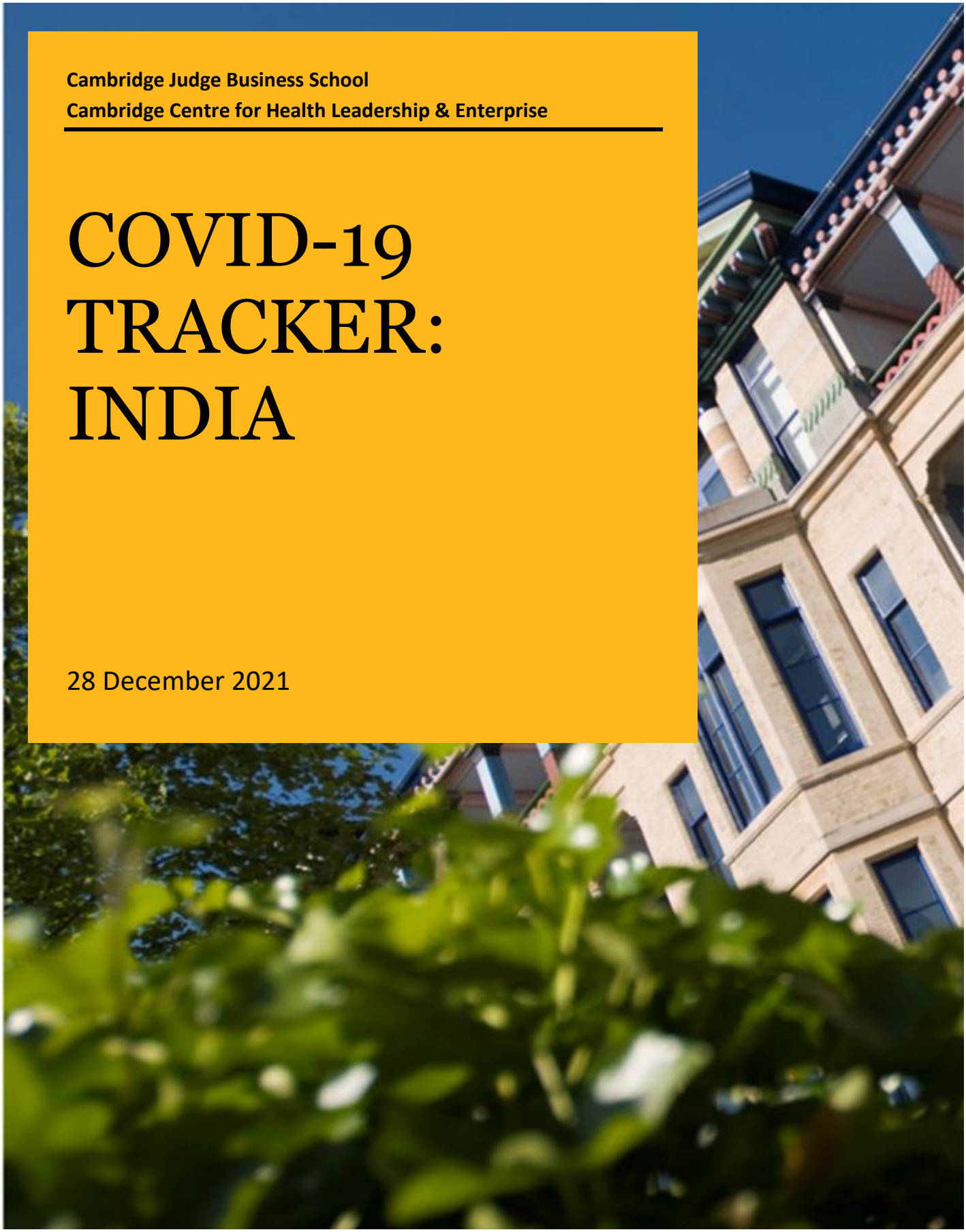
Cambridge Judge Business School
Cambridge Centre for Health Leadership & Enterprise

COVID-19 TRACKER: INDIA

28 December 2021



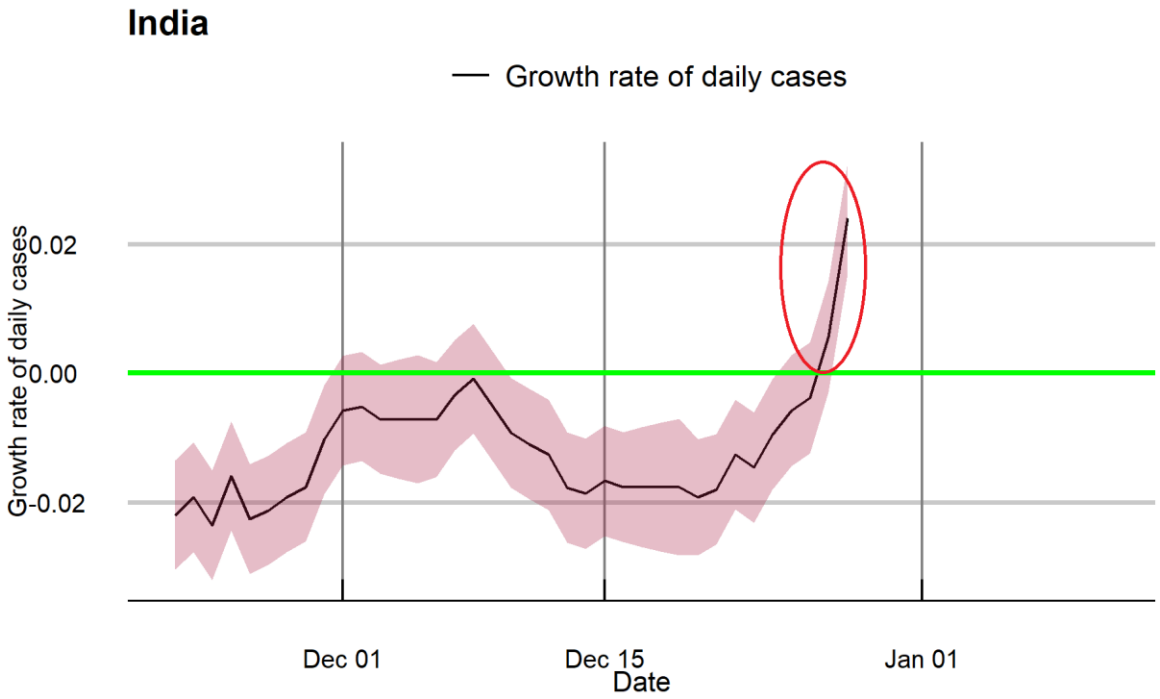
Centre for Health Leadership & Enterprise
UNIVERSITY OF CAMBRIDGE Judge Business School
HSTP Health Systems Transformation Platform
National Institute of Economic and Social Research

