rational compared to other investors. Therefore, they are considered professional rational investors in Chinese stock market, and promote development of financial market stably and healthily.

References

1. Lakonishok, J., Shleifer, A. and Vishny, R.W. (1992), "The impact of institutional trading on stock prices", Journal of Financial Economics, vol.32 No.1, pp.23-43.
2. Weremers, R. (1999), "Mutual fund herding and the impact on stock price", Journal of Finance, vol.54, pp.581-622.
3. Hirshleifer, D., Subrahmanyam, A. and Titman, S.(1994), "Security Analysis and trading Patterns When Some Investors Receive Information before Others",Journal of Finance, vol.49, pp.1665-1698.
4. Sias, R. W. (2004) ,"Institutional Herding", Review of Financial Studies, vol.17 No.1, pp.165-206.
5. Chiang, T. C. and Zheng, D. (2010), "An Empirical Analysis of Herd Behavior in Global Stock Markets", Journal of Banking & Finance, Vol. 34 No.8, pp. 1922-1921.
6. Hwang,S. and Salmon,M. (2001), "A new measure of Herding and Empirical Evidence".working paper, Cass Business School.
7. Brodsky,B.E. and Darkhovskay,B.S. (1993) "Nonparametric Methods in Chang-point Problems". Mathematics and Its Application, Vol.23, pp.99-107.
8. Perron,P.(2006), "Dealing With Structural Breaks", in Palgrave Handbook of Econometric.Vol.1:Econometric Theory, eds. K. Patterson and T.C. Mills, Great Britain: PalgraveMacmillan, pp. 278-352.
9. Shao,X.(2010),"Self-Normalized Approch to Confidence Interval Construction in Time Series". Journal of the Royal Statistical Society, Ser.B, Vol.72 No.3, pp.343-336.
10. Shao,X., and Zhang,X.(2010), "Testing for Change Points in Time Series". Journal of the American Statistical Association, Vol. 105 No.6, pp.1228-1240.
11. Tan,L., Chiang,T.C., Mason,J.R., and Nelling,E.(2008)," Herding behavior in Chinese stock markets: An examination of A and B shares", Pacific-Basin Finance Journal, Vol.16, Issues 1–2,pp. 61-77.
12. Yao,J., Ma,C., and He, W.P.(2014)," Investor herding behaviour of Chinese stock market ", International Review of Economics & Finance, Vol. 29,pp. 12-29.