Game Modeling and Differential Analysis of Supervisory Mechanism for Admissions Publicity in Colleges and Universities

Xin Zhao*[1a], Yulan Wang[2b] and Dong Lv[3c]

[1]Dean's Office Undergraduate admissions office, University of Electronic Science and Technology of China, Chengdu,
[2]Student Affairs Department Undergraduate admissions office, Southwestern University of Finance and Economics, Chengdu,
[3]Office of Admissions and Career Development, Southwest Jiaotong University, Chengdu.
[a]zx@uestc.edu.cn, [b]wangyulan@swufe.edu.cn, [c]158014997@qq.com

Abstract

With the deepening of the comprehensive reform of the National College Entrance Examination (NCEE), the competition among colleges and universities to attract excellent students is becoming more and more intense. In order to ensure the quality and optimize the components of students, colleges and universities put more and more emphasis on admissions publicity. It is necessary for the admissions office to supervise relevant colleges, departments and staff members in order for the precise interpretation on admissions policy, the avoidance of negative public sentiment and the safety and stability of admissions publicity. Based on the supervisory game theory, this paper builds a model of supervisory mechanism for admissions publicity in colleges and universities, obtains the reaction functions and the reaction curves through differential analysis, and gets the mixed strategy Nash Equilibrium. Thus, this paper studies the factors which influence the decision-making of both the admissions office and team, and puts forward some suggestions to improve the admissions publicity in colleges and universities.

Keywords: Admissions Publicity; Game Theory; Differential Analysis; Nash Equilibrium

1   INTRODUCTION

With the deepening of the comprehensive reform of the National College Entrance Examination (NCEE), the competition among colleges and universities to attract excellent students is becoming more and more intense. In order to ensure the quality and optimize the components of students, colleges and universities put more and more emphasis on admissions publicity. However, with the continuous upgrading and deepening of admissions publicity, the growing phenomenon of unsatisfactory publicity, such as imprecision in the interpretation on policy, excess of publicity, and staff members' being slack, has gradually become a key problem the admissions office has to tackle [1]. It is necessary for the admissions office to supervise relevant colleges, departments and staff members in order for the precise interpretation on admissions policy, the avoidance of negative public sentiment and the safety and stability of admissions publicity. As a classical model of game theory, supervisory game model is an effective way of helping the admissions office with decision-making and maintaining equilibrium.

At present, with regard to admissions publicity in colleges and universities, there are admissions leading group of overall responsibility and admissions office of concrete responsibility. There is also admissions committee which is entrusted by the admissions leading group with the task of making proposals for and playing a supervisory role of admissions publicity. The admissions office sets up teams in each affiliated colleges which do the admissions publicity all over the country.

In colleges and universities, the admissions leading group supervises the admissions committee which is responsible for democratic supervision. The admissions leading group and the admissions committee jointly supervise the admissions office which supervises all the admissions teams. The organization chart of the supervision of admissions publicity in colleges and universities is shown in Figure 1.
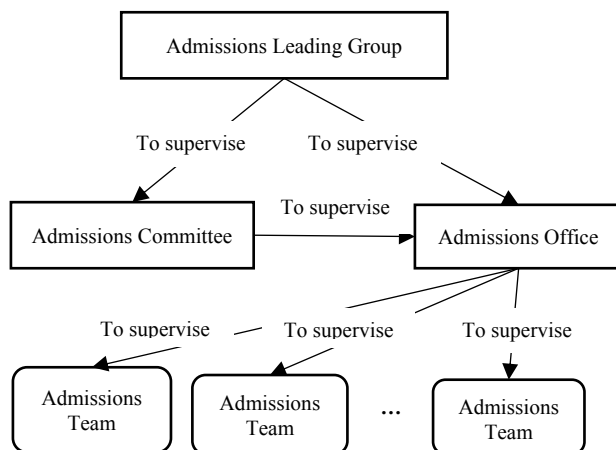
Figure 1: Organization Chart of the Supervision of Admissions Publicity in Colleges and Universities

2   GAME MODELING AND DIFFERENTIAL ANALYSIS

2.1   Modeling

This paper builds a supervisory game model to analyze the strategies which are adopted by admissions office and admissions team when they interact with each other in the process of publicizing, and to find the Nash Equilibrium. In order to build the model, the following hypotheses are needed.

