Discussion of Atkeson and Kissler

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BPEA, March 2024

Summary

- Combination of vaccines and behavioral response saved 800k lives compared to no vaccine counter-factual
  - 800k/330M ~ 0.25% of US population
  - H1N1 1918-1919 : 675k/103M ~ 0.65%

- Strong Complementarity
  - unmitigated deaths 3M ~ 1% of population
  - 2/3 vaccinated before first infection
  - Vaccine protects 5x in 2021

Basic Infection Model

- Pop size N, I_t infected individuals, S_t susceptible individuals

$$I_{t+1} = \beta e_t I_t \frac{S_t}{N} + (1-\gamma) I_t$$

γ is recovery rate, e_t exposure, β infection rate.

- **Definition: basic reproduction number**

$$\mathscr{R} = \sum_{\tau=0}^{\infty} \beta e_0 (1-\gamma)^{\tau} = \frac{\beta e_0}{\gamma}$$

- Initially $S/N \approx 1$, exponential growth

$$\frac{I_{t+1}}{I_t} \approx 1 + \beta e_0 - \gamma$$

Review of *SIRD* Framework

$$\text{Susceptible: } S_{t+1} = S_t - \beta e_t I_t \frac{S_t}{N} - \mathscr{V}_t$$

$$\text{Infected: } I_{t+1} = I_t + \underbrace{\beta e_t I_t \frac{S_t}{N}}_{\text{New infections}} - \underbrace{\gamma I_t}_{\text{Recoveries}} - \delta_t \underbrace{\kappa I_t}_{\text{Sick}}$$

$$\text{Recovered: } R_{t+1} = R_t + \gamma I_t + \mathscr{V}_t$$

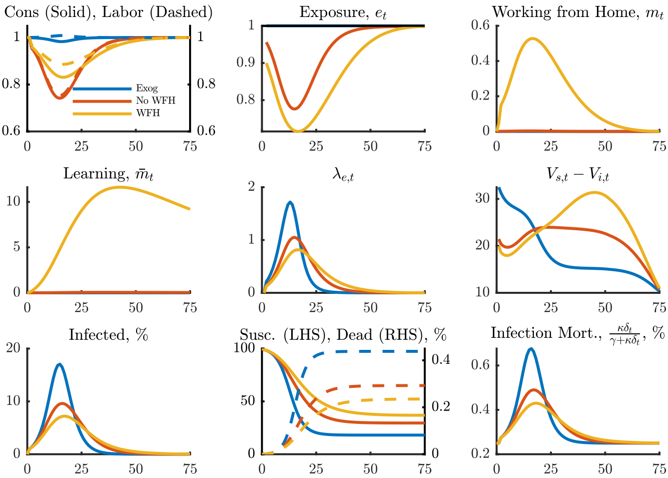
$$\text{Dead: } D_{t+1} = D_t + \underbrace{\delta_t \kappa I_t}_{\text{New deaths}}$$

$$\text{Death rate:} \delta_t = \bar{\delta} + \underbrace{\exp(\phi I_t) - 1}_{\text{Congestion}}$$

Results from Jones *et al.* (2021)

- Trade-off between infection risk and economic activity
  - Mitigate by reducing C, L, working from home
- Two key dynamic effects
  - Health care congestion $\bar{\delta} + \exp(\phi I_t) - 1$
  - Learning by doing in remote work

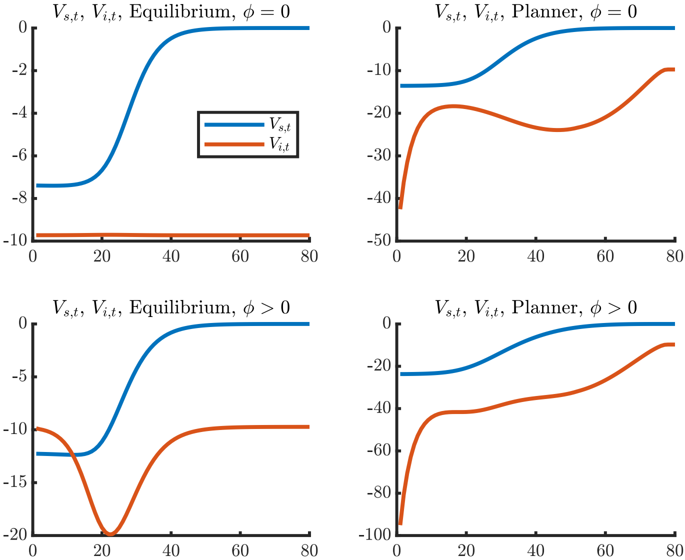
Planning Solution



Results from Jones *et al.* (2021)

