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- Research Question

The spread of Covid19 has resulted in a global pandemic. The attitudes and strategies of national governments to combat the new coronavirus vary greatly. Some are strict in fighting the epidemic, such as China, which maintains a zero policy, while others have a more open strategy. What is the likely impact of each strategy on the economy? Which one is better? Which creates more value (i.e., total GDP minus total spending) after the same runtime, the "no-footing" model or the "sheep herding" model?

- ODD Description

- 1Purpose and Patterns
We develop this model to quantify the specific effects of different strategies under the new epidemic. Specifically, we consider two strategies. One is to quarantine and ground the entire population after the outbreak, which we call the "grounding" model, and the other is to leave the quarantine and grounding in place and let people live as they did before, which we call the "sheep herding" model. (This model deals with the spread of Covid19 and the local economic impact under different epidemic prevention policies.) These scenarios can be depicted in several graphs, showing the transmission, including the number of infections, deaths, and cures, and the economic impact, including the medical cost to patients and the local GDP.
The model can also be modified to study the socioeconomic impact of other new coronavirus variants or other infectious diseases.

- 2Entities, State Variables & Scales
The objects in this model represent people, who have six variables that record whether they are infected, whether they have been cured, when they were infected, and whether they wear a mask, and one variable that represents age.
The model is a square with side length 201, and the square block with white side length 16 in the middle represents a hospital, where infected people enter the hospital for treatment and leave the hospital after being cured.
This model runs at a one-day time step.

- 3Process Overview & Scheduling
The model includes the following actions executed each time step.
Sickness, cure and death. Using a simplified model, a random newly infected person is treated in the hospital after being infected for more than 7 days (initial value, incubation period), and the people in the hospital no longer infect each other; a random selection of dead people from

among the infected people is made every day according to the mortality rate; a patient who is cured in the hospital is considered cured and discharged after more than 20 days (initial value, time required for treatment), and the cured person is immune by default and no longer infected.

Going to and leaving the hospital. The infected person will choose to go to the hospital, and the cured person will leave the hospital.

Output: On the economic side, the GDP is generated by the "average daily GDP" set for normal activities and is included in the total GDP, and the money spent by the "average treatment cost" for people treated in the hospital is included in the total treatment cost. The total treatment costs are included in the total treatment costs. In the output chart, you can see the number of sick, cured and dead people, as well as the total GDP and the GDP consumed for treatment.

4. Design Concepts

1. Basic Principles

The transmission model of the new crown, including mortality, transmission rate, treatment duration, and transmission mode, is based on the study of COVID 19 transmission published by Shereen in 2020 (Shereen et al., 2020).

2. Emergence

The main outputs of the model are the infection status and socioeconomic situation of the epidemic, which are derived from individual behavioral decisions influenced by policies that are mainly determined by the government. In the "grounded" model assumed above, our agent is inactive for the duration of the disease, i.e., does not generate any GDP, and continues to be active after it is confirmed that there is no disease, whereas in the "sheep herding" model, the agent remains inactive for the entire period and therefore GDP is generated all the time. The goal is to compare the value created by the "grounded" model (i.e., total GDP minus total costs) to the value created by the "sheep" model after the same runtime.

3. Adaptation

The infection rate of an individual is initially set, but initially it is determined whether to wear a mask or not, and if a mask is worn, the infection rate will decrease. The individual does not adjust the relevant attributes in any way.

The individual behaviors are not based on expected future state and do not change; no learning or prediction are represented.

5. Sensing

There is no apparent perceptual behavior.

6. Interaction

Direct interaction should come from the individual's proximity to infected individuals; the more infected individuals are nearby, the more likely they are to be infected.

7. Stochasticity

Stochasticity function is used for individual location, initial infected person and age, new infected person is also random.

8. Collectives

Collectives are not represented.

9. Observation

The key model outputs are the infection status and the economic status of the society, which we can count using line graphs.

5. Initialisation Start of model

The initial population is 10,000, and according to a study on the spread of Covid19 (Shereen et al., 2020), the initial infection rate is 1%, the infection rate is 80%, the mortality rate is 5%, the required treatment time is 20 days, and whether the person is grounded or not needs to be specified (initially grounded).

6. Input Data While running

No time-series inputs are used.

7. Submodels

This model simplifies a lot of content and can be refined to more closely match the reality of the situation and variables

(a) Make the infection rate of people influenced by the presence or absence of infected people in the vicinity, which should increase when there are more infected people in the vicinity

(b) Differentiate patients into severe and mild cases, with severe cases having higher mortality rates and requiring admission to hospitals, and mild cases having lower mortality rates, some GDP productivity, and no need for admission. When the hospital is full, new critically ill patients need to wait for available beds before they can enter the hospital, at which point the patients waiting to enter the hospital will also raise the risk of mortality, and this submodel takes into account the impact of infected people on the health care system.

(c) Infected individuals may have the potential to regain their positive status.

- Methodology

1. Exploratory parameter selection

According to the research questions, the main indicators explored in the output are total GDP, the proportion of total GDP spent on treating patients, and the mortality rate of people. "Grounded" and "sheep" are the two main different models needed for the comparison study, so the grounded variable was included in the selection, and in addition to the initial exploration, whether or not to wear a mask (true, no) was selected based on the initial exploration, and whether or not wearing a mask affects the transmission rate of the virus. rate, initial number of people (2000-10000, step=2000) as the main study variables, considering that these variables will have an impact on our main output indicators.

2.Systematic experiment

Repeat

Because there are some random initial variables, such as random human infection, etc., the same parameters were repeated 10 times and the results were averaged to minimize chance error.

