

# Behavior Analysis on the Security Object of the Public Rental Housing

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**Abstract:** With the establishment of the system of public rental housing supply, the vulnerable group would get great benefit in the promotion of social welfare, however, due to the existence of price gap and the imperfection of the public rental housing system, the game relationship formed between the management authority and the security object. Based on the definition to the security object in the public rental housing, the specific classification to the security object was analyzed at first, and then the motivation of the security object to obtain the unjust enrichment was discussed from the perspective of policy and the behavior. To stimulate the relationship and interaction between the management authority and the security object, a dynamic game model was presented in the context of basic hypothesis, the evolutionary strategy was summarized after the game process analysis. The possible paths to prevent from the behavior of free-riding of the security object was finally concluded.

**Keywords:** Free-riding, public rental housing, security object.

## INTRODUCTION

Security object could get benefit from the supply of public rental housing directly, whose temporary predicament of housing could be solved. According to the goal of public rental housing system, when the security object is no longer eligible to get the public rental housing, that is, could afford the cost of get the propitiate housing from the commercial housing market by themselves, they should return the public rental housing which will be re-assigned to new security objects. However, due to the huge price gap between the commercial housing and public rental housing, the opportunity benefit is increased greatly in the real world. As we known, based on the discussion of human nature in the theory of management science or economics science, the rational economic person would pursuit their maximum interests. Hence, in the context of lacking proper regulation, to get their interests, the security object has the tendency to occupy the public rental housing should be returned. Further, in addition to the bounded rationality of security housing, the asymmetry of information and the complicated environment conditions will exacerbate the uncertainty and variability of decision making and performance of public rental housing system.

Since the construction of the public rental housing is of crucial meanings to the promotion of the social welfare, relevant research is quite abundant. For example, YUAN discussed the possibility of the application of the PPP mode in the supply of public housing, McConnell studied the problem of race, legislation of the public rental housing system. Meanwhile, some research about the effect of supplying public rental housing was finished, such as the study done by H. L. Cooper on the economic influence, or the social impacts

of the marking scheme in public housing in Hong Kong studied by Yung Yau. However, the study on the security object, which is one of the most important participants in the process of public rental housing supply, is rarely seen. Hence, the discussion on the behavior choice of the security object is conducted to explain the free-riding behavior of the security object by the game theory [1-4].

## DEFINITION OF SECURITY OBJECT

According to the general method for distinguishing the object for which the public rental housing was supplied in the practice of various local government, the object need the public rental housing, the so called security object, could be divided into three kinds (see Table 1).

**Table 1.** The subjective classification of urban public rental housing demand.

Classification	The household capacity of payment	The housing status of household
First kind	The low and medium income household	without capacity to purchase commercial housing, affordable housing or capped-price housing
Second kind	The houseless new job population	
Third kind	The immigrant workers with steady job	

The first kind is the registered population whose income ranking from the lowest group to the medium group in the economic statistics, and they could not afford the payment of purchasing the commercial housing, the affordable housing or the capped-price housing;

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The second kind is the houseless new job workers among the registered population, and they temporarily could not purchase house from the commercial housing market;

And the third kind is the immigrant workers who are not registered in where the job located, and they could not afford the payment of purchasing the commercial housing, and are not qualified to buy the affordable housing or capped-price housing.

Besides, some individuals or their family may be covered by the supply of public rental housing occasionally. As this kind of supply is beyond the scope of quasi-public goods, we exclude them from the definition of security object.

In conclusion, to clarify the security object should be conduct from two layers:

The first layer is the payment capacity. When the individual or family cannot afford to purchase some proper housing for living, they may be the security object;

And the second layer is the housing status. Judged by the per capital housing area, the security object would be houseless or with the data lower than certain level.

**MOTIVATION OF THE FREE-RIDING FROM SECURITY OBJECT**

By the supply of public rental housing, the housing predicament of security object with very limited capacity of payment and per capital housing area would be relieved temporarily, and it would be solved that the commercial housing market could not provide the housing and service for the vulnerable group by the mechanism of demand-supply.

In general, the market price of rental housing is constituted by eight parts, including the maintenance fee, management cost, depreciation, interest, tax, premiums, profit and the land rent, which is positive correlated with the real estate price, whereas the rent for public rental housing belongs to a kind of quasi-cost for rent, forming the regulated price which only with parts of these eight kinds of categories, and is lower than the market rent for similar housing. Therefore, the security object could afford the pay-off of rent with their current income level.

The price elements of different kinds of housing are illustrated (see Fig. 1).

The regulation from the government leads to the “price gap” between the rent for public rental housing and for some similar commercial housing. Due to the positive correlation, the price rising of the commercial housing would accelerate the increase of rent, and the price gap is widened gradually, which stimulate the behavior of free-riding of security object.

