A Literature Review: Estimation of COVID-19 curves

- Title: Estimation of COVID-19 spread curves integrating global data and borrowing information
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A Literature Review: Estimation of COVID-19 curves

- Information on the disease is very limited and scattered even if it exists
- One of the major challenges in estimating an infection trajectory is the heterogeneity of the country populations
- Integrating global COVID-19 data is suggested to capture the crucial changes in infection trajectory with a unified view
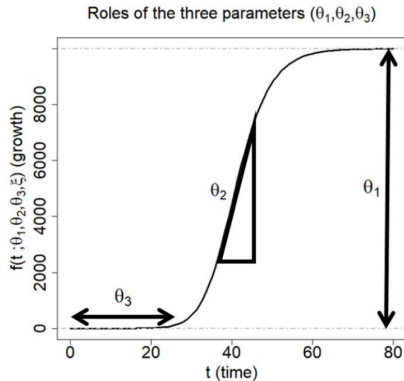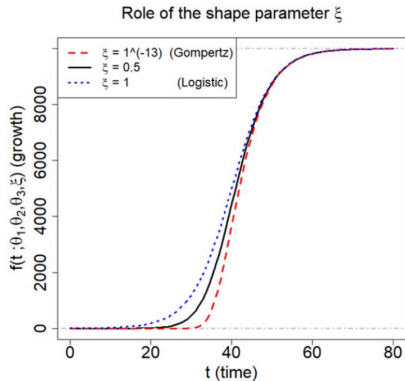
Richards growth curve models

Figure: Description of the Richards growth curve model.

Bayesian hierarchical Richards model (BHRM)

BHRM is a Bayesian hierarchical model based on the Richards curve.

Models

1. $y_{it} = f\left(t; \theta_{1i}, \theta_{2i}, \theta_{3i}, \xi_i\right) + \epsilon_{it}, \quad \epsilon_{it} \sim \mathcal{N}\left(0, \sigma^2\right)$
2. $\theta_{li} = \alpha_l + \mathbf{x}_i^\top \boldsymbol{\beta}_l + \varepsilon_{li}, \quad \varepsilon_{li} \sim \mathcal{N}\left(0, \sigma_l^2\right), \quad (l = 1, 2, 3)$
3. $\xi_i \sim \log \mathcal{N}(0, 1), \quad (i = 1, \cdots, N)$
4. $\beta_{lj} \mid \lambda_{lj}, \tau_{lj}, \sigma_l^2 \sim \mathcal{N}\left(0, \sigma_l^2 \tau_l^2 \lambda_{lj}^2\right), \quad \lambda_{lj}, \tau_{lj} \sim \mathcal{C}^+(0, 1)$

Gibbs Sampling and Elliptical Slice Sampling

- To sample from the full joint density, use a Gibbs sampler to exploit conditional independences among latent variables

- Find the full conditional distributions of all parameters except ξ_i to approximate posterior distributions by Gibbs Sampling

- Since the full conditional of ξ_i is not expressed in a closed form, use elliptical slice sampling to approximate
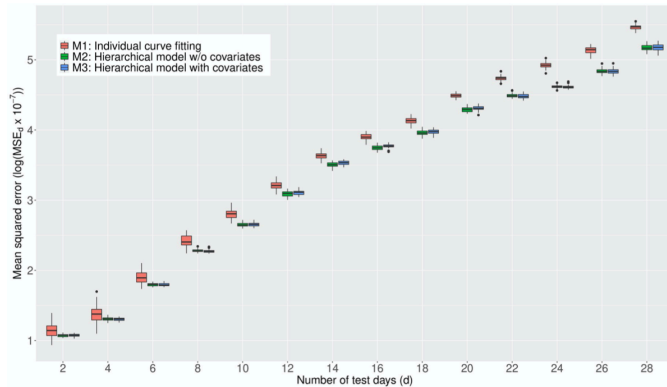
Results

Figure: Comparison of the MSE obtained by the three models.
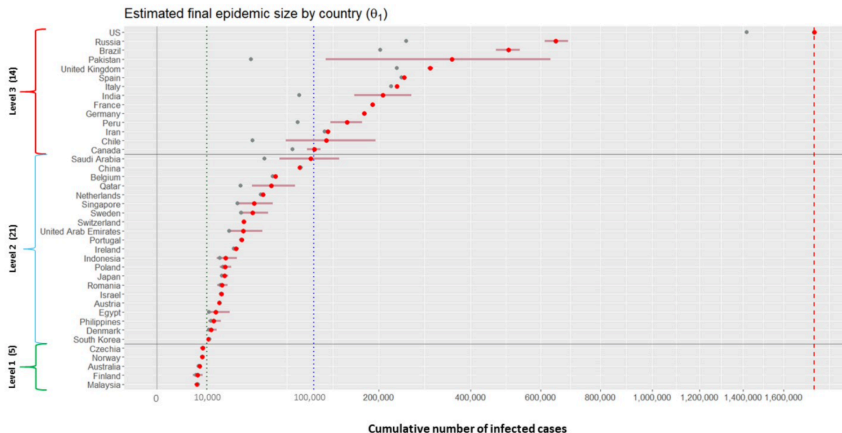
Limitations

Figure: Estimation results for the final epidemic size for 40 counties.

Plan of Actions

- Integrate COVID-19 data in 2021 and apply the model to the accumulated data

- Figure out potential predictors such as a vaccination rate and apply it to the model

- Analyze the data by the continents and compare with original model

Reference

- Lee, S. Y., Lei, B., & Mallick, B. (2020). Estimation of COVID-19 spread curves integrating global data and borrowing information. PloS one, 15(7), e0236860.