Policy tradeoffs during pandemics: six lessons from epi-econ models

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Based on joint work with Zhiyu Fu, Greg Kaplan and Gianluca Violante

Nobel Symposium on Covid-19 and the Economy

Plan

1. Brief review of epi-econ models

2. Six lessons

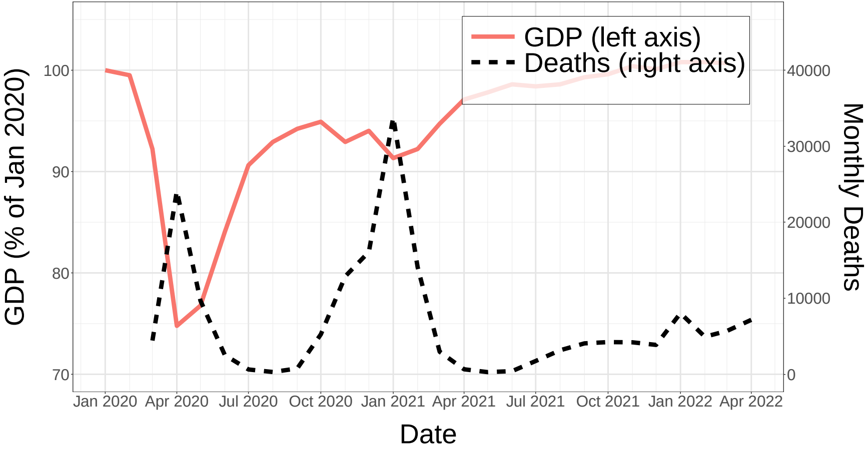
3. Benefit of hindsight: omissions of (early) models, are lessons robust?

Epi-econ models: integrated frameworks for thinking about

1. Empirical evidence on health and economic outcomes over last two years

2. Policy tradeoffs: save most possible lives while minimizing econ damage?

Typical evidence: epidemic, economy, policy (here for UK)



Source: UK ONS (publishes monthly GDP), Oxford COVID-19 Govt Response Tracker

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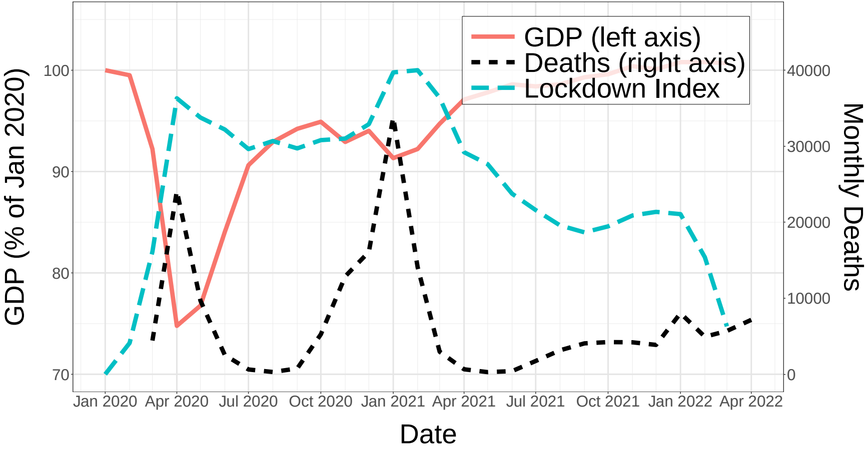
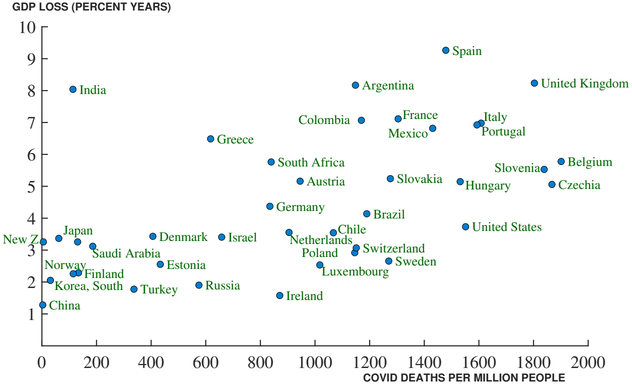


