

The Game of Social Forces Participating in the Evolution of the Housing Rental Market and Government Regulation

Jundong Qiu

School of Management, Jinan University, Guangzhou, China
Email: qjd0924@163.com

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Abstract

There is a correlation between the price of rent and the supply and demand of housing leases. While the government promotes financial innovation in the leasing market, there are also loopholes in financial supervision, which causes social forces to excessively participate in the “profit-seeking” behavior of housing leasing projects, further resulting in rising rental prices. Finally, this makes the public cannot afford housing. Based on the evolution game theory, this paper analyzes the evolutionary path and mechanism of government and social forces in repeated games. The results show that it is difficult for social forces to evolve naturally to non-participation without external forces, and the government needs to implement appropriate regulations to make the system evolve toward the target state.

Keywords

Social Forces, Housing Rental Projects, Macro Control, Game of Evolution

1. Introduction

Recently, some people said: “We couldn’t afford a house before, but now, we even can’t rent it.” Because of the soaring rent, a series of people’s livelihood problems emerged. Data shows that, excluding the seasonal increase in rent prices, the rise in rents in large and medium-sized cities is “fierce” than in previous years. Data from the China Real Estate Association shows that in July this year, Beijing’s average house rent reached 92.33 yuan/month/square meter, up 2.63% month-on-month and 21.89% year-on-year [1]. According to the statistics of the Shell Research Institute, in July this year, the rents of major and medium-sized cities showed a significant increase from the previous month. Among them,

Changsha has the maximum increase of 4%, and 1% for Shanghai and Guangzhou [2]. But what is driving the rapid rise in rents? Li [3] pointed out the mechanism of housing rent formation and the reasons for the rise and fall are as follows. One is the imbalance between supply and demand in the rental market, and two is the price formed by the housing transaction market. Excessive transaction prices affect renting quality and rent level, while the imbalance between supply and demand has a more severe impact. In 2016, the Chinese government proposed *the State Council's Several Opinions on Accelerating the Cultivation and Development of the Housing Leasing Market*, encouraging financial institutions to provide capital to housing lease enterprises. However, the leasing relationship formed using financial leverage has intensified the contradiction between supply and demand in practice. Some companies have utilized financial loopholes to over-participate in housing leasing projects. Over-participation in housing leasing projects refers to action that certain leasing companies, in accordance with the development model of “take a house-rent-finance-re-take a house”, quickly seize the house and drive up rents to disrupt the market, of which long-rent apartment is a typical pattern. It also refers to the action that people use the asymmetry of supply and demand information to publish false information in newspapers, radio, television, websites, new media and other channels to drive up rents. This kind of behavior that seriously damages people’s livelihood requires relevant government departments to make efforts in controlling the chaos in the leasing market in accordance with the actual situation and formulate a feasible plan.

Two main forces (social forces and the government) are constructed in this paper as finite rational party to repeat game. In this analytical framework, the core game analysis is a strategic adjustment of both parties, trends, and the ratio stability of using specific policy. It should be noted that the participation of rental housing projects of social forces mainly refers to the financial system and the real estate agents. To ensure the generality, social forces assume in the text is composed by those companies that are able to directly or indirectly to provide rental services. The regulation of the government includes policy release, administrative penalties and other regulatory measures

Evolution game combines game analysis and the analysis of dynamic evolution process to better reflect the dynamic equilibrium of the development of game behavior among finite rational groups [4]. As an important analytical tool, the evolution game model is continuously expanding its application and research. Babu *et al.* [5] integrated environmental, social, economic, cultural, governing and other dimensions, and used evolution game to simulate stakeholders and payment function to determine the sustainability of the supply chain and study the factors that impact the equilibrium change of the system on the long-term (but limited). Zeng [6] used the evolution game analysis model to study the interaction mechanism between the holding company’s selection of supervision strategies on subsidiary and the subsidiary’s strategy selection in group gover-

nance, and analyzed the important factors affecting the stability of the evolution process of the system. He provided new solutions for agency problems between the holding and subsidiary company. Fu [7] established an evolution game model of investment in carbon emission reduction of suppliers and manufacturers, and studied their behavior and strategy in the investment. Guo [8] and Pan [9] studied the role of government in building a low-carbon society and analyzed the stability of the game equilibrium between government and enterprises under incomplete information. Song [10] and Yu [11] used evolution game theory to discuss the mineral resource protection and affordable housing project, and pointed out the choice of government's control strategy.

