Herding Behavior, A New Technical Trading Rule and Market Efficiency

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Abstract

In this paper, I develop a brand-new technical trading rule, named H rules (Herding rule), which is established based on stock investors' herding behavior. The primary principle of this rule is that buying stocks when the daily price obviously increases, and selling them when the price obviously goes down. We think that the H trading rule can instantly capture the activated timing of the herding behavior as a means to make abnormal return. That is, the H trading rule is able to evaluate the pricing efficiency on stock markets. Our empirical study shows that, during 1992 to 1998, the H trading rule can gain excess profit on the Taiwan stock market. However, during the same period, applying the H trading rule do not gain excess return in the American, Japanese, German and British stock markets. Even though Politis and Romanos[25] stationary bootstrap resampling is employed to avoid pseudo fitness, the abnormal H trading rule performance still reaches significant level. When a randomly resampling is adopted, the abnormal performance of H trading rule disappears. Thus, we argue that the Taiwan stock market entails less efficiency than the other four markets.

1.Introduction

It has been more than a hundred years to apply technical trading analysis to the financing field. During this long period of time, researchers and practitioners ceaselessly develop and improve technical rules. Thus, numerous technical trading rules have been developed. Many researchers constantly analyze the prediction ability of technical trading rules as a means to evaluate the pricing efficiency on the capitalist market.

In fact, with the aid of the modern computing technology, technical trading rules can be infinitely improved, or different rules can be combined to construct more sophisticated trading strategies. Logically speaking, as long as the gaining capacity can challenge wholesalers' trading rules, the market's pricing inefficiency can be proven.

It is our interest to develop a semi-technical trading rule, which is called the H rule. This rule will be examined by comparing the pricing efficiency of five stock markets. The principle of the H rule is simple: I follow others to buy stocks; I sell my shares when people sell theirs. This idea is basically developed from the herding behavior of the theory of games. This rule is different from the traditional technical trading rule in that the latter establishes trading strategies based on the transaction amount and price in the past; the former is established based on the instant trading information. This difference will be discussed later on. The herding behavior on the capitalist market will be discussed in the second part of this paper. In the third part, the construction of the H rule is demonstrated. In the forth part, the empirical study on the H trading rule performance is provided. Discussion and conclusion are at the end of this paper.

2. The Herding Behavior and the Stock Trend

Classical economic theory often hypothesizes decision-makers' full rationality. Thus, equilibrium stays until the change of influential factors. For instance, the stock price reflects investors' rational expectation of a company's overall value. When a company's management does not change significantly, nor do supply and need alter, the stock price remains reasonable without any significant fluctuation. However, the fluctuation of the stock price is more significant than a company's basic structure. Shiller [31] argues that this phenomenon occurs because the stock price not only reflects information, but also investors' sentiment. Black [5] explains many non-rational behaviors on the market by referring to the term "noise". He does not think that all of the changes are rational. Some changes are derived from investors' predictions or emotions, instead of their rationality. Shleifer and Summers[34] explain the non-rational phenomenon by referring to noise traders' over-optimism and over-pessimism.

Regarding the abnormal fluctuation on the stock market, Debondt and Thaler[8,9] first study investors' over-reaction on the American stock market. They select stocks between 1933 and 1978. They create the winner's combination by accumulating 35 most profitable stocks and the loser's combination by accumulating 35 worst stocks. Accumulated abnormal profits are calculated on the annual basis. The result indicates that the performance of the loser's combination is obviously better than the winner's one. This phenomenon can be lasted for 5 years. Over-reaction still exists even though risk adjusts reward. Lehmann[20] and Campell & Kyle [7] also pay attention to the existence of over-reaction.

Obviously, the abnormal fluctuation of the stock price is not only formed by the existence of noise traders, but also by their learning and imitating others actions- the herding behavior. When most of the noise traders tend to buy and sell stocks concurrently, the stock price deviates from the fundamental value and fluctuates to the point that rational arbitrageurs' reversed actions cannot balance the change of stock price. More often, following the trend becomes the best arbitrage strategy, which in turn aids the abnormal fluctuation of the stock price. Since the price is often influenced by all sorts of information randomly, the stock market often characterized by the herding behavior.

