This tracker\(^1\) 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. The forecasts are based on a structural time series model that uses historical data in estimation but adapts to the trend emerging in the most recent period. The model is described in Harvey and Kattuman (2021) "Time series models based on growth curves with applications to forecasting coronavirus". Harvard Data Science Review, Special issue 1 - COVID-19.

The effective reproduction number (\(R_t\)) for India has risen to 0.98 as of 19 September (up from 0.88 a week ago). The filtered daily growth rate has increased to -0.6% (up from -3.3% a week ago). The trend value of reported cases in India is expected to be around 27,250 per day in two weeks, by 3 October.

A rapid ascent of the growth rate of cases in Maharashtra (to 9.1% as of 19 September) is largely responsible for the national upturn. Maharashtra now accounts for 11% of the cases in country and has an \(R\) value of 1.44. Festival gatherings in September and associated increased testing appear to have contributed. On a positive note, the growth rate in the state peaked on September 16, and appears to be heading down (page 23). This mirrors the experience of Kerala, where a post-Onam surge in August began to dissipate swiftly. Note however that while daily cases continue to decline in Kerala, the growth rate of cases bottomed out on 16 September and has starting rising, though it remains negative as of now (page 21).

Nine other states show tendencies of increase in infection, of which Mizoram and Tamil Nadu have sizeable incidences and are of concern.

\(^1\) CJBS COVID-19 Tracker for India can be accessed at: [www.jbs.cam.ac.uk/covid-india](http://www.jbs.cam.ac.uk/covid-india)
The companion spreadsheet contains all the estimates and forecasts.

Contact: Paul Kattuman  
[p.kattuman@jbs.cam.ac.uk](mailto:p.kattuman@jbs.cam.ac.uk)
Daily Covid-19 cases in India: Forecast

Forecasts of daily new cases for the period 20 September to 3 October 2021, based on data till 19 September 2021. The trend value of new COVID-19 cases is likely be around 27,250 per day by 3 October. The recent rising tendency of the growth rate suggests that this forecast may turn out to be optimistic.

The filtered growth rate of daily new cases was -0.006 (-0.6 %) as on 19 September 2021. The rising tendency in recent days might lead the growth rate to turn positive in the coming days.
Note: Small daily numbers (less than 25) currently seen in Arunachal Pradesh, Bihar, Chandigarh, Chhattisgarh, Gujarat, Haryana, Jharkhand, Madhya Pradesh, Nagaland, Rajasthan and Uttarakhand, make their estimates and forecasts less precise.
Daily growth rates of cases (%)  
Trend values as on 19 September 2021
Case forecasts and growth rates: States and Union territories

Andhra Pradesh

- Data
- Forecast
- New cases
- Trend

New Cases

Aug 15
Sep 01
Sep 15
Oct 01

Andhra Pradesh

Growth rate of daily cases

Aug 15
Sep 01
Sep 15
Oct 01
Probability that daily cases are accelerating
State with cases exceeding 100 and probability of acceleration greater than 0.5

Jammu and Kashmir: Probability that cases are accelerating. Probability on 2021-09-19: 0.78

Maharashtra: Probability that cases are accelerating. Probability on 2021-09-19: 0.9
Mizoram:
Probability that cases are accelerating.
Probability on 2021-09-19: 0.63

Tamil Nadu:
Probability that cases are accelerating.
Probability on 2021-09-19: 0.63
Note: Actual cases in the period 16-19 September fell above predictions for that period based on data till 12 September. This suggests that the transmission rate has risen relative to the past. This is largely attributable to the sharp rise in cases in Maharashtra.
Notes

**Data:** COVID-19 confirmed cases and deaths data are sourced from COVID19-India API: https://api.covid19india.org/

**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.


**Forecast accuracy:** is assessed using mean absolute percentage error of the forecasts of cases over the past week. Forecast accuracy will in general be lower for the smaller states / union territories. It is important to pay attention to the confidence intervals around the forecasts. The coverage of the confidence intervals presented is 68%, implying there is 16% probability of the upper bound being exceeded.

**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* (forthcoming). The confidence interval is based on one standard deviation, with coverage of 68%.

**Probability** The probability that the growth of new cases is increasing at an increasing rate is extracted from the statistical model. The pandemic phase is of extreme concern when this probability exceeds 0.5.

**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