Source: UK ONS (publishes monthly GDP), Oxford COVID-19 Govt Response Tracker

Typical evidence: GDP loss vs deaths across countries

Figure 2: International COVID-19 Deaths and Lost GDP



Source: Jones (2021) `https://web.stanford.edu/~chadj/Macroeconomics_Covid.pdf`

How make sense of evidence? Models can help.

Review of Epi-Econ Models

Simplest prototype epi-econ model

Version here due to Gianluca Violante. Many similar models in literature.
https://conference.nber.org/confer/2020/EFGs20/Violante.pdf

- Start with: susceptibles S_t, infectious I_t, recovered R_t, deaths at rate δ

$$\dot{S} = -\beta S I \tag{S}$$

$$\dot{I} = \beta S I - \gamma I \tag{I}$$

$$\dot{R} = \gamma I \tag{R}$$

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- Start with: susceptibles S_t, infectious I_t, recovered R_t, deaths at rate δ

$$\dot{S} = -\beta(Y)SI \tag{S}$$

$$\dot{I} = \beta(Y)SI - \gamma I \tag{I}$$

$$\dot{R} = \gamma I \tag{R}$$

$$Y = \mathcal{Y}(I) \tag{Y}$$

- Add: economic activity Y_t, normalize pre-pandemic $\bar{Y} = 1$ so $Y_t \leq 1$
- Infections $\Leftrightarrow$ activity:
  1. Risky activity: infections $\nearrow$ in activity: $\beta' > 0$, e.g $\beta(Y) = \bar{\beta} Y^{\alpha}, \alpha > 0$
  2. "Fear factor": activity $\searrow$ in infections: $\mathcal{Y}' < 0$, e.g. $\mathcal{Y}(I) = e^{-\sigma I}, \sigma > 0$
- Richer models: lots of heterogeneity (age, occupation, ...), ICU capacity, ...

Two polar positions in popular debate

1. **"Tradeoff between lives & livelihoods"**

   - Focuses on dynamics of infections

   $$\dot{I} = \beta(Y)SI - \gamma I \quad \text{with} \quad \beta'(Y) > 0$$

   - Policy that reduces $Y \downarrow$ implies $I \downarrow$ and ultimately $D \downarrow$

2. **"To save the economy, save people first"**

   - Focuses on behavioral response

   $$Y = \mathcal{Y}(I) \quad \text{with} \quad \mathcal{Y}'(I) < 0$$

   - Policy that reduces $I \downarrow$ (and hence $D \downarrow$) implies $Y \uparrow$

In standard epi-econ models, both polar positions are present

Policy intervention: two types of policies

1. τ = activity-reducing policies: reduce transmissions via reducing activity Y
   Examples: lockdowns, Pigouvian taxes, communication policy (e.g. Trump speech)

2. h = "health policies": reduce transmissions without affecting activity Y
   Examples: masks, contact tracing, better indoor ventilation, ...

$$\dot{S} = -\beta(Y, h)SI \tag{S}$$

$$\dot{I} = \beta(Y, h)SI - \gamma I \tag{I}$$

$$\dot{R} = \gamma I \tag{R}$$

$$Y = \mathcal{Y}(I, \tau) \tag{Y}$$

Example functional forms:

$$\mathcal{Y}(I, \tau) = \min\left\{(1-\tau), e^{-\sigma I}\right\}, \qquad \beta(Y, h) = \bar{\beta}(1-h)Y^{\alpha}$$

