The Impact of Vaccines and Behavior on US Cumulative Deaths from COVID-19

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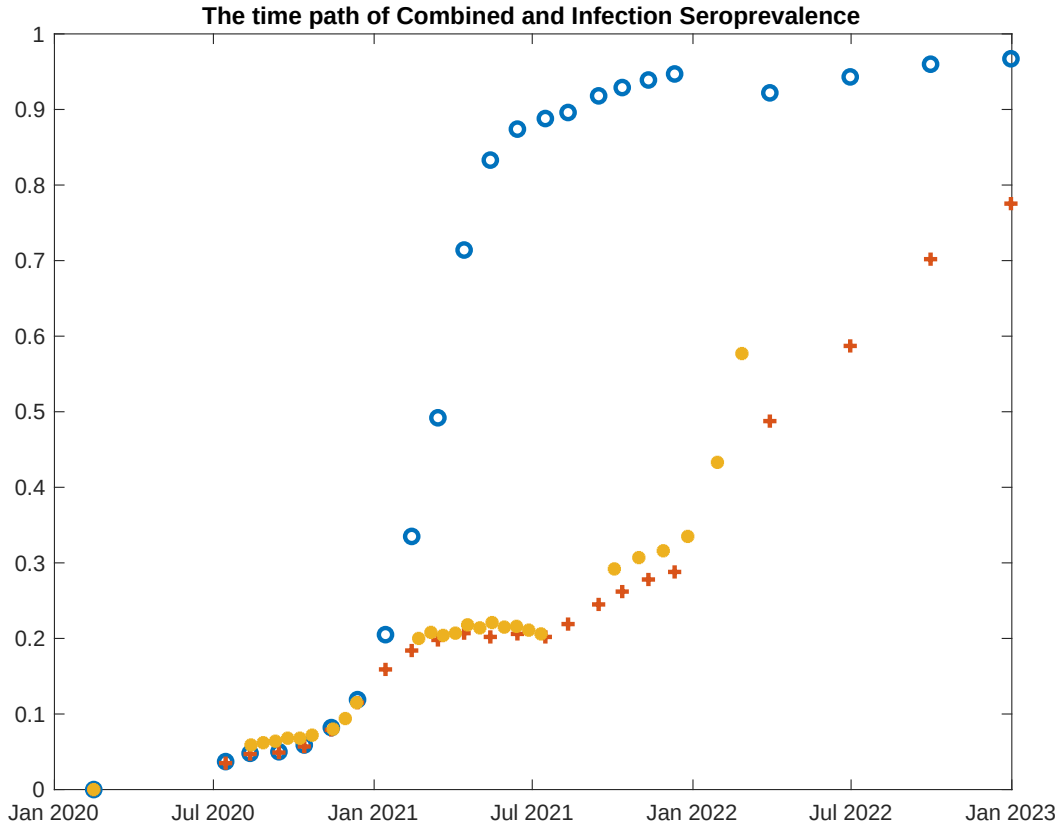
Impact of Behavior and Vaccines on COVID Deaths

