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A Discovery of Emergent Behavior Pattern in Trading of Unknown Goods

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Society sometimes suffers from erroneousvaluationof very large scale, like Enron incident. Since any individual reasonable risk evaluation or existence of greedy arbitragers should have prevented such long-term, large scale valuation errors, such events are often considered as a matter of errors of valuation system. This study suggests a computational model that describes interactions such as emergence and feedback, between individual valuation behavior and group behavior, which discovered a clear and distinctive pattern that the group's valuation may seems to converge into a consensus, even if it is not real. The model is a relatively new approach in explaining valuation behavior, linking individual decision and group behavior with feedback mechanism. Implications from the analysis can be helpful to managers who handle complex and uncertain goods.

Key words : Imperfect information, herding behavior, emergence and feedback.

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I. Introduction

Recently there were more than enough incidents that created significant disturbances from critical valuation error by a fairly major part of our society. Enron, for example, was a very fine example of successful M&A case for any good MBA courses, only until the reality came. 2008 subprime crisis was also partially based on erroneous valuation of real estate assets. Somehow charging high interest rate to subprime lending and making advanced securities from them was a viable business model, even sanctioned by government, and all of sudden it is not. Two stem-cell related academic papers were published at a major science journal, decorating the cover, making the researcher a national hero. Only after 3 years it was revealed by a journalist that all of his research was a fake[1]. Information technology was supposed to increase productivity of any industry, and many managers believed so and wondered why it is taking so long, only until Carr (2003) suggested the expected productivity increase may not come at all. Although these kinds of events do not happen in a daily basis, the chaos and disturbances from such events are great since so many people believed them as real.

Both academicians and practitioners have their own theories and systems to prevent such large scale and long term error from happening. Information economics suggest that if erroneous valuation is observed, any greedy arbitrager will take the opportunity and gain benefits, correcting the valuation (Fama, 1970). Number of studies suggested theories about decisions including herding behavior. According to Banerjee (1992) and Bikhchandani, Hirshleifer and Welch (1992), lack of information may push people to join a herd. However, theoretically such herding behavior should increase incentives for arbitragers to look for the real value and arbitrage, since the more people in the herd, gain from arbitrage increases. Also, practitioners developed various systems and agencies to monitor and report errors, like journalists, auditors, reviewers, even internet bulletin board and social networking system, to prevent errors from spreading among the society.

However, even with all those theories and systems,sometimes valuation errors may not be corrected fast enough, letting them to be believed in a long-term society-wide scale. Although such events created heavy chaos and disturbances among our society, it is still

1) http://en.wikipedia.org/wiki/Hwang_Woo-suk

considered as pretty rare. Therefore, I presume, it is considered as a matter of probability and therefore point of interest is on the perfection of the system. In other words, such errors can be reduced by increasing information efficiency of our society, thus our best efforts should be invested in making better systems. I suspect those are the reasons of lack of studies on the possibility of a repeatable and predictable mechanism existing in our behavior which initiates such large scale valuation error or building a model describing the mechanism.

Since goods involved such events are often very hard to understand, sometimes even for experts in the related fields, it is no wonder that valuation of such goods starts with relatively large amount of error and controversy. Intuitionally, if controversies or price fluctuations are decreasing as time passes, one can expect that the group have reached a consensus, thus the more reason to believe it is real, as there are often saying, "60 million people cannot be wrong" [2]. These kinds of intuitions usually work, since the major reason why a product's price fluctuation reduces is because of new information about the true value of the goods continuously discovered by interested parties. Therefore one can expect if no new information is available, definitive decrease of price fluctuation would be very hard, if not impossible. A good example would be a court trial. Both arguing parties have different points of view because information about the subject is not fully shared. Only after information from both parties is shared, usually by lawyers or police officers, relatively uninformed party can adjust their optimism, often leading to a settlement (Cooter, 2004).

Then, what can be expect from reasonable investors when they saw a steady decrease of price fluctuation of a good? Of course, even if there is nothing changed price fluctuation can be increase or decrease by effects of random errors or white noises. However as price fluctuation decreases steadily for a somewhat long term, the possibilities of random changes of fluctuation scale diminishes and one may jump into conclusions that the product's true value is being revealed (by other people), since to the best of my knowledge there are no academic theories suggest existence of repeatable and predictable pattern of price fluctuation when the product's true value is not known.