Yi [12] suggested that the evolution game model has the following characteristics: firstly, it takes the participating group as the object to analyze the dynamic evolution process, and explain why and how the group reaches the current state; secondly, there are both a selection process and a mutation process; thirdly, the behavior selected by the group has a certain inertia. The research objects in this article are government and social forces, which meets the finite theoretical assumptions, and its strategy selection is a process of constant adjustment. Therefore, this paper constructs an evolution game model to analyze the dynamic equilibrium and evolutionary path of government and social forces in the regulation of illegal housing rental projects, and proposes government intervention strategy.

2. The Construction of the Game Model

In order to keep the rental prices stable, and strive to improve people's livelihood and take new ways in social management to strengthen social construction, the government needs to be practical and realistic, which means the supervision and regulation on economic behavior of the social and economic subjects should be conducted based on the specific circumstances. Two main forces (social forces and the government) are constructed in this model as finite rational party to repeat game. In this analytical framework, the core game analysis is a strategic adjustment of both parties, trends, and the ratio stability of using specific policy.

It should be noted that the participation of rental housing projects of social forces mainly refers to the financial system and the real estate agents. To ensure the generality, social forces assume in the text is composed by those companies that are able to directly or indirectly to provide rental services. It is supposed that the initial state of the two parties in the game is "social forces do not participate and the government does not intervene", because social forces operate their company according to the general profit model, in which no new profit model has been formed, and the rental price is relatively stable, and the government does not need supervision. Therefore, this state is also the goal of government policy: the government does not interfere and the economy develops steadily.

In this game, the government has two options: "intervention" and "non-intervention". The strategy space is $S_G = \{\text{intervention, non-intervention}\}$. Among

them, the “intervention” strategy is that the government adopts specific strategies such as promulgating corresponding policies and regulations, administrative penalties and administrative incentives to guide and regulate enterprises not to participate in illegal lease projects. The “non-intervention” strategy means that the government does not take any regulatory action on enterprises in the economic operation. Social forces have two choices: “participation” and “non-participation”. The strategy space is $S_E = \{\text{participation, non-participation}\}$. Among them, the “participation” strategy is that companies take speculative actions to realize immediate benefits and participate in illegal leasing projects due to loopholes in government regulation. The “non-participation” strategy is the wake-up of corporate social responsibility awareness and the government implements strict intervention, and then the company participates in other general business projects to maximize benefits.

Assume that the basic earning of enterprises participating in general commercial projects is R_1 , and the basic income of illegal leasing projects is R_0 . If the government adopts an intervention strategy, it will need to pay certain cost (C), which result from collecting clues to identify whether some companies are participating in illegal leasing projects; assessing that whether the implemented intervention policies and measures have effective results; monitoring whether the enterprises that have been intervened are actively rectified their misbehavior; standardizing the unreasonable intervention. F refers to that for those enterprises participating in illegal leasing projects; the government takes corresponding intervention measures, such as increasing the deposit ratio of social security, establishing a blacklist of listing information about housing, and fining. For the policy support enjoyed by enterprises not participating in illegal leasing projects, including direct government incentives, tax incentives, land support and other policies, as well as related public opinion exposure and publicity, the quota is expressed as B . As the housing leasing project is related to people’s daily life, government intervention or non-participation of the company in speculative projects will enhance the government’s image and credibility, which will bring the government positive return (V). The game matrix between government supervision and social forces is shown in the following table (Table 1).

3. Evolution Game Analysis

3.1. The Construction of Replicator Dynamics Equation

Assume that the probability that an enterprise chooses “participation” strategy is x , and $1 - x$ for “non-participation” strategy; the probability that the government chooses “intervention” strategy is y , and $1 - y$ for “non-intervention” strategy.

1) According to the assumptions, the expected earning U_{EY} under the “participation” strategy and the expected earning U_{EN} under the “non-participation” strategy, and the average expected earning \bar{U}_E of the enterprise group are as follows:

Table 1. Social force participation and government regulation payment matrix.

