



Application of Game Theory in Selecting Covid-19 Immunity Methods

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Abstract. This paper aims to do a comprehensive analysis through research on the relationship between shield immunity and the city of herd immunity. And then the paper makes some evaluations and suggestions for the policy formulation in Shanghai by using game theory. To come up with the conclusion on the topic, this paper mainly uses game theory method combined with some basic data analysis approaches, which include the questionnaires and the interviews. The data used in this paper mainly reflects the relations of the two streams of data sources. Also, the results shows that there is a connection between shield and herd immunity, and the effect is remarkable. These findings give a clear path to the conclusion and possible recommendations for the work. Finally, according to the discussion, it is recommended that the application of the policies and the formulation of legislation by the Shanghai authorities that should reflect on the advantages of the two methods.

Keywords: Application, Game theory, Covid-19, Immunity.

1 Introduction

From the general point of view, the World Health Organization (WHO) described the COVID-19 as an infectious disease emerging from the SARS-CoV-2 virus. At the onset of its outbreak, the experts believed that the victims of the virus could face unique symptoms such as mild and moderate respiratory complications before being treated to go back home. However, as it turned out, the COVID 19 virus spiralled to become a global menace affecting the world population. The research of the Coronavirus that causes the COVID-19 was published in January 2020 [1]. From the experts' point of view, it can be concluded the disease is spreading through the interaction of people in various social places. On the same note, it is through mitigation measures and mechanisms that the disease can be controlled and prevented from spreading to other places. While there were various approaches that the governments put in place to see that this happened, it was challenging for the world health institutions to curb the disease. For the better part of 2020, the COVID-19 impeded the movements of people and interfered with their interactions in social places. On the same note, there needs to create a space for reducing its ambers on the global health threats.

Additionally, in the quest of ensuring the control and prevention of the spread of Covid-19, the application of shield immunity has been effective and efficient. The shield immunity is informed by the idea that some of the recovered patients from the Covid-19 pandemic are in a position to increase their contact rates [2]. Some of the health strategies that have been in use for some time in the control of the spread and effect of the Covid-19 are the mitigation and suppression of the impacts. According to professionals, the shield immunity approach has the potential of reducing by a substantive amount the length of the Covid-19. Thus, it is clear that the situation of the outbreak of the Covid 29 can be tentatively controlled through the use of shield immunity. As for the case of herd immunity, the attainment is arrived at when the larger part of the population is vaccinated and their status makes them immune to a specific disease [3]. It can be identified that after the vaccine for Covid 19 was discovered, it became possible for the bigger part of the population to be vaccinated which resulted in the prevention of the disease in various countries of the world.

Further, one of the global dynamics consequences of the Covid 19 in the global space was the deterioration of the health systems. Some of the countries that had been lauded before to be having good health and medical systems were overwhelmed by Covid 19. On the basic scale, the Covid 19 led to the demise of the bigger population [4]. Still, on the health aspect, the disease brought a dynamic situation and repercussion in that it led to increase observation of hygiene. While it was laudable that the procedure for mitigating the disease was key in the prevention of other diseases caused by unhealthy living habits, it confined people to some of the activities that they were not familiar with. On the economic scale, Covid 19 disrupted the commercial and financial activities as there were bans on travel and tourism in many countries. The consequences on the countries like China gave precedence to the manner in which the disease could be contained [5]. It was announced that there were zero cases of Covid-19 in Shanghai following the policy of non-movement of the people in the city. One of the policies was to ensure the enforcement of mass testing and isolation.

Nonetheless, game theory is described as the branch of study that provides the tools and necessary items for the purposes of analysis. In such analyses parties involved make decisions interdependently. From a different perspective, the game theory is identified as a theoretical framework that is geared at conceiving the social situation for the competing situations. In the long run, the results are expected to create an optimum and excellent decision-making process. In the case of economics, game theory is looked at in terms of the stakeholders as the players and how various situations lead to decision-making [6]. In connection to the relationship between the herd and shield immunities, the social situation presented by Covid-19 will probably analysed by using the two players. Specifically, herd immunity and shield immunity will both be considered in the quest of making decisions after which the best choice will be arrived at [7]. However, it is worth note that the interest of the government and that of the individual will be put into consideration when deciding on the best choice to make. In this case, the most essential point is on the shield and herd immunities and how effective they are in combating the Covid-19.