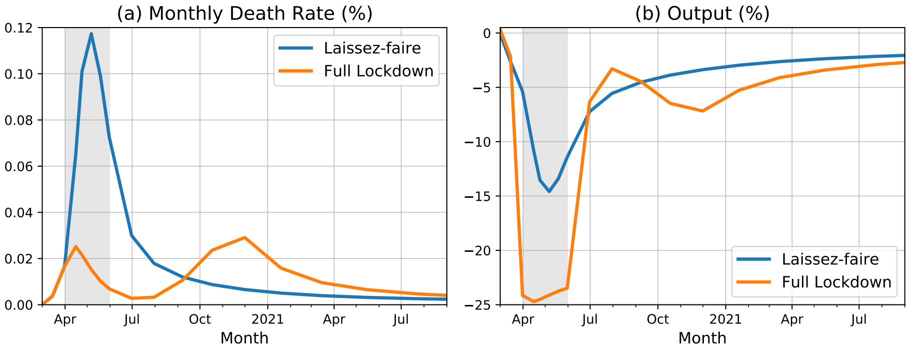
Lives and livelihoods: use models to populate this graph

- Laissez-faire counterfactual, activity-reducing policies, health policies

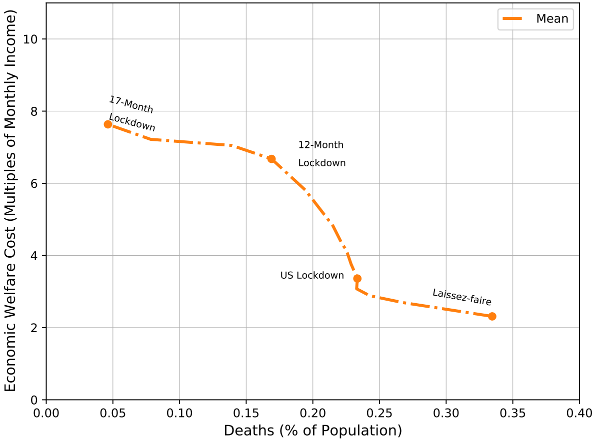
- Note: GDP loss and deaths both cumulative, $\int_0^T (1 - Y_t/\bar{Y})dt$ and $\int_0^T \dot{D}_t dt = D_T$

Typical lockdown dynamics vs laissez-faire counterfactual

Here: simulations from richer Fu-Kaplan-Moll-Violante (2020) model

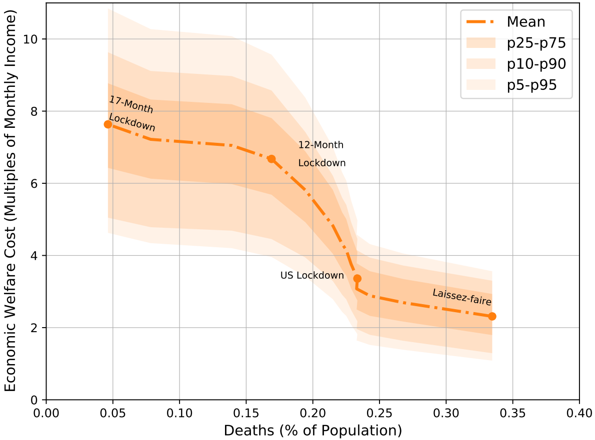


Pandemic Possibility Frontier (Fu-Kaplan-Moll-Violante)



Compare policies without taking stand on economic value of life

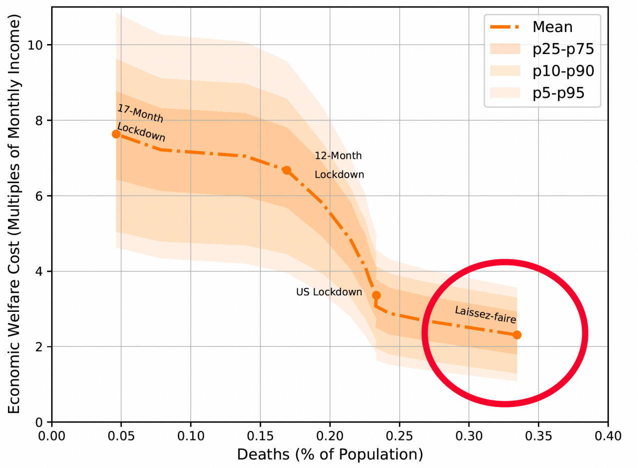
Distributional Pandemic Possibility Frontier (Fu-Kaplan-Moll-Violante)



