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Game Theoretic Analysis on Corporate Social Responsibility and Government Regulation

[1]Jin-Hua SUN, [2]Xing ZHANG, [3]Hong-Wei DING

[1] University of Shanghai for Science and Technology, Shanghai, China
[2] University of Shanghai for Science and Technology, Shanghai, China
[3] University of Shanghai for Science and Technology, Shanghai, China

Email: zstar_hr@sina.com

Abstract – Under the background of globalization, China began to pay more and more attention to corporate social responsibility. Meanwhile we have made certain achievements both in theoretical study and social practice and we have created favorable conditions for our enterprises integrated into the global market and participate in the international competition. However, throughout our country at present corporate social responsibility is also a headache, corporate social responsibility problem is still very challenging and should urgently to be solved. This paper is from the enterprise and the government perspective, trying to construct corporate social responsibility and government regulation game model, explore the evolution of the interaction between the enterprise and the government, and finally get the optimal strategy of the enterprise and the government, then make some beneficial conclusions.

Keywords – Corporate social responsibility; Government regulation; Evolutionary game model; Static game

1. Introduction

Due to the short-term economic benefits drive, the enterprises will not and would not consciously assume social responsibility which they should consciously perform. It makes enterprises related to national economy, people's livelihood and social interests etc. became public disapproval. Therefore, how to effectively supervise and urge enterprises to improve their social responsibility consciousness and undertake their social responsibility compulsory has become the focus of the public's concern, but also our government and the relevant regulators' responsibility.

In the enterprise performance level, behavior of enterprises is influenced by many kinds of factors: the size of the enterprise, ownership place of industry, the state's history, culture, system requirements, stakeholder needs, expectations and so on. It is a dynamic selection process with the change of the environment. In the government regulation level, government regulators' structure, personnel scale, capital allocation, regulatory authority, scope of regulatory, cross supervision, nongovernmental organizations and enterprises self-examination all will have affection to the government regulation and effect. The most important thing is, as stakeholders government regulator and enterprise performance behavior influence each other, and in the process of supervision they continuous interacted with each other. They make adjustments which conducive to their own according to each other's reaction in time. Just because this kind of dynamic and complexity, the perform and supervision of corporate social responsibility has been uncertainty. Therefore, study of our country's corporate social responsibility and government regulation and the game relation between them, is conducive to clarify the internal and external influencing factors, and help the government to establish perfect corporate social responsibility management system, promote the corporate social responsibilities level, which is also the purpose of the research.

This paper is from the enterprise and government perspective, trying to construct corporate social responsibility and government regulation game model, explore the evolution of the interaction between the enterprise and the government, and finally get the optimal strategy of enterprise and the government, then make some beneficial conclusions.

2. Overview of Evolutionary Game Theory

Evolutionary game theory is evolved on the basis of genetic ecologist in game theory to explain the results of animal and plant evolution. In 1973, the concept of evolutionary stable strategy (ESS) was first proposed in the papers published by Smith and Price, marked the official birth of evolutionary game theory. In 1978, ecologist Taylor and Chalk proposed copy dynamic concept when they examined the ecological evolution phenomenon, which is yet another breakthrough in evolutionary game theory. Both of them have become one of the most important events of the 1970s.

Compared to the traditional game theory, evolutionary game theory's biggest feature is combination of game theory and the theory of biological evolution. It researches human behavior and social issues in the use of biological evolution model of bounded rationality. Traditional game theory tries to analyze the interaction behavior of the participants' fully rational state. The entirely rational means that the game players in the pursuit of the best interests has rational consciousness, reasoning ability, identification judgment, memory capacity and ability to accurately behavior and other aspects of requirements. Any one of them imperfect belongs to bounded rationality. In the real case, completely rational is impossible to achieve, so evolutionary game theory based on bounded rationality assumptions in the application has been more and more favored.

The basic elements of the evolutionary game model including multiple game players participated in group, the strategy in the longer term, the strategy of the state space distribution, formal or extended game and a dynamic adjustment process. Game stipulated at every stage of the expected benefits of each policy, and the proportional distribution groups to adopt a different strategy. Game party in the course of the game within the stipulated time will have higher income strategy instead of the lower-income strategy, change the structure of the game at this time, the income change too, then participants judged the next strategy choice according to the earnings.

