



Academy of Mathematics and Systems Science,
Chinese Academy of Sciences

Disposition effect in an Agent-based Financial Market Model

By: Bangwei Li

Wei Shang

Hongquan Li

Lin Huo

Shanying Xu



Outline

- Introduction
- The Model
- Results
- Sensitivity Analysis
- Conclusion



Introduction

- Disposition effect refers to investors' being reluctant to realize losses.

Shefrin and Statman (1985)

- Disposition effect is very common in financial markets, especially in mainland China.

*Odean T (1998), Shapira Z (2001), Weber M(1998), Shumway T(2006),
Chen G (2007), Yonghong Z X W (2001)*



Introduction

- Purpose of research

1. The empirical study has found that strong non-rational factors in Chinese stock market, such as disposition effect, could bring the special asymmetric volatility : the impact of bad news (negative unexpected return) on future volatility is greater than the impact of good news (positive unexpected return) of the same magnitude.

Does disposition effect bring the special asymmetric volatility in the agent-based model?



Introduction

- Purpose of research

2. Some researchers think there is a negative relationship between the disposition effect and investment performance, but there are also some researchers who find no evidence of any contemporaneous measurable costs associated with disposition effect

Does disposition effect bring investors earnings or losses?



Introduction

- Purpose of research

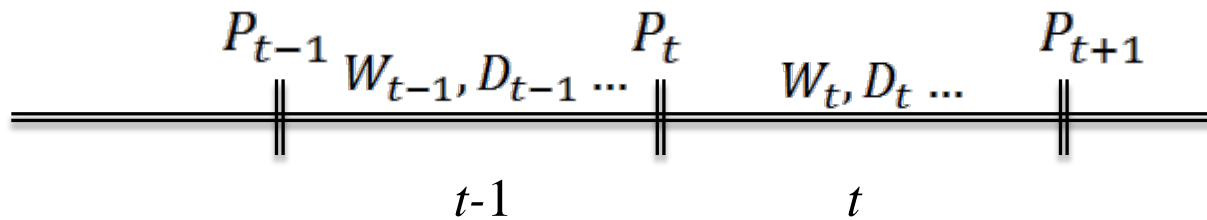
3. It's found that disposition effect may slow the rate at which this information influence the stock price.

Use agent-based model to verify this conclusion.

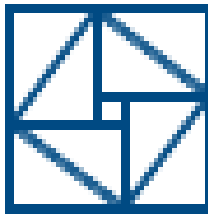


The model

- One asset:



- One market: N agents.



The model

- Every agent has three strategies:

1. Fundamentalist

$$D_t^f = c(F_t - p_t) + \gamma_t$$

2. Chartist (**Chartist has disposition effect, $f < 0$**)

$$D_t^c = \begin{cases} 0 & \text{if } p_t - p_{t-1} < f \\ b(p_t - p_{t-1}) + \beta & \text{else} \end{cases}$$

3. Inactive rule

$$D_t^0 = 0$$



The model

- The attractiveness of three strategies:

1. Fundamentalist

$$A_t^f = (\exp[P_t] - \exp[P_{t-1}])D_{t-2}^f + dA_{t-1}^f$$

2. Chartist

$$A_t^c = (\exp[P_t] - \exp[P_{t-1}])D_{t-2}^c + dA_{t-1}^c$$

3. Inactive rule

$$A_t^o = 0$$



The model

- The relative weights of the strategies :

1. Fundamentalist

$$W_t^f = \exp(eA_t^f) / (\exp(eA_t^c) + \exp(eA_t^f) + \exp(eA_t^o))$$

2. Chartist

$$W_t^c = \exp(eA_t^c) / (\exp(eA_t^c) + \exp(eA_t^f) + \exp(eA_t^o))$$

3. Inactive rule

$$W_t^o = \exp(eA_t^o) / (\exp(eA_t^c) + \exp(eA_t^f) + \exp(eA_t^o))$$



The model

- The log of the price of the asset in period $t + 1$ is given as:

$$p_{t+1} = p_t + a(W_t^C D_t^C + W_t^F D_t^F) + \alpha_t$$



Results

□ Stylized facts

1. Bubbles and crashes

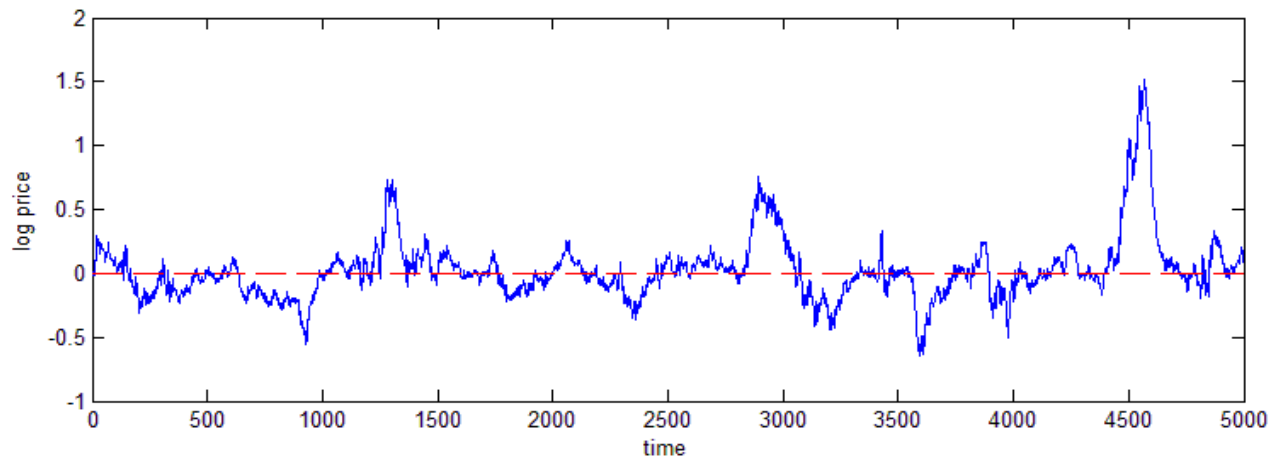


Fig.1. Time series of the log of price in simulation market



Results

- Stylized facts

- 2. Excess volatility and volatility clustering

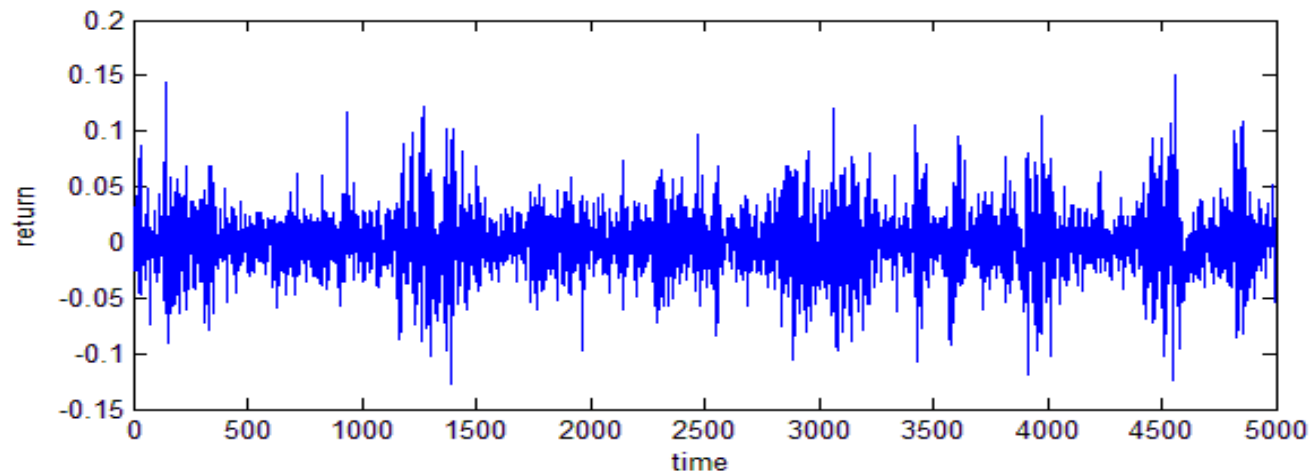
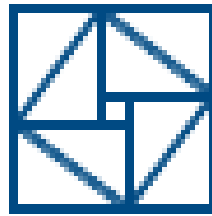


