

The prisoner's dilemma

Let's say that two persons A and B committed a crime together, and were arrested. So, the police interrogate them. What is a good strategy for the police to obtain cooperation from the criminals? The police suggest the following. If any of them cooperates, while the other doesn't cooperate, the one who cooperates does not get any sentence in prison, and the other one gets 9 years in prison. If none of them cooperates, each serves in prison for 1 year. If both cooperate, both serve in prison for 7 years.

Given this, what would each criminal think that he should do? See the table below.

	A cooperates with police	A doesn't cooperate with police
B cooperates with police	A: 7 years B: 7 years	A: 9 years B: 0 years
B doesn't cooperate with police	A: 0 years B: 9 years	A: 1 year B: 1 year

Table 1: Prisoner's dilemma

Let's see from the point of view of A. There are two cases: B cooperating with the police, or not cooperating. If B cooperates with the police, it's better for A to cooperate with the police because he gets 7 years himself if he cooperates with the police, while he gets 9 years if he doesn't cooperate. If B doesn't cooperate with the police, it's also better for A to cooperate with the police, because he gets 0 years if he cooperates, while he gets 1 year if he doesn't cooperate. So, A will conclude that he should cooperate.

Similarly, B will consider the two cases, i.e., the case in which A cooperates with the police and the case in which A doesn't cooperate with the police, and conclude that he also should cooperate with the police.

Thus, both A and B will cooperate with the police, and voila, each of them will get 7 years in prison. If they simply choose not to cooperate with the police, they will only get 1 year each! In other words, they will be better off! So, this is a dilemma. Each criminal chooses what he thinks is the best for himself, but the end result is much worse than the case in which they choose what is better for themselves as a whole.

How about if the two criminals were close friends or a married couple, and did not want to betray the other, because each of them did not want his or her partner to serve long in prison? Surely, he or she would feel bad about being set free for betrayal while his or her partner would have to serve long in prison. Then, each of them would not

cooperate with the police, and each of them would get only 1 year in prison. In other words, in such a case, the criminals will cooperate with each other rather than with the police.

You may think that this is just a fictional example that we may never encounter in our lives. Yes, indeed. Actually, I am not sure whether this is the strategy police use, but similar examples are all around in our society.

Let me give you some real examples. Two Korean companies competed fiercely to get a construction project in Libya. Each company cut its bidding price so that the Libyan government could choose their company. I do not remember the exact number, which I read in a newspaper decades ago, so let me invent the numbers. See the table below. I wrote how much money each company will get. For a simple analysis, let's assume that the Libyan government chooses the lowest bid, and when the bids are the same, they choose one of them with a 50 % chance. So, if a certain company gets the project with a 50% chance, I just wrote half of the amount of the money that would be offered.

	A bids \$ 300 million	A bids \$ 400 million
B bids \$ 300 million	A: \$ 150 million B: \$ 150 million	A: \$ 0 B: \$ 300 million
B bids \$ 400 million	A: \$ 300 million B: \$ 0	A: \$ 200 million B: \$ 200 million

Table 2: Bid by Korean companies for a Libyan construction project

Now, we can analyze what each company should do from its own point of view, as we did for the prisoner's dilemma. The analysis is exactly the same. Each company will conclude that bidding for a lower amount of money is good for them, just as each criminal will conclude that cooperating with the police is better for him.

Now, recall that in our earlier example of prisoner's dilemma, we saw that the criminals' decisions change if they choose to cooperate with each other. If they cooperate with each other, they only get 2 years in prison in total.

A similar thing can happen in this case too. If the two Korean companies cooperated with each other and promised each other not to bid a low price, but to bid a high price, they would be better off, if we count the total amount of money they would get. In the former case, they will get \$ 300 million, and in the latter case, they will get \$ 400 million. In other words, if they bid high together, the Libyan government does not have the option to pay a low price for its construction project and is forced to pay a high price.

