CREST-OR

Improving **C**ommunity **Re**silience and **S**ustainability **T**hrough **O**perational **R**esearch Capacity Building in Southeast Asia

Scoping Workshop, 15-16 July 2021

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Some Problem Related to Covid-19 and Mathematical Models

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Improving Community Resilience and Sustainability Through Operational Research Capacity Building in Southeast Asia

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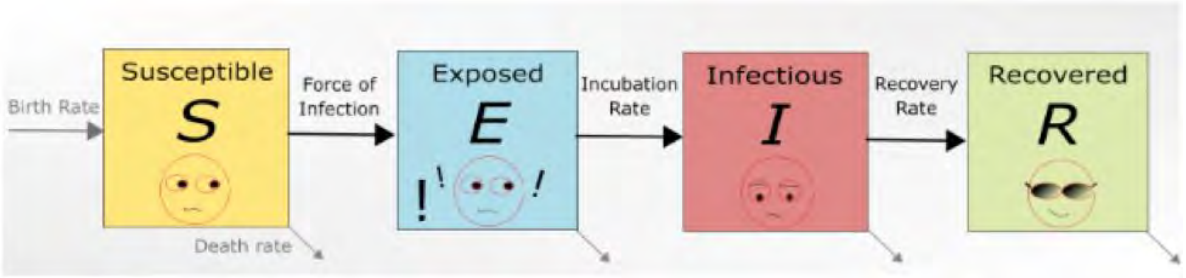
Outline

- Covid-19 Pandemic
- SEIR Model
- Strategies

Covid – 19 Pandemic

- Start in Wuhan in 12/2019 (may be before)
- Near 190 mils cases, more than 4 mils deaths (as in 07/15/21)
- Near 40k cases, 132 deaths in Vietnam
- First wave (01/23 – 02/25/2020): TP. Hồ Chí Minh, Khánh Hòa, Vĩnh Phúc (Lock down Sơn Lôi, Bình Xuyên, Unlocked in 03/04), no death
- Second wave (03/06 – 04/16): Start with Hà Nội (#17) and end with Hà Giang (#268), no death
- Third wave (07/25 – 09/03): Mostly in Đà Nẵng, 35 deaths
- Fourth wave:
  - First subwave (01/27/2021): Start with #1552, Alpha variant, mostly in Hải Dương, Quảng Ninh
  - Second subwave (04/27): Delta variant

SEIR Model

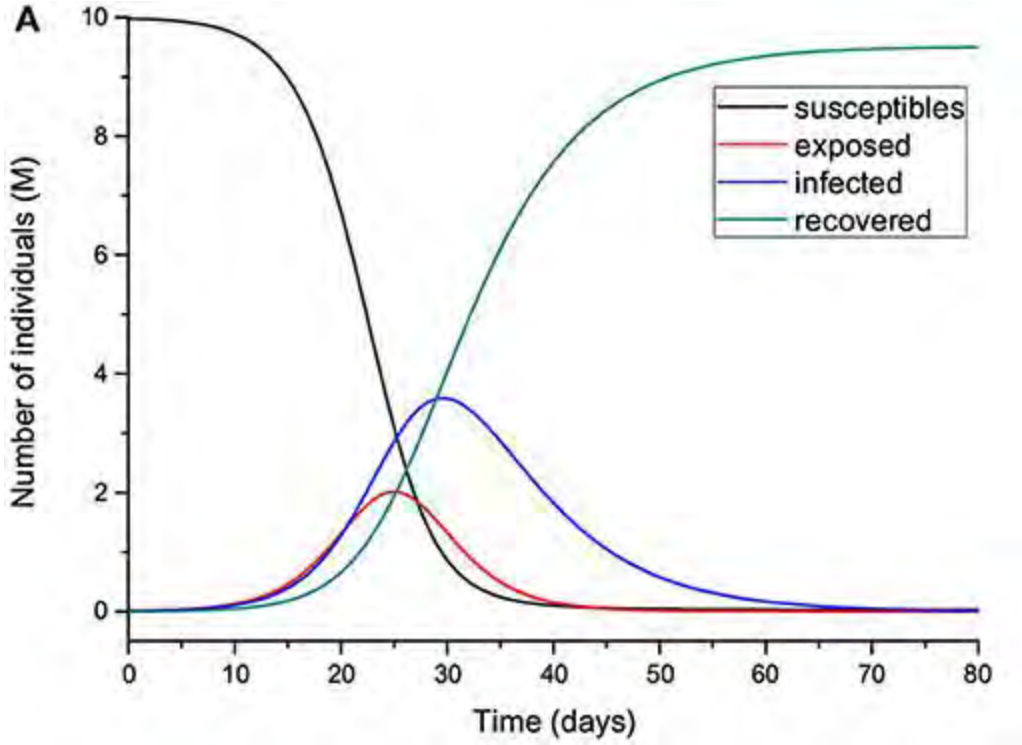


$$\frac{dS}{dt} = \mu N - \mu S - \frac{\beta I S}{N}$$

$$\frac{dE}{dt} = \frac{\beta I S}{N} - (\mu + a)E$$

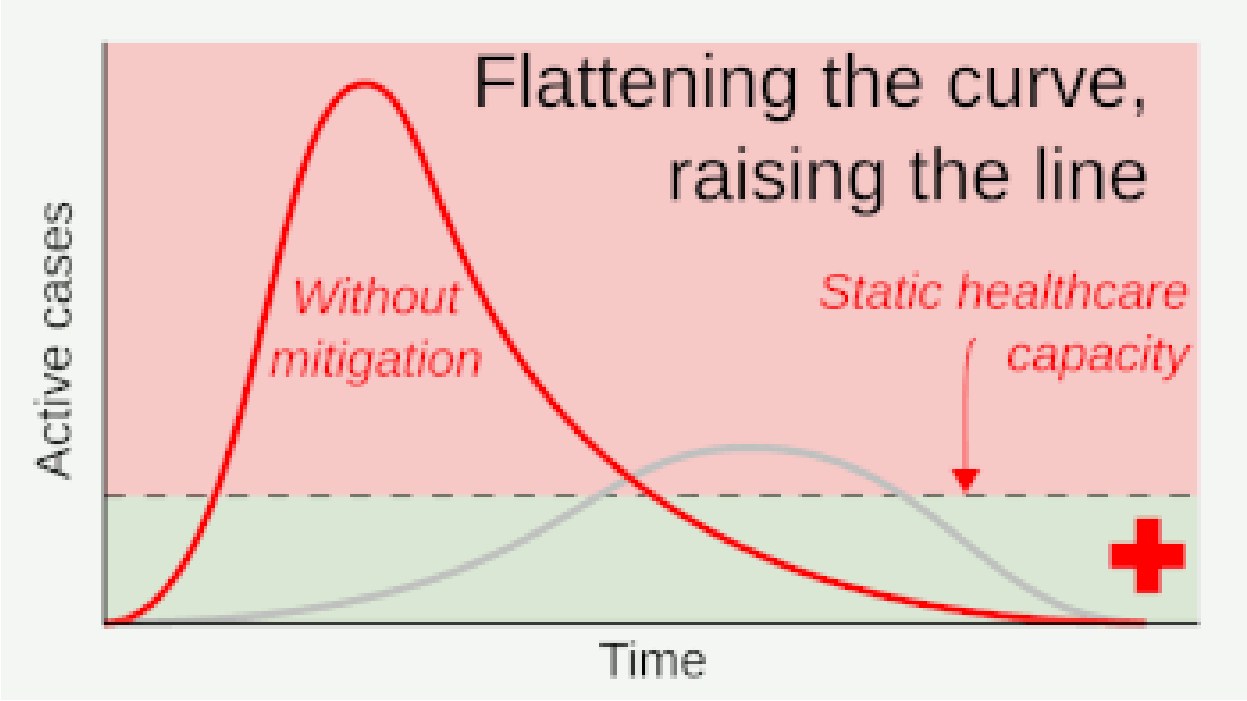
$$\frac{dI}{dt} = aE - (\gamma + \mu)I$$