Fig. 2. Time series of return rate in simulation market



Results

- Stylized facts
- 3. Auto-correlation

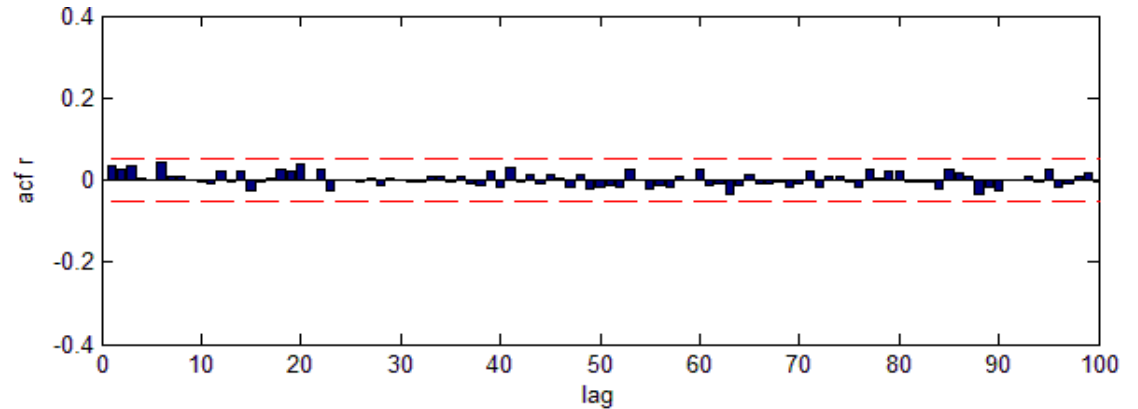


Fig.3. Auto-correlation diagram for the return series

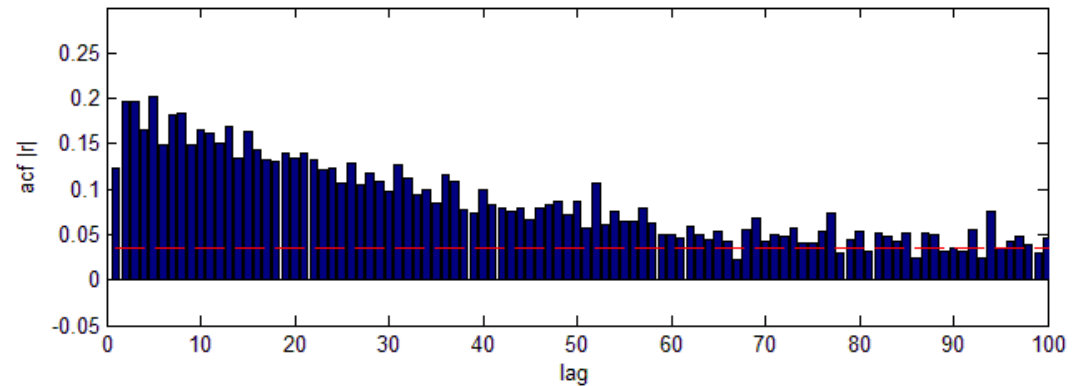


Fig.4. Auto-correlation diagram for the absolute return series



Results

- Stylized facts

4. Leptokurtosis and Fat-Tail

Table 1 Statistical properties of SHCI returns series and simulation returns series

Sample	Mean	Variance	Skewness	Kurtosis	JarBra
SHCI	0.00026	0.0182	0.4058	19.3788	50479.20
Model	0.00003	0.0253	0.1142	5.9020	1764.966



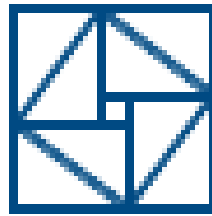
Results

□ Asymmetric Volatility

$$r_t = \theta_0 + \varepsilon_t \quad \varepsilon_t \sim N(0, \sigma_t^2)$$

$$\ln(\sigma_t^2) = \theta_1 + \theta_2 \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \theta_3 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \theta_4 \ln(\sigma_{t-1}^2)$$

Where r_t is the return, the asymmetrical coefficient in conditional variance model is θ_3 , which is to measure the strength of the volatility asymmetry.