Government	Social forces (enterprises)	
	Participation (x)	Non-participation ($1 - x$)
Intervention (y)	$F - C, R_0 - F$	$V - C - B, R_1 + B$
Non-intervention ($1 - y$)	$0, R_0$	V, R_1

$$U_{EY} = y(R_0 - F) + (1 - y)R_0 = R_0 - y$$

$$U_{EN} = y(R_1 + B) + (1 - y)R_1 = R_1 + yB$$

$$\bar{U}_E = xU_{EY} + (1 - x)U_{EN} = R_1 + x(R_0 - R_1) + yB - xy(B + F)$$

2) According to the assumptions, the expected earning U_{GY} and U_{GN} under the “supervision” and “non-supervision” strategies the government chooses and the group average expected return \bar{U}_G are as follows:

$$U_{GY} = x(F - C) + (1 - x)(V - C - B) = (V - C - B) + x(F - V + B)$$

$$U_{GN} = x \cdot 0 + (1 - x)V = (1 - x)V$$

$$\bar{U}_G = yU_{GY} + (1 - y)U_{GN} = (1 - x)V + y[x(F + B) - (B + C)]$$

3) The replicator dynamics equation $F_E(x)$ of the “participation” strategy of the enterprise and the replicator dynamic equation $F_E(y)$ of the “intervention” strategy of the government are:

$$F_E(x) = \frac{dx}{dt} = x(U_{EY} - \bar{U}_E) = x(x - 1)[y(B + F) - (R_0 - R_1)]$$

$$F_E(y) = \frac{dy}{dt} = y(U_{GY} - \bar{U}_G) = y(1 - y)[x(B + F) - (B + C)]$$

3.2. Equilibrium Point Stability Analysis

1) Stability test

The replicator dynamic equation describes a process in which the strategy of the enterprise and the government is constantly adjusted over time during the game. The steady state of both sides of the game satisfies the replicator dynamic equations $F_E(x) = 0$ and $F_E(y) = 0$. From this, we can get 5 equilibrium points: $E(0, 0)$; $E(0, 1)$; $E(1, 0)$; $E(1, 1)$, $E(x^*, y^*)$, where $x^* = B + C / B + F$; $y^* = R_0 - R_1 / B + F$; and only exists between $x^*, y^* \in \{0, 1\}$. For the equilibrium point should pass the stability test [4] before it becomes an evolutionary stable strategy (ESS), that is, the following conditions are met:

$$\frac{\partial F_E(x)}{\partial x} = (2x - 1)[y(B + F) - (R_0 - R_1)] < 0$$

$$\frac{\partial F_E(y)}{\partial y} = (1 - 2y)[x(B + F) - (B + C)] < 0$$

2) The stability analysis of 5 equilibrium points under different parameter is

shown in **Table 2**.

It can be seen from **Table 2**, $E(x^*, y^*)$ only exists under the condition of parameter ②, which is the saddle point of the system. It does not exist under other parameters because it does not fall into the plane $H = \{(x, y) | 0 \leq x \leq 1, 0 \leq y \leq 1\}$. The parameters are mainly derived from the comparison of the numerator and denominator of the x' and y' formulas. The phase trajectory diagram is used to describe the evolutionary dynamic trend of the system, which is shown in **Figure 1**.

1) Analysis of social force strategy selection

B is the government's positive incentives for "non-participation" enterprises, and F is a fine for "participation" enterprises. It is also a negative incentive for enterprises. Therefore, $B + F$ actually represents the government's incentive for "not participation" companies. It is known that R_0 is the income of an enterprise "participating" in the illegal housing rental market project, and R_1 is the income of an enterprise "not participating" in the illegal housing rental market, which is the largest earning from other general investment projects. This means that $R_0 - R_1$ is the difference in income between investing in illegal house leasing market projects and in general commercial projects, referring to a loss of revenue from "non-participation" in illegal leasing market projects. Therefore, when $R_0 \leq R_1$ ($R_0 - R_1$ is negative), this means that the benefits from participating in the illegal rental market are less than the benefits from general commercial projects, and the enterprise will choose the "non-participation" strategy based on the rational decision of maximizing benefits. When $0 < R_0 - R_1 \leq B + F$, this means that the total incentive strength of the government is greater than the loss of revenue from non-participation, and the company's strategic choices will be changed according to the government's strategic selection. When $R_0 - R_1 > B + F$, this means that the loss of revenue from the "non-participation" of social forces is greater than the government's total incentives, then the company will evolve to the "participation" strategy.

