Richard Harris,
School of Geographical Sciences,
University of Bristol.

Levelling up?

COVID infections and areas of affluence/deprivation in England

https://profrichharris.github.io/
@profrichharris

University of BRISTOL

Introduction

- Morrissey, Spooner, Salter & Shaddick (2021) show that area level deprivation is significantly associated with monthly COVID-19 cases in England over the period March to December 2020, a finding that is substantiated by other research.*
- Here that association is explored further with weekly and regional data over a longer period of 111 weeks, from 2020-03-07 to 2022-04-16.
- The key finding is that it is not only deprivation but affluence, too.

* Morrissey K, Spooner F, Salter J, Shaddick G. Area level deprivation and monthly COVID-19 cases: The impact of government policy in England. Soc Sci Med. 2021 Nov; 289:114413. doi: 10.1016/j.socscimed.2021.114413.

https://profrichharris.github.io/
@profrichharris

University of BRISTOL

The data

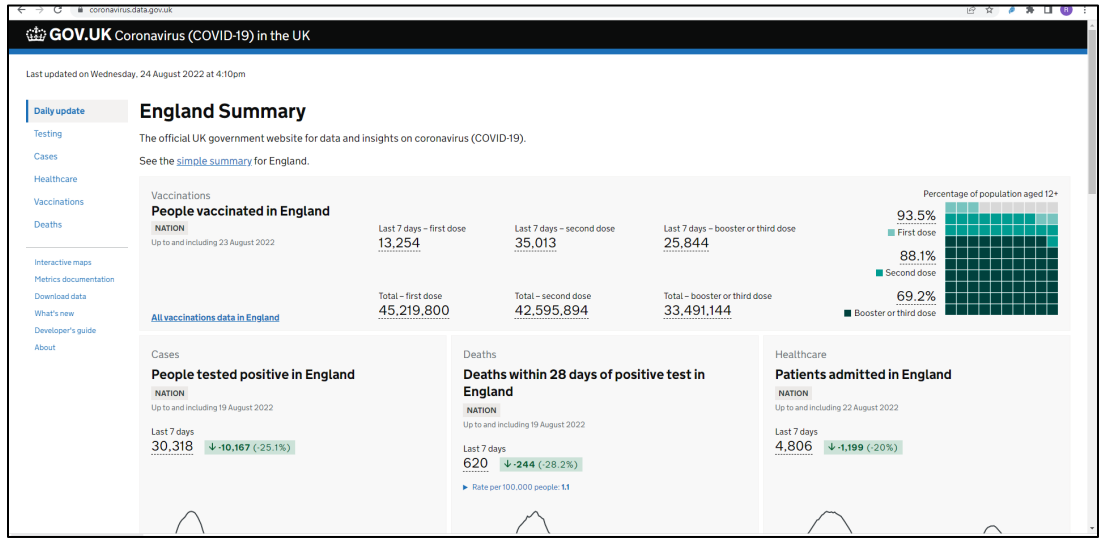
- Described by Harris & Brunsdon (2022)*
- Two sources of undercount:
  - Data censoring (1 or 2 cases → 0) #
  - Asymptomatic/non-testing^

Some correction now added

^ No correction

* Harris, R., Brunsdon, C. Measuring the exposure of Black, Asian and other ethnic groups to COVID-infected neighbourhoods in English towns and cities. Appl. Spatial Analysis 15, 621–646 (2022). https://doi.org/10.1007/s12061-021-09400-8

https://coronavirus.data.gov.uk/



To ensure the neighbourhood counts sum to their regional totals

https://profrichharris.github.io/
@profrichharris

University of BRISTOL

Initial Poisson model (x 111)

Number of cases in neighbourhood, i, at time, t

Population of neighbourhood, i

$$\log(\lambda_{it}) = \sum_m \beta_{(m)it} x_{(m)it} + \log(P_i) + \delta_{jt} + \varepsilon_{it}$$

$$\log(\lambda_{it}) - \log(P_i) = \sum_m \beta_{(m)it} x_{(m)it} + \delta_{jt} + \varepsilon_{it}$$

Control variables

$$\log\left(\frac{\lambda_{it}}{P_i}\right) = \sum_m \beta_{(m)it} x_{(m)it} + \delta_{jt} + \varepsilon_{it}$$

COVID rate

'IMD effect'
(10 groups)

Overdispersion (excess/deficit for neighbourhoods)
(6789 neighbourhoods)

https://profrichharris.github.io/
@profrichharris

University of BRISTOL

Weekly standardised effect on COVID-19 rate

(relative rate shown in light red)

(The 'fixed' effects)

