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The Interdependence between Individual and Group Decision-Making with Applications in Chinese Stock Market

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Abstract: It seems that understanding how individuals make decision within a group is an attractive and difficult challenge for economists, managerialists and researchers in human and social sciences for a long time, which is closely related to the theoretical development of economics. The rational assumptions of traditional economic theory, which are highly simplified and cannot manifestly illustrate the inherent mechanism for complexities of economic or financial phenomena (from behavioural perspectives). This paper devoted to seek a reasonable theoretical foundation under the framework of game theory and complex network, based on behavioral big data and the establishment of integrated model, to analyze the behavioral compatibility between individuals and collective deeply, which includes their static consistency and dynamic interactive adaptability. In addition, the paper built relevant computational experiment models to further understand the complex macro-phenomena based on real and heterogeneous investor's behaviors with more extensive applications.

Specifically, the paper contains three sections. Firstly, some typical types of relationship are listed for decision-making behaviors between individual and collective; Then, it is discussed to establish more coordinating consistent institutions and rules for understanding the independence between individual and collective decision-making behaviors through introducing virtual public player(s) into collective decision games; At last, by building the integrated ACE/F model of Chinese stock market, we try to clarify the inner relationship between the real investors' behaviors with heterogeneity, interactions at micro-level and stylized facts at macro-level. Consequently, our theoretic viewpoint, to some extent, is positively supported by empirical evidence.

Key words: ACE/F, individual and collective behavior, heterogeneous interaction, financial market emergence

JEL codes: C63, C91, G10

1. Introduction

Economists, managerialists and even human or social scientists have long been interested in understanding how individual makes decision within a group, which is related to how decision-making interdepend and interact, and how behavioral relationship is between individual and group or collective. The two points are of quite importance for understanding the complexity of critical decision, one of points is that we deeply analyze

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heterogeneous multi, another is its structure and evolution.

The behavioral inconsistency between individual and collective is a continuing issue in the history of human beings, it also exists in the most of aspects of humankind society, including business management, traffic regulation, economy etc. There is an example of it on the field of economic that is the binary opposition between the individuals' rational behavior and the optimization of collective, one of the most famous example is the "Prisoner's dilemma", of which the Nash equilibrium (Nash, 1951) is not optimization of collective choice. From the embarrassment of the development respectively of macroeconomic and microeconomic and the failure analysis of the macroeconomic phenomena by the mainstream macroeconomic approach since 1970s, economists tried to establish the macroeconomic models on microeconomics foundations on the basis of the representative agent, which was introduced into research program in order to link the two branches and firstly described by the work of Lucus and Rapping (1969), who studied the labor markets based on the model in terms of households and firms which are assumed be homogeneous or representative agents (RA). Although representative agent models has spread during the modern macroeconomic, especially the classical macroeconomic, while as Grabner (2002) noted, representative agent models are not to overcome the Lucas critique:

> Representative agent frameworks do in fact encounter the same problems as traditional macroeconomic models; they fail in achieving consistency and bypassing the aggregation problem and thus in providing micro-foundation…… representative agent models rest on the assumption that the behavior of a group of agents, indeed the aggregate economy, mimics the behavior of the single individual agents of whom it consists (Grabner, 2002).

Comparing with the assumption of representative agents for modern macroeconomic, the Austrian strand of economics affirmed that human action is the central point to understand the macro-phenomena, as Mises (1966) has observed that the collective only constitutes individuals' behavior. Moreover, Grabner (2002) also argues that individual behavior results in the economic phenomena.

In the last decade years, sociologists and economist have attempted to understand the relationship between individual behavior and macro-phenomena by the agent-based model (ABM) approach, in particular, the tendency of ABM used on the field of financial markets, termed as agent computational financial (ACF), has proved that sharply increasing researchers are aware of the importance of the ABM approach as a computational method that links the microscopic individual and macroscopic phenomena. However, the ABM approach seems to be weak in theoretical foundation, which is also essential to develop for some research methods. we consider that the theoretical foundation of ABM method should base on the features of it, including the characteristics of agents, in other words, the importance of interaction of micro-foundations of macroscopic phenomena in economics need to be stressed, moreover, we will focus attention on the relationship between individual behavior and macro-phenomena and illustrate the necessary to build a reasonable theoretical foundation on the base of the consistency and adaptability of behavior between individual and collective.

