Research Article
The Game Analysis of Public Participation in Food Security Supervision

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Abstract: Based on public participating in food safety supervision, this thesis comes to fully manifest the influential role and the significance of public participation in food safety supervision in the use of game theory by analyzing the behavior strategy performance of public, enterprises and government. It aims to provide a wide range of management theory on public's participation in food safety supervision and the multiplication of management.

Keywords: Food safety, game theory, public participation

INTRODUCTION

Food security issues are the major issues related with the national economy and people's livelihood in any country (Wong, 2008). Since China's reform and opening up, with the rapid economic growth and the development of science and technology, we have achieved the huge achievement in the total food supply. But the intense market competition has led to tiny profit for most of the manufacturers, and in order to seek profits some enterprises sacrifice food safety and quality. They make a big fuss by cutting corners, diluting or packing of goods, over drafting the quality of product security and even use non-food Raw materials and hazardous materials. In recent years, the frequent food security accidents show severe challenges in China's food safety, indicate the insufficiency in food security supervision, and reflect that the dependence on market and the government intervention is hard to problem of the deterioration of food safety in China. Food security has a bearing on people's health, safety, social stability and national prosperity, which is a public utility. To solve the problem of public food safety, on the one hand, it is necessary to strengthen the supervisory duties of market supervision department. On the other hand, it requires entire social fellowship. Because food safety is a kind of public welfare and is non-monopolistic, promoting public participation in food security not only reflects public decision-making process approval on benefit directly related issue to realize their rights and obligations (Dungumaro and Madulu, 2003). Moreover public participation can provide important basic experience information as well as effective practice and acceptable related program (Bell, 2001). Public participation is also a method to make full use of potential knowledge, enhance the public awareness of food safety and establish public trust.

Because for a long time China once has practiced the planned economic system and government-led economic strategy, the idea of "government center theory" is ingrained. The important position in public food safety and the awareness of Public participation are ignored, whether intentional or not. China's shortage of mechanisms for public participation and the weak sense in public participation, the degree of participation and efficiency not high, the participating means poor, the neglect of public's point of view or the proposal are patterns of "to report after the incident, "or" Victims to report to the authorities" (Wong and Ding, 2006). That is, public participation is only an individual's Activist activity. In real life, if the public receive food safety harm, they rarely use the law to protect their own rights and interests. This thesis will try to analyze the reasons through the gambling theory.

THE GAME ANALYSIS OF PUBLIC PARTICIPATION IN FOOD SECURITY

Food security problems in China mainly lie in four aspects: the First is the abuse of food additives. It means the massive use of chemical additive on food processing, and even the use of chemical additive which the country forbids explicitly, causing many foods to become "the toxicant". The Second is food fake and shoddy, such as counterfeiting white liquor with the industrial alcohol and so on. The third is food pollution. The fertilizer and agricultural chemicals excessively remains in agricultural product; the hormone and antibiotic are abused on livestock product. The fourth is expired food (Luo, 2007). The first one is greatest hazards to public. When public receive food

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security harm, they can protect their own right in the form of accusation, reporting, appeal and inquiry by letter. Assume that the game between the public and contrary enterprises is based on such process: when the public discover food security problem, they can protect their own rights and interests by reporting to the authorities or suing. But they may also suffer from the report.

When receiving public report, the government decides whether to accept the public reporting and carries on the supervision punishment to the contrary enterprise according to various aspects of assessment. We assume that the Government does not accept all public reports for this reality: The government has certain option to the public reporting, out of the funds, the personnel, the investigation cost and the severity of the problem. Moreover, not all Government departments and the staff are impartial. So the enterprise and the public may affect their decision through some other means. This assumption is based on reality in some degree.

Taking abusing food additive as the example, assume that people involved I = {1 = public, 2 = illegal enterprise} and the enterprise aims to realize the maximal profit, the public to realize the maximal their own welfare. Take $\omega \in [0, \bar{\omega}]$ as the severity of abusing the food additive, $\omega = 0$ indicates that the enterprise adds food additives in the prescribed limit $\bar{\omega}$ is the maximum limit allowed, beyond which the government will close the enterprise. $\pi(\omega)$ is the additional profit when the severity of food additive abusing is ω. $\pi(0)$, $\pi'(\omega) > 0$, means the more severe, the more profit. $D(\omega)$ is the extra loss to the public 1 in food safety incident in result of abusing food additives $D(0) = 0$, $D'(\omega) \geq 0$ means that the more severe, the more loss K = {k1, k2} is public's strategy collection, and k1 means that public report the damage from food incident to the authorities, k2 not to t report to the authorities out of some consideration.

