



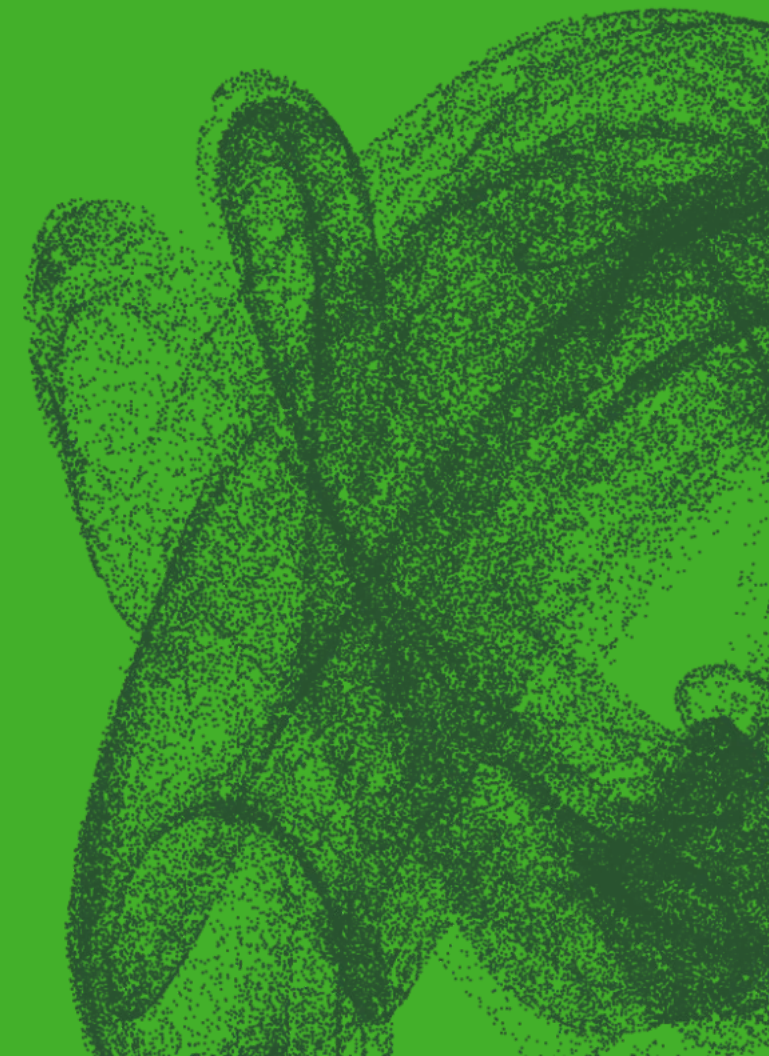
IQVIA COVID-19 Active Cases Curve Simulator

July 16, 2020

Murray Aitken, Executive Director, IQVIA Institute, SVP, IQVIA

**Yilian Yuan, SVP, Global Data Science and Advanced
Analytics, IQVIA**

Copyright © 2020 IQVIA. All rights reserved. IQVIA® is a registered trademark of IQVIA Inc.
in the United States and various other countries.



Contents

- + Introduction
- + Caveats
- + Modeling approach
- + Validation
- + Results
- + For more information

