NEUBERGER BERMAN

Neuberger Berman Data Science Team

CHIEF DATA SCIENTIST: Michael Recce

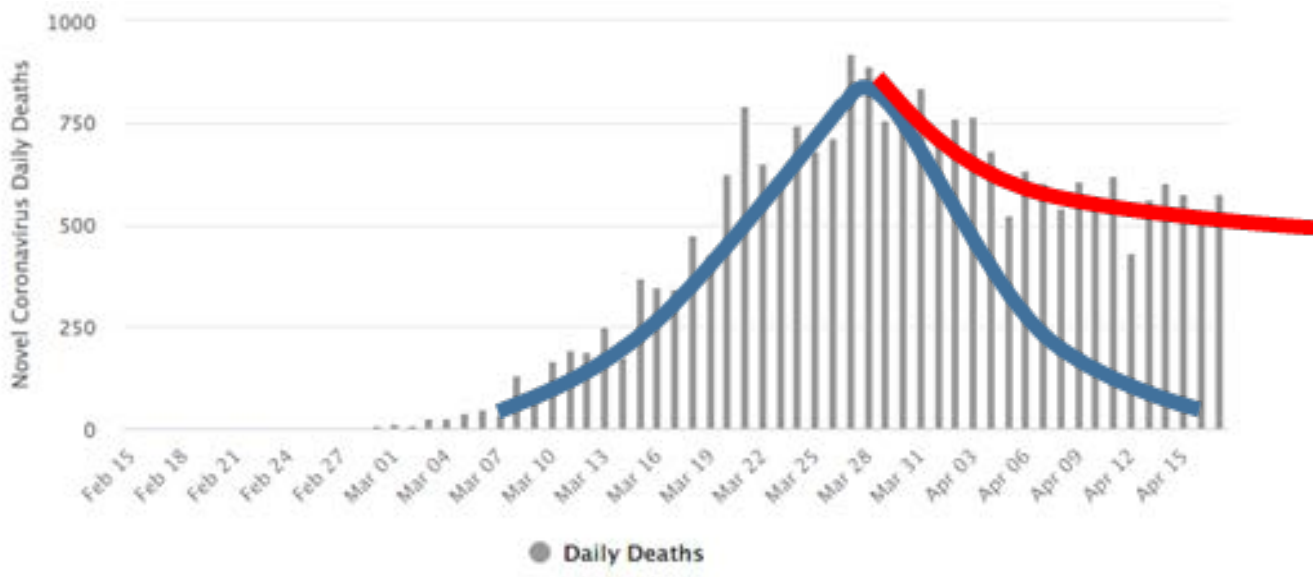
The Road Back – What the Data Says

The global spread of COVID-19 has moved into a new phase. In most of Europe and the U.S. the peak in positive cases and deaths in the first wave have occurred or will likely occur in the next two weeks. The path to fewer active cases is different than the path of increasing cases that we just experienced.

The Path Back Is Longer

The peak is not symmetric, and the ultimate shape of the curve will likely depend on the effectiveness of "social distancing", testing, and borders. As discussed in a prior note, the impact of interventions depends on how much it reduces the transmission.[1] The average transmission from an infected person (the reproductive number or "R0") is a combination of some who are infecting many others, some who are infecting few others, and many who are efficiently isolating themselves and not infecting anyone—it is a Pareto distribution following the "80:20 rule."