Hypothesis 1: There are two levels of the quality of admissions publicity, namely the standard ($Q=1$) and the minimum requirements ($Q=Q_0$). $Q=1$ represents that the quality of publicity completed by the admissions team fully meets the standard set by the admissions office. $Q=Q_0$ represents the minimum requirements of publicity that the admissions office is able to check without any cost of supervising.

Hypothesis 2: Let γ represent the probability that the admissions office can find the team disobey rules or fail to reach the required standard of admissions publicity, and $1-\gamma$ the probability that it cannot.

Hypothesis 3: Let R represent the bonus that the admissions team receives from the office for reaching the required standard or overfulfil the task [4]. Let L represent the loss that the admissions team suffers when it disobeys rules or fails to reach the required standard, which means that the admissions office would punish the team by cutting down on its spending and admissions and requesting it to straighten out the existing problems [5].

Hypothesis 4: Let V_Q represent the value created by the admissions team when it reaches the required standard (namely when $Q=1$). Let V_{Q_0} represent the value created by the admissions team when it fails to

reach the required standard (namely when $Q=Q_0$). Let V_C represent the costs of supervising of the admissions office, while the subscript C represents the working costs of the staff members in the admissions office [7].

Hypothesis 5: Let W represent the expenditure provided by the admissions office to the team, including that on staff, business trip, publicity materials, etc [10].

Hypothesis 6: Let H represent the working costs of the admissions team when it reaches the required standard, and H_{Q_0} the working costs when it fails to reach.

There are four strategies for both admissions office and team when doing the publicity, as shown in Table 1.

Table 1: Four Strategies in Admissions Publicity

	Admissions Team	
	S₁ (to supervise, substandard)	S₂ (to supervise, standard)
Admissions Office	S₃ (not to supervise, substandard)	S₄ (not to supervise, standard)

For admissions office and team,

If they adopt the strategy of S₁ (to supervise, substandard), the expected payoff of the admissions offices is

$$E_{AO} = \gamma(V_Q - R) + (1-\gamma)(V_{Q0} - V_C - W)$$

and that of the team

$$E_{AG} = (-H - V_C + R)\gamma + (W - H_{Q0} - L)(1-\gamma)$$

If they adopt the strategy of S_2 (to supervise, standard), the expected payoff of the admissions office is

$$E_{AO} = V_Q - V_C - W - R$$

The admissions office reaps the value V_Q created by the admissions team when it reaches the required standard. At the same time, it has to pay the costs of supervising V_C, admissions team's expenditure W, and bonus R. The expected payoff of the admissions team is

$$E_{AG} = W - H$$

It is provided with the expenditure W, while paying the working costs H of reaching the required standard.

When they adopt the strategy of S_3 (not to supervise, substandard), the expected payoff of the admissions offices is

$$E_{AO} = V_{Q_0} - W$$

The admissions office reaps the value V_{Q_0} created by the admissions team when it fails to reach the required standard, while paying admissions team's expenditure W. The expected payoff of the admissions team is

$$E_{AG} = W - H_{Q_0} - L$$

It is provided with the expenditure W, while paying the working costs H_{Q_0} of substandard publicity. Meanwhile, it has to bear the loss L.

When they adopt the strategy of S_4 (not to supervise, standard), the expected payoff of the admissions offices is

$$E_{AO} = V_Q - W - R.$$

The admissions office reaps the value V_Q created by the admissions team when it reaches the required standard, while paying admissions team's expenditure W and bonus R. The expected payoff of the admissions team is

$$E_{AG} = W - H$$

It is provided with the expenditure W, while paying the working costs H of reaching the required standard.

Thus a matrix table of payoff is yielded, as shown in Table 2.

