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Reference: Qin, Rui The simulation study of the change of accounting standards for business enterprises based on evolutionary game.

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The Simulation Study of the Change of Accounting Standards for Business Enterprises Based on Evolutionary Game

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This article tries to analyze the characteristics of the accounting standard for business enterprises, which is based on the idea of evolutionary game, in order to build a game model between stakeholders, and to conduct the simulation of the game model with NetLogo software. It shows the performance of all participants in the course of the game in a dynamic process, and the simulation results are analyzed, accordingly.

Keywords: Accounting Standards for Business Enterprises, Evolutionary Game, Change, NetLogo

JEL Classification: G32, F38, F40

1. Introduction

Since the 21st century, the game theory is widely used in various fields of social science research. Some researchers have started using it to explain the change of accounting standards for business enterprises (ASBE), and achieved research results. However, most of those are confined to the traditional game theory, which is only one side of the coin. Because we have to take the interaction among bounded rational people in different interest groups into consideration. Evolutionary game analysis solves the bottle-neck issue. It combines game analysis with dynamic evolution process analysis, of which all game players are viewed as bounded rational competitors, finishing their evolution in the competition with each other.

In addition, most scholars make use of evolutionary game theory to analyze problems mainly through analytic methods. This method is applicable to simple models in the game, but if the model is much more complex in the game, the analytical method is no longer applicable. With the help of computers, the simulation based on the multi-agent modeling method can deal with the complicated problem, but also can reflect participants' performance in the course of the game by dynamic process (Juanjuan, 2007; Ruan et al., 2011; Liu, 2012).

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Article History:

Received 9 August 2015 | Accepted 27 August 2015 | Available Online 17 October 2015

Cite Reference:

Qin, R., Jian, Z., 2015. The Simulation Study of the Change of Accounting Standards for Business Enterprises Based on Evolutionary Game. *Expert Journal of Finance*, 3, pp. 31-39

Acknowledgements:

This paper is supported by the research funds from National Natural Science Foundation of China (71272132); the Ministry of Education of New Century Excellent Talents Support Program (NCET-13-0210) and the Fundamental Research Funds for the Central Universities (2014ZDXMPY02).

2. The Applicability of Evolutionary Game Analysis in the Change of ASBE

2.1. Evolutionary Game Analysis

Evolutionary game analysis (Bai, 2004; Li, 2014) initially originated from the conflict between animals and plants and the game analysis of cooperative behavior, so it is based on biological evolution, the human economic activities competitive compared with biological evolution, and the study of human economic behavior to equilibrium convergence process of a kind of methodology. Different from traditional, the completely rational assumption of game theory, evolutionary game theory thought is limited to rational behavior's main body of economic activity, it cannot be implemented currently because of its environment and its change, and in turn, it provides the best response, but only if it is thought the most advantageous strategy available by imitating, trial-and-error learning, and eventually reaching a steady state (Wang et al., 2011).

Qingmu Changyan and Aoye Zhengkuan use evolutionary game theory to study the change of the economic system, and put forward the bounded rationality of game party which depends on the following three elements: the inertia - game strategy change cost increase causes part of the game party give up change strategy; Nearsightedness - forward strategic change is often based on the specific strategies; Trial and error - part of the game party attempt to adopt new strategies. Especially, emphasizing the third of three elements, therefore, in simple terms, evolutionary game theory is the game achieved through trial and error to reach game equilibrium, to complete the evolution of the group.

This group, the evolution process of both the process of choosing, also have a mutation process. Selection refers to the strategy can get higher pay will more be adopted in the participants in after the game, the mutation is refers to the part of the individual in the form of random selection is different from groups that exist in the strategy, these strategies may be able to get high pay, can also be get lower pay.

