COLLABORATIVE VERSUS COMPETITIVE APPROACH FOR COVID -19 VACCINE: A GAME-THEORETIC PERSPECTIVE

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Abstract –

The present study adopts a game theoretic perspective. Wherein a vaccine manufacturer can adopt either a cooperative game or a non-cooperative game or a hybrid game. In the cooperative game it will be have binding commitments externally enforced by WHO or other collaborations. In the non-cooperative game it can have its own self-enforcing commitments and can take its own decisions of pricing, target market, production volume etc. In the hybrid game, it can take a role (leader or follower) based on the market conditions and then formulate its strategies

I. INTRODUCTION

The entire world today is struggling to get out of the ongoing pandemic COVID 19. It has brought many changes in our lifestyles, ways of working and social interactions. While individual countries have taken strong measures like lockdowns and made progress in containing the spread, this is not a lasting solution as the disease is now re-emerging in places thought to have contained the spread. For every month that this pandemic continues, $375 billion is lost from the global economy (*TOI,A*). The world urgently needs vaccines to protect against COVID-19. In order to come out of this unwanted precarious situation, many researchers in many countries are tirelessly trying to develop a vaccination for COVID 19. Everybody has eyes fixed on these vaccines, as the ray of hope for survival.Vaccine development is moving at an unprecedented speed and scale, with more than 123 preclinical candidates in development and 10 in human trials(*GAVI Report,A*).

In regular times, vaccine development is long, complicated, and more often less prone to failure. Unlike the usual vaccine development projects, the Coivd 19 vaccine development project is a time-critical fast-paced project. When a successful vaccine is found, worldwide demand will be in the billions of doses to address the epidemiologic needs. But the initial supply will inevitably be limited. Therefore, the scaling up of manufacturing and completion of human trials for Covid 19 vaccine candidates must be done in parallel. As the trails and licencing approvals of COVID-19 vaccines are progressing, we need to simultaneously prepare ourselves for their accelerated development, manufacture, and distribution. Manufacturers need to urgently scale up production and reserve capacity for Covid 19 vaccine.Even with accelerated investment in manufacturing, and the completion of trials to ensure vaccine candidates are safe and effective, there is no scenario in which supply over the next 18 months will exceed demand. (*TOI,B*).While massive efforts are underway to establish large production capacity, initial supplies will need to be prioritized. Significant amounts of capital will be required for manufacturer- specific and market-wide volume guarantees and advance procurement for countries of all income levels.

Leaders are facing intense demands from their populations to secure vaccines and support the recovery of their economies. In response to this nervous situation two approaches are observed to be developing in the global scenario. The first approach is the competitive approach and the second is the collaborative approach e.g. COVAX by WHO. In the competitive approach the governments may prioritize their own populations. For example, some countries have already signed future contracts with the manufacturers to secure supplies of vaccines to protect their population. (*TOI,A)*However, such bilateral transactions with single manufacturers is highly risky because the probability of success for any vaccine in early stage development is low. The collaborative approach works on the premise that "Nobody is safe from COVID-19 until everybody is safe" and strives for equitable distribution of vaccine across the globe. Therefore, WHO has come up with COVID-19 Vaccines Global Access (COVAX) Facility, wherein countries have the opportunity to benefit from a portfolio of vaccine candidates so that their populations can have early access to effective vaccines (*Paglius et al.,2020*).

In the present study, we adopt a game theoretic perspective is adopted.Wherein a vaccine manufacturer can adopt either a cooperative game or a non-cooperative game or a hybrid game. In the cooperative game it will be have binding commitments externally enforced by WHO or other collaborations. In the non-cooperative game it can have its own self-enforcing commitments and can take its own decisions of pricing, target market, production volume etc. In the hybrid game, it can take a role (leader or follower) based on the market conditions and then formulate its strategies.

II. COMPETITIVE AND COLLABORATIVE APPROACHES

2.1. Competitive approach

Governments are heavily investing in vaccine development, but inevitably individual governments can only support a small number of candidates. Many underdeveloped countries have no access to the resources needed to develop a vaccine. Standalone vaccine development projects have higher risks of failure. Amid rising nervousness due to COVID 19 and its negative economic impact, governments have resisted multilateral institutions and international agreements. Many countries have responded to this pandemic by turning inward: closing borders, hoarding medical resources, and scapegoating foreigners (Bollyky et al., 2020). If left to market dynamics or individual government investment, there is no scenario in which the aggregate supply of safe and effective COVID-19 vaccines over the next 18 months will meet potential demand. Vaccine developers have reported that they are being approached by an increasing number of countries seeking to establish advance purchase arrangements. In addition, the competition for vaccine candidates, manufacturing supplies and capacity, R&D capacity, clinical trial sites, principal investigators, and hospitals is driving up prices and reserving resources.
The competitive approach ensures that whatever resources of its taxpayers the government is spending on vaccine development, they will be fully deployed for their well-being. In this race of COVID 19 vaccine development, the country that wins the race will be able to make critical decisions of licencing agreements. Manufacturers can make their own decisions of pricing, product volume, processes and target market. However, one major disadvantage of the standalone approach is that vaccine development is a highly risky project and in these pressing times the risks of quality, trial failures and quantity shortage are high. Further, the large scale investment required for setting up such massive manufacturing set up to meet the demand may pose heightened financial risks to the manufacturers.