age5.11 | age12.17 | age18.21

age22.34 | AandE | carebeds

$\hat{\beta}$

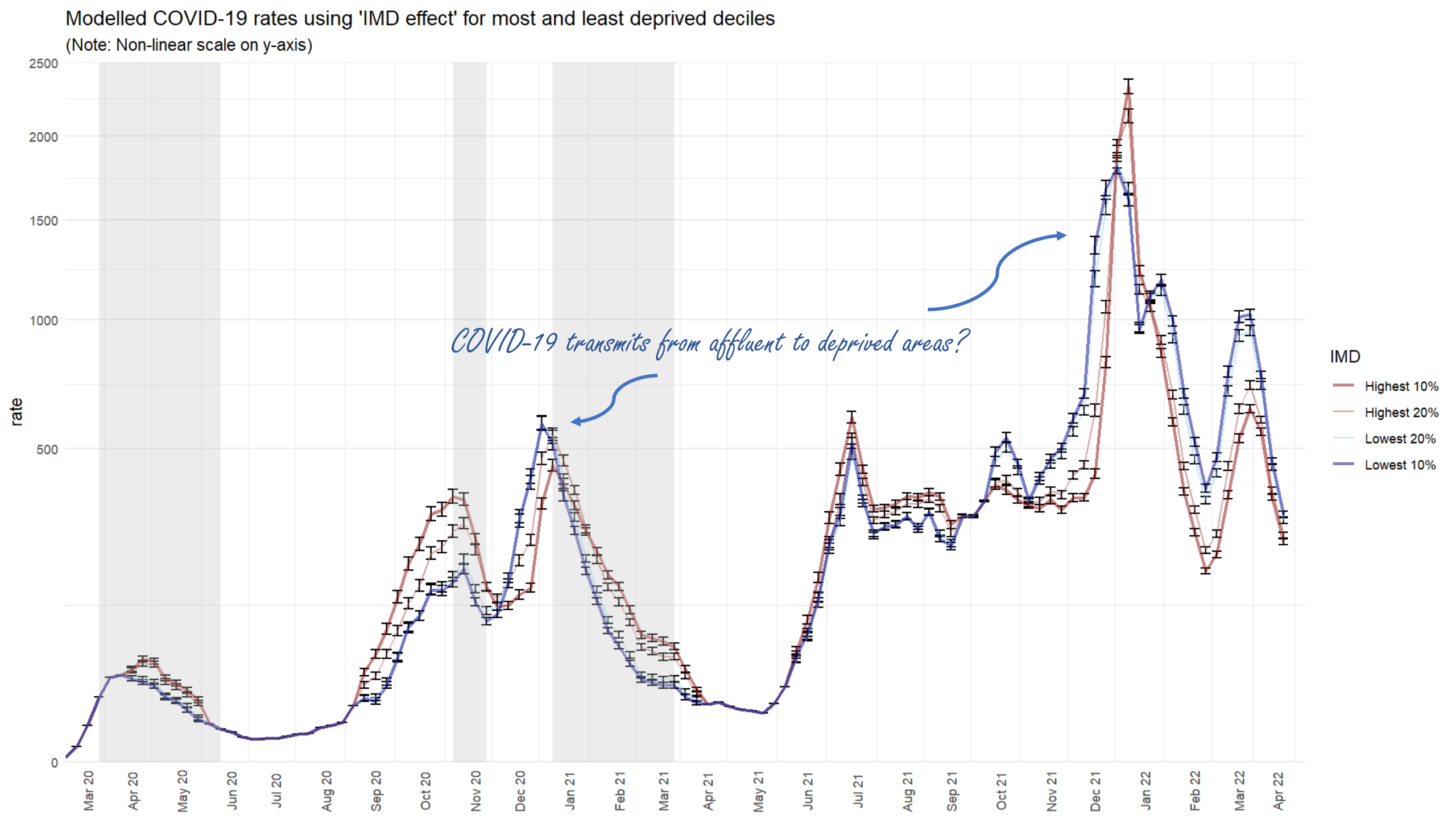
0.6 | 0.4 | 0.2 | 0.0 | -0.2 | -0.4

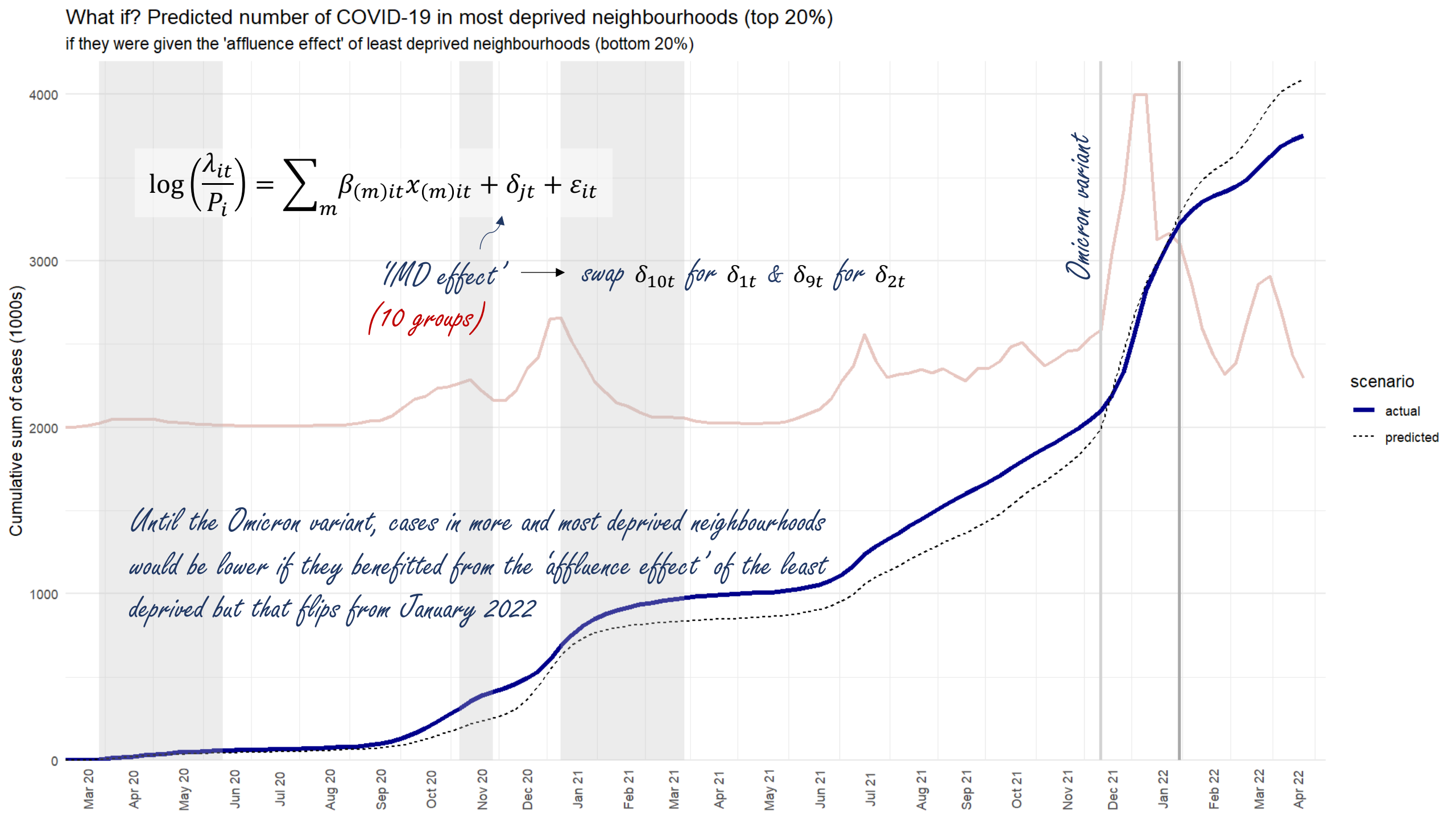
Mar 20 | Apr 20 | May 20 | Jun 20 | Jul 20 | Aug 20 | Sep 20 | Oct 20 | Nov 20 | Dec 20 | Jan 21 | Feb 21 | Mar 21 | Apr 21 | May 21 | Jun 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nov 21 | Dec 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22

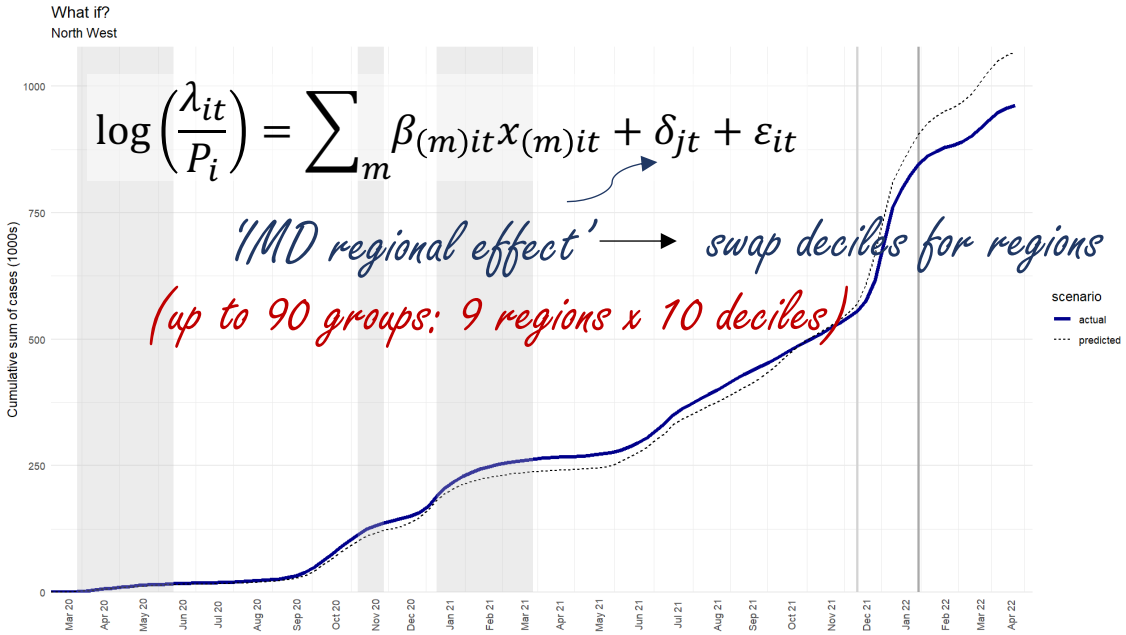
!

