2020 Fall Seminar Series
Laboratory of Digital and Computational Demography

Regional Mortality Analysis during the Outbreak of COVID-19: Two Case Studies

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21st October 2020

Outline

- Modelling COVID-19 mortality at the regional level in Italy

  joint work with Carlo G. Camarda

- Linking excess mortality to Google mobility data during the COVID-19 pandemic in England and Wales

  joint work with Diego Alburez-Gutierrez, Emanuele Del Fava, Daniela Perrotta, Marco Bonetti, Carlo G. Camarda and Emilio Zagheni

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Introduction

Background:

- More than 35,000 COVID-19 deaths registered in Italy between February and July 2020
- Vast territorial differences in COVID-19 mortality, with 70% of deaths occurring in the north of the country

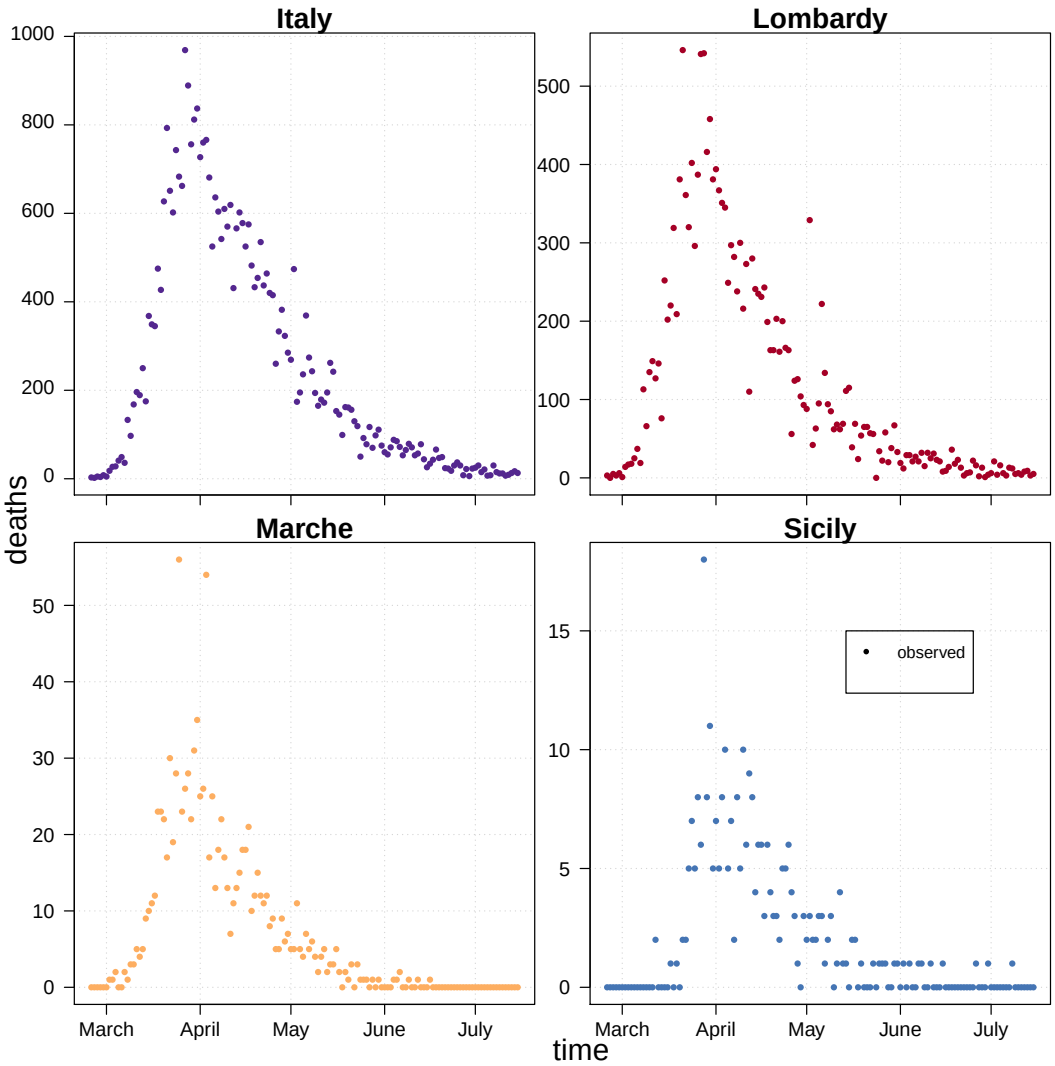
Goal:

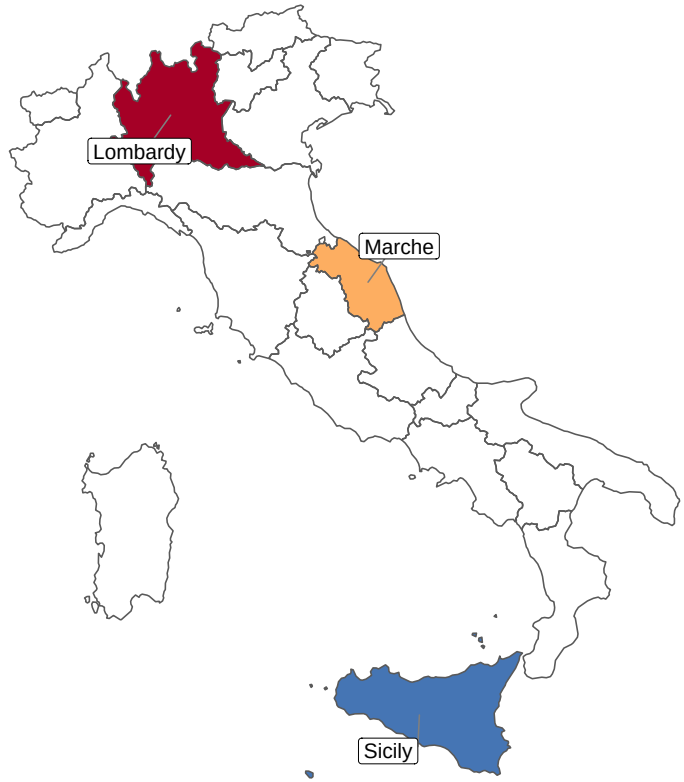
- Identify demographic and socio-economic factors that have contributed to the diverse regional impact of the virus

Approach:

- Principal components, cluster analysis and extended Poisson regression model

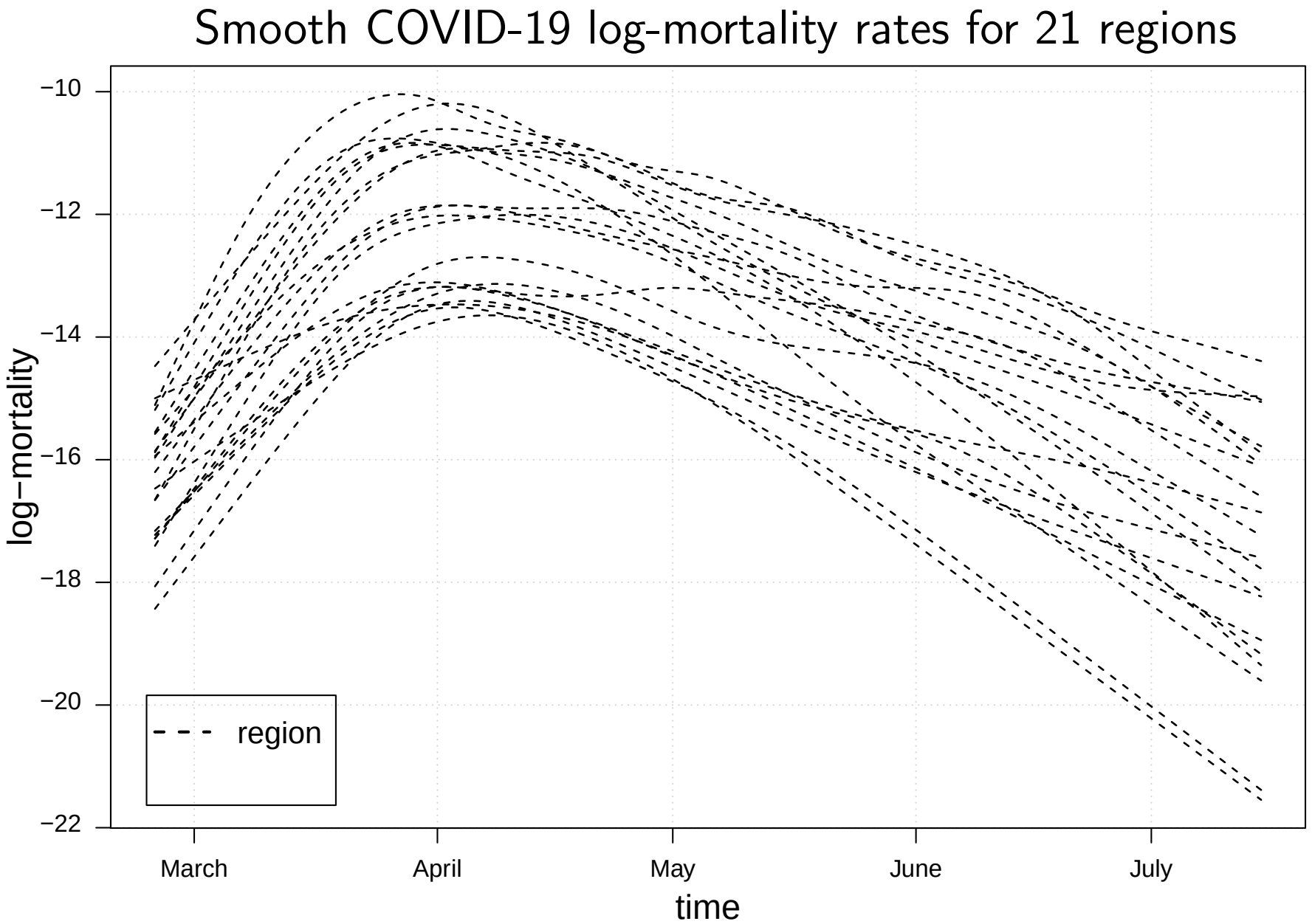
COVID-19 deaths



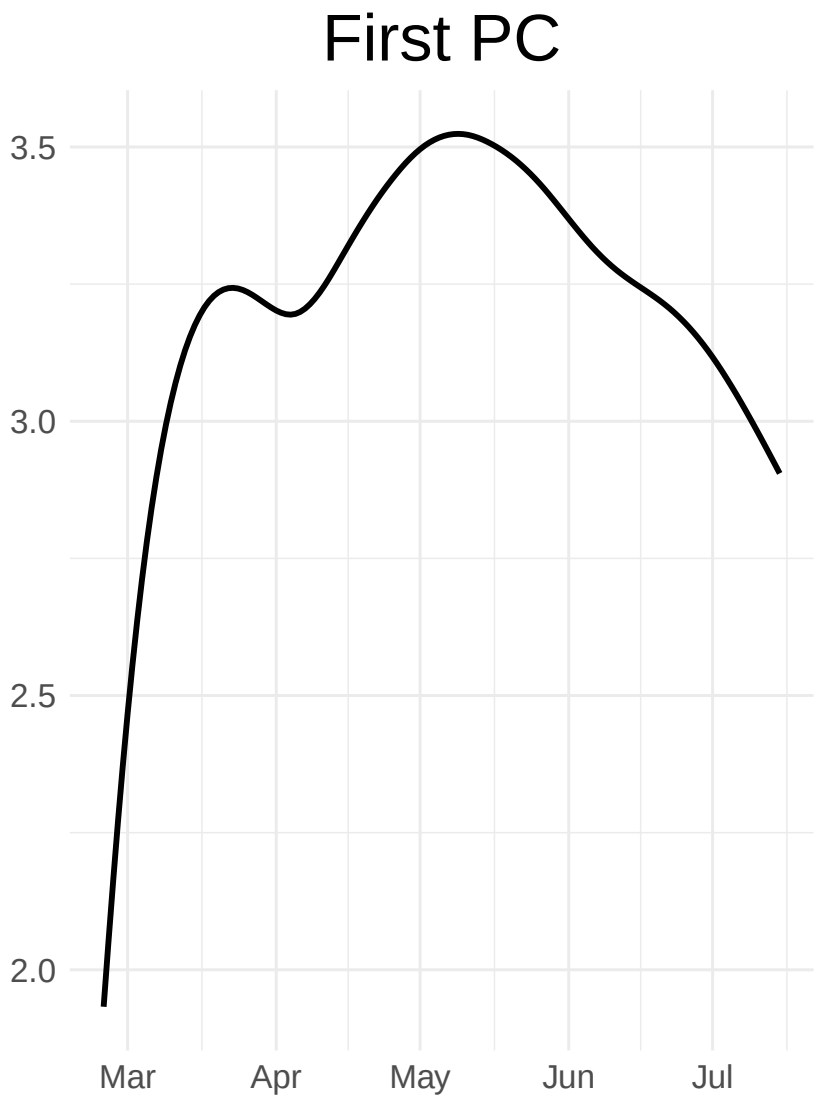


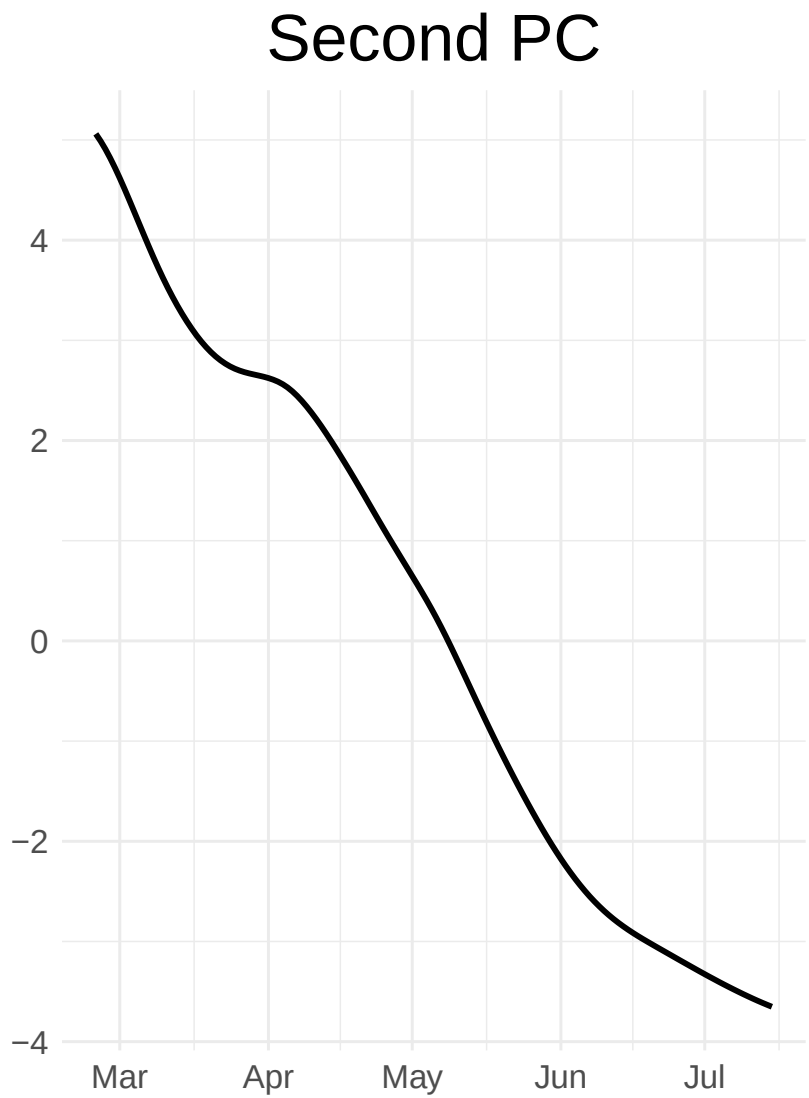
Daily number of COVID-19 deaths in Italy and three of its regions.
February 25 – July 15, 2020. *Source: DPC (2020)*