- Trade-off between infection risk and economic activity
  - Mitigation by reducing C, working from home saves 0.06% ~ 200k lives
- Compare private and social incentives
  - Private incentives weak (even perverse), back-loaded

Fatalism & Perverse Incentives



Take Away for Future Crises

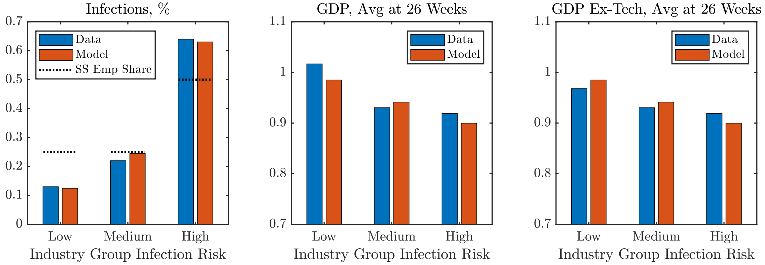
- Working from home is critical tool
  - Schools, broadband internet
- Externalities and misaligned incentives
  - Congestion: main rationale for govt. intervention
  - Testing: needs to be mandatory
- Mostly aligned incentives
  - Vaccines: Horizon effect helps a lot
  - Early announcement of *plausible* dates

Heterogeneity

- Old vs young
  - Understood. Risk factor 10+

- Across sectors & occupations
  - Understood. Risk factor ~5

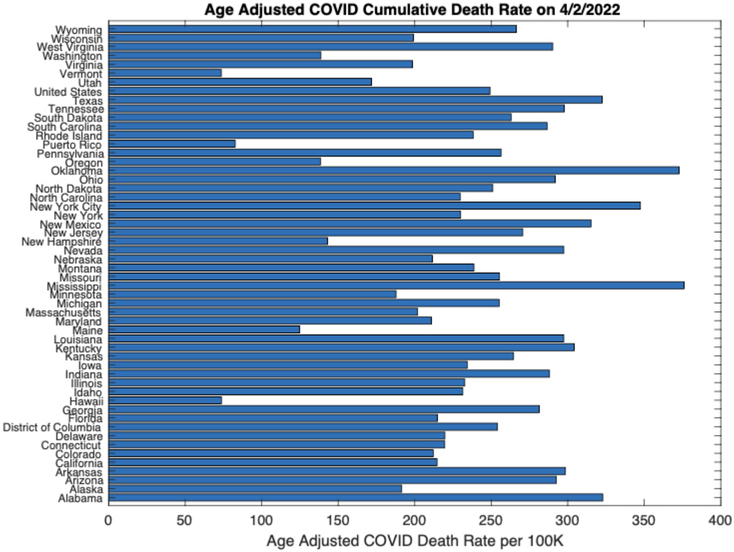
Multi-sector Model. Model v Data



Heterogeneity

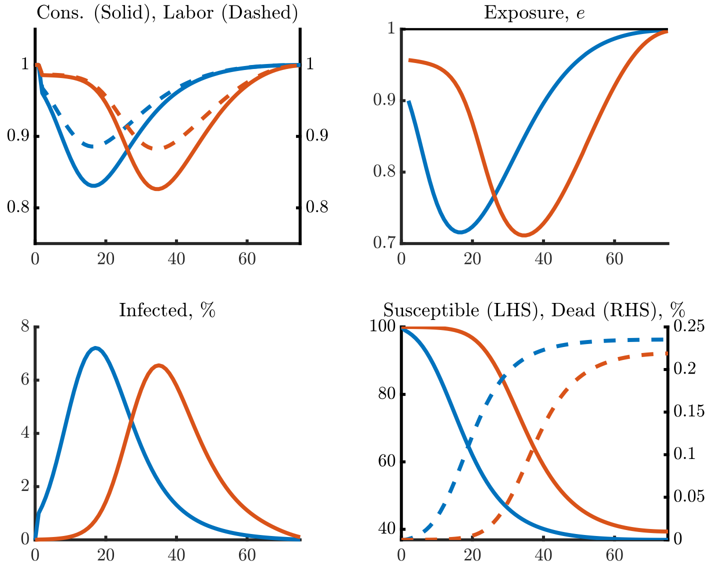
- Old vs young
  - Understood. Risk factor 10+
- Across sectors & occupations
  - Understood. Risk factor ~5
- States
  - Not understood. Neither health impact, nor economic impact
  - Factor of 5!

States

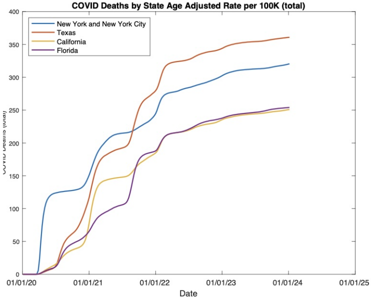

Age Adjusted COVID Cumulative Death Rate on 4/2/2022
Wyoming
Wisconsin
West Virginia
Washington
Virginia
Vermont
Utah
United States
Texas
Tennessee
South Dakota
South Carolina
Rhode Island
Puerto Rico
Pennsylvania
Oregon
Oklahoma
Ohio
North Dakota
North Carolina
New York City
New York
New Mexico
New Jersey
New Hampshire
Nevada
Nebraska
Montana
Missouri
Mississippi
Minnesota
Michigan
Massachusetts
Maryland
Maine