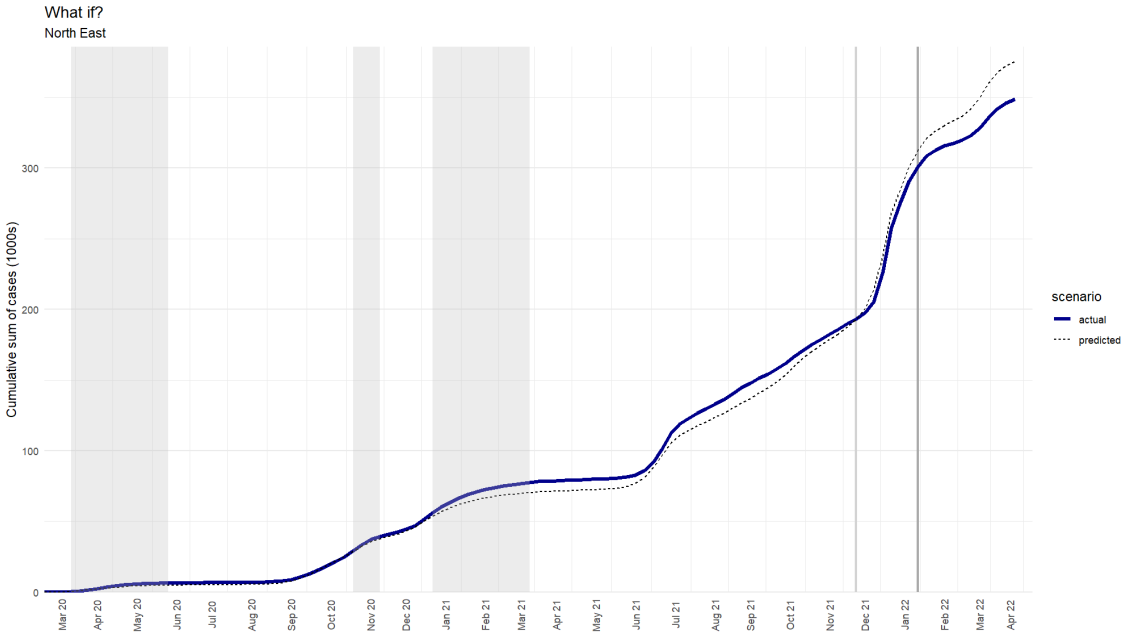
https://www.theguardian.com/education/2020/nov/05/security-fence-manchester-university-student-flats

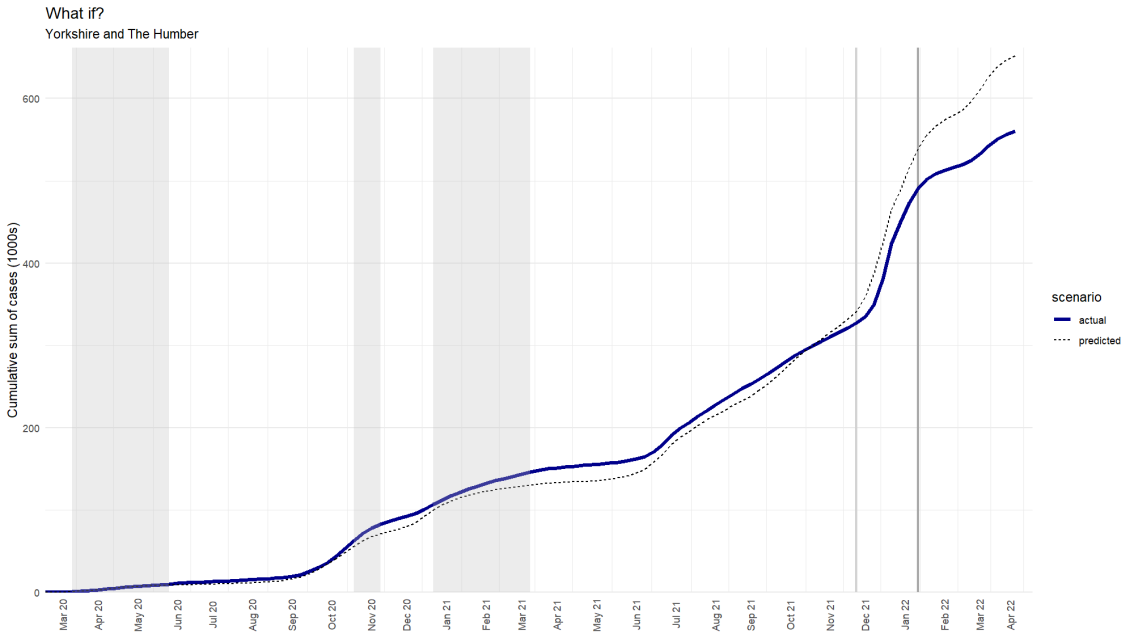
Omits data for 2020-03-07

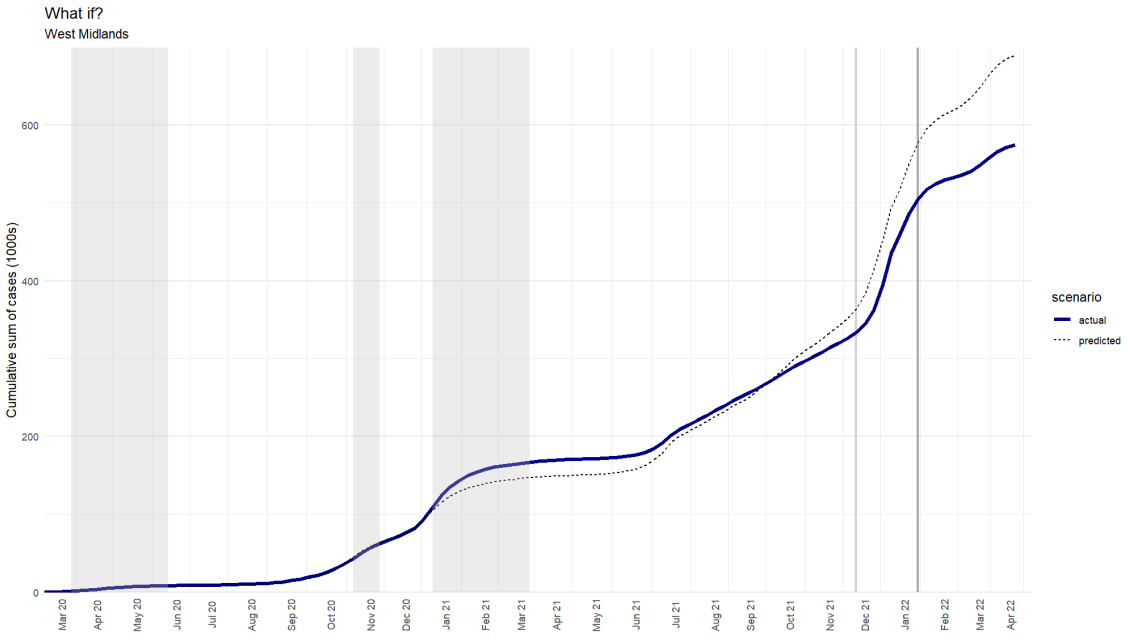

Modelled COVID-19 rates using 'IMD effect' for most and least deprived deciles
(Note: Non-linear scale on y-axis)
rate
2500
2000
1500
1000
500
0
COVID-19 transmits from affluent to deprived areas?
IMD
Highest 10%
Highest 20%
Lowest 20%
Lowest 10%
Mar 20
Apr 20
May 20
Jun 20
Jul 20
Aug 20
Sep 20
Oct 20
Nov 20
Dec 20
Jan 21
Feb 21
Mar 21
Apr 21
May 21
Jun 21
Jul 21
Aug 21
Sep 21
Oct 21
Nov 21
Dec 21
Jan 22
Feb 22
Mar 22
Apr 22


What if? Predicted number of COVID-19 in most deprived neighbourhoods (top 20%)
if they were given the 'affluence effect' of least deprived neighbourhoods (bottom 20%)
$\log\left(\frac{\lambda_{it}}{P_i}\right) = \sum_m \beta_{(m)it} x_{(m)it} + \delta_{jt} + \varepsilon_{it}$
'IMD effect' → swap δ_{10t} for δ_{1t} & δ_{9t} for δ_{2t}
(10 groups)
Omicron variant
Until the Omicron variant, cases in more and most deprived neighbourhoods would be lower if they benefitted from the 'affluence effect' of the least deprived but that flips from January 2022
Cumulative sum of cases (1000s)
0
1000
2000
3000
4000
Mar 20
Apr 20
May 20
Jun 20
Jul 20
Aug 20
Sep 20
Oct 20
Nov 20
Dec 20
Jan 21
Feb 21
Mar 21
Apr 21
May 21
Jun 21
Jul 21
Aug 21
Sep 21
Oct 21
Nov 21
Dec 21
Jan 22
Feb 22
Mar 22
Apr 22
scenario
actual
predicted