Smoothing mortality

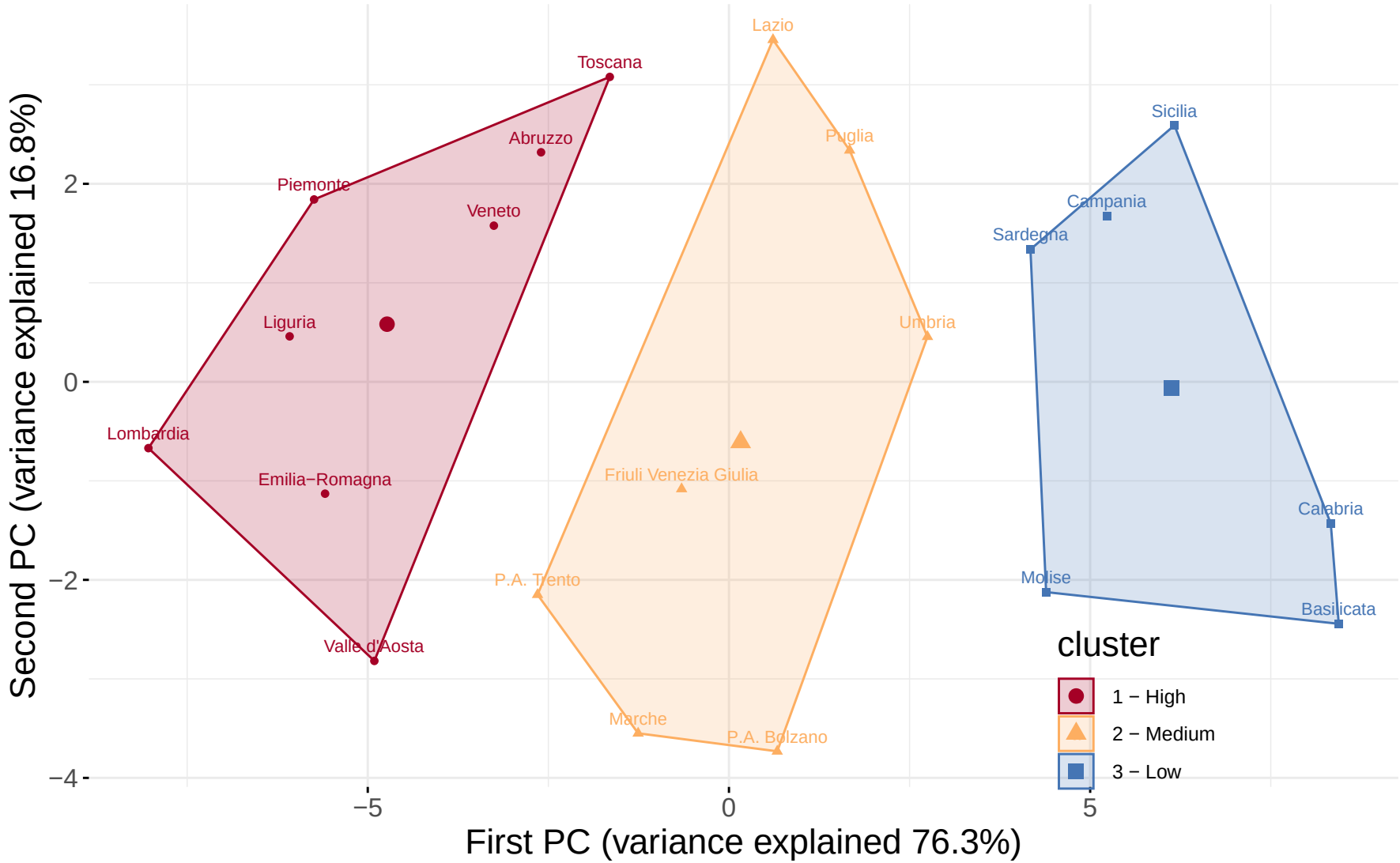


Principal Component Analysis

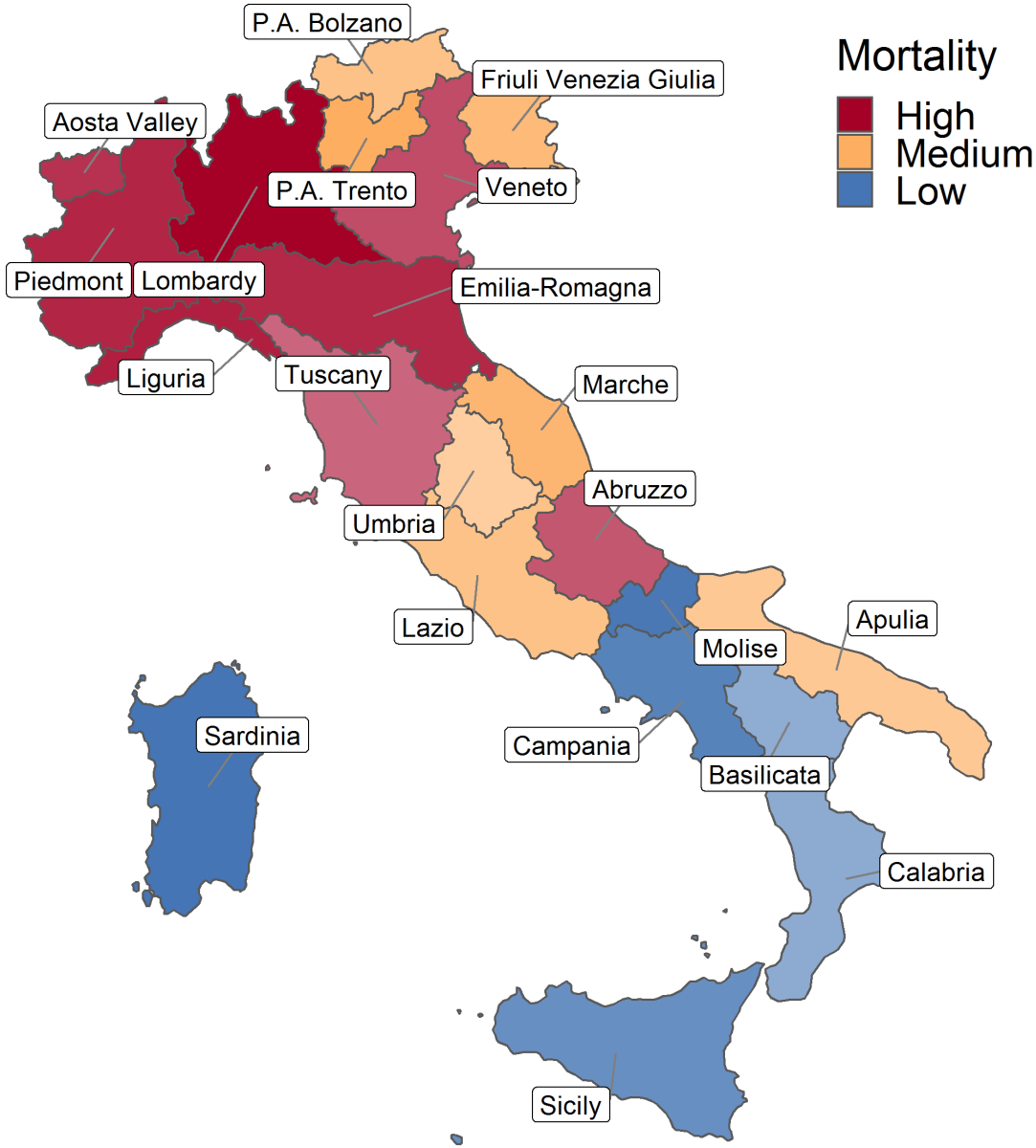




Cluster analysis on two PCs



Mortality clusters

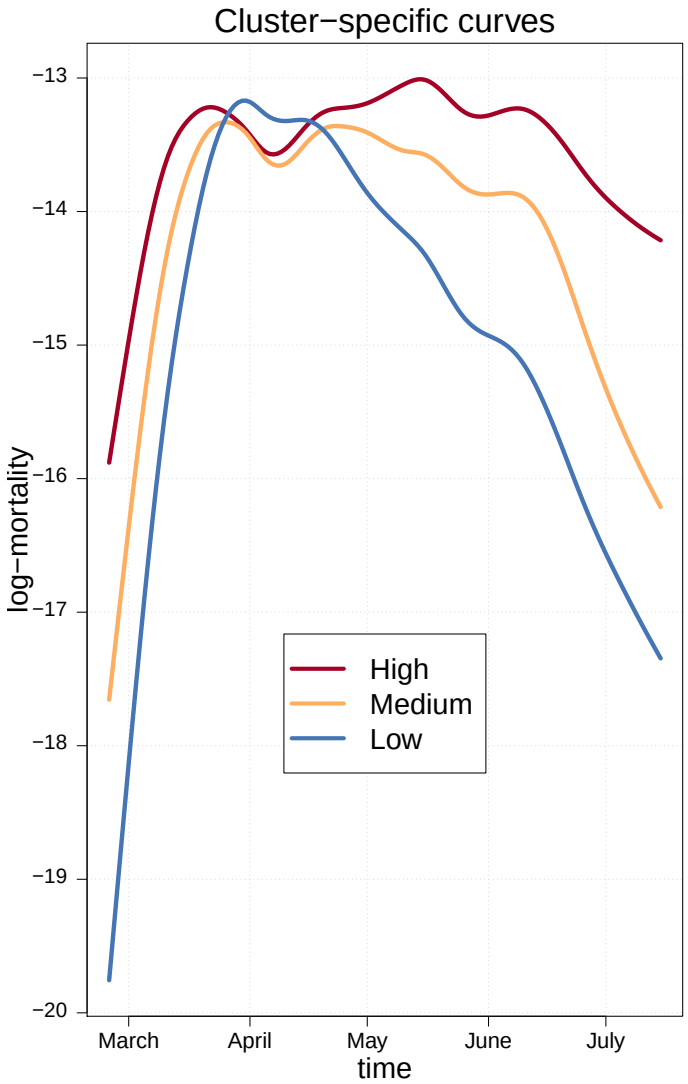


Explanatory variables

Variable	Type	Expected mortality effect
% population 65y+	constant	↑ (Dowd et al. 2020)
Population density	constant	↑ (Rocklv and Sjdin 2020)
# nursing homes	constant	↑ (Trabucchi and Leo 2020)
Mean household size	constant	↑ (Esteve et al. 2020)
GDP per capita	constant	↑
# days from the onset	constant	↓
% ICU utilization	time-varying	↑ (Volpato et al. 2020)
Daily cumulative tests	time-varying	↓
Daily positive cases	time-varying	↑

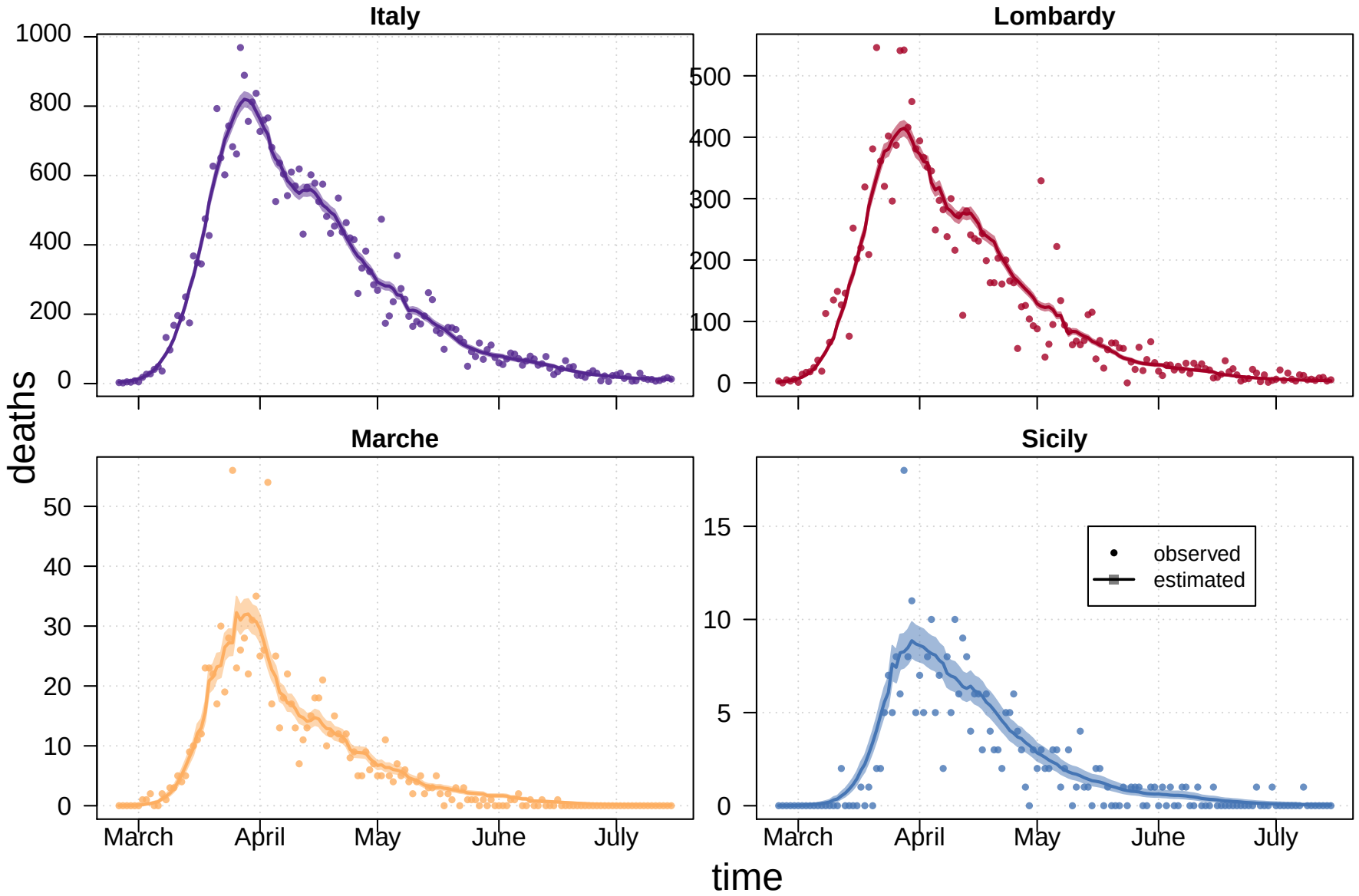
Sources: Ministero della Salute (2020); Dipartimento Della Protezione Civile (2020); Istat (2020); Istituto Superiore di Sanita (2020)

Model results



Variable	$\hat{\beta}$	Mortality effect
% ICU utilization	0.84	↑↑↑
# days from onset	-0.37	↓↓
Daily cumul. tests	-0.19	↓
GDP per capita	0.13	↑
% population 65y+	0.09	↑
Daily positive cases	0.08	↑
Population density	–	–
# nursing homes	–	–
Mean household size	–	–

Goodness-of-fit



Observed and estimated COVID-19 deaths in Italy and three of its regions. February 25 – July 15, 2020.