2.2. The Applicability of Evolutionary Game Analysis in the Change of ASBE

Evolutionary game theory can apply to study the change of the accounting standard for business enterprises, mainly because of the characteristics of accounting standard for business enterprises the following aspects:

- a. Stakeholders' rationality is limited in accounting standards for business enterprises setting. In practice, the actors at the unknown environment and their own cognitive limitations, can only appear as bounded rationality. Game theory and the assumption of rational man broke the traditional economics, better fitting of the motivation and process in the accounting standards change.
- b. The change of the accounting standard for business enterprises is always based on the original accounting standards subtle or a small amount of correction or improvement, little or no disruptive change. The lock-in effect rule of the change and the path dependence coincided with evolutionary game of 'inertia' and 'short-sighted'.
- c. The accounting standards for business enterprises is a process of change. Bounded rational because of the behavior of the individual, the enterprise accounting standards setters cannot be optimal in the initial set of accounting standards, but in a review of the facts, the understanding of the reality and the future information prediction, on the basis of making an adjustment to adapt to the environment and improve, form better accounting standards, and constantly reach an optimal equilibrium. Evolutionary game can help us to analyze the dynamic evolutionary process, and explain under the participation of stakeholders, how to achieve this equilibrium - the old to the new accounting standards convergence of accounting standards.
- d. Evolutionary game theory to analyze accounting standards modifications changed our point of view. Previous research showed that the main body of institutional change is to organize game theory and thought, whereas the organization behind the economic subject of income inequality is the source of institutional change. Using evolutionary game analysis on the change of the accounting standard for business enterprises, the main aspect will shift the analysis from the point of view of the game, and further explore the lifeblood of the accounting standards changes.

3. The Establishment of the Evolutionary Game Model

3.1. The Analysis on Game-Agent

Many scholars (Qi and Yang, 2003, 2004) on China's accounting standards formulated the classification of the stakeholders involved in the process. Its classification index content is basically the

same, only is in the mode of expression and divided differences. Through the analysis of the existing literature summary, the authors think that the interests of the involved aspects in the process of establishing accounting standards related group are divided into: makers, demanders and other stakeholders. Table 1 shows various stakeholders, the representation of the subject, motivation, impact on accounting standards setting process and its influence are analyzed and summarized.

Table 1. Each stakeholder's impact on the formulation of accounting standards

Stakeholder	Representative agent	Motivation	Way of influence	Degree of influence
Policymaker	The government (such as the ministry of finance)	The government interests is the most important	"Active rent creating" and "passive rent creating"	Very strong
Demander	User: shareholders	Acquire the information of other companies operating conditions, the pursuit of profit maximization	Priority to protect the interests of the shareholders in accounting standards setting	Relatively strong
	User: investors, creditors, employees, etc.	To understand the management information of the target enterprise	Focus on corporate governance and supervision and the opportunity to participate is few	Common
	Provider: all enterprises within the territory of China	Get better operating performance, earnings management	Convince other stakeholders agree on their side of the accounting standards, but does not participate in the development of accounting standards	Common
	Professional accounting organizations	Provide accounting information; analysis of enterprise production and operation conditions	Do not participate in setting accounting standards	Common
Other stakeholders	Such as Chinese Institute of Certified Public Accountants	Focus on auditing standards and professional standards	Do not participate in setting accounting standards	Weak

Source: Lu, 2008; Wu and Li, 2010

Based on the above analysis (Table 1), the interests related to the main body of the diversity and heterogeneity make accounting principles for the establishment of a multi-agent process of game. Accounting standards is always given priority to with a strong group, balancing the interests of other groups, and according to various stakeholders to the influence degree of the accounting standards setting process, we mainly consider the two main body government and shareholders (Zhang, 2009).

In addition, in the process of establishing accounting standards, the role of political interest groups should not be ignored. In general, in the process of accounting standard setting, political interests for their own interests, tend to formulate the intervention process, formulation process cannot effectively, institutional change path dependence, even in inefficient situations. So here, the Zhang (2009) is the political game between interest groups and the government that are analyzed.

3.2. Construction of Evolutionary Game Model

3.2.1. More Evolutionary Game Model between the Accounting Entity

The change of the system is often driven by the interests of stakeholders' conflict. Considering the change of accounting standards, intuition is an accounting entity is not follow after the ratio increased to a certain number of accounting standards as a result of direct need and inevitable demands. (Liu et al., 2015) Follow the accounting standard for business enterprises and an accounting entity or not, depends on the following and do not follow the rules of the size of the profits. Which can be set up game model between the accounting entity, explain the process of enterprise's accounting entity strategy choice of earnings (Table 2).