Table 2: Matrix Table of Payoff in Admissions Publicity

		Admissions Team	
		Substandard	Standard
Admissions Office	To supervise	E_{AO}, E_{AG}	$V_Q - V_C - W - R$, $W - H$
	Not to supervise	$V_{Q_0} - W$, $W - H_{Q_0} - L$	$V_Q - W - R$, $W - H$

2.2 Nash Equilibrium Analysis

The equilibrium is identified when all players choose their optimal strategies simultaneously. It refers specifically to the optimal outcome of a game in which players can no longer increase their payoff (or utility) by unilaterally deviating from their chosen strategy (and behavior) [8]. Nash Equilibrium, which owes its name to American Economist John Nash who has made outstanding contribution to game theory, is a concept where one's choice is optimal given the other's choice, and vice versa. Therefore, all players do not have any incentive to deviate from their initial strategy [6].

Let α represent the probability that the admissions office chooses to do supervisory work. Let β represent the probability that the admissions team fails to reach the required standard. An analysis of the mixed strategy Nash Equilibrium in admissions publicity results in the following conclusions.

1. The Expected Payoff of the Admissions Office

$$T_{AO} = \alpha[E_{AO}\beta + (V_Q - V_C - W - R)(1-\beta)] + (1-\alpha)[(V_{Q0} - W)\beta + (V_Q - W - R)(1-\beta)]$$

Differential solution:

$$\frac{\partial T_{AO}}{\partial \alpha} = V_Q\gamma - \gamma\beta V_{Q0} + V_C\beta\gamma + W\beta\gamma - R\beta\gamma - V_C$$

Let $\dfrac{\partial T_{AO}}{\partial \alpha} = 0$

Find $\beta = C / \gamma(1 - Q_0 + C + (W - R)/V_Q)$

For the admissions office,

When $\beta < C / \gamma(1 - Q_0 + C + (W - R)/V_Q)$, its optimal strategy is not to do supervisory work.

When $\beta > C / \gamma(1 - Q_0 + C + (W - R)/V_Q)$, its optimal strategy is to do supervisory work.

When $\beta = C / \gamma(1 - Q_0 + C + (W - R)/V_Q)$, it may supervise at random.

2. The Expected Payoff of the Admissions Team

$$T_{AG} = \beta[E_{AG}\alpha + (W - H_{Q0} - L)(1-\alpha)]$$
$$+(1-\beta)[(W-H)\alpha + (W-H)(1-\alpha)]$$

Differential solution:

$$\frac{\partial T_{AG}}{\partial \beta} = -H\gamma\alpha - V_C\gamma\alpha - W\alpha\gamma + H_{Q0}\gamma\alpha + L_{Q0}\gamma\alpha - H_{Q0} + H$$

Let $\dfrac{\partial T_{AG}}{\partial \beta} = 0$

Find $\alpha = H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L)$

For the admissions team,

When $\alpha < H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L)$, its optimal strategy is to complete the admissions publicity without reaching the required standard.

When $\alpha > H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L)$, its optimal strategy is to reach the required standard.

When $\alpha = H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L)$, it may complete the admissions publicity at random.

Based on the above, it can be concluded that the mixed strategy Nash Equilibrium in the game model for the supervisory mechanism for admissions publicity is

$$\alpha = H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L)$$

$$\beta = C/\gamma(1-Q_0+C+(W-R)/V_Q)$$

That is, the admissions office supervises the team with the probability α, and the admissions team completes the publicity with the probability of reaching the required standard $(1-\beta)$.

In the above game analysis, the reaction functions of the admissions office and team are:

Admissions office:

$$\alpha = \begin{cases} 0, if\ \beta < C/\gamma(1-Q_0+C+(W-R)/V_Q) \\ [0,1], if\ \beta = C/\gamma(1-Q_0+C+(W-R)/V_Q) \\ 1, if\ \beta > C/\gamma(1-Q_0+C+(W-R)/V_Q) \end{cases}$$

Admissions team:

$$\beta = \begin{cases} 1, if\ \alpha < H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L) \\ [0,1], if\ \alpha = H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L) \\ 0, if\ \alpha > H(1-Q_0)/\gamma(H+V_C+W-H_{Q0}-L) \end{cases}$$