Conclusions

- Three types of epidemics, broadly defined by the COVID-19 mortality level: High, Medium and Low
- Regression analysis to determine the relative contribution of different factors on regional mortality:
  - significant: % ICU utilization, delay of the epidemic, daily cumulative tests, GDP per capita, % older population & daily positive cases
  - not significant: population density, # nursing homes & household size
- Work in progress: % ICU utilization could be endogenous, different indicators of stress to health system

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Introduction

Background:

- Different non-pharmaceutical interventions (NPIs) implemented across the globe to contain the spread of COVID-19

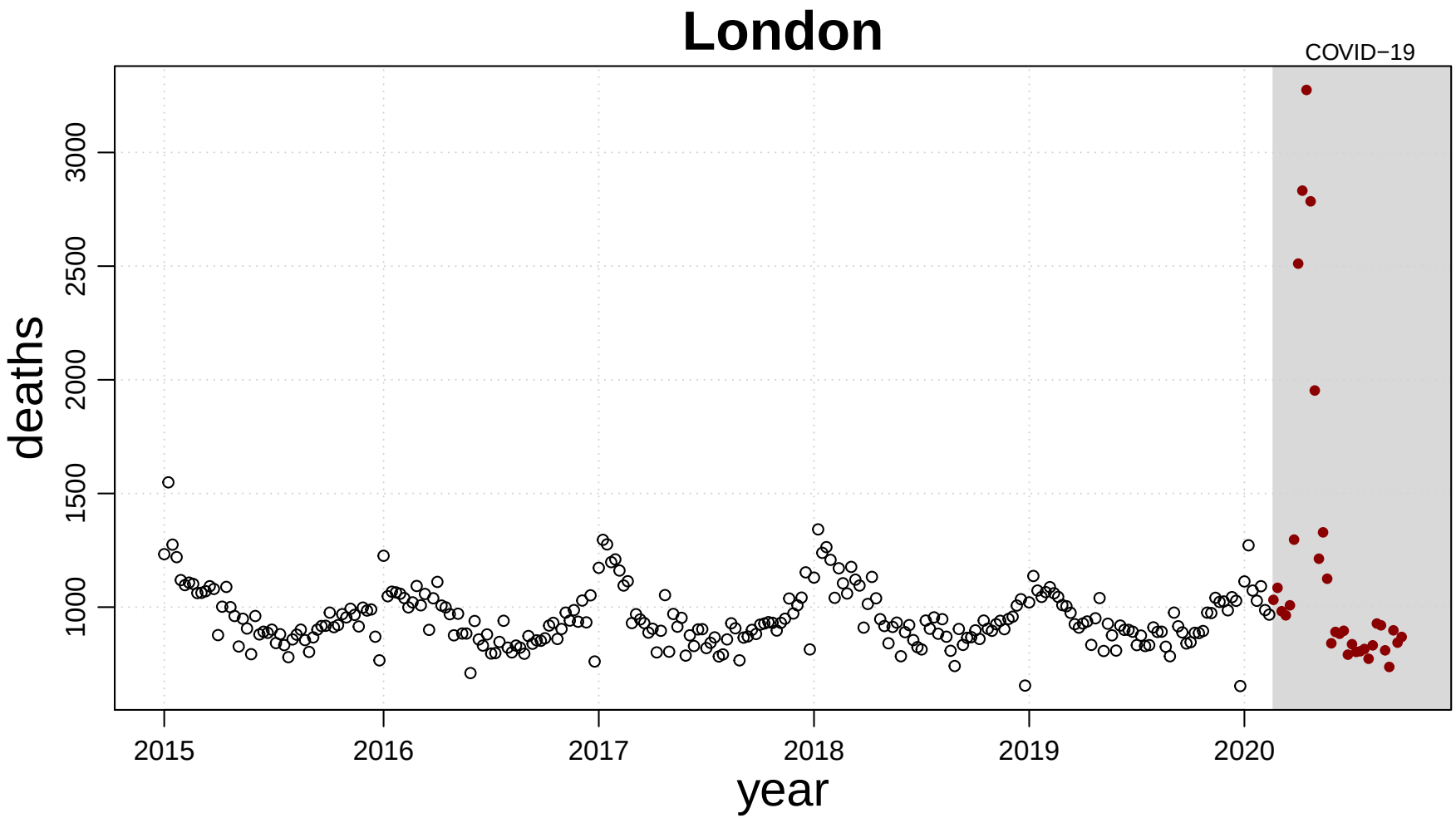
Goal:

- Assess the effectiveness of NPIs in reducing the mortality burden during the pandemic

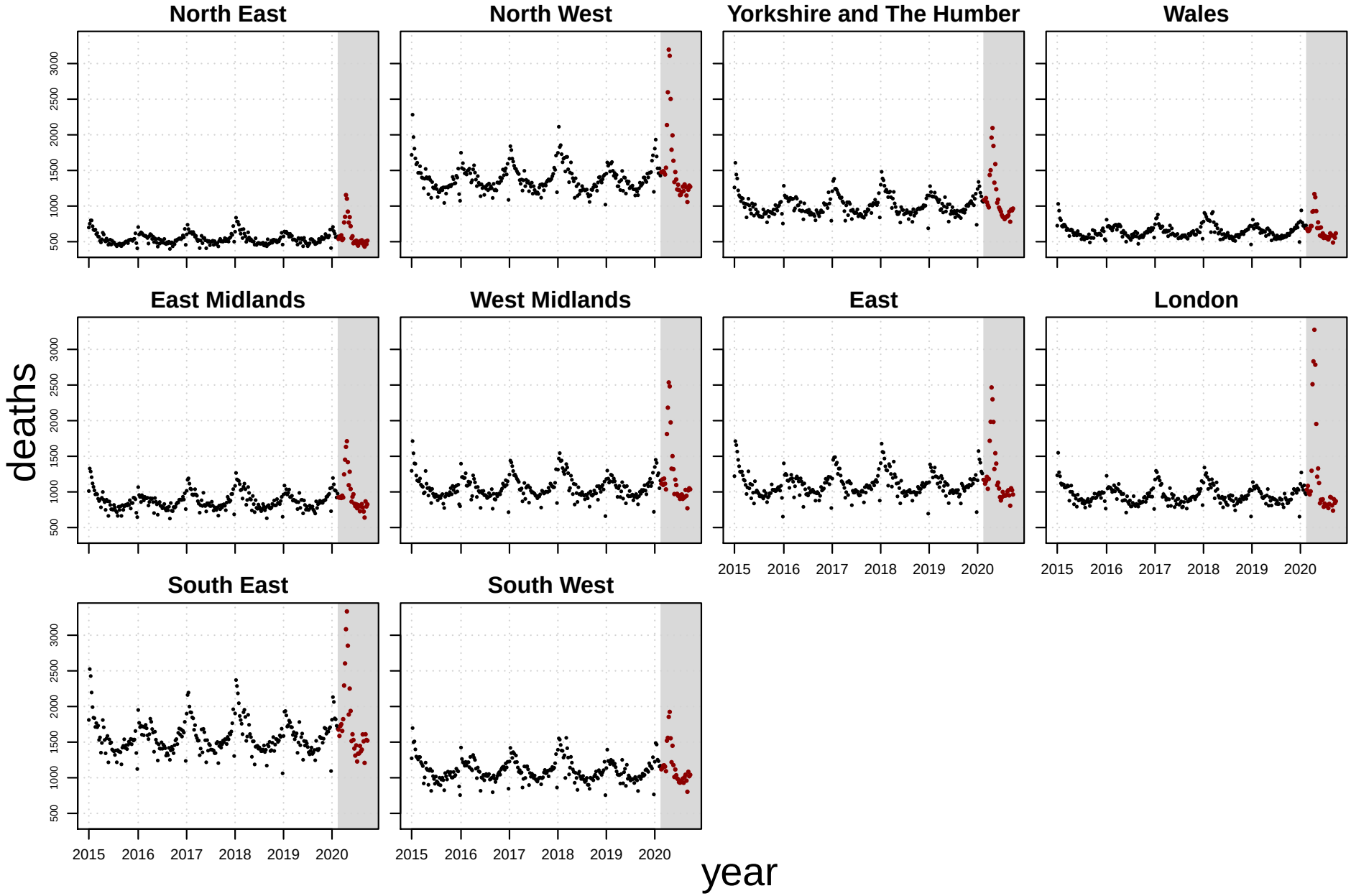
Approach:

- Study excess mortality and human mobility at regional level in England and Wales during outbreak of COVID-19
- Cross-sectional analysis and mixed-effect regression models

Mortality data: death counts

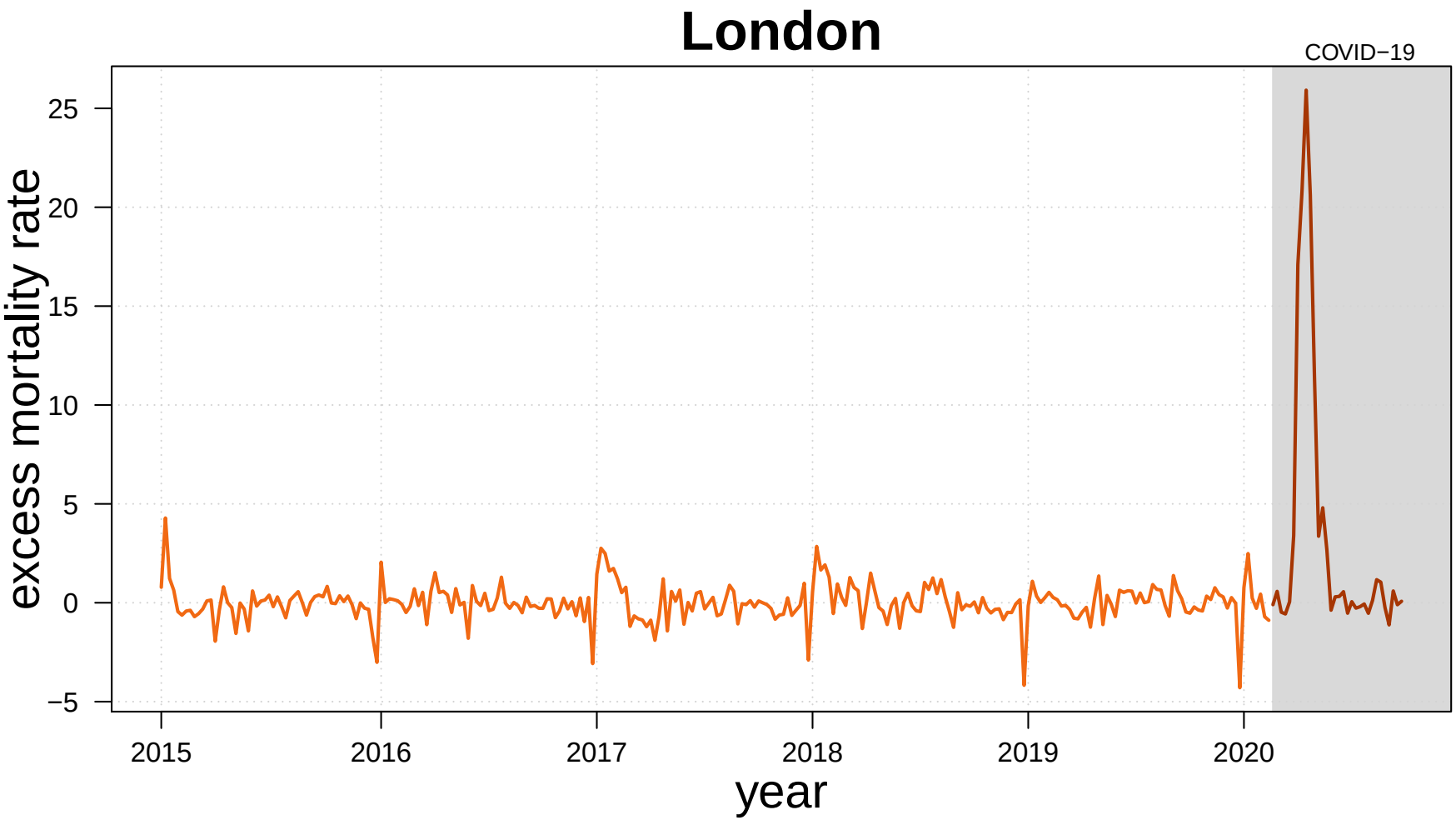


Weekly deaths registered in the region of London.
Week 1, 2015 – Week 39, 2020. *Source: ONS (2020)*

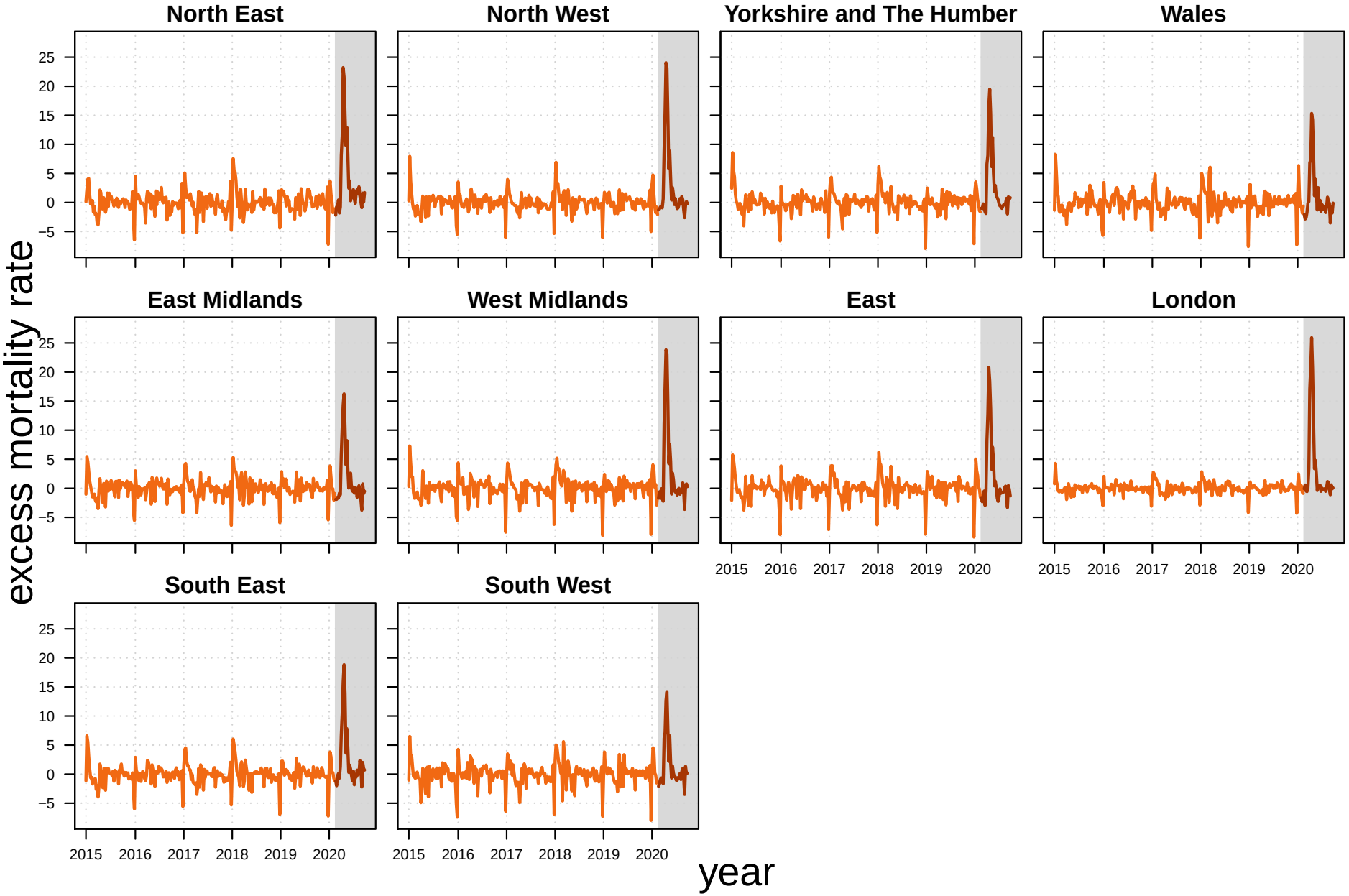


Weekly deaths registered in England and Wales by region.
Week 1, 2015 – Week 39, 2020. *Source: ONS (2020)*