In this situation, what would the Korean government do? From the perspective of the Korean government, it doesn't really matter which company gets the project as long as it is Korean. As the most competent candidates in this project were Korean companies, and it was unlikely that any companies other than the Korean ones get the project,

the Korean government actually tried to dissuade the two companies from cutting their bidding prices.

I do not remember reading whether the Korean government's dissuasion was successful or not. If any of you know what happened, or the exact prices bid by the two Korean companies, let me know.

Anyhow, sometimes companies do succeed in cooperating in such a manner. From 1999 to 2008, Korean Airlines and Asiana Airlines offered domestic routes at prices no more different than 500 won (500 won is approximately 40 US cents). When they raised their prices, they did almost at the same time, within the difference of less than a month [1]. Such cooperation is called "collusion" and is illegal in many countries, including South Korea and the United States. In 2010, Korean Airlines had to pay 48.742 billion won, and Asiana Airlines 20.66 billion won as fine for the collusion [2].

Why is collusion illegal? It's because the customers cannot use the product or the service of providers at a lower price. Actually, if you take an intro economics class, you will learn that the gain of the companies when they collude is less than the loss of customers due to the higher price they have to pay. In other words, when things are considered all together, it is a loss. However, some company owners argue that the collusion should be legalized, because this loss is small, and we would spend more money in investigating the collusion.

So far, we have seen examples in which two companies are concerned, i.e., the two construction companies and the two airlines, but sometimes collusion of multiple entities happens as well.

A good example is OPEC (The Organization of the Petroleum Exporting Countries). OPEC has 13 nations as its members. If all the member countries decrease the production of petroleum, the price will soar, which will make the member countries earn more money. This will happen when the cooperation between the member countries works well. However, for each member country, there is a strong temptation not to decrease the production of petroleum. If a certain member country increases the production of petroleum, while the other countries decrease the production of petroleum more than this member country increases, this member country will be able to sell the petroleum at a high price (because the total production has decreased) with a large amount. In prisoner's dilemma, it's just like you betray your partner and are released from prison. As this temptation is large, and each member state wants to increase the production of petroleum, while it wants the others to decrease, it is not easy to make an agreement between member countries, and it is not easy to decide the production quota. Should a big country with a lot of facilities have a high quota? Should a country in an economic crisis have a high quota? Each member country has its own argument. And what if the negotiation fails, and some member countries decide to quit OPEC? Indeed, there are

some petroleum producing countries that are not members of OPEC.

Another good example of cooperation that requires multiple parties is the prevention of the climate change. Cars, airplanes, factories, and power plants that use coal or oil produce a lot of carbon dioxide, which negatively affects our climate. This requires the cooperation of all nations, because carbon dioxide produced in one country does not stay there, but moves to all the other countries.

As was the case with OPEC, it is not easy to reach an agreement to solve this problem. Per person, rich countries produce more carbon dioxide than poor countries produce. Thus, it would be fair if the rich countries decrease the production of carbon dioxide. However, it is not easy. It could mean that rich people who are used to going to work by their own cars would have to use bus or train instead from tomorrow. It could also mean that rich people who are used to using heaters in winter, using elevators, and using lamps at night, would have to stay cold from this winter, use stairs from today, and stay dark from tonight. Of course, these problems could be solved if we from now on produce electricity in a more environmentally friendly way, such as by using wind power and solar power, and use cars that emit less carbon dioxide, such as electric cars or hydrogen-fueled cars, but we still need a lot of research to produce them more cost-efficiently, and time to replace the old ones. Again, this cannot be done overnight and requires a lot of money.

On the other hand, allowing poor countries to emit more carbon dioxide while limiting the carbon dioxide emission by rich countries only cannot be a solution either. Rich countries have technologies to manufacture the same product with less emission of carbon dioxide than the poor countries do. Moreover, rich countries have often more strict environmental regulations than poor countries. Therefore, if we limit the carbon dioxide emission by rich countries while not limiting the one by poor countries, factories that produce a lot of carbon dioxide would be relocated to the poor countries, producing *more* carbon dioxide than that would have been produced in rich countries. In total, the net effect would be *more* carbon dioxide emission, which is a sad news for the Earth as a whole. But, from the point of view of the poor countries, the rich countries have been enjoying economic development for a couple of centuries by emitting a lot of carbon dioxide, and now they are the ones who are trying to limit the carbon dioxide emission of poor countries, hindering their economic development to gain an unfair advantage in the world market, by forcing them to produce goods in a more environmentally friendly way, which makes them more expensive.