Twelve Indian states ***(Jharkhand, Delhi, Bihar, Gujarat, Rajasthan, Haryana, Uttar Pradesh, Maharashtra, Chhattisgarh, Goa, Madhya Pradesh, Punjab)*** *were of significant concern as of 28 December, experiencing rapid growth in infection, with their* ***filtered daily growth rates*** *of new COVID-19 cases exceeding 5% and trending further upward. Reproduction numbers of these states exceeded 1.3 on 28 December.*

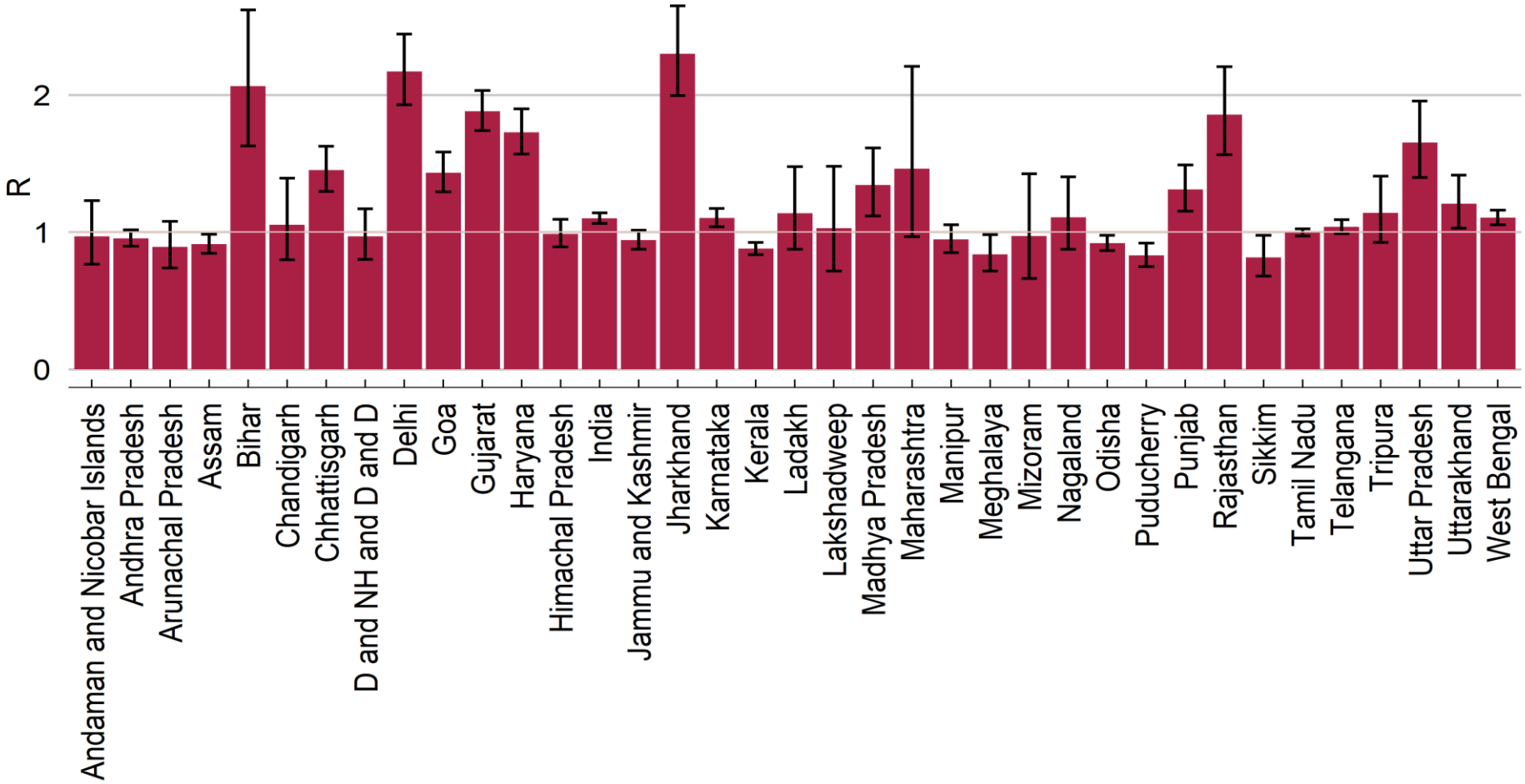
In addition, ***West Bengal****,* ***Karnataka*** *and* ***Uttarakhand*** *are of concern, with their* ***filtered daily growth rates*** *of new COVID-19 cases exceeding 2% and reproduction number exceeding 1.1, as of 28 December.*