Mortality data: excess mortality rate

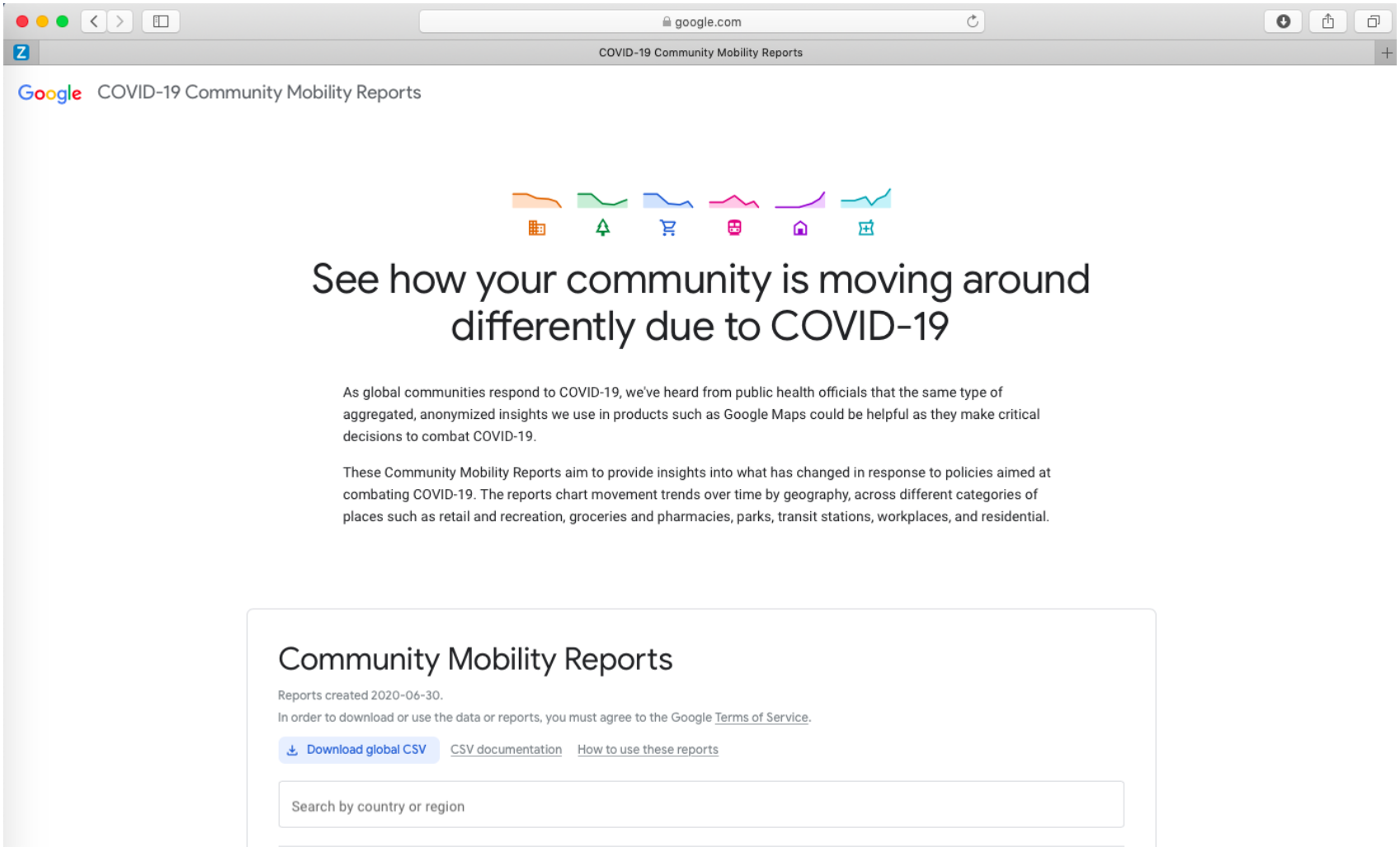


Excess mortality rate (per 100,000 individuals) in the region of London.
Week 1, 2015 – Week 39, 2020. *Source: elaborations of data from ONS (2020)*



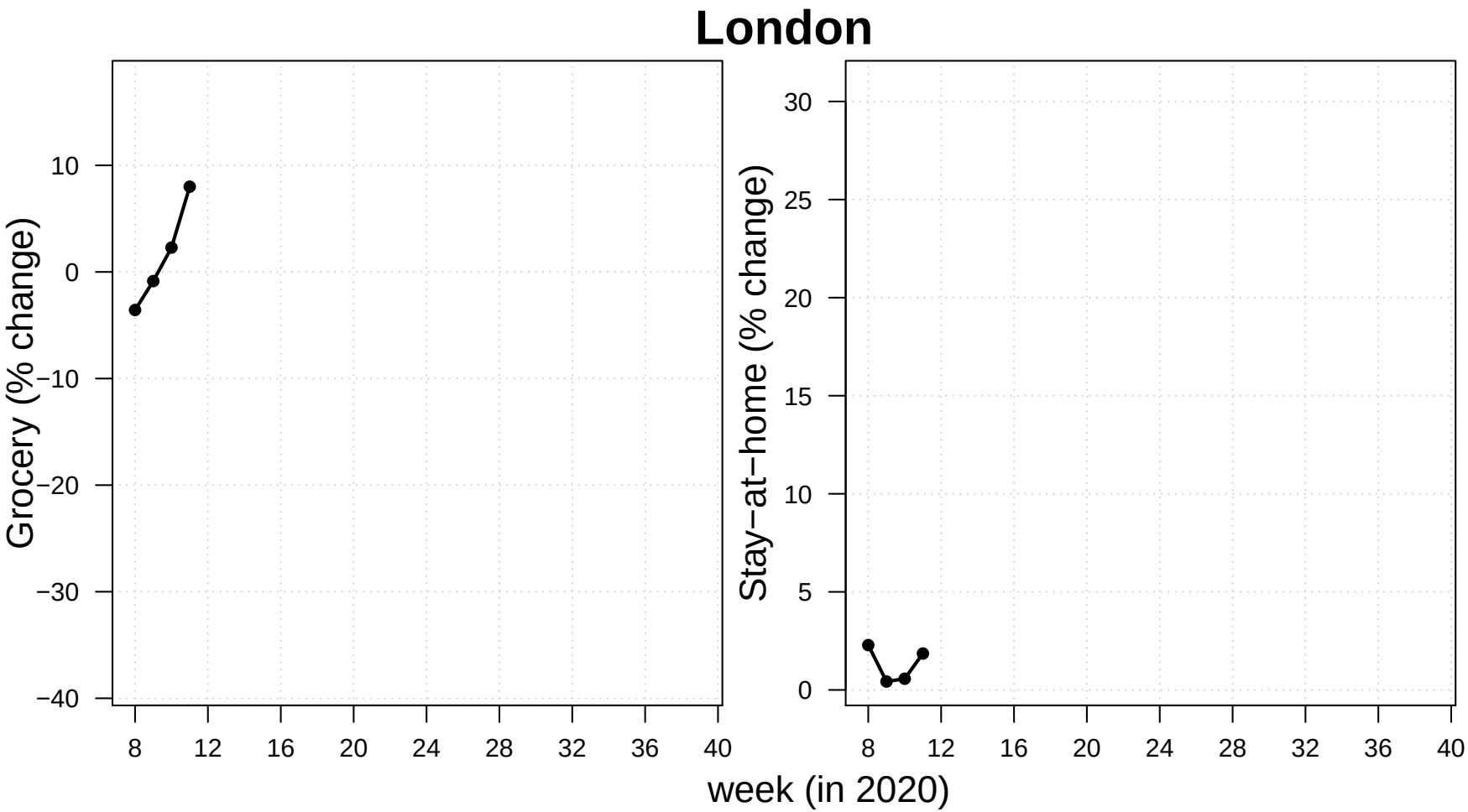
Excess mortality rate (per 100,000 individuals) in England and Wales by region.
Week 1, 2015 – Week 39, 2020. *Source: elaborations of data from ONS (2020)*

Mobility data: Google Community Reports



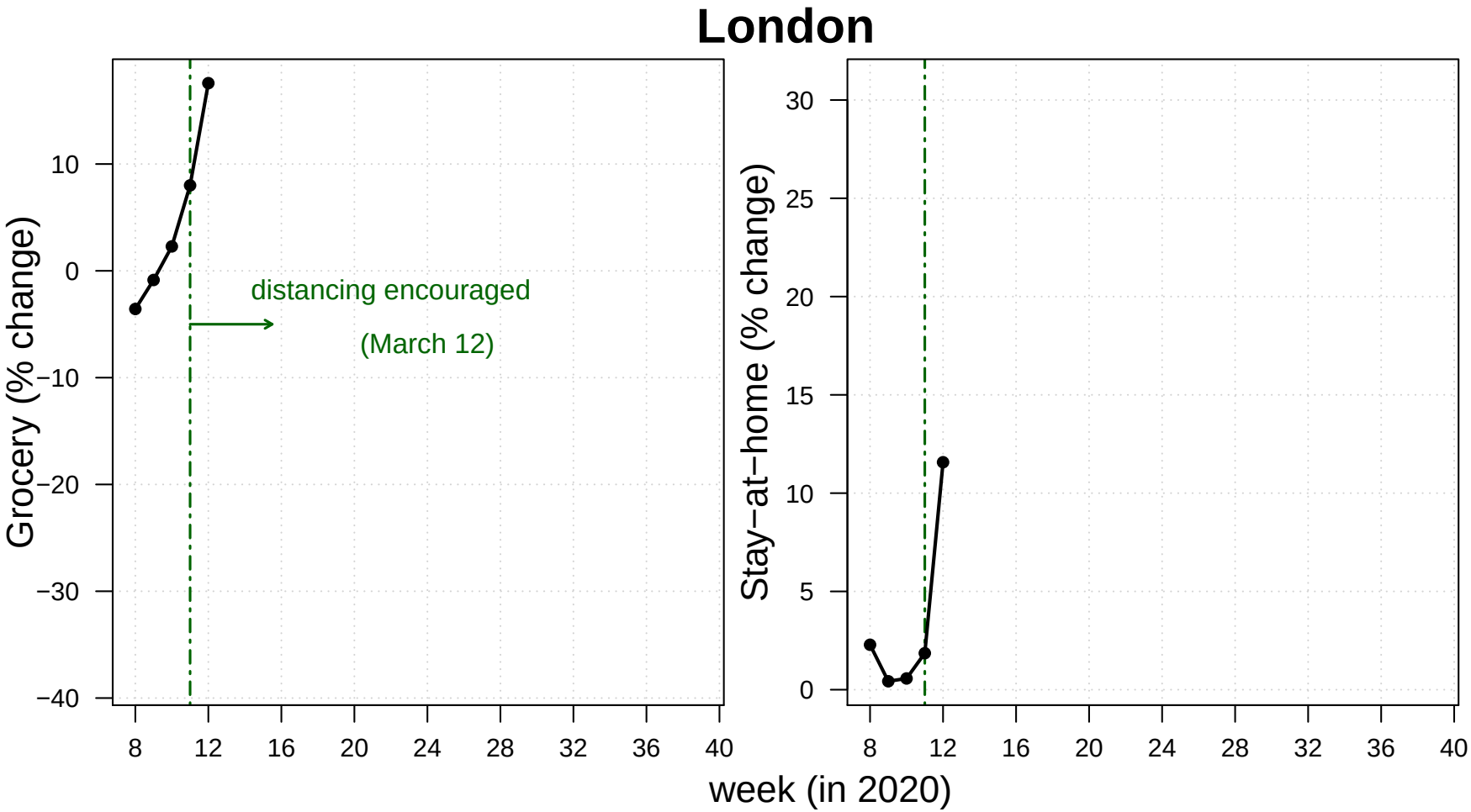
Available at `https://www.google.com/covid19/mobility/`

Mobility data: grocery & stay-at-home



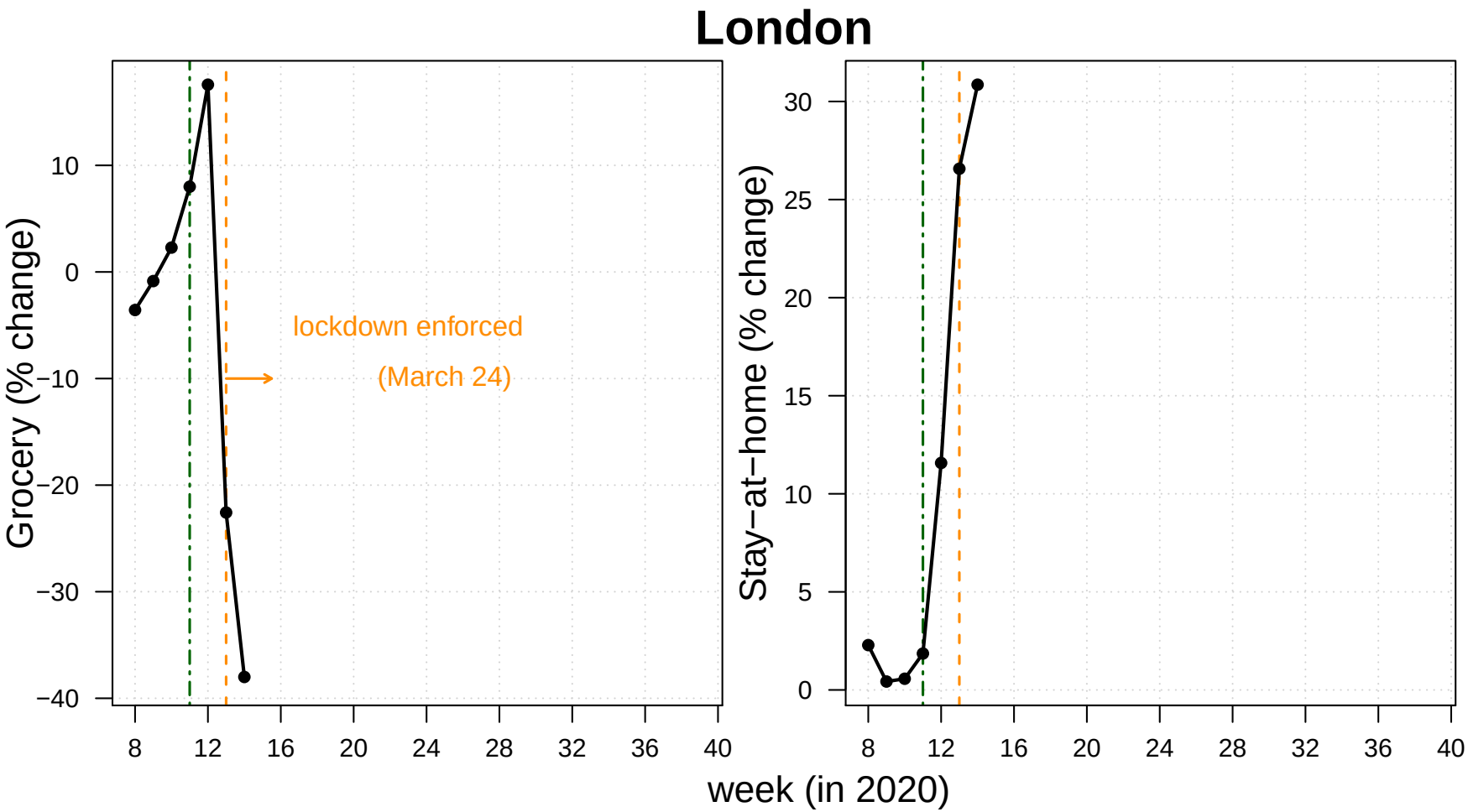
Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–11, 2020 (15 February – 13 March).
Source: elaborations of data from Google (2020)