Table 2. Game Payoff Matrix between an Accounting Entity

		Player2	
		Noncompliance (p)	Compliance (1-p)
Player1	Noncompliance	$(\frac{v-f}{2}, \frac{v-f}{2})(p=1)$	$(\frac{v}{2} - f * (1-p), \frac{v}{2} - e * p)$
	Compliance	$(\frac{v}{2} - e * p, \frac{v}{2} - f * (1-p))$	$(\frac{v}{2}, \frac{v}{2})(p=0)$

Assumptions:

- A.** game party 1 and party 2 on behalf of the enterprise accounting entity;
- B.** are respectively the bilateral unilateral do not follow the current accounting standards and gains;
- C.** is game both sides do not follow the current accounting standards of the punishment cost;
- D.** is the loss of the game both sides follow the accounting standards for unilateral interests.

Choosing not to follow the accounting standards of accounting entity, influenced by various factors.

In other words, evolution game strategy selection mechanism is varied. Nowak (2006) summarizes the evolution of cooperation mechanism in the evolution game, the mechanism of accounting subject behavior choice has the same significance:

- Kin selection: genetic similarity, the enterprise strategy choice is often a reference in the actual operation and its industry, scale and other similar enterprises business strategy;
- Direct reciprocity: the introduction of the discount factor and degree of punishment, when you do not follow the accounting standard for business enterprises of punishment cost will tend to follow the accounting standards for business enterprises, to seek cooperation;
- Indirect reciprocity: introducing reputation signal, do not follow the accounting standard for business enterprises will lead to the external image and reputation of the wreck;
- Network reciprocity: group of interconnected network structure;
- Group selection: introducing group, there are competition relations between groups and groups.

Considering the enterprise subject in choosing not to follow the accounting standards, will consider their own experience and expectations of compliance in other industries, therefore in the process of its strategy adjustment corresponding EWA learning algorithm (experience - weighted attraction) (Camerer and Ho, 1999; Arifovic and Ledyard, 2004; Hopkins, 2002) EWA learning algorithm is combined with reinforcement learning and beliefs of a way of learning, reinforcement learning refers to the decision-making according to the recent experience of success or failure of the adjust the probability of its choice, faith learning refers to the decision-making believe other participants will be based on its historical behavior to make current decisions, thus according to this belief, find its optimal decision.

EWA learning algorithm has two need periodic updates core variables: strategy charisma of $A(t)$ and weight of the past experience of $N(t)$:

$$A_i^k(t) = \frac{\phi \cdot N(t-1) \cdot A_i^k(t-1) + (\delta + (1-\delta) \cdot I(s_i^k(t), s_{-i}(t))) \cdot \pi_i(s_i^k(t), s_{-i}(t))}{N(t)} \quad (1)$$

$$N(t) = N(t-1) \cdot \phi \cdot (1 - \rho) + 1 \quad (2)$$

$$P_i^j(t+1) = \frac{(A_i^j(t))^\lambda}{\sum_{k=1}^{m_i} (A_i^k(t))^\lambda} \quad (3)$$

Note:

$A_i^k(t)$ means I choose k at the t period strategy charm value. Strategy of k to follow or not to follow the accounting standard for business enterprises;

$s_i^k(t)$ = the strategy k is chosen at the period of "t".

$s_i(t)$ = The strategy that i has chosen.

$s_{-i}(t)$ = Strategy combination that other subjects except i have chosen at the period of "t".

ϕ = Charisma score's attenuation coefficient.

Δ = the weights of income of unselected strategy.

ρ = Charisma growth factor.

$I(\dots)$ = indicator function. The weight coefficient indicates whether the strategy was adopted, evaluation: 0,1.

$\pi_i(s_i^k(t), s_{-i}(t))$ = the profits at the period of "t".

λ = Charisma score's sensitivity.