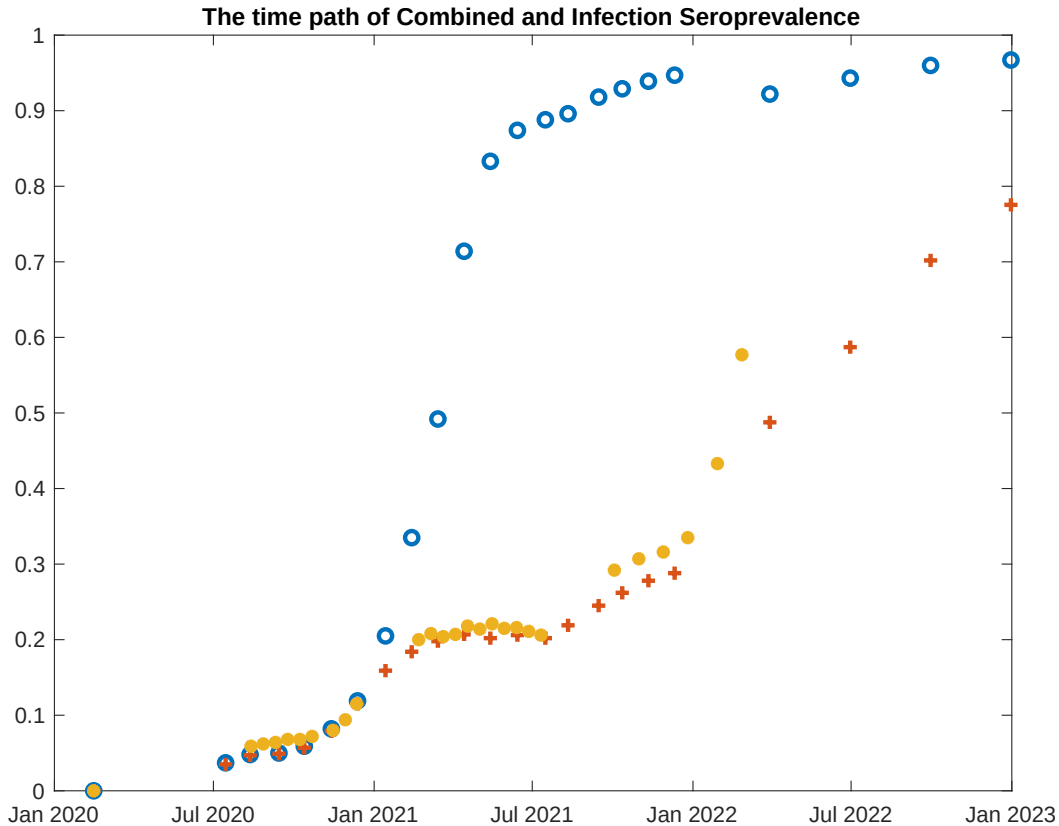
- **Mitigating behavior and vaccines saved $\approx$ 800,000 American lives**
- Mechanism: $\approx$ 68% of Americans got vaccinated before first infection
  - First COVID infection much less dangerous after vaccination
  - Back of the envelope estimate of lives saved
  - Full structural model of epidemic with behavior and vaccines
- Data for Estimate
  - Serology data on timing of infections and vaccinations
  - 30 states: COVID-19 deaths data by vaccination status

COVID-19 Infections and Vaccinations 2020-2022



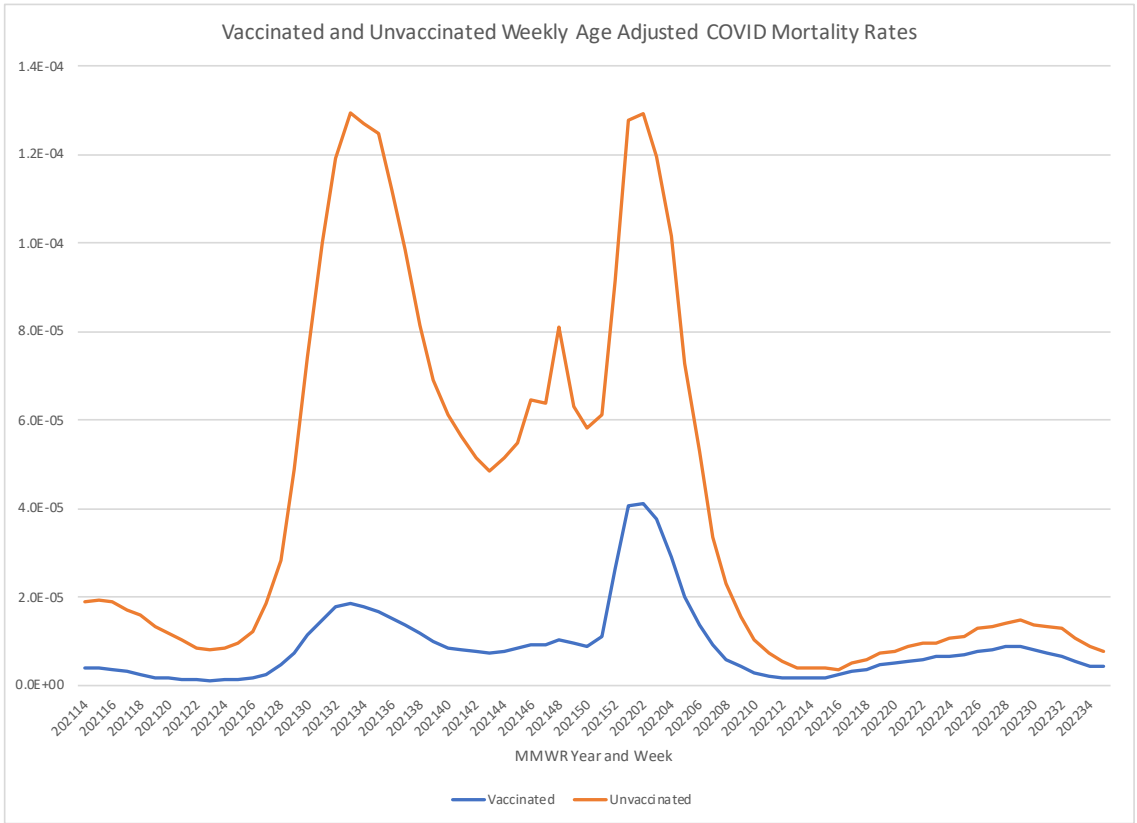
- Serology data: Blood Donor and Commercial Lab Surveys
- red and yellow – cumulative percent ever infected
- blue – cumulative percent infected plus vaccinated without infection