Finally, this paper is organized as follows. Section 2 reviews the literatures of ACE/F, next in section 3 the consistency and adaptability of behavior between individual and collective will be concretely explained, and then we build an integrated behavioral financial model between micro-behavior of investors and macro-anomalies of stock market in section 4, which is also specially demonstrate by Shanghai Stock Exchange's actual data in section 5. The final section contains concluding remarks.

2. Review of the Literature

From behavioral analysis perspective, only after summarizing the types and features of the relationship between individuals and groups (the interaction between people and scenarios), then it is more possible to deal with and resolve better the complex problems in social and economic development, to understand better the original causes and conducting mechanism of macro-complexity, and to grasp closer the characteristics of humanistic/social sciences and the root of real humanistic complexity. Furthermore, to deal with better the relationship between individuals and collective, it is also benefit for solving the interaction between individual behavior and the scenarios.

More specifically, the relationship between individual behavior and macro-phenomena is as follows: agents and their interaction (each other and with the external conditions) at micro-level result in the complex and changeable phenomena of macro-economy, and these individual decision-making behaviors are influenced and constrained by relevant macro-environment and the external factors. However, when the procedures those interact with each agents cannot be embodied by the conventional analytical methods of mainstream economy, numerous scholars convert their focuses on other analytical approaches, one branch of which is known as agent-based computational economics (ACE), which starts by building a multi-agent system comprising a number of agents who contain several characteristics, as Epstein (2006) claimed, for instance, heterogeneity, autonomy, bounded rationality etc. and follow simple rules, then interact with each other and the environment over time. Furthermore, agent-based modeling is widely used in financial markets, as LeBaron (2006) argued that the reasons that financial markets are appealing to applications for agent-based methods is not only because some debates about financial markets, such as efficient markets hypothesis (EMH), are not solved, but also as Markose (2006) pointed out，the characteristics of agent-based approaches can be contributed to solve the problems that cannot be solved by traditional methods of modern economy, which is based on the assumption of rationality and not manifestly illustrate the inherent mechanism of complex financial phenomena.

Moreover, as Tesfatsion (2006) raises the concern that, comparing with relative standard modeling methods, the most important advantage of ACE modeling is that agent-based methods can embody in relatively more autonomy, so the behavior of each agent can influence the others. In other words, the agent-based tools can facilitate the agents in ACE modeling with more realistic social features and learning ability. Besides, Chen et al. (2012) provide a summary of ACF on other aspect, which is call “N-type design” that differs from the “autonomous-agent designs”, by surveying the agent-based computational financial (ACF) models and witness the interaction between ACE and econometrics, including three stages divided by the development of the literature of ACF.

Also, there is another advantage for using the agent-based modelings, i.e., the representative agent method, which is commonly used in modern macroeconomics, is replaced by heterogeneous agent assumption (Epstein, 2006). In addition, there is a considerable body of papers on agent-based models that employs of heterogeneity for individual expectations, which is critical for social sciences and economics. Hommes (2006) has reviewed a number of dynamic heterogeneous agent model in economics and financial, and found that simple agent model with heterogeneous can explain important observed stylized facts in financial time series which is difficultly analyzed by traditional approach, likewise, LeBaron (2013) has built an agent-based financial market with the heterogeneity in gain levels, which is shown to be necessary for replicating realistic time series by comparing with some other style of gain levels, such as the variance forecast gain levels that converges to a situation close to

rational expectations. However, in addition to the key features of ABM which are described as above, there are some other characteristics, as Epstein (2006) observed, which are included in the methods containing bounded rationality, local interactions and non-equilibrium dynamics etc.

Although ACF modeling be briefly summarized as above, the area is not the only one that be applied with the approach, it is also introduced and widely used in all fields of social sciences, as in the case of the Smith's (2007) work on social psychology, who claims that the goal of social psychology is to understand the dynamic and interactive processes of social and psychological phenomena, while the ABM is an appropriate tool that is a link between individual agent behaviors at micro level and macro phenomena, so it can more effectively portray the features of social psychology. Finally, as we observed, the ABM approach seems to be weak in theoretical foundation as most of agent-based models analyze economic phenomena on a case-by-case base, however, it is obvious that each subject needs related theoretical foundation to support development further, and agent-based model is no exception, so we attempt to seek a reasonable theoretical foundation under the behavioral compatibility between individuals and collective, including their static consistency and dynamic interacting adaptability, as demonstrated below. In the following sections, the sufficient and necessary condition of the consistency will be proved, and we will discuss interacting adaptability of individual behavior.