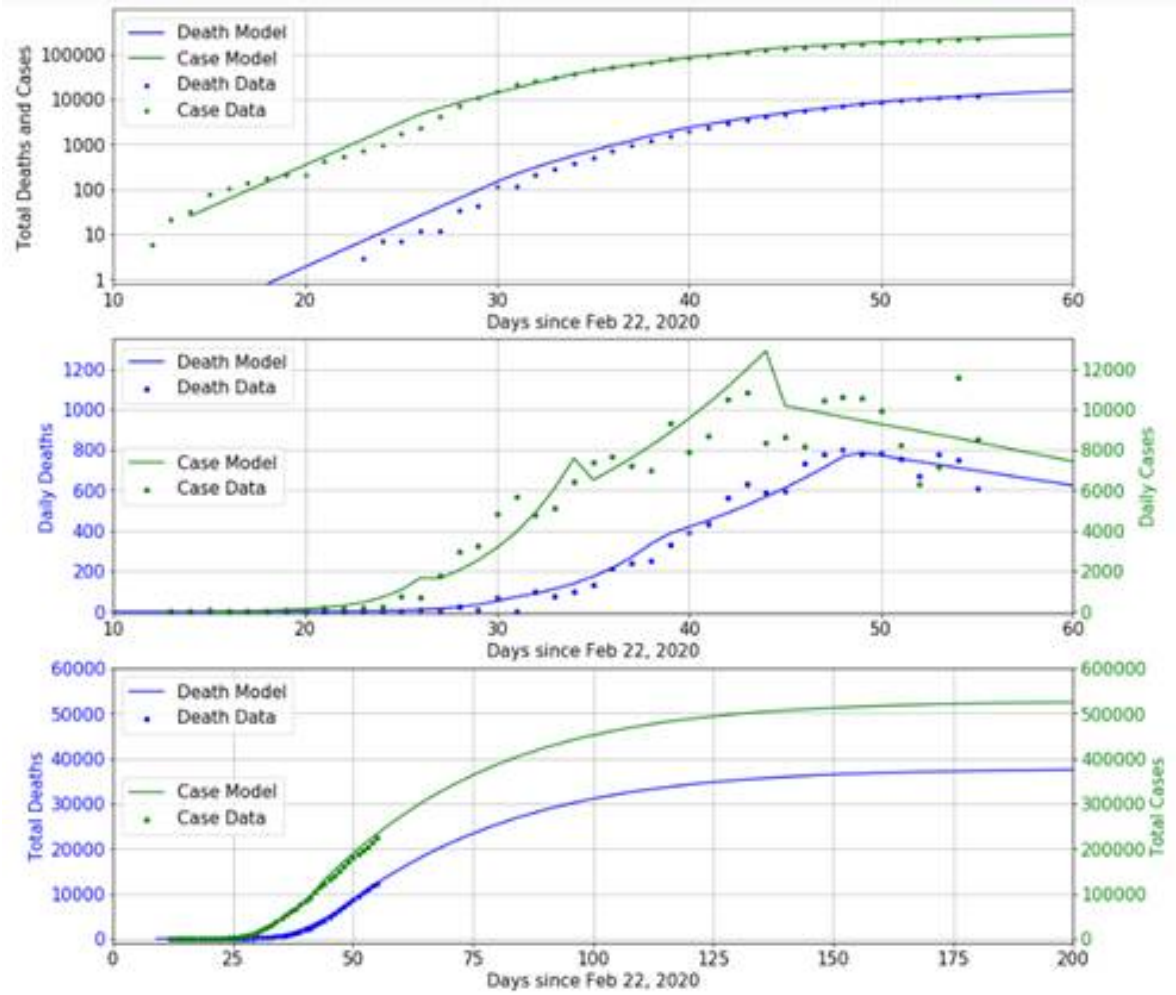
The graph below shows the daily number of deaths in Italy, where the R0 was 0.75—in other words, 100 people with the SARS-COV2 virus (that causes the COVID-19 disease) infected 75 other people.



Worldometers.info (as of April 18)

The graphs on the following page are a fit of the cases and deaths in Italy to a Susceptible, Infected, Recovered (SIR) pandemic model. The model is fit with piecewise intervals of time during which specific interventions are in place. The fit predicts that **1.5% of the Italian population (approx. 1 million people)** are infected and that it could take **five to six weeks** before the reported positive cases decrease to less than **1,000 per day**. It could potentially take closer to **10 weeks** for the actual positive cases to fall to this level, since it is likely that only 25% to 40% of the positive cases are detected at current levels of testing. One thousand new cases per day is one of the proposed criteria for reopening the economy in Italy.