3. The Herding Rule and Empirical Research Design

3.1 The Formation of the Herding Rule

The formation of the Herding rule is in need of a communicated mechanism in order to negotiate investors' information and belief. Famous analysts' suggested dartboard is one type of communication mechanism (Greene & Smart[18]) (Liang[22]). The latest gross economic indicator is another type of arbitrary mechanism. Among different types of mechanism, pricing plays a significant role. Cho and Krishnan [7] hold that, on a large-scale market, pricing is significantly informative since it conveys other investors' actions. Thus, the market as a whole pays more attention to price than to the private information. In general, there is a certain amount of noise traders on the market. These people do not have sufficient information, nor do they process an appropriate evaluation of how information influences price. That they wait and observe other people's actions becomes a rational strategy. Banerjee[3] establishes a sequential decision model. In this model, decision-makers first observe the action of the precious decision-makers, and then formulate their own strategies. Banerjee thinks that this is a rational decision-making process since some important information may be hidden behind other decision-makers' actions. As a result, this type of decision making forms the herding behavior.

Pricing reflects how the market evaluates information, and it also reflects other investors' behaviors. Pricing conveys every participant's behavior on the market. That is, it plays the role of communicative mechanism. There are many arbitrary mechanisms based on pricing. Technical analysis is one of the commonly used examples. Based on the stock price and amount in the past (or those of other investment instruments), technical analysis establishes trading strategies. What are implied are the pattern of the stock price, and the repetition of the same pattern. In fact, if technical trading strategy can gain excess, it indicates that there is no efficiency of the market pricing, and that the herding behavior occurs among investors. There is no obvious evident which supports the self-developed pattern and repetition of the stock price. The only possibility is that the same group of people employs the same trading strategy or pays attention to the same information. As a result, they commonly buy and sell the same stocks, which forms the repetitive trend of the stock price. That is, pricing is influenced by this behavior.

After receiving the pricing information, noise traders may react in two ways: first, the market reaction fits in the original prediction of noise traders. This enhances noise traders' belief. Second, the market reaction is against noise traders' original prediction. Thus, noise traders may be influenced by the market and modify their original ideas. They may also insist on the evaluation of their private information and take the opposite actions. It is impossible to argue which possibility is more likely to occur. What can be asserted is that intelligent traders are more likely to adopt non-modified and self-insisting strategies than are noise traders. Thus, we can conclude that it must be the result of noise traders' modifying belief and adoptive strategy when pricing does not instantly or fully reflect the influence of information, but it gradually reflects the trend formation. This also indicates no efficiency of market pricing.

Based on the above argument, this research establishes a technical rule: buy when the price goes up, and sell when the price goes down. Or, when other people buy stocks, I buy them, too; when other people sell their shares, I sell mine, too. This rule is established because pricing reflects investors' behaviors. Increasing prices indicate that most of the investors tend to buy stocks; decreasing prices

indicate that most of the investors tend to sell their shares. This trading rule entails the following meaning:

If the trading price of a security moves up over X percent in one day, buy and hold the security until its price moves down over X in one day, at which time simultaneously sell and go short. The short position is maintained until the trading price rises over X percent in one day.

This rule hypothesizes that there is a certain amount of noise traders on the market who prefer following to conducting the reversed strategy. Thus, when smart investors understand this feature, they also adopt the same following strategy. Therefore, they are able to obtain excess resulted from followers' herding behavior. In this rule, excess is derived from the herding behavior. This research terms this rule as the H trading rule (Herding trading Rule). The definition of this rule is as follow:

If the rise of the stock trading price exceeds a certain point from the low within a day, such as h%, (the rule suggests) buying and holding this stock until the decline of the price to a certain degree within a day, such as h%. (The rule also suggests) simultaneously selling this stock and establishing the short position until the rise of the trading price over h%.

