Country Specific semiparametric model of COVID 19

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Introduction

The novel coronavirus, COVID-19, originated in China and has spread across the globe very rapidly. As of 6 April 2020, there have been almost ~70000 death and ~1.3 million infection (https://www.worldometers.info/coronavirus/) across the world due to the coronavirus pneumonia pandemic(COVID 19). The COVID 19 pandemic also causes ~4000 infection and ~100 death India as on 6th April, 2020. Hence , we are here exploring the temporal distribution of daily infection and mortality rate due to COVID 19 across worstly affected countries and compare the same against India. Further we are also dynamically exploring the time to pick, time to dip and time to plateau through a semiparametric framework.

Country Specific semiparametric model for daily COVID-19 infection rate

Let $\{y_{it}, x_{it}\}$ be the daily count of the infection of COVID 19 and time scale on day t, since first infection reported in i^{th} country. A semiparametric country specific Poisson regression model is assumed as follows

$$logE\{y_{it}\} = f_i(x_{it}) \qquad (1)$$

Where, $f_i(.)$'s are assumed to have mixed effects model structure of penalized spline with polynomial basis function(Wand, 2003) as follows

$$f_i(x_{it}) = \alpha_{i1} + \alpha_{i2}x_{it} + \alpha_{i3}x_{it}^2 + \cdots + \alpha_{ip}x_{ip}^p + \sum_{k=1}^{K} u_k(x_{it} - \kappa_k)_+^p \qquad (2)$$

Let $\kappa_1, \kappa_2, \ldots, \kappa_K$ be a set of distinct knots in the range of x_{it} and $X_+ = \max(0, X)$. The number of knots K is fixed and large enough to ensure the flexibility of the curve and p is the order of polynomial. The bam() function in the R library mgcv with country specific (interaction) penalized cubic spline is used to generate following curves in Figure 1. The above is adjusted for country specific population.

Country specific trend analysis and comparison

The movement of the country specific curve of cumulative infection rate over time is further analyses and compared by first order derivative. The first order derivate of any function $y = f(x)$ at a given $x = a$ is the slope of the curve at a. Hence first order derivative of the equation (2)

for each country is derived by a simulation and bootstrap confidence interval of the slopes are also derived. Further the curve $f'(x)$ for different countries are compared. A curve is supposed to be plateauing after a time point if simultaneous CI beyond that point include '0'.

Figure 1: The figure compares the daily infection rate of select countries per one million population. The bottom panel is in log infection scale to get a better visibility and comparability. The curve of China and South Korea are depicting that they are at end of the pandemic, whereas Spain, Germany and Italy have already experienced the pick and now the trend is downward. However other countries including India are yet to experience the pick.