Table 2. Local stability analysis of system equilibrium points under different parameters.

Equilibrium points	Parameters					
	①	②	③	④	⑤	⑥
	$B + C \leq B + F$	$B + C \leq B + F$	$B + C \leq B + F$	$B + C > B + F$	$B + C > B + F$	$B + C > B + F$
	$R_0 - R_1 \leq 0$	$0 < R_0 - R_1 \leq B + F$	$R_0 - R_1 > B + F$	$R_0 - R_1 \leq 0$	$0 < R_0 - R_1 \leq B + F$	$R_0 - R_1 > B + F$
$E(0, 0)$	ESS	Unstable	Unstable	ESS	Unstable	Unstable
$E(0, 1)$	Unstable	Unstable	Unstable	Unstable	Unstable	Unstable
$E(1, 0)$	Unstable	Unstable	Unstable	Unstable	ESS	ESS
$E(1, 1)$	Unstable	Unstable	Unstable	Unstable	Unstable	Unstable
$E(x^*, y^*)$	non-existent	saddle point	non-existent	non-existent	non-existent	non-existent

It can be seen from **Figure 1** that, for social forces, when $y^* < 0$, that is, $R_0 - R_1 \leq 0$, regardless of the initial state, whatever strategy the government adopts, the strategic choice of social forces will be toward “not participation”. The direction evolution is shown in the parameter ① and ④. When $y^* > 1$, that is, $R_0 - R_1 > B + F$, regardless of the initial state, whatever strategy the government adopts, the strategy of social forces will evolve towards the direction of “participation”, as shown in the parameter ③ and ⑥. When $0 < y^* \leq 1$, that is, $0 < R_0 - R_1 \leq B + F$, the strategic choice of social power is related to the government’s strategic selection: when the probability of the government’s “intervention” strategy is $y > y^*$, the social forces’ strategic choices will evolve towards “non-participation”. When the probability of government adopts the “non-intervention” strategy is $y < y^*$, the social forces’ strategic choices will evolve toward the “participation”, shown in parameter ② and ⑤.

2) Analysis of government strategy selection

C is the cost of the government’s intervention strategy, and B is the government’s reward for the “non-participation” enterprises, and it is also the government’s expenditure. Therefore $B + C$ is the government’s total incentive cost for non-participating companies. For the government, if $B + C > B + F$, that is, $C > F$, this means that the total government incentive cost is greater than the government’s total incentive intensity for “non-participating” enterprises, and the government lacks the inherent motivation for “intervention”. At this time, strategy choices tend to be “non-intervention”. If $B + C \leq B + F$, that is, $C \leq F$, this means that the government’s total incentive intensity for non-participating companies is greater than the total government incentive cost. At this time, the government’s strategic choice will be changed on the basis of the company’s strategy. When the proportion of company participation is large enough, the government’s strategic choices will tend to “intervention”. When it is small, the government’s strategic choice will tend to be “non-intervention”.