At the national level, the ***filtered daily growth rate*** *of new COVID-19 cases was 2.4% on 28 December with a trend that is increasing. Reproduction number was 1.1.*

Filtered daily growth rates of new cases: days leading up to 28 December



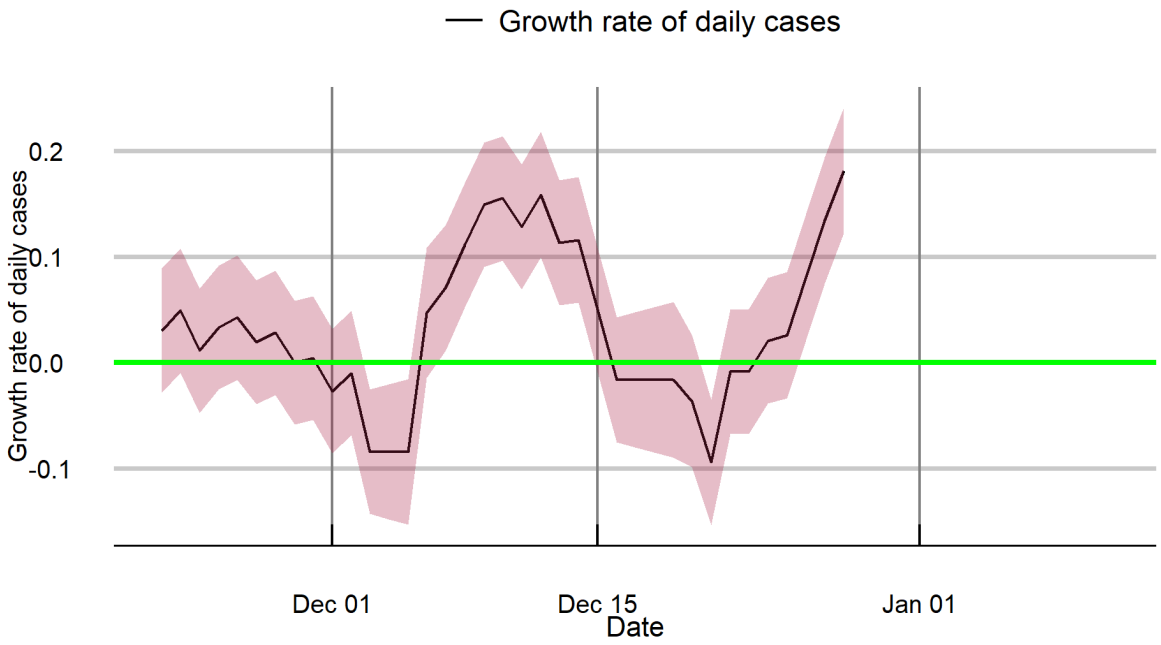
Reproduction numbers on 28 December 2021



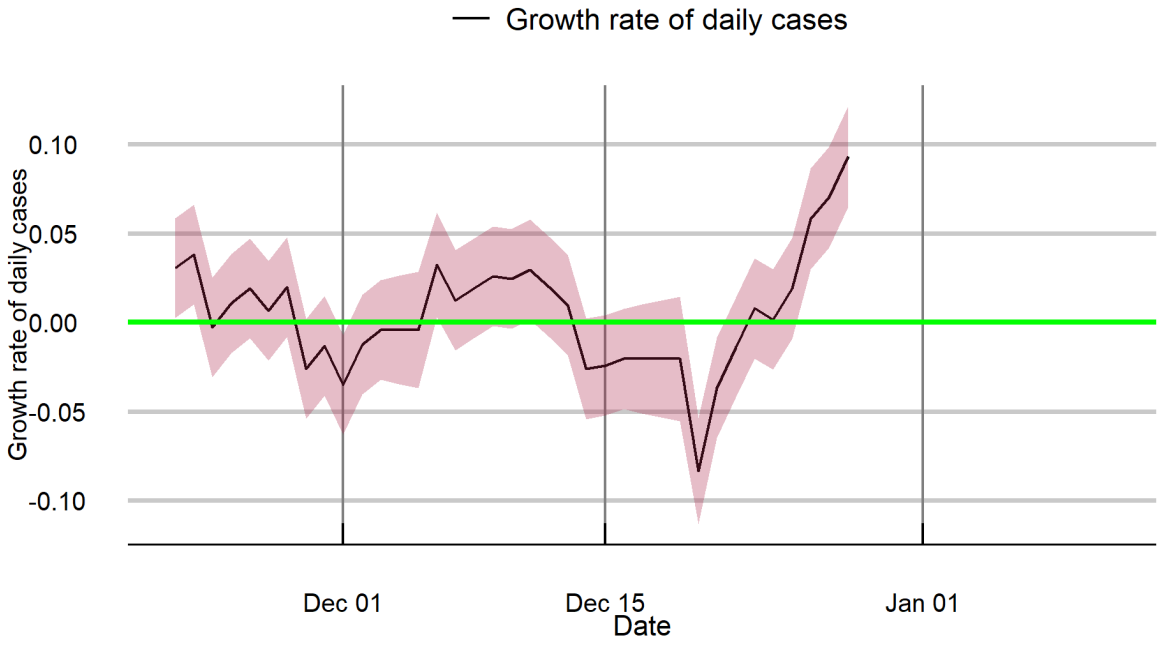
Bar chart shows point estimates of R and the ± 1 standard deviation confidence intervals

