Advances in Social Science, Education and Humanities Research, volume 286

3rd International Seminar on Education Innovation and Economic Management (SEIEM 2018)

Analysis on the Auction Mechanism of State-owned Land Considering Security Housing Factors

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***Abstract*—After 2008, there are some new forms of state-owned land auction in China, such as Limited Housing Price Auction (LHPA), Limited Land Price Auction (LLPA) and Limited Land Price Auction with Security House (LLPA-SH). This paper discusses the implementation of the Limited Land Price Auction with Security House (LLPA-SH) on the basis of Bayesian equilibrium, and gives the conditions for the implementation of the truth-telling mechanism through the introduction of the security housing factor. The results show that both LLPA and LLPA-SH can accomplish the goal of the optimal allocation and utilization of resources. When private information exists, social welfare is primarily a trade-off between consumers and real estate developers, while under the truth-telling mechanism; the distribution of benefits is mainly between consumers and the government.**

Keywords—land auction; competitive security housing area; mechanism design; truth-telling

I. INTRODUCTION

Keeping rising of House price has a great impact on the national welfare and the people's livelihood, which arouses widespread concern from the country and society. The government set policies and regulations to control price, but price still rises rapidly. The rising house price is mainly due to the irrationality of China's state-owned land auction mechanism. The single land auction mechanism has made land sales price soar, resulting in a sharp decline in consumer's welfare. Zhao Ya [1], through the establishment of a limited price of two-stage land auction and closed auction model, analyzes the optimal strategy of real estate developers and local governments , also finds that " Limited Land Price, Competing with the Security Housing Area " can be achieved by the corresponding bidding. Meanwhile, she concludes that it will be better to put up the listing if the government aims to implement the security housing construction, and the bidding will be better if the land price decreases, Zhang Xueqing, Wang Haijun[2], through the construction of the land auction model with housing price control and by means of case analysis, draw a conclusion that the government can achieve effective control problem of land price and housing price by setting the unified bidding index of price control. Tan Xianyao [3] argues that the traditional land auction model is the main factor that makes land price rise. Moreover, through the application of bidirectional auction model in state-owned land auction, he concludes that under the bidirectional land auction model, the problem of rising land price can be effectively solved. Zhang Xuefeng [4]compared the efficiency of the three mechanisms in the auction of state-owned land and its impact on social welfare under truth-telling mechanism. It is concluded that when the auctioneer can strategically select the action to make the government welfare be the largest, the choice of Limited Housing Price Auction and Limited Land Price Auction is equivalent. Compared with the non-market mechanism and the market mechanism, the trade-off between the land finance and the consumer's welfare is the key; truth-telling mechanism directly shows the trade-off of government, real estate developers and consumers, but it do not improve social welfare. Zeng Jingfen, Meng Weijun [5], through the design mechanism of the land auction and security housing bundled, maintain that the government should fully consider the interests of real estate developers in the increasing construction of security housing and guide that the real estate developers should be involved in the auction, so that they can be attracted by the construction tender. In addition, the government should take measures to ensure and improve the probability of successful auction.

This paper studies the welfare changes of consumers, real estate developers and government by constructing an auction model with security housing mechanism, and compares it with the auction mechanism of the no security housing, so as to provide data support and policy advice for the government's "limited land price, competitive security housing area".

II. MODEL

A. Assumption and Variables

There is a land of A square meters for commercial housing development. Government formulated a reasonable upper limit of L. Consider two potential real estate developers, m and n, which take the form of a first-class sealed price in auction.

Supported by the North China University of Technology outstanding young teacher training program, funded Beijing Social Science Foundation (Grant No.16LJC008) , the Great Wall Scholar Reserve Talents Training Program and Foundation for The Excellent Youth Scholars of Beijing (Grant No.2016000020124G021)

1) Assumption 1: Distribution Assumption

The expected land quotation of real estate developers m is EL according to his own evaluation of land and land expectation. When the EL is less than L, the area of security housing is 0; when the EL is greater than or equal to L, bidding for the area of security housing begins. At this point, a square meters is used to build security housing, assumption: (t is the proportion of security housing area to the whole land area). In order to facilitate model design, the paper assumes that EL is greater than L. The construction cost per unit land area belongs to the independent uniform distribution [0, 1]. The distribution function F is a continuous differentiable non-decreasing function, and F is common knowledge.