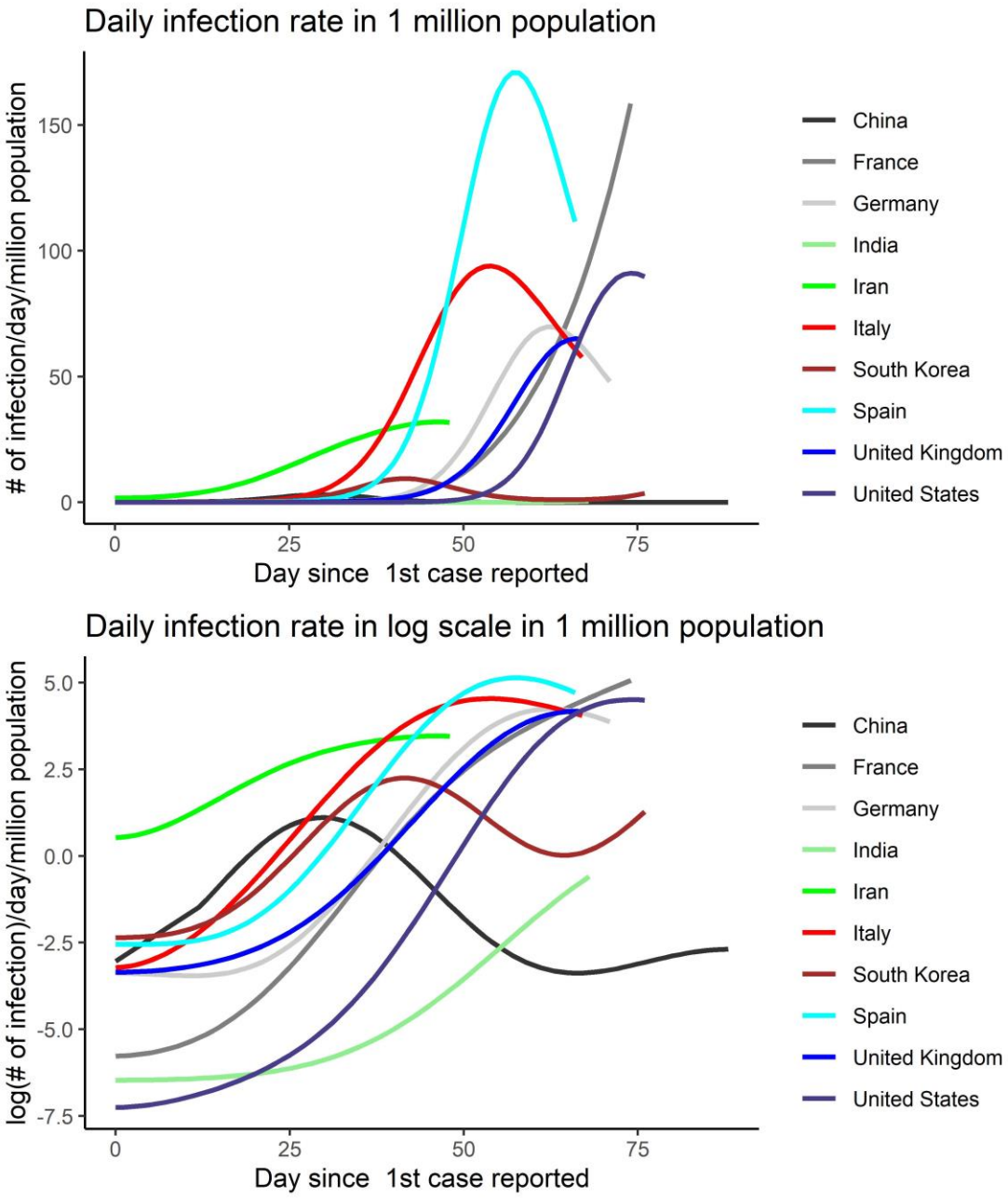

Figure 2: The figure compares the daily death rate of select countries per one million population. The curves for mortality are also depicted the same as infection rate.

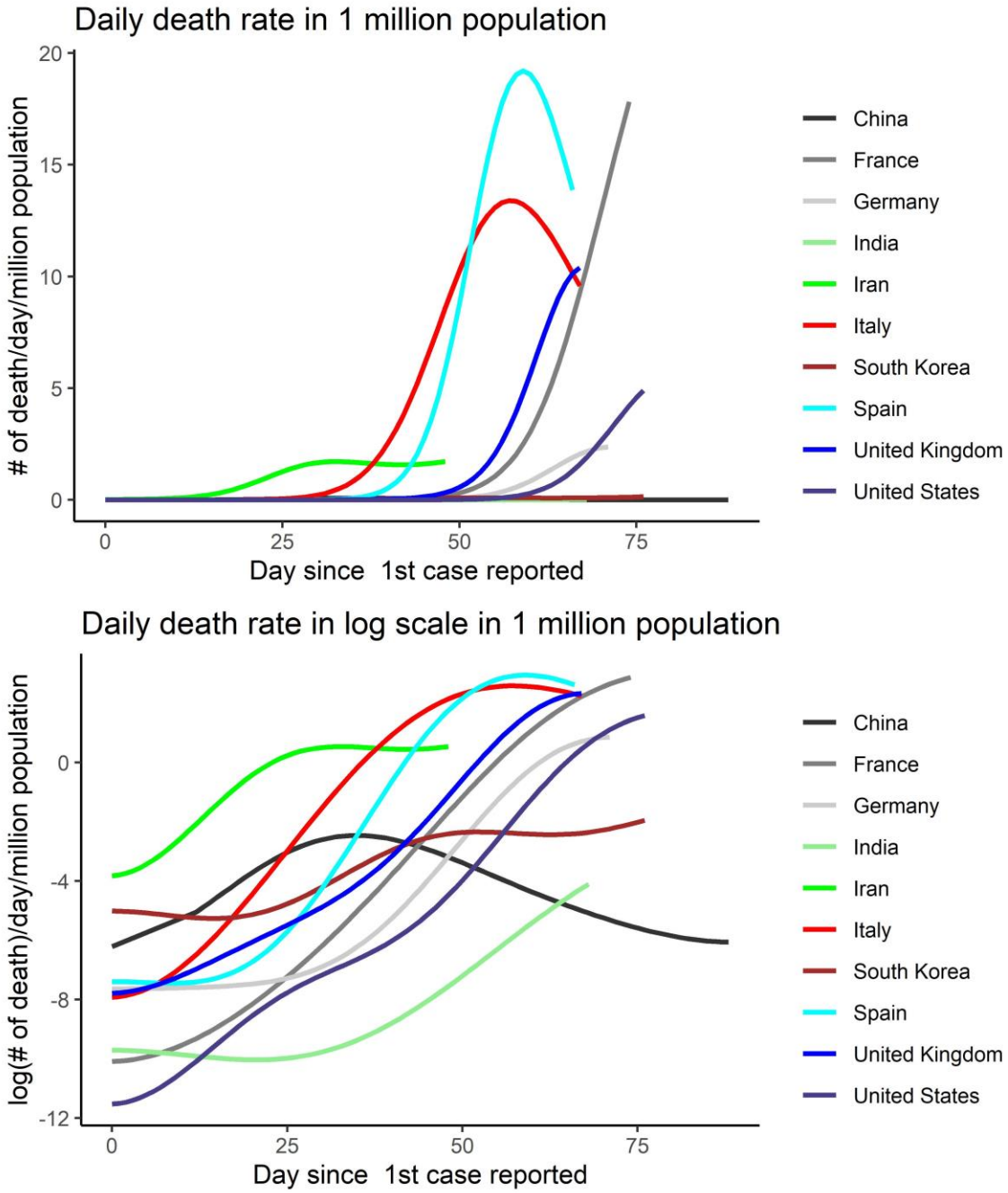

Figure 3: The figure shows the daily COVID 19 cased in India since 1st case reported. The vertical dashed lines are the days on which different intervention was taken place by GoI. India is yet to reach at its pick of infection rate. Instead of having multiple interventions, cases are increasing very rapidly.

