Ranking effectiveness of worldwide COVID-19 government interventions
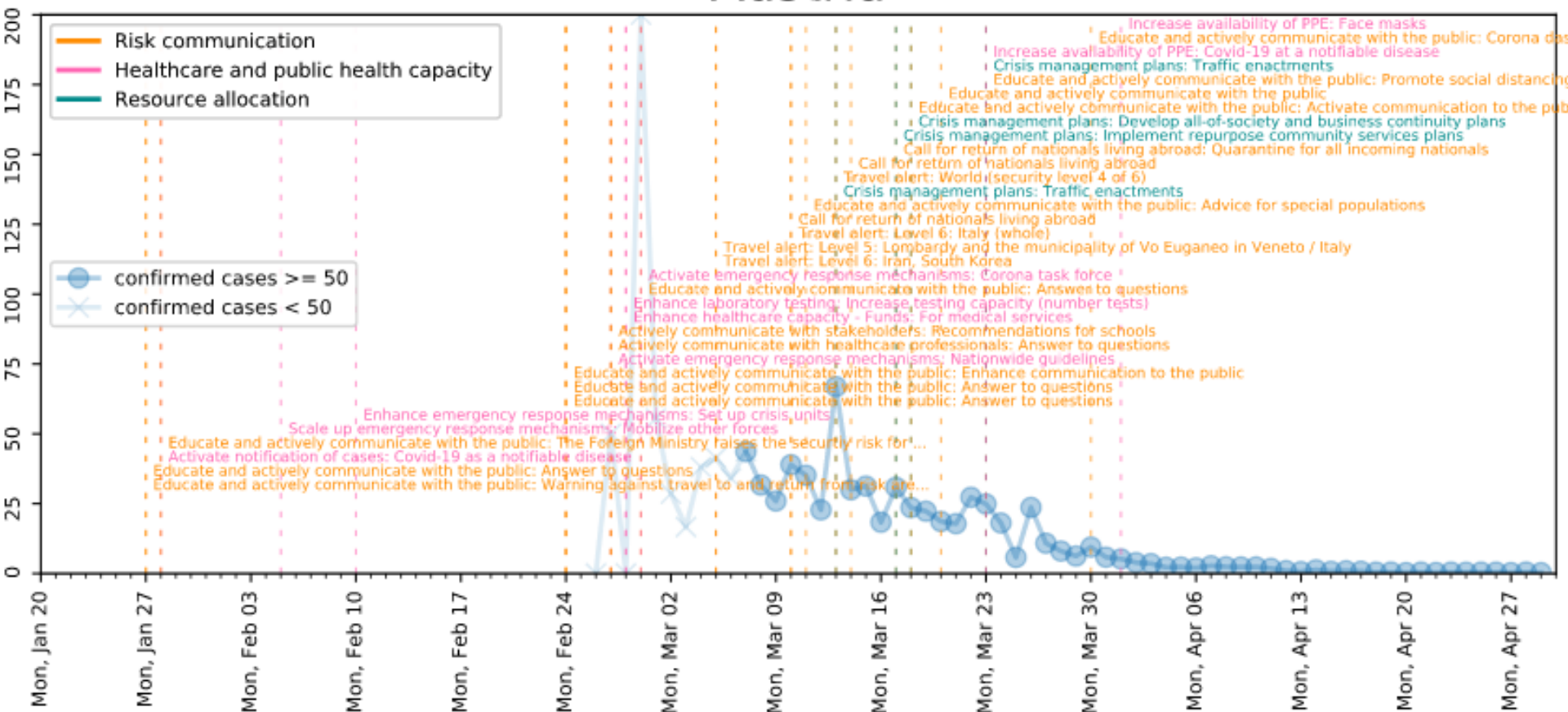

N Haug, L Geyrhofer, A Londei, E Dervic, A Desvars-Larrive, V Loreto, B Pinior, S Thurner, P Klimek

1. N Haug, L Geyrhofer, A Londei, E Dervic, A Desvars-Larrive, V Loreto, B Pinior, S Thurner, P Klimek,
Ranking the effectiveness of worldwide COVID-19 government interventions.
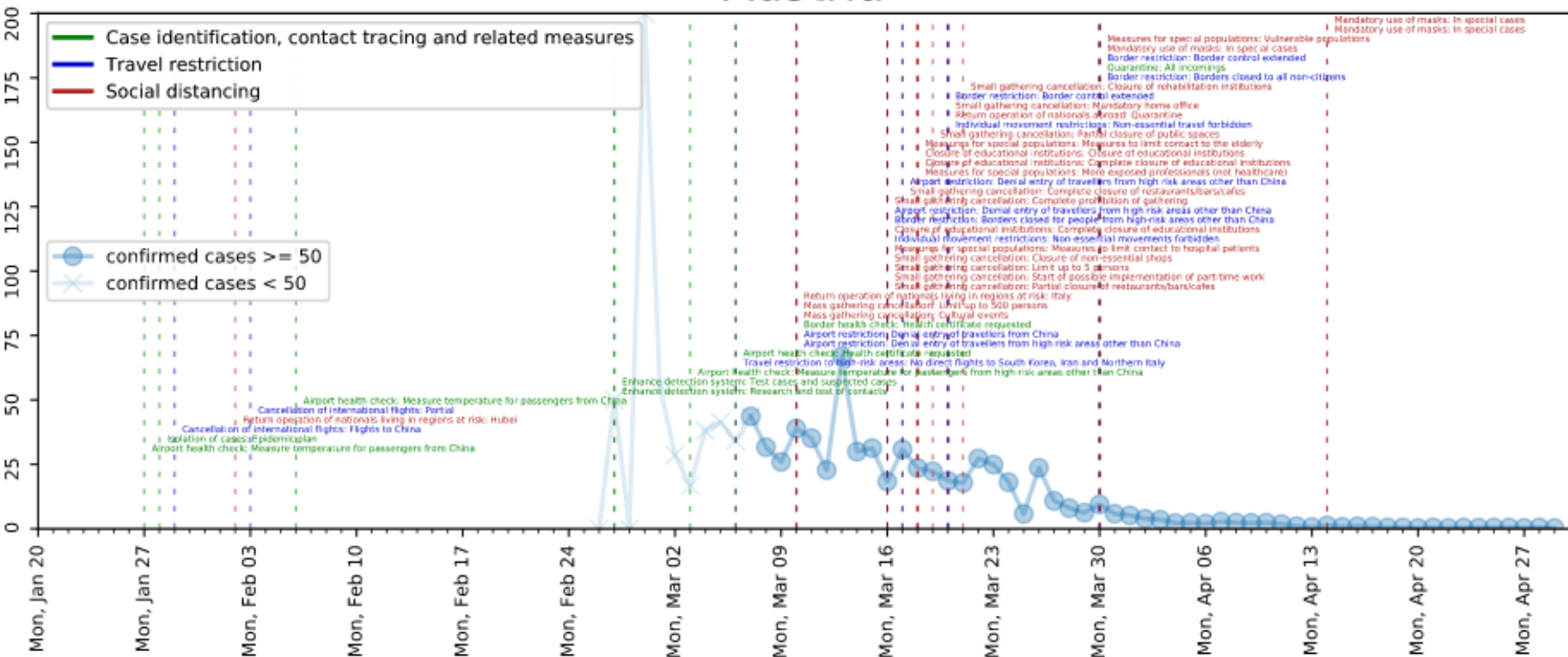Nature Human Behavior 4 (2020) 1303–1312