However, the agreement is not the only hard part. We need enforcement. How can we make sure that each country follows the agreement? What if some countries lie about the amount of their carbon dioxide emission? Should we send inspection teams to make sure that each country does not lie? Some countries may think that such an inspection

would be a violation of sovereignty and would be deeply offended; how can a country say another to what to do? In what authority? And if it turns out that some countries did not follow the agreement, should we punish them? What punishment should be given to the countries violating the agreement? Or should such a punishment be allowed at all? Is it possible in practice?

In any case, as richer and bigger countries have more economic and diplomatic means, they have more bargaining power in the negotiation for the prevention of climate change than poorer and smaller countries, all despite the fact they are more responsible for climate change than the poorer and smaller countries. Nevertheless, an ideal approach would be for rich countries to help poor countries with technology to produce less carbon dioxide emissions, which is the approach taken by some responsible rich countries.

Indeed, as we see in these cases, cooperation is not easy. A personal example that shows this. When I tried to get a room to study at a graduate school in Seoul, the landlord said that she could offer a room at a low price, but I should not tell anyone else that she was offering a room at this rate. Apparently, she wanted to betray other landlords, but she didn't want them to know it because she would be in trouble. Luckily, I later learned that I was eligible to live in a dormitory.

Let me give you another example, which the prisoner's dilemma allows us to look at critically. In Korea, it is a serious social problem that teenagers study too hard. Of course, you may not agree with me and say teenagers indeed need to study hard; they need to learn the knowledge that is essential to survive in the society that they will be part of when they grow up, and they also need to learn to think critically, without which our society won't develop. I agree. However, my point is that they study *too* hard. Basically, most high school students study except when they sleep and eat. And, as if this is not enough, they reduce their sleep, so that they can study more. There is a well-known expression in Korean: “4당5락” (sadang-ohrak). If you sleep four hours a day, you get accepted from university, and if you sleep five hours a day, you get rejected. Even though this is an exaggeration, many high school students still sleep little. According to a survey conducted by the Ministry of Education in 2018, 43 % of high school students sleep less than six hours [3]. Sleep-deprived, it is very common that students fall asleep during class. Moreover, there is not much time left to enjoy youth and play sports.

So, let's analyze the situation. In Korea, you study to be better than other students. Therefore, what matters is not how much you study, but how much more you study than the others. See Table 3. The analysis is just like the other two tables. If all the other students study too hard, you study too hard too, because it's better to get a modest rank than a bad rank, even though you may be more tired. If all the other students study just enough, you study too hard as well, because it's better to get a high rank than a modest rank, even though you may be more tired. So, you are better off, if you

study hard, no matter what the others do. However, you are not the only one who thinks so. So, all the other students study too hard as well, so you attain only a modest rank, and every student is tired.

	You study too hard	You study just enough
All the other students study too hard	You: modest rank, too tired All the other: too tired	You: bad rank, not tired All the other: too tired
All the other students study just enough	You: high rank, too tired All the other: not tired	You: modest rank, not tired All the other: not tired

Table 3: Should you study too hard or just enough?

What can be done to correct this situation? Something similar to what OPEC has done in our earlier example can be done. For example, the city of Seoul introduced a ban on classes at cram schools after 10 pm. Then, every student in Seoul can be less tired. However, in my opinion, the impact of such a solution is limited, even though it is good. This problem cannot be ultimately solved as long as we live in a competitive culture, where everyone has a mindset that he or she has to be better than others. The change is not easy.

References

- [1] <http://www.jejusori.net/news/articleView.html?idxno=53767>
- [2] <https://www.asiae.co.kr/article/2010052710122008140>
- [3] <https://www.hankyung.com/society/article/2019032723921>