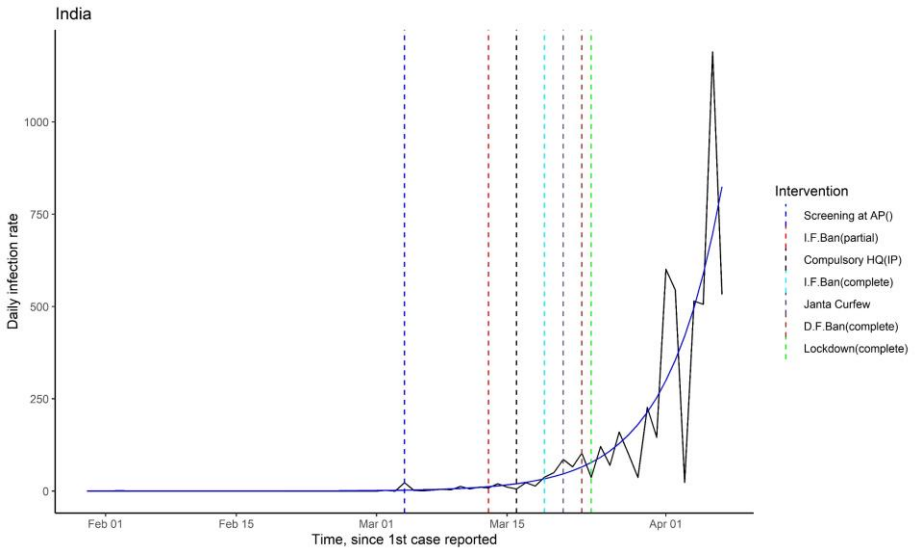

Figure 4: Figure depicts the changes in slope of the curve of cumulative infection rate in India. The curve depicts a constant increase of cases at present. The plot indicates that the number of cases is increasing almost at a constant rate at present in India. There was a short-term dip in starting March, however with a poor confidence because of very limited infection during that period. we tried methodology for detection of time to peak, plateau or dip and the results are still inconclusive. We will keep repeating this analysis for the first evidence of a downturn

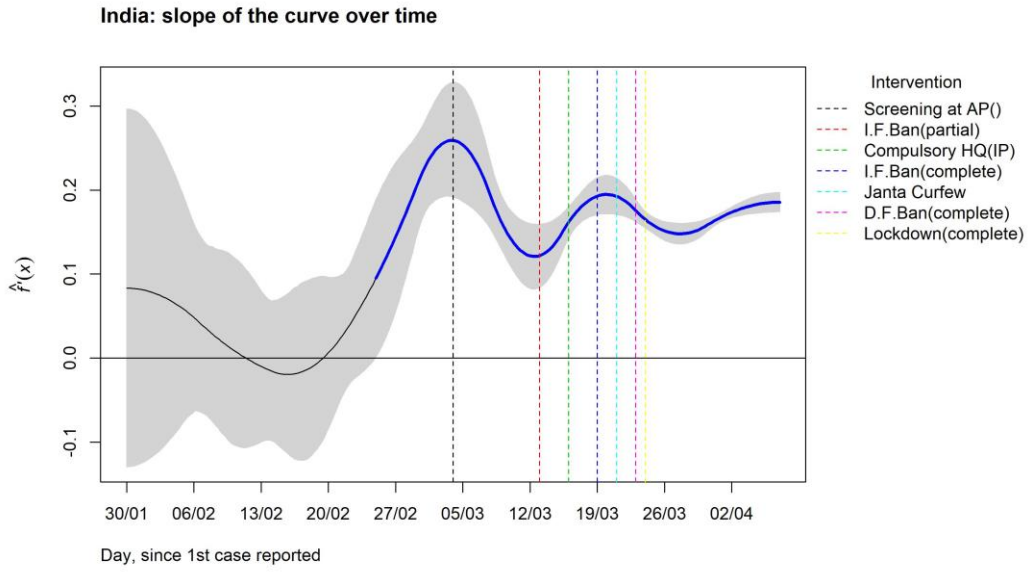

Figure 5: The figure compares the 1st order derivatives of country wise curve of cumulative COVID 19 infection rate. A curve is supposed to be plateauing if it touches '0' line and simultaneous 95% confidences there on include '0'. The plot shows only the curves of China and South Korea have reached at plateau. The curves France, India, USA and UK are moving at constant space at present.