When $N(0)=1$, $\rho=1$, $\delta=0$, the model is simplified to reinforcement-based learning model.

When $\delta=1$, $\rho=0$, the model is simplified to beliefs-based learning model.

In view of the enterprise accounting entity, strategy choice is to follow or not to follow the accounting standard for business enterprises. Enterprise accounting entity through the reference of its past historical experience and other accounting subject strategies, the strategy choice of the next round of adjustment, in order to achieve a stable state, is under the condition of the current enterprise standards and a market status, enterprise accounting subject to follow the trend towards accounting standards or not.

Based on the above analysis, we can propose, according to the following four parts to EWA based multiple simulation (Jing and Yang, 2010) between enterprise accounting entity, the following steps:

Step 1: according to the payoff matrix, initialize each strategy of the initial charm value;

Step 2: according to the strategy of charisma, the formula (3) is used to calculate each policy choice probability;

Step 3: according to the strategy of choice of probability, each stochastic accounting entity is given in the next round of strategy choice;

Step 4: calculate the next round of the charm of each policy value, and repeat steps 3, 4.

4. The Simulation of Evolutionary Game Stability and Result Analysis

By using evolutionary game simulation system, the authors, have carried on the simulation to be in the economic model of evolutionary game analysis. (Zhu, 2010)

4.1. The Simulation of Evolution Game Between Accounting Subjects

4.1.1. Experiments Settings

To realize the above model in Net Logo platform, namely, to establish the evolution system based on multi-agent strategy choice, as shown in figure 1, the system is divided into three parts of input, control, and output. Among them, in the Input is used to add or adjust the value of benefits and costs of the enterprise accounting entity, and all kinds of related coefficients; the Control part is used for initialization of the control system as well as the evolution process; the Output part is used for the visualization of the system model, real-time output of the main body of strategy choice evolution process.

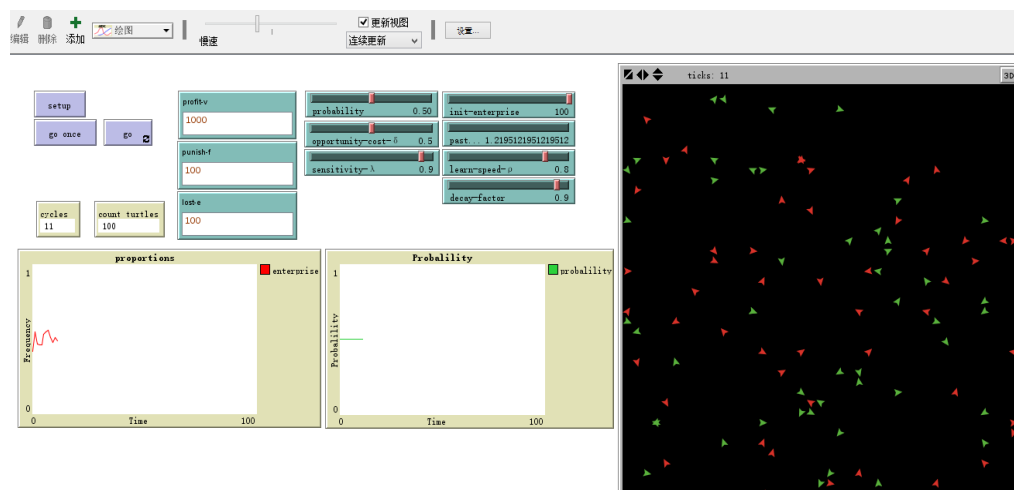


Figure 1. Based on the multi-agent simulation model of rendering

Before the simulation operation, as shown in table 2 game model is given to the parameter selection, and type of the corresponding input box. The EWA involved in the model parameters of the experimental data is used with reference to existing literature (Camerer et al., 2002), by using maximum likelihood estimation, it is concluded that these parameters are fitting values, as shown in table 3. For each experiment the maximum number of rounds is 1000, that is to say, if running after 1000 applications of the simulation program, the simulation results still do not show convergence, then this this experiment does not present convergence. In addition, because enterprise accounting entity is in the process of strategy selection, based on the attraction strategy, which is based on the probability of random selection, so in the process of simulation, the enterprise accounting entity strategy choice is of frequency fluctuations.