However, what if our behaviors have definitive tendencies that make a product's price fluctuation decreases even if the product's true value is not being revealed at all? If so, not

2) http://www.amazon.com/Sixty-Million-Frenchmen-Cant-Wrong/dp/1402200455

only the society may accept erroneous valuation in a long term but also may deter discovering true value of the product because it may give wrong impression that there are enough information already in effect to determine the product's true value. Although in that case it seems important to identify such conditions and react accordingly to make our society stay efficient, this "hat-if" ssumption may seem baseless and pure imagination.However, my suggestion is that such possibilities are simply neglected by previous studies because of usual assumptions suggested by traditional models. So far many studies focused on short term behavior and assumed that decision maker's situation does not change (Veeraraghavan et al, 2008, Froot, 1992). Such assumptions are natural and sufficient if considered in short-term or one-shot decision analysis. However, in a long-term analysis, individuals and group may build a tendency and shift from neutral by observing and adjusting each other's behavior. Many studies used complex adaptive model discovered there can be emergent pattern of group behavior, from interactions between individuals and group, even if the individuals do not intend to do so. Miller and Page (2004) discovered even with well diversified individual preferences, interaction between individuals can make a group take a very extreme behavior. Carley and Svoboda (2010) discovered a small error from a small population of a group, which is of course not intended, can push the group's performance to an optimal limit. Therefore, it is my belief that such possibilities have been ignored not because they are unlikely to happen or just a fantasy, but because previous studies mainly focused on short-term static decision, often ignoring long-term interactions between individuals and group. Such tendency or pattern, if it can be discovered, may greatly help to understand why our society at large sometimes sticks to the wrong valuation and consequently suffers from it.

However, both analytic and empirical models are not easy to apply to such cases. To investigate if individual and group's valuation in such cases have some patterns or not, it should be under a laboratory condition that the true value of the goods are absolutely not available, since any piece of information regarding the true value of the goods will change the behavior dramatically, making it impossible to distinguish whether it is induced by individual's interaction or by revealing the true value. Applying empirical methods can be next to impossible since there is almost no way to control real world information flow. Experiments involving real human subjects under controlled environments are too costly to observe a long term and a large group pattern. Analytic models based on microeconomics often need to be simplified to execute humanly possible analysis. Therefore modeling large

number of interactions is very hard to achieve, if not impossible.

Moreover, modeling individual's valuation behavior under no knowledge of the true value of the subject has been a debate for a number of years. Any traditional microeconomics textbook can suggest that reasonablerisk assessment would prevent any individual from buying a good which she does not know well enough. However, behavioral scientists discovered that if one can observe other people's behavior, thing can be different. People often believe other people have more information than them, thus following other people's behavior with little questions. Raafat et al. (2009) suggested such herding behavior is one of psychological nature of a human being, while Veeraraghavan (2008) suggested one can reasonably choose doing on her own or following others by economically analyzing the situation. However, all of those studies only considered very short-term decisions since there was no reason to look into a long-term pattern of behavior, so far. To identify existence of a long term pattern, interactions between individual's behavior and group's valuation should be considered, since they can be important factors creating a pattern of behavior.

Our paper aims to investigate the existence of definitive emergent pattern from interactions between individual and group's valuation and to focus on previously neglected research setting involving long term interactions between individuals and group, which may have great opportunities of new important findings regarding valuation of complex goods and market efficiency. And if such pattern exists, suggest practical implications for managers who must handle very complex goods and market such goods are listed, by suggesting conditions for long-term sustaining valuation error can happen.

To look into proposed research question, I present a computational model which simulates interactions including emergence and feedback, between individual decision and group behavior. The analysis suggests a possibility of definitive behavior pattern of reducing price fluctuation of a good even if true value of the good is completely unknown.

In section 2, I presenta computational model to describe interactions between individuals and group for valuation under extremely scarce information. Section 3 shows results of analysis from the model, suggesting interactions between individuals and group can create a pattern that shows definitive and predictable changes of price fluctuation of a good. In section 4 explains implications from the analysis, along with this paper's limitations and possible future extensions.

2. Model

The goods in this paper are considered as something people want to trade but they actually do not know anything about them. A good example would be stocks of a very complex company, or a politician running a campaignwhose character is not well known, or an academic paper which describes a very complex theory.The goal of this paper is to investigate how people valuate such goods even without the true of the goods known in a relatively long term. Therefore a very controlled laboratory setting is needed andthe following is description about the settings.

Simulation starts with a new product suddenly appeared in a market, initially priced by the provider. Assume that although there is no true value regarding product available, there are some people who are going to buy or sell the product. Although any reasonably risk-averse people would refrain from buying or selling such unknown thus risky product, the model assumes some people may still start trading the product. For example, any desperate day-trader may attempt to buy some relatively unknown securities and hope for it turned out to be good. Or someone can be pushed to express an opinion about a politician whom he or she does not even know about, to save his or her face in a bar. Another example would be a court that faced the famous Microsoft antitrust case. The court stated "ourts are ill equipped to evaluate the benefits of high-tech product design" (Economides, 2001).