2. A Desvars-Larrive, E Dervic, N Haug, T Niederkrotenthaler, J Chen, A Di Natale, J Lasser, D S Gliga, A Roux, A Chakraborty, A Ten, A Dervic, A Pacheco, D Cserjan, D Lederhilger, D Berishaj, E Flores Tames, H Takriti, J Korbel, J Reddish, J Stangl, L Hadziavdic, L Stoeger, L Gooriah, L Geyrhofer, M R Ferreira, R Vierlinger, S Holder, S Alvarez, S Haberfellner, V Ahne, V Reisch, V D P Servedio, X Chen, X M Pocasangre-Orellana, D Garcia, S Thurner,
A structured open dataset of government interventions in response to COVID-19.
Scientic Data 7 (2020) 285

What are the NPIs taken in the world?

Austria

Legend:
- Risk communication
- Healthcare and public health capacity
- Resource allocation

- confirmed cases >= 50
- confirmed cases < 50

Annotations:
- Increase availability of PPE: Face masks
- Educate and actively communicate with the public: Corona da...
- Increase availability of PPE: Covid-19 at a notifiable disease
- Crisis management plans: Traffic enactments
- Educate and actively communicate with the public: Promote social distancing
- Educate and actively communicate with the public
- Educate and actively communicate with the public: Activate communication to the pu...
- Crisis management plans: Develop all-of-society and business continuity plans
- Crisis management plans: Implement repurpose community services plans
- Call for return of nationals living abroad: Quarantine for all incoming nationals
- Call for return of nationals living abroad
- Travel alert: World (security level 4 of 6)
- Crisis management plans: Traffic enactments
- Educate and actively communicate with the public: Advice for special populations
- Call for return of nationals living abroad
- Travel alert: Level 6: Italy (whole)
- Travel alert: Level 5: Lombardy and the municipality of Vo Euganeo in Veneto / Italy
- Travel alert: Level 6: Iran, South Korea
- Activate emergency response mechanisms: Corona task force
- Educate and actively communicate with the public: Answer to questions
- Enhance laboratory testing: Increase testing capacity (number tests)
- Enhance healthcare capacity - Funds: For medical services
- Actively communicate with stakeholders: Recommendations for schools
- Actively communicate with healthcare professionals: Answer to questions
- Activate emergency response mechanisms: Nationwide guidelines
- Educate and actively communicate with the public: Enhance communication to the public
- Educate and actively communicate with the public: Answer to questions
- Educate and actively communicate with the public: Answer to questions
- Enhance emergency response mechanisms: Set up crisis units
- Scale up emergency response mechanisms: Mobilize other forces
- Educate and actively communicate with the public: The Foreign Ministry raises the security risk for...
- Activate notification of cases: Covid-19 as a notifiable disease
- Educate and actively communicate with the public: Answer to questions
- Educate and actively communicate with the public: Warning against travel to and return from risk are...

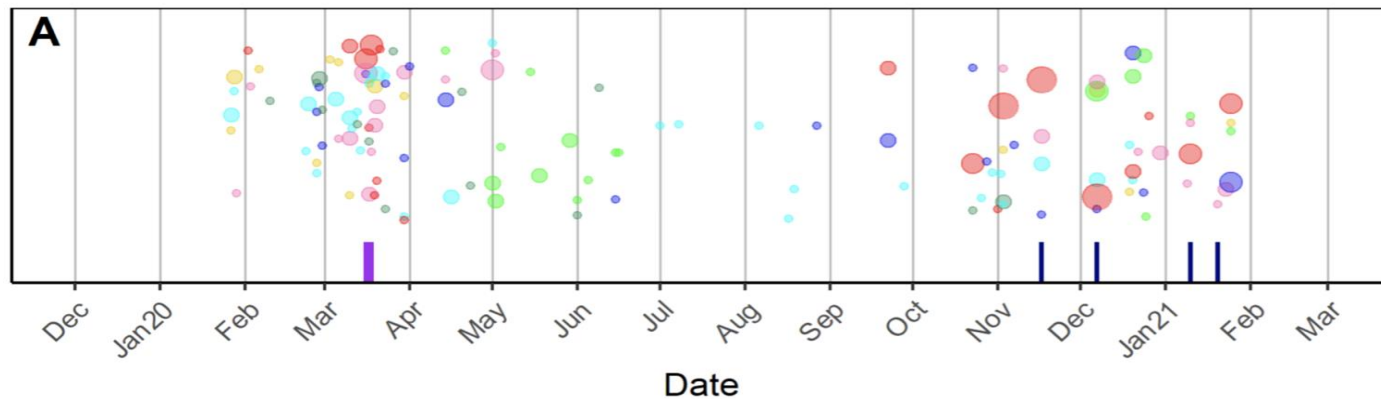# Austria

Austria (AUT)

Name of implemented government measure
- Case identification, contact tracing and related measures
- Environmental measures
- Healthcare and public health capacity
- Resource allocation
- Returning to normal life
- Risk communication
- Social distancing
- Travel restriction

