The Application and Limitation of Game Theory in Different Scenarios

Ruiyun Yin[1,a,*]

[1]*Shanghai Weiyu High School, Shanghai, 201100, China*
a. yin_ruiyun@mail.sdufe.edu.cn
*corresponding author

Abstract: Nowadays, the game theory has been widely used in many different area but it is really harmful to blindly use the game theory since it is important to know what will effect when using the game theory. In order to acknowledge the information about the game theory, the passage below will focus on the effect and the limitation of game theory by analyzing the situation that might has been found in the real life and the solution in the condition. Also there will be using the diagram from game theory to find what will happen when using the diagram in the market and financial area. At each part of the passage, it has mention about what kind of choices is best to use in the different condition and what problem can not be solved through this choices when using the game theory. In this way, the passage might provide the appropriate way to use the game theory in different area.

Keywords: Game theory, Audition, Market, Financial area.

1. Introduction

1.1. Background

Nowadays, the game theory has been a really popular method to be used in the audition, market area and the financial area. But actually people who use the game theory might do not understand what will happen when using the game theory, this will make some really harmful effect when they use the wrong strategy and cause some negative effect on the profit for the people who use this strategy. If they know the basic theory of the game theory, they will not blindly believe other advises. They have the chance to think more deeper on the choices and find the most appropriate one that will bring the people to have the highest profit. All these things can be happened after seeing the passage below. Therefore, it is easy to find the necessary of this theme and better understanding about the use of the game theory in the audition, market area and financial area.

1.2. Related Research

These are several articles that talk about the game theory is used in the auction which make think a lot about it.

Laffont first summarize the basic theory that have been used in discussing the theory, than review about the Bayesian Nash equilibrium and its prediction about the result , and the first price auction and brings to the revenue equivalence theorem. Laffont pointed out the collusion for these

model and using the symmetric affiliated model to provide some restriction on the model [1]. Lorentziadis first examined the effect that done by the historical bid prices to the possible distribution of the bidder's valuation ,tested the model that combine the value of private and common and than expand the original model. Than Lorentziadis considered about the asymmetry among participants and the information management about in the IPV programme. Next Lorentziadis investigated on how to put the auction into larger model. Lorentziadis also planned some of the future study on the competitive bidding [2]. Alexandrova questioned about the the tendencies that have been showed in the economic models by using the method of isolation and its justification including finding the private value auction on two investors ; interacting on first-price auction; seeking out the derivation facilitators that have not mentioned in the economic model. Alexandrova also questioned the necessary on the method of isolation by using the design of the FCC Auction [3]. Roth redesigned the entry level labor market for American doctors, since there are some problem on the model that have been brought by market failure and created a more complex model than the original one. ROTH also mentioned the Federal Communications Commission on the part of the radio spectrum licenses and claimed about some of the overview and an exhortation [4].

Than I look for the use for game theory in the financial area which can help me to write the essay blew.

Migdalas mentioned the role of the Nash equilibrium, Bayesian equilibrium, signaling games and agency model in the finance, emphasized the problem that might been faced during using of the mathematical model. Migdalas showed the asset pricing and portfolio selection, using of the game theory in the corporate finance, the theory of the agent model and incentive contracting and the benefit of using the game theory in the finance area [5]. Nwogugu first mentions about the issue on economic and policy area- ESR get in trouble with their finance because of not solve the manage problem in a right time and right way and then talks about the price and stocks performance in M and As and LBOs and several hypothesis base on it. Nwogugu also claims about the bank loans and several hypothesis about it [6]. Allen and Morris mention how the game theory model has been used in the financial area. First is the assert price for the investors. Second is the corporate finance for the decisions of firms. The model can assume on the uncertainty and make the financial decision relatively simple to be understand and use. It also brings to some new theory about the finance [7].

At last I found some essays on the market area which help me understand more about the use of game theory in this area.