Table 3. EWA model parameters

$N(0)$	1	$A_i^k(0)$	1
δ	0.5	ρ	0.8
\emptyset	0.9	λ	0.9

4.1.2. The Simulation Results and Corresponding Analysis

Simulation scenario 1: when v for 1000 units, f and e are 100 units, and the original do not follow accounting standards was 30%, the proportion of businesses can get the following results as shown in figure 2. It does not follow the accounting standards formed stable at 49.99% (Figure 2).

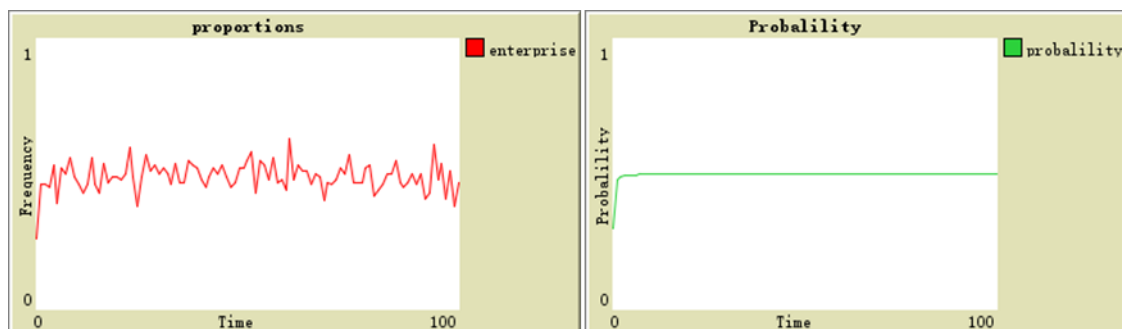


Figure 2. Simulation scenario 1

Simulation scenario 2: when v for 1000 units, f to 500 units, e for 100 units, and the first to 30% do not follow the accounting standards for business enterprises, can get the following result is shown in figure 3. It does not follow the accounting standards formed stable at 18.3% (Figure 3).

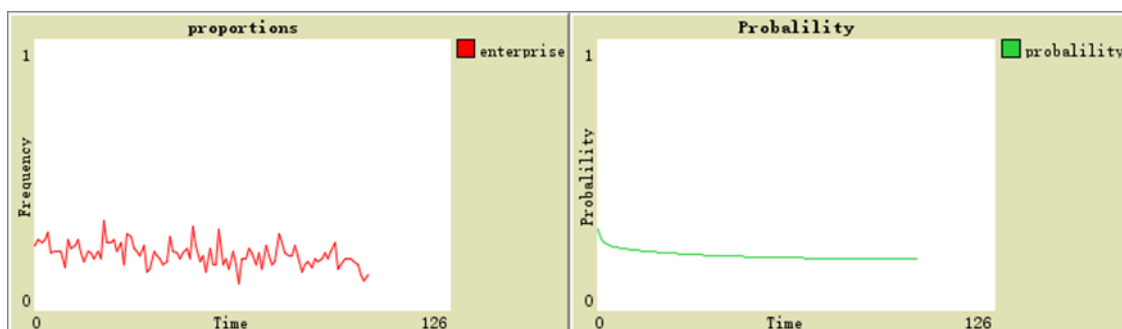


Figure 3. Simulation scenario 2

Simulation scenario 3: when v for 1000 units, f to 100 units, e for 300 units, and initially do not follow the accounting standards was 30%, the proportion of business can be shown in figure 4, the following results are obtained. It does not follow the accounting standards formed stable at 57.5% (Figure 4).