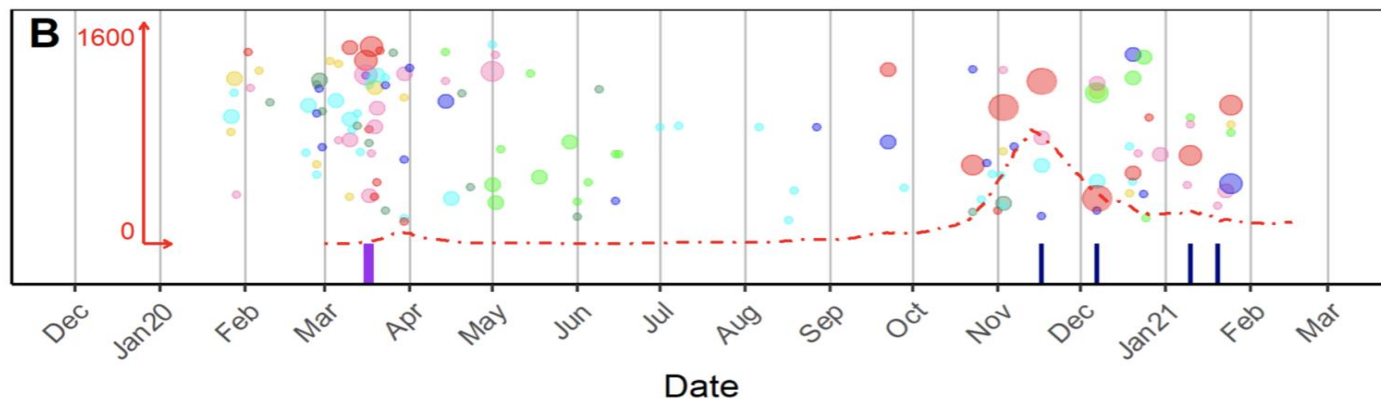**Number of specific implemented government measures per day**
- 40
- 20
- 10
- 4
- 2
- 1

**Special measures**
- National Lockdown
- Cordon sanitaire

Smoothed daily-new confirmed COVID-19 cases per million people (Source: Our World in Data)
- New cases

Countries

All Countries - [A] | All Countries - [B] | All Countries - [C] | All Countries - [D] | Albania | Austria | Belgium | Bosnia and Herzegovina | Brazil

Canada | Croatia | Czech Republic | Denmark | Ecuador | Egypt | El Salvador | Estonia | Finland | France | Germany | Ghana | Greece | Honduras

Hong Kong | Hungary | Iceland | India | Indonesia | Ireland | Italy | Japan | Kazakhstan | Kosovo | Kuwait | Liechtenstein | Lithuania | Malaysia

Mauritius | Mexico | Montenegro | Netherlands | New Zealand | North Macedonia | Norway | Poland | Portugal | Romania | Senegal | Serbia

Singapore | Slovakia | Slovenia | South Korea | Spain | Sweden | Switzerland | Syria | Taiwan | Thailand | United Kingdom

United States of America
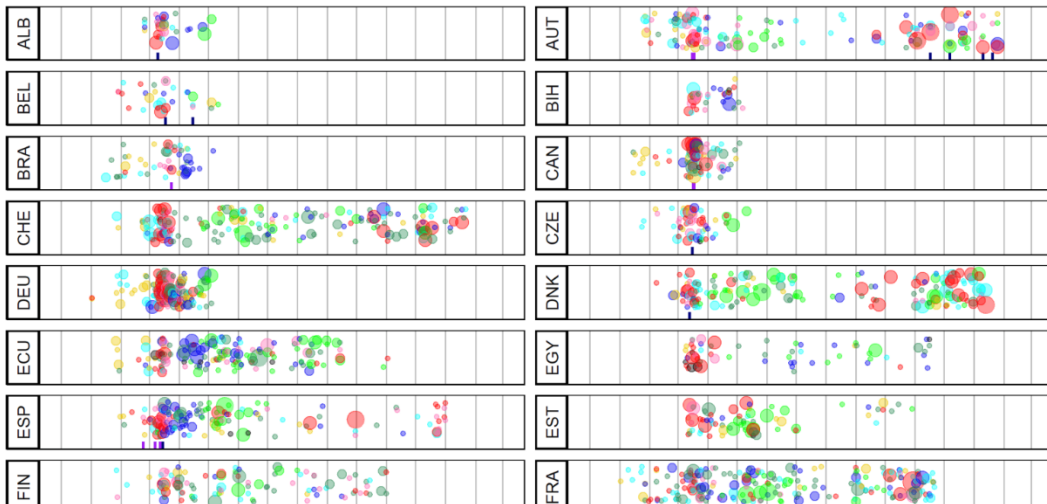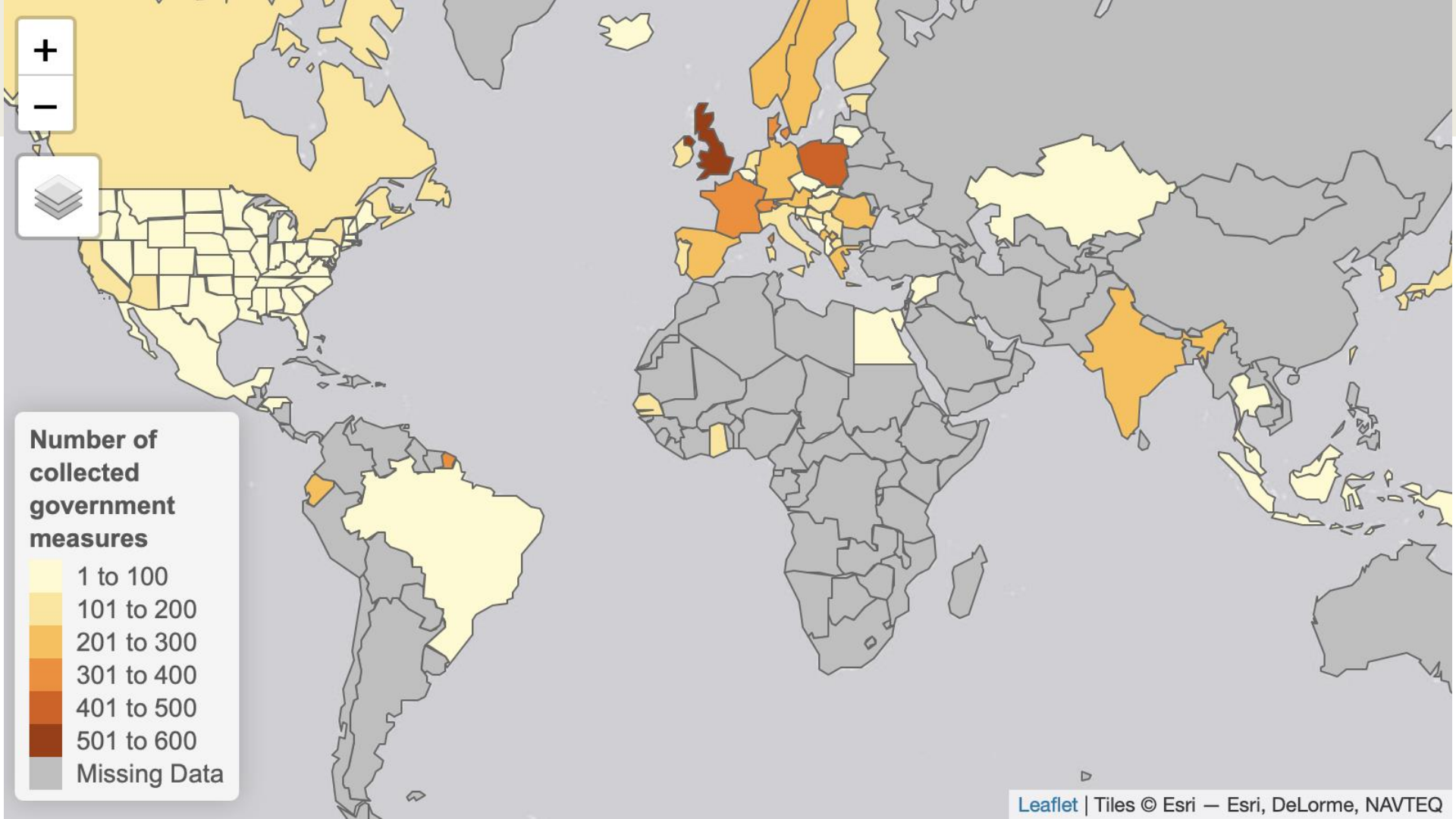
Number of collected government measures