What if?
North West
$\log\left(\frac{\lambda_{it}}{P_i}\right) = \sum_m \beta_{(m)it} x_{(m)it} + \delta_{jt} + \varepsilon_{it}$
'IMD regional effect' → swap deciles for regions
(up to 90 groups: 9 regions x 10 deciles)
Cumulative sum of cases (1000s)
scenario
actual
predicted

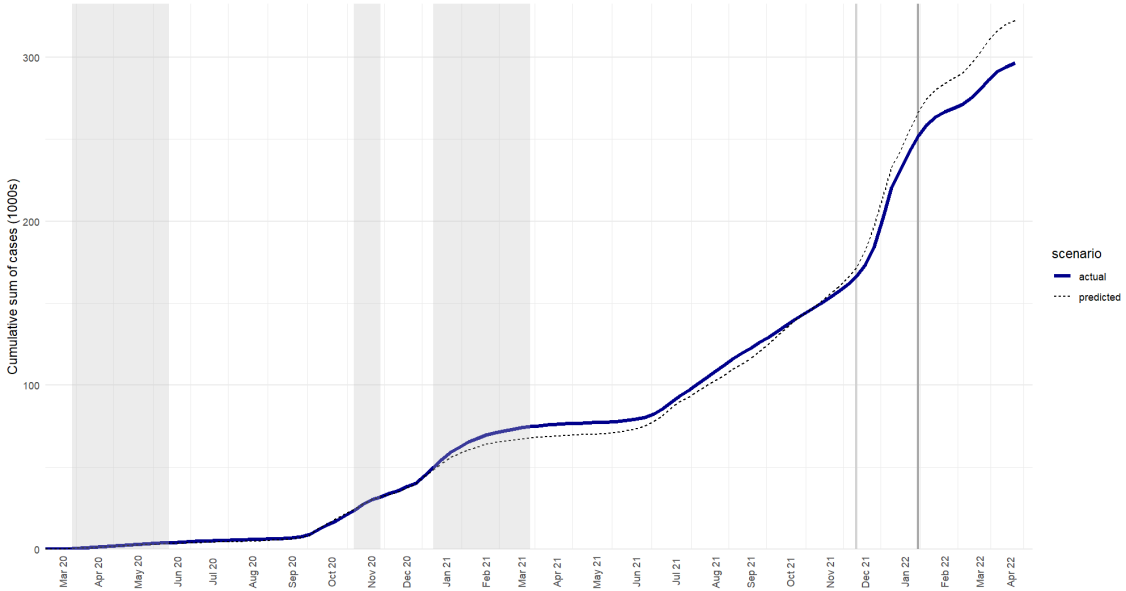

What if?
North East
Cumulative sum of cases (1000s)
scenario
actual
predicted


What if?
Yorkshire and The Humber
Cumulative sum of cases (1000s)
scenario
actual
predicted


What if?
West Midlands
Cumulative sum of cases (1000s)
scenario
actual
predicted

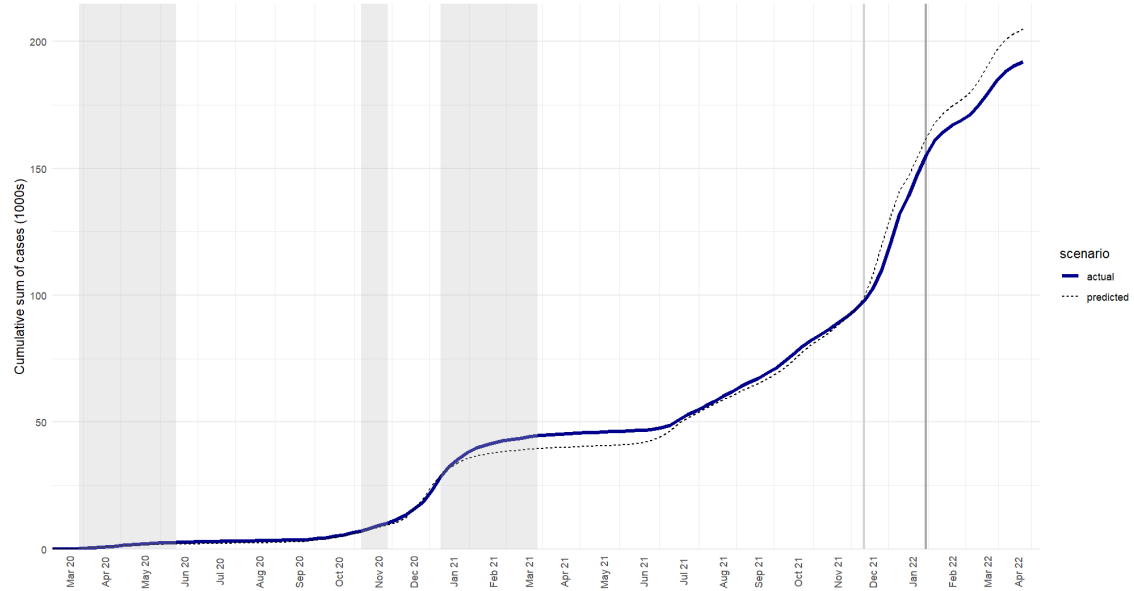
What if?

East Midlands



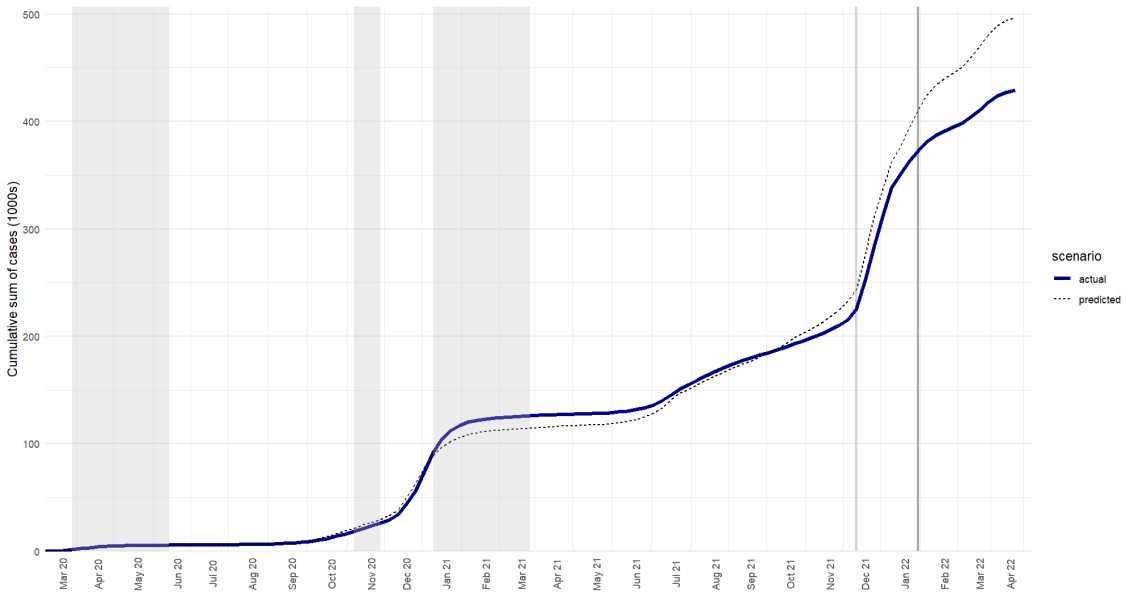
What if?