3. Static Consistency and Dynamic Interacting Adaptability of Behaviours between Individuals and Collective

It is obvious that individual behavior interacts with macro-phenomena, if individual rational choice needs to consistent with collective rational choice, then agents not only make optimal decisions based on their budget constraints, but also consider the restraints which come from environment. Therefore, to achieve the compatibility, individuals and collective need to be paid equal attention, next, we demonstrate behavioral compatibility from, respectively, static consistency and dynamic interacting adaptability. It may be make it clearer to understand the inner relationship between micro-behavior and macro-emergence that puts theoretic foundations for both developing ABM-like technology and enriching its value, through describing manifestly the behavioral compatibility and recapitulating the complex behavioral relationship between individuals and collective.

3.1 Consistency of Individual Behaviour and Collective

Consistency may be defined as that individual rational behavior is in accord with collective rational choice. As game strategy of play i (i = 1,2) in "Prisoner's dilemma", the consistency indicates that if the payoff of choice for players when they act independent are same with the payoffs when they cooperate. However, the consistency of individual behavior and collective indicates that the players' choices violate the prediction of traditional principles of economics, which assume that the player is absolute rationality. On the basis of this assumption, as a consequence, there are some constraints that confine themselves to select the cooperation strategy otherwise the consistency cannot be achieved, in other words, the payoff of cooperation cannot be realized unless the strategies of players are subject to limitation, which maybe come from the environment and influence the expectation of individuals, thus individual behavior and collective action are considered as consistency based on the assume that the expectation of agents under constraints are same with the strategy under independent decision making. Therefore, the sufficient and necessary condition is that the expectation of behavior of all agents for any one should be consistent with their actual behavior.

$$\sum_{i=1}^{n} \max u_i(s_i) = \underset{i}{Arg} \max \sum_{i=1}^{n} u_i(s_i^*, s_{-i}^*) \Leftrightarrow \forall i \in N, E_i(s_{-i} | s_i) = s_{-i}^* \tag{1}$$

3.2 An Example for the Sufficient and Necessary Condition

There is an example of finite game to explain the sufficient and necessary condition under the assumption of utilitarianism, in which the belief of participants regarding the formation and ongoing of another players' cooperative behavior is the key point. Supposing that the organizational efficiency coefficient, which is marked as E, is defined as following form:

$$E = \frac{E_N^{\ i}}{E_i}$$

Where $E_N^{\ i}$ is social expectation, of which the factors contain the distribution of information, the relationship among groups and internal structure etc., in contrast, E^i is the individual expectation that is formed by themselves. As a result, when the value of E is equal to 1, the social expectation is accord with individual expectation.

Next, the organizational efficiency coefficient will be incorporated into a summation formula as weighting factor in order to explain the consistence between individual rational behavior and social optimal choice under the assumption of utilitarianism. Given that the collective utility is simply weighted sum of individual utility:

$$U_N^r(\mathbf{a}) = \sum_{i=1}^{N} \frac{E_N^i}{E_i} U_i(a_i, \mathbf{a}_{-i}) \tag{2}$$

Where $U_i(a_i, \mathbf{a}_{-i})$ is payoff of play i when the strategy is a, $U_N^r(\boldsymbol{a})$ is actual total payoff. If $E_N^{\ i} / E_i = 1$, $U_N^r(\mathbf{a}) = \sum_{i=1}^{N} U_i(a_i,\ \mathbf{a}_{-i}) = U_1(a_i,\ \mathbf{a}_{-i}) + \ldots + U_i(a_i,\ \mathbf{a}_{-i}) + \ldots + U_N(a_i,\ \mathbf{a}_{-i})$, then individual rational behavior is in accord with collective rational choice when the expectation of behavior of all agents for any one is consistent with their actual behavior.

3.3 Interacting Adaptability of Individual Behaviour and Collective

There are some very strong assumptions about agents' abilities in traditional economics, the agents are described as omniscient, they know everything, in fact, no one can know the truth for all that happen around him, even the researchers. However, it is obvious that agents can learn the experience from past events and change their behaviors to adapt the transformation, so it seems to be feasible to name this behavior as interacting adaptability. In general, agents can change their behavior by collecting information from interacting with other agents and environment. An example of the interactive between agents and environment is process of the formation for equilibrium price, at the first time, buyers or consumers take shape the price of goods by evaluating the cost of it and collecting other information from market, next the price may be adjusted according to the result of the trades those they participate in, and then the interaction behavior would be infinitely circulated.