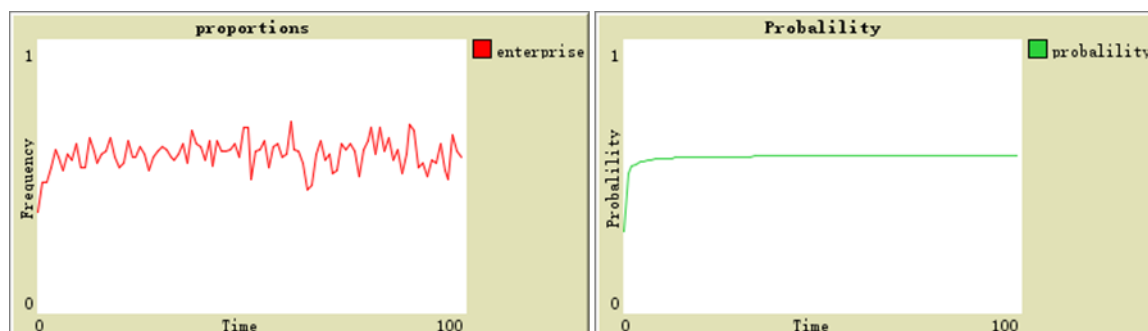


Figure 4. Simulation scenario 3

By comparing the above three simulation scenarios, we can find that when we do not follow the accounting standard for business enterprises of penalties, namely the f value increases, the market does not follow the accounting standard for business enterprises the proportion of reduced, and stable. When following the accounting standard for business enterprises, the enterprise is affected by other companies that

do not follow the accounting standard for business enterprises, due to the inaccurate information leading to the pay increases, the corresponding e value increases, and the enterprise is more inclined to follow the accounting standard for business enterprises. These results might be more clear and intuitive in figure 5. Among them, we propose a variation of the data by controlling the input values of the complex simulation system, and re-run the system. In figure 5, on the left side of this chart, v value and e value is set to 1000 units and 200 units for the change of value of f . On the right side of figure 5, the value of v and f value is set to 1000 units and 200 units respectively, change the value of e .

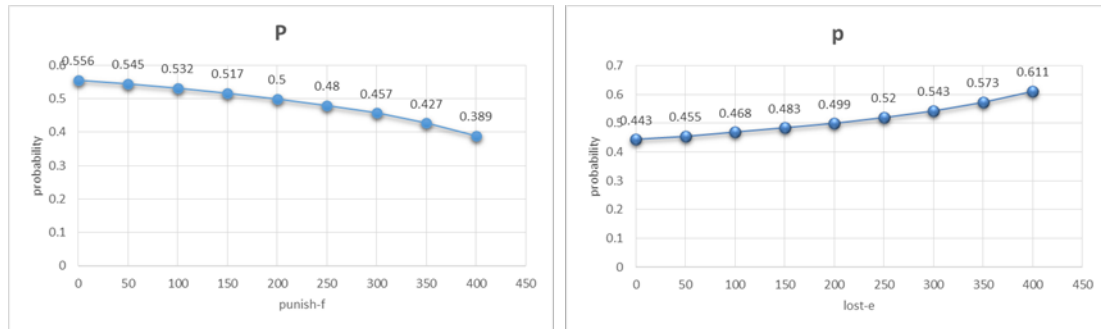


Figure 5. Do not follow the accounting entity proportion of accounting standards change table

When the market does not follow the accounting standard for business enterprises of enterprise main body reaches a certain value, the accounting standard for business enterprises is not good corporate code of conduct, resulting in a decline in corporate reputation and market order confusion. Therefore, considering the strict market supervision cost is huge, standard setters and revision should pay attention to control the market proportion of businesses do not follow the accounting standard for business enterprises, under the condition of lower costs, make the enterprise accounting standards specification function to the optimal.

4.2. Evolutionary Game Between the Two Groups, Multi-Agent Simulation

In Net Logo platform is used to realize the above model, namely, to establish, based on two groups, between multiple subjects the evolution of the system, as shown in figure 6, the system into three parts of input, control, and output. Among them, in the Input is used to add or adjust the payment value between different groups, and all kinds of related coefficients; the Control part is used for initialization of the control system as well as the evolution process; the Output part is used for the visualization of the system model, real-time output of two groups the of the strategy choices of their evolution process.