Mobility data: grocery & stay-at-home



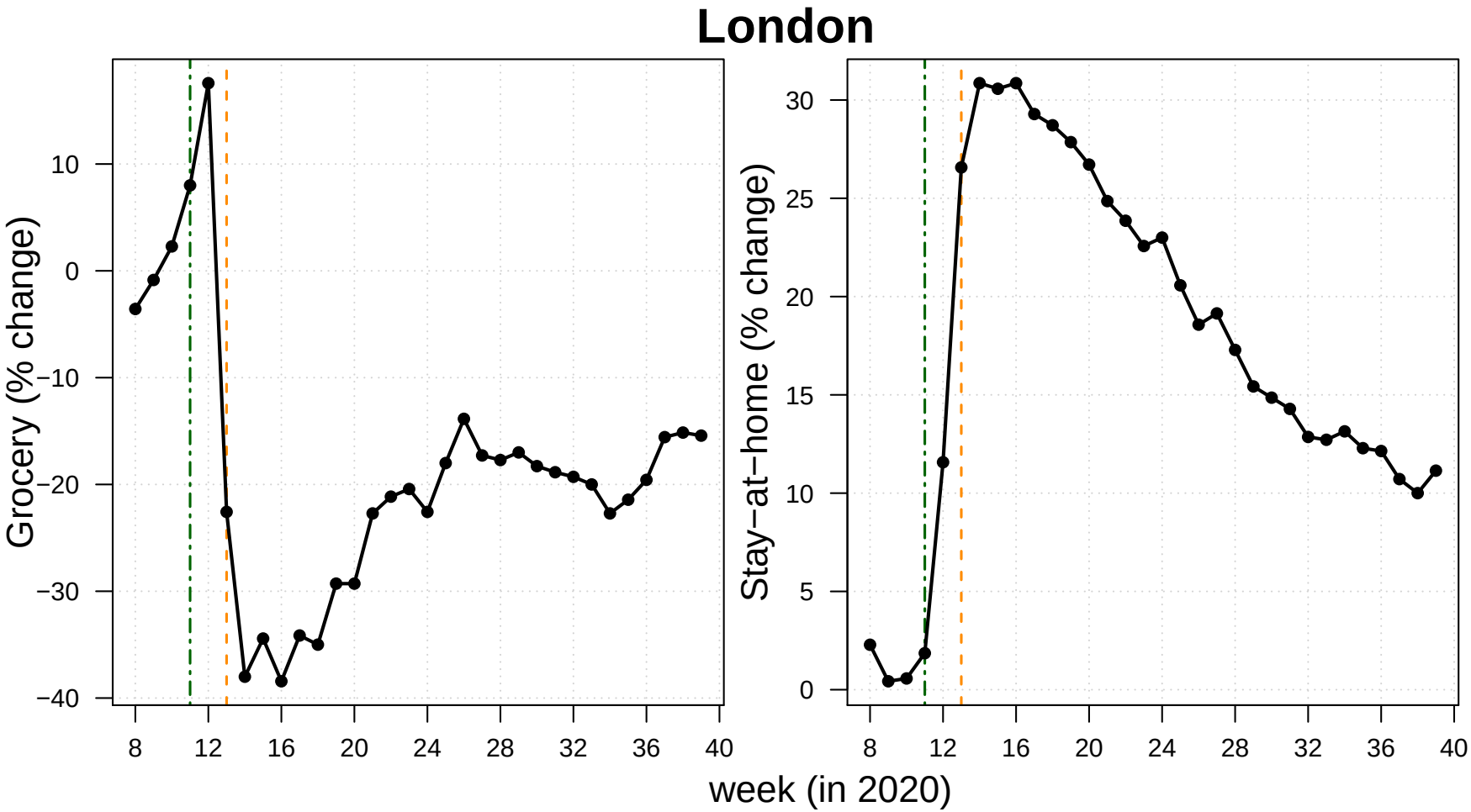
Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–12, 2020 (15 February – 20 March).
Source: elaborations of data from Google (2020)

Mobility data: grocery & stay-at-home



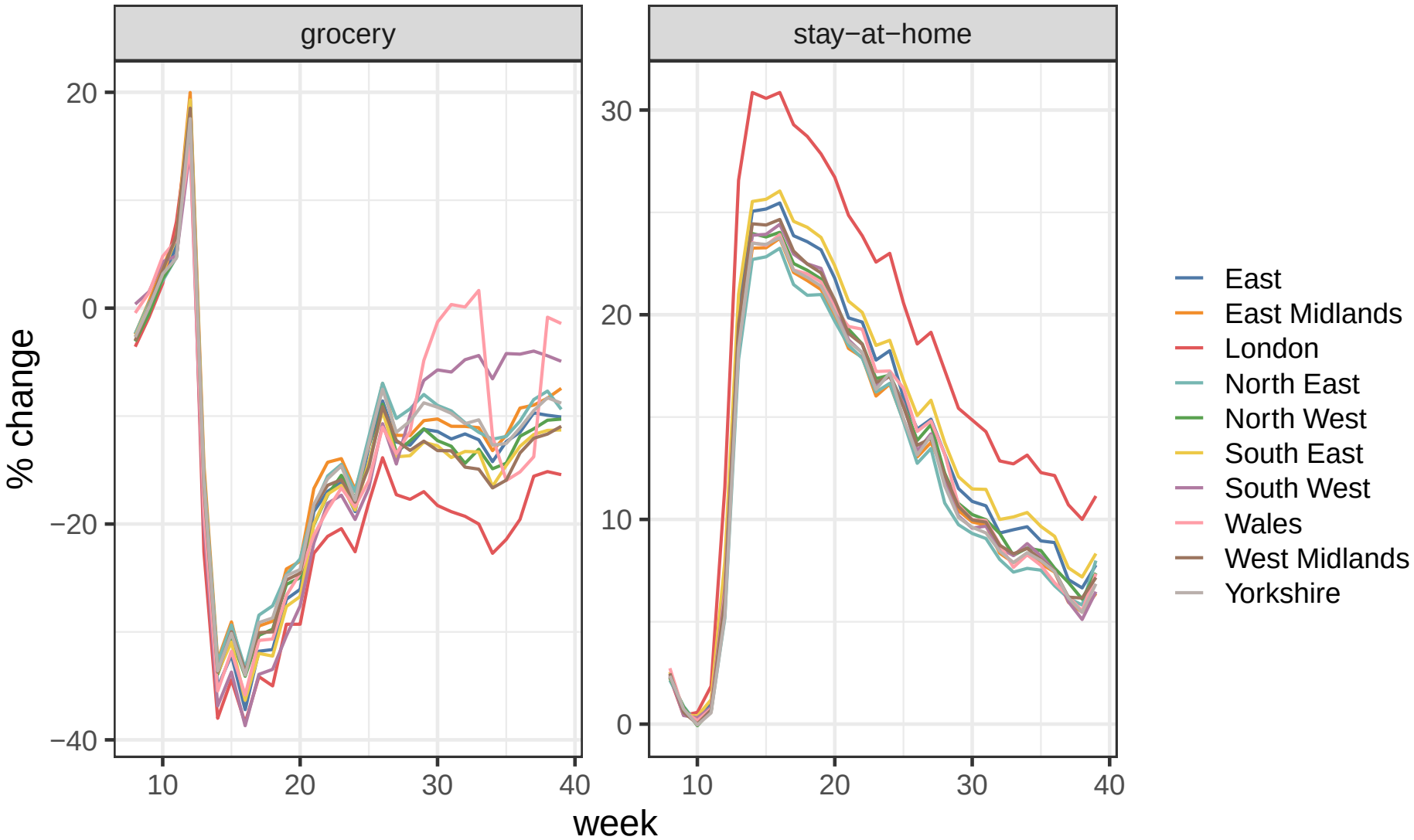
Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–14, 2020 (15 February – 04 April).
Source: elaborations of data from Google (2020)

Mobility data: grocery & stay-at-home



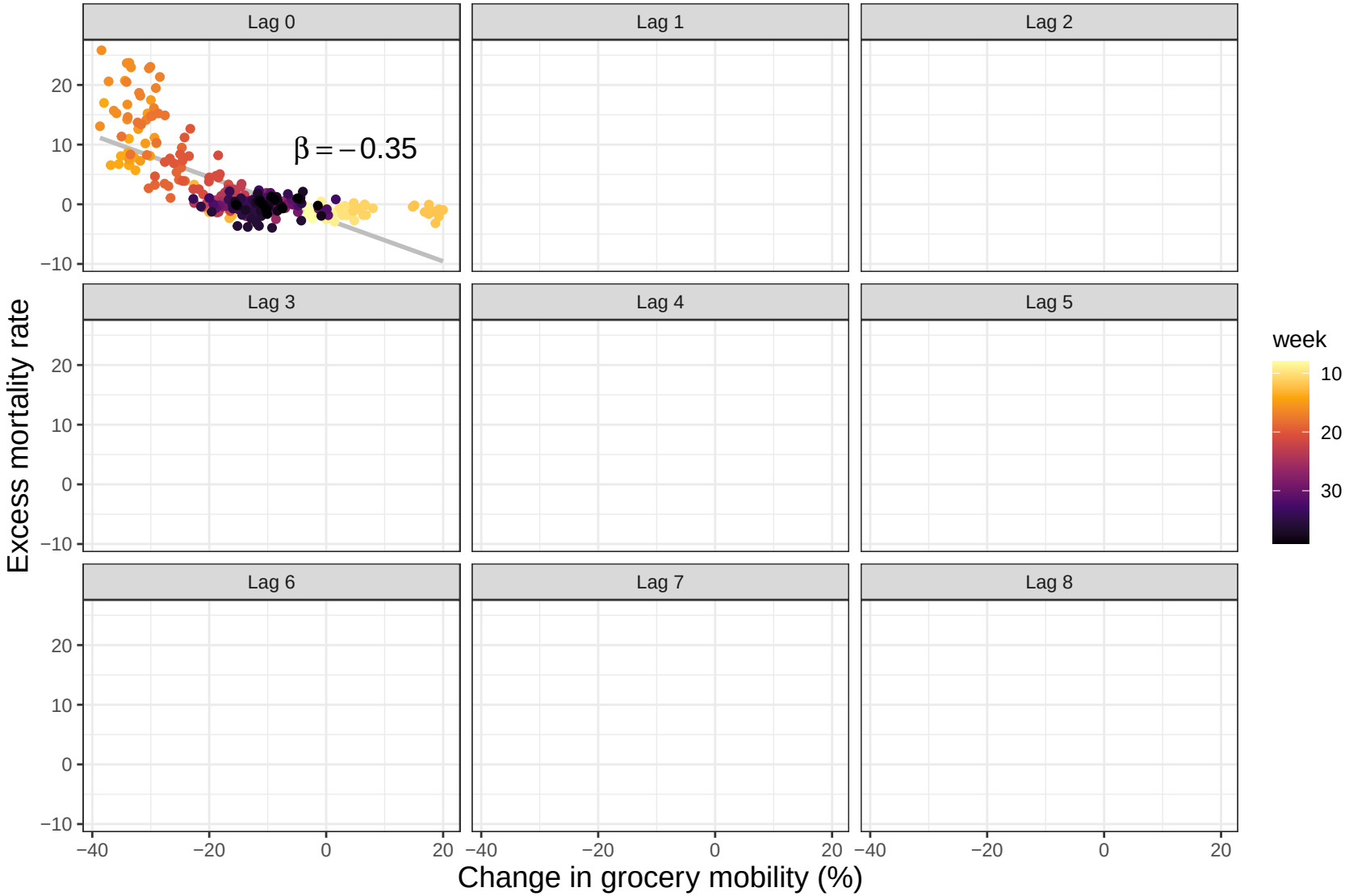
Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. Region of London, weeks 8–39, 2020 (15 February – 25 September).
Source: elaborations of data from Google (2020)

Regional mobility data



Relative change in visits to groceries and pharmacies and time spent at home with respect to start of 2020. England & Wales by region, weeks 8–39, 2020 (15 February – 25 September).
Source: elaborations of data from Google (2020)

Excess mortality & lagged mobility (grocery)