2 Methodology

2.1 Scenario one: Shield Immunity Variable

In the quest to determine the benefits of the shield and herd immunity for the control of the Covid 19 spread, there were variables that were considered. Note that this study selected a sample size of 200-300 people for the purpose of questionnaires response and the recording of the results. The policy was that the most vulnerable people and the health workers were subjected to vaccination in Shanghai as a means of preventing them from contacting Covid 19 [8]. After their vaccination, they were encouraged to increase their contact rates. Further, there were interviews that were carried out with the medical experts on the effectiveness of shield immunity. Specifically, 20 doctors and medical nurses were subjected to the interviews on the same. The survey and research tools were spread and diversified so that there was the inclusion of the various samples and the views from different perspectives. Through the interviews, the professional opinion could be captured while the questionnaires gave the quantitative findings on the scenario

2.2 Scenario two: Herd Immunity Variable

In the achievement of herd immunity, the sample size of 200-300 individuals was selected and subjected to the process of questionnaires and surveys. The selected individuals were picked on the basis that they had undergone the process of full vaccination, and thus they were not threatened by the Covid-19. For the first study, the survey took place in the district of Huangpu while the second study was carried out in the district of Putuo within Shanghai. In the quest of achieving herd immunity at least 30% of each household was subjected to vaccination [9]. The population was projected to be the vast majority in Shanghai and the districts identified for the two processes. As could be confirmed from the first scenario, there was the involvement of the two research techniques of interviews and questionnaires. Again, in this case, the questionnaires were for quantitative purposes while the interviews were for qualitative purposes of determining the professional views.

2.3 Scenario three: The Non-Variable

The third scenario involved the non-variable which can be termed controlled research. In this case, there were no vaccination and immunity at all. The above-identified approaches were not involved in the process. In essence, there was no intervention where a given portion of the population was involved. However, it is essential to learn that this process involved the sample size and the population as in the two scenarios above. The number of interviews, in this case, was 20 for the professional medical stakeholders. On the same note, there were 200-300 questionnaires that were administered to the identified sample size for the purposes of response [10]. The process was identical to the first and the second scenarios in that there were the same number of people in each

sample and the selections were done in terms of either a medic or the common populace who have no such qualifications.

2.4 Comparison of the Methods

In terms of comparison, the first method of shield immunity is inclined to specific populations which are more vulnerable to the covid-19 infection. However, for herd immunity, the idea is aimed at ensuring that the people vaccinated reach a given threshold so that there is the overall protection of the entire population. While this difference was considered in the design and administering of the questionnaires, it was remarked that there should be equality in the number of tools and the approaches used in the two scenarios. In the third scenario, there is no inclusion of the herd or shield immunity making it qualify as a control mechanism and comparison platform for the two cases. The three districts that were chosen for the process all have the policy put in place to safeguard the process. It was possible to identify from the process that there was a difference in the application of the methods above.

Further, the analysis is based on two categorical variables shield immunity and herd immunity with both having the same groups of categories. The variables are grouped as: excellent, effective, moderate, less effective, not effective, and poor. However, for herd immunity, there were no observations for not effective and poor. From the data each category has a different percentage representation as shown in table 1.

Table 1. Frequencies on the shield and herd immunities

Item	Frequency	Percent	Valid Percent	Cumulative Percent
Excellent	80	30.0	40.0	40.0
Effective	60	40.0	30.0	70.0
Moderate	20	10.0	10.0	80.0
Less effective	10	10.0	5.0	85.0
Not effective	20	5.0	10.0	95.0
Poor	10	5.0	5.0	100.0
Total	200	100.0	100.0	-

Table 1. above shows the frequency of the entered respondents from the questionnaires conducted. From the table, the cumulative number of respondents for the excellent category stood at 40 percent. The valid percentage for the entire sample size stood at 100% which is indicated as shown in the table above. Notable from the table is that the cumulative percentages for every category of response varied with the highest being the excellent at 40% both for the cumulative and valid percentages.

