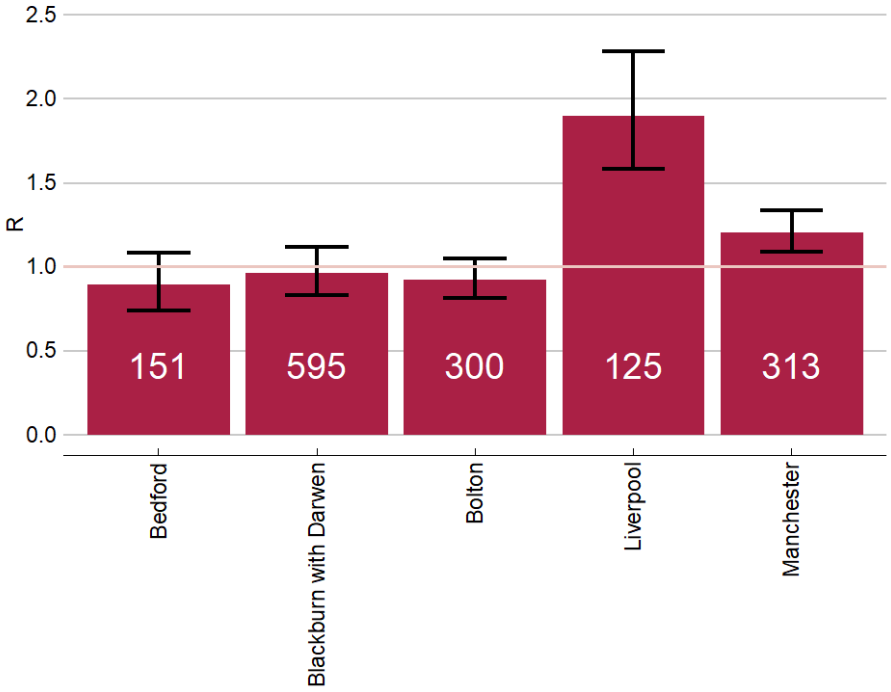
Reproduction Number (R) and Forecasts of New Cases: Surges, spill overs and swells

Figure 1 – R: Local Authorities in England with high case rates



Bar chart shows point estimates of R and the ± 1 standard deviation confidence intervals. The numbers in each bar represent the count of cases in the last seven days of the estimation sample per 100,000 population.

Main points

- We comment on the structure and composition of the widely anticipated wave emerging in the UK. The advancing pattern is consistent with a race between, on the one hand, local surges that spill over geographically due to higher transmissibility of the now dominant Delta variant, and on the other, the vaccination programme that reduces the susceptible pool.
- We illustrate this by extending consideration to two additional local authorities in the North West that appear to have followed on the same track as the first set of local authorities to experience sharp but localised increases in case rates.
- Figure 1 provides R number estimates and the case rates per 100,000 population, for *Bolton*, *Blackburn and Darwen*, *Bedford*, *Manchester* and *Liverpool,* based on specimen date data series released on 15th June 2021. We discard data for the last

3 days due to data revisions in that time window. The estimates reported are to be read in the context of the policy of increased testing in local authorities with relatively high case rates.

- A sudden surge in infection in any specific location can lead to a sharp increase in the estimated reproduction number. A part of this increase in R may be due to increased testing in the location. A part of it may be driven by the fact that the increase is from a low base. Importantly, if infection can be contained through a focussed and timely vaccination programme, the reproduction number will fall.
- The trajectories of infection *Bedford*, *Blackburn and Darwen* and *Bolton* -- in the initially concerning local authorities -- appear to fit this profile (Figure 2). The lower reproduction numbers in these areas at present may reflect the efficacy of the accelerated vaccination programme reducing the effective size of the susceptible population, notwithstanding some degree of vaccine escape.
- At the same time, the more transmissible Delta variant was always likely to spill over and take hold in surrounding geographical areas. With lower base numbers the initial growth rates will be high. This appears to be the situation in Manchester and Liverpool in the North West.
- At the end of our estimation sample on 11th June 2021, the R numbers had fallen in the initially concerning local authorities: to the range 0.80 - 1.05 for Bolton (case rate 300), 0.75 – 1.10 for Bedford (case rate 151), 0.85 – 1.10 for Blackburn and Darwen (case rate 595). The R numbers were much higher in areas that entered the watch list more recently: in range of 1.60 – 2.30 for Liverpool (case rate 125) and 1.10 – 1.35 for Manchester (case rate 313).
- We should expect regional and national level incidence patterns to reflect an aggregation of a succession of local surges that spill over geographically even as they are contained through vaccination. As the unvaccinated proportion of the adult population diminishes the incipient wave is more likely to become a ripple that rapidly settles down.