As the public do not have any power to punish enterprise, they can only report of an offence to the government to make them punished. Thus public should pay for the report (Lin, 2007).

$\gamma(\omega)$ is the probability of public reporting when they get harm. Assume the coast is M. T = {C1, C2}. C1 means the government accepts the report and carries on the investigation. C2 means the government does not adopt further investigates. $p(\omega)$ is the probability of an investigation. F(ω) means the fine paid for excessive food additives, meanwhile the government confiscate the excessive profit. M = {m1, m2} is enterprise's choice strategy collection. M = m1 means enterprises choose to abuse food additives. M = m2 means enterprises choose to obeys the law. $\theta(\omega)$ is the probability of abusing food additives in a different level of adding out of limit.

To facilitate the discussion, we do not consider the cost of the investigation, regarding it manifested in the investigation probability.

Table 1: The business's and the public's matrix game tables T = C1

		Public	
		$K = k_1(\gamma(\omega))$	$K = k_2(1-\gamma(\omega))$
Business	$M = m_1(\theta(\omega))$	-F(ω), -M	$\pi(\omega)$, -D(ω)
	$M = m_2(1-\theta(\omega))$	0, -M	0, 0

Table 2: The business's and the public's matrix game tables T = C2

		Public	
		$K = k_1(\gamma(\omega))$	$K = k_2(1-\gamma(\omega))$
Business	$M = m_1(\theta(\omega))$	$\pi(\omega)$, -M-D(ω)	$\pi(\omega)$, -D(ω)
	$M = m_2(1-\theta(\omega))$	0, -M	0, 0

Enterprises first choose to add excessive level of food additives, that's ω. When the public report the offence of abusing whose severity is represented as ω, neither the public or Enterprises know whether the Government will accept the report and carry on the investigation. But they know:

$$P\{T = C_1\} = p(\omega) \quad P\{T = C_2\} = 1 - p(\omega)$$

It is clear that enterprises and the public and enterprises are very concerned about the government's affirmation degree on public participation. When the government treats the public reporting in different manners, there are different gaming results, Such as the game Matrix Table 1 and 2.

The solution to the model: When the abusing degree is ω, the business's predicted utility is:

$$E_u = -F(\omega)\theta(\omega)\gamma(\omega)p(\omega) + \pi(\omega)\theta(\omega)$$
$$(1 - \gamma(\omega))p(\omega) + \pi(\omega)\theta(\omega)(1 - p(\omega))$$
$$= \pi(\omega)\theta(\omega) - \pi(\omega)\theta(\omega)\gamma(\omega)p(\omega) - F(\omega)\theta(\omega)\gamma(\omega)p(\omega)$$

And the public hope the less loss, the better. Their predicted loss is:

$$E_v = M\theta(\omega)\gamma(\omega)p(\omega) + D(\omega)\theta(\omega)(1 - \gamma(\omega))$$
$$p(\omega) + M(1 - \theta(\omega))\gamma(\omega)p(\omega)$$
$$+ (M + D)\theta(\omega)\gamma(\omega)(1 - p(\omega)) + D(\omega)\theta(\omega)$$
$$(1 - \gamma(\omega))(1 - p(\omega)) + M(1 - \theta(\omega))\gamma(\omega)(1 - p(\omega))$$
$$= M\gamma(\omega) + D(\omega)\theta(\omega) - D(\omega)\theta(\omega)\gamma(\omega)p(\omega)$$

Because enterprise aims to realize the maximum profit, the enterprise hopes to choose ovenproof add ω to maximize expected utility Eu. While as the supervisor and the victim, the government and the public hope the enterprise adds food additives as little as possible or even never add them to guarantee food quality. Therefore, they hope to work out supervision, investigation and penalty measures to minimize enterprise's unjust enrichment and to make enterprises give up the desire to add excessive food additives. So it does not lose the generality. Suppose Eu = 0, then:

$$\pi(\omega)\theta(\omega) - \pi(\omega)\theta(\omega)\gamma(\omega)p(\omega) - F(\omega)\theta(\omega)\gamma(\omega)p(\omega) = 0$$