- 1 to 100
- 101 to 200
- 201 to 300
- 301 to 400
- 401 to 500
- 501 to 600
- Missing Data

Data structure

SCIENTIFIC DATA

A structured open dataset of government interventions in response to COVID-19

Amélie Desvars-Larrive [1,2 ✉], Elma Dervic [2,3], Nils Haug [2,3], Thomas Niederkrotenthaler [2,4], Jiaying Chen [2,3], Anna Di Natale [2,3], Jana Lasser [2,3], Diana S. Gliga [16], Alexandra Roux [5,6], Johannes Sorger [2], Abhijit Chakraborty [2,7], Alexandr Ten [8], Alija Dervic [9], Andrea Pacheco [10], Ania Jurczak [11], David Cserjan [2], Diana Lederhilger [16], Dominika Bulska [12], Dorontinë Berishaj [16], Erwin Flores Tames [2], Francisco S. Álvarez [13], Huda Takriti [2], Jan Korbel [2,3], Jenny Reddish [2,14], Joanna Grzymała-Moszczyńska [11], Johannes Stangl [16], Lamija Hadziavdic [16], Laura Stoeger [2], Leana Gooriah [10], Lukas Geyrhofer [2], Marcia R. Ferreira [2], Marta Bartoszek [11], Rainer Vierlinger [16], Samantha Holder [16], Simon Haberfellner [16], Verena Ahne [2], Viktoria Reisch [16], Vito D. P. Servedio [2], Xiao Chen [16], Xochilt María Pocasangre-Orellana [13], Zuzanna Garncarek [11], David Garcia [2,3] & Stefan Thurner [2,3,15]

- Hierarchically coded NPIs divided into

- 8 themes (e.g., social distancing) divided into

- 63 categories (Closure of educational Institutions) divided into

- > 500 subcategories (Closure of kindergardens)

COMPLEXITY SCIENCE HUB VIENNA

How to measure the effectiveness of NPIs?

- Without vaccines or antiviral medication, non-pharmaceutical interventions (NPIs) are the **only** option to moderate viral spread

- In the first wave most governments implemented bundles of **highly restrictive NPIs** under great scientific uncertainty and under rapidly changing epidemiological conditions

- Several trackers started to categorize & document NPIs in numerous countries

- In total, we consider 3 databases with ~50k NPI implementations in >200 countries

- Looking back at March-Mai 2020, what worked? What did not work?

Implementation of 4 methods

Correlate NPIs across countries with time-dependent effective reproduction number R(t)

with

1) Timeseries regression model using LASSO regularization
2) Regression model with case-control design
3) Random forest
4) Transformer deep learning model

Validation

- within models (e.g. cross validation, leave-one-out analysis)