Louisiana
Kentucky
Kansas
Iowa
Indiana
Illinois
Idaho
Hawaii
Georgia
Florida
District of Columbia
Delaware
Connecticut
Colorado
California
Arkansas
Arizona
Alaska
Alabama
0
50
100
150
200
250
300
350
400
Age Adjusted COVID Death Rate per 100K

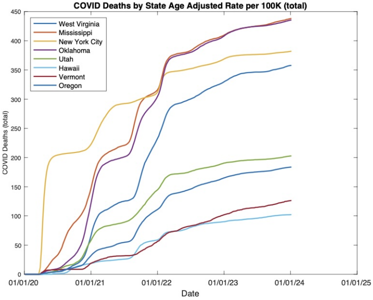
D

Random? NY vs CA



States


COVID Deaths by State Age Adjusted Rate per 100K (total)
New York and New York City
Texas
California
Florida
Date
01/01/20
01/01/21
01/01/22
01/01/23
01/01/24
01/01/25


COVID Deaths by State Age Adjusted Rate per 100K (total)
West Virginia
Mississippi
New York City
Oklahoma
Utah
Hawaii
Vermont
Oregon
COVID Deaths (total)
Date
01/01/20
01/01/21
01/01/22
01/01/23
01/01/24
01/01/25

Conclusion

1. Complementarity mitigation / vaccine? Yes.
2. Long term mitigation was a surprise? Not sure.
   - WFH and internet.
   - $5 trillion! (Romer 2021)
     - $2T good, $1T dubious, $2T wasted
3. Common behavioral response across U.S. States? Maybe
   - Still 5x. NH, VT ~ Denmark; AZ, MS ~ Russia
   - Really all random?
4. Next time
   - Identify vulnerable populations faster
   - WFH and schools
   - Information structure, test & track

EXTRA: Model

A representative household

- pools infection and consumption risks
- chooses labor supply and work-from-home

Production technology

- Work-from-home $\downarrow$ exposure but also $\downarrow$ productivity
- Learning-by-doing $\downarrow$ productivity losses over time
- Baseline: single-sector

Infection block

- exposure both through consumption and production
- true status (S, I) unobservable