"The current picture is one of localised outbreaks that spill over geographically due to the higher transmissibility of the Delta variant. As vaccination coverage becomes universal, shrinking the susceptible pool, local surges will tend to peak quickly and die out. The national and regional patterns which arise from the aggregation of numerous staggered local surges, may be a more a swell than a wave.

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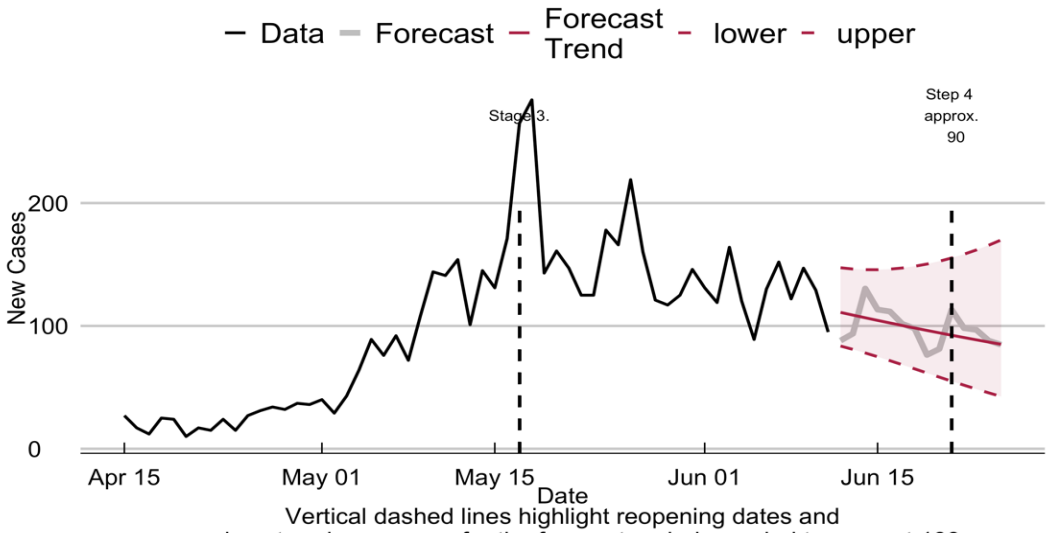
Senior Economist - Macroeconomic Modelling and Forecasting

Results

Figure 2 provides forecasts of daily cases of Covid-19 for the period until early – July, for the three local authorities that have seen notable flare-ups, and highlights the underlying trend value of new cases to be expected on remaining key dates in the Government's roadmap: step 4 reopening postponed from 21st June to 19th July.