Compare policies without taking stand on economic value of life

Six lessons from epi-econ models

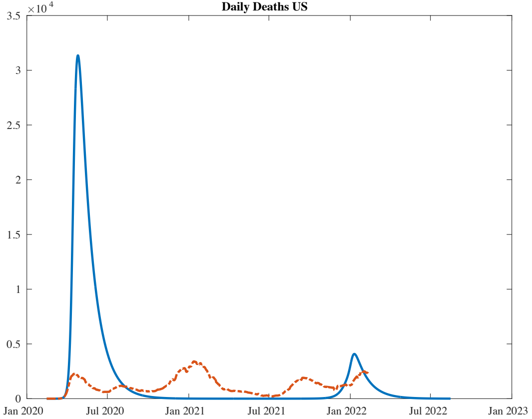
Lesson 1: “fear factor” ⇒ large costs even in laissez-faire counterfactual



Simplistic view that can be dismissed: in absence of lockdowns, economy would have experienced only very mild recession or no recession at all

Lesson 2: “fear factor” flattens and draws out epidemic

Dynamics of epidemic **without** behavior: model vs data



Source: Atkeson (2022) model with Alpha, Delta, Omicron variants

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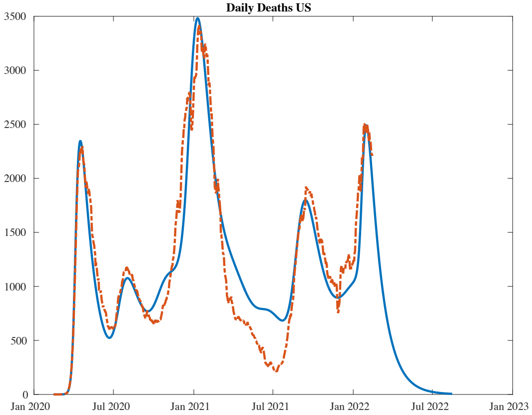
Dynamics of epidemic **with** behavior: model vs data



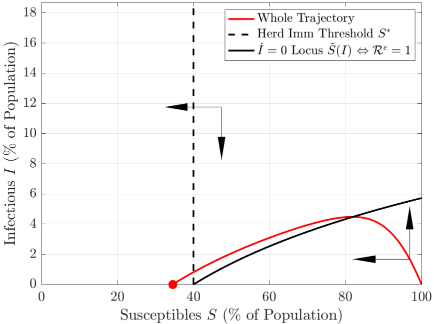
Source: Atkeson (2022) model with Alpha, Delta, Omicron variants

Lesson 2: “fear factor” flattens and draws out epidemic

Atkeson (2022) “Behavior turns what would be a short and extremely sharp epidemic into a long, drawn out one”

- effective reproduction number $\mathcal{R}^e \approx 1$ for long time
- rel. to pure epi model, epidemic “overshoots” herd imm. threshold by less

Farboodi-Jarosch-Shimer, Atkeson-Kopecky-Zha, Bognanni-Hanley-Kolliner-Mitman,...