Introduction

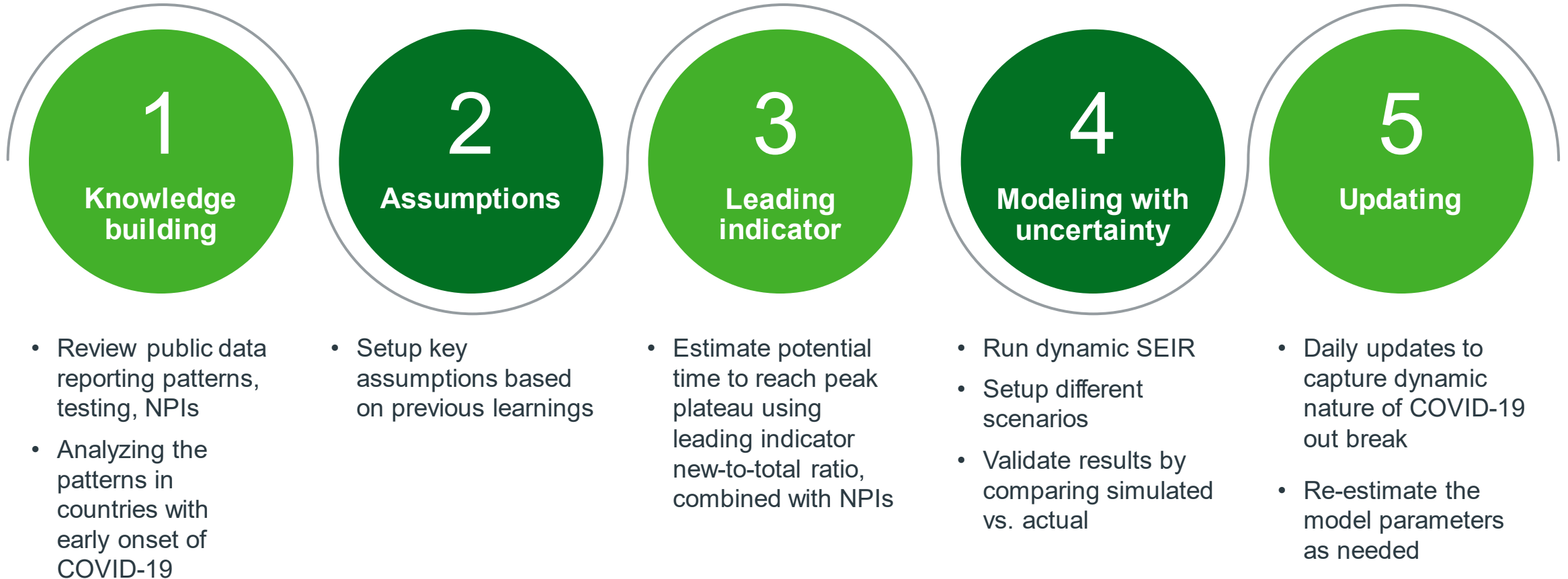
- This COVID-19 Active Cases Curve Simulator has been developed by the IQVIA Data Science and Advanced Analytics team as a tool to help stakeholders make decisions based on the level and trajectory of active cases in their country, region or state
- The core of the model is the Susceptible-Exposed-Infectious-Removed epidemiology model, and inputs are from publicly available sources updated daily
- The simulator focuses on “total active cases” as a metric that speaks to the overall impact COVID-19 is having, not just limited to hospitalizations or deaths (where other models are focused, e.g. IHME). We believe the active cases curve will be used by public health officials – along with other considerations, such as availability of testing – to guide their decision-making on modifying stay-at-home rules
 - Active cases are those confirmed diagnosed cases, excluded those that have recovered or died.
- The simulation shows the number of active cases (per population), shape of increase of the curve, timing of the apex of the curve and the shape and timing of the decline from the apex.
- Scenarios are labelled as “normal”, “optimistic” and “pessimistic” based on the following
 - “Normal” scenario means the model parameters are derived to fit most closely to the actual reported public data
 - “Optimistic” scenario is the lower bound, assuming people closely follow nonpharmaceutical interventions (NPIs), and reference what was achieved in other countries with similar characteristics
 - “Pessimistic” scenario is the upper bound, assuming people do not closely follow NPIs and time from exposure to diagnosis takes longer than reported in the literature

Caveats

- As with any model, the IQVIA COVID-19 Active Cases Curve Simulator is dependent on the quality and completeness of public data sources. In the course of developing and updating this model over the past several weeks, we have noted several cases of data gaps and inconsistencies e.g. weekend reporting practices, distinguishing PCR and antigen testing levels.
- The active cases curves are modelled based on the current level of mitigation practices remaining in place over the next 150 days. We would expect some change in those practices as the number of active cases declines and testing increases. The curves are not predictions of what will happen. They are simulations of what will happen based on data to date and assuming mitigation practices remain in place.
- The model is updated daily and with the addition of each day's new data, the simulator necessarily adjusts the future levels and curves of active cases. Therefore, changes in the model output can and should be expected from day to day.
- We can provide simulations at the sub-national level for select countries, because subnational level is of greatest relevance and interest. The sub-national level simulations are based on public data reported on state, regional, provincial or county boundaries.
- Simulations assume continuation of current mitigation strategy. Interpret with caution.
- As the non-pharmaceutical interventions are being relaxed, these will be taken into consideration for future simulation updates.