$$\frac{dR}{dt} = \gamma I - \mu R.$$

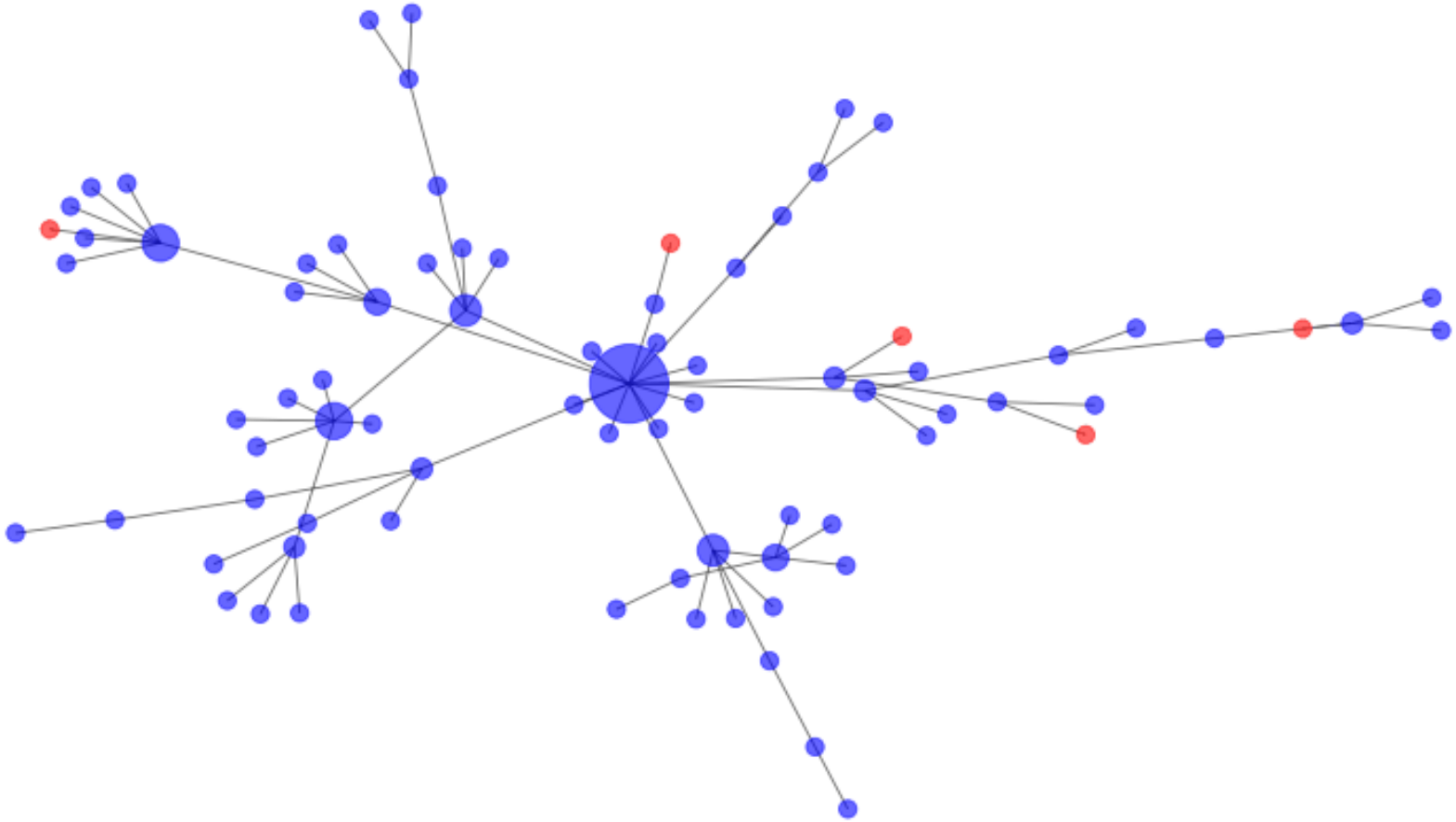


Strategies

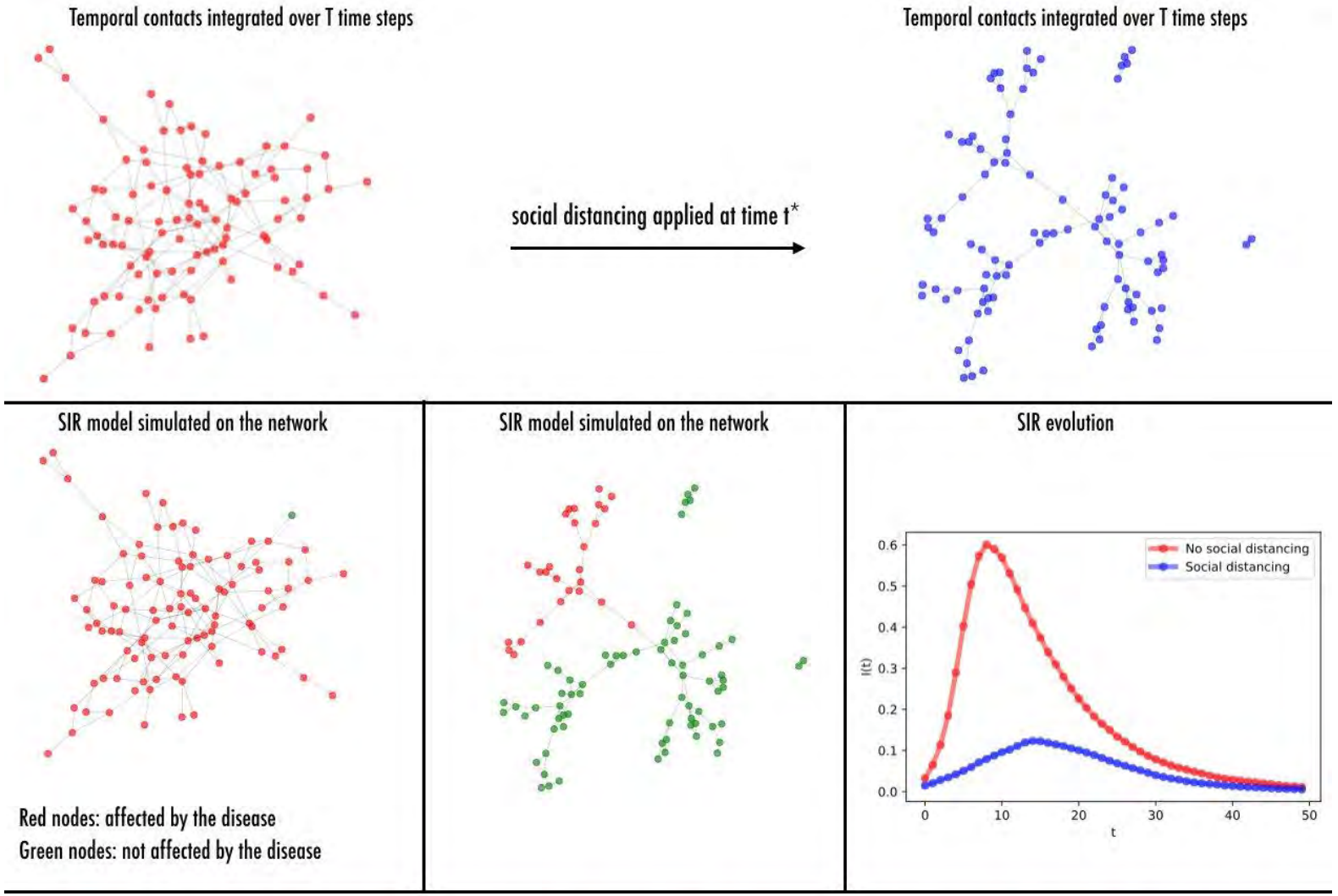
- Flatten the curve
- Avoid super spreader
- Contact tracing
- Testing
- Travelling Ban
- Vaccination