- across models by comparison of rankings of significant results

- comparison across 3 different databases (CSH, Oxford, Coronanet)
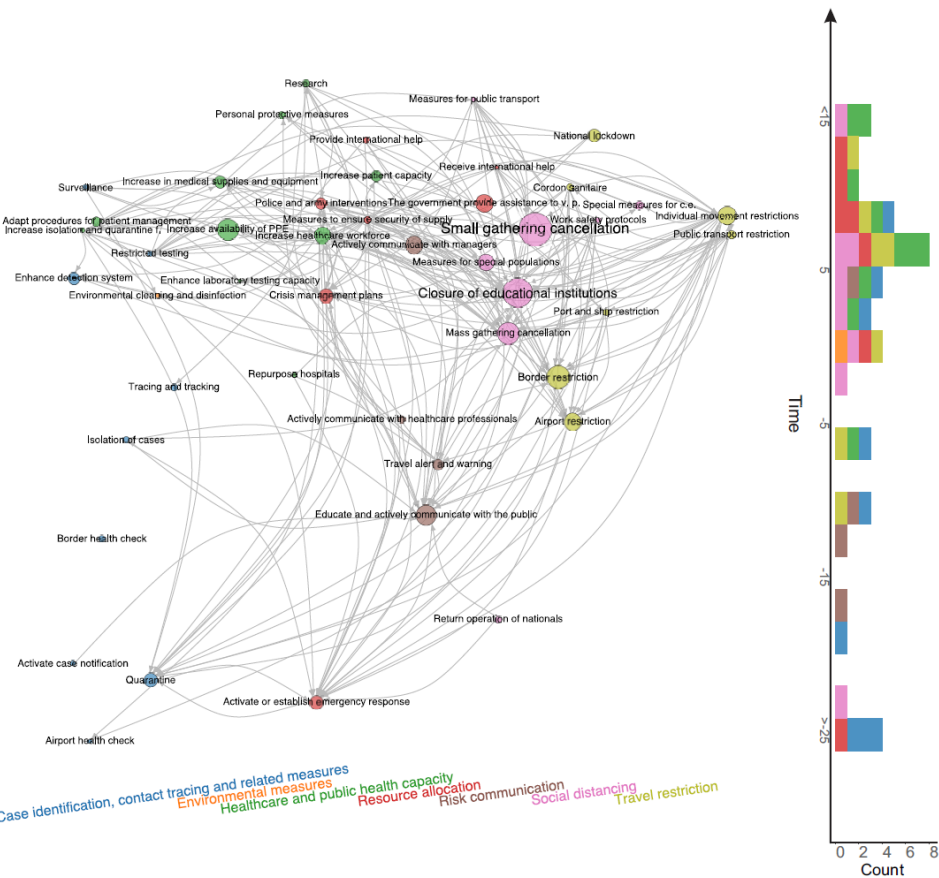
- Circles are NPI categories
- Size: proportional to effectiveness
- Color: NPI theme (broad classification)
- From bottom to top: epidemic age, time after 30 cases appeared
- Progression from soft NPIs to lockdown
- *The hammer*: bulk of NPIs comes about 10 days after reaching 30 cases
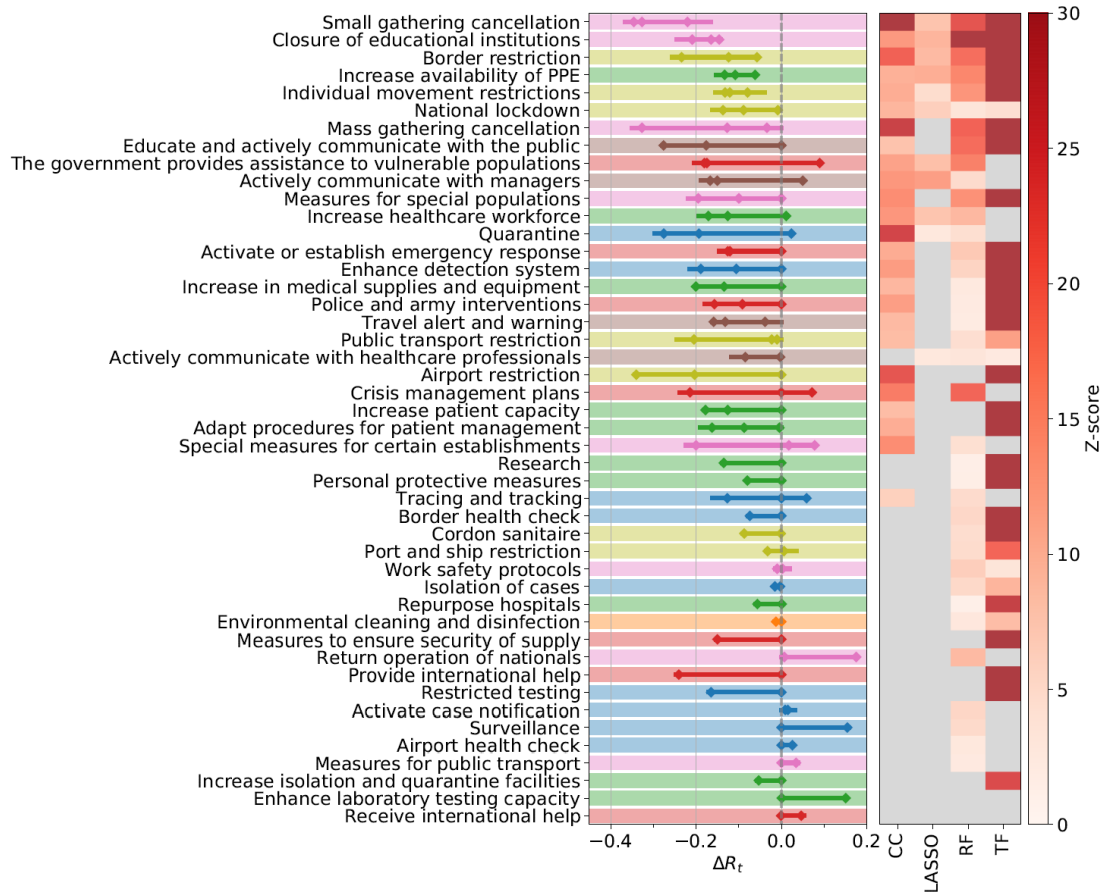
Results first wave

nature human behaviour

Article | Published: 16 November 2020

Ranking the effectiveness of worldwide COVID-19 government interventions

Nils Haug, Lukas Geyrhofer, Alessandro Londei, Elma Dervic, Amélie Desvars-Larrive, Vittorio Loreto, Beate Pinior, Stefan Thurner & Peter Klimek

Nature Human Behaviour **4**, 1303–1312(2020) | Cite this article

356k Accesses | **51** Citations | **9345** Altmetric | Metrics

- Most effective: close everything where people meet in smaller groups for extended period of time (offices, schools, restaurants, bars, …), movement restrictions, increase healthcare capacity

- Also effective: risk communication (toward public & stakeholders), governmental assistance for medically and economically vulnerable populations