Lesson 3: lockdowns save lives primarily by buying time & ICU capacity

Theoretically four broad channels through which lockdowns could save lives

1. reduce "epidemic overshoot"
2. eliminate disease ("#ZeroCovid")
3. flatten curve below ICU capacity constraint
4. buy time
    - vaccines
    - better treatments
    - learning, e.g. better hygiene

Epi-econ models:

1. overshoot small (straight from $\mathcal{R}^e \approx 1$)
2. elimination impossible (by assumption but perhaps not so crazy, eg China)

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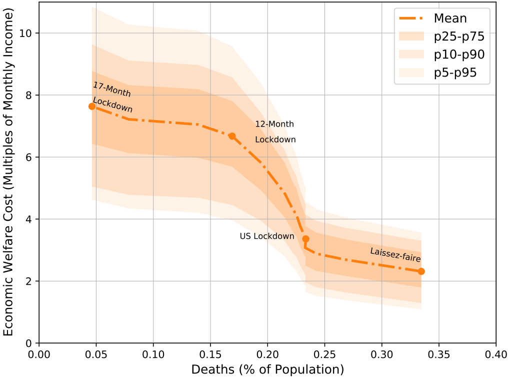
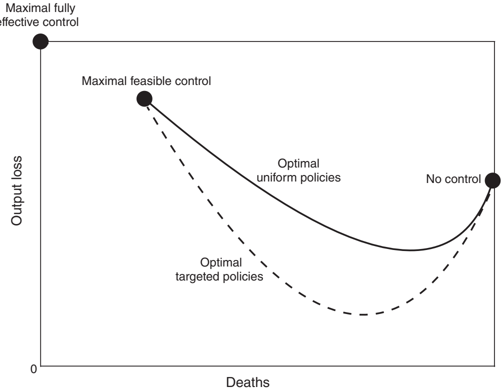
Lesson 4: lockdowns ⇒ tradeoff between lives & livelihoods



Another simplistic view that can be dismissed: with blunt lockdown-only policy (US, UK), there is no tradeoff between lives and livelihoods

- I've never seen upward-sloping frontier in reasonably calibrated model

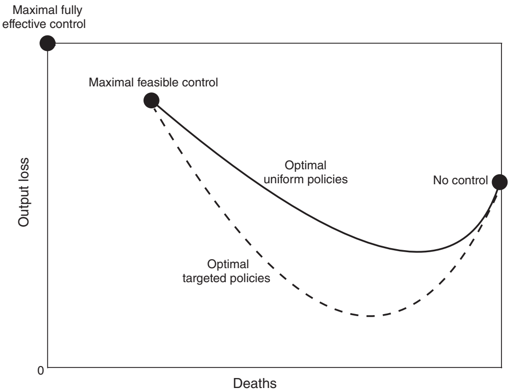
Lesson 5: targeted lockdowns & Pigouvian taxes do better



Dimensions considered in literature

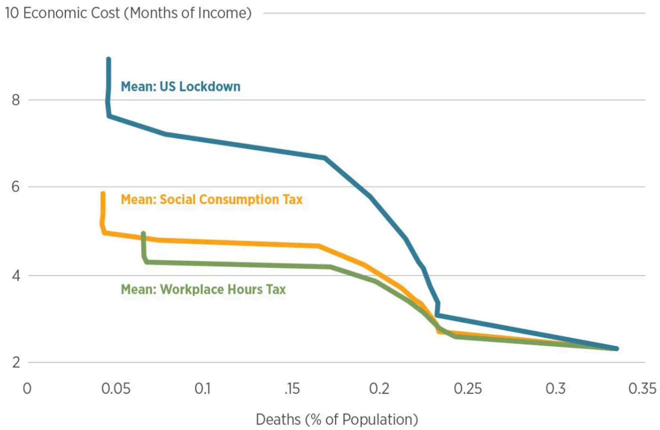
1. **Sectors:** Baqaee-Farhi-Mina-Stock, Favero-Ichino-Rustichini, Azzimonti-Fogli-Perri-Ponder
2. **Age:** Acemoglu-Chernozhukov-Werning-Whinston, Brotherhood-Kircher-Santos-Tertilt, Glover-Heathcote-Krueger-RiosRull,...
3. **Occupations:** Fu-Kaplan-Moll-Violante