Avoid Super Spreader



Avoid large public gathering

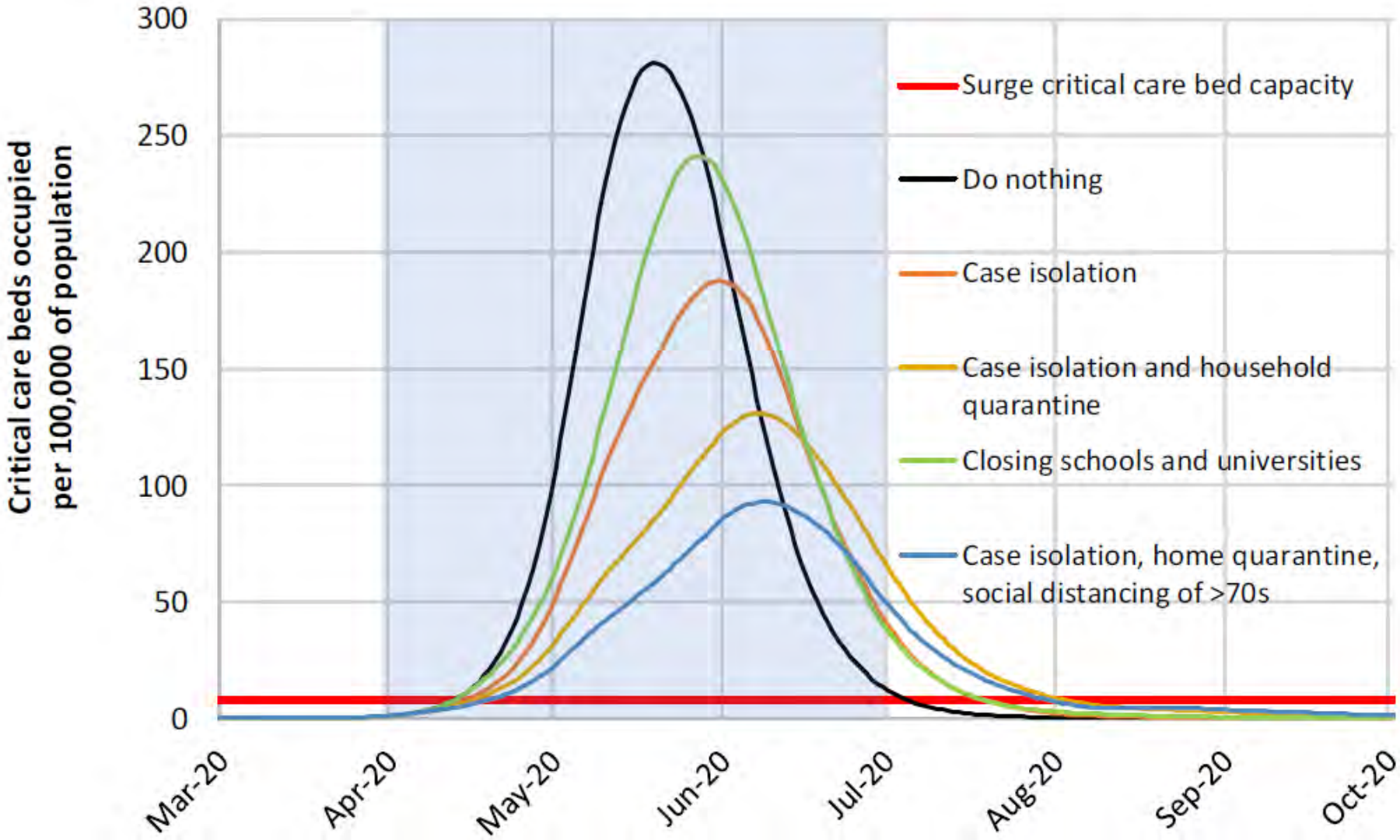


Disclaimer: this is just a theoretical toy model to illustrate the effects of social distancing

