Network Simulation: Forecasting the Spread of COVID-19 under Different Reopening Strategies*

Meng Liu Raphael Thomadsen Song Yao

Olin Business School
Washington University in St. Louis

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*Please contact Liu (mengl@wustl.edu), Thomadsen (thomadsen@wustl.edu), or Yao (songyao@wustl.edu) for correspondence.

This note quickly lays out the network effect simulation. A unique feature of our model is that we estimate an exponent on the number of contagious cases. We include this flexibility because such a model fits the data much better, and also leads to forecasts that have more limited growth after an initial take-off of COVID-19 cases, as is commonly observed. We illustrate that the concave relationship we estimate for the number of contagious individuals on the number of new cases can come from social networks between people through a very simplified model of networks and disease process.

To do this, we simulate a network with the following process: We take 10,000 individuals. We create a network by first randomly assigning that any two individuals will be joined with a common node with probability 11/20,000. Call these connections "round-1 friends." We then expand this network by assigning each node to have an edge with each of the friends of round-1 friends with a probability of 0.8.

We assume that the disease spreads with the following process. We seed 4 individuals to have the disease in period 0. Then in each period we assume that any connected individual will get sick with probability 0.4.

After simulating this process, we then regress $(\ln(y_t) - \ln(S_t)) = c + \omega \ln(y_{t-1}) + \varepsilon_t$. The mean value for $\hat{\omega} = 0.57$. This shows the plausibility of network effects leading to an estimate in the range that we have estimated in our main model. We have placed the R code for this simulation at `https://github.com/songyao21/covid_data_depot/network_simulation`, so that interested readers can play with the parameters to understand the process more.