Table 2. Frequencies on herd immunity

Item	Frequency	Percent	Valid Percent	Cumulative Percent
Excellent	7	25.0	35.0	35.0
Effective	5	35.0	25.0	60.0
Moderate	7	25.0	35.0	95.0

Less effective	1	15.0	5.0	100.0
Total	20	100.0	100.0	-

The formula used is that p-value of 0.001 is less than the alpha value of 0.05 hence we abandon the null hypothesis and adopt the alternative hypothesis.

Table 3. Model results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	33.447	1	33.447	47.209	<0.0001
Residual	12.753	18	0.708	-	-
Total	46.200	19	-	-	-

From the analysis holding shield immunity as a dependent variable, it explains 70.9% of the model as observed in the adjusted R². The significance of the model is tested with the f statistics that provide a p-value of .000 which is less than the alpha value of .05 thereby proving the significance of the general model. From the plot, the regression analysis presents a linear representation confirming a linear relationship between the variables.

3 Results and Discussion

3.1 Results

3.1.1 Findings on Shield Immunity.

Figure 1 indicates the scores in terms of the probability of the responses where people can establish the correct meaning of the method and activity. From the figure, it was identified that most of the respondents accounting for 50% believed that shield immunity is excellent. Following the list as can be observed 20% of the respondents believed it is effective. In the first scenario as presented by figure 1, it was established that 15 out of the 20 medics that were interviewed confirmed that shield immunity is necessary and essential for the prevention of the Covid 19 spread. As a matter of probability, it was identified that 75% of the medical practitioners believed that the method is effective. In the case of the questionnaire, there were selected specific questions that were dimmed vital for this study. It is notable that 95% of the selected population participated and responded to the questionnaires which were within the required threshold for the study. From the questionnaires, it was established that there are three categories of the responses in line with the effectiveness of the shield immunity. Further, in the case of shield immunity, it is apparent that there should be the selection of a given group of individuals preferably the vulnerable so that they develop the prevention mechanisms for the purposes of preventing the spread of the disease. The shield immunity is developed from the recovered population who exhibits some of the preventive mechanisms that result in the reduction of the strength of disease. Thus, it is probable that with the use of the shield immunity the community stands to benefit from two angles including treatment and prevention.

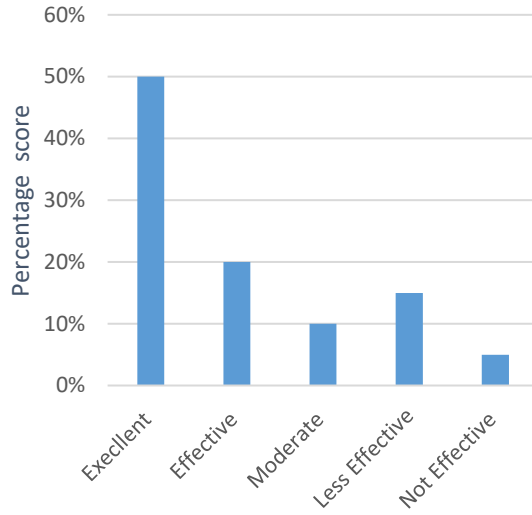


Fig. 1. The opinion of respondents on Shield Immunity

In figure 2 above, the focus was the same but with a different sample and populace which involved particularly the medical practitioners. 55% of the medical doctors confirmed that shield immunity was essential for the prevention and combating of the Covid-19 pandemic. There was a 25% of the respondents in the interview believed that the method is effective but not excellent. Further, 15% of the respondents believed that the application of shield immunity is not effective and possibly should not be adopted in the hospitals within Shanghai. Additionally, 5% of the respondents are for the idea that the process of shield immunity should not be part of the prevention procedure because it has drawbacks. The respondents have identified the effectiveness of the shield immunity can easily contend and vouch for its excellence. As a matter of analysis, it is realized that shield immunity is vouched for by most people. As can be observed in the two scenarios, it is clear that the process is more effective from the view of the general population and the medical practitioners.