Individual traders have two strategies to follow if there is no direct information about the true value of the product available. First option is a random guess. Since there is no known true value of the product, one can randomly chooses whether to buy or sell the product. If one is sure about his or her guessed value and thinks the current price of the product is lower than he or she thinks, he or she will buy the product, otherwise will not. Although it can be considered as the one is best-guessing from one's past experience, it is assumed that individual's past experiences are diversified enough to set the probability of buy or sell is uniform random distribution. Therefore agent's rule for independent guessing is:

〈Table 1〉 Agent's behavior when decided not to follow others

Behavior	Chance
Buy	1/3
Sell	1/3
Stay	1/3

On the other hand, if an individual trader does not have confidence about one's guessing, the individual can watch the others doing and try to mimic the majority's behavior, often referred as a "erding behavior". In this paper, the majority's behavior is considered as changes of the market price. If there are more buyers than sellers, the market price would increase. Since the market price is observable by everyone, one can easily monitor the majority's behavior. Now, if one does not have enough confidence on her random guess, (even if the one does not think it is random) she will take the market price as the indicator of majority vote, and try to follow them. Therefore agent's rule for herding behavior is:

〈Table 2〉 Agent's behavior when decided to follow others

Behavior	Condition
Buy	If market price has gone up
Sell	If market price has gone down
Stay	If market price is same as before

To decide which strategy one should take, each individual has own confidence level or herding tendency for its own judgment. The model used herding tendency as a measure of confidence level,as those two are assumed to have negative correlation, normalized to [0,1]. If one has a herding tendency of 0, individual is absolutely sure about her own judgment, therefore she will not consider following other people's behavior. On the other hand if one has herding tendency of 1, she will blindly follow others completely ignoring her intuition. Every time a decision is needed, one with low herding tendency is more likely to follow independent guess, while one with high herding tendency is more likely to follow other's behavior.

It is assumed that each agent can only buy and sell 1 unit of product at a time. Since the model uses many agents and any reasonable rich individual would consider securitization

along with portfolio strategy, the assumption should not be much deviated from real individual's behavior.

The whole reason why a computational model is needed is explained in the following. Even if this is a laboratory setting that enforces absolutely no true value of the product available, that does not mean an individual do not change one's strategy over time. And the changes of strategy may affect market behavior, thus affecting one's strategy again. This kinds of emergent-feedback mechanism is the focus of this paper and in order to observe the mechanism, the agents are set to change their strategy according to result of their trade. Each agent will change her herding tendency slightly according to the result of their investment. In the model, if one bought and sold by only her own guess, and resulted a loss, she will raise her herding tendency by a small amount. If one bought and sold by following others, and the result was a loss, she will lower her herding tendency by a small amount. The following table shows how the agents change their herding tendency according to the result of investment.

〈Table 3〉 Agent rules for changing herding tendency

Behavior	Condition
Increase herding tendency by 0.1	Followed others and resulted a gain Did not followed others and resulted a loss
Decrease herding tendency by 0.1	Followed others and resulted a loss Did not followed others and resulted a gain
Do not change herding tendency	Wealth did not changed

Since the model is built for investigate pattern of individual and market behavior, the simulation gives individuals a fairly large number of opportunities. Table 4shows important variables considered in the model, including number of opportunities.

〈Table 4〉 Variable settings for simulation

Variable	Value
Number of agents (Integer)	100
Herding tendency of agents (Real)	[0,1]
Maximum number of unit can be traded by an individual at a time (Integer)	1
Number of trading run (Integer)	1,000
Initial pricing (Integer)	100

To summarize structure of the model,Figure 1 shows simplified pseudocodeof the simulation.

〈Figure 1〉 Pseudocode of suggested simulation model

```
Generate agents
Assign values to herding tendency of each agent
Generate random number and decide strategy of each agent
For each agent in shuffled order
    If decided not to follow others
        Generate random number
        Buy or Sell or Stay according to random number
    If decided to follow others
        Compare market price of current stage and previous stage
        Buy or Sell or Stay according to comparison
    If the agent sold the product
        Compare wealth before and after the transaction
        Adjust herding tendency according to net gain
    Decide strategy for next run
Next until given number of trading run reached
```

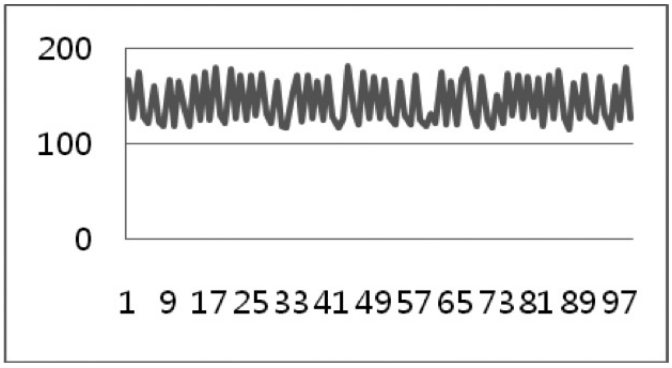
With the model, the analysis was done in an exploratory manner, observing the resulting behavior while changing various initial conditions. The result of analysis is shown in the following section.