Preferences and Technology

Utility: $\sum_{t=0}^{\infty}(1+\rho)^{-t}u(c_t, l_t; i_t, d_t)$ where

$$u(\cdot) = (1 - d_t - \kappa i_t)\left(\log(c_t) - \frac{l_t^{1+\eta}}{1+\eta}\right) + \kappa i_t(\log(c_t) - u_\kappa) + d_t(-u_d)$$

Effective labor: $\hat{l}_t = (1 - d_t - \kappa i_t)\left(l_t - \frac{\chi_t}{2} m_t^2\right)$

Cost of working-from-home: $\chi_t = \overline{\chi}\left[1 - \Delta_\chi\left(1 - e^{-\overline{m}_t}\right)\right]$

Learning-by-doing: $\overline{m}_{t+1} = \overline{m}_t + \underbrace{m_t}_{\text{Work-from-home}}$

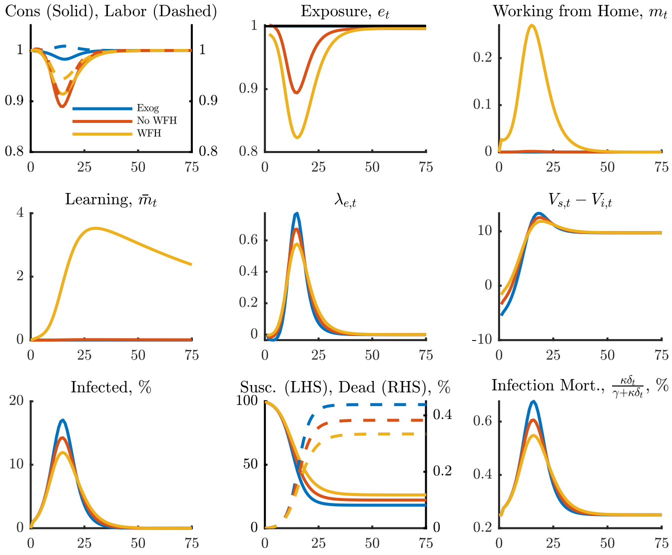
Exposure: $e_t = \bar{e} + \underbrace{e^c c_t C_t}_{\text{From shopping}} + \underbrace{e^l(1 - m_t)(1 - M_t)l_t L_t}_{\text{From work}}$

Optimality: Private vs Planner

$$
\begin{aligned}
c_t &: \; c_t^{-1} = \lambda_t + 2\lambda_{e,t} e^c c_t \\
l_t &: \; l_t^{\eta} = \lambda_t - 2\lambda_{e,t} e^l (1 - m_t)^2 l_t \\
m_t &: \; \lambda_t \chi_t m_t = \frac{\beta V_{\bar{M},t+1}}{1 - d_t - \kappa i_t} + 2\lambda_{e,t} e^l (1 - m_t) l_t^2
\end{aligned}
$$

$$
\begin{aligned}
V_{it} = &-\kappa u_\kappa - \kappa\lambda_t \left(l_t - \chi_t m_t^2 \right) + \kappa \frac{l_t^{1+\eta}}{1+\eta} + \lambda_{e,t} \kappa e^l (1 - m_t)^2 l_t^2 . \\
&- (1-\gamma) \lambda_{it} - \beta e_t s_t (\lambda_{it} - \lambda_{st}) - \left(\delta_t \kappa + \delta_t' \kappa^2 i_t \right) (\lambda_{dt} - \lambda_{it})
\end{aligned}
$$

Decentralized Equilibrium



Calibration (2021 data)

- Baseline values
  - Recovery rate, $\gamma = 0.35$
  - Base Infection Fatality Rate $\frac{\delta_t \kappa}{\delta_t \kappa + \gamma}$ = 0.5%
  - At $\frac{I}{N} = 0.2$, Infection Fatality Rate $\frac{\delta_t \kappa}{\delta_t \kappa + \gamma}$ = 1.5%
  - Reproduction number (at $e_t = 1$) $\mathscr{R}_0 = \frac{\beta}{\gamma + \delta_t \kappa} = 3.3$
- Considerable uncertainty (heterogeneity?)

JONES, C., PHILIPPON, T. and VENKATESWARAN, V. (2021). Optimal mitigation policies in a pandemic: Social distancing and working from home. *Review of Financial Studies*.