East of England



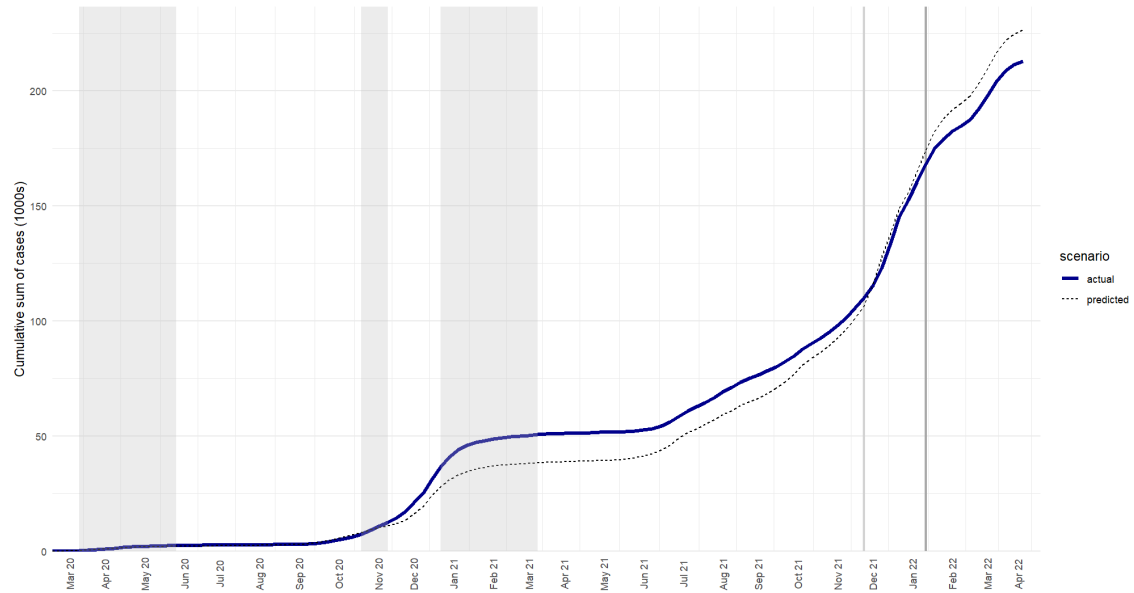
What if?

London



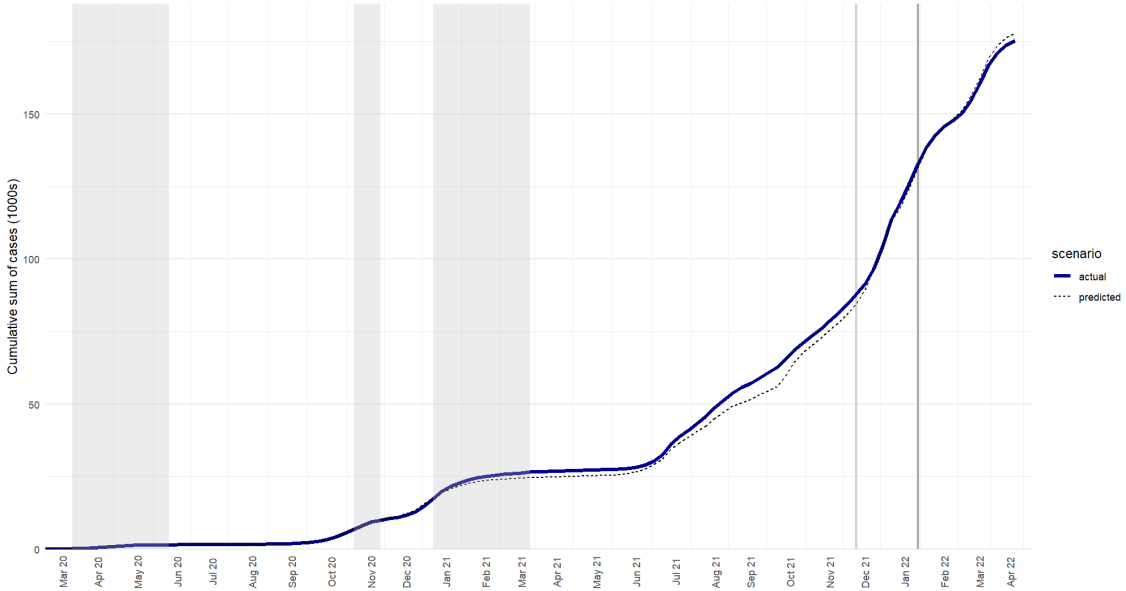
What if?

South East

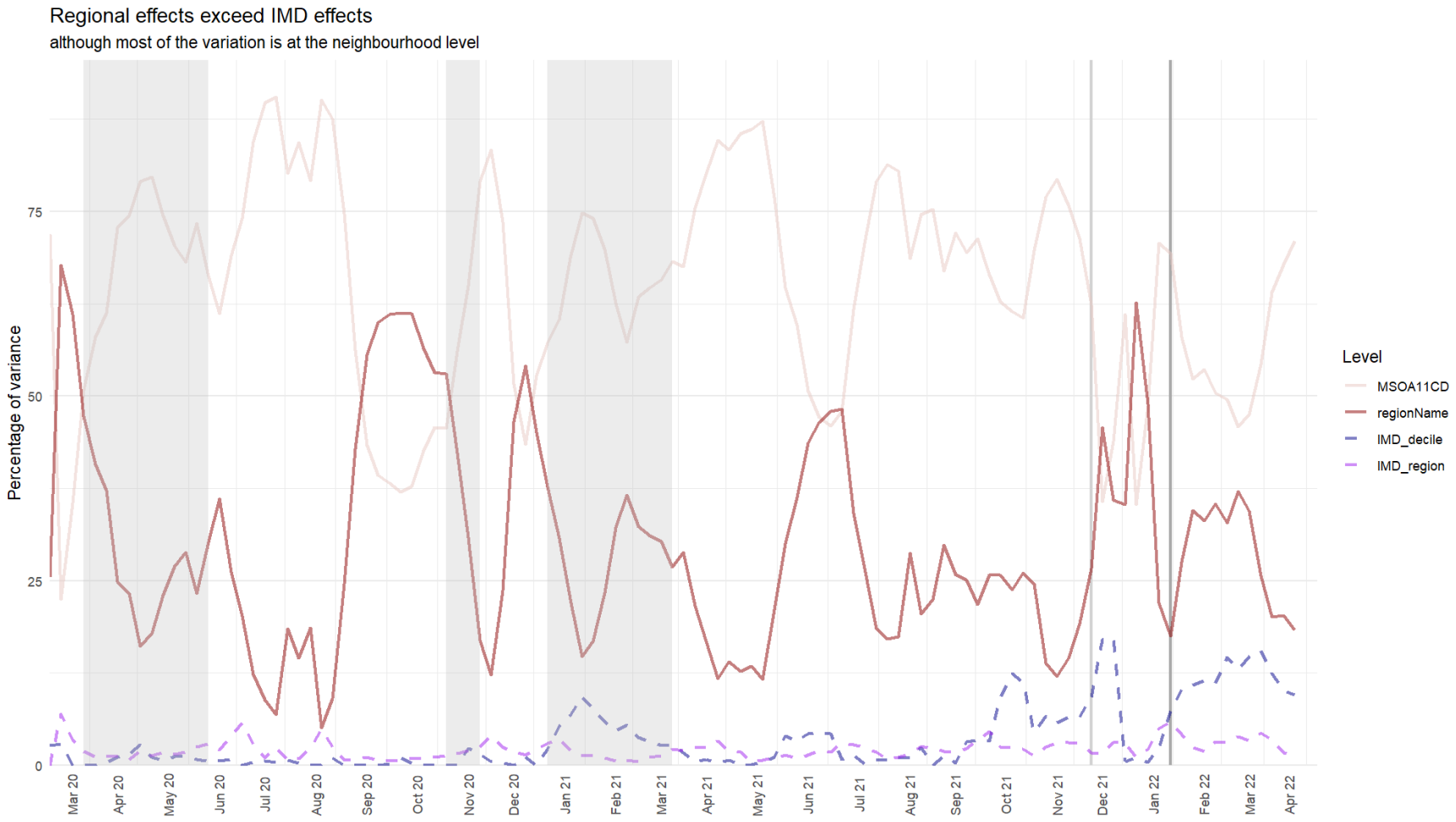


What if?