3. Analysis

From the data generated by the simulation, pattern analysis and statistical analysis from the generated results are conducted. The results of analysis and possible implications are described in this section.

3.1 No Feedback, neutral herding tendency

First test is to observe how the model would behave without feedback mechanism. The expected result is that the market's behavior pattern does not change over repeated transactions, and the actual result is the same. Average herding tendency is set to 0.5: About half of the traders will follow others and the other half will guess on their own.



〈Figure 2〉 Price change, no feedback, avg. herding = 0.5

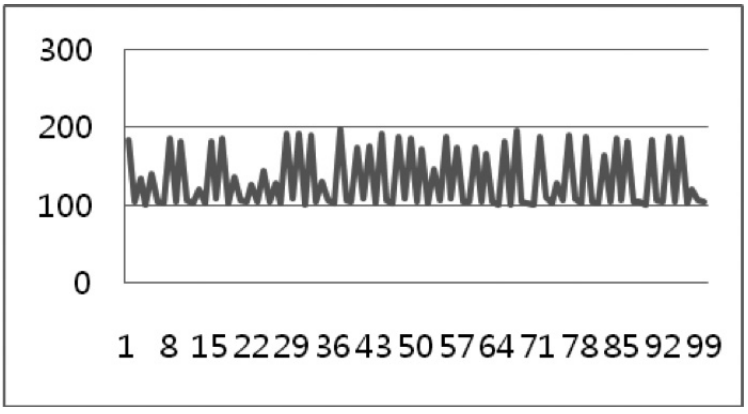
Since there is no short-sale, price is started with higher than initially set. There was no change in standard deviation along the 1,000 trade run: 23.39.

As explained in previous sections, my suggestions is that this kind of simple extension of models suggested by previous studies yielded no valuable results to analysis, and this is why related research did not executed fully.

Veeraraghavan and et al. (2007) suggested that people reasonably chooses whether to follow others or not, according to their own confidence level. The model is tested with higher average herding tendency in the next section.

3.2 No Feedback, high herding tendency

To see how relatively high individual herding tendency affects market behavior with simple no-feedback setting, the initial average herding tendency is set to 0.9.

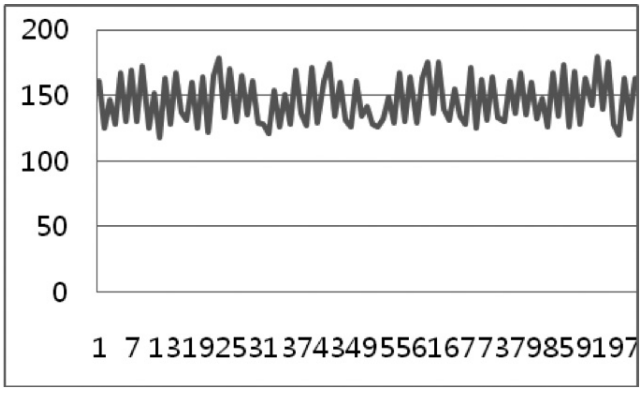


〈Figure 3〉 Price change, no feedback, avg. herding = 0.9

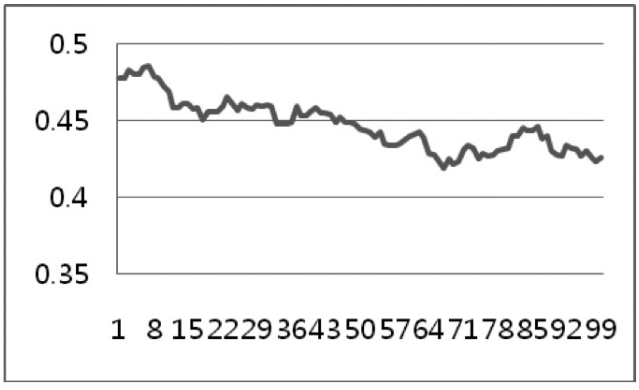
Standard deviation is 35.54 and steady along the 1,000 run. The less people do not have confidence in their judgment, the more they are likely to show herding behavior, making the market more chaotic. The result may support behavioral researcher's claim, including Banerjee (1992) and Bikhchandani, Hirshleifer and Welch (1992).

3.3 Feedback, neutral herding tendency

These analyses are shown for the model is working in thesimpler manner, which does not involve a long term interaction between market and individuals. Now let me activate the feedback mechanism of the model. As explained in the previous section, each individual changes their herding tendency according to the result of her investment. First, average initial herding tendency is set to 0.5, assuming there are roughly equal number of people who wants do judge on their own and people who follow other's decision.