Key Facts from Serology Data



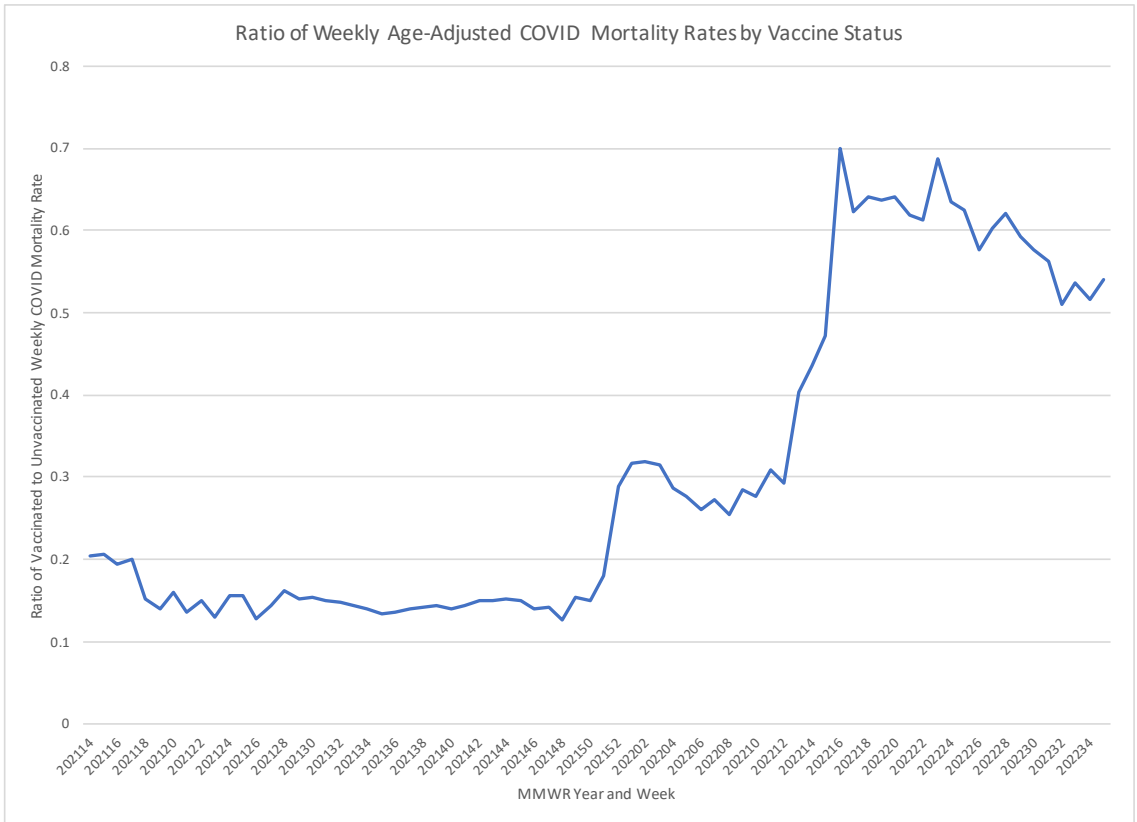
- Few infections in 2020 and early 2021
- By July 2021, 68% of Americans got vaccinated prior to first infection
- Almost all of us have been infected by now