2) Assumption 2: Assumption on The Profit Function of Real Estate developers

Assuming that price remains unchanged, commercial housing price is a constant P, and security housing price is a constant. The profit function of real estate developers is continuously differentiable, and $\frac{\partial_{\pi_m(c_m,t_m)}}{\partial t_m} < 0$, $\frac{\partial_{\pi_m(c_m,t_m)}}{\partial c_m} < 0$.

B. Land Auction Mechanism Design

1) Mechanism 1: LLPA-SH

The profit function of real estate developers m in the LLPA-SH is

$$\pi(c_m t_m) = \begin{cases} (1-t_m)\left[p-(L+c_m)\right]+t_m\left[p_a-(L+c_m)\right], t_m \geq t_n \\ 0, t_m < t_n \end{cases} \quad (1)$$

Proposition :the equilibrium bidding strategy of real estate developers m is satisfied if every real estate developers is ex ante identical,

$$t_m*(c_m) = \arg\max E_m\left[\pi_m(c_m,t_m) | t_m(c_m) \geq t_n(c_n)\right] \quad (2)$$

In the symmetric Nash equilibrium of $t* = \left(t_m(c_m), t_n(c_n)\right)$, the equilibrium strategy of real estate developers m is

$$t_m*(c_m) = \frac{1}{2(p_a - p)} c_m + \frac{L-p}{p_a - p} \quad (3)$$

The optimal bid price $t_m(c_m)$ increases while the construction cost declines.

2) Mechanism 2: LLPA

Application to State-owned Land Auction in China, a paper published in Chinese Management Science in June 2014 by Wu Kangping, Zhang Xuefeng and Ni Lijie, has conclude that :

Under the profit margin assumption, the equilibrium bid price of the real estate developers m is:

$$b*(L,c_m) = L + \frac{c_m + \bar{c}}{2} \quad (4)$$

Which is the best quotation for real estate developers; L is the limited land price for the government. c_m is the construction cost per unit land area. c_m belongs to the independent uniform distribution $\left[\underline{c}, \bar{c}\right]$, and $0 < \underline{c} < \bar{c}$.

C. Comparison between Mechanisms

LLPA-SH and LLPA are all non-market mechanisms. This paper discusses the efficiency of these two mechanisms from a overall perspective and find the relationship between the government, the real estate developers, and the consumer to achieve maximum benefits, so that we can design a more efficient auction mechanism to realize the overall optimal.

TABLE I. KEY INDEXES IN LAND AUCTION MECHANISMS

Mechanism	***LLPA-SH***	***LLPA***
Optimal bidding	$\frac{1}{2(p_a-p)}c_m + \frac{L-p}{p_a-p}$	$L + \frac{c_m+\bar{c}}{2}$
Housing price	p , p_a	$L + \frac{2\bar{c}+c}{3}$
Land price	L	L
Expected return of the government	L	L
Expected payments of the real estate developers	$\frac{L}{2}$	$\frac{L}{2}$
Expected profits of the real estate developers	$-\frac{1}{3} + \left[t_m(p_a-p) + (p-1)\right]$	$\frac{\bar{c}-c}{6}$

The optimal security housing area is the function of reducing construction cost of real estate developers in LLPA-SH (the lower the cost of the real estate developers, the greater the area of the optimal security housing).Therefore, real estate developers of the lowest cost eventually get the land, which implements the optimal allocation and utilization of resources .

House price is an increasing function of cost in LLPA (the lower the cost of real estate developers, the lower the housing price), so real estate developers of the lowest cost eventually competes for the land. Thus, these two mechanisms LLPA-SH and LLPA have achieved the maximum efficiency of social resources.

The two mechanisms are based on the limited land price; the expected revenue of the government is unchanged and equal to the limited land price L. Therefore, the government can realize the trade-off of the welfare distribution between consumers and real estate developers through the design of these two mechanisms.

House price P is the income of real estate developers, and land price L is the cost of real estate developers. Among them, the cost of building security housing for real estate developers

increases when the security housing area is increasing. Therefore, the expected profit of the real estate developers in this mechanism depends on the limited land price L and the security housing area of government.