Lesson 5: targeted lockdowns & Pigouvian taxes do better



- Caveat: political, ethical, practical issues
- Most policy is targeted in practice (e.g. “work from home if you can”)

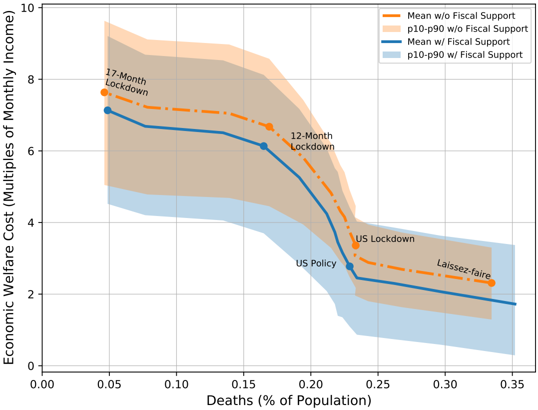
Lesson 5: targeted lockdowns & Pigouvian taxes do better



Pigouvian taxes: Fu-Kaplan-Moll-Violante, Bisin-Gottardi

Lesson 6: heterogeneity ⇒ importance of social insurance

Data: extremely heterogeneous exposure & vulnerability by occupation (eg waiters



CARES act shifts down PPF: cost ↓ by 20% on average, highly redistributive

- stimulus checks, pandemic UI, PPP, pension saving withdrawals

Lesson 6: heterogeneity ⇒ importance of social insurance

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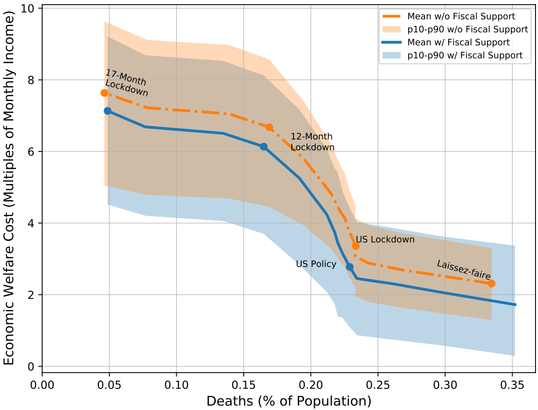

But: diverting $ from fiscal toward “health policies” may generate large gains

Summary: Six Lessons from Epi-Econ Models

1. "Fear factor" $\Rightarrow$ large costs even in laissez-faire counterfactual
2. "Fear factor" flattens and draws out epidemic
3. Lockdowns save lives primarily by buying time and ICU capacity
4. Lockdowns $\Rightarrow$ tradeoff between lives & livelihoods
5. Targeted lockdowns & Pigouvian taxes do better
6. Heterogeneity $\Rightarrow$ importance of social insurance

Benefit of Hindsight: Omissions

Important features of Covid not included in early models

1. Waning immunity
2. Declining disease severity with partial immunity
3. Variants (Delta, Omicron etc)

Do these affect the six lessons?

Simple model to think this through

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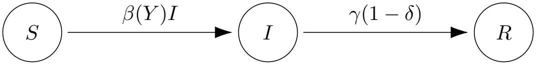
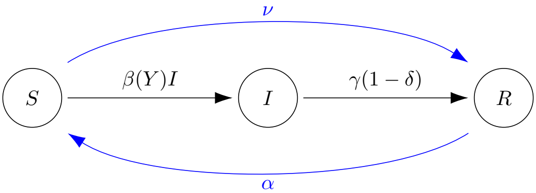