`	Reproduction number on 28/12/2021	Filtered daily Growth rate on 28/12/2021
India	**1.10**	**2.4%**
Jharkhand	2.30	20.8%
Delhi	2.17	19.4%
Bihar	2.06	18.1%
Gujarat	1.88	15.8%
Rajasthan	1.86	15.5%
Haryana	1.73	13.6%
Uttar Pradesh	1.65	12.6%
Maharashtra	1.46	9.5%
Chhattisgarh	1.45	9.3%
Goa	1.43	9.0%
Madhya Pradesh	1.34	7.4%
Punjab	1.31	6.7%
Uttarakhand	1.21	4.7%
West Bengal	1.11	2.5%
Karnataka	1.10	2.4%

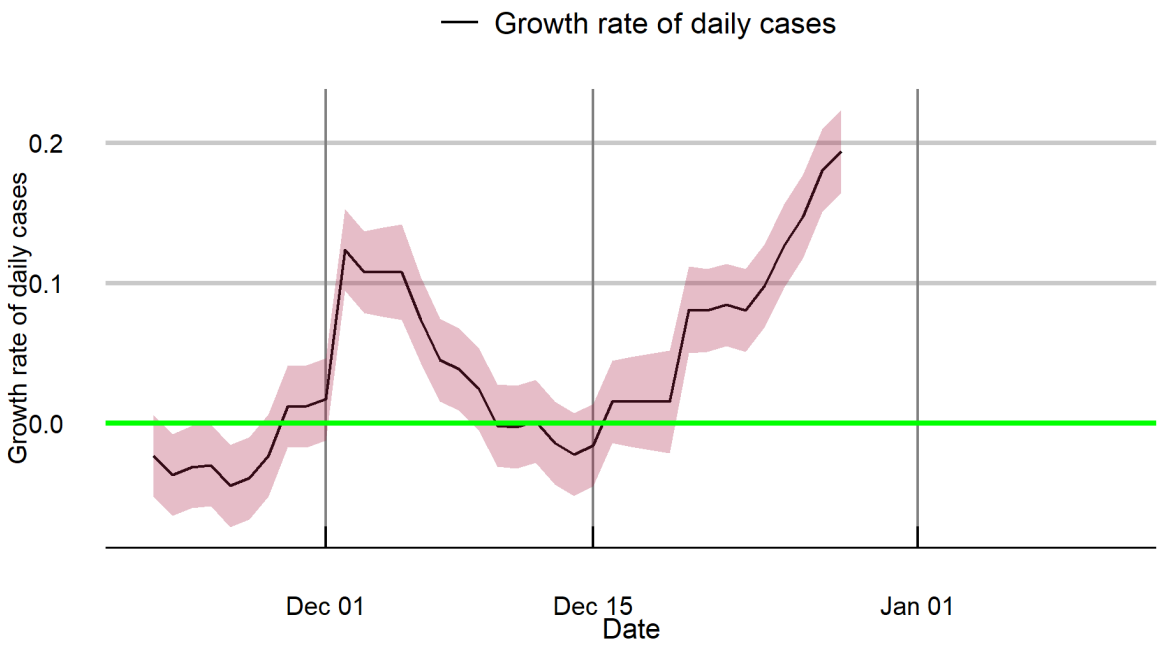
Bihar



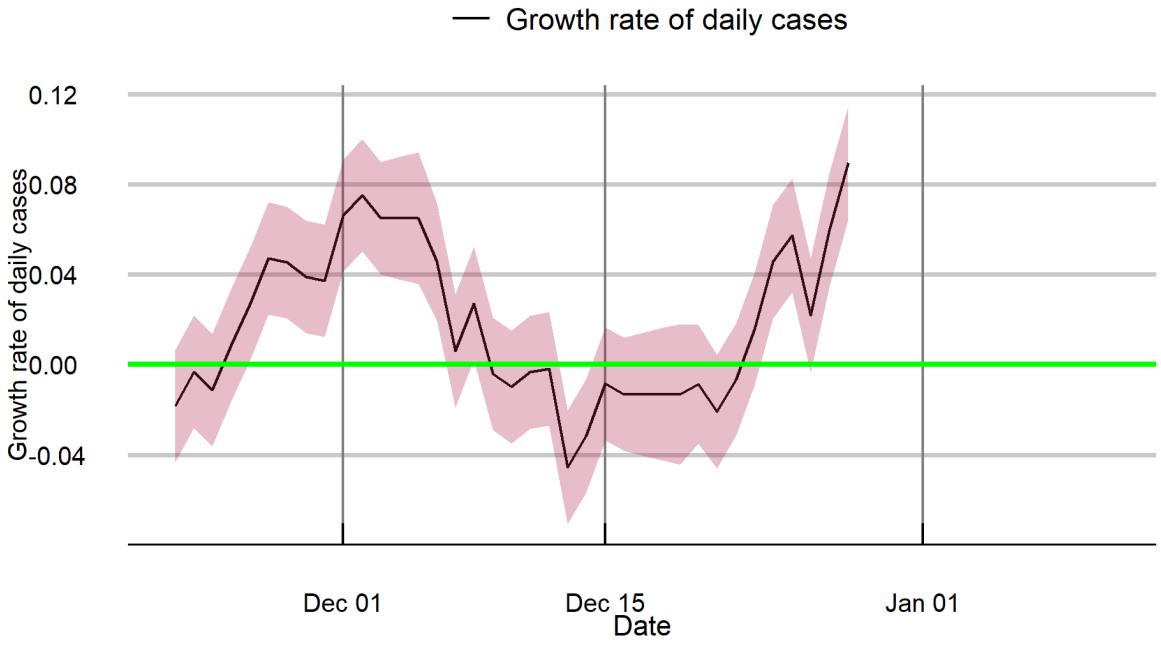
Chhattisgarh



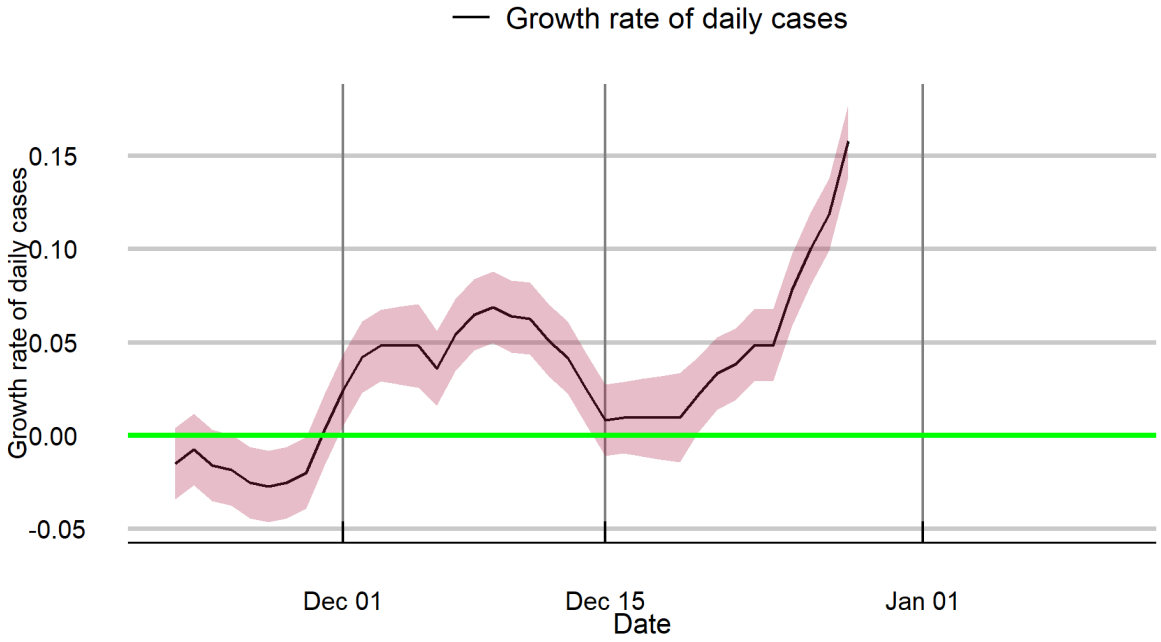
Delhi


Growth rate of daily cases
0.2
0.1
0.0
Growth rate of daily cases
Dec 01
Dec 15
Jan 01
Date

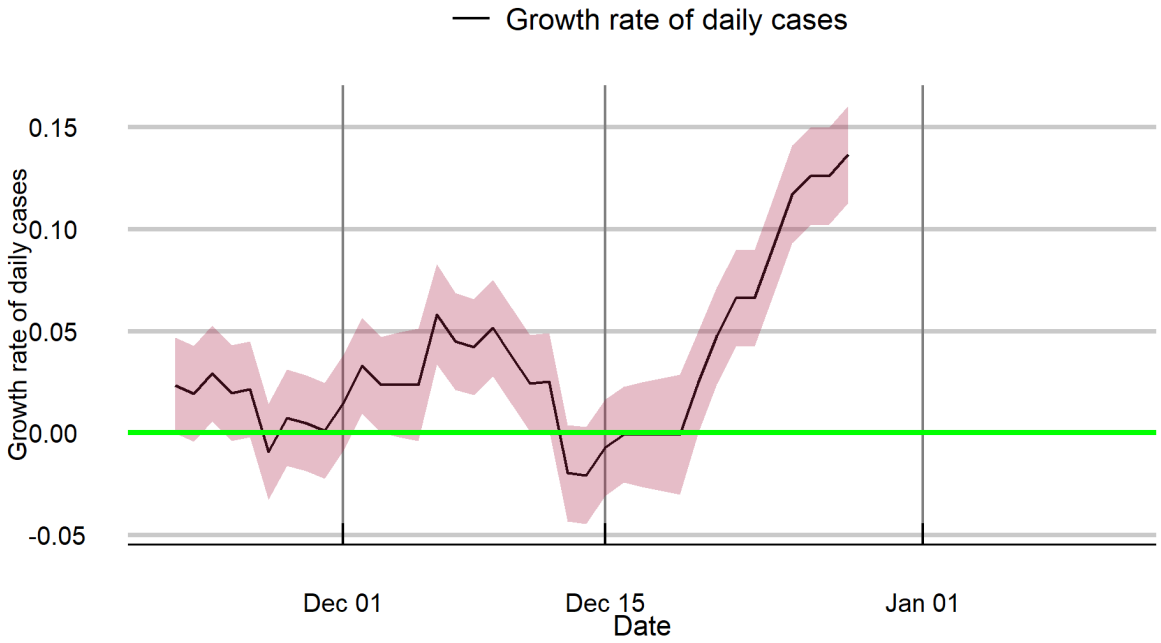
Goa


Growth rate of daily cases
0.12
0.08
0.04
0.00
-0.04
Growth rate of daily cases
Dec 01
Dec 15
Jan 01
Date