The free-riding of the security object in the process of the supply of public rental housing is obtaining the public rental housing by certain abnormal methods to seek unjust enrichment through the behaviors as occupying, employing or making money, which leads to the loss of the property of quasi-public goods of public rental housing. The case of free-riding was far from rare in the supply of affordable housing. Some disqualified resident could buy the affording house whose price were obviously lower than the price in the

commercial housing market through some illegal or irregular methods, to get extra income by living, renting or reselling, and the goal of supplying affordable housing was distorted consequently and the efficiency of supplying security housing was seriously damaged. Similarly, if the mechanism of the examination for applicants and the regulation were not perfectly established, the free-riding would be unavoidable in the process of public rental housing supply.

Type of Housing	Rent of Market							
Commercial Housing	Rent of Market							
Affordable Housing	Rent of Cost				Price Gap			
Public Rental Housing	Rent of Quasi-cost			Price Gap				
Low Rent Housing	Low Rent	Price Gap						
Price Constitution	Maintenance Cost	Management Cost	Depreciation Cost	Interest on Investment	Taxes	Insurance Cost	Profit	Land Rent

Fig. (1). The price elements of different kinds of housing.

In accordance with the division of duties to different participants involved in the supply of public rental housing, in the process of supplying, the nonprofit organization is in charge of accepting the application and conducting the examination as the management authority, so that the distribution of security housing is under control. Due to the inevitable existence of housing price gap, the supply of this kind quasi-public goods stimulates the emergence of “rent”, which means the extra income obtained by getting the qualification of security housing. The income becomes much tempting when the housing price is rising up, and then the rent-seeking from certain individuals is motivated greatly. Some disqualified individuals think of ways to get the qualification by illegal method to seeking unjust enrichment. There are two categories from the ways for rent-seeking, including:

- (1) Rent-seeking by the lacking of policy. The large scale of construction and supplying of public rental housing in China began from 2010. The entire supply system are still on construction, and the modes of supply from local government are in the process of exploration. For the method to clarify the qualification of security object, to survey the personal income, to set up the exit strategy, both central and local government are lacking of practical experience. The imperfect of policy system is easily used by the individuals for rent-seeking, and they may obtain the unjust enrichment without the awareness of management authority. Along with the construction and improvement of supply system of public rental housing, the

dynamic management and regulation to the condition of security object could be helpful to detect and correct the case of rent-seeking. Therefore, rent-seeking by the lacking of policy is a kind of explicit behavior which is relatively easy to detect and correct. And,

- (2) Rent-seeking by tunneling. Although it is the non-profit organization who is on duty to the distribution and management, which is thought to pursuit and maintain the public interest, the non-profit organization is no doubt formed by individuals with the property of “economic person” and having the tendency to maximum their own benefit. In the context of weak regulation and management, it is common to produce the phenomenon of anomie. When the price gap between public rental housing and commercial housing stimulates the disqualified individual to apply for the security housing, it is possible that some will choose to bribe the staff of the management authority to get the qualification, and some member of the staff who should be the representative of the public interests would break the control of policy. Ought to the tunneling for the rent-seeking is of intentionally purpose, it is a kind of hidden behavior, which is difficult to be detected and corrected.

**GAME ANALYSIS BETWEEN THE MANAGEMENT AUTHORITY AND SECURITY OBJECT**

Around the supply of public rental housing, the management authority and the security object forms the relationship of interaction, and the relationship could not be simulated by the static game model. The behavior choice of the management authority and the security object is not coinstantaneous, the strategy is chosen by observing the behavior of other participants in the game, so that the dynamic game would be formed.

For the potential unjust enrichment, the security object chooses the strategy whether to seek the rent or not based on whether the management authority would regulate the rent-seeking behavior of the security object. The security object observes the strategy of management authority to modify their strategy.

**Hypothesis of Model**

- (1) In the process of public rental housing, the strategy space of the security object is {seeking rent, not seeking rent}, the probabilities of different strategies are  $p$  and  $1-p$  respectively.
- (2) When the behavior of rent-seeking of the security object succeeds without the proper regulation of the management authority, the unjust enrichment of the security object will be  $D_1$ , whereas the cost of rent-seeking will be  $C_1$ ; when the behavior of rent-seeking of the security object does not succeed due to the proper regulation of the management authority, the security object still needs to pay the cost of  $C_1$ , and the punishment from the management authority will be  $C_2$ ; when the security object complies with the policy of public rental housing, the normal income will be  $D_2$ , and evidently  $D_1 > D_2$ .
- (3) To the rent-seeking of the security object in the process of public rental housing supply, the strategy space of the management authority is {regulating, not regulating}, the

probabilities of different strategies are  $q$  and  $1-q$  respectively.