〈Figure 4〉 Price change, feedback, avg. initial herding = 0.5



〈Figure 5〉 Avg. herding tendency change, avg. initial herding = 0.5

There is no visible pattern in the first 100 run. However for average confidence level it shows clear pattern.

Figure 5 shows that average herding tendency decreases as the transactions are repeated. Intuitional interpretation is the following: At starting point, an individual trader may rely on other behavior for she does not have confidence about the value of the product. However since other people also do not know about the true value of the product, the market behavior is chaotic as many people participate in the herd. Therefore, as transactions are repeated, some people naturally give up on believing other people and chaos created by them.

Table 5 compares starting value of standard deviation of price and average herding tendency and ending value. Interesting point is with feedback mechanism activated, the stan-

dard deviation of the price is lower than the case of no feedback. Even if people are ignorant about the product, that does not mean they are stupid. By learning and adjusting their behavior the market as emergence of individual behavior clearly reduces chaos or price fluctuations. The only problem is they still do not know about the real value of the product, and by reducing controversies it may create wrong impressions. Detailed discussions are in following sections. Although both values decreased after 1,000 run, the amount of difference is may not seem clear. The next experiments show the differences more clearly.

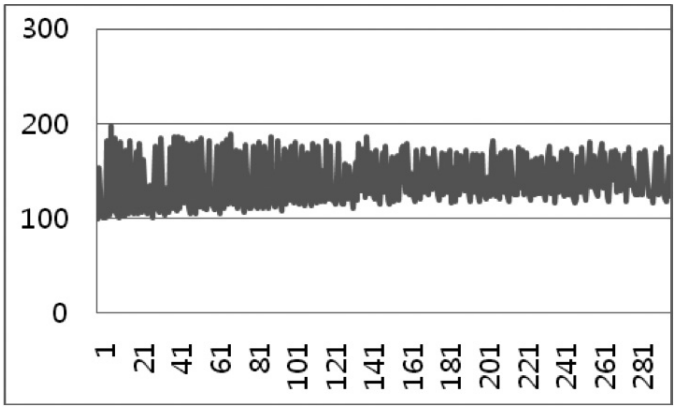
〈Table 5〉 Changes in prices standard deviation and avg. herding tendency. Initial = 0.5

	Standard deviation of price	Average herding tendency
First 100 of 1000	18.261	0.478
Last 100 of 1000	16.895	0.331

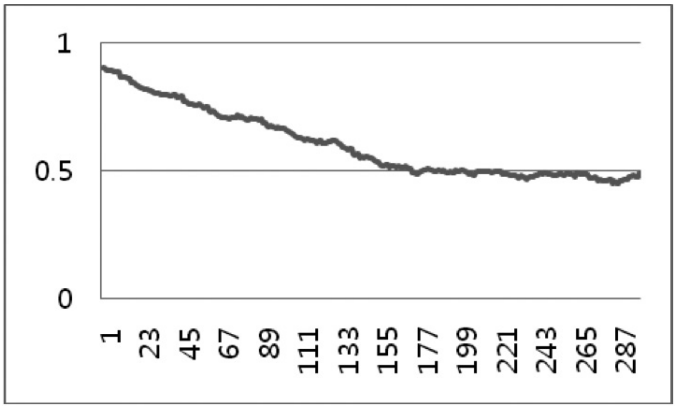
3.4 Feedback, high herding tendency

Now initial average herding tendency is set to 0.9. The results show more dramatic decrease in both standard deviation of price and average herding tendency.

Figure 6 now shows visible pattern of decreasing standard deviation of market price and Figure 7 also shows clear decrease of average herding tendency of individuals.



〈Figure 6〉 Price change, feedback, avg. initial herding = 0.9



〈Figure 7〉 Avg. herding tendency change, avg. initial herding = 0.9

Table 6 shows clearer drop of numbers than Table 5, meaning the trading individuals are adjusting their strategy in a direction of reducing market price fluctuation.

〈Table 6〉 Changes in prices standard deviation and avg. herding tendency. Initial = 0.9

	Standard deviation of price	Average herding tendency
First 100 of 1000	33.133	0.9
Last 100 of 1000	19.010	0.424

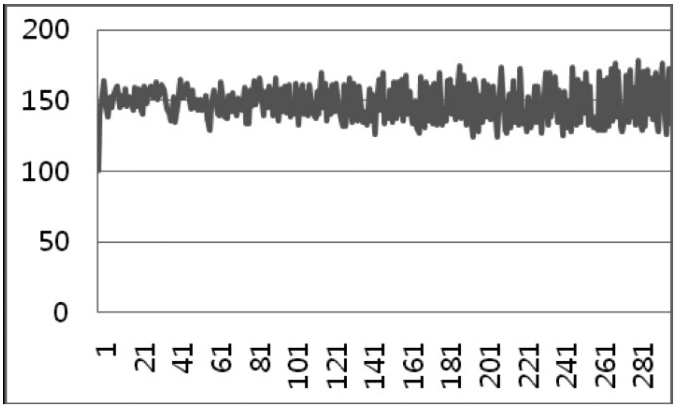
The result shows same pattern as the previous case, when initial herding tendency is neutral.