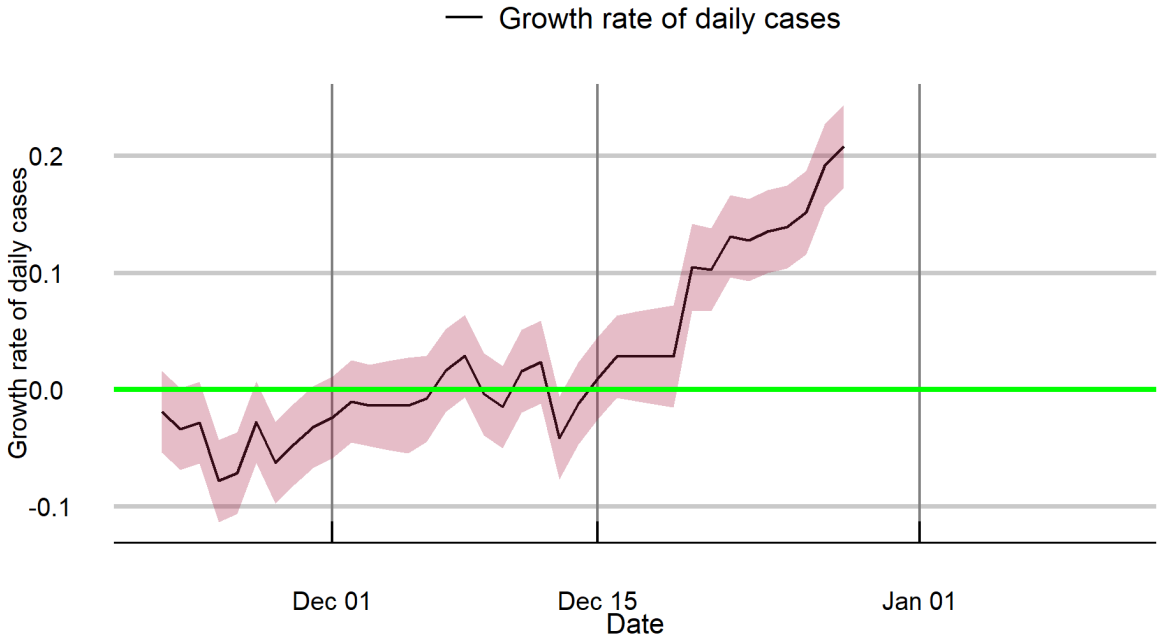
Gujarat



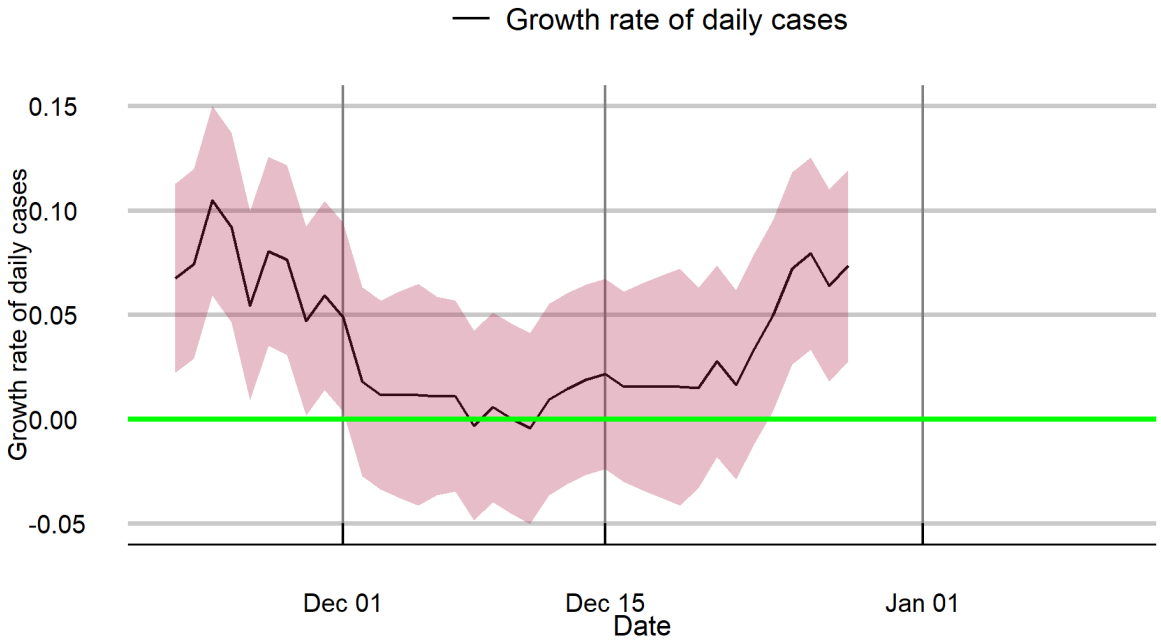
Haryana



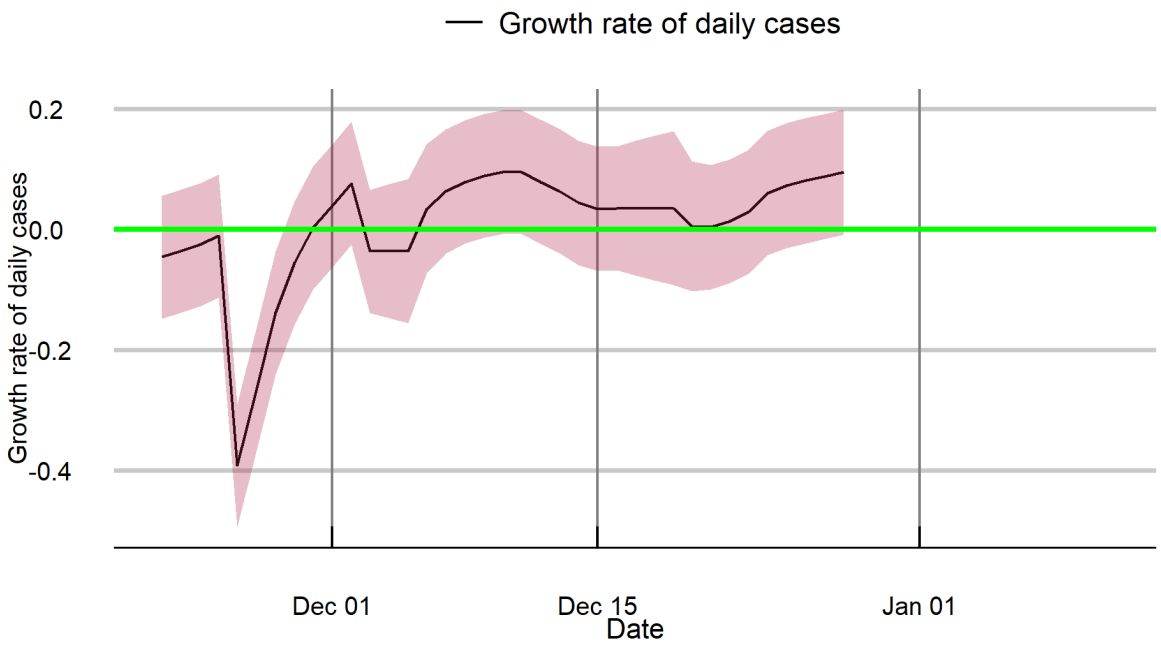
Jharkhand



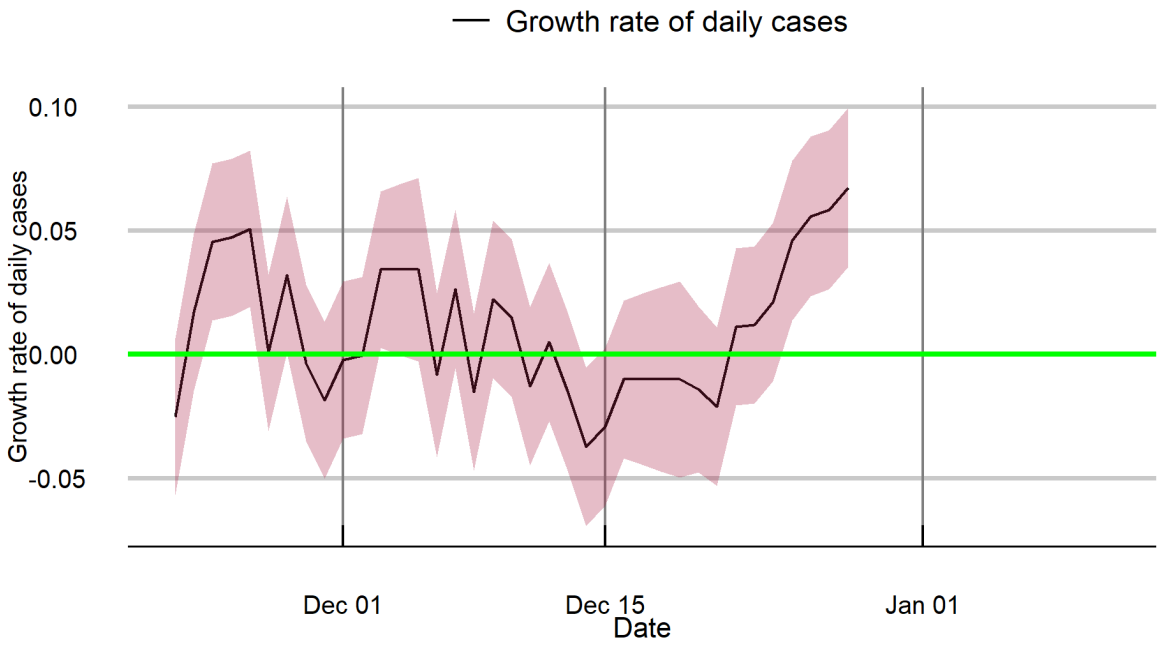
Madhya Pradesh



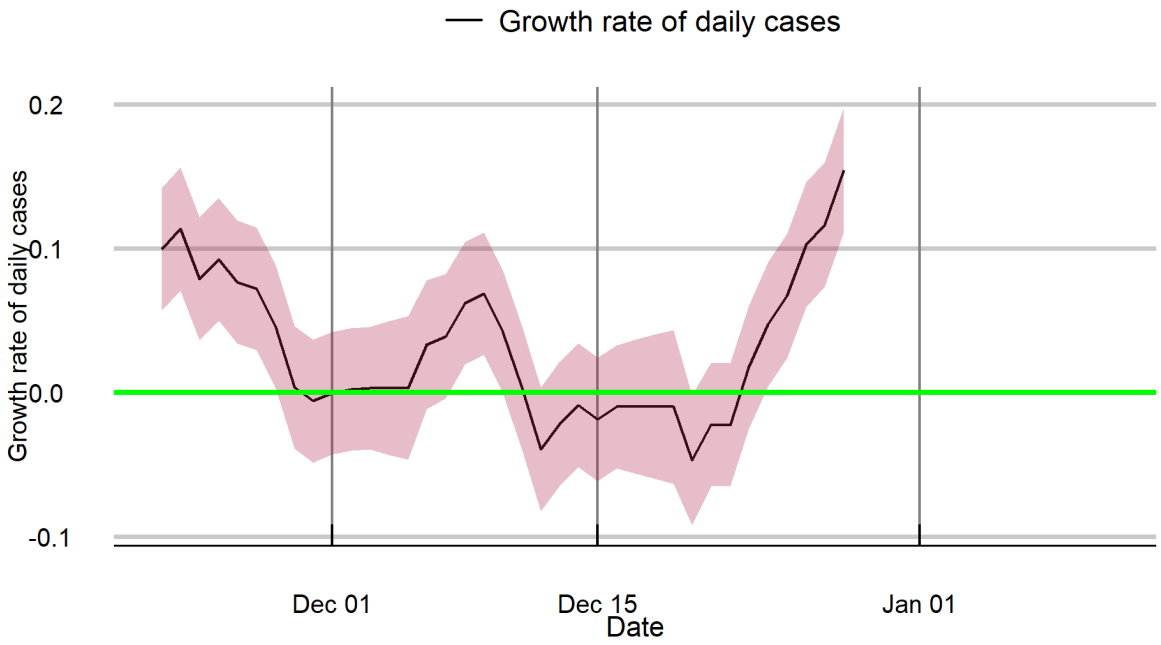
Maharashtra



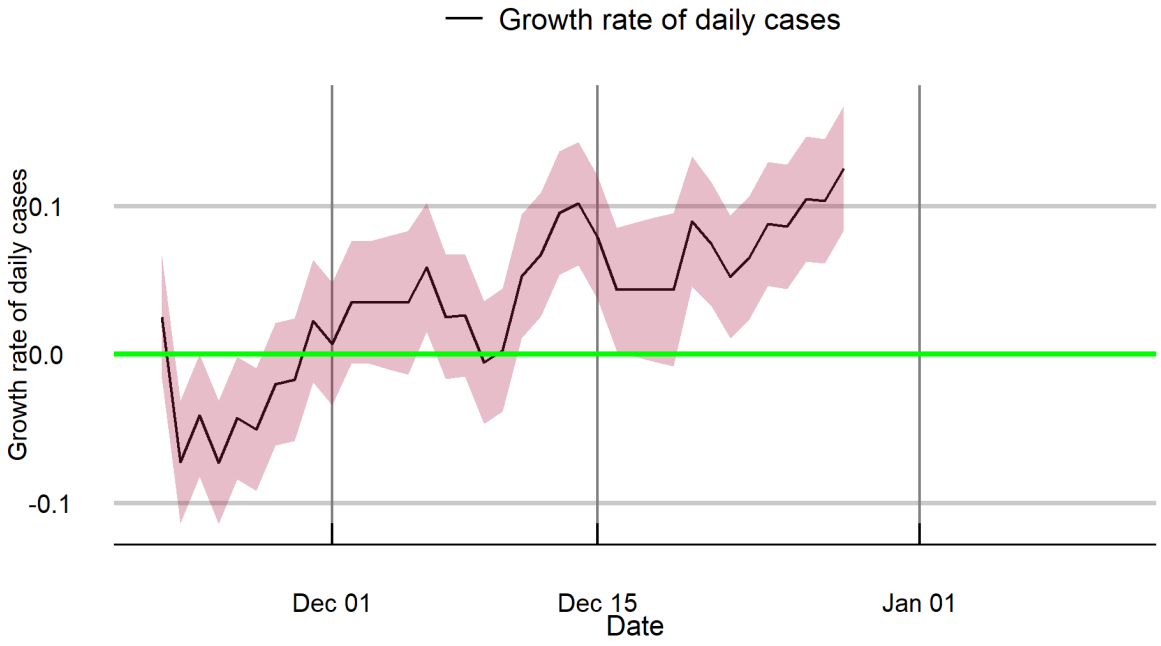
Punjab



Rajasthan



Uttar Pradesh



Notes

This tracker was developed by researchers at Cambridge Judge Business School and National Institute of Economic and Social Research, working with Health Systems Transformation Platform in India, as part of a pandemic monitoring series devoted to India and its states and union territories. It provides short term forecasts of the trajectory of the pandemic, identifying states and union territories that are at risk of increases in infection incidence.

Data: COVID-19 confirmed cases and deaths data are sourced from Johns Hopkins University (JHU), Center for Systems Science and Engineering (CSSE).

New cases: forecasts. Forecasts above are based on a structural time series model that uses all the data in estimation but adapts to the trend emerging in the most recent period.