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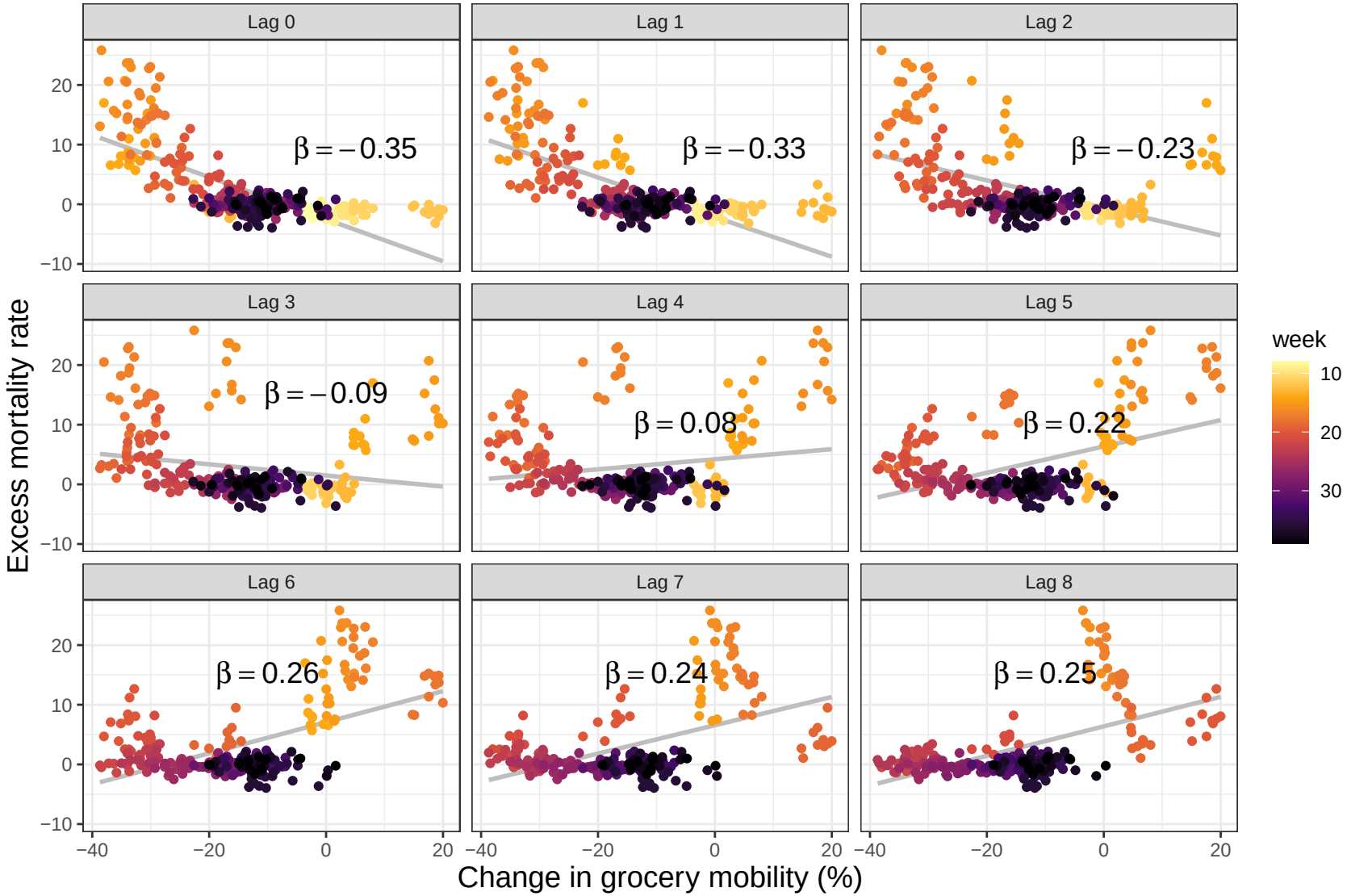
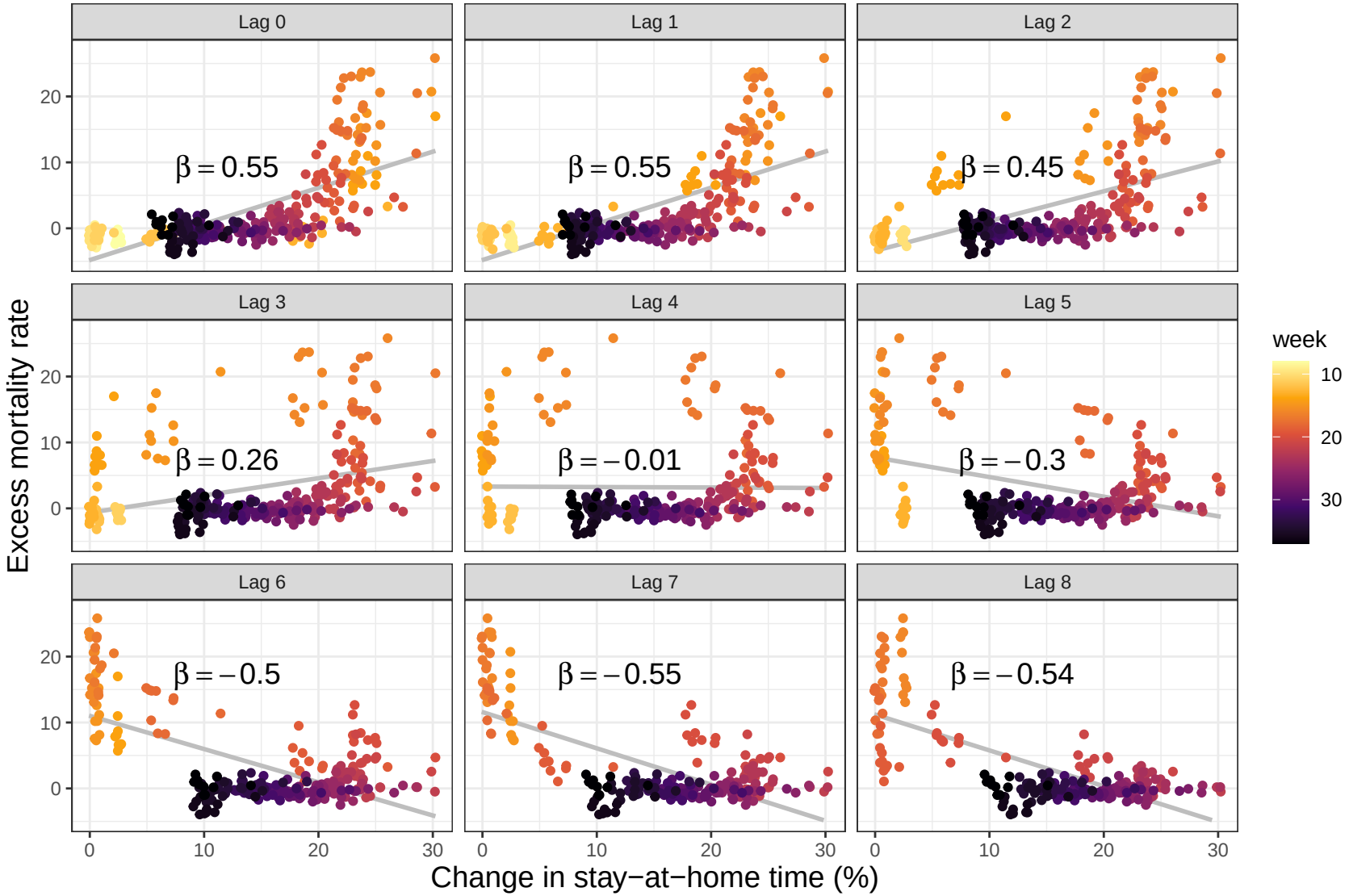
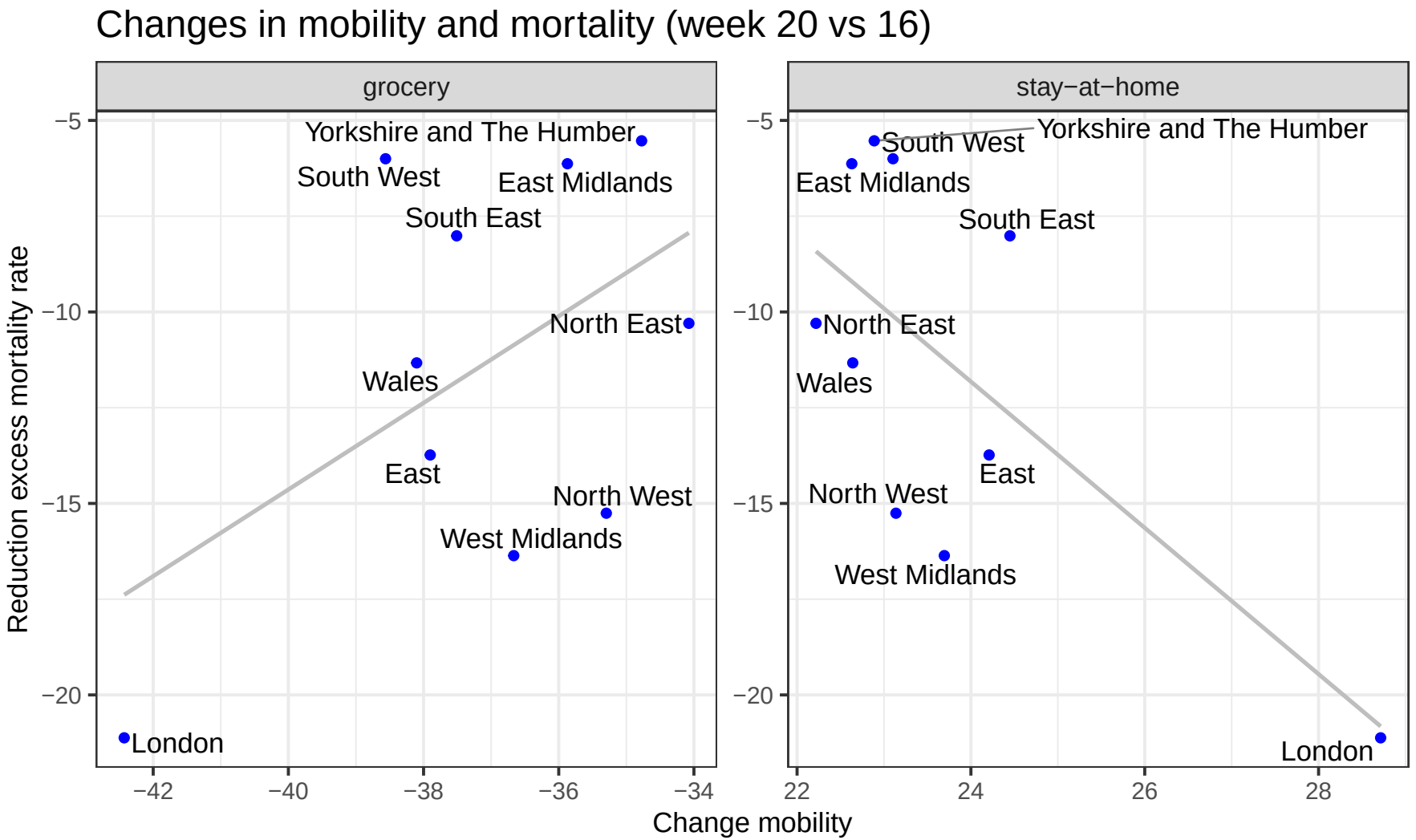


Excess mortality & lagged mobility (home)



Cross-sectional analysis

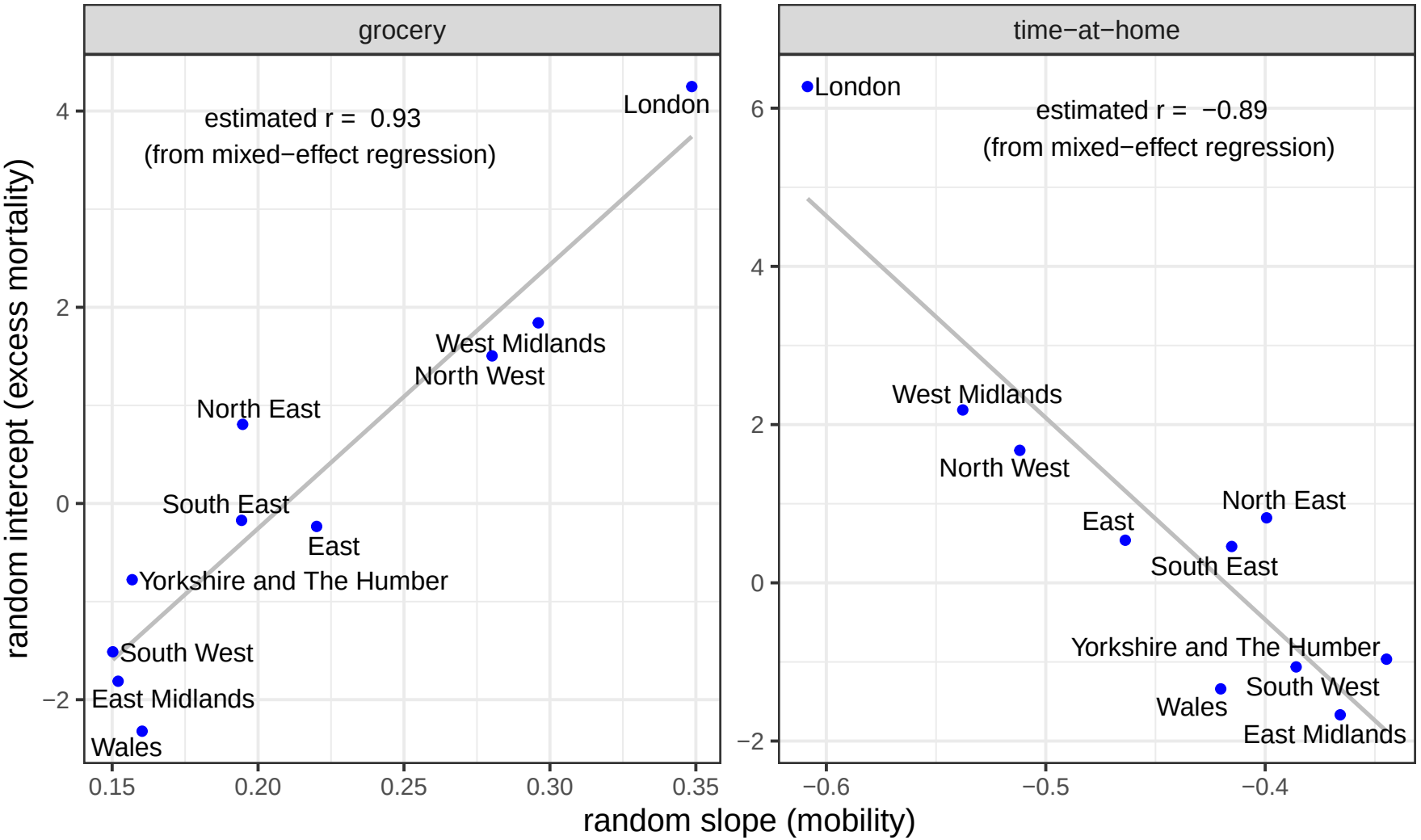


Regression analysis

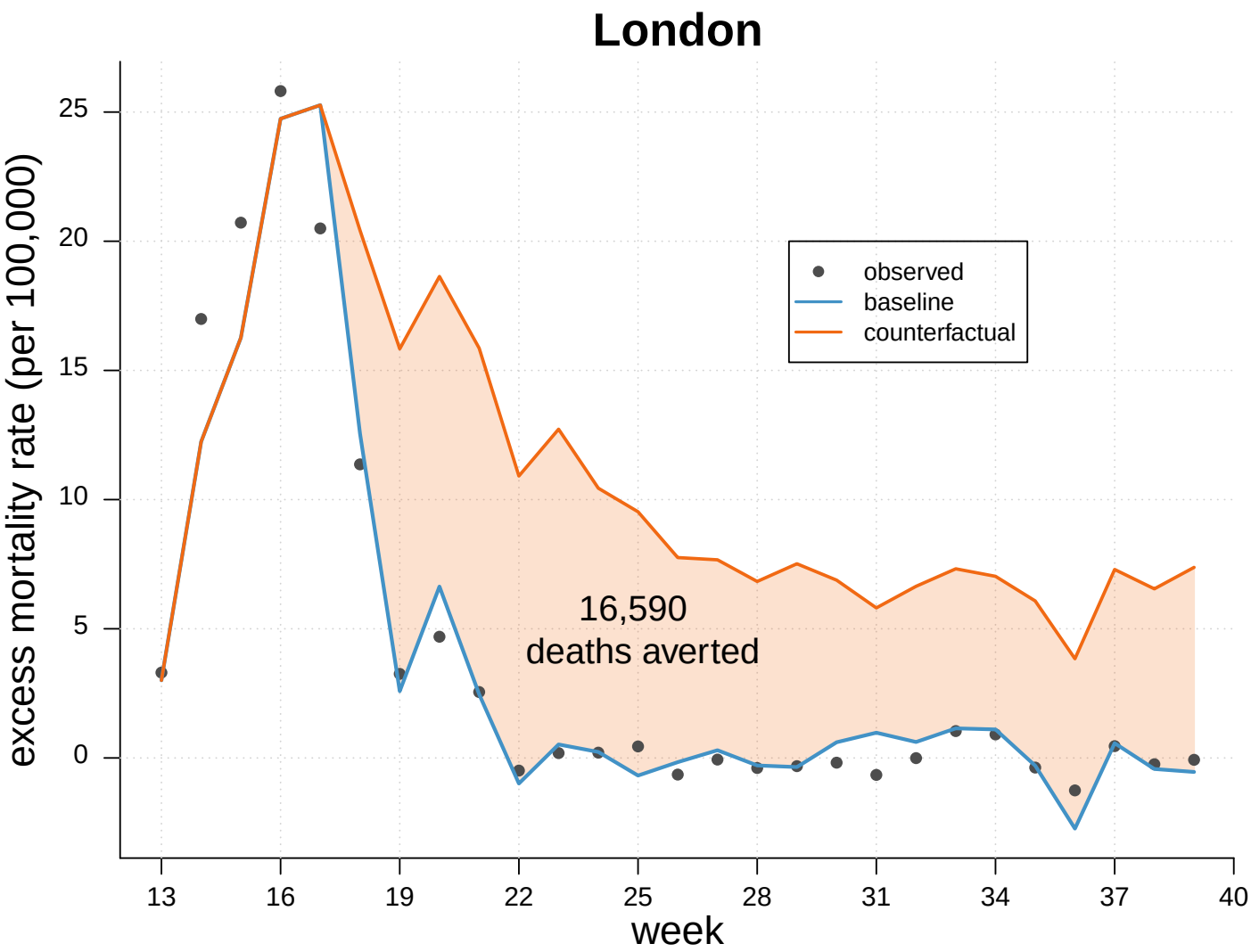
	Dep. variable: excess mortality rate	
	Linear mixed-effects regression	
Fixed effects	grocery	stay-at-home
change in mobility 5 weeks before	0.22	-0.45
(95% conf. interval)	(0.12, 0.32)	(-0.74, -0.16)
Random effects (variance)		
region (intercept)	4.15	5.87
mobility (slope)	0.01	0.01
residual	2.12	2.16
Observations	270	270
Log-Likelihood	-459.40	-461.59
AIC	982.79	987.17
BIC	1097.94	1102.32

Note: the models control for the pandemic time trend using a smooth function of time, and for different regional effects using random intercepts and slopes

Model results



Counterfactual analysis



Conclusions

- Considering a lag of five or more weeks, positive relationship between excess mortality and outdoor mobility, and negative relationship with time spent at home
- Results confirmed in a regression setting that accounts for pandemic time trend and regional differences
- The estimated 50,000 excess deaths occurred in E&W would have been more than doubled in the absence of mobility reductions

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Thank you for your attention!