Timing does matter!
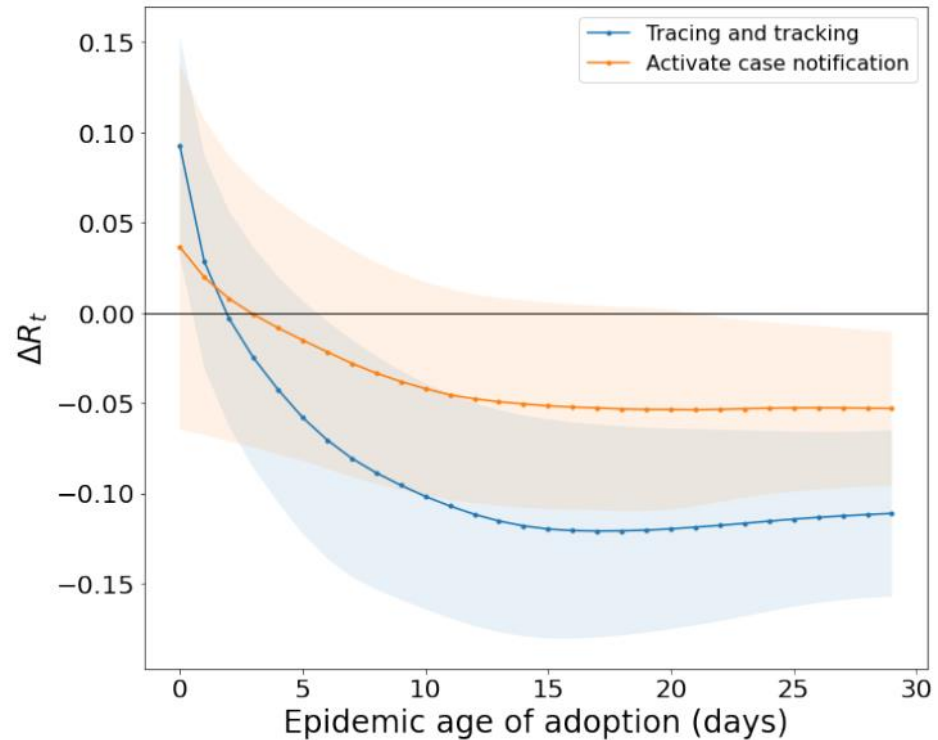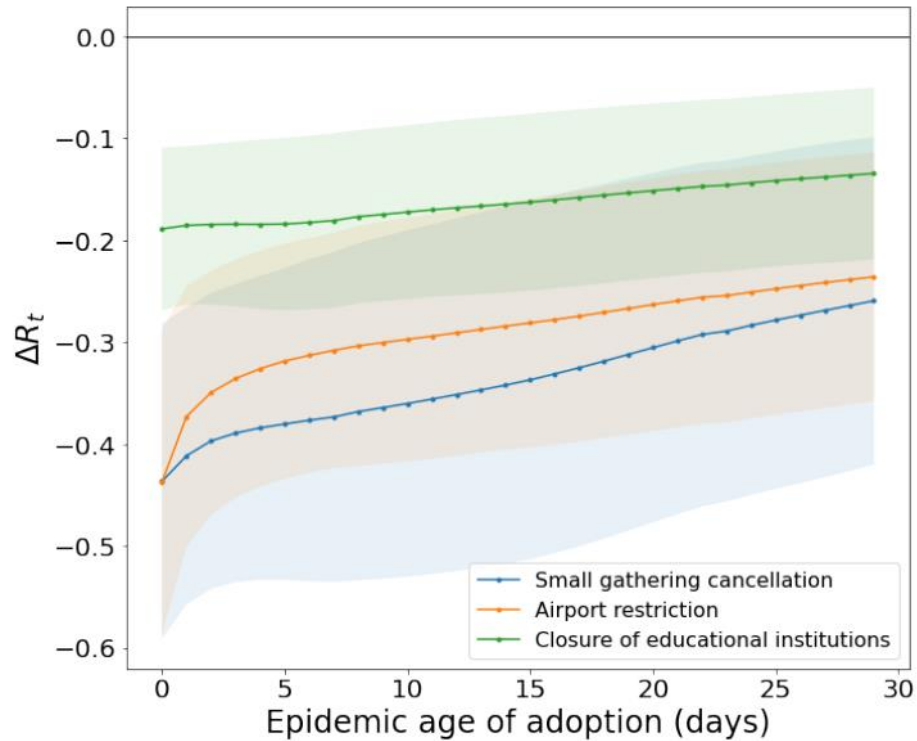
Context matters

Regression analysis: population density, GDP, HDI, political stability,…

- Tracing & tracking more effective in high GDP countries with low accountability in governance

- NPIs to increase healthcare capacity (PPE, medical supplies) more effective in countries with high control of corruption, regulatory quality and government effectiveness

Effects of strong lockdowns?

Lockdown defined as a bundle of NPIs including: curfews, individual movement restrictions, closure of public places

In most cases some NPIs were in place before lockdowns were implemented

Typically severe lockdowns added "little delta" on top of measures in place

A suitable combination (including a good sequence and timing of implementation) of a smaller package of NPIs *can* substitute severe lockdowns

COMPLEXITY
SCIENCE
HUB
VIENNA

Other works

Full-service restaurants
Fitness centres
Cafes and snack bars
Hotels and motels
Limited-service restaurants
Religious organizations
Offices of physicians
Grocery stores
Used merchandise stores
Pet stores
Sporting goods stores
Other general stores
Hobby and toy stores
Hardware stores
Automotive parts stores
Department stores
Gas stations
Pharmacies and drug stores
Convenience stores
New car dealers

10^1 10^2 10^3 10^4

Additional infections (per 100,000 individuals),
compared to not reopening

nature

Explore content ⌄   Journal information ⌄   Publish with us ⌄

nature > articles > article

Article | Published: 10 November 2020

Mobility network models of COVID-19 explain inequities and inform reopening

Serina Chang, Emma Pierson, Pang Wei Koh, Jaline Gerardin, Beth Redbird, David Grusky & Jure Leskovec ✉