Roth first talked about the history for the labor market on the medical area and than mentioned about a Prisoner's Dilemma problem in the market because of the sign employment contract. Next, Roth also analysis the problem that have been mentioned above and on the stability and incentives. Roth associate to contemporary issues that have been raised by National Resident Matching Programme [8]. Herbig mentioned the game theory has been changed from competitive behavior to other application of markets and compared two opposing viewpoint, talk about the use of the mathematics model and explain how to use these to predict about the real world. Next, Herbig mentioned several arguments and the obejections to the Usefulness of game theory and use of game theory in the market [9]. Roth and Wilson mentioned about the game theory model about the complementation model which is better than the normal theory in the market and found out how it had been provided and improved in the real market. They also mentioned about how the game theory had been taught, what was needed for practical Market design and the reason of the difference between auction design and Matching market design [10].

1.3. Objective

This paper will talk about using of the game theory in the audition, market and financial area. What choices is better to using in different situation, what effect will happen when using the appropriate choice under the game theory and several limitation when using the game theory in these area.

2. Game Theory in the Artwork Auction

2.1. The Background for the Artwork Auction

In the artwork auction, the sellers usually will decide one way of auction among: English auction, Butch auction, first-price auction and second-price auction. In nowadays artwork, the English auction has been widely used since in this types of auction, the seller can earn the same amount of money and arouse payers' clarity, which might lead to higher price of the goods. Although the sellers decide the types of the auction, the main conflict do not happen between the seller and payers.

2.2. Policy that Used in the Artwork Auction

The main conflict presents between the payers since all the payers want to provide a price as low as possible but higher than all other payers. In order of this, there are several policies that can be used in this situation.

The first policy is to do more research on other participants' background and their financial reserves. In this way, it might be use for to find the maximum price that they might provide in the auction and compare to their own price. It can allow participants find whether they have the chance to gain the goods and if not, they can also do more works before the auction like sending some negative information about the artwork, which might lower other participants' valuation or they can think more about whether the value of artwork is high enough to let participant to spend higher money, since to just think during the auction may made the participant do some improper decisions.

The second policy is to do more research on the artwork that would be presented during the auction. In this way, the history and background of the artwork can be clearly showed, which enable the participant to determine their own valuation. Another important point is that do not change the valuation as soon as it has been decided, especially during the auction, since in this time, the participant might lack of thinking when making the decision and might do some improper decision. Through the graph of the payoff matrix value's underline, it is easy to find that there will be ten Nash equilibrium in this situation. Since the participants have already know other's valuation after researching, it is reasonable for them to find weakly dominant strategy which can enable them to gain the same or higher return than if they gave other price what ever other participant's valuation.

2.3. Factor that Might Effect on the Policy

By using these two policies, it will enable participants have the chance to get the good they want in the auction in a price region that is affordable for the participant. But there are also several factors that can not be account in the game theory during the auction that might made the policies above less valuable and dependable.

The first factor is that there are some evidences factors during the auction, which may made the participant forget about the valuation that they have made before and just want to buy the good what ever the price of it. In this way, the participant will lose large amount of money on the

unreasonable part. Other participants may also be effect by the emotion that made the people can not gain the good they want, which they thought they can get it before the auction.

The second factor is that it is really hard for people to find enough amount of information before or during the auction since during the artwork auction, nearly all the participants' information do not be provided to the public. It makes the work of researching extremely hard to do and can not do the appropriate on the valuation of themselves. In this way, the auction will become easy to lose control and hard to gain the good in the price that the participant want.

3. Game Theory in the Financial Field

3.1. Introduction about the Background

In the financial field, the most common place that the game theory has been used is between the investor of the company. Since they people can not control others choices and do not know other's discussion before they have presented to the public, it is similar to the situation that have been called the prisoner's Dilemma, which is the diagram that can presented what will cause when making the decision. The most important things that the investor need to think about is the Nash equilibrium in the situation and the way to let the other people make the discussion that they want. The prisoner's Dilemma be showed in the form of Table 1.

Table 1: Prisoner's Dilemma

	One person	
	A,B	C,D
Other person	E,F	G,H

3.2. Several Hypothesis that is Necessary for Explanation

To make the explanation easy to be understand and discussing in a really clear way, it is necessary to suppose that there are just two investor in this situation. There are several hypothesis:

(1) The first investor has largest share of one company and the second investor has second large share, which can shows that the first investor has A1 amount of shares and the second investor has A2 amount of shares, A1>A2. it is easy to suggest that the first investor has large chance to take the action that may effect companies' value.