COVID much less deadly if vaccinated prior to first infection



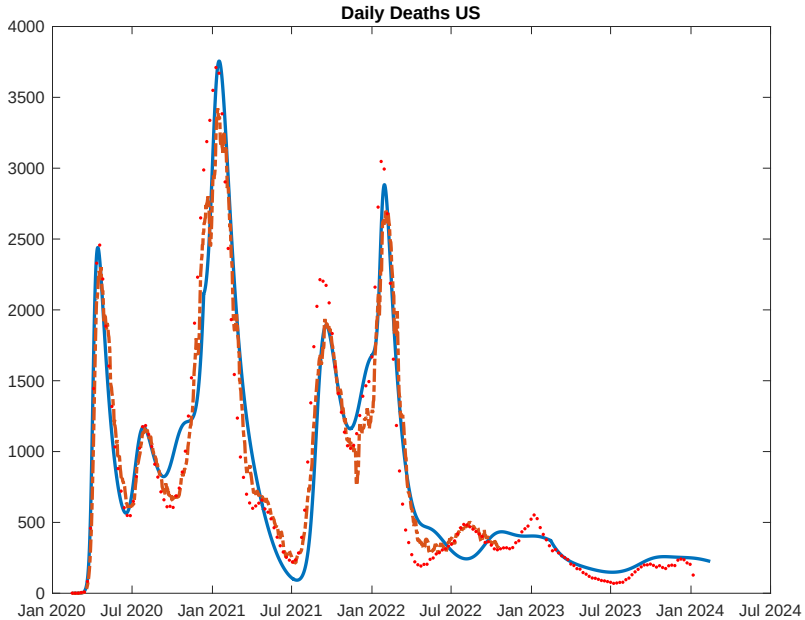
- 30 States: linked vaccine and mortality data
- Weekly COVID death rates for vaccinated and unvaccinated
- 2021 was very dangerous for the unvaccinated
- Rates converge after first Omicron wave as no one left naive

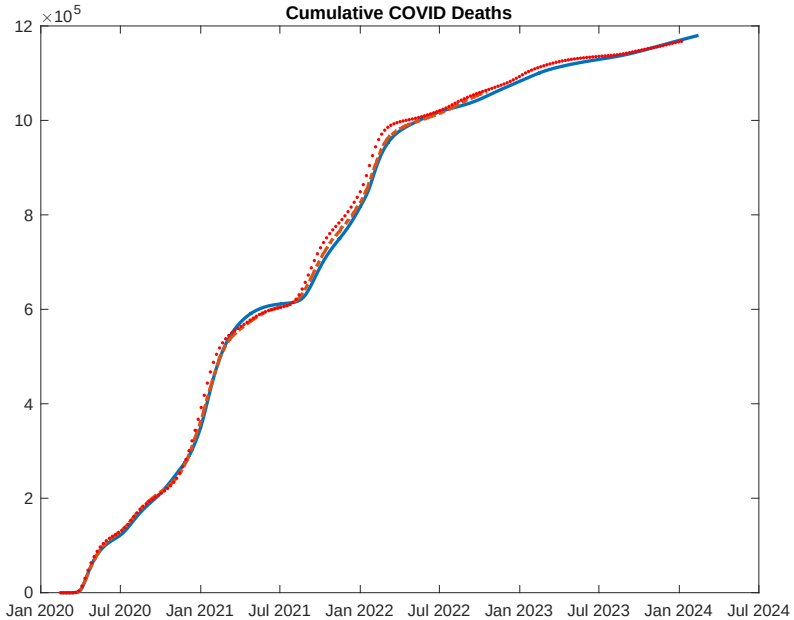
Back of Envelope Lives Saved by Vaccines