So: $\gamma(\omega) = \pi(\omega) / (p(\omega)(\pi(\omega) + F(\omega)))$

or: $p(\omega) = p(\omega) / (\gamma(\omega)(\pi(\omega) + F(\omega)))$

Besides, the public hope to minimize the loss, that's, when Eu = 0 and in the probability variable bound condition, account:

$$\min E_v = M\gamma(\omega) + D(\omega)\theta(\omega) - D(\omega)\theta(\omega)\gamma(\omega)p(\omega)$$

Make use of the above formula to gain the power exponential function of y, then the first-order condition of the public optimization is:

$$M - D(\omega)\theta(\omega)p(\omega) = 0$$

The reaction function of enterprise is:

$$\theta(\omega) = \frac{M}{D(\omega)p(\omega)}$$

Then get the mix Nash Balanced result is:

$$\gamma^*(\omega) = \frac{\pi(\omega)}{p(\omega)(\pi(\omega) + F(\omega))}$$

$$\theta^*(\omega) = \frac{M}{D(\omega)p(\omega)}$$

RESULTS ANALYSIS

The enterprise's, the public's and the government's strategy choice are as follows:

- The public regard the probability $\pi(\omega) / (p(\omega)(\pi(\omega) + F(\omega)))$ as the threshold. When the excessive degree is ω, the greater the Government's punishment dynamics is, t he less the enterprise's profit is and the smaller probability of abusing food Additives is. Because the greater the Government's punishment dynamics is, the more risk the enterprise will take. If the profit is not great enough, then the temptation is not strong.
  Therefore, companies know that if the public enterprise reporting standard to add food additives is greater than the probability, the companies do not choose the best strategy is to add excessive food additives; if the probability is less than the public report, the corporate strategy is to select the best standard Add food additives.
  The enterprise knows this point, therefore, if the rate when the public report to the authorities for exceeding food additive is higher than $\pi(\omega) / (p(\omega)(\pi(\omega) + F(\omega)))$, then enterprise had better not abusing food additive; while If the rate is lower

than $\pi(\omega) / (p(\omega)(\pi(\omega) + F(\omega)))$, then enterprise's would abuse food additive.

- Since they know that "if the public don't report to the government, the government will not investigate either", the enterprise will take into account of the public's reaction to food safety problems. their strategy depends on the cost of public's participation and the severity of food safety problems, and The probability of abusing food additives is $M / (D(\omega)p(\omega))$, because the enterprise think the more loss the public suffer when the severity is ω, the larger probability of reporting to the government to protect their rights is. While if the reporting cost is too high, the public will consider whether to obtain their benefit through the accusation to a certain extent. The more cost the reporting is, the less probability of reporting, and then the enterprise will be more inclined to abuse food additives. In addition, the enterprise's strategy is affected by the government's probability to accept the report and investigate it, and the affect is negative. It is easy to understand: the larger probability of accepting the report and investigate there is, the more attention the government pay to the report and public's advice, which make the enterprise dare not take the risk of abusing food additives and not bring harm to the public. Therefore the abusing phenomenon becomes less common as the reality shows.
  The public knows this, so if the probability of abusing is greater than $M / (D(\omega)p(\omega))$, the public will choose to report as the best strategy. While if the probability is less than $M / (D(\omega)p(\omega))$, then the public's best strategy is not to report.

- For the government, the judgment point of whether to deal with the abusing report is $p(\omega) = \pi(\omega) / (\gamma(\omega)(\pi(\omega) + F(\omega)))$. The government judges the regulation enforcement in accordance with the enterprise's profit and amount of fine when the food additives excessiveness is ω. They think the more amount of fine they impose, the stronger policy signal the enterprise will get. Therefore the enterprise is less likely to take the risk of abusing food additives. Since the less profit the enterprise gains, the lighter the relative temptation it faces and the less likeliness it chooses to abuse food additives.