Modeling approach

A data-driven approach to build simulation models for multiple countries, at national and regional levels



Data sources

- Johns Hopkins University Center of Systems Science and Engineering (JHU CSSE): <https://github.com/CSSEGISandData/COVID-19>
- Ministère des Solidarités et de la Santé (Department of national health and public affaire of France): <https://raw.githubusercontent.com/opencovid19-fr/data/master/dist/chiffres-cles.csv>
- European Centre for Disease Prevention and Control: <https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide>
- Instituto de Salud Carlos III (Spain): <https://covid19.isciii.es/>
- Government of Canada: <https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection.html>
- Ministry of Health of Italy: <https://github.com/pcm-dpc/COVID-19>

Dynamic SEIR Compartmental Model

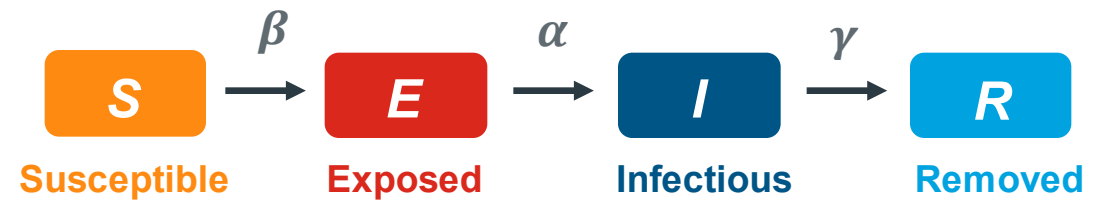
Assumptions

- $N = S + E + I + R$, N is the total population
- Assume the population size remains constant;
- The infectious rate β is changing over time;
- Exposed group estimated by projection factor (scaling up parameter) based on confirmed cases
- Initialize average duration of recovery is 14 days, which is similar to SARS;
- Initialize average incubation period as 14 days(time-to-confirmed period);
- Initialize death proportion in Removed group is 2%.

Model training

- Contact rate estimated from historical data based on predefined function (see right)
- Scaling-up parameter and time-to-confirmed period will be adjusted based on learning from other countries.
- Simulation bands are generated based on different scenarios:
 - Normal
 - Optimistic
 - Pessimistic

SEIR



β , the infectious rate, controls the rate of spread;

α , the incubation rate, the rate of latent individuals becoming infectious;

γ , the recovery rate, is determined by the average recovery duration.

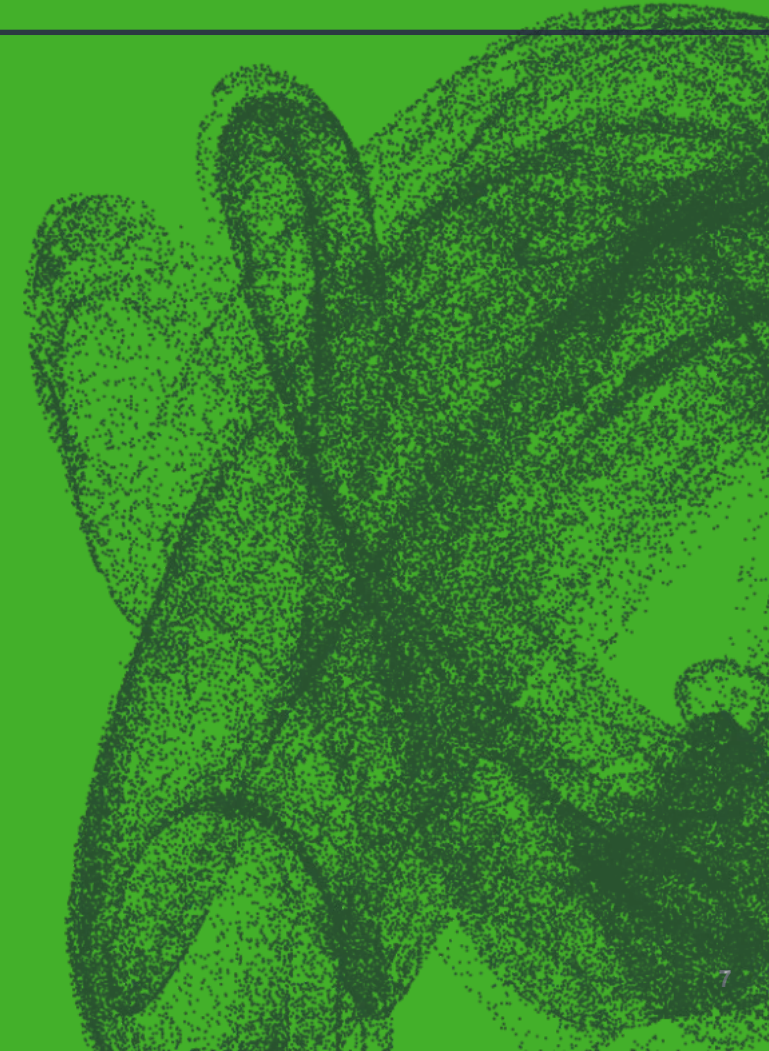
Dynamic Contact Rate β as a function of time t