Nature **589**, 82–87(2021) | Cite this article

549k Accesses | **49** Citations | **11802** Altmetric | Metrics
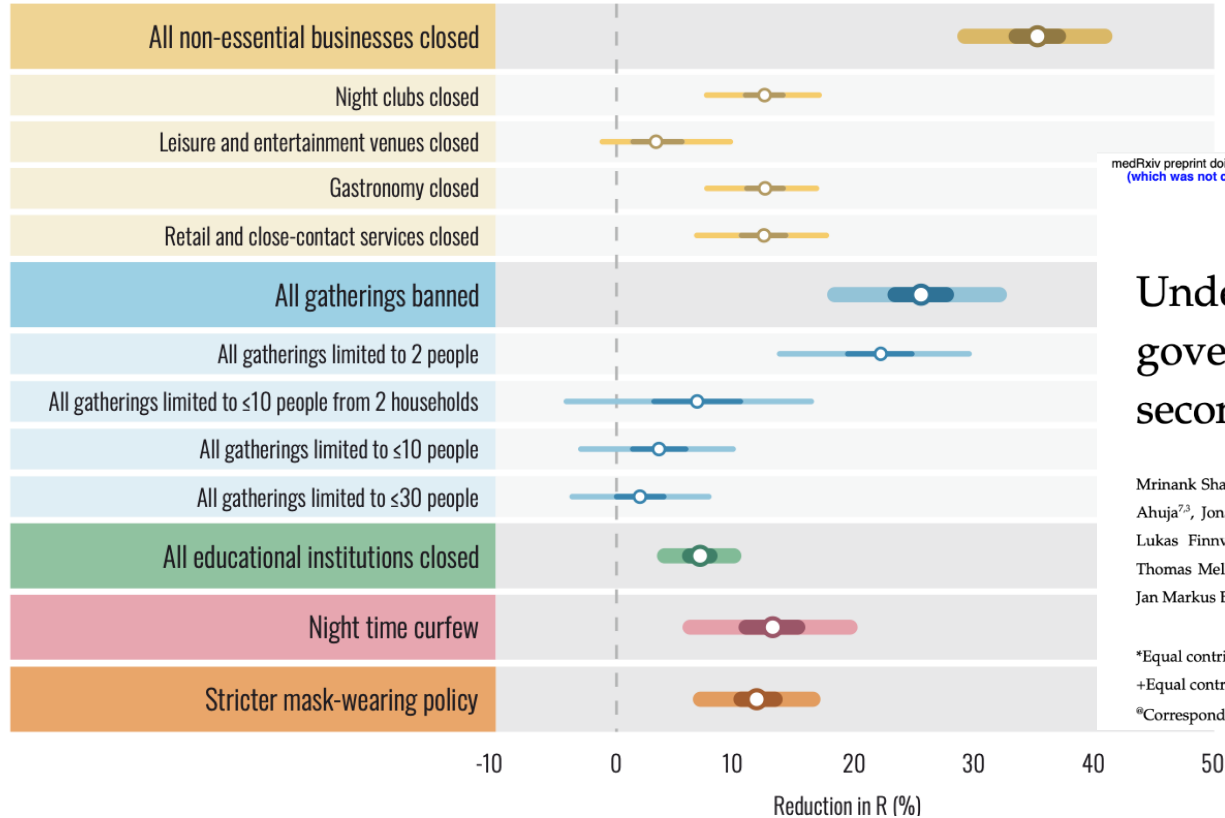
COMPLEXITY
SCIENCE
HUB
VIENNA

Second wave

A)

Figure axis label: Reduction in R (%)

Understanding the effectiveness of government interventions in Europe's second wave of COVID-19

Mrinank Sharma*[1,2,3], Sören Mindermann*[4], Charlie Rogers-Smith[5], Gavin Leech[6], Benedict Snodin[3], Janvi Ahuja[7,3], Jonas B. Sandbrink[7], Joshua Teperowski Monrad[8,9,3], George Altman[10], Gurpreet Dhaliwal[11,12], Lukas Finnveden[3], Alexander John Norman[13], Sebastian B. Oehm[14,15], Julia Fabienne Sandkühler[16], Thomas Mellan[17], Jan Kulveit[3], Leonid Chindelevitch[17], Seth Flaxman[18], Yarin Gal[4], Swapnil Mishra[+,17,19], Jan Markus Brauner*[+,@,4,3], Samir Bhatt[+,@,20,17,19]

*Equal contribution to first authorship
+Equal contribution to senior authorship
@Correspondence: jan.brauner@cs.ox.ac.uk, s.bhatt@imperial.ac.uk

COMPLEXITY
SCIENCE
HUB
VIENNA

Second wave

Schools

- Deeper analyses (finer catgories) school closures effective for ages12y–18y

- Effects in kindergartens and primary schools are visible but statistically less robust

- Findings in line with contact tracing data: the lowest attack rates in age group <10y

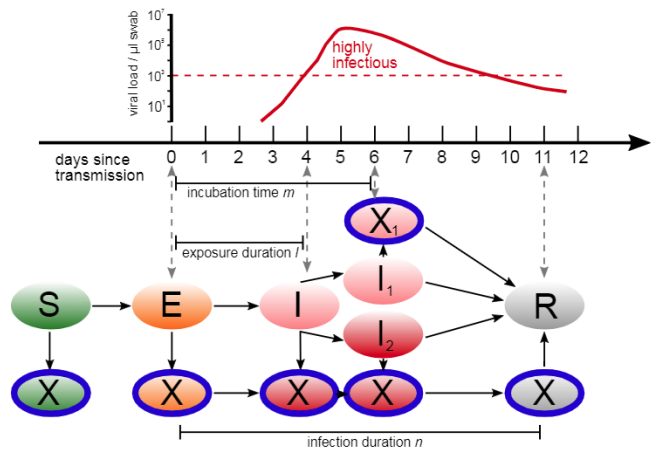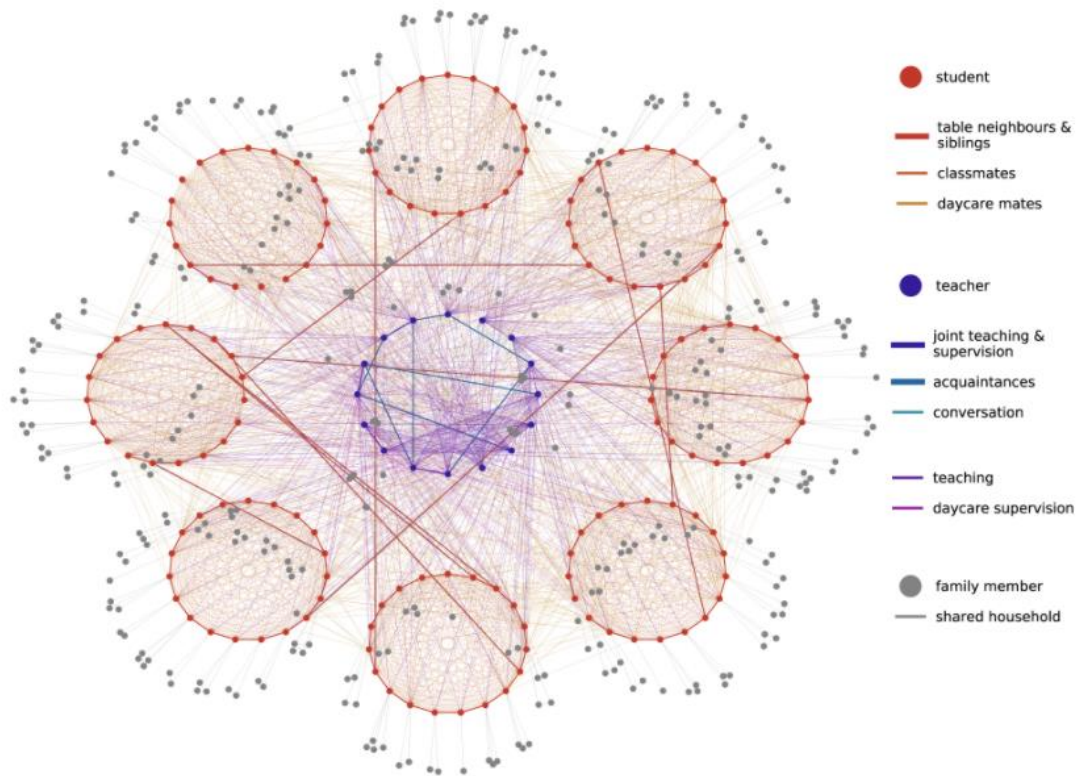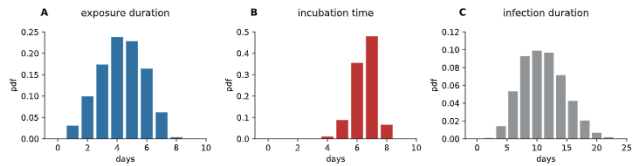# Agent-based model of infections in schools with NPIs