Comments or questions?

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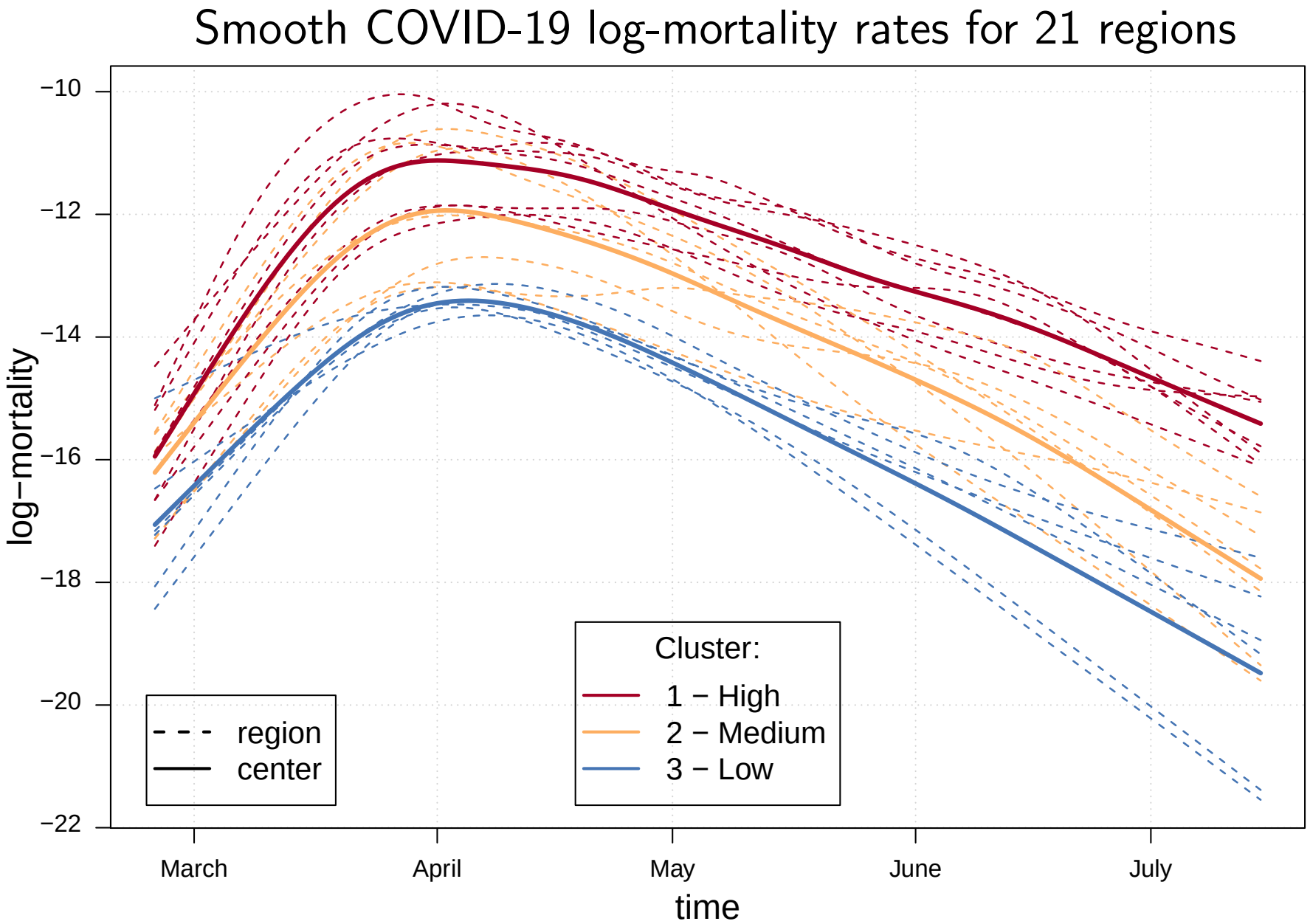
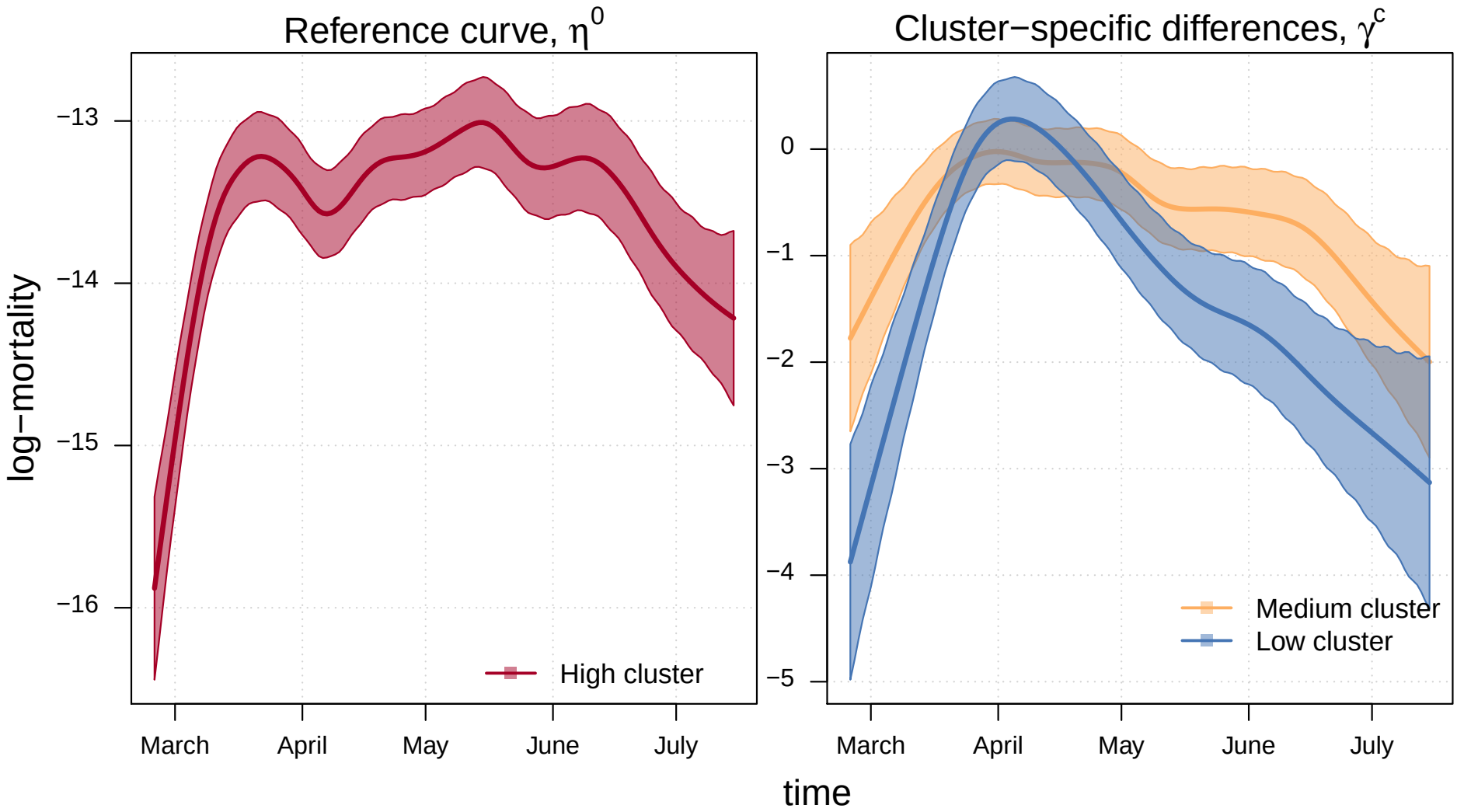
SocArXiv pre-prints available at:
Italy: https://osf.io/preprints/socarxiv/ykc6w/
England & Wales: https://osf.io/preprints/socarxiv/75d6m/

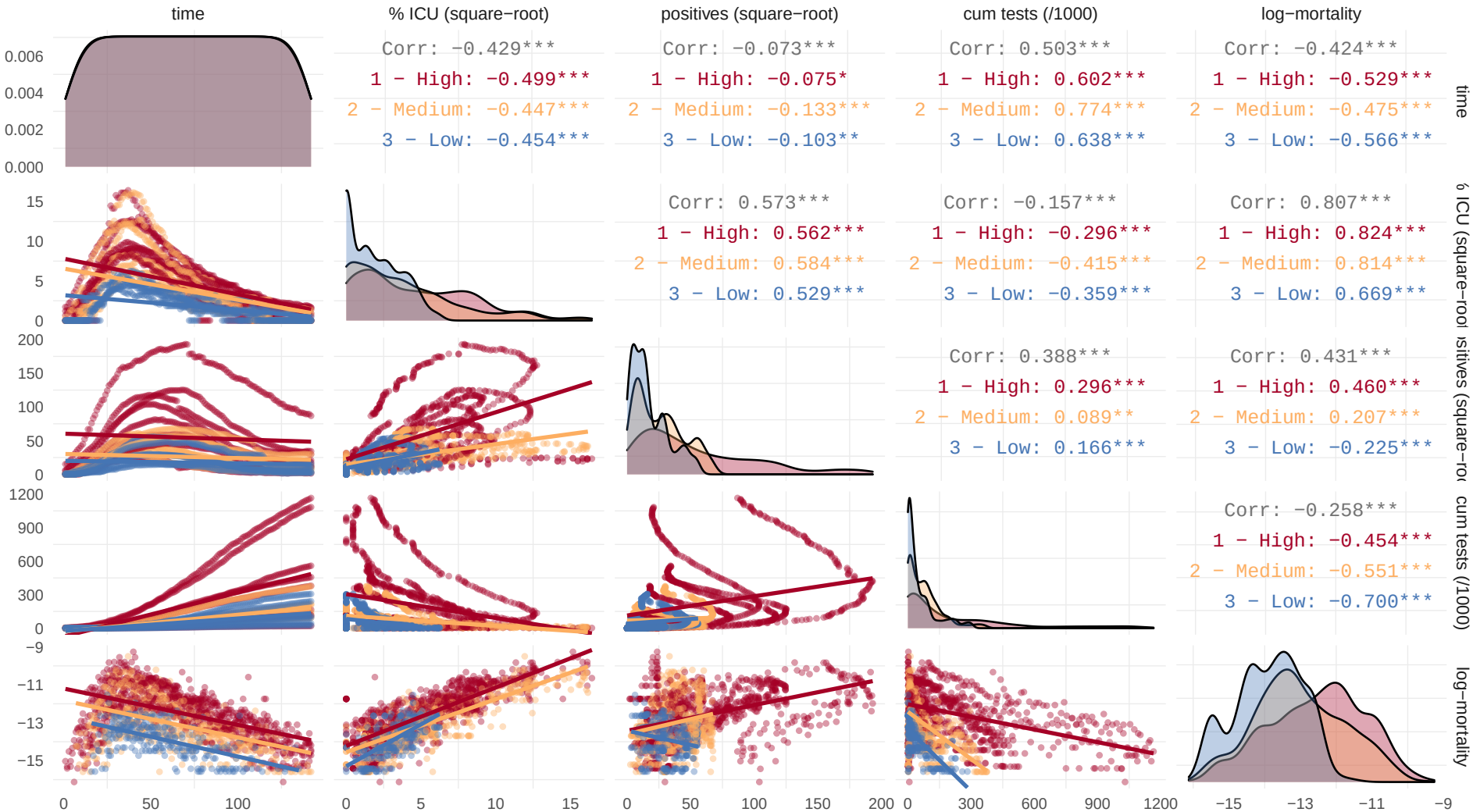
Cluster analysis: results



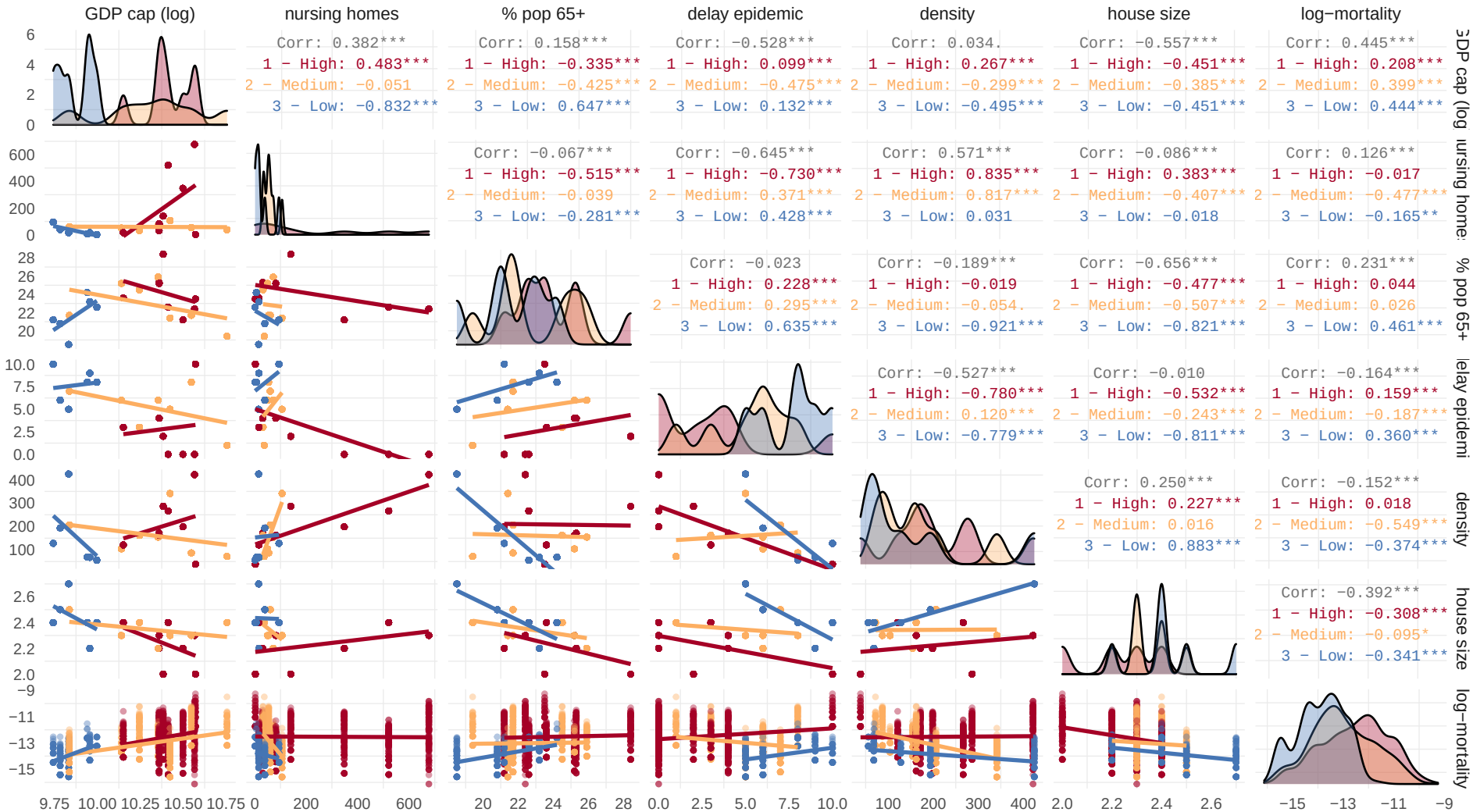
Model results: cluster-specific epidemics