3.4 Description of Interacting Adaptability

Interactive agents possess the information of the environment, it is reasonable assumption that they are in a certain a state on period t, which is denoted by the letter S_t, in the meantime, as agents have interactive

adaptability, they can collect new information on period t and adjust another state which is more beneficial to them. The process is described as below:

$$S_t \xrightarrow{(a_t, I_t)} S_{t+1} \tag{3}$$

Where I_t is the information that agents contain on period t, and a_t represents the action on the end of period t. S_{t+1} is the new state after agents change their actions.

Specifically, given that there is a group that has N individuals, and time is discrete. $\mu_{i,t}(s_j, \hat{r}_{-i,t})$ represents the subjective judgments of agent i which is formed on the basis of the potential group level pattern s_j ($j \le m$) and the expectations of other agents' expected revenue for agent i . In addition, $r_{i,t}(s_j)$ is the income on corresponding macro-phenomena s_j at time t. Next, we consider the actual revenue and expected revenue for agent i , which is expressed by $r_{i,t}^*$ and $e_{i,t}(r) = \sum_{j=1}^{M} \mu_{i,t}(s_j, \hat{r}_{-i,t}) r_{i,t}(s_j)$ respectively, likewise, $E^{\Omega}(Q_t) = \underset{i \in N}{\Omega} r_{i,t}(s_j, \hat{r}_{-i,t})$ represents the total income on a certain type group pattern s_j , and Q_t^* is the actual total income. Furthermore, we illustrate the interacting adaptability of individual behavior and collective on the individuals and group level respectively.

$$\begin{cases} \left| e_{i,t}(r) - r_{i.t}^{\,*} \right| \\ \left| E^{\Omega}(Q_t) - Q_t^{\,*} \right| \end{cases} \tag{4}$$

As 4 described, the error between the expected and actual value shows a trend of decline. Specifically, the adaptability interaction between individual and macro market mainly refers to the dynamic process, containing the characteristic that the behavioral expectations of individual and collective both keep close to reality (real behavior occurred). Thus the micro and macro level both presents a gradually approaching trend (but does not rule out the existence of local and repeated some point in time), which also aims to explain the behavior of micro and macro market (virtual overall) has learning adjustment function. Moreover, the arguments are based on expected behavior and the history of the formation of a subjective belief or judgment (macro indicators of individual performance, or the history of the macroscopic characteristics change function). Therefore, the influencing factors include the individuals' behavioral features, the interaction among agents and between subjects and interactive market environment. Also, the behavioral equations of macro market，which is a weighted combination of the various possible ways of generating evolution, shows that both the consistency of market dynamics structure and generation method of total amount tend to be stable and clear.

4. Behavioral Relationship and Integrated Model Between Micro and Macro on Capital Market

4.1 Relationship Between Micro-Behavioural and Macro-Phenomenon

There is no doubt that the relationship between heterogeneous individual choice and collective action is complex, on the one hand, any economic and financial activity is the process and result of human behavior, and the root cause of all phenomena of financial market can be found from the investor's behavior at micro level. No

matter what complicated they are, their internal mechanism, conducting process and structure evolution are also cognitive. Their relationship is illustrated in Figure 1 as below. On the other hand, individual will be also influenced by macro, individuals make a decision by utility maximization principle under some certain constraints according to the classical economic theory, When there is a change in the macro-economic, then the constraint set and utility function of individuals would change, which also impact individuals behavior. This research aims at finding some relationship between them. Maybe it is better to treat and solve the complex emergence in real financial markets caused by many heterogeneous investors' behavior, such as anomalies and stylized facts, than using the methods of traditional econometrics and quantitative finance.