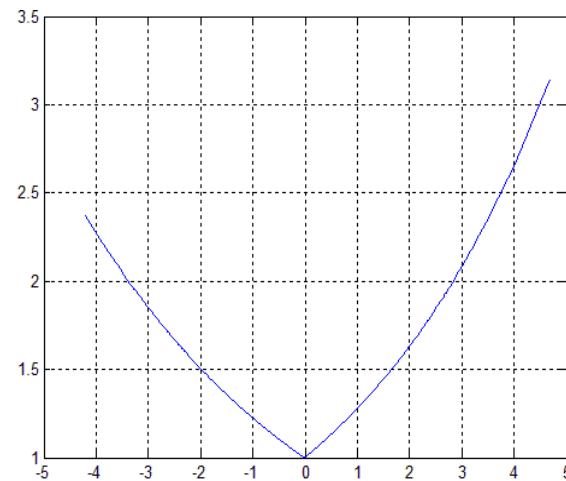
Results

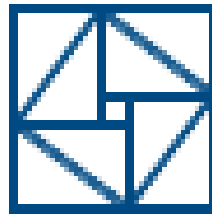
- Asymmetric Volatility: the chartist's disposition behavior can produce the special volatility asymmetry in Chinese mainland market.

1. The estimated coefficients

Variable	Coefficient	Std. Error	z-Statistic	Prob.
θ_0	8.80E-06	0.000277	0.031821	0.9746
θ_1	-0.318795	0.029142	-10.93943	0.0000
θ_2	0.224813	0.013087	17.17865	0.0000
θ_3	0.019719	0.006580	2.996727	0.0027
θ_4	0.980689	0.003138	312.5267	0.0000

2. News impart curve





Sensitivity Analysis

- The value of f is changed gradually from -0.01 to -0.15 at the step of -0.01 (the smaller f is, the weaker disposition effect is).

Table 3 The asymmetry coefficient under different value of f

f	Asymmetrical coefficient	Prob.	f	Asymmetrical coefficient	Prob.
-0.01	0.450473	0	-0.09	0.014288	0.0869
-0.02	0.369855	0	-0.10	0.01225	0.0869
-0.03	0.297115	0	-0.11	0.010841	0.1354
-0.04	0.025946	0.0001	-0.12	0.009846	0.1773
-0.05	0.019719	0.0027	-0.13	0.010033	0.1695
-0.06	0.015629	0.0229	-0.14	0.009936	0.174
-0.07	0.013653	0.0468	-0.15	0.009936	0.174
-0.08	0.011983	0.0845			

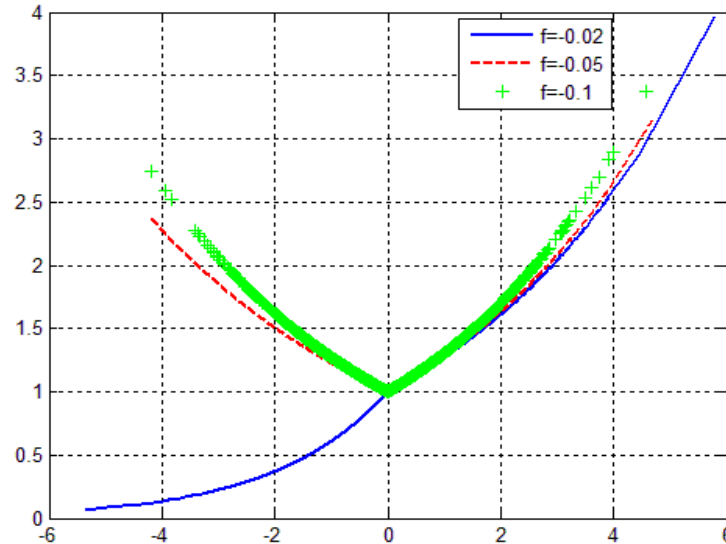
With the decrease of f , the asymmetry coefficient also becomes smaller, it means that **the more sensitive agents are to loss, the more obvious the phenomenon of volatility asymmetry is.**



Sensitivity Analysis

- The reaction speed to news

In these curves, the one which has smaller f is steeper.