Due to the unawareness of the public and virus variation, β increased in the early stage, then decrease due to non pharmaceutical interventions being implemented:

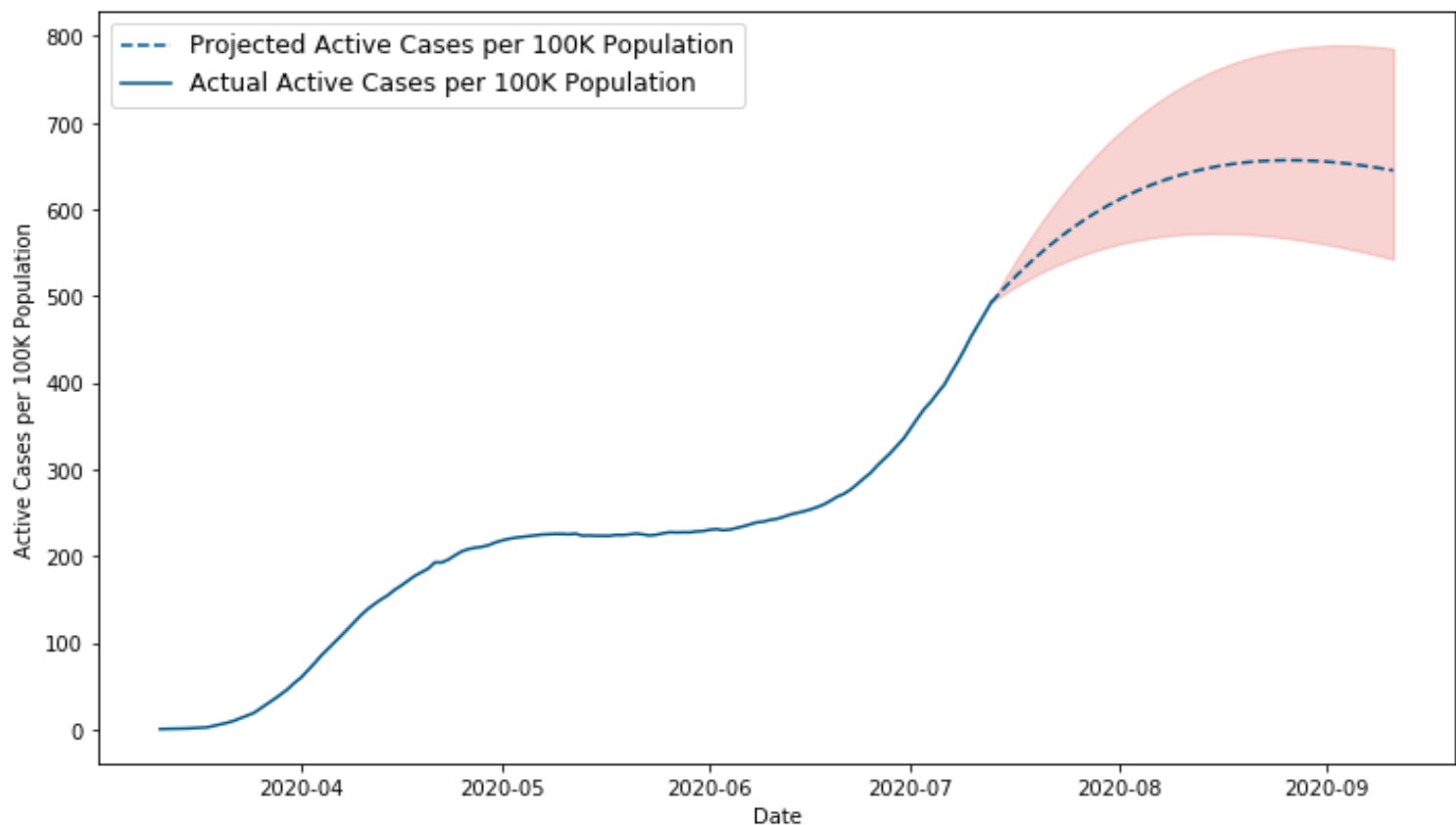
$$\beta(t) = \frac{C e^{-\alpha(t+b)}}{(1 + e^{-\alpha(t+b)})^2}$$