So far two tested cases showed similar pattern of decreasing price fluctuations if feedback is allowed. One can wonder this decreasing pattern is the only form of possible pattern. Next test result is showing somewhat different pattern.

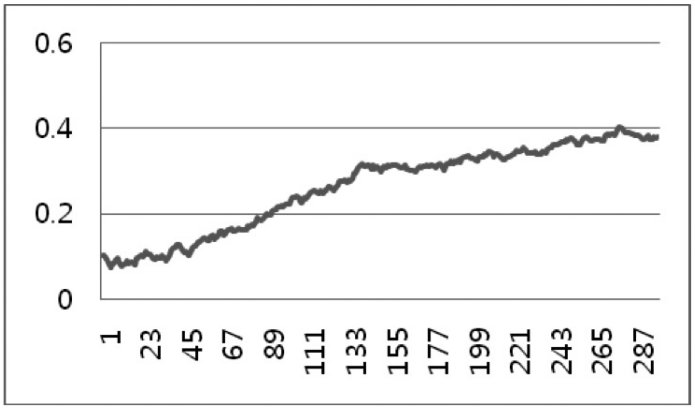
3.5 Feedback, low herding tendency

The initial average herding tendency is set to very low value, 0.1. Note that low average initial herding tendency means that almost all traders have confidence in their own valuation of the product, while actual value of the product is completely unknown. In the two previous tests with neutral or high initial herding tendency value can be considered sufficiently reasonable because as Veeraraghavan (2007) suggested if we do not know about the prod-

uct, we are more likely to take herding behaviors. However, this low average herding tendency is a relatively unrealistic setting in comparison of previous two tests, because it may reflect a situation which assumes that vast majority people are delusional.Regardless, in a sense of scientific curiosity, the result is shown below.



〈Figure 8〉 Price change, feedback, avg. initial herding = 0.1



〈Figure 9〉 Avg. herding tendency change, avg. initial herding = 0.1

Trading individuals are increasing their herding tendency until some level of price fluctuation is reached. Table 7 shows initial and last state of price standard deviation and average herding tendency.

〈Table 7〉 Changes in prices standard deviation and avg. herding tendency. Initial = 0.1

	Standard deviation of price	Average herding tendency
First 100 of 1000	9.914	0.1
Last 100 of 1000	17.424	0.385

The pattern is clear however its direction is reversed and in the end standard deviation of price and average herding tendency is somewhat similar to the previous tests.

3.6 Implications from pattern analysis

All the tests so far suggests if no new information about the product is not produced for the market, no matter how initially the traders thought how much they knew about the product, eventually roughly 60% of the traders would follow majority's decision, while remaining about 40% would decide on their own, by the process of feedback.

This can be an interesting phenomenon since Iassumed at the beginning of the model these traders are the few people who want to trade the product even though the product is not well known to them, for their own reasons, and many average risk-averse traders refrain from investing in such product since for them, uncertainty of the product is too large to bear.

However, the test results suggest that even if the true value of the product is not discovered, price fluctuation may decrease. Now intuitionally if price fluctuation decreases, a major reason for the decrease is usually discovery of the true value of the product. Such intuitions usually work because most of the time it happens. The problem is that even with no true value of the product available, price fluctuation can be changed over time, only by interaction between the traders. This may create an illusion of the true value being discovered. Without considering feedback mechanism, scale of price fluctuation should stay same and there is no reason to reconsider investing in such a risky product. However with feedback mechanism the price fluctuation can be decrease as time flows, and if one observes the decrease of fluctuation, one may suspect that the product's real value is being revealed and thus the market is stabilizing, and maybe the one does not have enough time to investigate the actual reason of decrease of price fluctuation.And as the more people believe it, the more people can be have hard time to deny it: "his many people cannot be wrong".

