Game Theory Approaches for The Analysis on Estate Market in China

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Abstract: As an important part of the national economy in China, the modern estate industry is faced with lots of issues. Game theory approach is defined as a tool for dealing with problems faced by participants in estate industry. This paper provides a comprehensive review of the application of game theory approach to the games among the government, estate developers and buyers. It is concluded that developers are suggested to meet the expectations of buyers and to lower the marginal cost of developing. Buyers could make the purchase when the price is expected. Moreover, the government is advised to cooperate with developers and to use fiscal and financial policies to promote a healthy development of estate market. The main contributions of recent research in the area of employment of game theory to estate industry are studied and discussed in detail.

1. Introduction

As a pillar industry of the national economy in China, the modern estate industry is of great importance in the development of the society and the economy, the urban construction and the improvement of social environment [1]. However, it is encountered with a series of challenging issues, one of which is the sustained growth of its price [2]. The price of residential property in China has increased simultaneously and rapidly [3]. This change has increased the hardness of decision-making process for the government to stabilize house prices, for the estate developers and the house buyers to gain more profits.

Game theory is introduced as an effective tool for the analysis of participants' decision-making process in the estate industry [4]. As an analytic tool, game theory is used by economists to make strategic interactions. In other words, game theory approach is an effective method to analyze strategic behavior taken by rational decision makers. In the process of urban planning, game theory approaches are used as a method for balance the interests of the government and citizens so as to make a final plan. Similarly, in the estate industry, the result of games among the government, the estate developers, and the house buyers could be analyzed using game theory method.

The aim of this paper is to provide a comprehensive review of the estate industry based on game theory approaches. The main model of the published papers in the game of estate market will be provided. Also, various proposed model in recent publications will be shown to help analyze players behavior in the estate market.

Before the main part of this review, some game theory concepts will be introduced. Best response function concept suggests each player is the best reaction that he can do when his opponents do a specific action. One of the important concepts of game theory that is based on the best response concept is Nash Equilibrium. In Nash Equilibrium, no player will have an incentive to deviate from his chosen action with assuming other players' choice. When it refers to the absolute advantage theory, it suggests that out of two or more parties, the one that produces more product with the same resources has the advantage. Moreover, in a perfect information game, the players will not only have the knowledge of its own payoff function but also knows its opponents' payoff functions. A Bayesian game is a game in which the players have incomplete information on the other players, but they have a known probability distribution on the opponent strategy profile.

The remainder of this paper is organized as follows: Sect. 2 provides game theory approaches applied to the estate developer and buyers. Similarly, the game between estate developer and the

government and the game among different estate developers will be prepared in Sect. 3 and Sect. 4, respectively. Finally, the paper will be concluded in Sect. 5.

2. The Game Between Estate Developer and Buyers

In the game between estate developer and buyers, the estate developer tries to get a good price for houses, while buyers are eager to gain the house as cheap as possible. Developer's estimations of the price, the psychology and expected price of house buyers are related factors that would affect this game.

Author Lu studied the game relation of each player in the estate industry in [1] to analyze the estate developer and the investor's behaviors. A Nash Equilibrium was found where both of the players had gained the biggest payoffs. Therefore, the estate developer was suggested to lower the price, meanwhile the buyers were advised to enter the market.

Table.1. Strategic Game with Imperfect Information [1]

Estate Developer	Buyers		
		Wait	Enter
	Keep the price	-3, -3	2, -2
	Lower the price	-2, 2	5, 5

In [5], a similar matrix was introduced for the analysis of the game between estate developer and buyers, which had been based on the reference [1]. The conclusion was accomplished by the author that if the developer maintained a high price, their interest would be harmed. Therefore, the estate developer was suggested to lower the price so as to satisfy house buyers' satisfactions, at that time, buyers could choose to enter the market.

In other research, a reference [6] studied a static game between estate developer and buyers. A Bayesian Nash equilibrium was also found where the developers had risen the price and buyers had chosen to enter the market. Due to the prediction by buyers that housing prices were going to rise continually, the developers were advised to add the price of houses to gain excess profits and buyers were suggested to enter the market in case of the price to be unaffordable.