The H rule is similar to Alexander [1] filter rule. However, these two rules are different in two points. First, The H rule only needs the daily trading price to determine the trading strategy. The filter rule requires the observation of the sequential pricing for a period of time. Second, the filter rule adopts the accumulated range as the judgment standard. Meanwhile, the trading price can move up or down. As long as the accumulated range reaches the default standard (the filter scale), trading can be conducted. The H rule only requires the day trading or instant pricing change scale. That is, these differences make the H rule more accurate in capturing the activated timing of investors' herding behavior. The comparison between the two will be shown later.

When a market is with efficiency, the stock price often sufficiently and rapidly reflects the related information. Thus, a reasonable pricing is instantly formed. Under this circumstance, implementing the H rule cannot obtain excess. On the contrary, if the H rule can obtain extra profits in the long run, it indicates that the stock pricing is not often up to the reasonable standard. That is, the market pricing entails no efficiency. Thus, it is argued that the H trading rule can evaluate the degree of efficiency. The more the excess obtained by adopting the H rule, the less efficient the market is.

3.2 Research Period and Sampling

In order to examine the performance of the H rule, the market index becomes our research target. Between 1992 and 1998, the daily closed index of five stock markets is studied. These include Taiwanese, Japanese, New York Dow Jones, German Frankfurt, and British London indexes. Our data is provided by the AREMOS database, which is built by the Ministry of Education, R.O.C. There are 8,997 daily closed indexes in total: 1989 for Taiwan, 1728 for Japan, 1769 for the U.S., 1754 for Germany and 1757 for Britain.

3.3 Performance Evaluation and Comparison

Based on the definition of the H rule, it is the trading signal when the stock price goes up or down more than a certain range (h%) within a day. It is difficult to determine the value of h%. Empirically, we set h within the range between 0 and 3%. h=0 signifies the timing of the rising or declining stock price and the buying/selling opportunity. It is rare to see the decline of index more than 3%. In addition, when the hypothesized signal occurs, investors complete their trading according to the daily closed price.

The H rule is similar to other traditional technical analyses since they are all based on the information of the trading volume and price for the establishment of operation strategies. These strategies can also examine the market pricing efficiency. In order to ascertain the effect of the H rule, the reward of the buy-and-hold strategy is used as the comparative standard. Furthermore, the performance between the H rule and filter rule is also compared. The filter rule defined by Fama and Blume [15]

When the daily closed price of one specific stock exceeds f% of the lowest point within a consecutive period of time, buying and holding this specific stock until the daily price declines more than f% within a consecutive period of time. This stock is sold and the short position is established until the price moves up more than x% from the lowest point within a consecutive period of time.

In our research, in order to compare the performance of these two rules, the boundary of f is fixed as that of h, that is, 0-3%. The indicator of the performance evaluation includes the mean return and Sharpe Ratio. X1, X2... XT represents the ordinary time series of the daily closed index during the research period, $y_t = (X_{t+1}-X_t)/X_t$ stands for the daily stock pricing fluctuation rate or daily return during the research period. $R_{t+1,k} = \ln[1+y_{t+1}*S_k(y_t, y_{t-1},...)]$. K stands for a technical trading strategy. $S_k()$ stands

for the trading signal produced by the technical trading strategy. 1 stands for buying or maintaining the short position. -1 stands for selling or maintaining the short position. O stands for the neutral position. R_{t+1} stands for the return on the t+1 day produced by technical trading rules of the trading strategy on the t day. During the research period, technical trading rules produce the consecutive return which can be accumulated as

$$Rd$$
, $k = \frac{1}{N} \sum_{t=1}^{N} Rt$, k

The daily return of the buy-and-hold strategy is:

$$Rm = \frac{1}{N} \sum_{t=1}^{N} \ln (1 + y_t)$$

The Sharpe index requires a non-risk return and risk. It is hypothesized that the non-risk rate is fixed at 5% (this value does not affect our conclusion), and this rate is converted into the daily return: $R_f = ln(1+5\%)/360$. Risk is evaluated by the daily return. σ d, k and σ m stand for technical rules and the risk of the buy-and-hold strategy. Sharpe indicators Sd, k and Sm are:

$$Sd$$
, $k = \frac{Rd}{\sigma d}$, $k - Rf$
 $Sm = \frac{Rm - Rf}{\sigma m}$

When comparing the performance of technical trading rules, their best trading strategies are selected as the comparative representatives. Rd, h and Rd, f stand for the best strategy performance of the H and filter rules. Furthermore, in order to avoid the fallacy resulted from data-snooping, Efron[14] bootstrap resampling technics is employed to duplicate 500 pseudo samples for statistical analysis. Politis and Romano [25] propose the stationary bootstrap for the weak sequential data. Sullivan, Timmermann and White[33] employ the stationary bootstrap in examining the performance of technical analysis. We follow the sampling procedure:

- 1. Let t=1. Between natural number 1 and T, v is randomly and exclusively selected. y_v is selected from the daily return's timing sequence {yt, t=1, 2, ...T}. Let W(t)=y_v.
- Let t=t+1. Between real number 0 to 1, a number U is randomly drawed.
 (1) if U <q, between natural number 1 and T, v is randomly and exclusively selected. y_v is also selected from the daily return's timing sequence {yt, t=1, 2, ...T}. Let W(t)= y_y.
 (2) if U>=q, set W(t)= y_{v+1}, v=t+1, if v>T, reset v=1.
- 3. Repeat Procedure 2 until t=T.

In this resampling procedure, q is a smoothing parameter. Sullivan et al (1999) indicate that q between 0.01 and 0.5 does not significantly affect the empirical result. This research sets the value of q at 1,0.1,and 0.01. That is, the average block length is 1,10, and 100 (block length is equal to 1/q).

By following the above procedures, 500 pseudo time series samples are acquired. This facilitates the statistical analysis of technical trading rule performance. When the H rule performance is evaluated by the mean return, Rd, a(b), and Rm(b) stand for the H rule's best trading strategy and the performance of the buy-and-hold strategy. The following null hypothesis will be tested:

$$H_0: R_{d,h} \leq R_m$$

the corresponding P value is,

 $p=\#\{R_{db}(b) \leq R_m(b)\}/500, b=1,...,500.$

The p value stands for the times when Rd, h is smaller than Rm among 500 samples. When p is smaller than the demanded standard, data-snooping hypothesis is rejected. The best trading strategy of the H rule is ascertained to be more stable than the performance of the buy-and-hold strategy.

By following the same procedures, the following can be examined:

 $\begin{array}{ll} Hypothesis \ 2. & H_0: \ R_{d,h} {\leq} R_{d,f} \\ Hypothesis \ 3. & H_0: \ R_{d,f} {\leq} R_m \\ Hypothesis \ 4. & H_0: S_{m,h {\leq}} S_m \\ Hypothesis \ 5. & H_0: \ S_{m,h {\leq}} S_{m,f} \\ Hypothesis \ 6. & H_0: \ S_{m,f {\leq}} S_m \end{array}$

4. Empirical Result

Based on the above articulation, we enter the closed indexes of five stock markets between 1992 and 1998. The program written by our research team calculates trading strategies of H and filter rules. The result of the H rule is shown in Table 1 (the mean return) and Table 2 (the Sharpe ratio). Table 1 shows that the H trading rule on the Taiwanese stock market performs much better than the buy-and-hold strategy. The annual return of the buy-and-hold strategy is 4.96%. The best performance of the H rule is 65.67% when the buying/selling signal h=0.9%. This performance is better than that of the buy-and-hold one. Nevertheless, the H rule in Japan, U.S., Germany, and Britain does not have such a significant performance. Table 2 shows the same result with that of Table 1. It is mainly due to the fact that risk (the standard deviation of return) produced by technical trading rules is very close to the risk resulted from the market combination.

The filter rule performances are shown in Table 3 and 4. These two tables show that the filter rule performs better than the buy-and-hold strategy in Taiwan. The annual return is 47.35% in average when the filter band f=0.9%. Table 4 shows that the filter rule still performs better when risk is adjusted. Nevertheless, the excess return is not happened on other four markets.

