

The application of game theory in COVID-19 time

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Abstract. The essay is mainly about the application of game theory in markets of COVID-19 time. And it explains the thoughts of people (customers and companies) when the new policies came out. The essay gets the conclusion that COVID-19's causes anxious of citizens, and this kind of feelings lead to the shortage of goods, then the governments or firms came out the policies to make sure there is enough goods by limiting number of goods people can buy. This research will help explaining the reason of the policies set by the governments and firms, and also explaining people's reaction and feelings or thoughts about these policies. It helps the governments or firms learn and prepare from this virus infection events to next one.

Keywords: COVID-19; Economics; Game theory; Markets; Policies.

1. Introduction

Recently, I played rock, paper, and scissor games with my friends, and I discovered that it is an exciting game. It remains the only option, and the one who wins; wins the dispute. In this game like chess, we know the consequences but are unaware of what another player will do. Moreover, this strategy is frequently used in daily life, for example, in markets, competitions, etc. It reminds me of the economic phenomenons and lifestyle changes in COVID-19 time.

During COVID-19 in China, when the government of one district or city tells its citizens that several people are infected, people will rush to the supermarket and buy lots of things like food, commodities, and so on. However, at the same time, the government will set several policies to make people not all go to the supermarket and snap up the goods. In addition, during the COVID-19 period, some brands have exited the market, not just bankrupt companies but also their own, waiting for the pandemic to end before returning to the market. Therefore, during COVID-19, many game theories are used by citizens, governments, firms, and companies.

Game Theory The game theory is said to be the science of strategies which comes under the probability distribution. It determines logical as well as mathematical actions that should be taken by the players in order to obtain the best possible outcomes for themselves in the games.

Nash equilibrium where each player has nothing to gain by changing strategy, given the choices of the other player. A Nash equilibrium is not necessarily pareto efficient. Both players could gain from co-operation.

2. Methodology

When people rush to the supermarket and buy lots of goods, they are rational, although, on a collective level, it causes a shortage of goods; on the direct way, they are preparing for the lock-down, and they want to reduce the possibility of getting COVID-19. If many people hoard supplies, hoarding becomes the best choice, but not only a reasonable one, because they consider avoiding the supply problem. For example, no one wants to hoard a Hand Sanitizer, but if lots of people are hoarding Hand Sanitizer, others will imitate this action and start hoarding Hand Sanitizer. So for the same reason, buying tissue will not help prevent COVID-19, but if neighbors all rush to the store and buy tissue, people who did not buy tissue will also buy lots of tissue.

However, at the same time, the supermarket and the government do not agree with this idea. For instance, some supermarkets enable limited people to go into it, some stores have a policy that each person can only buy two or three goods to avoid a shortage, and some increase the price of goods to let fewer people be able or willing to buy those goods. The following Fig. is a direct way to see how the game theory relates to the COVID-19 period's market.

		Firm A	
		Increaseing goods' price	Restrict people go to store
Firm B	Increasing goods' price	15%,15%	30%,20%
	Restrict people go to store	20%,30%	25%,25%

Fig. 1 Firm A and B's profits by using different strategy

This Fig. shows that after people snap up goods in-store, these two strategies will provide extra profits to each store (firm A and firm B). If they both increase goods' price, both of them will increase 15% profits than usual. Since if they choose this strategy, in extreme conditions, goods are still quickly sold out. So they need to get more products, but the products are at a high price. However, if one restricts people from going to stores, the other profits will increase to 20%. However, it will only increase by 30%, since if there is a policy that a limited number of people go into stores, the goods will not quickly sell out, as the store can control the number of goods. If two stores restrict people from going to stores, they will each get 25% more profits than before. Thus, when the COVID-19 came, firms and companies all can earn more profits, and it is just the problem about earn how much more. Most possible condition will be that, stores firstly increases their prices of goods, because of shortage, and at that time, the increasing of price will make part of people buy less. However, later, because the goods are still not enough for everyone as people will buy more than they need. The companies are still not having enough.

Therefore, the best way for these two stores to earn profits should be increasing goods prices. However, there is also another possibility that because they both want to earn more profits than the other, they will choose to restrict people from going to the store. In this case, both of them will choose to limited number of customers and make sure that their supplies are enough, so they will increase about 25% profits.

3. Conclusion

Above all, the game theory is used in the market a lot, and the COVID-19 period brings a new way of using game theory. Those two strategies in markets and economics are not always used in markets, but it does use in COVID time. As people cause shortages, the governments and firms have different ways to combat the shortage and, at the same time, provide goods to clients. The game theory in the markets enables similar stores to earn similar as well since they probably will choose both limited number of customers in the store and limited goods they can buy. Therefore, in this case, researching the application of game theory in the COVID-19 period is significant. These two strategies are not only used in China. For example, it is also used in the British, the US, Japan, etc. This phenomenon can also prove that these two strategies are good policies to solve the shortage problem and avoid people infecting the COVID. The research provides the governments and companies several situations to learn from and prepare for

Markets' problems mainly concern citizens' food, clothes, and commodities. However, during the COVID time, except for the goods shortage issue, there was another significant problem: traveling. People are confined to their homes, and many governments do not allow people to go out or travel. This makes people very unhappy. In the future, I might research the policies set by the government about travel and find the application of game theory in that area. For instance, the percentage of people infected per day was related to the no-going-out, home-quarantine policies. Whether the game theory table can determine the policy works. If the percentage of getting infected by COVID-19 is higher when every city sets the policy, that means the policy is meaningless, even making things worse. However, if the percentage of getting infected by COVID-19 is lower when every city sets the

policy, the policy of no-going-out and home quarantine is working. Another possibility is that some cities set this rule. However, others do not, and the policy does not influence its percentage, which means the policy does not affect preventing people from getting infected.

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