Apart from this, a bidding game model between the estate developer and the investor was studied by the author in [7]. A static Bayesian game in [7] had been utilized for obtaining the equilibrium of sales volume and price in the estate market. An area of transaction (Fig1) was introduced, so developers were suggested to lower the price when buyers' expectations had been lower than developers' estimations. Meanwhile, when the price met their expectations, buyers were advised to make the purchase.
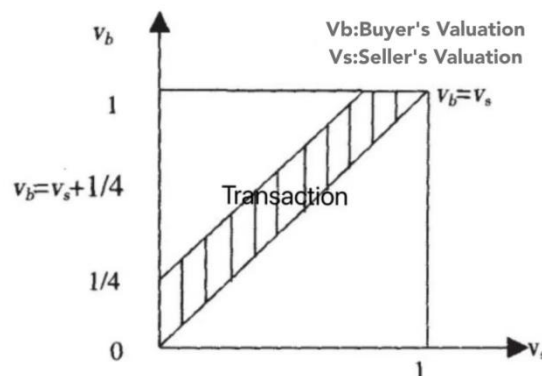

Fig 1. Bayesian utility function [7]

Moreover, a more complete relationship between the estate developer and the investor was proposed in [8]. The proposed model in this reference included a static game with imperfect information for investors to decide whether it was the time to purchase their house, in which a Bayesian Nash equilibrium had been employed by the author. In conclusion, developers were advised to lower

the developing cost to gain more profits in this game, and buyers were going to make the purchase mostly in the booming market.
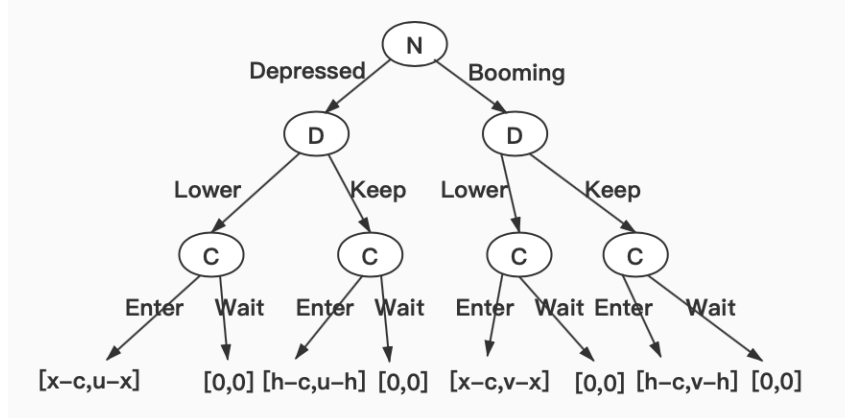

Fig 2. Static Game with Imperfect Information [8]

3. The Game Between Estate Developer and the Government

In the game between estate developer and the government, developers try hard to gain the land as cheap as possible, while the government is going maintain a healthy development of the estate industry. They are possible to cooperate with each other. The land supply, the fiscal and financial policies and the focus of government work are all related factors that would affect this game.

Author Zhao had studied the application of game theory in the regulation of estate market for achieving a healthy development of this market [9]. A dynamic game with imperfect information was provided to analyze the behavior of estate developer and the government. Fiscal and financial policies and land supply were two methods for the government to protect a sound development of estate market, meanwhile, developers were advised to gain enough information from the government to lower the developing cost.

In [10], a more complete analysis on developers and local governments in estate development process was introduced. The situation of chicken game, prisoner's dilemma and boxed pig game were found in this game. A conclusion was made by the author that whatever the situation was, developers and local governments had gained maximized profits when they cooperated with each other, so they were strongly advised to do so.

In other research, a reference [11] studied developers and government's control on this game. A quantity and price curve (Fig3) were employed, in which the equilibrium price had been figured out. When the developers and the government cooperated with each other, developers were able to gain access to land resources and also both of their profits would be maximized, so they were suggested to reach the cooperation.
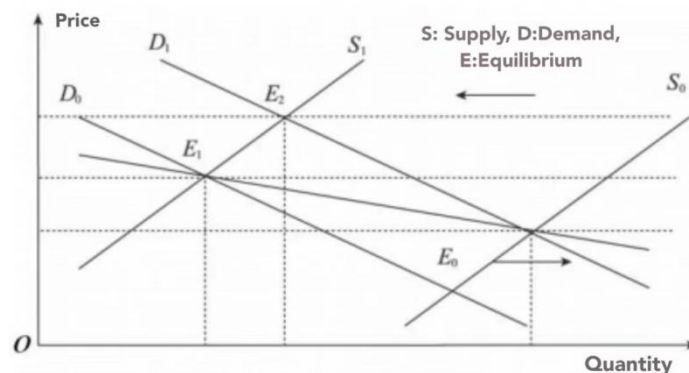

Fig 3. The demand and supply curve of land [11]