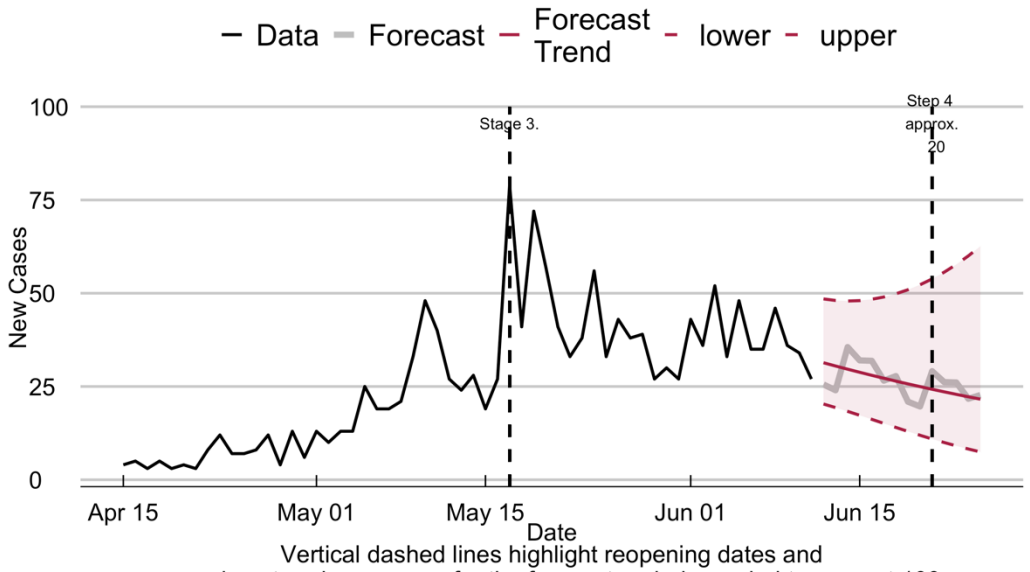
Currently, the doubling time for trend cases in Liverpool is between 4-5 days and around 14 days for Manchester. However, realised trajectories are likely to settle down and undershoot forecasts if local containment is successful.

Figure 2a - Bolton forecast of new COVID-19 cases



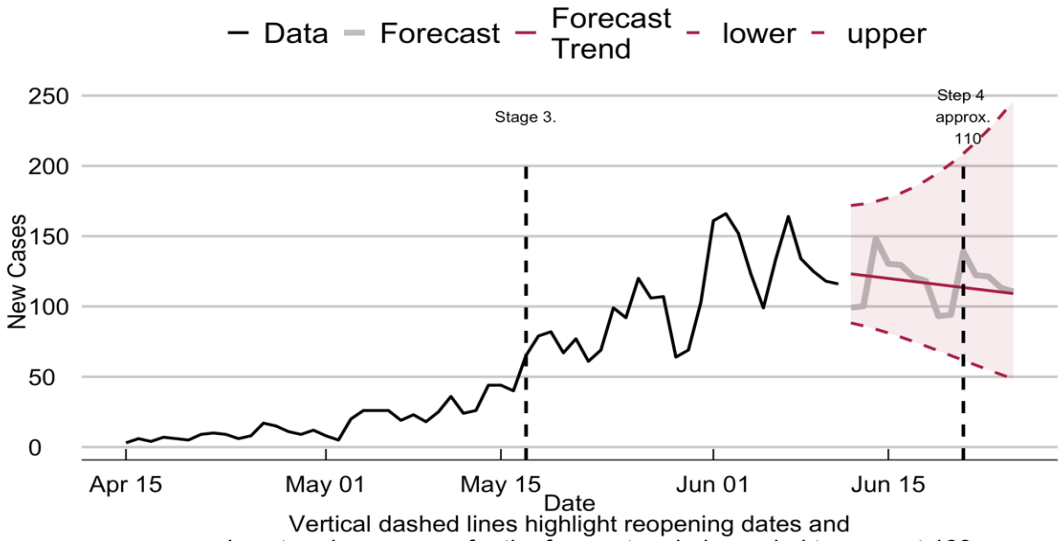
Vertical dashed lines highlight reopening dates and show trend new cases for the forecast period rounded to nearest 100. Specimen case data available on 15 June 2021. Data for the last three days which are subject to revision are discarded, so the estimation sample ends on 11 June 2021.

Figure 2b - Bedford forecast of new COVID-19 cases



Vertical dashed lines highlight reopening dates and show trend new cases for the forecast period rounded to nearest 100. Specimen case data available on 15 June 2021. Data for the last three days which are subject to revision are discarded, so the estimation sample ends on 11 June 2021.

Figure 2c – Blackburn with Darwen forecast of new COVID-19 cases



Vertical dashed lines highlight reopening dates and show trend new cases for the forecast period rounded to nearest 100. Specimen case data available on 15 June 2021. Data for the last three days which are subject to revision are discarded, so the estimation sample ends on 11 June 2021.