(2) The first kind of cost of encroach on the first investor or check the second investor has been called the B1, the second kind cost of the punishment at the time of investigation is B2.

(3) The earning of the second investor during the counterbalance has been called the I.

(4) the total earning more the program is P. The earning for the first investor during the encroach is E. The decision for the second investor is effect by the earning that has been mentioned in the (3).

3.3. The Diagram that Use for the Explanation

By using this information that have been showed above, it is easy to get Table 2 about the Nash equilibrium for this situation.

Table 2: Nash equilibrium diagram in the market

| | | The first investor | |
		Encroach	balance
The second investor	encroach	A2(P-E)+I-B1(A2), A1(P-E)+E-B1(A2)-B2	A2(P)+I-B1(A2), A1(P)
	balance	A2(P-E), A1(P-E)+E-B1(A2)	A2(P), A2(P)

In this diagram, the things has been presented is that the domestic strategy for the second invester which means that whatever the first investor's choice, he will make the same choice, which is because they he can gain largest value through this strategy. Since the intention of using the game theory is to find the want to prevent the first investor from control the company, the second investor need to encroach and first investor's earning of the encroach smaller than the cost, the equation can be showed below:

The first part of the condition is:

$$A2(P − E) + I − B1(A2) > A2(P − E) \tag{1}$$

And

$$A2 × P + I − B1 × A2 > A2 × P \tag{2}$$

In this way, it is easy to can get the result:

$$I − B1 × A2 > 0 \tag{3}$$

And

$$I > B1 × A2 \tag{4}$$

The second part of the condition is :

$$A1(P − E) + E − B1(A2) < A1 × P \tag{5}$$

Since the first investor has no information about the second investor's information, supposing that the chance for the second investor to encroach is t and the chance for the second investor to balance is 1-t.

$$(A1(P − E) + E − B1(A2) − B2) × t + (A1(P − E) + E − B1(A2)) × (1 − t) = A1 × P \tag{6}$$

Therefore,

$$t = \frac{(1−A1)×P−B1×A1}{B2} \tag{7}$$

3.4. The Things that the Company Can Do

Therefore, if the t is small enough, the chance for the second investor to balance will have large chance and the first investor to encroach will have small chance. The first way to do it is to increase the stock than contain by the first investor which means that the Y1 increase and lead the t to decrease. The second way is to increase the penalty cost, which made the B2 to increase and decrease the t. The first investor need to take more risk to encroach. In this two way, it can prevent the first investor to control the company. There might several effect that is really hard to determine and do not mention in the equation above.

4. Game Theory in Audit

4.1. Introduction of the Background of the Audit

In the audit, there might be some person that do not belong to this company but will check the information about the company and try to find some point that is illegal. If this kind of situation happens, this company may come into a really big trouble. If the auditor choose to hind the truth from the public, they might have the chance to earn extra money from the company. In this situation, what is determined the choice of the auditor is really important. In the passage below, i will try to us the diagram that similar to the prisoner's Dilemma , the Nash equilibrium and the domestic strategy as the tool to explain this situation.

4.2. The Advantage of Using the Game Theory

Before find the factor that might effect the auditor, it is crucial to figure out why the game theory has been used in the audit and been seen as a necessary tools.

Firstly, by using the diagram to show the situation, it can help people to find the best solution for the situation and under what kind of condition can form this solution. In this way, it can enable the company to have more prepare before the auditor has made the decision and get the result that the company prefer. Since the diagram can contain lots of different factors and situation, it is really effective to solve the real life situation which made the game theory has been widely through the whole world.

Secondly, in nowadays' situation, lots of the company are working under a really low efficiency, which is a really serious problem that is needed to be solved. By using the game theory, it can clearly show what kind of area the company needed to improve that can help the company to fit the auditor's require. Also, if the auditors can use the game theory, it can also help them to work in a higher efficiency when auditing different company and find the true problem for the company in a relative shorter time than do not use the game theory.