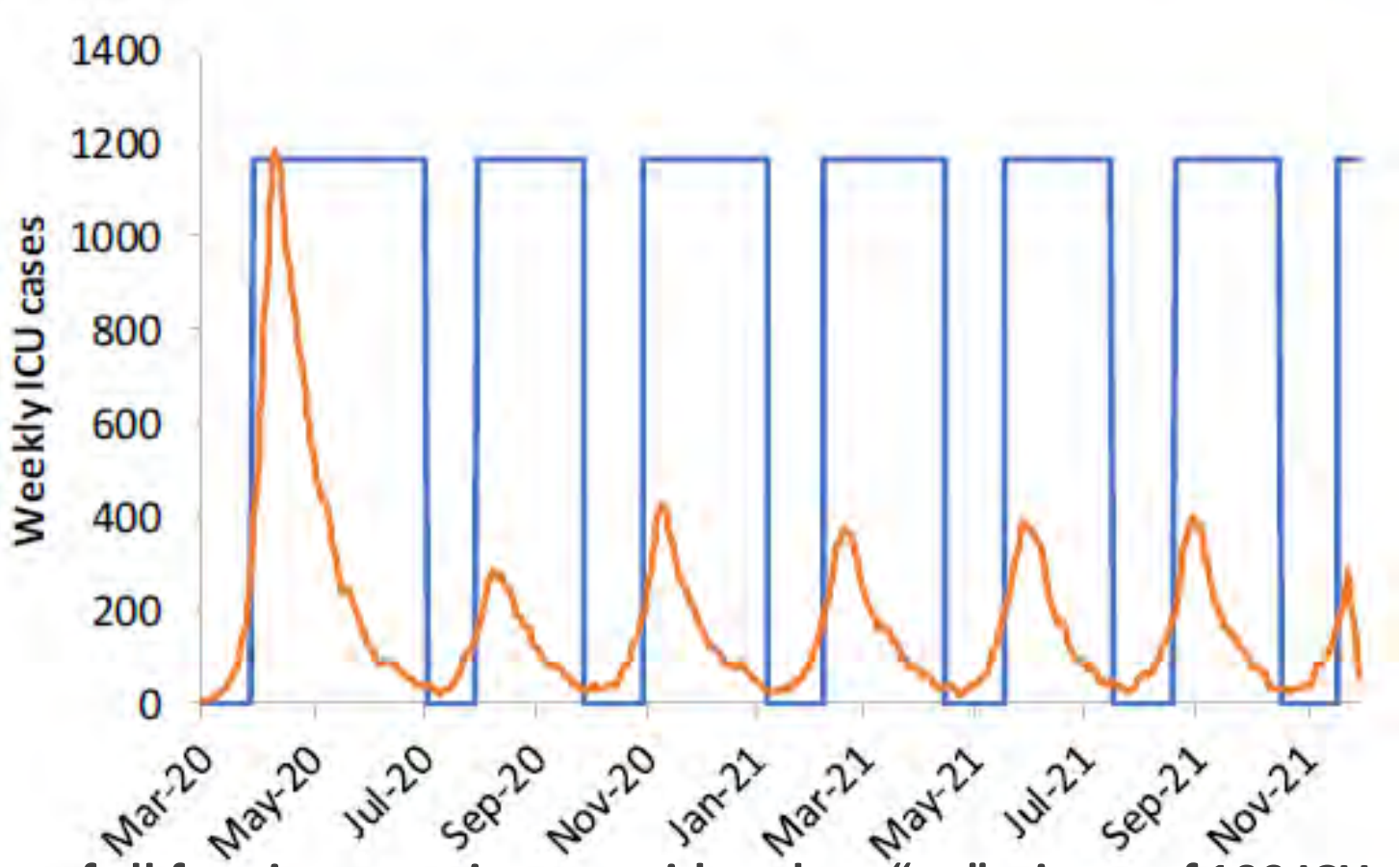
Questions?

- How much social distancing is required to flatten enough to stop hospitals being overwhelmed?
- Is it enough to quarantine people who have been in contact with confirmed cases? (F1 – F5 of Vietnam)
- Do we need widespread closure of events, school and workplaces?
- Who should work from home?
- Which place should be social distancing, locked down? Whom should be quarantined?
- Cost/Benefit problem