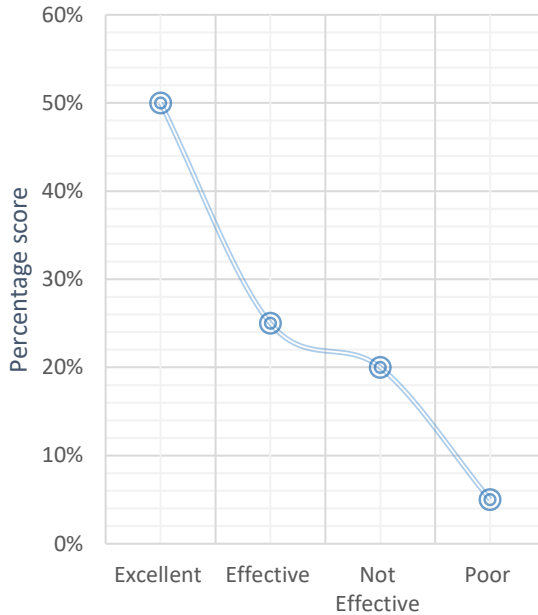


Fig. 2. The medical practitioner's Opinion on Shield Immunity

3.1.2 Findings on Herd Immunity.

As pointed out earlier, the approach of herd immunity was also applied where the 200-300 respondents were involved in the survey as shown in figure 3 above. Out of the sample size, 100% responded as required and directed in the questionnaires. Out of the 200-300 respondents, 35% believed that it is an excellent means of ensuring the prevention of the Covid-19 pandemic. As will be observed in figure 3, 25% of the respondents have confidence that the method of herd immunity is effective and can be instrumental in the prevention of Covid 19 in Shanghai districts. Consequently, 30% of the respondents believed that the method was not effective and should not be applied in the quest for determining a better method of combating the pandemic. Again, 10% of the 200-300 respondents believed that the prevention method of herd immunity should be abolished as it wastes time and resources. It is precise that the use of the herd immunity for the protection of the people against Covid 19 has been essential. However, it is a requirement that the population should attain a given threshold to achieve such status and be effective. During the height of the Covid-19 pandemic, some medical pundits including Dr. Fauci asserted that reaching the potential threshold for herd immunity about 75-80% of the population should be vaccinated. However, the attainment of the threshold in the herd immunity is elusive. Thus, it becomes one of the challenging methods of pandemic control that are more expensive and require more resources.