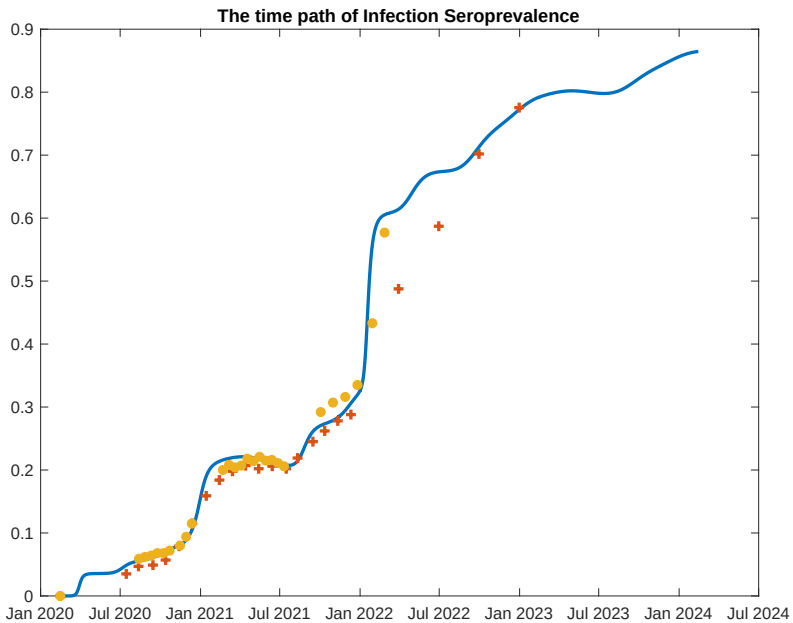


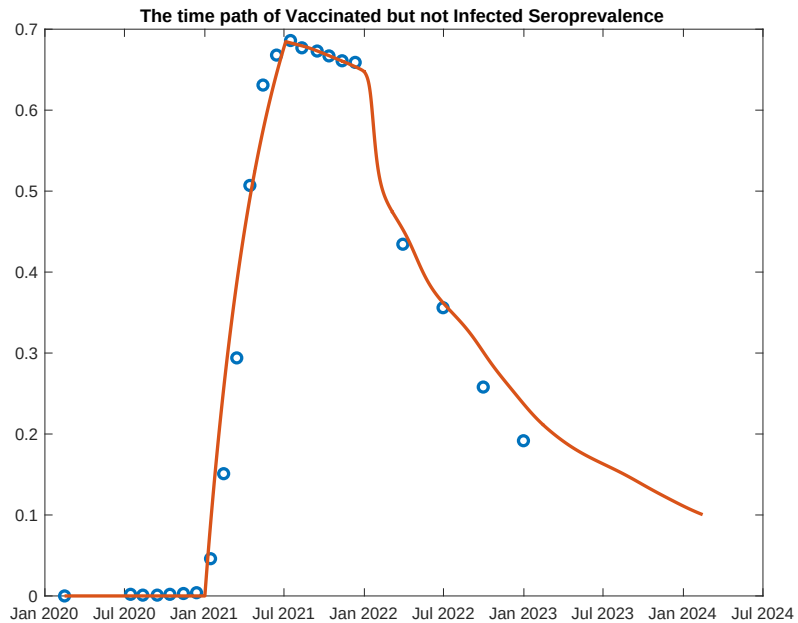
- 68% of Americans vaccinated prior to first infection
- They would have gotten infected without protection of vaccines
- Higher IFR without vaccines implies 845,000 additional COVID deaths