[1] "April is the Cruelest Month"



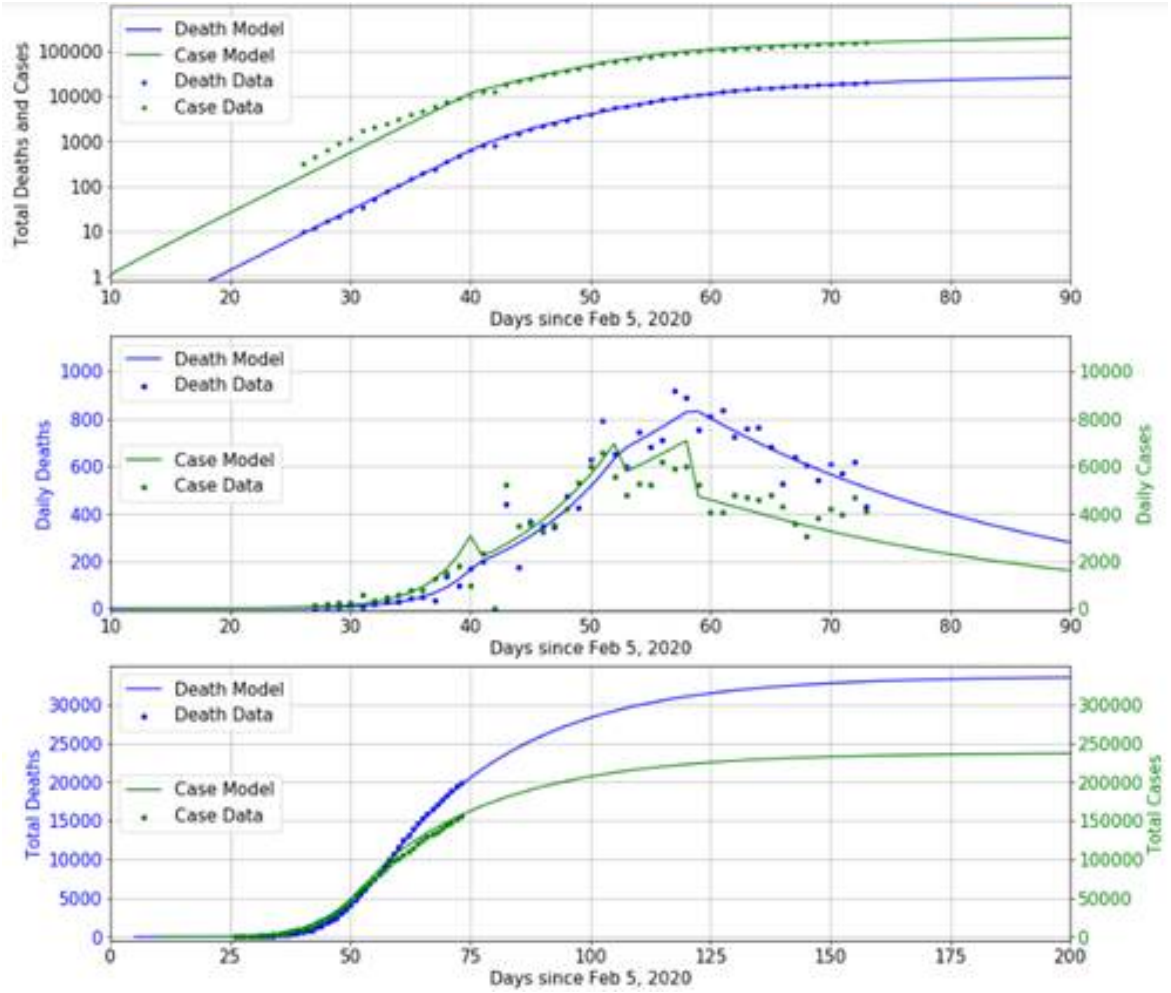
Source: Neuberger Berman, data from Johns Hopkins (as of April 18)

New York—The Epicenter

New York has been following Italy with a lag of about two weeks, and the peak daily deaths during the first wave of the spread appears to have passed—which is great news. However the R0, as measured by the model below, is 0.9 (10 people are infecting nine others, on average). That is larger than the 0.75 R0 for Italy. This may improve with additional data, but it could mean that intervention has been more effective in Italy, and it will likely take longer for the same amount of decline in New York. As shown in the charts below, the model projects **9 — 10 weeks** for the reported positive cases to decrease to **1,000 per day**, and **12 — 13 weeks** for the actual positive cases to reach that level. The threshold of 1,000 new cases per day may be small enough to make contact tracing possible. The Institute for Health Metrics and Evaluation (IHME) model predicts a faster decline in deaths and positive cases, based on a further reduction in R0 in the coming weeks.