South West



Regional effects exceed 'IMD effects'



https://profrichharris.github.io/
@profrichharris

University of BRISTOL

But the geography of deprivation is itself regionally distributed

Cumulative proportion of adults in each IMD decile

IMD	East.Midlands	East.of.England	London	North.East	North.West	South.East	South.West	West.Midlands	Yorkshire.and.The.Humber
1	0.08	0.03	0.02	0.21	0.23	0.03	0.03	0.17	0.19
2	0.19	0.08	0.15	0.38	0.35	0.07	0.09	0.30	0.31
3	0.27	0.15	0.33	0.52	0.46	0.14	0.17	0.39	0.42
4	0.36	0.24	0.47	0.62	0.56	0.21	0.27	0.50	0.51
5	0.47	0.36	0.60	0.69	0.63	0.29	0.40	0.59	0.59
6	0.57	0.48	0.71	0.77	0.70	0.40	0.54	0.68	0.68
7	0.66	0.61	0.78	0.84	0.78	0.51	0.68	0.78	0.77
8	0.77	0.73	0.86	0.89	0.85	0.64	0.81	0.87	0.86
9	0.89	0.88	0.94	0.95	0.94	0.78	0.93	0.94	0.92
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

https://profrichharris.github.io/
@profrichharris

University of BRISTOL

What is the effect of the concentration of poverty?

$$\log\left(\frac{\lambda_{it}}{P_i}\right) = \sum_m \beta_{(m)it} x_{(m)it} + \sum_n \gamma_{(n)kt} p_{(n)kt} + \vartheta_{lt} + \mu_{kt} + \delta_{jt} + \varepsilon_{it}$$

Proportion of population per 'place' that is in each IMD decile (decile 6 as base)

Random effects for neighbourhoods, places, IMD_decile & regions

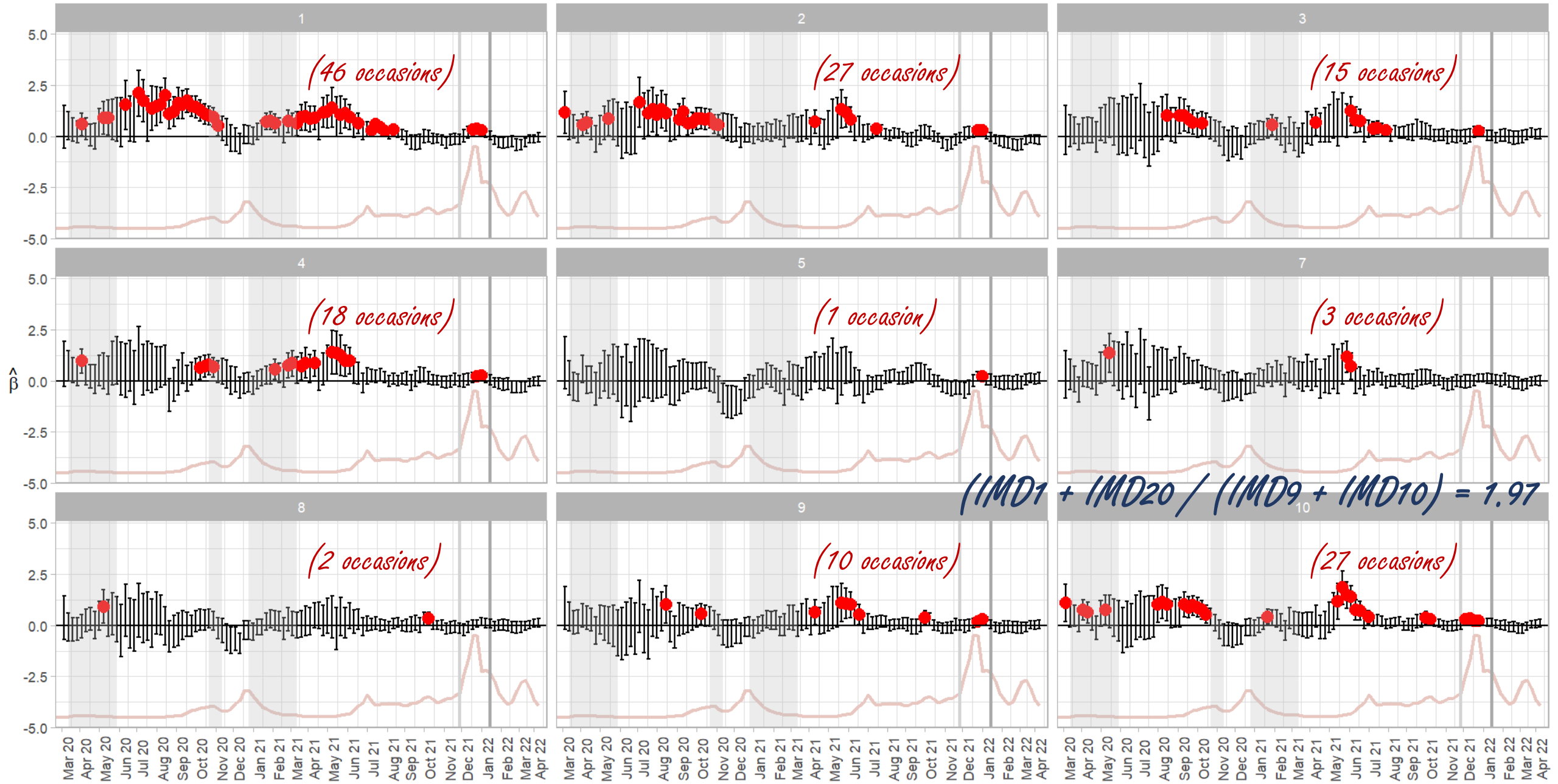
'Places' are defined at a sub-regional scale based on the ONS 2015 definition of Major Towns and Cities, London Boroughs and (sometimes truncated) local authorities