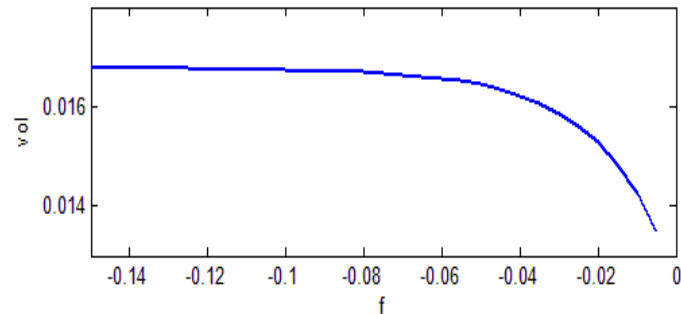
Disposition effect become stronger, the market's reaction speed to news is slower.



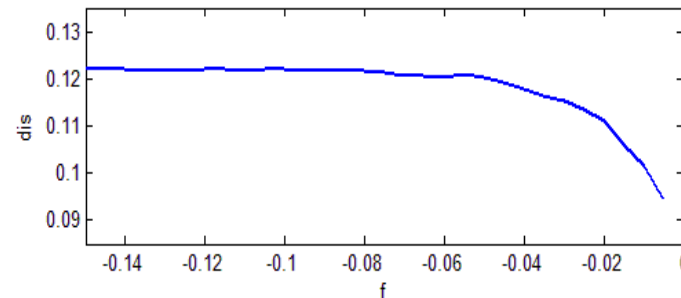
Sensitivity Analysis

□ The influence on the market dynamic

1. Change of volatility



2. Change of distortion

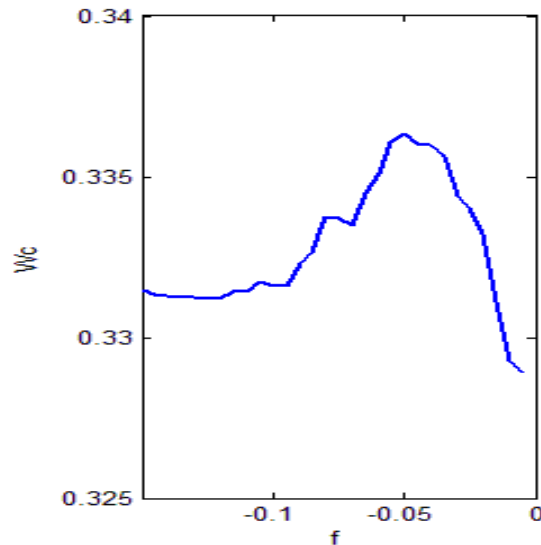


Disposition effect has inhibitory effect on market swings and price deviating.

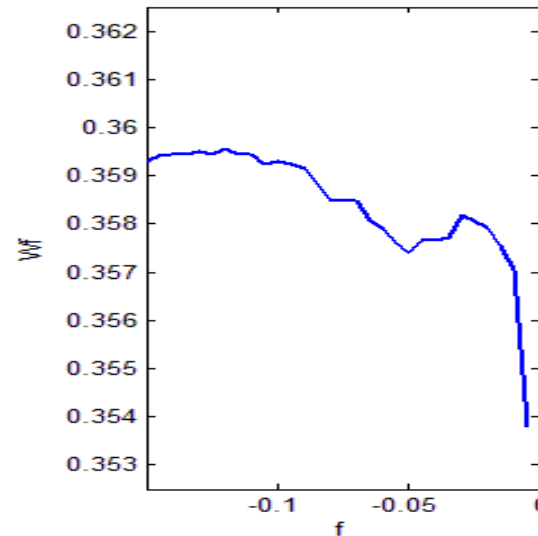


Sensitivity Analysis

□ Earnings or losses ?



The weight of chartist



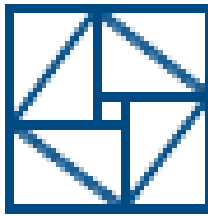
The weight of fundamentalist

1. In most cases disposition effect reduces investors' earnings.
2. Proper disposition effect can make chartists to avoid some loss, when the price drops badly.



Conclusion

- **Chartists' disposition effect can produce such asymmetric volatility:** the impact of bad news is greater than the impact of good one.
- **Investors' disposition behavior slows the release rate of bad news,** which has a function to inhibit the fluctuation of asset price and reduce the deviation between asset price and its fundamental value.
- **Disposition effect doesn't always mean loss.** When investors' disposition behavior is very strong, they may earn less, but if there is a proper strength of disposition effect, investors can avoid some loss and make higher return.



Thank you!