Social distancing

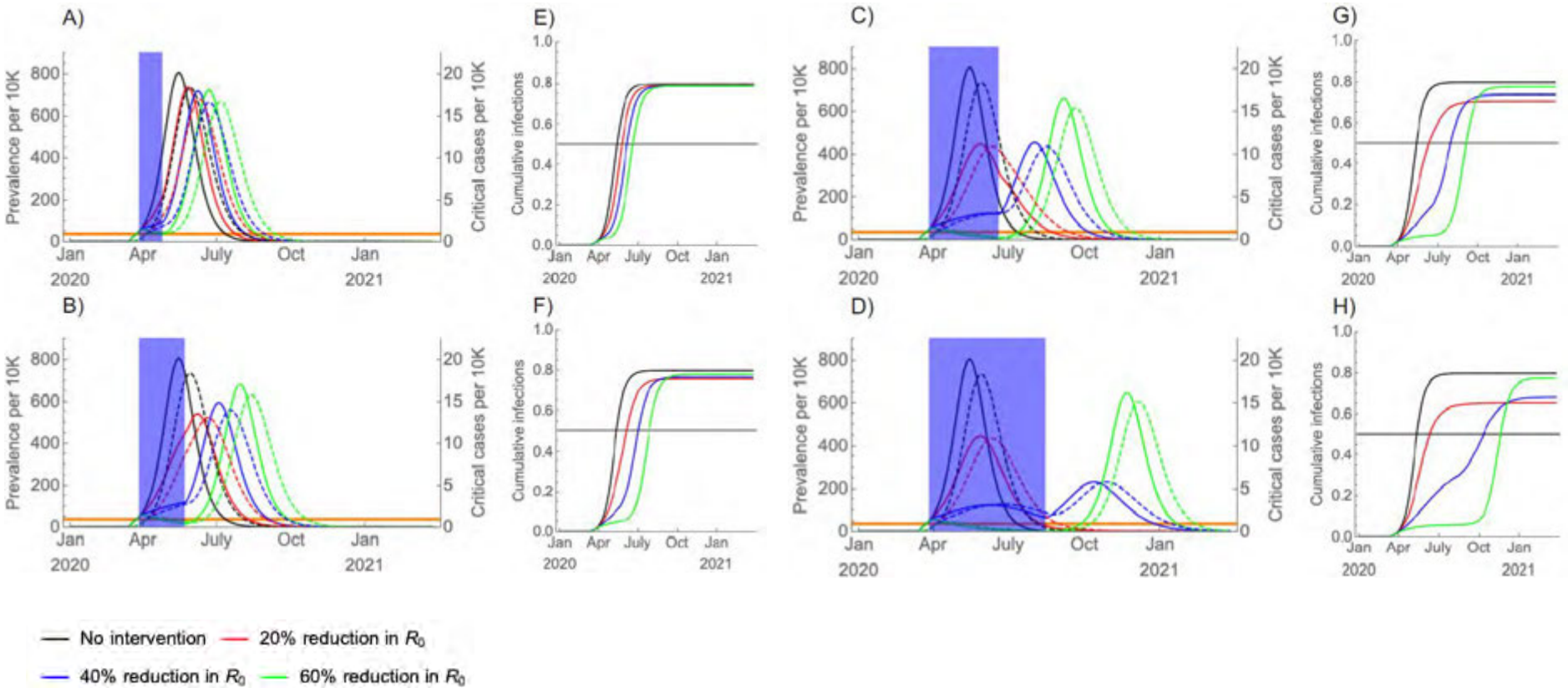


Suggest of Imperial team



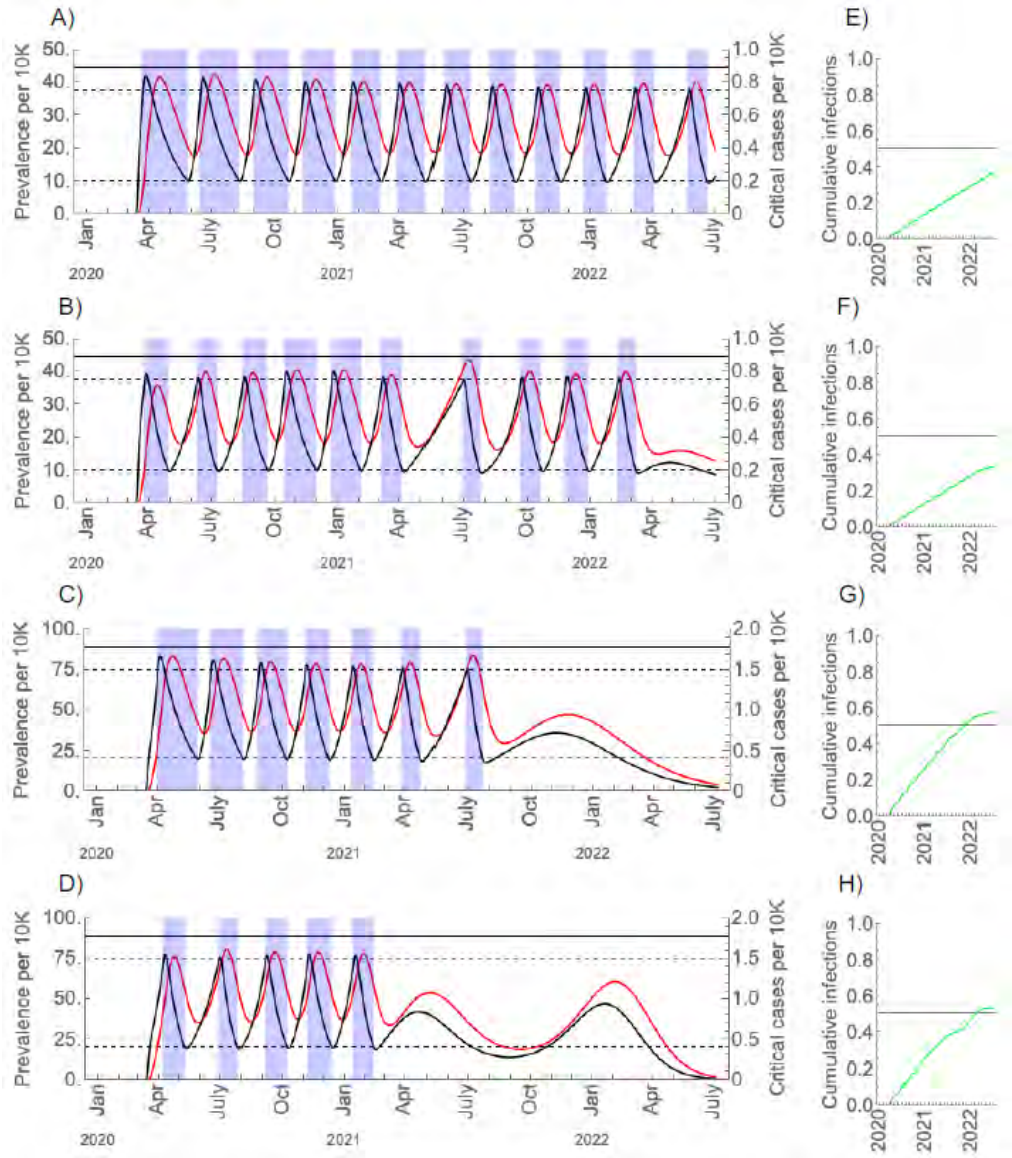
A policy of all four interventions considered, an "on" trigger of 100 ICU cases in a week and an "off" trigger of 50 ICU cases. The policy is in force approximate 2/3 of the time. Only social distancing and school/university closure are triggered; other policies remain in force throughout. Weekly ICU incidence is shown in orange, policy triggering in blue.

Havard's team result



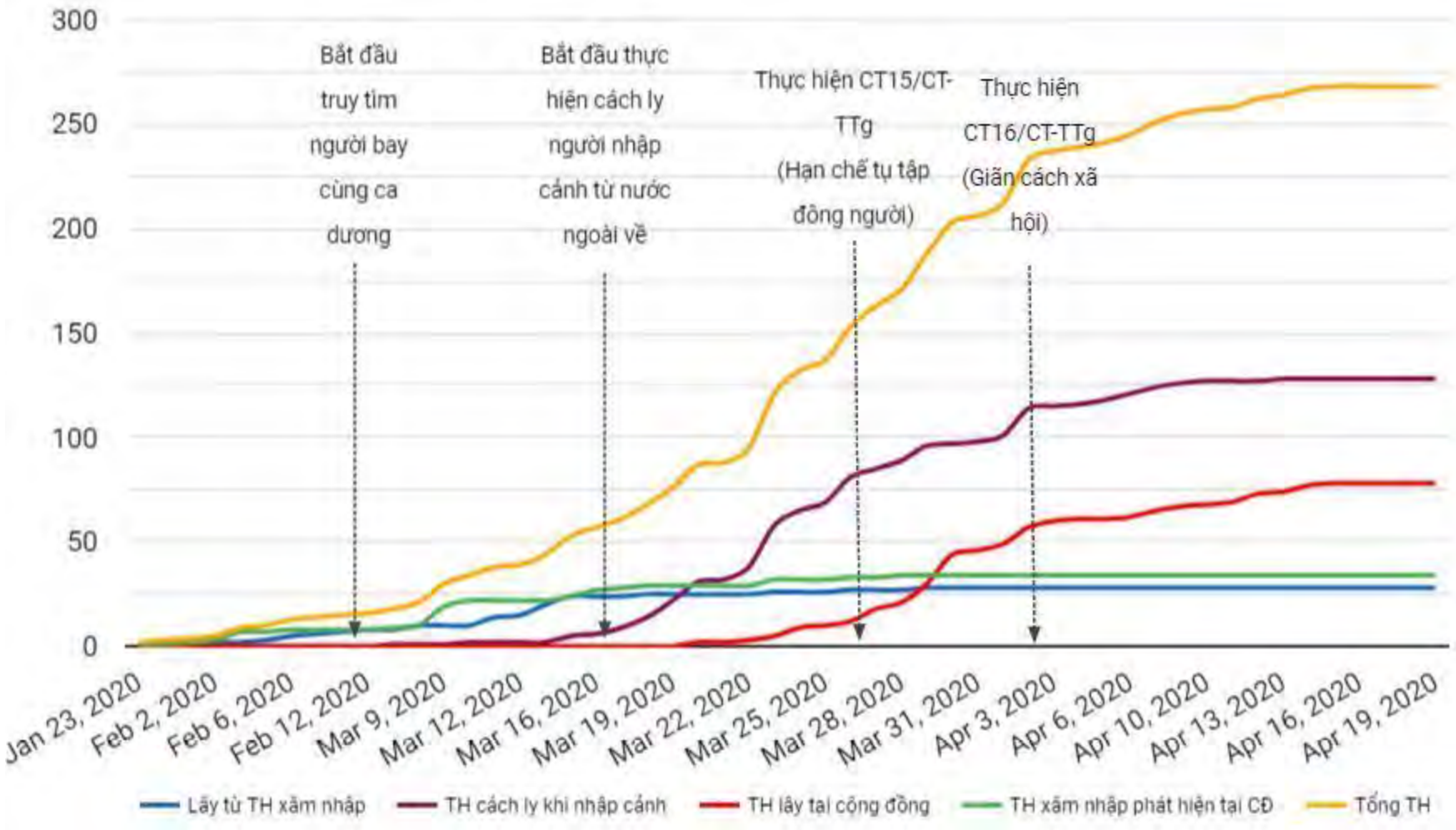
(A-D) Simulated prevalence of COVID-19 infections (solid) and critical COVID-19 cases (dashed) following establishment on 11 March 2020 with a period of social distancing (shaded blue region) instated two weeks later, with the duration of social distancing lasting (A) four weeks, (B) eight weeks, (C) twelve weeks, and (D) twenty weeks.