Background

NIESR aims to set out projections of the future path of the Covid-19 epidemic in the United Kingdom, its constituent nations and the regions of England, based on current policies.

NIESR has been producing weekly updates on Thursdays, projecting new cases and estimating the R number using a class of time series models developed by Prof. Andrew Harvey and Dr. Paul Kattuman of Cambridge University; see Harvey and Kattuman (2020a). From June 3, 2021 onwards NIESR will be producing fortnightly updates on Thursdays, focusing on monitoring whether sudden increases observed are local spikes or are indicative of the start of a new wave.

The models generate forecasts by extracting changing trends from historical data. They are relatively simple and transparent, and their specifications can be assessed by standard statistical test procedures. The advantage of the time series approach is that it can adapt very quickly to the most recent information and hence produce timely estimates. This flexibility enables the effects of changes in policy, virus mutations and human behaviour to be tracked. The models are data driven and so are different from the structural models used by epidemiologists which rely on assumptions about transmission and behaviour; see Avery et al (2020).

A description of the methods used to produce these estimates and an evaluation of their forecasting performance can be found in Harvey, Kattuman, and Thamotheram (2021).

Data

Data: COVID-19 confirmed cases and deaths data are sourced from
https://coronavirus.data.gov.uk

Data on Covid-19 cases are reported by the government by 'specimen date' and by 'published date'. Specimen cases relate to the date when the sample was taken from the person being tested, while published cases relate to the first date when they are included in the published numbers. At the present time we regard the specimen date data as a more reliable indicator of the trend in new cases. The model based on specimen dated observations has better captured the effect of the sharp increase in testing on the day that schools reopened and also suffers less from data errors or revisions.

On 27 March 2021, 850 historic cases were removed due to a laboratory processing error. This affected specimen date data between 23 and 25 March in local authorities primarily in the North East and Yorkshire. The cumulative total number of people tested positive was revised down on 27 March 2021. Historic published date totals have not been

changed. The downward correction on 27th March is mixed with the positive upward revisions of cases as more test results are returned over time making it impossible to date these corrections accurately. Thus, we cannot back out on which day these corrections were made. For published data, we choose to remove 300, 300 and 250 cases on 24, 25 and 26th of March respectively.

Between 2nd to the 5th April significant disruption to cases and deaths for Wales and Northern Ireland occurred. This was corrected on the 6th April but with a 48-hour reporting period. As the last date in the estimation sample for specimen cases is April 2nd we will decide how to account for this change in next week's forecast. We leave published cases unchanged.

On April 9th rapid LF tests that are confirmed as negative by Polymerase Chain Reaction (PCR) test within 3 days were removed. For published cases, we set 9th April as missing as no correction is applied to the historic data by Public Health England.

Caveat

The model relies on historical data and does not incorporate future outlined changes in the underlying environment. Thus, it is important to read the forecasts in this context. For example, the current forecasts make no assumptions about the effect of reopening non-essential retail on increasing transmissions. On the other hand, the effect of the vaccine program will be in the opposite direction.

Authors

Professor Andrew Harvey is Emeritus Professor of Econometrics at the University of Cambridge and a Fellow of Corpus Christi College. He has published over 100 articles and is the author of four books: *The Econometric Analysis of Time Series* (1981), *Time Series Models* (1981), *Forecasting. Structural Time Series Models and the Kalman Filter* (1989) and *Dynamic models for Volatility and Heavy Tails* (2013). He is a Fellow of the British Academy and the Econometric Society.

Dr Paul Kattuman is a reader in Economics at Cambridge University. He has been a Senior Research Fellow at the University of Cambridge Department of Applied Economics, and a lecturer in economics at Durham. He has held Visiting Professorships at Université Paris 12 and Paris-Est Créteil and was appointed Grupo Santander Visiting Professor at Universidad Complutense de Madrid. He was visiting Faculty Scholar at the Kennedy School of Government, and at the Department of Statistics, both at Harvard University.

Dr Craig Thamotheram is a Senior Economist at NIESR. Prior to joining NIESR, he studied Engineering at Imperial and obtained a PhD in Economics at Warwick. He has work experience as a post-doc in macro and financial econometrics.

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Notes for editors

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