https://profrichharris.github.io/
@profrichharris

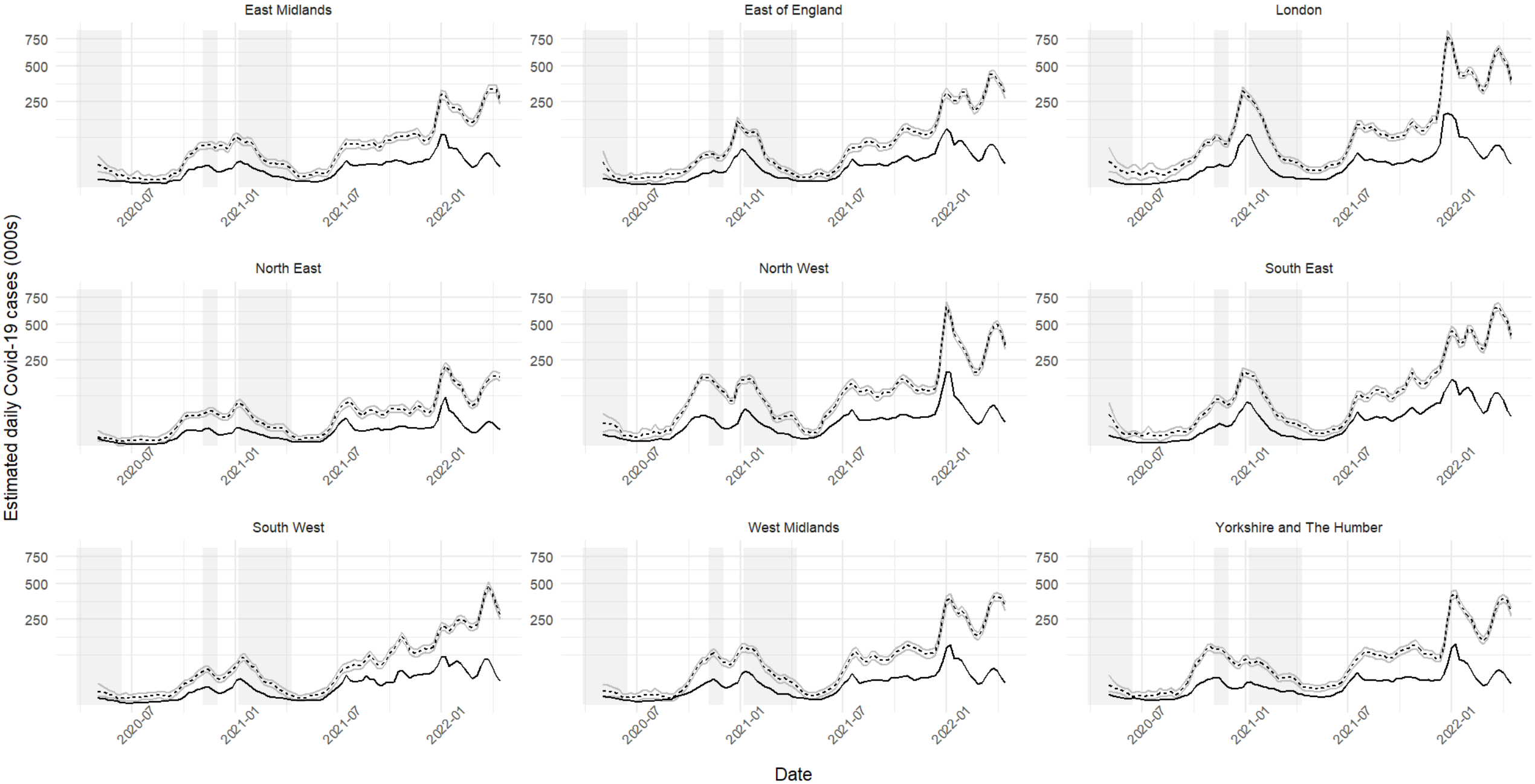
University of BRISTOL

Is the percentage of the population in the IMD group per 'place' significant to the COVID-19 rate?

Significant occasions indicated in red

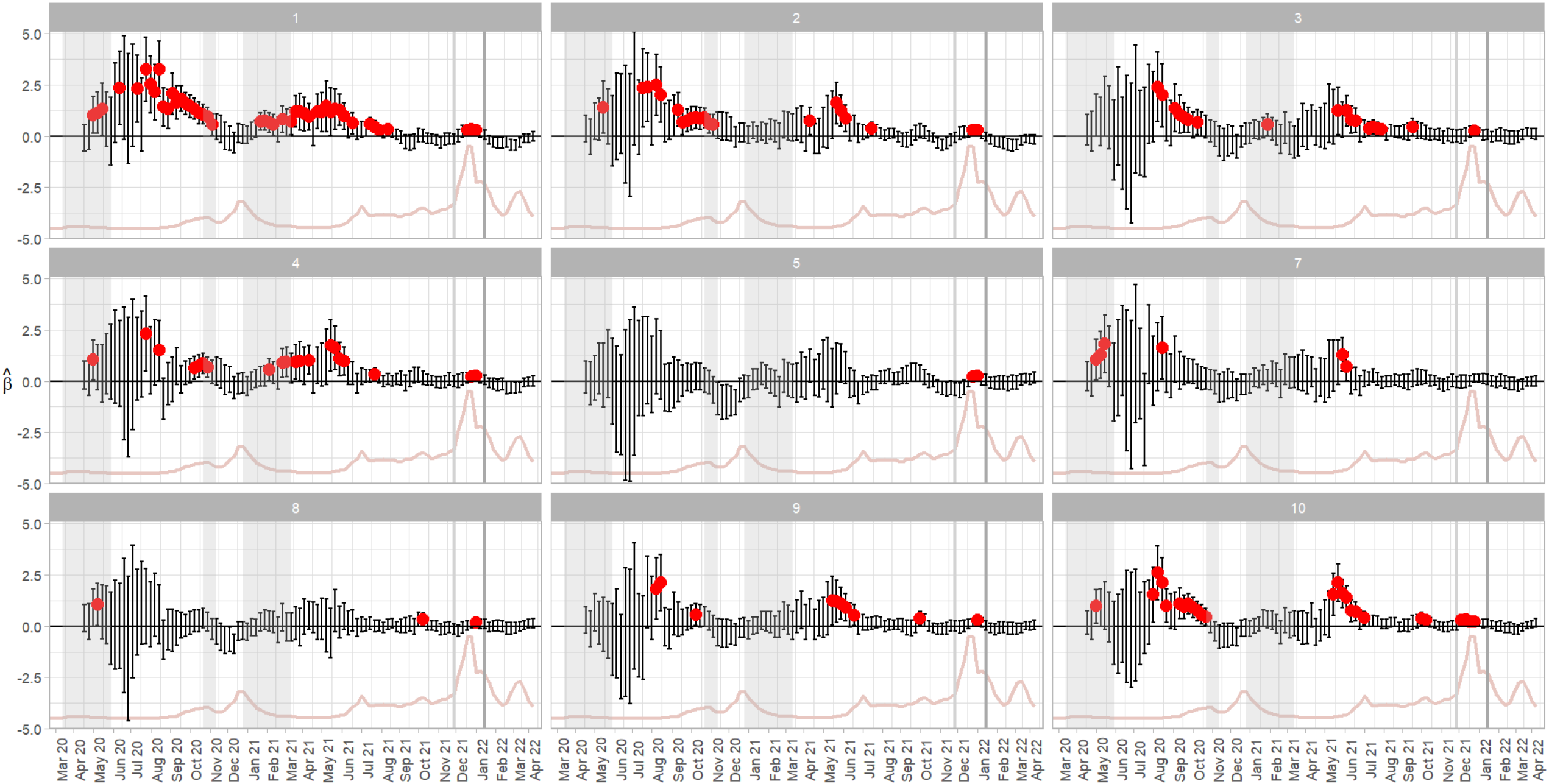


Omits data for 2020-03-07 & 2020-03-14


East Midlands
East of England
London
North East
North West
South East
South West
West Midlands
Yorkshire and The Humber
750
500
250
2020-07
2021-01
2021-07
2022-01
Estimated daily Covid-19 cases (000s)
Date

Is the percentage of the population in the IMD group per 'place' significant to the COVID-19 rate?