As the basic equilibrium concept in game theory, evolutionary stable strategy (ESS) reflects the stability of the state of equilibrium solution. The strategy to meet the following conditions is the ESS:

$u(\sigma^*, (1-\varepsilon)\sigma^* + \varepsilon\sigma) > u(\sigma, (1-\varepsilon)\sigma^* + \varepsilon\sigma)$

ε is a very small positive number, and all $\sigma \neq \sigma^*$. Its meaning is that when the system is in the evolutionary stable state, if a small number of individual holders mutation strategy invasion, unless such a very strong external impact, the system is not deviate evolutionary stable state, the original equilibrium unchanged.

For the evolution of the phenomenon of a socio-economic system, the analysis of the process in the method of the evolutionary equilibrium ESS can be broadly summarized as follows:

Step 1: find out all of the Nash equilibrium in the basic game;

Step 2: Determine if these Nash equilibria are met ESS stability conditions: according to the stability judgment eigenvalue method, analyzes the sign of the root of the characteristic equation of the equilibrium point Jacobian, when all of root is less than zero, the system in balance point is in the stable state.

3. Game Matrix Establishment

Fulfillment of corporate social responsibility is the result of joint efforts of the stakeholders, though the interests of all parties is the pursuit of maximum utility, all stakeholders as a whole benefit achieves optimal almost impossible. In the actual performance of the process, the other stakeholders of the business constraints are reflected in the economic level, the government supervision over enterprises can come through the system and the system constraints. The focus of this paper is focused on corporate and government regulators, and the interaction between both of them is to study how to promote the enterprises to better fulfill their social responsibilities.

The game participants were divided into the enterprise and government regulatory agencies, referred to as the enterprise and the government. The information of each operation is disclosure. For ease of analysis, we clear corporate social responsibility and government regulation game's various assumptions and parameters first.

(1) Game parties are limited rationality.

(2) The enterprise and the government are risk neutral, the expectation is to maximize revenue.

(3) The strategic choice of the enterprise is fulfill their social responsibilities and do not fulfill their social responsibilities, the strategic space for short is (performance, non-performance), the probability is x and 1 - x. x is the probability to fulfill their social responsibilities.

(4) The strategic space of the government is (regulatory, not regulatory), its probability is y and 1-y. y is the probability of government regulation.

(5) the income of enterprise is R, V (x) is the cost of the enterprise in order to fulfill their social responsibilities which generally increases with the probability to fulfill their social responsibility, is a strictly convex function of the performance of the rate, that is $V(x) > 0$, $V'(x) > 0$, $V''(x) > 0$, when the boundary cost change rate is a,V (x) can be defined as

$V(x) = ax^2$, $a > 0$

(6) The costs of the government is U (y), and $U'(y) \geq 0$, $U''(y) \geq 0$, $U(0) > 0$, which show that the greater the probability, the higher the cost of government. The regulatory costs is the positive y-correlation function, $U'(y) \geq 0$; growth rate with the regulatory costs higher with the probability of the regulatory c, $U''(y) \geq 0$, if the government malfeasance, it still has basic costs, so $U(0) > 0$, set $U(0) = C$, without loss of generality, it can be set

$U(y) = by^2 + c$, $c > 0$

(7)The government gain W (superior funding, incentives, and maintain social stability invisible from the regulatory cost can be estimated), the net proceeds of the government is W-U (y). If not, the receipt is W; if the government found that companies are not legitimate, the enterprise will be punished for F, the government's income is: W-U (y)+F.

Game of the enterprise side and the government side utility matrix is shown in Table1:

Table 1. Utility Matrix Between Enterprise and Government

Utility / Strategy	Strategy	Government	
		supervise (y)	un-supervise (1-y)
Enterprise	perform (x)	R-V(x) , W-U(y)	R-V(x) , W-C
	Defaulting (1-x)	R-F , W-U(y)+F	R , -C

4. Single Stage Static Game Model Analysis

The probability of the enterprise and the government are often changing, both of them do not know exactly what strategies the other choose. It easy to show that this game has no pure strategy Nash equilibrium, but there is a mixed strategy Nash equilibrium.