According to the two reaction functions, the reaction curves in the game model are worked out. The intersection of the two reaction curves is the mixed strategy Nash Equilibrium in the game model of supervisory mechanism for admissions publicity in colleges and universities [3], as shown in Figure 2.
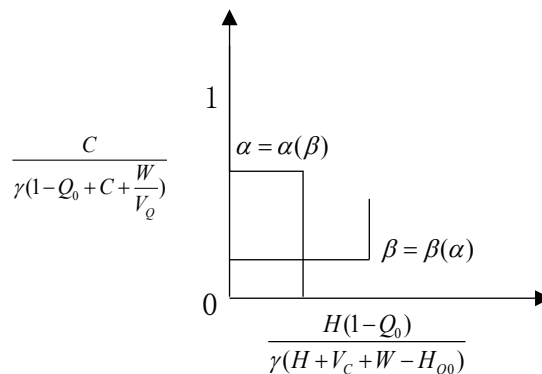

Figure 2 Reaction Curves in the Game Model of Supervisory Mechanism for Admissions Publicity in Colleges and Universities

2.3 Analysis on the Model

2.3.1 Analysis on the Admissions Office's Supervisory Behavior

1. With the increase of the expenditure W provided to the team, the punishment F for substandard publicity and the bonus R for publicity of high quality, the chances of the office's doing supervisory work α decline, as well as the chances of the team's substandard publicity β. That is why many colleges and universities continue to enhance the system of rewards and punishments to encourage better performance in admissions publicity.

2. The chances of the admissions office's doing supervisory work increase with the working costs associated with the admissions team's publicizing H and H_{Q_0}. Therefore, with regard to the provinces and majors where the admissions team has difficulty publicizing, the admissions office should strengthen supervision.

3. When the costs of supervising V_C and the working costs of the staff members in the admissions office C increase, and the probability that the admissions office chooses to do supervisory work α remains constant, the admissions team is more likely to have substandard performance. Therefore, the more difficult it is to supervise the admissions publicity, the less likely it is that the admissions team will be able to reach the required standard.

2.3.2 Analysis on the Admissions Team's Publicizing Behavior

1. The bonus R, which the admissions team receives from the office, should increase with the value V_Q created by the admissions team when it reaches the required standard. It is where the significance of the principle of reward according to merit lies.

2. The bonus R should increase with the costs of supervising V_C and the working costs of the staff members in the admissions office C. The admissions team tends to fail to reach the required standard when it is difficult to supervise. So the admissions office needs to offer high reward to reduce the frequency of substandard publicity.

3. The bonus R and the costs of supervising decline with the increase of the punishment L, suggesting that the admissions office can urge the team to reach the required standard of admissions publicity through effective punishment.

3 SUGGESTIONS

First, the costs of supervising should be reduced. The higher the costs are, the less likely the admissions office chooses to do supervisory work, and the more likely the admissions team fails to reach the required standard. Therefore, the admissions office should try to minimize the costs of supervising which mainly include expense and time. The increase of the expense costs leads to covert loss of payoff, while the increase of the time costs leads to ineffective utilization of resources [9].

Second, the competence of supervision and evaluation should be improved. A higher level of competence in the admissions office's supervisory work means more deterrents to the admissions team. Therefore, the admissions office should perfect the evaluation system and improve the evaluation methods, so as to increase the chances of successful supervision. Focusing on key objects and links can not only promote work efficiency but also make full use of resources.

Third, it is of utmost importance for the admissions office to establish a long-term, close and mutually beneficial relations with the admissions team. A long-term partnership greatly enhances the chances of the admissions team's reaching the required standard of admissions publicity [2].

4 CONCLUSION

Based on the supervisory game theory, this paper builds a model of supervisory mechanism for admissions publicity in colleges and universities, and works out the mixed strategy Nash Equilibrium through differential analysis. Furthermore, it studies the factors which influence the decision-making of both admissions office and team, and puts forward some suggestions to improve the admissions publicity in colleges and universities.

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