US



Simulation band of active cases in next 60 days in US

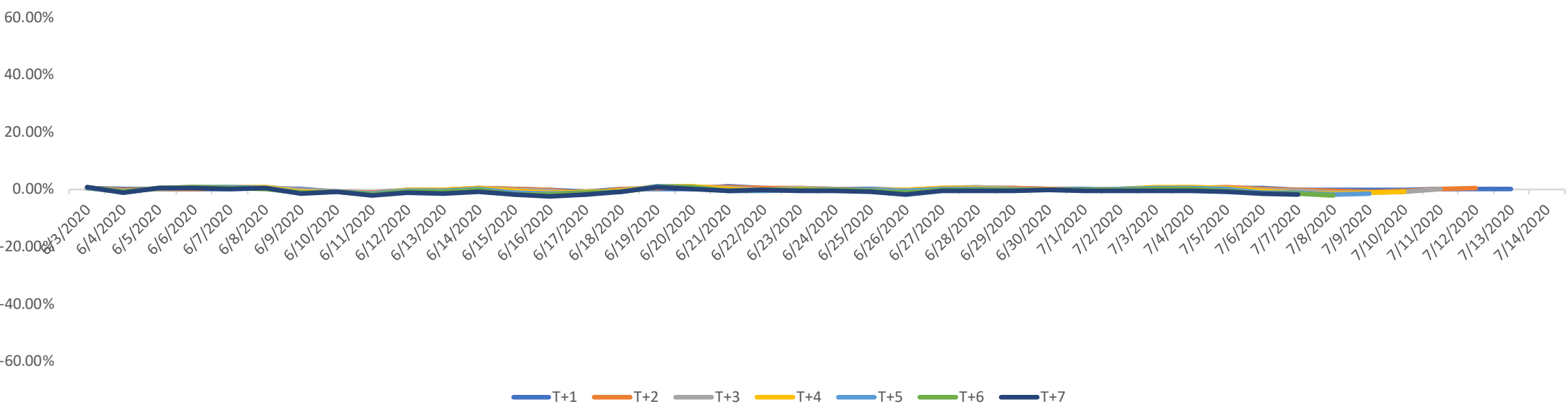


| | Projected total confirmed cases | Projected total confirmed cases per 100k population |
|----------------------|---------------------------------|---|
| Optimistic Scenario | 5.4M | 1635.8 |
| Normal Scenario | 5.9M | 1803.5 |
| Pessimistic Scenario | 6.7M | 2038.6 |