Step endpoint

After pre-exploration, we found that the infection of Covid19 started to remain constant within 140 days, and the Step of this experiment was selected at 180 days as the longest days of the experiment was greater than 140 days and left a surplus of 40 days of steps.

/	grounded	Masked	Initial number of people	Number of repetitions	Total number of experiments
Explanation	Is the policy grounded	Does the policy require the wearing of a mask	Initial number of models	Number of repetitions of the same condition	/
Scope	[true, false]	[true, false]	[2000,4000, 6000,8000,10000]	/	/
Number in variables	2	2	5	10	2*2*5*10=200

Table1 Parameter list

- Results

Figure 1 is a graph of the results of this experimental investigation. It can be seen that the overall sum-sick,death-rate-treatment cost in total GDP is positively correlated, supposedly because more infections usually mean more deaths and more treatment expenditures.

Statistical indicators	Sum-sick	Death-rate	treatment cost in total GDP	average treatment cost %	sum-GDP
Explanation	The number of people who have won the new crown	Real mortality rate	Treatment spending as a percentage of total GDP	Percentage of total treatment costs for the two categories of grounding or sheep	TotalGDP
Formula	Sum(been sick)	= Number of deaths / Initial number	= treatment cost/Total GDP	=SUM(treatment cost in total; grounded=TRUE or False)	=GDP

Table 2 List of statistical indicators

grounded	Initial number of people	masked	sum-sick	death-rate	treatment cost in total GDP	average treatment cost %	sum-GDP
TRUE	2000	TRUE	20.67	0.0667%	0.8873%		427714.7
TRUE	2000	FALSE	20.33	0.1000%	0.8481%		426239.3
TRUE	4000	TRUE	45.00	0.0917%	0.9725%		841893.3
TRUE	4000	FALSE	44.00	0.0750%	0.9427%		850027.3
TRUE	6000	TRUE	71.00	0.0833%	1.0468%	0.9915%	1242963
TRUE	6000	FALSE	66.67	0.0889%	0.9545%		1274865
TRUE	8000	TRUE	95.33	0.1250%	1.0725%		1608657
TRUE	8000	FALSE	93.33	0.0958%	0.9952%		1694375
TRUE	10000	TRUE	125.33	0.1067%	1.1138%		2037827
TRUE	10000	FALSE	127.00	0.1233%	1.0820%		2117385
FALSE	2000	TRUE	27.00	0.1833%	0.8616%		558121.3
FALSE	2000	FALSE	35.67	0.1167%	1.1831%		558092
FALSE	4000	TRUE	72.00	0.1250%	1.1763%		1116065
FALSE	4000	FALSE	217.33	0.5167%	3.5198%		1107859
FALSE	6000	TRUE	169.67	0.2111%	1.8450%	18.9711%	1670695
FALSE	6000	FALSE	2937.67	4.6333%	33.8661%		1532711
FALSE	8000	TRUE	676.33	0.8458%	5.1289%		2205368
FALSE	8000	FALSE	6019.00	7.7125%	56.5912%		1909409
FALSE	10000	TRUE	3029.67	2.8800%	19.0183%		2657132
FALSE	10000	FALSE	8563.67	8.4467%	66.5208%		2319971

Figure 1 Experimental results data and its visualization

1. Grounded versus sheep herding

The columns of grounded, sum-sick, treatment cost in total GDP, and sum-GDP in Figure 1 show that the number of diseases, mortality rate, and treatment cost are all lower in the "grounded" model compared with the "sheep herding" model. The total GDP of the "no-footing" model is generally smaller than that of the "sheep herding" model, but the difference is not significant; when the initial number is 10,000, the treatment cost for "sheep herding" without a mask is 66% of the GDP. The required treatment cost was 66% of GDP, while the "sheep herding" model required only 1%. In the case of a larger initial population, the "sheep herding" mode cost more than 60% of the GDP for treatment.

2. Masks

In the "sheep herding" model, masks have a significant effect, reducing the number of infections by 94% at an initial population of 6000. There is also a clear economic benefit.

3. Initial number of people

In the "sheep herding" model, when the initial number of infected people is greater than or equal to 6000, the number of infected people and the mortality rate increase significantly, which means that there may be a threshold value for the initial number of infected people, and when it is greater than the threshold value, the infection effect of the epidemic increases dramatically, and the economic impact also increases dramatically.

Conclusion & Discussion

It is clear from the above experiments that, based on the research questions, it is concluded that although the total GDP generated by the "sheep herding" model is slightly higher than the "fencing" model, the social value generated, after deducting expenses, is much lower than the "fencing" model. The "fence" model produces far less social value after expenses are deducted. After all, the value of life can never be measured by GDP. Wearing masks is a good way to control the epidemic. When the initial number of people is low, the spread of the epidemic is not bad, but when a threshold is exceeded, the spread of the epidemic intensifies rapidly and the number of infected people increases rapidly, which can be explored further.
Although the procedure reflects the great difference in the economic impact of the two models. However, there are many areas of the model that need to be debated. For example, the lack of economic models (there is actually no economic model in this program, especially the simulation of the economic impact of the epidemic on different industrial structures, industry characteristics, etc.), the crudeness of the spread model (the agent in this program uses a completely random wandering, which is also inconsistent with real-life human activities, which makes it difficult to simulate this characteristic of community spread), and the implausibility of secondary spread (the The default in our program is not to re-infect after the cure, while the new crown is a secondary infection for the cured), etc. These are all areas for continuous improvement.

Bibliography

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