Havard's team result

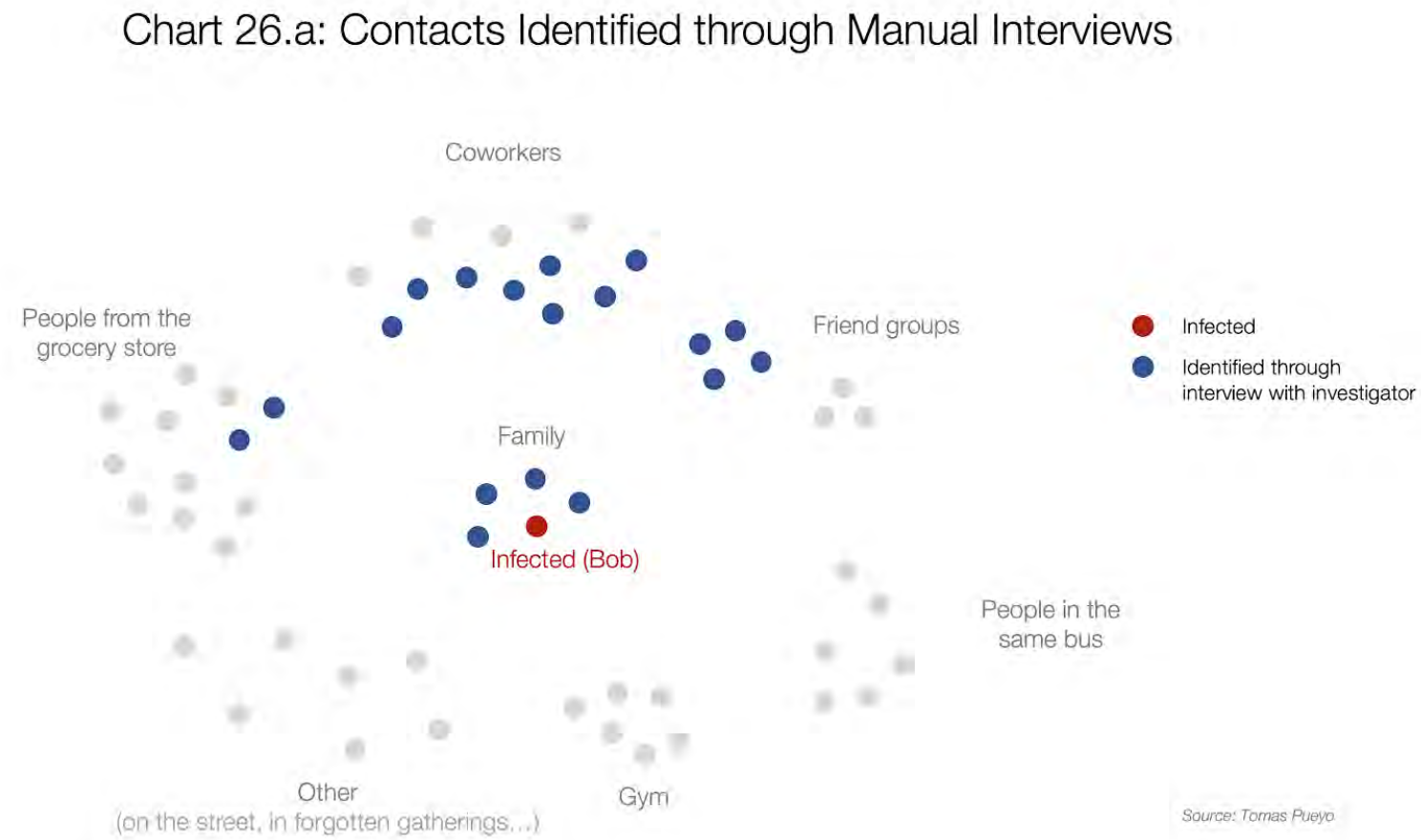


SARS-Cov-2 prevalence (black curves) and critical cases (red curves) under intermittent social distancing (shaded blue regions) without seasonal forcing (A, C) and with seasonal forcing (B, D). Distancing yields a 60% reduction in *R0*. Critical care capacity is depicted by the solid horizontal black bars; (A) and (B) are the scenarios with current US critical care capacity and (C) and (D) are the scenarios with double the current critical care capacity. The maximal wintertime *R0* is 2 and for the seasonal scenarios the summertime *R0* is 1.4. To the right of each main plot (E-H), the proportion immune over time is depicted in green with the herd immunity threshold (horizontal black bar).