The model discovered that even if there is no information about the actual product avail-

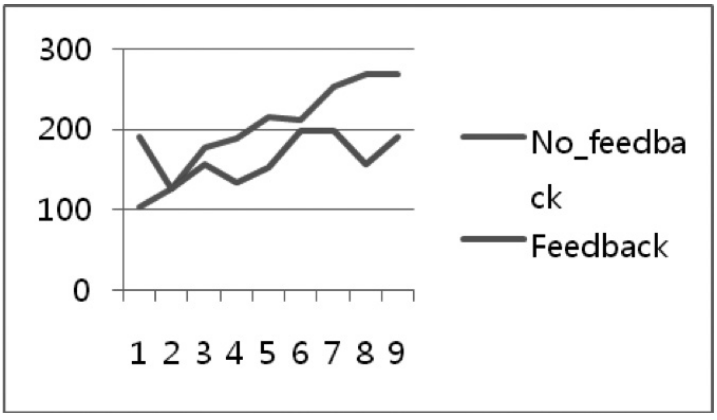
able, the fluctuation of market price can be changed in distinctive and predictable patterns. Therefore I suggest that the patterns discovered by the model can be a viable answer to the suggested research question: A discovery of distinctive and predictable market behavior pattern when valuating unknown goods. The test results also suggest new and valuable implications for the real world. As explained in previous sections, without considerations of feedback mechanism, the price fluctuation may not have enough reason to decrease, deterring risk-averse investors and thus keeping the majority of the market from making valuation error of a very large scale. However without the true value of the product being revealed, only by interactions between individual traders the price fluctuation may change, more likely in a decreasing direction, can give a very wrong impression to the general risk-averse people such as reducing incentives of finding more accurate value about the product. Therefore the test results can be a viable explanation for real world phenomenon: why an erroneous valuation of a complex product can spread a very large scale and can sustain such error for a very long time. Any manager, who wants to identify the value of a very complex product relatively better than her competitors, may lose opportunities to arbitrage or fall for the illusion of truth. A steady reduce of stock price fluctuation of a high-tech company may seem like "inding its place" and thus have less opportunities of arbitrage, only it may not.

This kind of approach is especially dangerous if a manager tries to make a course of action based on behavior pattern. For example, a lot of financial indicators like Sharp's ratio involve price fluctuation or variance. Without detailed analysis on the source of changes in variation, some previously dangerous asset can be gradually become a relatively safer asset, making various financial indicators get better. The problem is that our test results suggest it is likely that even without any real changes the true risk of the product the variance of price can be gradually decrease. In other word, previously there were not enough reasons to believe without any external shock, a price variance would have some kind of predictive pattern.Stock market analysts usually relate various indicators and the real world. If some indicators signaling the stock have become safer however there are not enough reasons to support it, do not try to make unreliable links to explain the changes of indicators, instead try to remember the market as group of individual investors, may have tendencies showing such changes in price fluctuation, regardless of the product's true value, showingan illusion of truth.

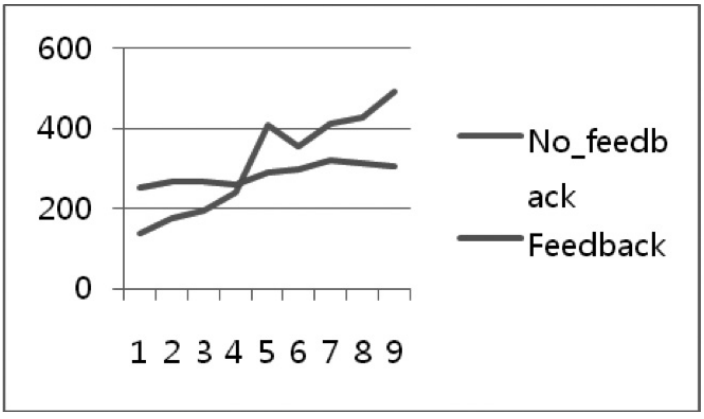
3.7 Additional analysis

Next two figures show how individual traders' behaviors and their wealth are related.Figure 10 shows average wealth of participated individuals after 1,000 decision and Figure 11 shows the variance of them. Without feedback mechanism, higher initial herding tendency, which is maintained until the end of the simulation, achieve higher average wealth however also higher variance of wealth among individuals. This can be explained intuitionally as majority of investors following each other, few which followed others in a timely manner can earn extreme profit while few unfortunately missed the opportunities repeatedly may end up bankrupt. The higher average herding tendency, the fluctuation is larger, which means if one could ride a good wave he can arbitrage a big time. Again, common saying like "f unsure, follow others" works perfectly in this setting, and it is very likely be true if not considering changing one's tendency under long term time span.

However, with feedback mechanism things can be quite different. As it may look like following others very quickly can be beneficial at the early stage, in a long run, if people can change their behavior based on experience, may not be always true. The final average wealth and variance of wealth is almost same regardless of initial herding tendency. It is more realistic in an intuitional sense because if a trader started with high herding tendency and kept losing in his investment, he is more likely to change his strategy to follow his own guts, reducing the windfall effect incurred by herding behavior. Therefore, eventually benefits from following others reduce gradually, and finally even the strongest believer of other people's judgments cannot ride a big enough wave.