Suppose y is fixed, enterprises in the choice of completely fulfill their social responsibilities (x = 1) and do not fulfill (x = 0), the expected utility:

Ee (1, y) = (R-V (x)) * y +(R-V (x))* (1-y) = R-V (x)

Ee (0, y) = (R-F) *y+ R * (1-y) = R-Fy

Regulatory authorities' best probability is getting the same expected utility when enterprises adopt different strategies:

Ee (1, y) = Ee (0, y), solution was:

$y^* = V(x) / F$

If the government's regulatory probability y <V(x)/F, the enterprise's best choice is not to perform; y> V (x) / F, the enterprise will make efforts to fulfill; y = V (x) / F, the enterprise's fulfill rate is not impacted by the effectiveness of the enterprise, the enterprise will operate according to their own principles of random selection.

Similarly, given the enterprise fulfillment rate x, the government chooses regulatory (y=1) and non-regulatory (y = 0), the expected utility:

Eg (x, 1) = (W-U (y)) * x +(W-U (y)+ F)* (1-x) = W-U (y) +F-xF

Eg (x, 0) = (W-C) * x+ (-C) * (1-x) = xW-C

The enterprise's best fulfill rate is regardless of any regulatory, its expected utility is the same:

Eg (x, 1) = Eg (x, 0),

$x^* = (W-U(y)+F+C) / (F+W)$

When the enterprise x <(W-U (y)+ F+C) / (F+W), the government for their own utility considerations, the optimal choice is strictly regulated; x> (W-U (y)+ F+C) / (F+W), the best choice of the government is not regulatory; x = (W-U (y)+ F+C) / (F+W), the government regulatory or non-regulatory has the same utility. Therefore, regulation will be determined randomly.

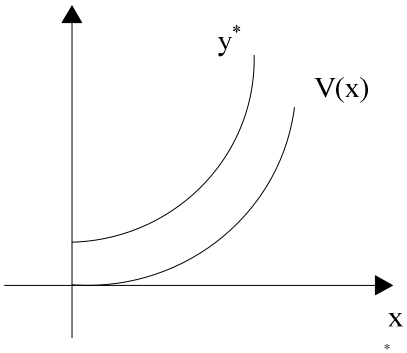

Figure1. The relationship between y^* and V(x)

From the above analysis, the regulatory game balance is related to U (y), W, F, R and V (x):

(1) The greater the punishment, the greater the utility the government will get, the enterprise is more likely to choose to fulfill. This is because the larger the utility for regulators, the higher the probability of their supervision, the enterprise of non-compliance will be found more easily, which can promote the enterprise abide by the law.

(2) When the enterprise penalties was punished more severe, the government check probability may be smaller; enterprises pay the greater cost, the government probability will become larger. When the enterprise fears of being investigated and seriously affect their own utility, will naturally improve fulfillment level regulatory probability; if fulfill their social responsibilities costs too much, the enterprise will evade responsibility, the government should intensify supervision.

On the other hand, we can analyze x and y how to influence best regulatory rate and the best fulfillment rate.

V (x) is strictly convex function, y * = V (x) / F, the relationship of y *, V (x) and x can be showed by the Figure 1. y * and V (x) has the same shape of the function, that is, when improve fulfillment rate, the best regulatory probability corresponding increase. This phenomenon can be explained when the enterprises improved to fulfill, they paid increase in variable costs. So the enterprises tried to evade their responsibilities to reduce spending impulses, strengthen supervision at this time is to ensure the fulfillment of social responsibility effective means.

Similarly, U (y) is a strictly convex function, x *, U (y) and the relationship of y can be represented by Figure 2, then combined with formula x * = (WU (Y) + F + C) / (F + W), when the regulatory probability y increases, U (y) increases, x decreases. This phenomenon can be explained as follows: When regulators increased inspection frequency, they pay the cost of larger and get smaller overall utility, while the larger the possibility of punishment, in order to pursuit of maximum utility enterprises may choose to reduce spending to obtain maximum effectiveness, resulting in a vicious cycle and the case of adverse selection.

5. Analysis of Evolutionary Game Model

The influence of various parameters on the enterprise side and the government side has been cleared by the static game analysis. However, on a mixed strategy Nash equilibrium is based on the game players have fully rational premise, but in face of the complex social and

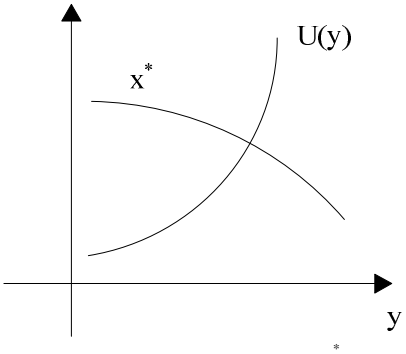

Figure2. The relationship between x^*, U(y) and y

economic environment, the requirements that all the players are fully rational decision-maker is clearly unrealistic and impossible. Game parties in the decision-making is rational constraints leads to they often cannot find the optimal strategy in the beginning and need to go through repeated games, and learn from each other, imitating advantage strategy, and ultimately reach a stable equilibrium, this is in line with the reality of the performance of this game process performance

characteristics of biological evolution, evolutionary game theory can better analyze the fulfillment of corporate social responsibility and regulatory issues.