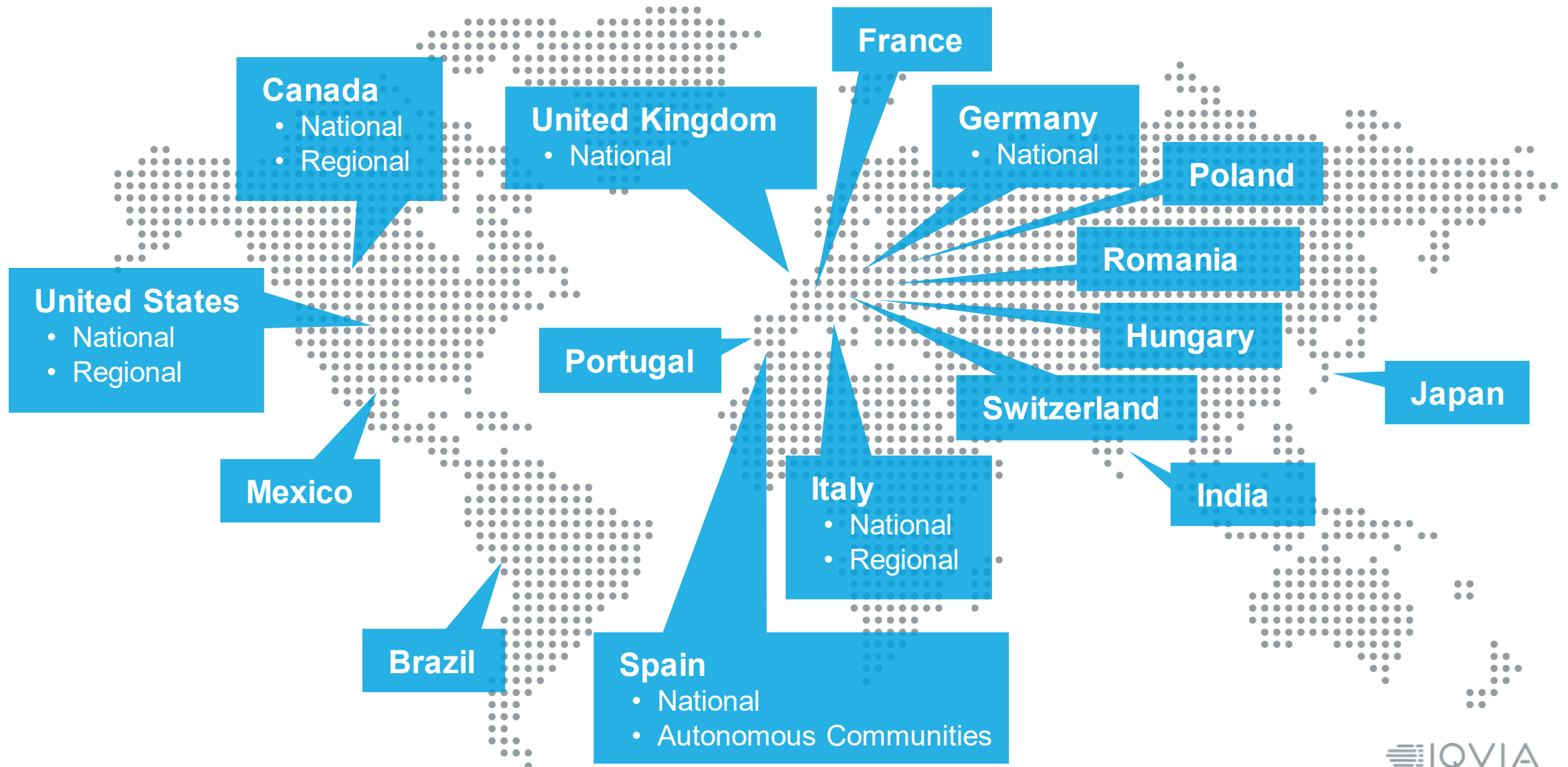
Note: Shaded area is the range of values that is likely to include the correct projected estimate for a given data category. Wider band can result from limited data availability, small studies, and conflicting data, while smaller band can result from extensive data availability, large studies, and data that are accurate and transparent. The model presented has 3 scenarios and is represented by the shaded area(s) on each chart. The simulation will be further updated due to gradual opening-up of states, regions, and/or countries. Updated July 14, 2020

Validation results for US

*Predicted vs actual cases deviation in US
Jun 03– Jul 14*



COVID-19 Simulation Platform has been created for multiple regions and countries





For more information and to request simulations for additional countries

Contact info@iqviainstitute.org

Visit www.iqviainstitute.org/institute covid19