An Integrated Economic Epidemiology Model Minimizing COVID-19 Burden of Disease and Economic Growth Trade-off *

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Introduction

- Stay-at-home (SAH) orders partly cause economic disruptions during COVID-19 yet proven to be an effective measure to control the pandemic spread [2, 1]
- Agent-based models help mitigate the disease but often overlook crucial economic factors [4]
- SIR models aim to optimize health expenditures but don't account for lockdown impacts [3]; COVID-19 fits better in an SEIR framework
- Implementing SAH orders reduces infections and deaths, lowers the disease burden, and shortens the pandemic, aiding quicker economic recovery

Objective

An integrated economic-epidemiological model to optimize lockdown policies and balance disease control with economic growth

Methods

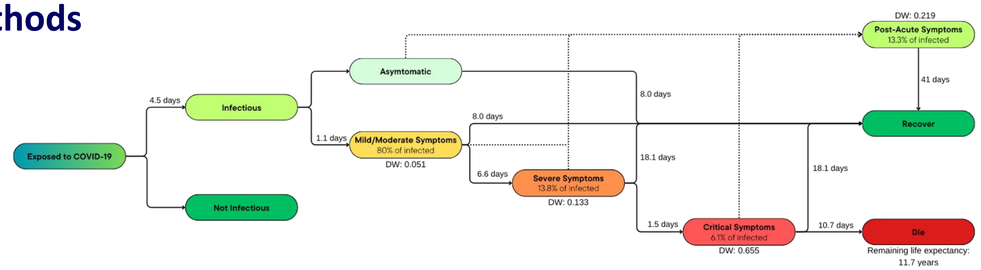

Figure 1. COVID-19 Disease Compartment Flowchart to calculate monetary loss of Disability-Adjusted Life Years (DALY) for our integrated economic-epidemiological model. Each DALY is valued at $95075 USD. Disability weights (DW) for COVID-19 are provided by the European Burden of Disease Network protocol

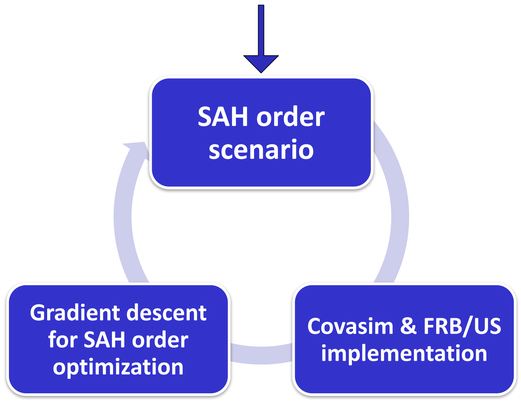

Figure 2. Integrated economic-epidemiological model architecture using gradient descent algorithm

- Define stay-at-home scenarios and simulate with Covasim and FRB/US to evaluate disease and economic impacts
- Optimize policies using gradient descent to minimize total loss
- Iterate until the global minimum loss is reached

Results

GDP Loss	DALY Loss	Total Loss
$2.13 trillion USD	$9.85 trillion USD	$11.98 trillion USD

Table 1. Minimal economic and health-related losses due to COVID-19 were calculated using a gradient descent algorithm

- GDP Loss: the minimal total monetary loss in Gross Domestic Product
- DALY Loss: the minimal total loss in Disability-Adjusted Life Years

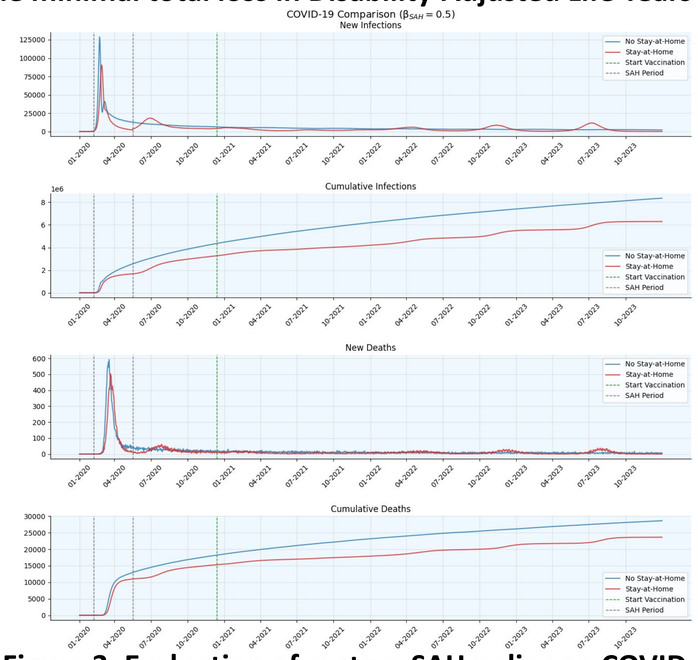

Figure 3. Evaluation of custom SAH policy on COVID-19

- Simulation period: 2020–2024, population: 1,000,000
- SAH policy adjusted transmission rate; testing intervention included
- Vaccination and contact tracing applied in all simulations

Discussion

- Custom SAH policies minimized COVID-19's economic and health impacts
- Gradient descent successfully reduced total GDP and DALY losses
- Simulations (2020-2024) showed that adjusted transmission rates, testing, vaccination, and contact tracing improved outcomes
- Optimized SAH policies led to fewer infections, deaths, and economic losses
- Combining Covasim and FRB/US models provided a comprehensive assessment of policy effectiveness

References

[*] Read the full research paper here: qmjnh.github.io/cv_frbus/Research_Paper_cv_frbus.pdf
[1] Baek et al. (2020). *The Review of Economics and Statistics, 1–72.*
[2] Fowler et al. (2021). *PLOS ONE, 16(6)*.
[3] Goenka et al. (2021). *Journal of Mathematical Economics, 93*.
[4] Perrings et al. (2014). *Ecohealth, 11(4)*.