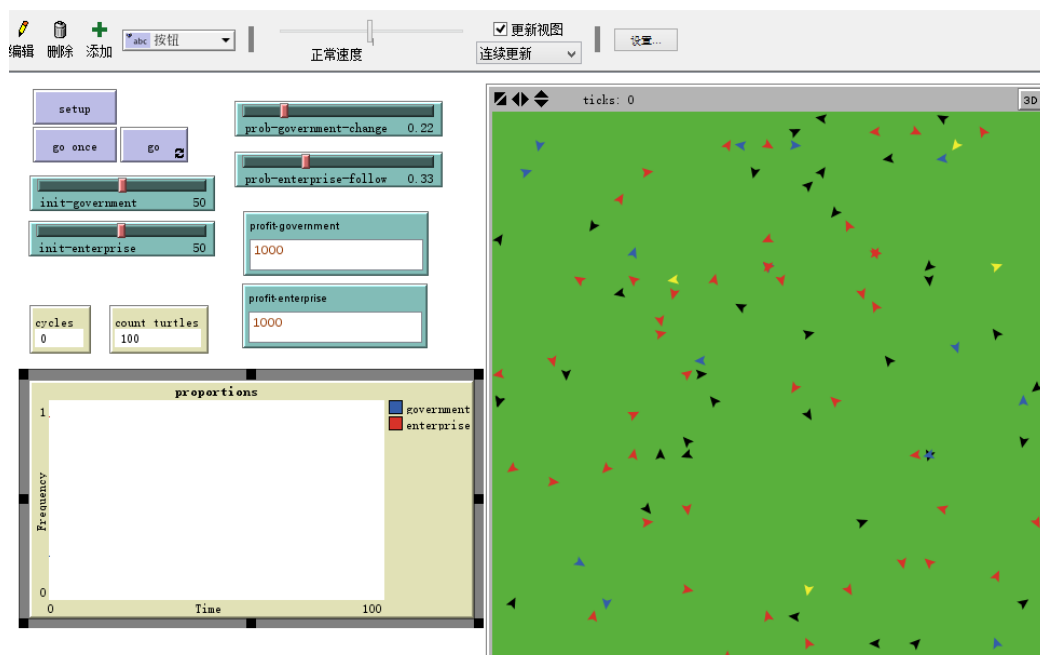


Figure 6.Based on the multi-agent simulation model of rendering

This model has two groups, four different main bodies (Figure 6): (a) units of government support the accounting standards change (the black marks), (b) units of government do not support the accounting standards (the blue marks), (c) following the body of the accounting standard for business enterprises (the red marks), (d) not following the body of the accounting standard for business enterprises (the green marks). To simplify the model, we assume that the enterprise accounting entity and the government pay the value of the subject and are not accounted for by their decision. Each subject within the space of the canvas moving step per unit time, considering two different groups of subjects, when they met separately in the game, comparing the decision-making behavior of the other side and their own different decisions, they make final decisions.

5. Conclusion

This article shows that the structure of benefits often leads to the change of the accounting standard for business enterprises. The fundamental power of change of accounting standards for business enterprises comes from the comparisons, the stakeholders in the current accounting standards of earnings or cost and the ones that do not follow the current accounting standards, and paid the corresponding benefits or costs. Strategy choice (following or not following the accounting standard for business enterprises) results in specific levels of the costs and benefits, which is the basis of the change of the accounting standards and the direction of the change of these accounting standards.

Because of bounded rationality, as well as the limitations of difficulty experienced in getting all the information, it is difficult to make the optimal decision. However, people in the decision-making process tend to absorb their past experience, and refer to other people's experiences. Therefore, learning and imitation is one of the interactions between stakeholders, which play an important role in the change of the accounting standard for business enterprises. Learning and imitating maintains consistency of the decision-making behavior between enterprise accounting subjects, possibly leading to 'lock' effect and 'path dependence' of the change of the accounting standards (Gai, 2012). Thereupon, the strengthening of accounting regulation and strengthening the punishment dynamics can break the 'lock' state. Finally, we can keep the effectiveness and sustainability of accounting standards for business enterprises.

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