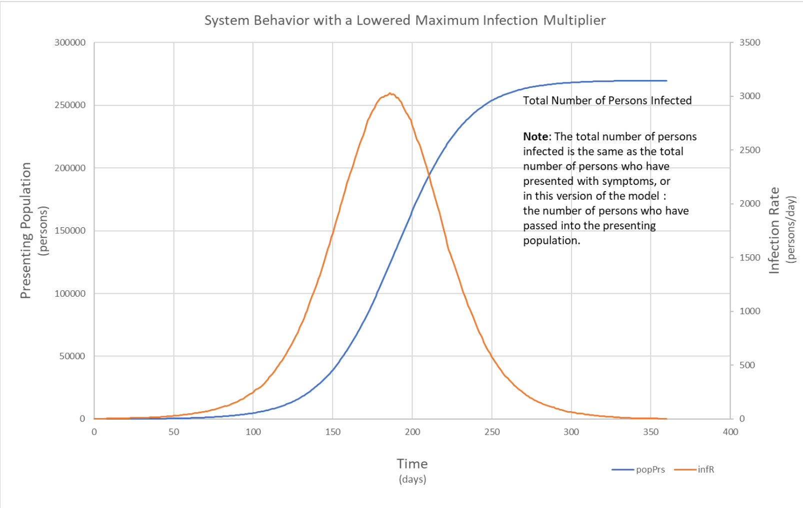

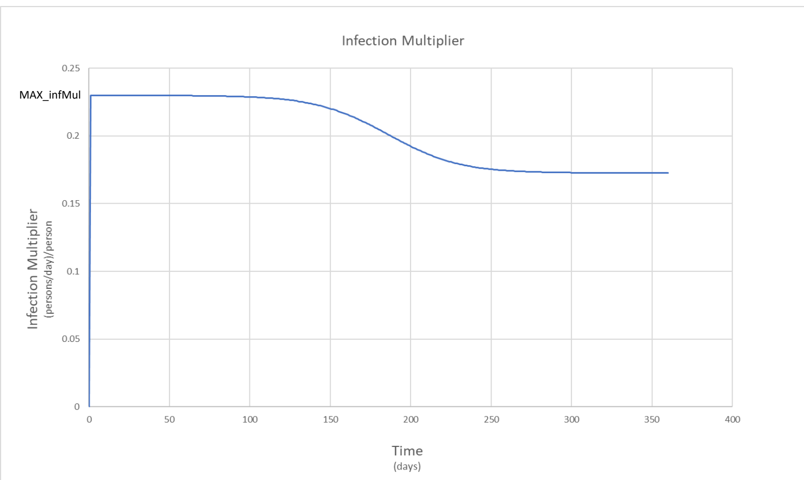

System behavior with a lowered maximum infection multiplier

Prerequisites:
Article: COVID-19 Dynamics Part One: Infection Dynamics
Input/Output Table: Analysis Title: Comparison of the effects of different maximum infection multipliers

Analysis:
We ran the model with a maximum infection multiplier—MAX_infMul—of 0.23 in conjunction with an incubation period of 3 to 7 days distributed uniformly with an expected value of 5 days. This dictates an expected value of 0.20 as the equilibrium infection multiplier(1). This numerical value is confirmed by looking at the data file: Run_01, or by referring to the plot of the infection multiplier in the adjoining chart. Note that 0.20 is the inflection value of this time series. As it should, this value corresponds precisely with a change in the slope of the infection rate—infR— between negative and positive, as can be seen in the chart above.

In this simulation we have purposefully chosen a value of MAX_infMul just above the equilibrium value of the infection multiplier—infMul—in order to simulate a population in a given region adopting measures to mitigate the spread of the virus. This model does not explicitly include a protective measures section; that is intended to be implemented in Part Three, of this Article series. But for simulating protective measures with this model, lowering the MAX_infMul will have exactly the same effect. Protective measures are by definition designed to lower the infection multiplier. Just remember, though, that the actual MAX_infMul of this virus is much higher than 0.23. Some estimates have it as high as 0.5. We have shown you the results of that value in our previous Analysis.