〈Figure 10〉 Final average wealth



〈Figure 11〉 Final standard deviation of wealth

These results can yieldquite useful implications for managers. If competing investors are very reluctant to change their already higher herding tendency, and if you already lost while following other's behavior, you are more likely to end up with empty trading account. Of course one can take advantage of the subject's complex nature and try to ride a big wave, however if competing investors are flexible in changing their strategy, beware that the size of the wave may decrease rapidly than expected even without any detailed news about the product coming forward.

Table 8 shows the relationship between individual herding tendency and final wealth. Simple regression is done with final wealth as dependent variable and final herding tendency as independent variable. Without feedback, in this initial herding tendency is same as

final herding tendency, individual herding tendency is positively correlated with final wealth and significant. As shown in Figure 10, the higher herding tendency means the higher chance of better final wealth. Although the result seems to support the benefits of herding, with feedback mechanism the result does not show any correlation.

〈Table 8〉 Statistical relationship between herding tendency and final wealth

		Coefficient	t-statistic	p-value
No Feedback	Intercept	-35.9496	-0.50259	0.616
	Herding Tendency	358.4547	2.971124	0.003732**
Feedback	Intercept	161.66	3.534409	0.0006
	Herding Tendency	-87.8521	-0.97975	0.32962

Again, with feedback mechanism, individuals gradually change their strategy, reducing overall price fluctuation and thus reducing benefits of following others or "iding windfall". Implications can be also similar with two previous figures, as individuals adapting to raging bull, chance of riding a big wave decreases, therefore it may be better not to expect chaos to prevail even without any real facts discovered.

4. Conclusion

This paper presents a model which describing emergence-feedback mechanism incurred by traders who deals extremely unknowable goods. Academically to the best of my knowledge there were no theories that suggest existence of any distinguishable pattern of market and individual behavior if no true value of the goods available. Therefore one could only guess about the price fluctuation of such goods would be increase or decrease or even stationary. Hence, if one observes decrease of price fluctuation, one usually wants to find out the reason, hoping that some news about the goods have revealed the true value of the goods. However, the analysis from suggested model shows that the price fluctuation is very likely to decrease under such circumstances by a distinguishable and predictable pattern.This can be a rare and valuable addition to academic field since what has been considered as a simple noise or error may be a result of predictable pattern of behavior. To

practitioners, usually decreasing price fluctuation caused by some reason, like the true value of the goods has revealed. However, this paper suggests it is very likely to happen without any such discovery, creating an illusion of truth. Therefore a manager dealing very complex goods may have to be aware such possibilities and may have to refrain from fruitless searching for viable reason, let alone believing it to be a signal of true value being discovered. I suggest that from the simulation results and related implications this paper can be a viable answer to the suggested research questions, by discovering behavior pattern applicable on specific situations.

This paper has a few limitations and possibilities of future research. Although emergence-feedback behavior pattern discovered by the model is very clear, it is not clear that which microeconomic or psychology theories are linked to the pattern discovered. The basic rules governing the agents' behavior in the simulations are strictly from microeconomic theories and are reasonable under the given assumptions. However, emergent pattern is not clearly linked to any specific previously suggested academic theories, although it still can be a key to understand some real world phenomenon. A case study about some events happened in a reasonably similar situation that this paper relies on, would be a good supporting argument for the model's applicability on the real world. Finally, a few simulation parameters can be added to the model and see how the pattern changes, if any valuable contributions are expected.

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경영관리연구
(제4권 제2호)

환상이 진실로 받아들여지는 원리 : 불완전 정보 하에서 재화의 가치평가

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본 연구는 최근의 금융위기 또는 이전의 황우석 사건과 같이, 우리 사회 전반이 공통적으로 인식하고 충분히 검증했다고 생각한 어떤 재화의 가치 평가가 뒤늦게 실제가치와 크게 차이가 나는 것이 밝혀져 큰 혼란을 일으킨 경우들에 대해, 그러한 현상이 발생하는 매커니즘을 복잡계 방법론을 적용하여 분석하였다. 분석 결과, 부분과 전체의 상호작용(Emergence-Feedback) 효과에 의해, 어떤 재화의 실제 가치를 평가할 수 있는 그 어떠한 정보도 존재하지 않는 이론적인 환경에서 조차, 구성원들이 해당 재화에 대한 평가가 어떤 합의점을 이루는 것처럼 관측되는 일정하고 명확한 패턴이 발견되었다. 본 연구는 지금까지는 단순한 혼돈의 발현이라고 여겨졌던 사회 현상들이 예측 가능한 패턴을 가질 수 있다는 새로운 가능성을 제시함으로써 사회과학 및 경영학 분야에서의 학술적 가치에 기여할 수 있으며, 가치평가가 매우 어려운 산업에 관련된 경영자들에게 새로운 관점의 함의를 제공한다.

주제어 : 불완전 정보, 집단 행태, 상호작용

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