The Neuberger Berman Data Science team's model predicts that 5% of the population of New York State will likely be infected during the first wave, and total deaths (without an effective new treatment) will likely exceed 30,000.[2] These numbers could be significantly lower were R0 to be decreased.

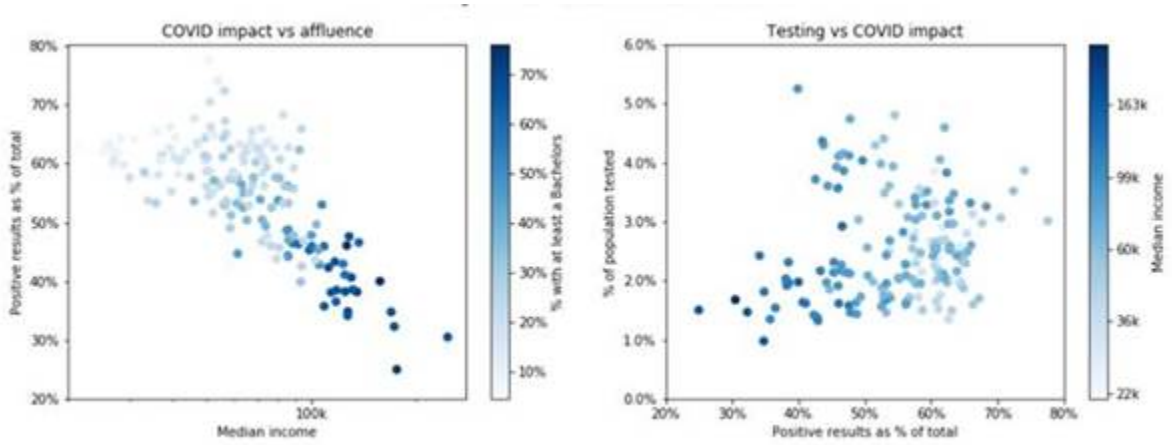
[2] Update: COVID-19 Cases in New York State. Towers, Terri. 1 April, 2020.



Source: Neuberger Berman, data from Johns Hopkins (as of April 18)

COVID-19 Continues to Spread in New York

The charts below show the results of testing in New York by zip code as of April 16. Based on the charts the number of positive cases are higher in less affluent zip codes. Also, the effectiveness of testing, as measured by the percentage of positive tests, shown with shading in left panel, is lower in less affluent zip codes. This could be due to the higher proportion of essential workers living in these areas. A further decrease in R0 could be reached by increasing the number of tests done in these areas.



Source: Augvest (as of April 18)