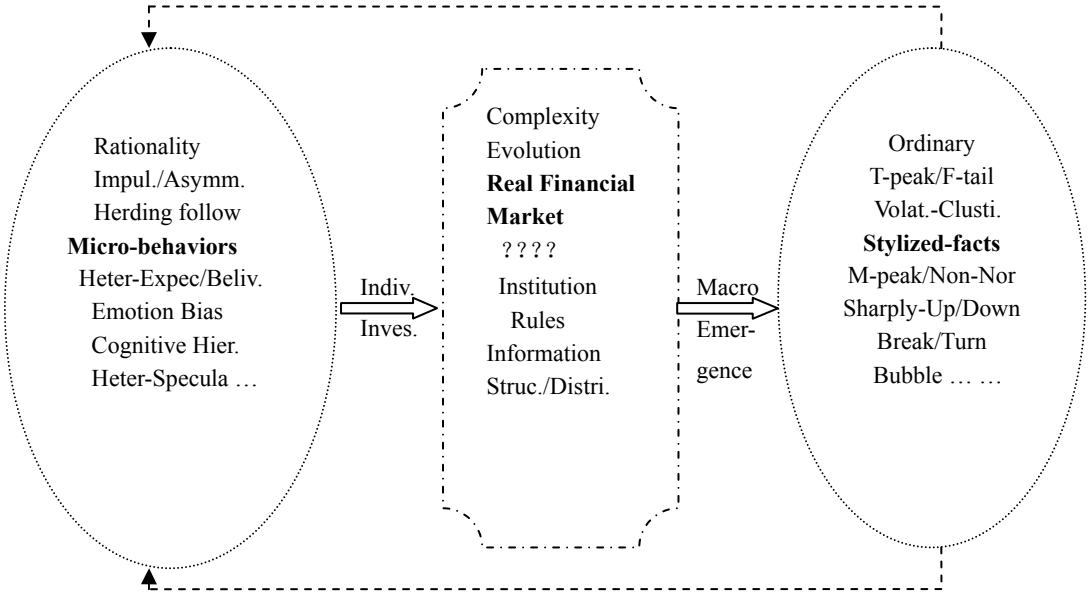

Figure 1 Inner Relationship between Investor's Behaviors with Bias and Stock Market Emergence

In order to know how individual complex behaviors lead to macro-emergence and economic phenomena and vice versa, it is necessary to make sure the conductive mechanisms from micro to macro, not only from macro to micro by layers. ACE is a very suitable method to explore the relationship between individual microscopic and macroscopic phenomena, because it is difficult to study the heterogeneity, interaction and other characteristics by using the conventional logic paradigm, and there are several advantages to analyze complex investment behavior by compared with traditional financial modeling methods, on the one hand, in order to obtain reasonable microscopic explanation for the anomaly phenomena of financial market, ACE can directly study the system features of financial markets by characterizing the interactive behavior of microscopic heterogeneity body, including individual preference, cognitive, psychological and other factors. On the other hand, it has gradually turned to combine HS with CA from artificial financial market, so that it is can provide a more reliable basis for modeling by investor behavior, and perceive the macroscopic financial phenomena mechanisms based on the microscopic individual behavior. More significantly, it will be of great concern to analyses the real investment behaviors and their key characteristics in the stock market of China by computational experiment.

4.2 The Integrated Behavioural Financial Model Between Micro-Behaviour of Investors and Macro-Anomalies of Stock Market

This part is applied in the reference model of capital market with micro-macro link. It improves the

integration of former research results (De-Grauwe, 2010; Scheffknecht & Geiger, 2011; Lengnick & Wohltmann, 2013) and basic representation as well as real micro behavior and key characteristics.

Considering a given stock market in China, supposing that y_t expresses net the output gap in period t, r_t is the nominal interest rate, and π_t is the rate of inflation, then we can obtain a series of behavioral equations which depict macro-states with variables and relationship between several factors as follows:

Aggregate demand equation:

$$y_t = a_1 \widetilde{E}_t^0[y_{t+1}] + (1-a_1) y_{t-1} - a_2 (r_t - \widetilde{E}_t^0[\pi_{t+1}] + \varsigma_t) + u_t \tag{5}$$

Aggregate supply equation:

$$\pi_t = b_1 \widetilde{E}_t^0[\pi_{t+1}] + (1-b_1)\pi_{t-1} + b_2 y_t + v_t \tag{6}$$

and the market behavior following the amending Taylor's rules:

$$r_t = c_1 r_{t-1} + (1-c_1)[c_2(\pi_t - \pi_t^*) + c_3 y_t + c_4^{\mathrm{T}} \chi_t] + w_t \tag{7}$$

Where: $\widetilde{E}_t^0$ represents the expectation of the overall market (pseudo-player) at t time, *a.*, *b.*, and *c.* are the factors or parameters that need to be estimated; $\pi*$ is the expected control targets of the inflation; x_t is a vector, which includes all other factors impacting the yield, ς is the risk and risk-free real interest rate spread; u_t, v_t, and w_t are (random) disturbance/error term or white noise disturbance term.