- (4) When the regulation is weak in the process of the rent-seeking, the unjust enrichment of the management authority will be  $D_3$ , in the form of the tunneling from the security object to the staff of the management authority. When  $D_3 = 0$ , it means the lacking of policy system is the reason of rent-seeking. The social cost of the target distort of public rental housing supply leading by the successful rent-seeking will be  $C_3$ ; when the management authority conducts proper regulation to the behavior of rent-seeking, the cost of the regulation will be  $C_4$ . When the powerful punishment is implemented, there is no obvious economic benefit, but some positive social benefit  $D_4$  could be brought out.

Therefore, the payoff matrix of the dynamic game between the management authority and the security object would be as shown in Table 2.

**Table 2. The game matrix between administrative department and guarantee object.**

Security object	Management authority	
	Regulating $q$	Not regulating $1-q$
Seeking rent $p$	$-C_1 - C_2, D_4 - C_4$	$D_1 - C_1, D_3 - C_3$
Not seeking rent $1-p$	$D_2, -C_4$	$D_2, 0$

**Analysis of the Dynamic Game**

The expected revenue when the security object chooses the strategy of “seeking rent” and “not seeking rent” and the average revenue are respectively

$$E_{11} = q(-C_1 - C_2) + (1-q)(D_1 - C_1) = D_1 - C_1 - q(D_1 + C_2)$$

$$E_{12} = qD_2 + (1-q)D_2 = D_2$$

$$\bar{E}_1 = pE_{11} + (1-p)E_{12}$$

Then the Replicator Dynamics Equation of whether the security object is tend to seek the rent is

$$F(p) = \frac{dp}{dt} = p(E_{11} - \bar{E}_1) = p(1-p)[D_1 - D_2 - C_1 - q(D_1 + C_2)].$$

When  $\frac{dp}{dt} = 0$ , the solution would be  $p_1^* = 0, p_2^* = 1,$

$$q^* = \frac{D_1 - D_2 - C_1}{D_1 + C_2},$$

$$F'(p) = (1-2p)[D_1 - D_2 - C_1 - q(D_1 + C_2)].$$

As illustrated in the Fig. (2), when  $q = q^*$ , no matter the value of the  $p$ , there is  $F'(p) = 0$ . That is, when the solution is in the scope of  $0 \leq p \leq 1$ , it would be the Evolutionarily Stable Strategy (ESS), and

$$q^* = \frac{D_1 - D_2 - C_1}{D_1 + C_2}$$

is the probability that the management authority conducts the regulation in the situation of equilibrium under the mixed strategies.

When

$$q \neq q^*, \text{ if } q > \frac{D_1 - D_2 - C_1}{D_1 + C_2},$$

$p_1 = 0$  and  $p_2 = 1$  would be the stable point of the dynamic game,  $p_1 = 0$  would be the Evolutionarily Stable Strategy;

$$\text{if } q < \frac{D_1 - D_2 - C_1}{D_1 + C_2}, p_1 = 0$$

and  $p_2 = 1$  would be the stable point of the dynamic game,  $p_2 = 1$  would be the Evolutionarily Stable Strategy.

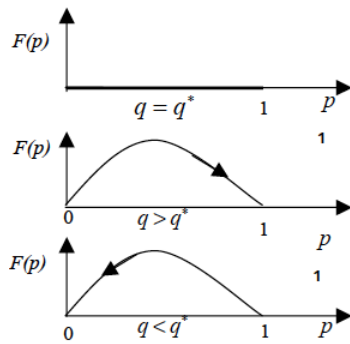


Fig. (2). The phase diagram of guarantee object.

The expected revenue when the management authority chooses the strategy of “regulating” and “not regulating” and the average revenue are respectively

$$E_{21} = p(D_4 - C_4) - (1 - p)C_4 = pD_4 - C_4$$

$$E_{22} = p(D_3 - C_3) - (1 - p)0 = p(D_3 - C_3)$$

$$\bar{E}_2 = qE_{21} + (1 - q)E_{22}$$

Then the Replicator Dynamics Equation of whether the management authority is tend to regulate is

$$F(q) = \frac{dq}{dt} = q(E_{21} - \bar{E}_2) = q(1 - q)[p(D_4 - D_3 + C_3) - C_4]$$