How to sustainably open schools?
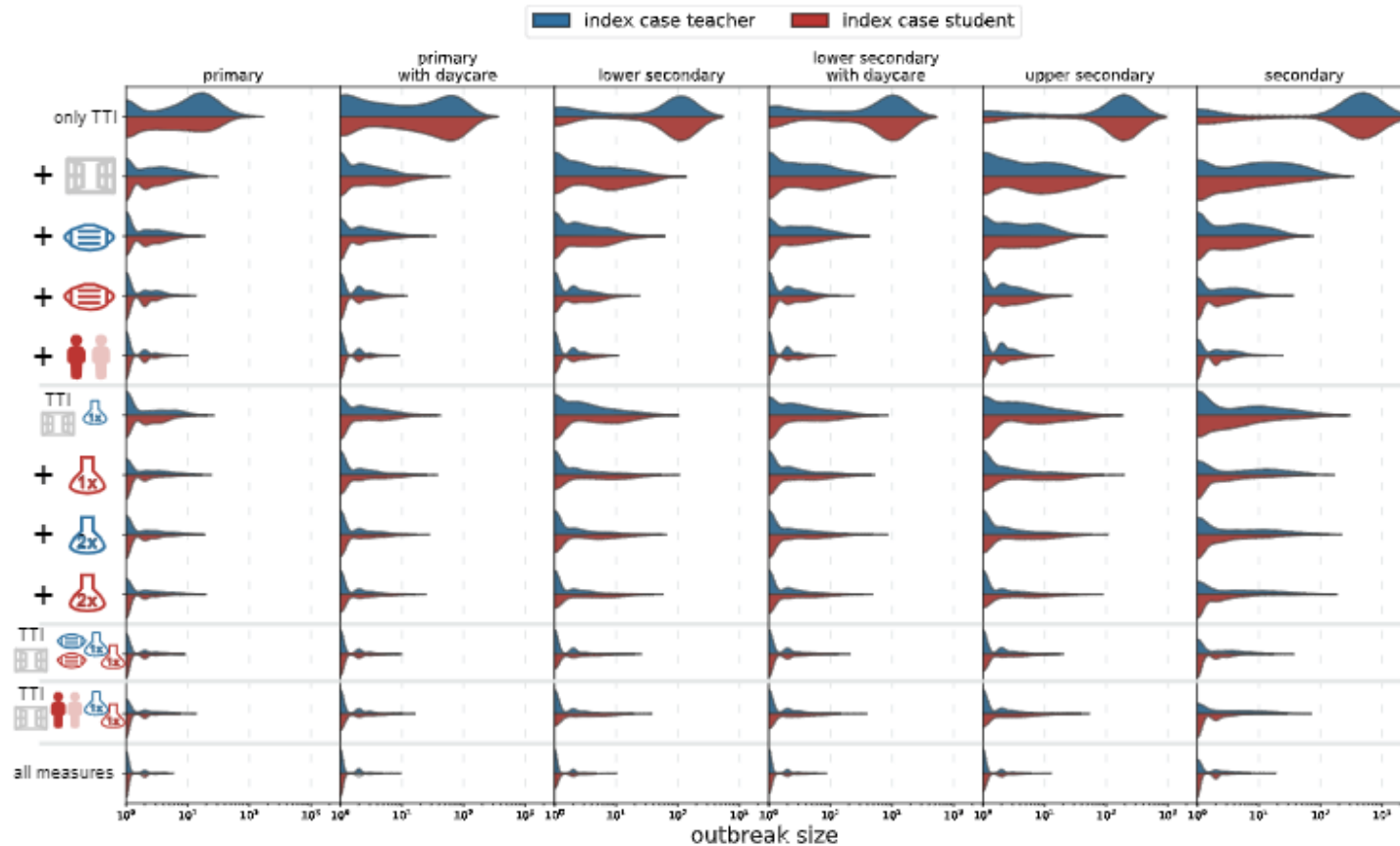
Take home

It is possible to disentangle effectiveness of individual NPIs

- Significant effectiveness
    - Small groups and gatherings
    - Gastronomy
    - Education (if school closures necessary – should target age groups 12+)

- Minor
    - Curfews
    - Culture
    - More strict mask policies

COMPLEXITY
SCIENCE
HUB
VIENNA

Reception

WHO database

Conference on NPI assessments

Wider public attention

Altmetric paper # 36 in 2020