In a fully exposed population, an infection multiplier starting at 0.5 can decimate an entire population in a matter of days. From start to finish the entire process takes less than two months. In addition the rate of infection ramps to a fully visible exponential rate of growth after only a couple of weeks. Contrast that behavior with that of a MAX_infMul of only 0.23: the one we have chosen for this simulation. That value does not produce a steady state condition, but does take at least 100 days to begin to ramp up to visible exponential proportions. But, regardless of its low initial value, by halfway through the year, we are looking at an infection rate of at least 3,000 people per day! That all due to a miserly 0.03 difference in the number of people capable of being infected by another person in one day! That is the insidious nature of exponential growth.

What looks to be a plus, however, is the total number of people who have actually been infected. It tops out near 270,000. That is "only" 25% of the total population. Contrast that number with those in the fully exposed population of the previous analysis, with a MAX_infMul equal to 0.50, which tops out at 1,067,214, which is 99% of the total population!

In this simulation our protected population drops down to an infection rate of only a few people per day after a full year of taking all sorts of measures to keep the infection rate as low as possible. Even so, for much of that time, they have experienced an extremely elevated infection rate through no fault of their own!

Policy Analysis
The population in this simulation spends nearly two months in sheltering mode in order to keep the infection rate low. At the end of that period, the infection rate continues to be mostly steady at 40 people per day, or growing very slowly. In such a society, there would be a lot of public pressure for people to get back to school and work. And who could deny that the low rate of infection doesn't warrant a release from lockdown status? So the consensus would probably be to eliminate the lockdown conditions; businesses, schools, and churches would reopen, and crowds would once again congregate at sporting events, restaurants, theaters, and political rallies… And the pundits would proclaim that extreme measures need not have been taken in those locations where the disease was not actually concentrated. What they don't realize is that the remaining small incubating population will be busily reseeding the infection among thousands of people. The susceptible population will end up in a worse state than they were ever in during the lockdown, with infection rates that could run into the *hundreds of thousands* per day. Society as they knew it would cease to exist.

Our actual situation on the ground at the moment is somewhat different, but not by a lot in most areas of the country. The value of the infection multiplier is larger in some regions and smaller in others. The question as a matter of public policy is what course of action should we take in regions that are locked down, and have reasonably low infection rates? You already know the appropriate answer.

We know that even if you maintain those low infection multipliers by sheltering and other mitigation efforts, you are still going to see what appears to be an inexplicable rise in the infection rate. In our opinion the only course of action that makes sense is to remain in lockdown, allowing perhaps 25% of the original workforce who have had the disease to return to work during the year Their antibodies will fully protect them from reinfection. The rest of the population need wait for a proven vaccine or a curative drug. We should advise the general populace, now, of the rather long period of time they will be spending physically isolated from one another. And we should be focusing on building an economy that takes advantage of a personal workspace at home.

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1. The equilibrium value of the infection multiplier—infMul—represents the value at which the number of people becoming infected is just equal to the number of people exiting the infectious state. At that point the rate of growth of infections on a daily basis will neither be increasing or decreasing, which is confirmed by the data. The equilibrium infection multiplier is computed by dividing 1 by the number of days that a person remains infectious and capable of transmitting the virus to another person or persons. In this model we have assumed that transmission can only occur while a person remains in the incubating population—popInc.

If unfamiliar with the computation of finding the equilibrium infection multiplier, think of it this way. As infectious people leave the infected state their numbers decrease, and their capability as a group to infect people would decrease as a result. But if they can replace themselves, i.e., add one more infectious person to the infected population before they leave the group, then they can retain their numbers. In this model, the amount of time that an infectious person spends being infectious occurs only while they are in the incubating population: a most dangerous state because they are asymptomatic at that time. In this simulation an infectious person spends an amount of time in the incubating population an average of five days. (The I/O table specifies a min and max value of 3 and 7 days, respectively. The average value is thus (3 +7)/2 = 5 .) Since the newly infected person has on average five days to replace themselves before they leave the incubating state, if they can infect 0.2 people/day (on average) over that period, then they can insure the addition of exactly one person in the incubating (infectious) population. Simply dividing 1 (person) by 5(days) gives the needed replacement rate of 1/5 = 0.2 persons/day, which is the equilibrium value of the infection multiplier.