Under the previous assumptions and the same payoff matrix involved in the two sides do evolutionary game analysis?

Enterprise's expected revenue chooses to fulfill their social responsibility, choose not to fulfill the social responsibility and average revenue were:

$E_{e1} = y * (R-V(x)) + (1-y) * (R-V(x)) = R-V(x)$

$E_{e2} = y * (R-F) + (1-y) * R = R-Fy$

$E_e = x * (RV(x)) + (1-x) * (R-Fy) = R-Fy-xV(x) + Fxy$

Copy dynamic equations fulfill strategic type proportion enterprise that is dynamic change speed:

$dx / dt = f(x) = x(E_{e1}-E_e) = x(1-x)(Fy-V(x))$

In accordance with the above formula, $y \in [0, 1]$ interval, when $dx / dt = 0$, to obtain:

$y = V(x) / F$

In a similar way, the copying dynamic situation of supervisor as following:

Expectations revenue of regulatory, expectations income and average income of non-regulatory were:

$Eg1=x*(W-U(y))+(1-x)*(W-U(y)+F)=W-U(y)+(1-x)F$

$Eg2=x*(W-C) + (1-x)*(-C)=xW-C$

$Eg=y*(W-U(y)+(1-x)F)+(1-y)*(xW-C)$

Replication dynamic equation of regulators had the proportional regulatory strategy:

$dy/dt=f(y)=y(Eg1 -Eg)=y[W-U(y)+(1-x)F- y(W-U(y)+(1-x)F)-(1-y)(xW-C)]=y(1-y)[(1-x)(F+W)-U(y)+C]$

According to the above dynamic equation, if $dy/dt=0$, $x= (F+W+C-U(y))/(F+W)$ is a steady situation of y.

Now the possible fulfillment rate of corporation will consider the unfulfilling social responsibility, and also considerate the regulator's revenue.

If $x \neq (F+W+C-U(y))/(F+W)$, derivation to f(y):

Figure 3. Copying Dynamic Phase Map of Corporation

This means that all x are steady state and $V(x) \leq F$ .It shows that when regulators regulatory probability equal to V (x) /F, the game is always in equilibrium. It also suggests that we can analyze which measure to take according the relationship of V (x) and F.

$df(y)/dy=f'(y)=(1-2y)[(1-x)(F+W)-(by^2+c)+C]-2by^2(1-y)$

$f'(0)=F+W-c+C-(F+W)x$

$f'(1)= (F+W)x-(F+W +C-b-c)$

It's obviously that, if $x>(F+W-c+C)/ (F+W)$, then

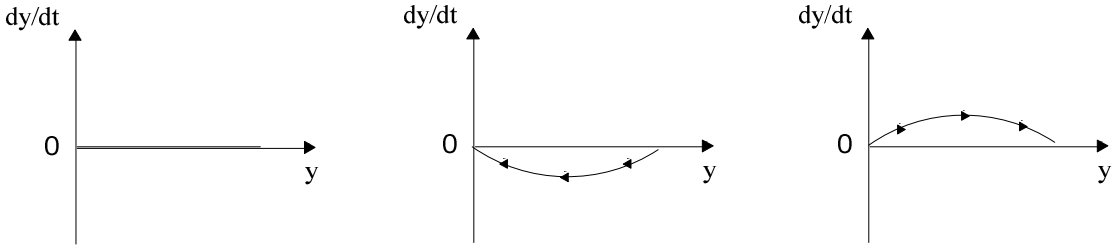

Figure 4. Copying Dynamic Phase Map of Supervisor

If $y \neq V(x)/F$, the steady situation of copying dynamic equation $dx/dt =x(1-x)(Fy-V(x))$ are x=0, x=1. Derivate X to dynamic equation:

$df(x)/dx=f'(x)=Fy(1-2x)+ax^2(4x-3)$

$f'(0)=Fy$

$f'(1)=a-Fy$

From the above equation, x=0 is not where ESS is. Obviously, if $y < a/F$, then $f'(1)>0$, x=1 is not where ESS is. If $y>a/F$, then $f'(1) < 0$, x=1 is ESS. Figure 3 are copying dynamic phase maps.