According to Table 1 to Table 4, we find that both H and filter rules can acquire the excess return on Taiwan stock market, and band of 0.9% as the buying or selling signal is the best trading strategy of these two rules. What differentiates these two rules is that the H rule sells or buys when the daily price change over 0.9%; the filter rule sells or buys when the cumulated change of price exceeds 0.9%. This result indicates that the H rule performs better than the filter one on both mean return and Sharpe ratio. The summary statistics of the best trading strategy of these two rules is shown in Table 5.

However, these two technical trading rules cannot gain excess profit on the Japanese, American, German and British markets. Pricing on the Taiwan stock market entails the least efficiency. Table 6 shows statistical results examined by bootstrap resampling method. Since the risk produced by technical trading rules is close to the buy-and-hold one, the average reward and Sharpe ratio have the same statistical results. In Table 6, the smaller the smoothing parameter q, the larger the average sampling area, the better the performance of technical trading rules. When the value of q becomes smaller, resampling tends to maintain the pricing trend of the original price series. When q=0.1, and at 0.1 significance level, the H rule outperforms the market can be assured. When q=1, two technical trading rule cannot gain excess. This phenomenon matches our argument that the profit of the H rule is derived from the stock trend. When the total random sampling cancels the stock trend, the H rule cannot gain excess return from the market.

				Unit : %	
Market Trading Rule	Taiwan	Japan	U.S.A.	Germany	U.K.
Buy-and-hold	4.9612	-6.1055	26.9982	22.0736	19.5147
H rule h=0.0%	15.4674	-11.7113	11.2832	1.4238	18.0918
0.1%	13.0934	-11.4669	18.4572	3.9146	16.1528
0.3%	22.3988	-11.0794	24.9798	12.2748	18.6261
0.5%	17.3589	-11.0100	7.4997	12.0781	13.3249
0.7%	45.7840	-11.0847	2.5585	6.1443	3.9270
0.9%	65.6776#	-7.9408	2.7407	0.9288	6.2059
1.0%	47.4650	-9.9230	0.6655	4.6457	-0.1578
1.1%	48.0653	-8.8876	1.5534	2.0802	2.8294
1.5%	5.9869	-8.1238	-3.0663	2.7331	-3.6442
2.0%	-1.2333	-6.4850	-6.4013	10.1807	-7.5906
2.5%	-7.7524	-6.2810	0.9853	-8.0138	-10.2372
3.0%	-5.5211	-7.9352	-3.9269	-8.4764	-10.0230

 Table 1. The H rule performance- the mean return

Note: 1. The sign # stands for a better strategy than the buy-and-hold one, which is also the best one of the H rule.

2. Numbers in this table are converted into the annual return.

Table 2. The H rule performance- the Shapre Ratio(omitted)

Market	Taiwan	Japan	U.S.A.	Germany	U.K.
Trading Rule					
Buy-and-hold	4.9612	-6.1055	26.9982	22.0736	19.5147
Filter f=0.0%	15.4674	-11.7113	11.2832	1.4238	18.0918
0.1%	13.934	-11.4669	18.5717	5.5047	16.2972
0.3%	22.3543	-11.0471	21.8897	11.4451	20.7558#
0.5%	15.6380	-10.6316	15.2242	15.5992	14.2572
0.7%	38.3623	-11.7568	3.2587	9.1332	10.3162
0.9%	47.3485#	-10.0942	1.1200	3.3845	7.5743
1.0%	32.6471	-10.8360	-2.6033	-3.4996	-0.4305
1.1%	22.0560	-9.3568	-5.2355	1.9747	-0.4562
1.5%	25.9855	-10.1295	-4.6646	2.3243	-2.3523
2.0%	26.1238	-7.5355	-3.0719	2.8360	-4.6797
2.5%	13.8300	-10.0386	-0.1794	3.6191	-4.3554
3.0%	25.8674	-5.5772#	0.3036	-3.5966	-6.9603

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Note: 1. The sign # stands for a better strategy than the buy-and-hold one. This strategy is the best one of the filter rule.