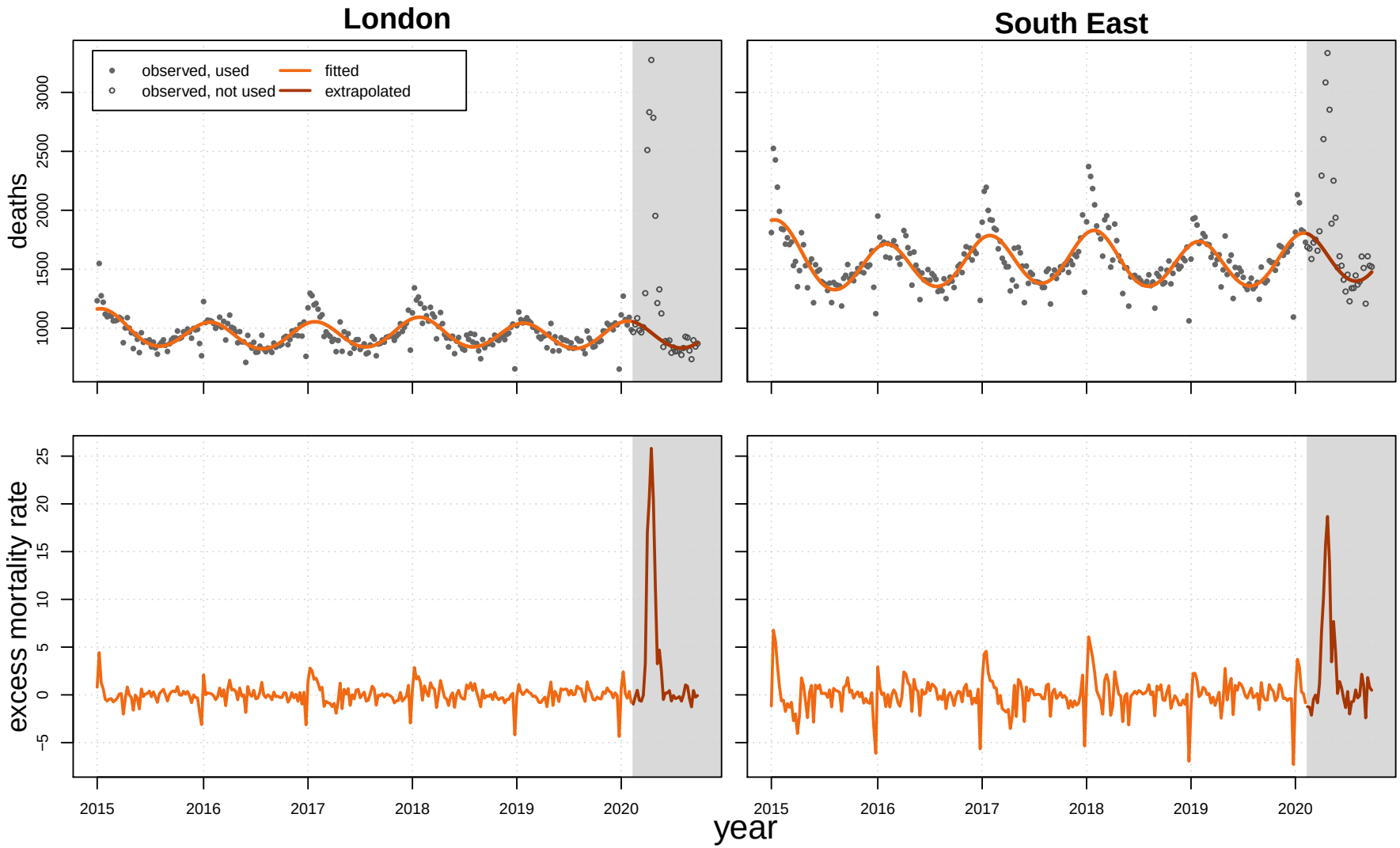
Descriptive analysis



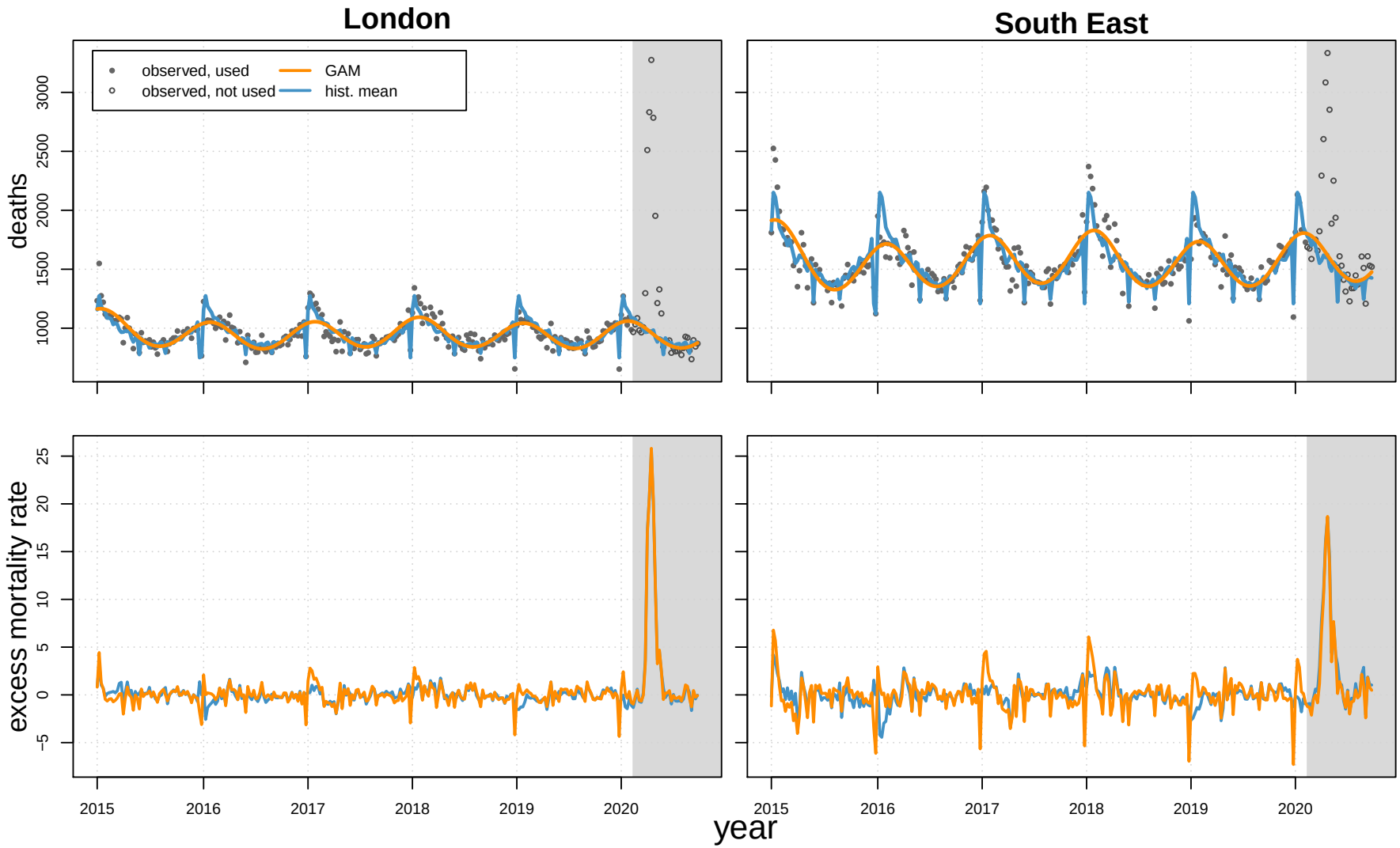
Descriptive analysis



Excess mortality I



Excess mortality II



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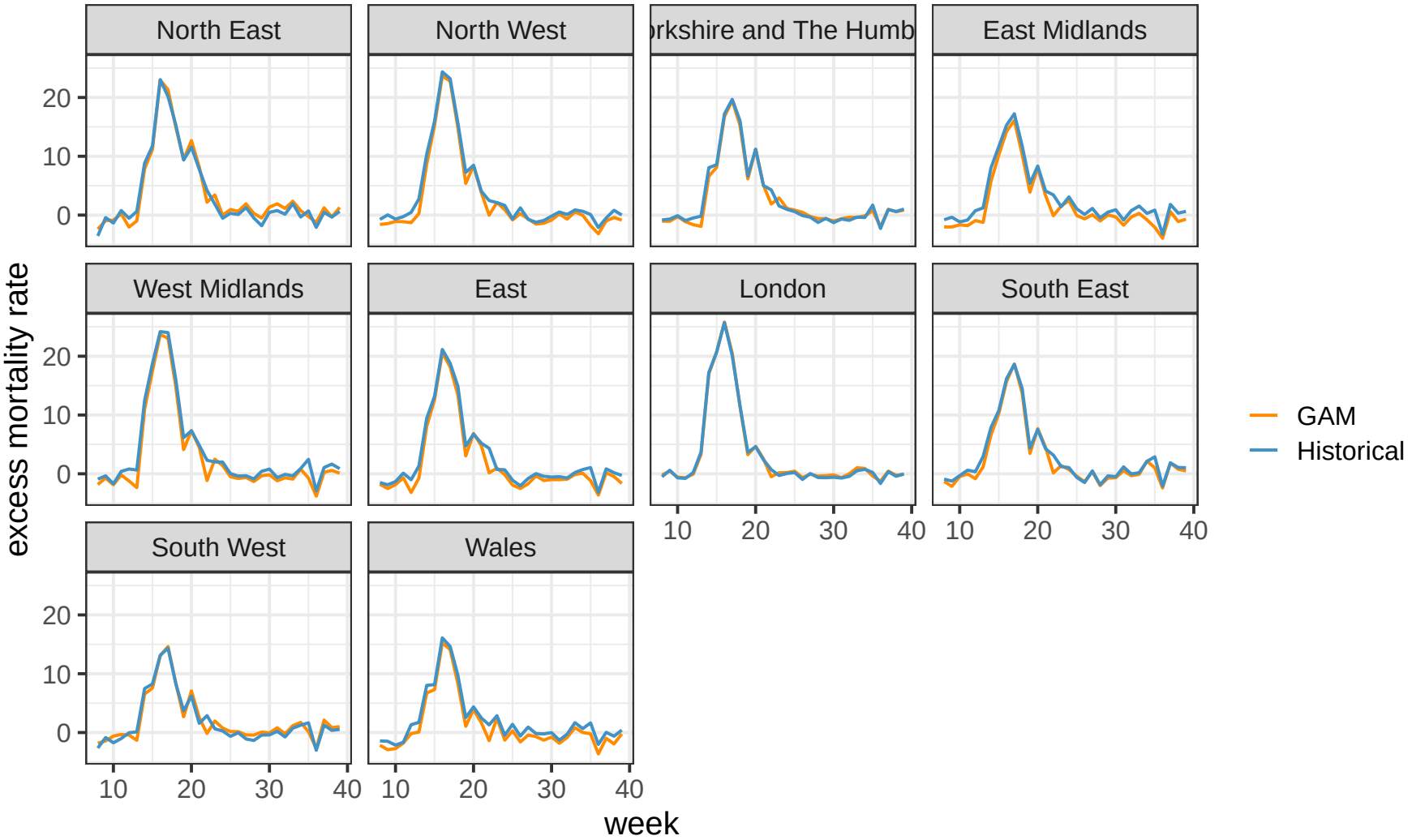
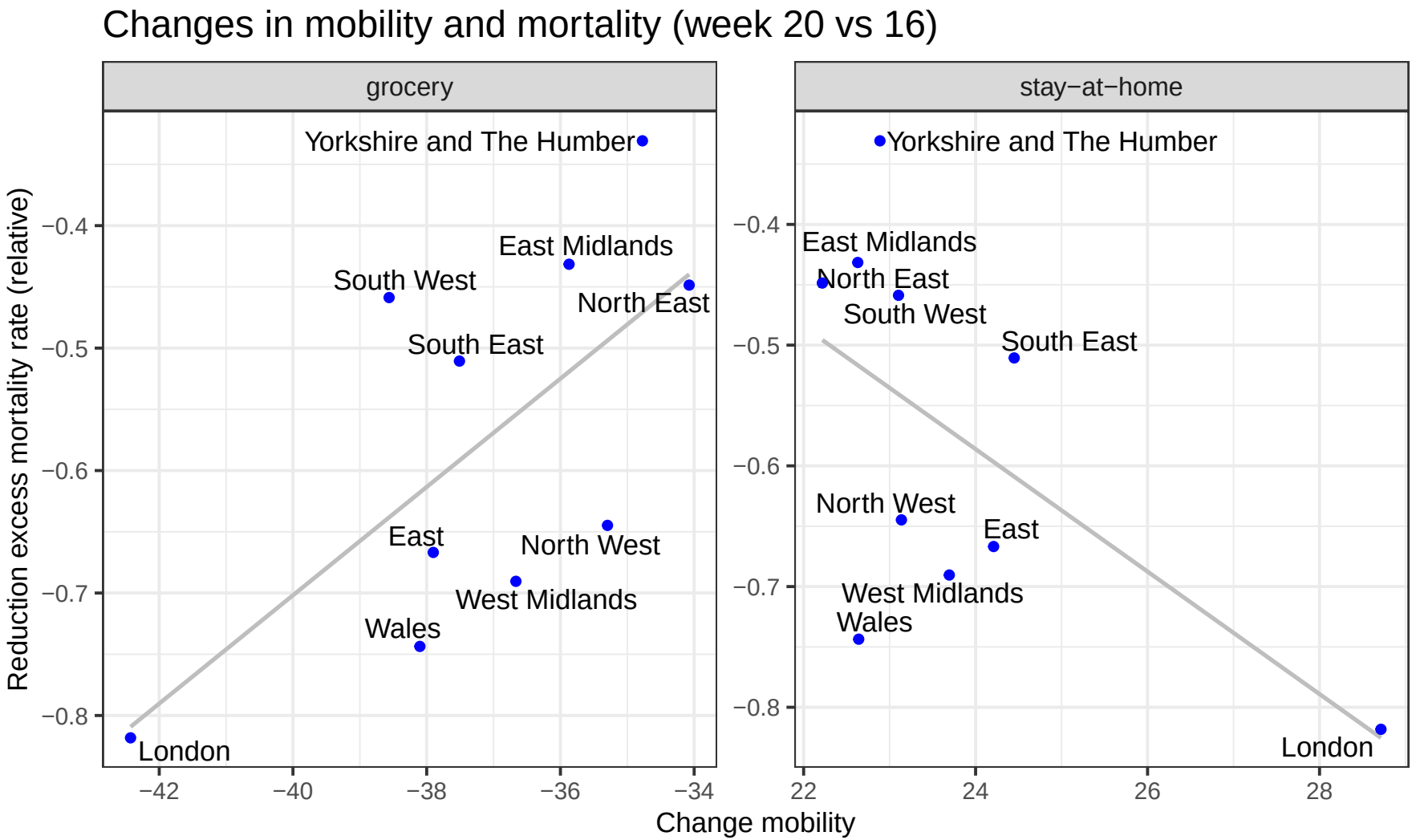


Cross-sectional analysis II



Other mobility data