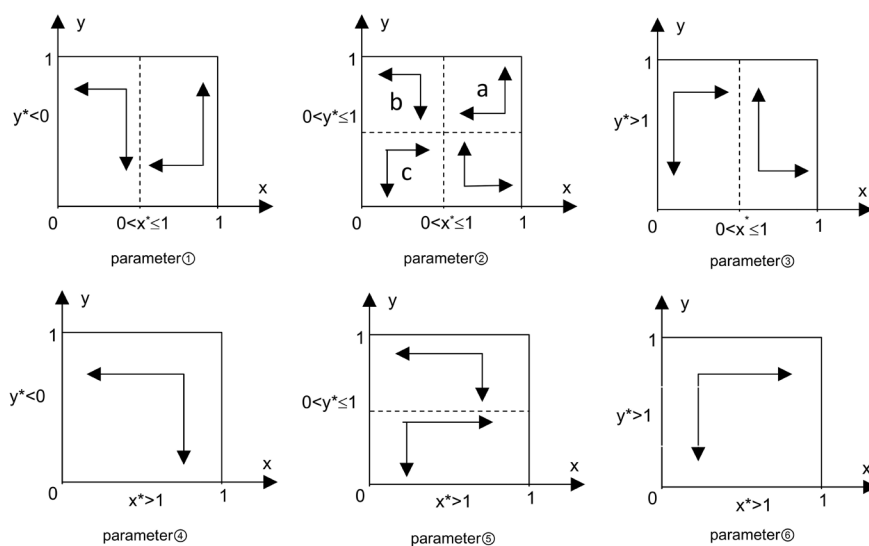


Figure 1. The evolutionary trajectory of government departments and social forces.

Seen from **Figure 1**, for the government, when $0 < x^* \leq 1$, that is, $C \leq F$, the government's strategic choice will depend on the proportion of social forces participation: when the proportion of social force participation is large enough, such as When $x > x^*$, the government's final strategic choice will evolve toward "intervention"; when the proportion of social forces is insufficient, such as $x < x^*$, the government's final strategic choice will evolve toward "non-intervention", shown in parameter ①, ② and ③. When $x^* > 1$, that is, $C > F$, no matter what the social forces choose, the government's final strategic choice will evolve towards the "non-intervention", as shown in the parameter ④, ⑤, and ⑥.

3.3. Evolution Path

From **Table 2** and **Figure 1**, it can be further concluded that the strategy choices of the two game players will be continuously adjusted under different parameters. Their evolutionary trajectory map will be based on the value range of the parameters and the equilibrium point formed. During the game, there will be five states, of which the initial state and the target state are all consistent. The analysis is as in **Table 3**.

Showing in **Table 3**, due to the enough supply in the leasing market, the leasing price and demand are relatively stable, and the benefits of social forces participating in general commercial projects are higher than those of participating in house leasing projects ($R_0 - R_1 \leq 0$). Therefore, social forces will rationally choose not to participate to maximize their own interests. With the initial implementation of the policies such as "equal rights for home tenants and owners", financial innovation of the housing leasing market, and "rent and sale are equally important", etc., state I is transforming to state II.

With the initial implementation of related policies, the stability of the leasing market has caused that the government lagged behind in evaluation. As the government has not implemented strict controls, "participating" companies have a relatively large profit space. The government has relatively large regulatory loopholes in "participating" companies, which means the government has not taken corresponding intervention or punished more leniently on the "participating" companies. On the other hand, the government department also lacked relevant technologies and experience in assessment, mobilization and deployment, supervision on enterprise self-examination, regulation establishment and implementation. Besides, the cost of intervention, such as staffing, is generally higher than the corporate fine ($F < C$). At the same time, the supply is reduced (the policy leads to a reduction in the supply of new rented houses, and the price of government-supplied land is too high), and the demand increases (the house price is too high, and buyers resorts to renting; seasonal peaks such as graduation season; equal rights for home tenants and owners). The imbalance of supply and demand has led to the continuous increase of rents, making social forces believe that the benefits of participating in illegal housing leasing projects are greater than participating in general commercial projects ($0 < R_0 - R_1$), and continue to

Table 3. System evolution trajectories and intervention methods under different parameters.

State	Parameter	Evolutionary stability strategy	Trajectory area	Intervention method
I	$R_0 - R_1 \leq 0$	$E(0, 0)$	④	/
II	$0 < R_0 - R_1, F < C$	$E(1, 0)$	⑤, ⑥	$F \uparrow C \downarrow$
III	$R_0 - R_1 > B + F, F \geq C$	$E(1, 1)$	③	$B \uparrow F \uparrow$
IV	$0 < R_0 - R_1 \leq B + F, F \geq C$	/	②	$B \uparrow F \downarrow$
V	$R_0 - R_1 \leq 0, F \geq C$	$E(0, 0)$	①	/

participate in speculation. Eventually, an equilibrium of “social forces participate and the government does not intervene” will be formed, namely $E(1, 0)$, such as ⑤ and ⑥. In order to promote the transformation of social forces from “participation” to “non-participation”, government intervention is required. Government intervention can regulate B , F , and C . Therefore, it is necessary to increase punishment at this stage ($F \uparrow$). On the other hand, reduce the cost of government intervention ($C \downarrow$) by optimizing the management process, accelerating the work of talent adaptation, and strengthening the linkage mechanism of the department. By doing these, intrinsic motivation for intervention will be strengthened and promote the transition from state II to state III.