The parameters could be obtained from the market empirical date according to traditional measuring empirical approach (related to the two fundamental assumptions, rational investor and EMH in modern financial theory), or be inferred from the investor's actual behavior in the market when there are bias. Observing the actual investment behavior occurred in the stock market, an integrated model will be formed through construction of related behavior equation and connection with macro state equation, and then the computational experiment will be conducted to find out the potential correspondence between micro behavior and stylized facts (anomalies) in the stock market (seeing Figure 1). For the perfectly competitive market of general goods, the general equilibrium is the exception of game equilibrium under the condition of materialization. At this point, neutral system, complete information, individual rationality is satisfied with agreement of individual and collective rationality; if the assumption of perfectly competitive market is significantly deviated, a similar method could be used to find the internal relation between actual micro behavior and abnormal complex phenomena in the market. Thus, the complex economic and financial problems now could be better explained to find a way of quantifying evidences and realized the technology. The description and extension of micro investment behavior are as follows:

$$I_B(i) \rightarrow \begin{cases} S_b & \text{at Prob. } p_1 \\ S_h & \text{at Prob. } 1-p_1 \\ S_s & \text{at Prob. } p_2 \end{cases} \Longrightarrow \qquad I_B(i) \rightarrow \begin{cases} S_b & \text{at Thres. Value } TB_b \\ S_h & \text{at Thres. Value } TB_h \\ S_s & \text{at Thres. Value } TB_s \end{cases}$$

The behavior property, critical change and threshold difference reflect individual diversity (heterogeneity). The determination of threshold connects the combined action of numerous agents' behavior and external conditions change, including the influence among agents, namely endogenesis and interaction; the threshold is determined according to the total available market received by the individual, other investors' strategies and individual characteristic parameters. It could also be used in various key behavior characteristics for the agents in

general market, and the feasible method and process can be found in another paper (Wang, 2015) for integrated modeling as a benchmark model.

4.3 Some Financial Applications in China

Any agent i who has two kinds of asset: risk assets A_R and risk-free assets A_F, the return rate of risk assets and risk-free assets are R_t and R_f respectively, where R_f is a positive constant, then agent i has the total assets, which is marked as $W_{i,t}$, by holding the two types asset, which is allocated to risk assets and risk-free assets by the proportion $\alpha_{i,t}$ and $\alpha_{i,f}$ respectively, and $\alpha_{i,t}+\alpha_{i,f}= 1$. Then suppose that the utility of investor i at time t+1 on a given risk attitude Y is:

$$U\left(W_{i,t+1}\right) = -\exp\left(-\gamma W_{t+1}\right)$$

Where $W_{i,t+1}$ is normally distributed, γ is absolute risk aversion and the parameter γ satisfies $\gamma > 0$.

Next we introduce the parameter of emotional factors, given that $\tau_{i,t}$ is the emotional factors, which is formed at time t, that can impact the expected value on time t+1, then suppose that the absolute risk aversion is a decreasing function of $\tau_{i,t}$, $\gamma_1 = \gamma e^{-\lambda\tau_i}$, where $\lambda > 0$. Investors would show optimism and risk aversion will decreases if $\tau_{i,t} > 0$, on the contrary, investors showed pessimism and risk aversion increases. Under the assumption of maximizing investors' utility, we can get the optimal distribution weight of the wealth which is assigned to risk assets at time t:

$$\alpha_{i,t} = \frac{E\left(R_{i,t+1}\right) - R_f}{\gamma e^{-\lambda\tau_{i,t}} W_{i,t}\sigma_{i,t+1}^2} = \frac{E\left(R_{i,t+1}\right) - R_f}{\gamma W_{i,t}\sigma_{i,t+1}^2} e^{\lambda\tau_{i,t}} \tag{8}$$

The regular of the expected yield of risk assets of investors, who have the emotions, is formed as follows:

$$E\left(R_{i,t+1}\right) = \left(R_f - \frac{1}{2}\gamma\sigma_{i,t+1}^2\right)\left(1+\tau_{i,t}\right)$$

Where $\sigma_{i,t+1}^2$ the expected return volatility at time t+1, and $-\frac{1}{2}\gamma\sigma_{i,t+1}^2$ is risk premium.

