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Using Iterated Prisoner's Dilemma & Grim Trigger Strategy to Model the People's Adoption of Safety Measures During the COVID-19 Pandemic

For the last 2 years, COVID-19 pandemic has been a major concern for humanity. Although vaccines have been available for some time now, the pandemic is still not over, so it is crucial to analyze the act of people adopting safety measures to limit the virus spread in a modeled game-theoretic context. In this paper, I will explore to what extent do people comply with the safety measures in different time-periods and places along with how the equilibrium shifts as the pandemic progresses.

One of the games which seems very applicable to model decisions in the pandemic is Prisoner's Dilemma. The outcomes of this game are relatively straightforward when applied to the pandemic:

If people choose to cooperate by following the safety protocols (wear masks, quarantine etc.), their outcome is to limit their liberty and pleasure (let's say it is -1). If a group of people, G1, does not cooperate, G1's outcome will be positive (let's say 1) because G1 will be at relatively low risk of catching covid (because the other group continues taking protective measures) while enjoying liberty. The other group's outcome will be negative as they are at higher risk (than they were initially exposed to) while not enjoying their liberty because of G1 (let's say -3). If all players refuse to cooperate, they can enjoy their liberties but their chances of getting infected increase. I will assume that regaining liberty is slightly better than the change in the risk of getting infected so the outcome can be modeled as -2 or b.

Group G1/Group G2	Comply	Not comply
Comply	(-1,-1)	(-3,1)
Not comply	(1,-3)	(-2,-2)=(b,b)

The Pure Strategy Nash Equilibrium for this game is easy to compute, and it is to not comply because it is the dominant strategy for both groups. But this raises an important question: “Why do people still cooperate and take protective/safety measures?”

Let’s examine the rationality behind players cooperating in taking safety measures. The answer is based on the assumptions of this game. The first assumption which is not applicable in the real world is that both players only choose once. The pandemic is an ongoing game, not a one-shot game. The second assumption is that there is no future in Prisoner’s Dilemma, but actually players care about the future.

An adapted version of this game – the Iterated Prisoner’s Dilemma – is more suitable to model this game because in this case players engage in a succession of Prisoner’s Dilemma games, and they also remember the other player’s previous decisions. The game also has a non-zero probability of being over after every iteration (which is suitable for a pandemic because we never know when it might be over). To model the pandemic using the Iterated Prisoner’s Dilemma, I will consider five assumptions:

1. Players do not have knowledge of when the pandemic will be over.
2. The payoffs will be the same as in the normal Prisoner’s Dilemma.
3. If group G1 does not comply, group G2 obtains more positive utility from the liberties gained than negative utility from the slightly increased chance of catching covid.
4. If one group does not comply, this increases the other group’s infection chance.
5. Players value avoiding a COVID-19 infection more than liberties and care about the future.

To compute the likely outcome of this game, I will use a piece of game theory called “grim trigger strategy”[1]. For the pandemic game, if one group ever chooses to defect, the other group will then defect for the rest of the repeated games. In reality, this is unlikely because, if both groups start deflecting and the pandemic does not stop, they might turn to a new agreement, but for simplicity I will assume no future agreements will be possible. If both players in the pandemic game engage in grim trigger and value future

outcomes enough (let's forget about nihilists [2] for the sake of an equilibrium), then an equilibrium is for both players to cooperate (assuming the discount rate to be d) as shown:

Gains from complying (Gc) = -1 - d - d*d … = -1/(1-d)

Gains from not complying (Gnc) = 1+b*d+b*d*d..= (1+(b-1)*d)/(1-d)

Players will cooperate if Gc > Gnc => d > 2/(1-b)

In conclusion, if we model the Covid pandemic as an Iterated Prisoner's Dilemma game with grim trigger players (which in my opinion is a rational assumption), engaging in protective measures against Covid-19 is the best strategy for both groups and forms an equilibrium as long as a person's underlying impatient preferences, and an exogenous probability that the game might end before the next period (taken into account through d) is greater than ⅔. And, this will be the case in the initial example where b = -2.

Given our model, let's try to analyze situations in different countries and timeframes. In the model, I assumed that b = -2, which means gaining liberty gives less increase in payoff compared to the decrease in payoff due to increased health risk. This may not very well be the case in different communities and timeframes. For example,as per *The Atlantic*, now people are more likely to have increased payoffs for liberty than the decreased payoffs due to the associated risk because the pandemic is becoming less and less severe by the decrease in fear about COVID-19 in people [3]. Hence, this may lead to an alteration of payoff b to -1. This may lead to a shift from people complying to people not complying with the protocols because in this case d > 1 to sustain cooperation, which is not possible as d lies between 0 and 1. Hence, people would live as if the COVID-19 pandemic was over. Moreover, we can say that the payoff b will be higher in rural america than in its urban counterparts due to rural America's false sense of security leading them to care less about risks and more about liberty even in the same timeframe [4]. Similarly it is easy to see that during the initial phases of pandemic when the vaccines were not in place, the payoff b might be even lower, thus making it easier for people to comply with the safety measures because they feared more.

Bibliography:

[1] Grim trigger–Wikipedia: https://en.wikipedia.org/wiki/Grim_trigger

[2] Nihilism: https://en.wikipedia.org/wiki/Nihilism

[3] https://www.theatlantic.com/ideas/archive/2021/12/where-i-live-no-one-cares-about-covid/620958/

[4] https://www.theatlantic.com/politics/archive/2021/11/pandemic-covid-urban-rural-divide/620730/