Model Fit to COVID Deaths, Infections, and Vaccinations

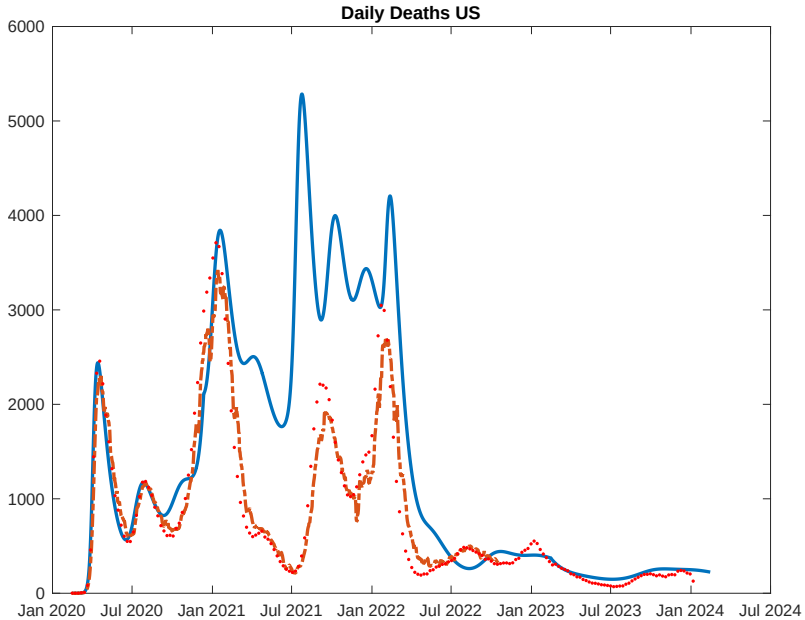


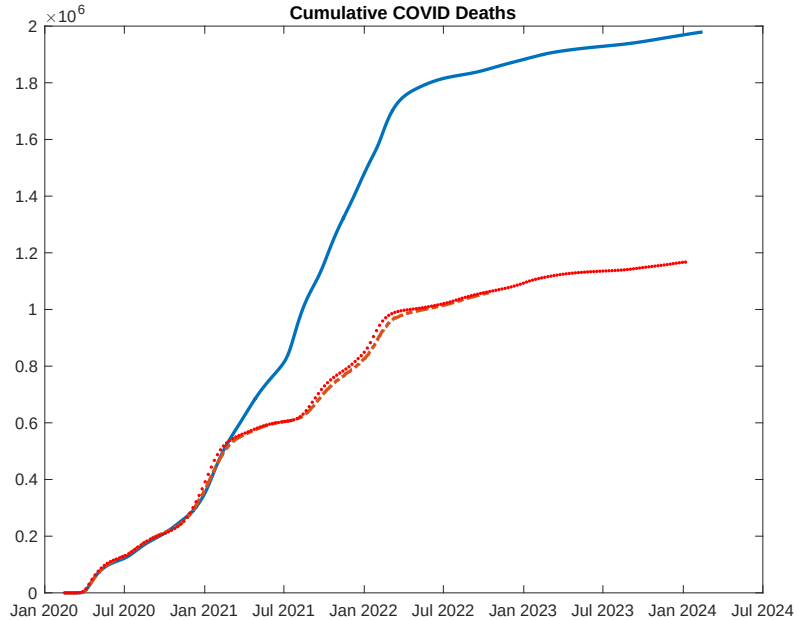


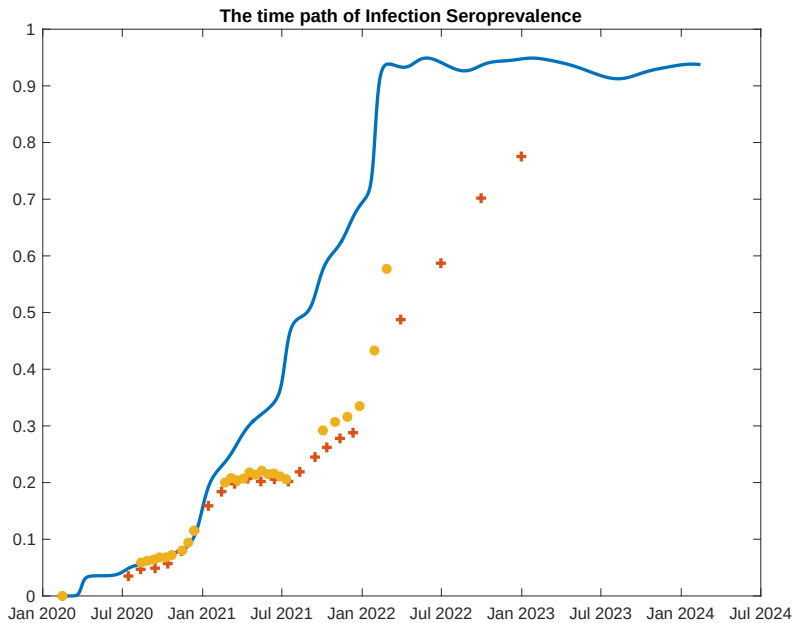




Baseline Behavior No Vaccines: +795,000 deaths







Four Lessons From COVID-19

1. Both behavior and vaccines needed to save lives
   - Behavior alone delays deaths
   - Vaccines come too late without mitigation

2. Success in delaying infections 2020-21 a surprise
   - Relative to "Spanish" Flu
   - Ferguson et. al. 2006 – modeling pandemic influenza
     "After first 120 days" vaccines too late to save lives
   - **Long-term mitigation is possible**

3. Behavioral response had a lot in common across U.S. States
   - $\mathbb{R}_{eff}(t) \to 1$ fast in all states
   - No state had a a big wave like New York City
   - All states had slow spread in 2020 and fast vaccines in 2021

4. Both behavior and the purpose of mitigation will be different next time

What Information Infrastructure Do We Need?

- With COVID-19 we were "flying blind"
- Assessing Transmission Routes
  - What activities/venues contribute most to transmission?
  - Real-time monitoring of relevant behaviors and transmission
- The Course of Infection
  - When is one infectious?
  - Who is at what risk of mortality or morbidity?
  - What treatments/vaccines are available?
- Tracking Incidence and Immunity
  - U.S.: fragmented data infrastructure
  - Systematic serological studies

Two Questions Going Forward

- For Public Health
  - What public health impact can we have with targeted mitigation measures?
  - What resources do we need to implement such measures?
- For Economists
  - What economic and social benefits can be gained from targeted mitigation measures?
  - How much should we spend to be able to implement such measures?