To explore the investors' emotional factors how to impact the portfolio assets ratio and derivate the Eq. (8), we can obtain the first-order conditions:

$$\frac{\partial\alpha_{i,t}}{\partial\tau_{i,t}} = -\frac{\lambda}{2W_{i,t}} e^{\lambda\tau_i} + \frac{\left(R_f - \frac{1}{2}\gamma\sigma_{i,t+1}^2\right)}{\gamma W_{i,t}\sigma_{i,t+1}^2} e^{\lambda\tau_i} + \frac{\lambda\left(R_f - \frac{1}{2}\gamma\sigma_{i,t+1}^2\right)\tau_{i,t}}{\gamma W_{i,t}\sigma_{i,t+1}^2} e^{\lambda\tau_i}$$

Let $\frac{\partial\alpha_{i,t}}{\partial\tau_{i,t}} = 0$, then

$$\tau_{i,t} = \frac{\gamma\sigma_{i,t+1}^2}{2\left(R_f - \frac{1}{2}\gamma\sigma_{i,t+1}^2\right)} - \frac{1}{\lambda}$$

When $\tau_{i,t} > \frac{\gamma\sigma_{i,t+1}^2}{2\left(R_f - \frac{1}{2}\gamma\sigma_{i,t+1}^2\right)} - \frac{1}{\lambda}$, risk assets ratio of investor i will increases with emotional factors increase, and $\tau_{i,t} < \frac{\gamma\sigma_{i,t+1}^2}{2\left(R_f - \frac{1}{2}\gamma\sigma_{i,t+1}^2\right)} - \frac{1}{\lambda}$, risk assets ratio of investor i will decreases with emotional factors increase, as shown in Figure 2.

Based on the theoretical model, we will simulate the investors' behavior by ABM method, given that the agents are sophisticated investors, which means that the investors' behavior has the heterogeneity and interactive qualities, and the expected yield of sophisticated investors is defined as:

$$E\left(R_{i,t+1}\right) = \left(1-\mu_i\right)\left(R_f - \frac{1}{2}\gamma\sigma_{i,t+1}^2\right)\left(1+\tau_{i,t}\right) + \mu_i \frac{1}{m}\sum_{\substack{j=1 \\ j\neq i}}^{m} E\left(R_{j,t}\right)$$

Expected yield contains two parts: the first one is the heterogeneous behavior of investors, which means the expected rate of return of investor i is formed by their heterogeneous behavioral characteristics by probability $1-\mu_i$, The second one is the interactive behavior of investors, which means the probability of investor i mimics other people's behavior is μ_i, moreover, it is indicated that investor has obvious herding behavior if $\mu_i > 0.5$, and m is the number of the neighbors who can affect the formation of investors' expected yield rate, as Schelling (1969) discussed, when the interaction is taken into account, the small preference of individuals for living in a neighborhood that is dominated by other individuals also can lead to the emergence of macroscopic phenomena