2.2. Collaborative approach

On 24 April, the World Health Organization (WHO) hosted the launch of the Access to COVID-19 Tools (ACT) Accelerator, a new global collaboration to accelerate development, production, and equitable access to COVID-19 diagnostics, therapeutics, and vaccines(*GAVI Report,B*) . The vaccine pillar of the Access to COVID-19 Tools (ACT) Accelerator is launching a COVID-19 Global Vaccine Access Facility (Covax Facility), which will pool resources and share vaccine development risk. All countries will be invited to participate in the Covax Facility. This vaccine effort should be guided by three imperatives: speed, manufacture and deployment at scale, and global access. It provides its participants with insurance against the risk of particular vaccine candidates not being successful. Through COVAX Facility, countries have the opportunity to benefit from a portfolio of vaccine candidates so that their populations can have early access to effective vaccines. The GaviCovax AMC will give manufacturers confidence to invest in scale-up of manufacturing capacity for vaccine candidates in advance of their licensure and create economies of scale. It supports pricing principles consistent with manufacturers seeking appropriate returns and affordability for participating countries (Bollyky et al., 2020)

The advantages of such collaborative approach is that it offers demand guarantees for vaccine manufacturers which will create access to substantial volumes of vaccines that will ultimately be safe and efficacious; better allocate capital; and support the manufacturing and procurement of sufficient volumes of vaccines to support equitable access globally. The manufacturers will be supported by financing instruments to facilitate pooled procurement for all participants. As doses from successful candidates become available, they will be allocated to all participating countries at the same rate until all countries have received sufficient doses through the Facility to ensure coverage of 20% of their populations(*GAVI Report,C*).

However, one major disadvantage of the collaborative approach is that the taxpayers of the country where successful development of COVID 19 vaccine will happen, will have to wait for a longer duration to reap the benefits of their invested resources. The manufacturer will not have any decision making authority, and all pricing, volume and market-related decisions will be taken by the collaborative body. Profit maximization will not be the objective of the decisions, instead social impact and reach to low underdeveloped economies will be the priority objectives.

III. RESEARCH QUESTIONS

Deriving motivation from the aforementioned two potential approaches, the following research questions are posed.

Research Question 1. What are the all the political, economic and psychological factors during present COVID 19 pandemic, that play an essential role for devising potential approaches of manufacturers?

Research Question 2. What are the potential game plans that can be devised by the manufacturers?

Research Question 3. What are the outcomes of various game plans when multiple players in the COVID 19 market place compete?

Research Question 4. How the outcome/utility of the game changes with the change in the overall objective of the market game?

The present study will address the above research questions in two steps. In the first step, all the political, economic and psychological factors will be studied to devise multiple potential approaches that manufactures can adopt and various steps that they can take in their game plan of COVID 19 vaccine race. Further, all factors of the first step will be converted into quantitative measures either directly or through surrogate modelling. Thereafter, in the second step, all the potential game plans will be modelled in the game theory model based on their risks, advantages and disadvantages. Further, different types of objective functions such as profit, social impact, rate of disease spread, death rate, recovery rate, flattening of curve etc. will me modelled for evaluating the potentialgame plans devised the manufacturers.

IV. METHODOLOGY

Game theory is the process of modelling the strategic interaction between two or more players in a situation containing set rules and outcomes. Each player's preference ordering among multiple alternatives is captured in an objective function for that player. The nature of this objective function can be the maximization of a utility function or benefit function or minimization of cost function or a loss function.

For a non-trivial game, the objective function of a player depends on the choices (actions, or equivalently decision variable) of at least one other player, and generally of all the players, and hence a player cannot simply optimize her own objective function independent of the choices of the other players. This thus brings in a coupling between the actions of the players, and binds them together in decision making even in a non-cooperative environment. If the players were able to enter into a cooperative agreement so that the selection of actions or decisions is done collectively and with full trust, so that all players would benefit to the extent possible, and no inefficiency would arise, then we would be in the realm of cooperative game theory, with issues of bargaining, coalition formation, excess utility distribution, etc. of relevance there. If no cooperation is allowed among the players, then we are in the realm of non-cooperative game theory, where the first one has to introduce a satisfactory solution concept.

Collaborative or Cooperative game theory is the part of game theory that pertains when players can sign binding contracts determining their actions and payoffs. Cooperative game theory model scenarios, where agents can benefit from cooperating, and binding agreements are possible. In cooperative games, actions are taken by groups of agents, coalitions, and payoffs are given to the group, that has to be divided among its members.

Competitive or Non-Cooperative Games studies situations where the profits (gains, utility or payoffs) of each player depend not only on his own acts but also on the acts of the other players. Here, the players are assumed to be rational so that each player will try to maximize his/her profit function (utility or payoff) given his/her conjectures or beliefs on how the other players are going to play. The outcome of the game will depend on the acts of all the players. A fundamental characteristic of non-cooperative games is that it is not possible to sign contracts between players.

V. CONCLUSION

The expected outcome of the study will be the insights on potential game plans that manufacturers of Covid 19 vaccine can adopt and their impact. The game theory based model can be used by the manufacturers to evaluate their game plans and accordingly plan their real-time approach.

The present study will contribute to the developing literature on COVID 19 vaccine from the business management perspective, which is still lacking.

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