However, the expected profit of the real estate developers is a fixed value in LLPA, which does not change as the housing price changes. As a result, the mechanism has no effect on the profits of real estate developers.

III. TRUTH-TELLING MECHANISM

The benchmark model shows implementation issues associated with these two land auction mechanisms, but the government set L according to the real estate developers evaluation of land and land expectations EL. Therefore, in order to ensure EL reliable, the government needs to set a truth-telling auction mechanism to make sure welfare is maximized. For example, government can design the secondary seal price auction mechanism to prevent the collusion between developers.

The government can design a truth-telling mechanism in the land auction process, in which the real estate developers of private information will be revealed. So the optimal bidding of real estate developers shows their private information in two mechanisms. According to their types of space, real estate developers give the true evaluation of security housing area or housing price.

TABLE II. KEY INDEXES IN TRUTH-TELLING LAND AUCTION MECHANISMS

Mechanism	***LLPA-SH***	***LLPA***
Optimal bidding	$\frac{L-c_m-p}{p_a-p}$	$L+c_m$
Housing price	p , p_a	$L+\frac{2\bar{c}+c}{3}$
Land price	L	L
Expected return of the government	L	L
Expected payments of the real estate developers	$\frac{L}{2}$	$\frac{L}{2}$
Expected profits of the real estate developers	0	0

In LLPA-SH, the optimal bidding of security housing area is still inversely proportional to its construction costs (as(p_a-p)<0)). Namely, the building cost of real estate developers is higher, the security housing area will be less, and there will be more unfavorable to oneself in land auction. On the contrary, the building cost is lower, the security housing area will be more, and there will be more favorable. Compared to others, the real estate developers who have lower construction cost have a greater probability to get land A. But under truth-telling mechanism, for the private information of real estate developers has been effectively displayed, the expected profit is zero.

Similarly, the private property information of real estate developers has been effectively demonstrated in LLPA, and the government designs reasonable land price based on the expected profits of the real estate developers, which eventually made the expected profit of real estate developers be zero.

Therefore, under truth-telling mechanism, LLPA-SH and LLPA have achieved maximum efficiency

Because the expected profit of real estate developers is zero in the two auction mechanism based on truth-telling, and the expected return of government is the fixed price L, the government can make profits of real estate developers fall to zero. The transfer of benefits to consumers enhances consumer's welfare. Therefore, the government realizes the maximization of consumer's welfare in truth-telling mechanism,.

IV. CONCLUSIONS AND POLICY RECOMMENDATIONS

A. Conclusions

In LLPA-SH and LLPA, a real estate developer whose cost is the lowest eventually gets the land A. Therefore, these two mechanisms achieve the optimal allocation and utilization of resources and the maximization of the social efficiency. In truth-telling mechanism, the expected profit of real estate developers is zero, which also achieves the best social efficiency.

LLPA-SH and LLPA in truth-telling mechanism realize transfer of profit of the real estate developers, so that benefits of consumers and government increase, and eventually make consumers to achieve maximum social welfare. When private information exists, social welfare is primarily a trade-off between consumers and real estate developers, while under the truth-telling mechanism the distribution of benefits is mainly between consumers and the government.

B. Policy Recommendations

At the different stages of economic development, the government can choose the mechanism according to different social contradictions so as to achieve the healthy development of the economy. For example, in the economic depression, the government can choose LLPA-SH based on no truth-telling mechanism. The real estate developers can obtain a certain profit, it will further lead to real estate developers to develop so more land that they can provide more employment opportunities, reduce unemployment rate, and increase social welfare.

Meanwhile, when real estate developers build commercial housing, they will build a certain percentage of security housing, so the social welfare for low-income groups has also been improved.

In the period of economic prosperity, the government can choose LLPA based on truth-telling mechanism. In this mechanism, the profit of real estate developers is zero; therefore, the number of construction of commercial housing will be reduced. At the same time, because of the housing price restrictions, housing prices will not surge. So it is of great significance to the healthy development of economy.

In the stage of economic development with a relatively large gap, it is more advisable to choose LLPA-SH to promote the social welfare of low-income people. In the stage of

economic healthy development, LLPA can be chosen to achieve sustained and stable economy.

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