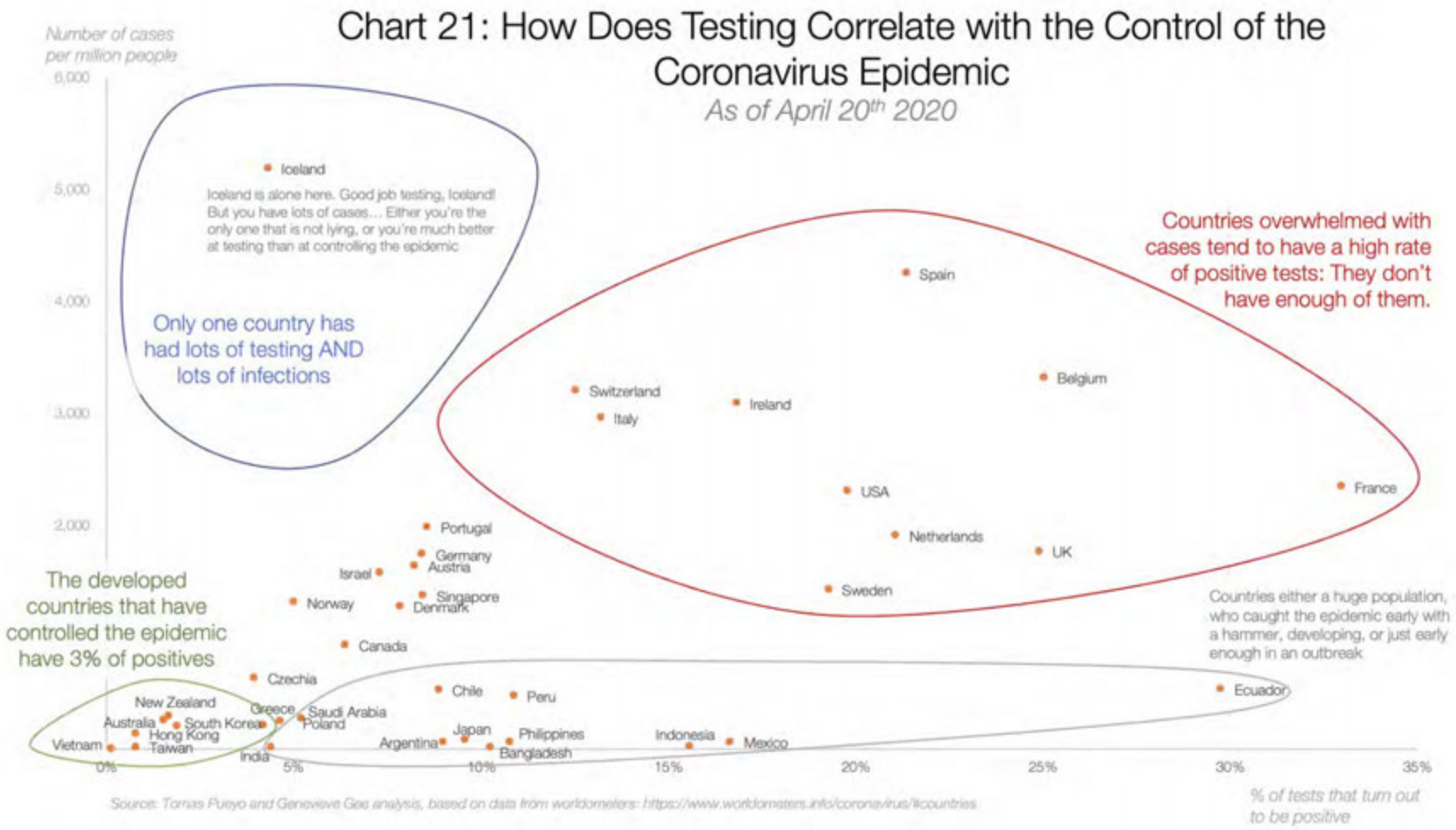
Impact of Policies



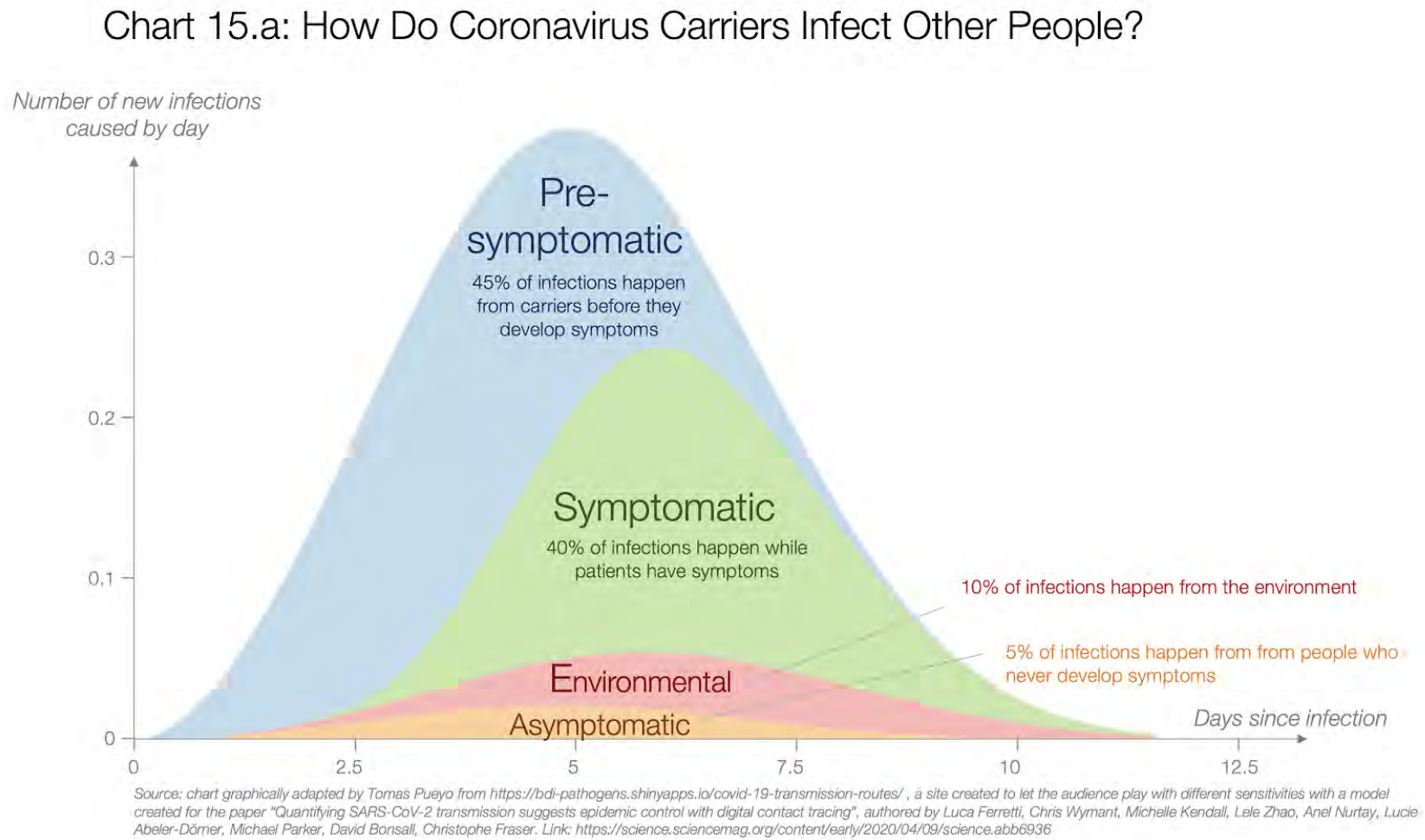
Contact Tracing



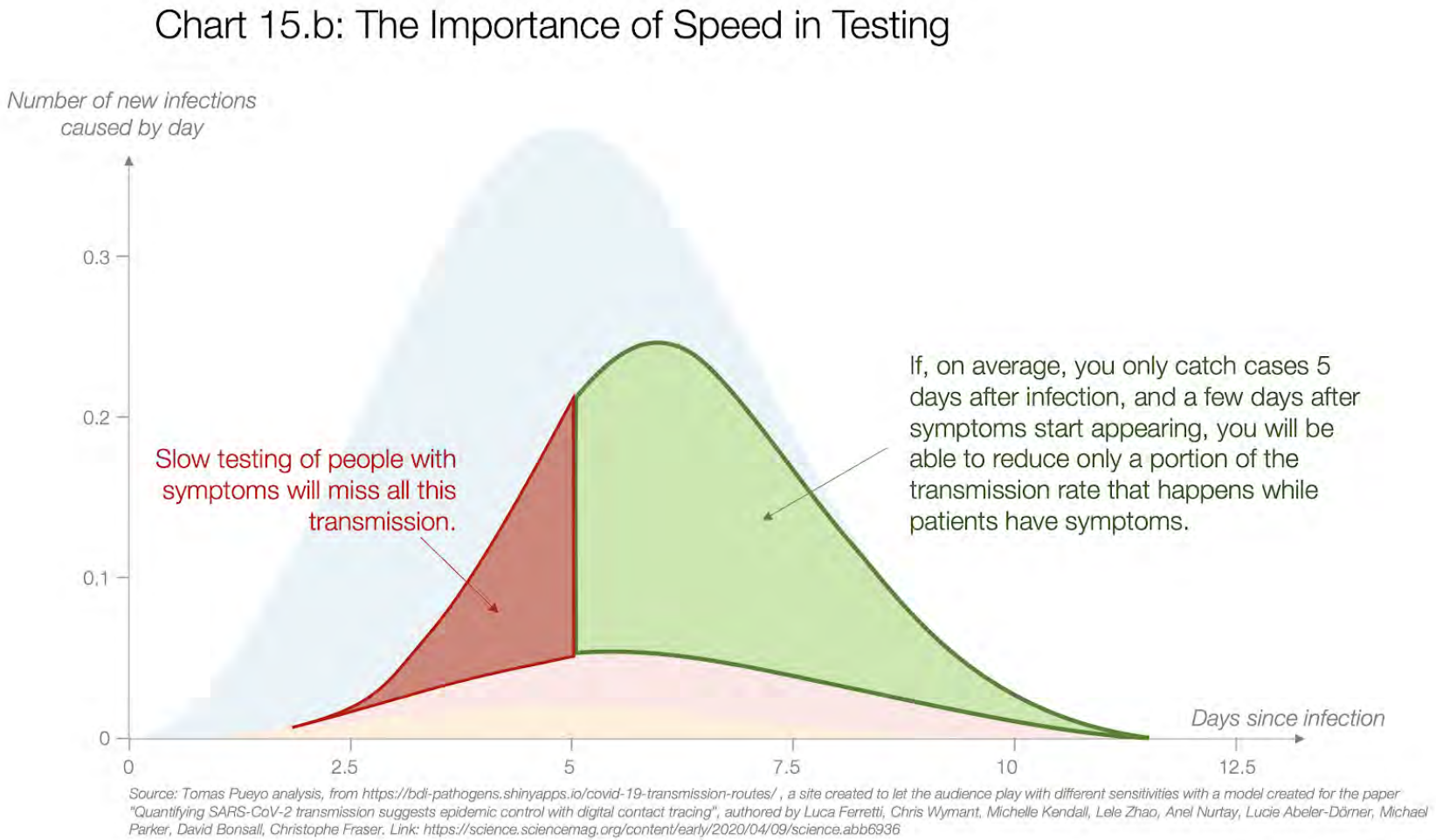
Impact of Testing



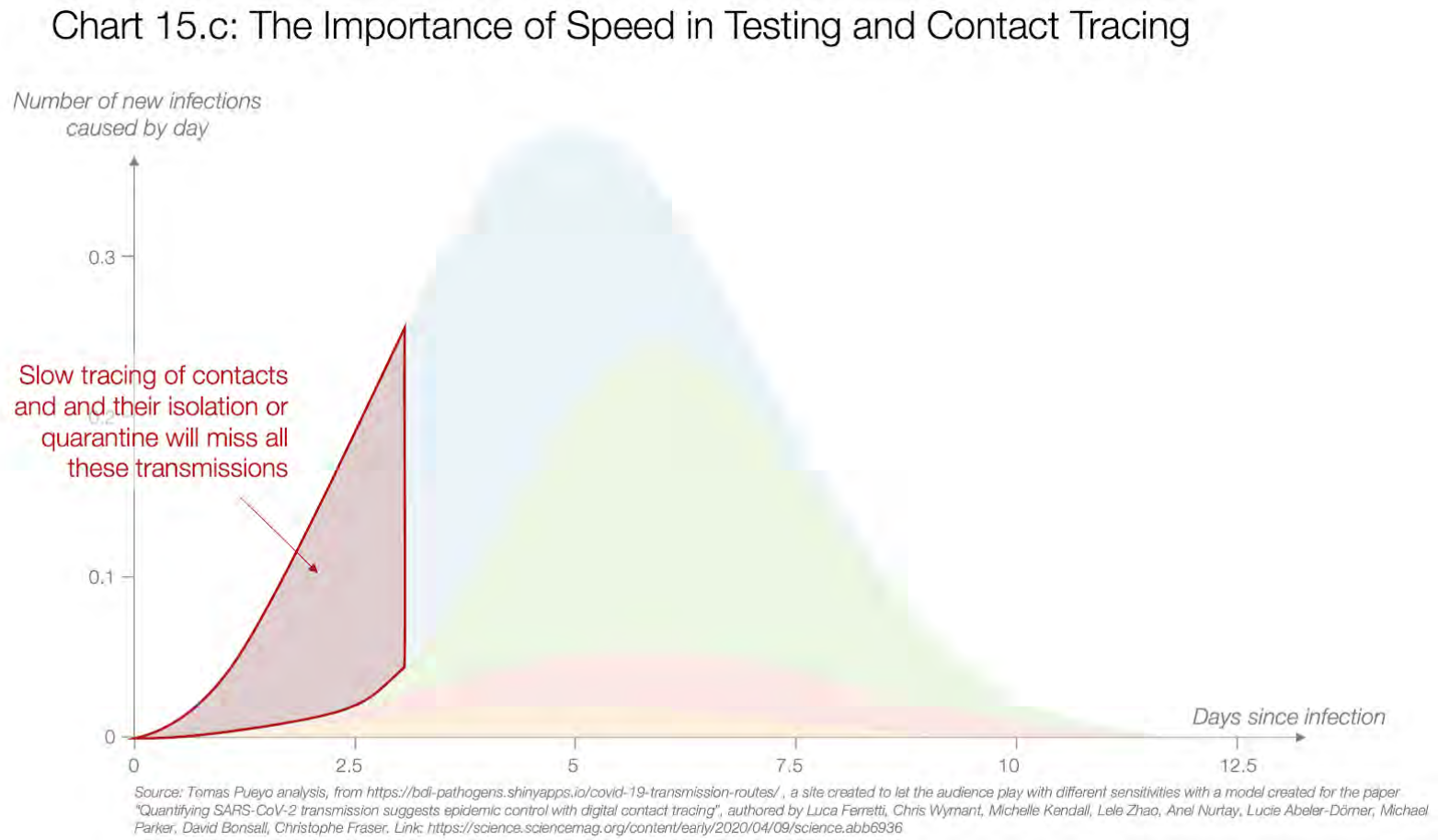
Why it’s important



Impact of testing



Impact of tracing and testing



Questions?

- How to perform contact tracing? Which question? How detail?
- Whom should be tested? Where?
- Cost/Benefit Problem

Effects of Travelling Ban?

- A study on restrictions in Italy showed they reduced travel by 50% in affected regions after three weeks.
- A global analysis that modelled how travel restrictions have affected transmission revealed that a travel ban in Wuhan delayed the inevitable epidemic progression by only three to five days in Mainland China. But travel restrictions were effective in reducing international transmission by nearly 80%, suggesting that such bans can be effective when paired with other interventions.

Strategies for Vietnam so far

- Case report
- Data summary
- Information extraction
- Decision for contact tracing, testing, and social distancing

Mathematical Models

- SEIR Compartment Model
- Network models for individuals and communities (provinces/districts/communes)
- Multi-agents simulation modelling
- Geographical Information
  - Population
  - Mobility
  - Health care facility
- Risk assessment
  - Pandemic
  - Death
  - Hospitality

Vaccination

- Constrain: Vaccine supply, facility
- Priority groups:
  - Health care workers
  - Frontline workers
  - In risk group
- Free and on-demand (type of vaccines)
- Problems:
  - Supply Chain
  - Logistic
  - Multi objectives under uncertain conditions

Thank you!