$f'(0) < 0$, and y=0 is ESS. If $x < (F+W-c+C-b)/ (F+W)$, then $f'(1) < 0$, and y=1 is ESS, copying dynamic phase map as following (Figure 4):

Make $x_1^*=(F+W-c+C-b)/(F+W)$, $x_2^*=(F+W-c+C)/(F+W)$, $y_1^*=a/F$, replicate the dynamic relationship between the change in the proportion of the two groups, in different circumstances, shown the two proportions on the coordinates can get the replication of corporate social responsibility and government regulation game dynamic relationship and stability chart.(Figure 5)

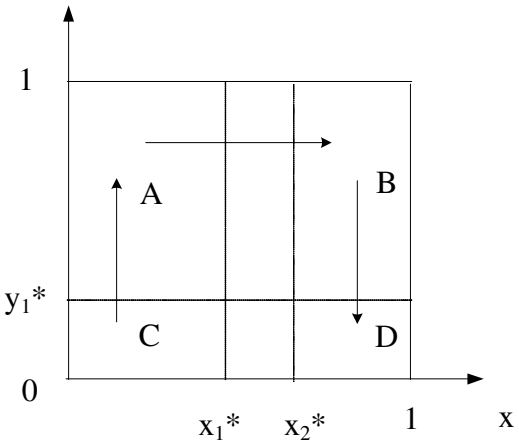

Figure 5. Copying Dynamic Relationship and Stability of Regulatory Game.

Through the above analysis, for corporate parties, when corporations are investigated for do not fulfill corporate social responsibility that the punishment F is greater or a become smaller (variable cost reduction under same fulfillment rate), the probability of $y > y_1$ * is greater, it increasing the probability that strategy of corporation fell on the A and B area, during the long-term process of evolutionary game, corporation will tend to $x \to 1$ (to fulfill their social responsibility). Under this situation, the greater the punishment is, the more likely the corporation to improve fulfillment rate.

For supervision, if $x < x_1$*, the strategy of supervisor will fell on the A area and C area, means when the implementing rate form corporation is low, the regulators evolution strategy of supervision probability increased gradually $y \to 1$. If $x > x_2$*, the strategy of supervisor will fell on the B area and D area, it means that when the implementing rate form corporation is high, the regulators evolution strategy of supervision probability reduce $y \to 0$ so that to reduce their own costs, and achieve maximization of utility. Of course, increase the revenue of regulators W+F or reduce b+c, in the same probability of supervision, it seems to reduce supervision cost can increasing the probability that strategy of corporation fell on the A or C area, also the corporation choose to take the social responsibility $x \to 1$.

This regulatory game has no stable strategy like evolutionary game, that is, there is no automatic evolution trend can let the regulators and corporate parties automatic take the strategy from external influence caused by changing strategy. It means that, when the cost of fulfill corporate social responsibility is too high, corporate parties will choose unfulfilling strategy, and the regulators will exercise complete supervision, final get the loss at both side, also cannot create social utility, which is the last situation we want to see.

6. Conclusions

In conclusion, this paper established an evolutionary game model between the social responsibility of corporate and government regulation. Based on such game model, the paper also analyzed the evolution process of the game model to looking out for an evolution stable strategy. Based on parameters settings of corporate social responsibility-government regulation game model, we can get following conclusion:

(1) The corporate social responsibility-government regulation game model is a complex and dynamic process, because the different incomes of each side, it may eventually produce entirely different results.

(2) It may form an unsteady state in this game model that the corporation gradually tend to avoid fulfilling responsibilities, when fulfill responsibility need a high cost, the corporation income is much lower, and the punishment is not enough. In view of such situation, following actions may help to establish a steady balance, like actively reduce costs by companies, optimize business environment by government and penalties increase for non-performance social responsibility etc.

(3) The situation is much more complicated and without a determined equilibrium when the fulfilling responsibilities cost and their income is lower than the penalties of non-performance.

In fact, through the reasonable system, appropriate rewards and punishment mechanism, reduce the cost of supervision and improve the supervision of revenue, it also can obtain a satisfactory game equilibrium.

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