Important features of Covid not included in early models

1. Waning immunity at rate α, vaccination at rate ν
2. Declining disease severity with partial immunity



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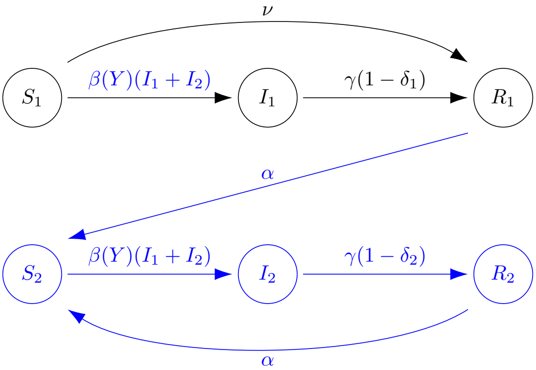

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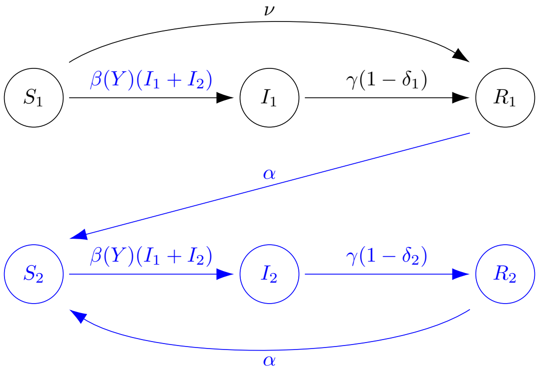
   - Assumption for cleanest results: $\delta_2 = 0$, i.e. die only from first infection



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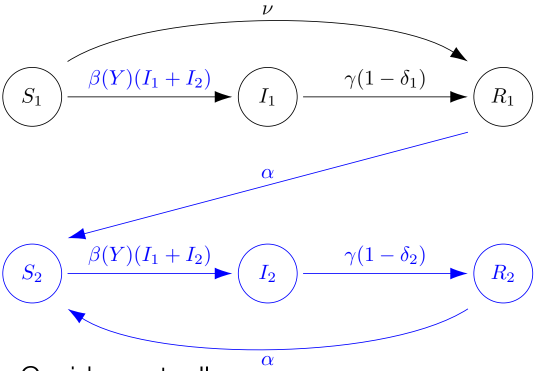


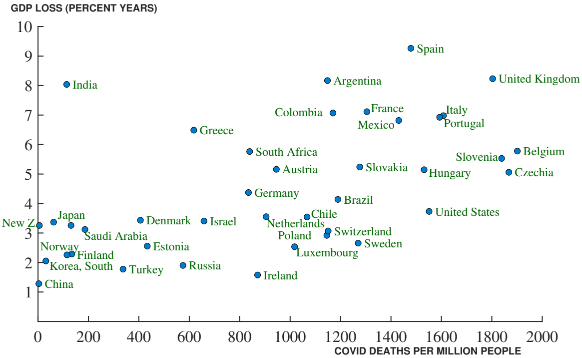
- Everyone gets Covid eventually
- Without vaccines etc, fraction δ_1 of pop. dies regardless of lockdowns

⇒ All Six Lessons of Epi-Econ Models are Robust

1. "Fear factor" ⇒ large costs even in laissez-faire counterfactual
2. "Fear factor" flattens and draws out epidemic
3. Lockdowns save lives ~~primarily~~ only by buying time and ICU capacity
4. Lockdowns ⇒ tradeoff between lives & livelihoods
5. Targeted lockdowns & Pigouvian taxes do better
6. Heterogeneity ⇒ importance of social insurance

Open question: cross-country patterns? (FernandezVillaverde-Jones)

Figure 2: International COVID-19 Deaths and Lost GDP



Candidate explanations for countries with good outcomes in both dimensions

1. good “health policies” $\beta(Y, h)$: masks, contact tracing, better indoor ventilation, ...
2. good luck: low β or δ, e.g. age structure

Important caveat: figure above from 2021, needs updating

Thanks!