2. Numbers in this table are converted into the annual return.

Table 4. The Performance of the filter rule -Shapre Ratio(omitted)

Table 5. Summary Statistics (omitted)

Table 6. Bootstrap P-Values

Table 7. BOOTSTRAP P-Values

	Bootstr		
Hypothesis	q=0.01	q=0.1	q=1
1. $H_0: R_{d,h} \leq R_m$	0.022**	0.066*	0.658
2. $H_0: R_{d,h} \leq R_{d,f}$	0.236	0.188	0.476
3. $H_0: R_{dh} \leq R_{df}$	0.060*	0.120	0.662
4. $H_0: R_{dh} \leq R_m$	0.022**	0.066*	0.658
5. $H_0: R_{dh} \leq R_{df}$	0.236	0.188	0.476
6. $H_0: R_{d,h} \leq R_{d,f}$	0.060*	0.120	0.662

Note: 1. q is the smoothing parameter of Politis and Romanos' stationary bootstrap. 1/q stands for the average block length of resampling. When q=1, resampling is totally random.

2. Risk produced by technical trading rules is very close to that produced by the long-term buy-and-hold strategy. Thus, the mean return and Shapre ratio produce the same statistical standard.

5. Discussion and Conclusion

Based on investors' herding behavior on the stock market, this research establishes the H trading rule in capturing the activated timing of the heading behavior as a means to acquire the excess from the market. That is, the H rule evaluates the pricing efficiency of the stock market. The herding behavior occurs by virtue of investors' imitating and following behaviors. Price is the result of investors' actions, and it is also the communicative mechanism between investors. The rising price attracts more following actions. As a result, the stock price moves in a patterned direction, instead of a random one. The more obvious the price trend, the less efficient the market pricing, the better performance the H rule.

Our empirical study shows that, during 1992 and 1998, the H rule can acquire excess on the Taiwanese market, but not on American, Japanese, German or British stock markets. Even though Bootstrapresampling is implemented in order to avoid the effect of pseudo fitness, the abnormal performance of the H rule can still reach the statistically significant level. When the total random resampling is adopted, this abnormal performance disappears. That is, there is less efficiency on the Taiwanese stock market than on the rest of four studied markets. This is on account of the fact that the stock price entails the arbitrage possibility.

Regarding the comparison between the performance of the H rule and that of Alexander's filter rule, the former's abnormal performance is better than that of the latter regarding the original stock pricing data. However, the p of Bootstrap is not statistically significant. Thus, we cannot assert that the H rule is better than the filter one.

An important information should be noted in Table 5. The H rule's excess ratio in the total trading number is no more than 0.5 (the filter rule shows the same result); yet, in general, the H rule can still gain profits. This is probably due to the fact that pricing is instantly and sufficiently reflective to certain information, or that the obvious rise or decline of the price may be adjusted in a reversed mode. In other words, not every sudden change of the price activates the herding behavior.

In this research, the simplified principle of each rule is given when we compare the investment performance of the H rule with that of the filter rule. In fact, technical trading rules are not fixed ones. A better performance can be acquired after some modifications. This deserves further investigation. Certainly, the H rule can be modified in several ways. For instance, it is possible to maintain the short strategy when some conditions are established; it is also feasible to create different levels of buying/selling signals; it is even viable to integrate information about the transaction volume. These can possibly improve the abnormal performance of the H rule.

If the abnormal performance of the H rule is correlated to the herding behavior, this rule can be better implemented to the abnormal performance of small-scale stocks. This is on account of the fact that the small-scale stock is more easily affected by the herding behavior than the large-scale one. We believe that this comparative study can examine the relationship between the H rule and herding behavior.

As the final and the most important remark of this paper, the H trading rule can be established by articulating the characteristic of the herding behavior. We also conclude that this finding is based on the instant nature of the H rule in capturing the activation of the herding behavior. Nevertheless, why is the herding behavior easily formed along with the obvious pricing change on certain markets (i.e. the Taiwanese stock market)? And why isn't this phenomenon commonly seen on other markets (i.e. the American stock market)? Do investors bear different degrees of rationality? Or do trading and market structures influence different degrees of the herding behavior (i.e. the corporation ratio or the limit of the rise/decline range)? In order to answer these questions, more investigations are required.

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