When  $\frac{dq}{dt} = 0$ , the solution would be

$$q_1^* = 0, \quad q_2^* = 1, \quad p^* = \frac{C_4}{D_4 - D_3 + C_3}$$

$$F'(q) = (1 - 2q)[p(D_4 - D_3 + C_3) - C_4].$$

As illustrated in the Fig. (3), when  $p = p^*$ , no matter the value of the  $q$ , there is  $F'(p) = 0$ . That is, when the solution is in the scope of  $0 \leq q \leq 1$ , it would be the Evolutionarily Stable Strategy (ESS), and

$$p^* = \frac{C_4}{D_4 - D_3 + C_3}$$

is the probability that the security object conducts the rent-seeking in the situation of equilibrium under the mixed strategies. When  $p \neq p^*$ ,

$$\text{if } p > \frac{C_4}{D_4 - D_3 + C_3},$$

$q_1 = 0$  and  $q_2 = 1$  would be the stable point of the dynamic game,  $q_2 = 1$  would be the Evolutionarily Stable Strategy;

$$\text{if } p < \frac{C_4}{D_4 - D_3 + C_3},$$

$q_1 = 0$  and  $q_2 = 1$  would be the stable point of the dynamic game,  $q_1 = 0$  would be the Evolutionarily Stable Strategy.

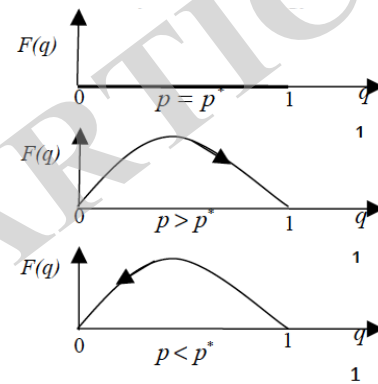


Fig. (3). The phase diagram of administrative department.

### Analysis of the Evolutionary Strategy

Based on the method of local stability analysis of the Jacobi matrix, there are five equilibrium points, including (0,0), (0,1), (1,0), (1,1) and the saddle point

$$\left( \frac{C_4}{D_4 - D_3 + C_3}, \frac{D_1 - D_2 - C_1}{D_1 + C_2} \right)$$

in the plane  $V = \{(p, q); 0 \leq p \leq 1, 0 \leq q \leq 1\}$ .

$$\frac{D_1 - D_2 - C_1}{D_1 + C_2}$$

is the expectation of the security object to the regulation from the management authority. When having the expectation of the strict regulation from the management authority, the strategy choice of the security object would be evolved to not seeking rent. To compel the security object to choose not seeking rent, the value of

$$\frac{D_1 - D_2 - C_1}{D_1 + C_2}$$

needs to be decreased;

$$\frac{C_4}{D_4 - D_3 + C_3}$$

is the expectation of the management authority to the rent-seeking of the security object. When the value of

$$\frac{C_4}{D_4 - D_3 + C_3}$$

is relatively high, then the tendency of the rent-seeking would be more obvious, and the regulation from the management authority should be enhanced.

### The Strategy Choice of the Players

The rent-seeking of the security object damages the public welfare target of the public rental housing supply. Besides calling for the self-regulation of the security object, the key for the governance of the rent-seeking is to improve the policy system. The specific methods could be chosen from,

- (1) Enhancing the cost of rent-seeking from the security object, and promoting the value of  $C_1$ . For the potential rent-seeker in the security object, if the expected revenue is larger than the expected cost of rent-seeking, then the change to the real rent-seeking would be conducted based on pursuing the maximum benefit. To increase the expected cost, efficient supervising system and regulating system need to be established, as a result, on the one hand, the expected revenue would be decrease, on the other hand, the expectation to the cost would be increased.
- (2) Enhancing the punishment to the rent-seeking behavior, and promoting the value of  $C_2$ . Economic penalties and regulatory penalties are the general methods for the penalty. By paying the fines and returning the unjust enrichment, the penalty to the security object could be enhanced. Meanwhile, the ratio of the potential rent-seeker to the real rent-seeker would be reduced by the establishment of the citizen credit system, the association between the rent-seeking of the security object with the citizen information record.
- (3) Reducing the cost of regulation, promoting the efficiency of regulation, and reducing the  $C_4$ . The cost of the regulation constrains to the management authority for the implementation of the regulation. The significant decrease of the regulation cost should be realized on the improving the supporting system of income and credit, the optimizing to the procedure of regulation by the system design

and the clarifying the duties of management. The efficiency of the regulation would be promoted and the detection to the rent-seeking behavior, so that the security object would follow the management policy of the public rental housing.

### CONCLUSION

Security object is of great importance in the process of public rental housing supply, whose influence is always ignored. Due to the price gap between the commercial housing and the public rental housing, it is natural of the impulse to get unjust enrichment from the security object, taking advantage of the imperfection of the public rental housing system, or the tunneling to the management authority. The behavior of free-riding not only harmed the efficiency of the whole system, but also distorted the target of the supply of public rental housing. By simulating the behavior of the security object with the management authority, the path of controlling the rent-seeking and free-riding could be detected, which is helpful to improve the current system of public rental housing.

### CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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