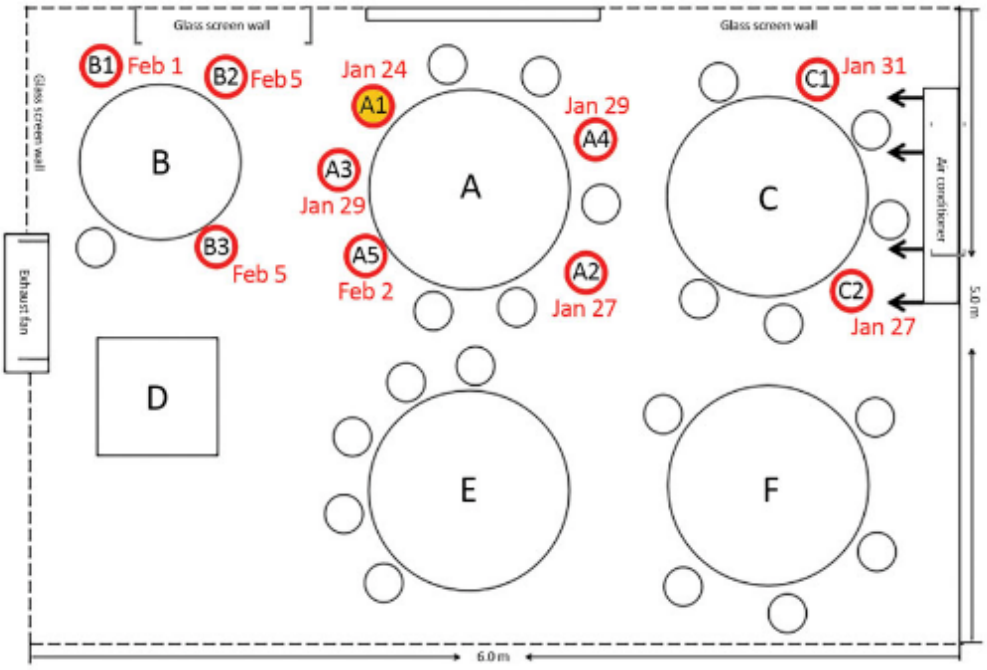
Silent Infection

In a Nature Medicine paper published on April 15, Xi He and colleagues used data to model the measured viral load (the amount of the virus in an infected person's body) and the infection process in 77 pairs of transmissions.[3] In their model of the data the Coronavirus is present 2.3 days prior to symptoms, resulting in 25% to 69% of the infections occurring in the pre-symptomatic time period. Peak viral load occurred at the time of the onset of symptoms, in contrast to similar viruses. With SARS, infectiousness increases 7 — 10 days after symptom onset, for example, while influenza is characterized by increased infectiousness around the onset of symptoms.

On April 7, 2020, the Center for Disease Control and Prevention (CDC) published a study by Sanche and colleagues that analyzed the spread of COVID-19 in China.[4] Their work increased the consensus view of the contagiousness of the disease from an R0 of around 3 to an R0 of 5.7, which could be compared to an R0 of 1.5 for the flu and 12 for measles.

These properties make SARS-COV2 particularly difficult to contain, and to trace. Contact tracing needs rapid, effective testing, but it also requires large teams of trained people to perform the tracing and a manageable number of active cases. Japan and Singapore both have developed highly organized contract tracing methods, and in both cases, as of April 18, even a moderate relaxation of quarantine is resulting in a second wave of infections.

On April 18, an early release article from the CDC (Jianyun Lu, et.al vol 26:7) describes the results, from contact tracing, of the spread from one individual (A1 in the diagram below) to nine others at nearby tables in a restaurant.[5] They model the role that the air conditioning unit may have had, and evaluate the distances involved in infection.



Source: Lu J, et. al (Ref 5)

Apple and Google are developing a smart phone app that could assist in the tracing process. If everyone in this restaurant were using this or a similar app, the contact tracing could work in the following way. Each person would have previously downloaded the app on their phones, and it would be running in the background. On each phone, at the start of the day, each phone would generate a unique one-day key. Every 15 minutes during the day the app would exchange, via Bluetooth, the one-day key with all of the other smartphones that are in range, producing a log of all of the contacts during each day for each phone within range of Bluetooth. At some future date, when a person tests positive, that person can choose to identify anonymously all of the recorded contacts that occurred in the past two weeks. Several countries, including Singapore and Korea have deployed similar apps.

[3] He, X., Lau, E.H.Y., Wu, P. *et al.* Temporal dynamics in viral shedding and transmissibility of COVID-19. *Nat Med* (2020). https://doi.org/10.1038/s41591-020-0869-5

[4] Sanche S, Lin YT, Xu C, Romero-Severson E, Hengartner N, Ke R. High contagiousness and rapid spread of severe acute respiratory syndrome coronavirus 2. Emerg Infect Dis. 2020 Jul [*date cited*]. https://doi.org/10.3201/eid2607.200282

[5] Lu J, Gu J, Li K, Xu C, Su W, Lai Z, et al. COVID-19 outbreak associated with air conditioning in restaurant, Guangzhou, China, 2020. Emerg Infect Dis. 2020 Jul [*date cited*]. https://doi.org/10.3201/eid2607.200764