4.3. The Diagram for the Use of the Game Theory in the Audit

In order to make the diagram easy to be understand and available, there are several hypothesis that is needed to be sited:

1) There are only two participant, the auditor who do not belong to the company and the manager for the whole company

2) Both of the auditor and the manager are self-interested, they all want to get the highest value and take less risk

3) They do not know other's decision when themselves are doing the decision

4) There are two choice available for the manager: provide the real information or provide the fake one. There are two choice for the auditor: keep neutrality or lose neutrality.

Under these hypothesis, the diagram can be formed. When the manager decides to provide the real information, he can gain R. At the same time the auditor decides to keep neutrality, he can gain N. If the auditor lose neutrality in this situation, he will has the cost of reputation damage C. Therefore, the auditor is N-C. If the manager choose to provide fake information and the auditor keep neutrality, the manager might chance the auditor which the auditor will lose the income I, than the value of the auditor is N-I. Since the manager take risk when fake the information, it has extra cost, the value will change to R-D. If in this situation, the auditor decide to lose neutrality, both auditor and the manager can gain the extra value for doing this : V. But if let others know their behavior, they might have some value lost L1 and L2. It can be showed as Table 3.

Table 3: Nash equilibrium in the financial area

		Auditor	
		Keep neutrality	Lose neutrality
manager	Real information	N,R	N-C, R
	Fake information	N-I, R-D	N+V-L1,R+V-L2

Through the diagram it is easy to find out that when

$$N - I < N + V - L1 \tag{8}$$

And

$$R < R + V - L2 \tag{9}$$

Happen in the same time, the auditor will choose to lose neutrality for the whole time and manager choose to fake information due to the domestic strategy, which is the situation that needed to be prevented. By providing the third party to monitor, the problem can be largely solved, which can increase the auditor's neutrality and let the manager to provide real information.

5.   Conclusion

This passage mainly analyze about using the game theory in audition, market and financial area by using simulating the real life example in audition, creating the appropriate diagram about the market and financial area. In this way, it is easy to find what will effect when using the game theory. Through these process, there are several important findings that have been discovered by the passage. In the audition, it is important to do more research about what will be sold in the art auction and find the valuation for themselves, It is also necessary to do not change the valuation through the auction. In the market area on the stock transferring, to prevent the first investor to control the market, it is fair to give more stock to the first investor in appropriate way. In this sense, he will satisfy with it and no longer buy more stock. In the financial area, only use the game theory is not enough to solve the problem, the third party is also really necessary. Through this passage, it is easy to find that in most time only use the game theory to solve the problem is not enough other factor and method need to be used with the game theory together to have a better result.

References

[1]   Laffont, J. J. (1997). Game theory and empirical economics: The case of auction data. European Economic Review, 41(1), 1-35.
[2]   Lorentziadis, P. L. (2016). Optimal bidding in auctions from a game theory perspective. European Journal of Operational Research, 248(2), 347-371.Lorentziadis, P. L. (2016). Optimal bidding in auctions from a game theory perspective. European Journal of Operational Research, 248(2), 347-371.
[3]   Alexandrova, A. (2006). Connecting economic models to the real world: Game theory and the FCC spectrum auctions. Philosophy of the Social Sciences, 36(2), 173-192.
[4]   Roth, A. E. (2002). The economist as engineer: Game theory, experimentation, and computation as tools for design economics. Econometrica, 70(4), 1341-1378.
[5]   Migdalas, A. (2002). Applications of game theory in finance and managerial accounting. Operational Research, 2, 209-241.
[6]   Migdalas, A. (2002). Applications of game theory in finance and managerial accounting. Operational Research, 2, 209-241.
[7]   Allen, F., & Morris, S. (2013). Game theory models in finance. In Game theory and business applications (pp. 17-41). Boston, MA: Springer US.
[8]   Roth, A. E. (1984). The evolution of the labor market for medical interns and residents: a case study in game theory. Journal of political Economy, 92(6), 991-1016.

[9]   Herbig, P. A. (1991). Game theory in marketing: Applications, uses and limits. *Journal of Marketing Management, 7(3)*, 285-298.

[10] Roth, A. E., & Wilson, R. B. (2019). How market design emerged from game theory: A mutual interview. *Journal of Economic Perspectives, 33(3)*, 118-143.