In [12], the analysis of a dynamic game with imperfect information between estate developer and the government was introduced, which had been based on the reference [10] and [11]. The conclusion was made by the author that when the benefit gained by the developer was larger than average social profit of capital, then the developer was advised to develop. As for governments, when their benefits earned in estate development projects were greater than zero, they were willing to promote the supply.
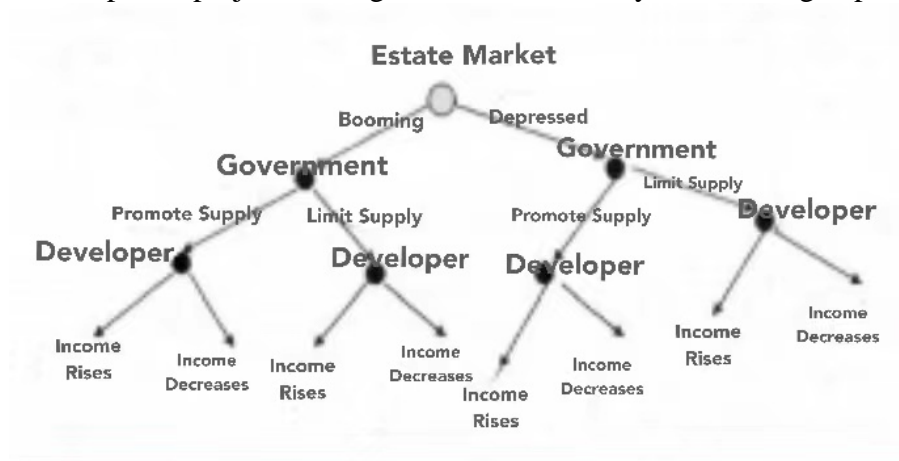

Fig 4. The game between estate developer and the government [12]

Moreover, a game of estate market with complete information was proposed in [13]. The Nash equilibrium was used to help players to decide their optimal strategies. In conclusion, when the governments expected a rise in the price of estate industry, they could lay emphasis on the growth of GDP. Moreover, the developers were advised to adjust housing prices according to governments' behaviors.

4. The Game among different Estate Developers

The game between estate developers is different from the former two games, since the developers are difficult to cooperate with each other as competitors. To gain as much profits as possible is a goal of developers. The marginal cost, the number of estate developers and the scale of estate market are all related factors that would affect this game.

The reference [14] studied a pricing strategy for different estate developers. A Bertrand Oligopoly model was employed, and a Nash equilibrium was found in this model. This helped developers to decide the time whether to continue to construct new estates in order to gain more profits.

Based on [14], the reference [15] focused on the analysis of game between estate developers. The prisoner's dilemma was used to analyze two developers' behavior——to cooperate or to compete. To compete had been proved to be the dominant strategy for two developers.

Moreover, the reference [12] also analyzed the game between two developers. Similar to the reference [14], a Bertrand model was employed in this research. It was found that the essence of this game was a cost war, so developers were suggested to lower their marginal cost.

The reference [5] also used the concept of prisoner's dilemma to analyze the game between two developers, which had been based on the reference [12]. The matrix of this game was provided to analyze two developers' behavior. To cooperate and keep the price was a strategy for two developers to gain more payoffs.

Table.2. The Game Between Two Developers [5]

Estate Developer	Estate Developer		
		Keep the price	Lower the price
	Keep the price	10, 10	-2, 5
	Lower the price	5, -2	3, 3

In [16], a study on estate supply chain was introduced based on a dynamic game. A Nash equilibrium could be found to analyze the formation of price in estate market. To conclude, when the number of estate developers was a constant number, developers were advised to continue to develop so as to gain more total profit.

5. Conclusion

Game theory method is successfully implemented in recent studies for analyzing the game in estate market. In this review, a survey on the application of game theory approach for decision makings associated with estate developers, buyers and the government is provided. At first, some typical games between estate developers and buyers are introduced. Developers are suggested to lower the price when the price is greater than buyers' expectations or add the price when it is predicted by buyers that housing prices are going to rise continually. Meanwhile, buyers are suggested to enter the market when the price meets their expectations. Then, the games between estate developers and the government is discussed, leading to a conclusion that based on the factors including the land supply, the fiscal and financial policies and the focus of government work, developers and the government are advised to cooperate with each other. Moreover, in the game among different developers, lowering the marginal cost and deciding the optimal time to develop are possible suggestions for developers to enhance competitiveness. The contribution of this paper in the area of application of game theory to the estate market can effectively help the researchers in the area of decision making in such situations.

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