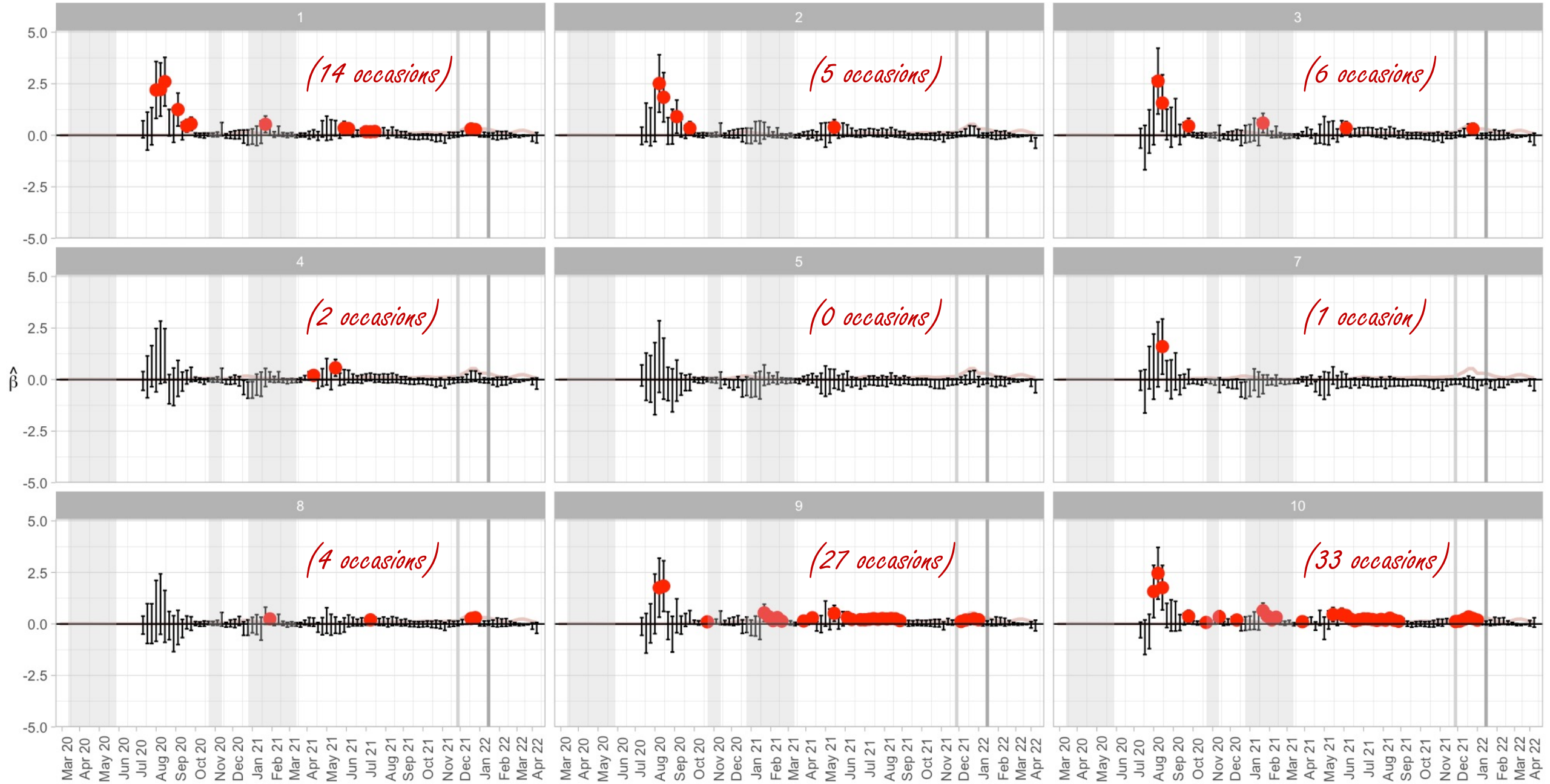
Significant occasions indicated in red (with linear upscaling of cases)



Omits data for 2020-03-07 & 2020-03-14

Is the percentage of the population in the IMD group per 'place' significant to the COVID-19 rate?

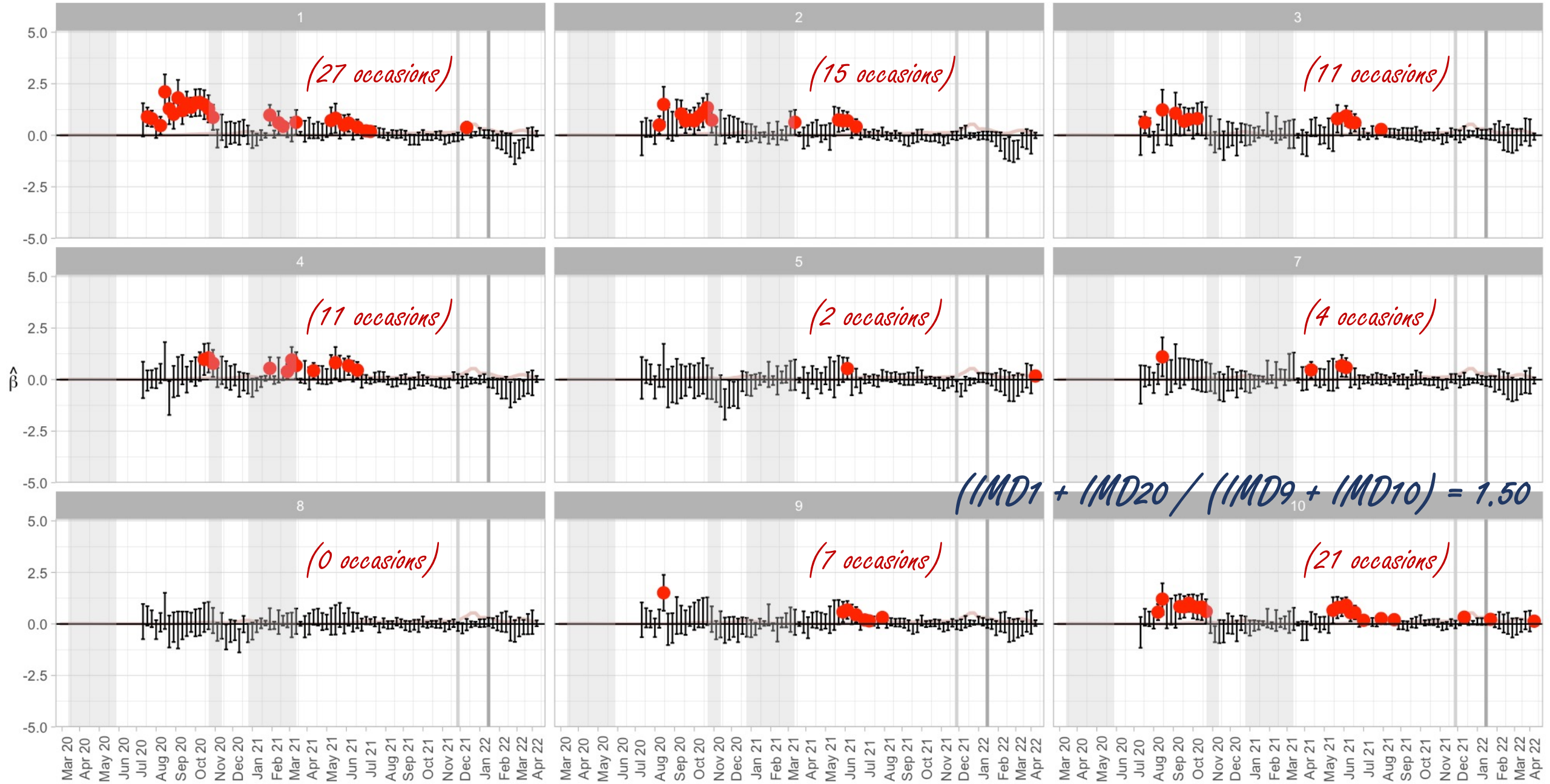
Significant occasions indicated in red (iterative reweighting against ONS age rates)



Omits data for 2020-03-07 & 2020-03-14

Is the percentage of the population in the IMD group per 'place' significant to the COVID-19 rate?

Significant occasions indicated in red (iterative reweighting against ONS regional age rates)



Omits data for 2020-03-07 & 2020-03-14

Summary

- Area level deprivation is significantly associated with monthly COVID-19 cases in England over the period.
- For much of the pandemic, if deprived neighbourhoods had had the (unexplained) 'neighbourhood benefits' of affluent neighbourhoods (or their populations), cases would have been lower.
- But this changes with the Omicron variant.
- Area level affluence is also significantly associated with monthly COVID-19 cases in England over the period.
- Are the more affluent the disease vector?!

https://profrichharris.github.io/
@profrichharris

University of BRISTOL


https://rpubs.com/profrichharris/COVID-deprivation