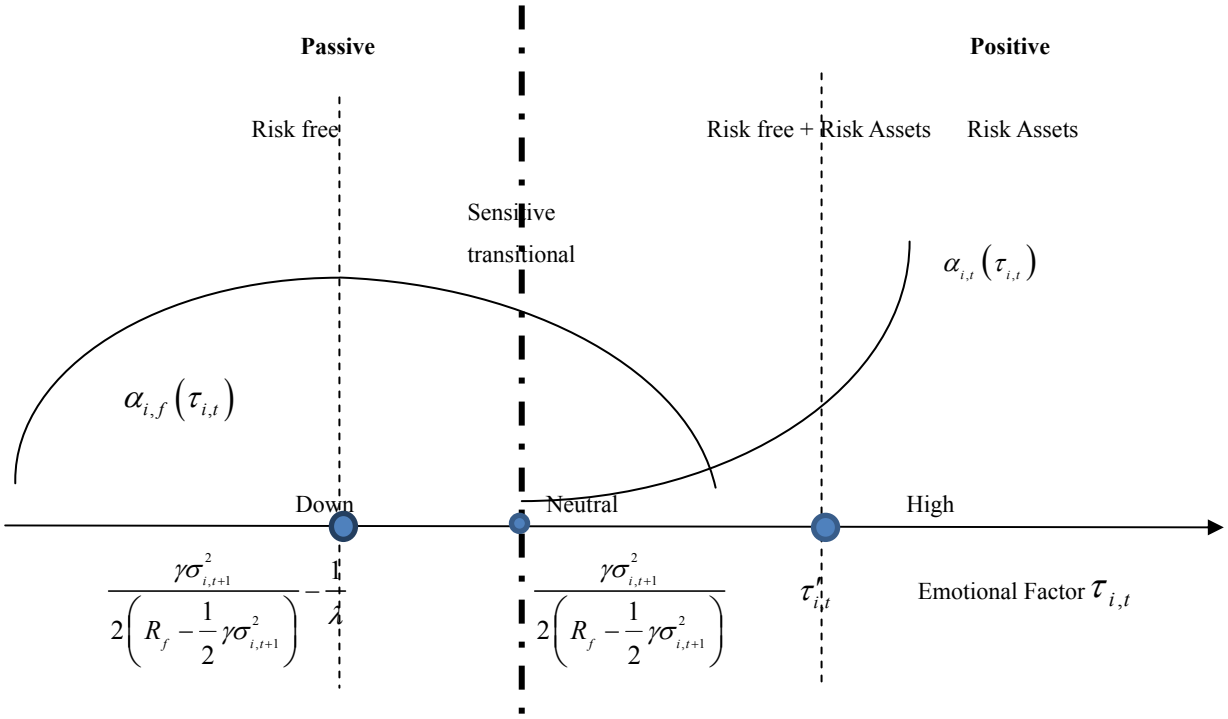

Figure 2 Threshold Analysis of Emotional Factor

Next, we use MATLAB R2013a to simulate and analysis the model, each experiment runs 1,000 times, the parameters of the model is set as table 1, one of the most important is that the investors emotional factor is assigned at interval [-1,1], and the step of the adjustment is 0.1.

Finally, we have several conclusions: firstly, individual emotional factor has the critical point and asymmetry property for macroscopic phenomena, and when the absolute value of the emotional factor is increased, the yield volatility increased, In particular, when the absolute value is greater than 0.5, the emotional factors have a significant impact on the stock market. And when emotional factor value ranges between (-0.5, 0.5), the yields series is a sequence of first-order autocorrelation, and speculative bubbles is more prone to emerge in financial markets. Secondly, negative emotions affect stock market volatility factor stalemate, slow response, in contrast, positive emotional factors put the influence effect on stock market volatility is relatively large, for the features, such as kurtosis, skewness and volatility clustering, are more obvious; finally, returns series has the "inertia" and "long-term reversal" phenomena, and the "long-term reversal" phenomenon with a higher short-term trend reversal and return characteristics.

Table 1 Simulating Parameters List

Para.	Value	Definition
ρ	0.1	Adjusting to E(ρ_{t-1})
N	100	Amount of investors
m	8	Number of Neighbours
μ_i	(0,1)	Imitative Probability
$\tau_{i,t}$	[-1, 0.1,1]	Emotional Factor
λ	> 0	Asset Type Adjusting
W_0	100	Average Endowment
R_f	0.1	Rate for risk free
S	1	Supply for risk asset
$\alpha_{i,0}$	0.5	Initial ratio for structure

5. Concluding Remarks

The above discussion highlights that the method that combines the development of ACE/F approach with deepening behavioral analysis will undoubtedly promote understanding and recognition of economic and financial complex phenomena, which will not only embody the features and advantages of ACE/F approach and conform with the trend of human self-awareness, but also can promote the diversity of method to research complex phenomena, adopting the case by case research method or a systematic theory based on a reasonable theoretical foundation.

Next, we illustrate the static consistency and dynamic interacting adaptability of the behavioral compatibility between the individuals and collective, in particular, the dynamic interacting adaptability is discussed in two aspects, including the interaction, respectively, among the individual and between the individual and environment, moreover, the expectation lies on an important position for the static consistency and dynamic interacting adaptability, however, the most important of the demonstration is that the error of individuals between expectation and actual value shows a trend of decline.

In addition, we illustrate the inner relationship between investor's behaviors with bias and stock market emergence, and in order to make sure conductive mechanisms from micro to macro, we build an integrated behavioral financial model between micro-behavior of investors and macro-anomalies of stock market. Moreover, Shanghai Stock Exchange's actual data were taken as an example to explain the key points of the above statement by the ACE/F method, finally, we found that the main performance of investor's mental fragility is sensibility around the critical point, the first-class behavior may cause booming and the second-class behavior may cause slumping. The most important of further research is to explore the inner mechanism and evolution path from micro to macro by the ACE/F method, and find the critical point that impels the consistency of individual behavior and collective choice by deepening the behavioral analysis, so the characteristics of the agents' behavior should be paid more attention, and different behavioral property would be researched for different issues.

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