The method is described in: Harvey, A. and P. Kattuman (2020). Time series models based on growth curves with applications to forecasting coronavirus. *Harvard Data Science Review*, Special issue 1 - COVID -19. https://hdsr.mitpress.mit.edu/pub/ozgjx0yn/release/2 , and Harvey, A., P. Kattuman, and C. Thamotheram (2021). Tracking the mutant: forecasting and nowcasting COVID-19 in the UK in 2021. *National Institute Economic Review*. 256, 110-126. doi:10.1017/nie.2021.12.

New cases: growth rate. The filtered trends presented for daily growth rates of cases are estimated using the Kalman filter, applied to the observed series. The method filters out day of the week effects and random noise to reveal the underlying signal. Unlike methods such as the moving average, this method adapts the trend to changes in real time and characterises underlying patterns of surges or attenuations that are hidden in the volatile series. The method is described in the papers listed above.

***R*:** The *R*-estimates are based on the nowcast of the growth rate; the estimation approach is described in Harvey, A. and P. Kattuman (2021). A farewell to R: Time series models for tracking and forecasting epidemics. Journal of the Royal Society Interface, 18, 20210179, https://royalsocietypublishing.org/doi/10.1098/rsif.2021.0179.The confidence interval is based on one standard deviation, with coverage of 68%.

Note: The accuracy of forecasts rely on the quality of the published data. Further, changes in government pandemic policies and in transmission relevant social behaviour may lead realised numbers to deviate from forecasts.

Andrew Harvey[*], Paul Kattuman[*], Rajeev Sadanandan[#], Stefan Scholtes[*], Craig Thamotheram[+]

[*]University of Cambridge.
[#]Health Systems Transformation Platform.
[+]National Institute of Economic and Social Research

Cambridge Centre for Health Leadership & Enterprise
Cambridge Judge Business School
University of Cambridge
Trumpington Street
Cambridge
CB2 1AG
United Kingdom

T +44(0)1223 339700
health@jbs.cam.ac.uk
www.jbs.cam.ac.uk/health