With the government’s increasing punishment intensity, when the penalty exceeds the intervention cost ($F > C$), and the loss of income of the “non-participation” in housing rental project exceeds the total government incentives ($R_0 - R_1 > B + F$), the system will enter state III. At this time, driven by the benefits, more social forces tend to “participating”, and at the same time, the internal motivation of government intervention is increasing ($F > C$), so the government will actively increase the proportion of “intervention”. However, on the other hand, the government’s total incentives are not enough to make up for the loss of income from social forces’ “non-participation” in illegal housing leasing projects. Social forces will still tend to “participating” in investment behavior, thus forming a equilibrium of “social force participation and government intervention”, that is, $E(1, 1)$, as shown in ③. In this state, government intervention can increase overall incentives: increase positive incentives ($B \uparrow$) while it continues to punish $F \uparrow$, thereby influencing the strategic choice of social forces through intervention, and reducing the participation in illegal housing rental projects, to achieve the transition from state III to state IV.

When the total government incentives are sufficient to make up for the loss of revenue from non-participation in illegal housing leasing projects ($0 < R_0 - R_1 \leq B + F$), and the government has sufficient motivation for intervention ($F \geq C$), the system enters state IV. At this time, state IV satisfies the phase trajectory of parameter ②. During the transition from the state III to the state IV, a state of “high proportion of both social forces participation and government intervention” will be formed. Therefore, as long as the government intervention ratio $y > y^*$, the game will first enter the area a. At this point, the

participation ratio of social forces will begin to reduce. In order to increase the evolution rate of the system, the government needs to continue to increase its incentives ($B \uparrow, F \uparrow$). When the social force participation ratio satisfies $x < x^*$, the game enters the area b. In area b, social forces will further reduce the proportion of participation, and the government will further reduce the proportion of intervention. This state is in line with policy goals. Therefore, the entrance to area b is the key of the entire game. However, we should try to avoid the proportion of government intervention $y < y^*$, because as the proportion of government supervision shrinks, social forces will naturally increase the proportion of participation, as shown in area c. Therefore, in order to achieve that “social force does not participate”, policy intervention is needed to keep the game in the area b, mainly to increase the area of b, which can be increased by increasing x^* and decreasing y^* . Specifically, increase reward $B \uparrow$, reduce the penalty $F \downarrow$, and increase the B should be more than decrease of F .

With the government’s continuous intervention and guidance through policies, the company’s awareness of social responsibility and rectification has continued to increase. With the continuous expansion of area b, the system enters state IV. At this time, because of the social benefits such as corporate image improvement and public relations improvement brought by not participating in illegal leasing projects, and the government’s publicity and political exposure to non-participating companies, more advertising revenue has been created for companies, making R_1 constantly increased. In addition, previous interventions have continued to reduce the revenue R_0 from participating in illegal housing rental projects. When $R_0 < R_1$, $y^* < 0$, the enterprise will spontaneously evolve not to participate. And the government will gradually reduce the proportion of intervention, enter a period of evolution, and eventually meet the policy goals.

4. Conclusions and Suggestions

This article lacks a discussion of V , which is the government’s positive return. The government should implement its policies based on the public needs instead of its earnings.

Based on the above analysis, the following conclusions can be drawn: 1) The participation of enterprises in illegal housing leasing projects has the feature of “profit-seeking”, which is closely related to the government’s regulatory loopholes in advocating financial innovation in the real estate market, including the rental market; 2) The initial state of the game between the two sides of finite rationality and the government’s incentive and restraint mechanism largely determine the evolution path of the game: it refers to an important decision criteria in the situation that determine the government’s current intervention policy via identifying the system’s current state to promote the system’s transition to the target state; 3) When government intervention measures are implemented, appropriate evaluations should be made, and overall plan for solutions should also be made.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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