Simplest prototype epi-econ model: reduced form

- Define

$$\tilde{\beta}(I) := \beta(\mathcal{Y}(I))$$

- Clearly $\beta' > 0$ and $\mathcal{Y}' < 0 \Rightarrow \tilde{\beta}' < 0$
  - Example: $\beta(Y) = \bar{\beta}Y^{\alpha}$ and $\mathcal{Y}(I) = e^{-\sigma I} \Rightarrow \tilde{\beta}(I) = \bar{\beta}e^{-\alpha\sigma I}$

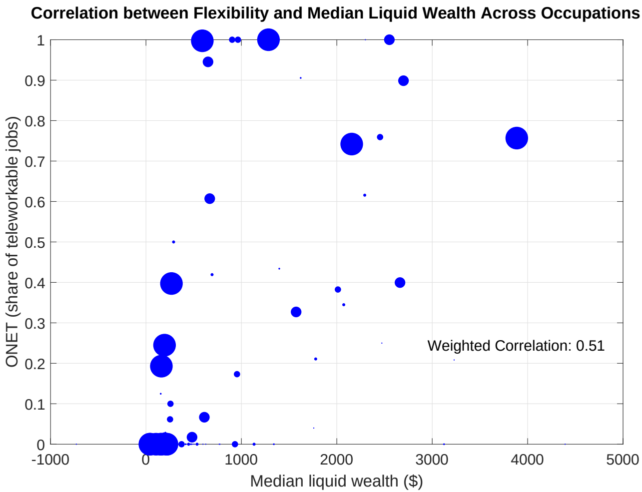
- Reduced form epi-econ model:

$$\dot{S} = -\tilde{\beta}(I)SI \quad \text{(S)}$$

$$\dot{I} = \tilde{\beta}(I)SI - \gamma I \quad \text{(I)}$$

$$\dot{R} = \gamma I \quad \text{(R)}$$

More exposed occupations also more financially vulnerable



References in these slides (clickable hyperlinks)

- Acemoglu, Chernozhukov, Werning, and Whinston (2021) “Optimal targeted lockdowns in a multigroup SIR model”
- Atkeson (2022), “Behavior and the dynamics of epidemics: An update for Delta, Omicron, vaccines, and waning immunity”
- Atkeson, Kopecky and Zha (2021) “Behavior and the transmission of Covid-19”
- Azzimonti, Fogli, Perri, and Ponder (2020) “Pandemic control in econ-epi networks”
- Baqaee, Farhi, Mina, and Stock (2020) “Policies for a second wave”
- Bisin and Gottardi (2021) “Efficient policy interventions in an epidemic ”
- Bognanni, Hanley, Kolliner, and Mitman (2020) “Economics and epidemics: Evidence from an estimated spatial econ-SIR model”

References in these slides (clickable hyperlinks)

- Brotherhood, Kircher, Santos, and Tertilt (2021) "An economic model of the Covid-19 pandemic with young and old agents: Behavior, testing and policies"
- Favero, Ichino, and Rustichini (2020) "Restarting the economy while saving lives under Covid-19"
- Farboodi, Jarosch, and Shimer (2021) "Internal and external effects of social distancing in a pandemic"
- Fu, Kaplan, Moll, and Violante (2020) "The Great Lockdown and the Big Stimulus: Tracing the pandemic possibility frontier for the U.S."
- Glover, Heathcote, Krueger, and Rios-Rull (2020) "Health versus wealth: On the distributional effects of controlling a pandemic"
- Fernandez-Villaverde and Jones (2020), "Macroeconomic Outcomes and COVID-19: A Progress Report"

Additional references: epi papers discussing behavior

- Ferguson et al (2006), “Strategies for mitigating an influenza pandemic”
- Ferguson (2007), “Capturing human behaviour”
- Eksina, Paarporn and Weitz (2019), “Systematic biases in disease forecasting – The role of behavior change”
- Weitz, Park, Eksin and Dushoff (2020), “Awareness-driven behavior changes can shift the shape of epidemics away from peaks and toward plateaus, shoulders, and oscillations”