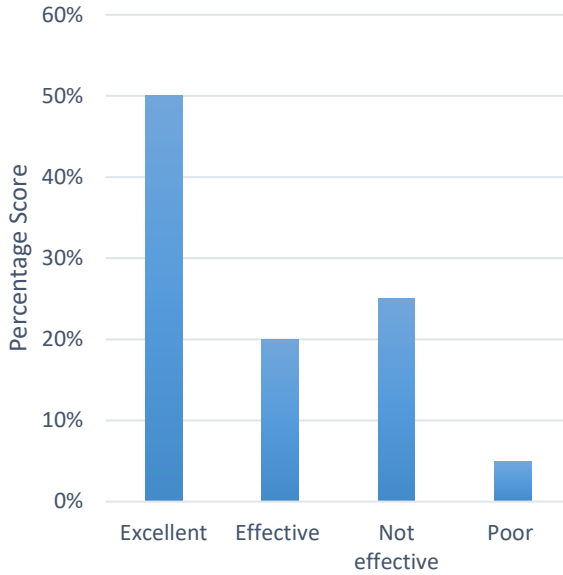


Fig. 3. Respondent opinion on herd immunity

Apart from the 200-300 respondents who were subjected to the questionnaires, there were 20 medical practitioners who were involved in interviews for the expert opinion shown on figure 4 above. Out of the 20 interviews, 50% of the interviewees thought that herd immunity is excellent. Further, 20% believed that the method of herd immunity is effective and can play a major role in ensuring that the Covid-19 is prevented. However, 25% of the respondents were for the idea that the process of herd immunity is not effective and should not be used as a means of ensuring that there is the prevention of the spread of Covid 19. Further, 5% of the interviewees believe that the process of herd immunity should not be used as part of the policy because of its drawbacks. Thus, it can be confirmed that there were many medical practitioners who believe that the intervention of herd immunity is not a good idea for the prevention process. However, from the overall viewpoint, it was observed that the application of the method of herd immunity is good. Specifically, there was a total of 50% of the respondents who believe that the approach is good. Nevertheless, it is equally confirmed that 50% of the medical respondents were not confident with the idea as will be observed in figure 4 above.

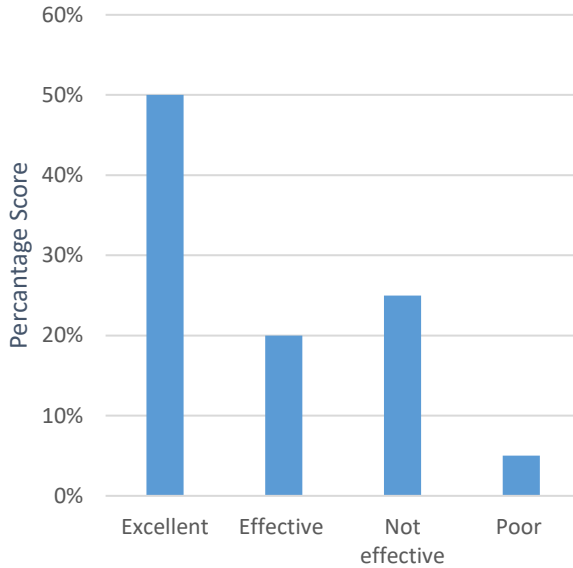


Fig. 4. Medical practitioner's view on herd immunity

Concerning the game theory, it is realized that the concepts are more applicable when looked at from the perspective of the two methods used above. Game theory is essential in this case in that it gives insight into the connection between the various social variables such as the shield and herd immunity. The main idea informing the herd immunity as dictated by the shield immunity is that the former ensures that the latter takes place. Thus, it can be argued that herd immunity is the path toward the achievement of shield immunity. There is a complementarity between herd immunity and shield immunity where the latter is more dependent on the former for its attainment and achievement. According to the dictates of game theory, there are possibilities that the people will fail to comply with the mandates placed for reducing the spread of the disease. It is thus, required that there is the involvement of the mechanisms to combat the diseases where the herd and shield immunities are significant.

4 Conclusion

In the re-evaluation of the background, information concerning this research, it is appropriate to conclude that both the shield and herd immunities are essential in the prevention of the Covid 19. However, the two methods should be applied complementarily because their operations depend on one another. Thus, in setting up the policies by the Shanghai authorities, the consideration should not be inclined to one approach, instead, they should be done in comprehensively so that the advantage of the other can neutralize the drawbacks of another. In the re-analysis of the methods, it is remarkable that the

two are both essential in the prevention and negativities caused by Covid 19. Nonetheless, it is apparent that herd immunity is more involving and results in a wider scope in terms of coverage. Therefore, in the quest for the application of the game theory, there is the analysis of the two approaches and identifying the most suitable ones for the purposes of providing a better output. In terms of the results evaluation, it is observed that most of the respondents in the questionnaires which are lauding shield immunity as compared to their counterparts vouching for herd immunity. However, in both cases, there is a slight difference in terms of the opinion of both the professionals and the respondents who were subjected to the research. Therefore, it is recommended that for the profit of both the individuals and the government, the two approaches and the methods should be involved because herd immunity follows the path of shield immunity. Thus, as part of the recommendations, there is the need for the inclusion of both methods in the prevention of Covid 19. The further studies should be launched on the specific mechanisms that should be put in place to ensure a seamless connection between the two methods.

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