From the model analysis above, we can see that the Government's policy has a strong effect on the public's and enterprise's strategy. For example, if the Government take the attitude of indifference to the public's report, that is, T = C2, at this time the only pure strategy of the game is balanced, that's (m1, k2). The result is that the enterprise will definitely abuse food additives in pursuit of high profits, and the public

will not take the risk of losing more welfare to report the violations to The Government, since they are also aware of the government's indifferent attitude. If on the one hand the Government can attach importance to the public's report (to choose $T = C1$), and reduce the blocks of their reporting and the cost of public participation (to reduce M). On the other hand, the government governs the enterprise more severely (to enhance $F(\omega)$), then the probability of abusing food additives will reduce to a large extent.

From the balanced results in this model, we can see that the probability of the Government accepting public's report and investigating it is inversely proportional to the probability of the public scrutiny and reporting to the authorities. It exactly shows the mutual interdependence relations between the Government and the public. If the Government takes severer measures to the illegal enterprise and enforce the law more efficiently, the public will think that the government's attitude is so strict that the enterprise is little likely to get out of line (and therefore the probability of their supervision will be small). On the contrary, if the public does not participate actively, namely $\gamma(\omega)$ is small, the Government has to improve the efficiency to make the enterprise sure of standard quality, this will inevitably increase the control cost This conclusion shows that the more active the public participate, the greater the pressure the food producers will feel, which will relatively relieve the government's supervision, namely, the benign public participation can alleviate the government's extent and work in this aspect.

CONCLUSION

Foodstuff is all-important to the people. It is out of question that food safety has an important impact on common people. Participation in food safety represents public's enjoyment of their security benefits and maximum of their interests. To strengthen the supervision of food safety, it not only requires strengthen professional departments' daily supervision of food safety, but also encourages public participation in the supervision. According to the above struggling analysis and discussion, the conclusion will be summarized as follows:

- The choice of enterprise's strategies whether to violate the rules or not is influenced by the cost of public's participation in the supervision and complaint as well as the damages suffered. The higher the cost of public participation, the more liable for companies to violate, and the greater the damages public will suffer.
- The choice of public's strategies to supervise and report depends on the additional profits gained by the enterprise and the government's force of punishment. The greater profits under some certain exceeding degree, the greater the encouragement to

exceed. If the government enhance the force to punish, public's trust to and dependence on the government will be strengthened while the consciousness to supervise enterprises will be weaken.

- Government's strategy of accepting the public's report and making investigation is accorded with the public's strategy, that is, in proportional to the additional profits gained by the enterprise while inversely proportional to the force of punishment. With incompletion information, it is also related to the public's probability of choice, which is in symmetry with the choice of strategy. This fully shows that, as trustee of the public, the government shares the same goal on food safety with the public. Public's participation will ease government's attention and investment to a large degree in this field.

In many areas of law enforcement, it is not enough to rely only on the professional department's limited management of cat-catching-mouse-style, and it is prone to the corruption of rent-seeking of the right. It will cause incompleteness of the supervision and lead to the separation of some professional departments from the public, worse more, serve the interest of certain department. Multi-departments, multi-thread, they rush to manage while there exists profits and throw to each other without benefits, which departed from the goal of management. With regard to the government, it should increase the force of punishment on the illegal enterprises, enhance the efficiency of the law and reduce the cost of public participation to enhance the management of enterprises' illegal action.

It is each government's responsibility that taking effective measures to protect public's food safety and ensuring their basic right of survival and well-being. Thus, the government should enhance its professional construction, intensify the sense of being the subject of the market supervision, implement the system of accepting duty, increase the efficacy of enforcing the law, protects reporters' legal right making thoroughly investigation of the complaints and increase the cost of enterprises' violation to ensure the results of the government's enforcement and supervision.

Public participation in food security cannot be equated with the government's regulation. It is only the manifestation of multi-management, having great effect and significance of the guarantee of food safety. Therefore, the government should introduce incentives to lower the threshold for reporting complaints and take advantage of economic levers to encourage and support the public to report and complain enterprises' violation of rules and law, and appropriately expand the scope and base of compensation and incentives to inspire the public to participate in food safety management and supervision. Through the construction and fast operation of the mechanism of public's participation in the supervision, it may make up for the functional departments' isolated fight, insufficiency of manpower,

surveillant range but not wide supervision and other possible problem. It may avoid the situation of public's misunderstanding of the government while sympathizing the supervisee, thus, to make the violation of rules and law be scolded by all the public, which is helpful in the foundation of harmonious society.

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