COVID-19 Economics: Measuring the Benefits & Costs of Social Distancing

how did the assumptions made in March turn out in retrospective?

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16 Oct 2020

In retrospect:

- If we had to do this all over again, would we do it like we did it?
- YES

Endogenous risk

- My career
  - Ehrlich-Becker style endogenous risk models under different economic institutions (theory and the lab), with various degrees of insight into the implications to most everything environmental/natural resources.
  - Preferences, beliefs, and risk reduction technologies
  - Nature affects people, people affect nature
  - Integrated Health modeling and transferable risk
- My year of living dangerously
  - SAM/FMD
  - COVID-19 – low probability/high severity event
  - Wildfire

By Amy Harmon

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As an America desperate to stem the coronavirus outbreak put in place sweeping restrictions last week on every facet of public life, the University of Wyoming economist Linda Thunstrom asked what felt like a taboo question: "Are we overreacting?"

It helped that Dr. Thunstrom was in her kitchen, drinking coffee with her husband, Jason Shogren, a fellow economist who studies how much Americans are willing to pay to reduce risk of threats like terrorism, food-borne illness and climate change.

Team response to the COVID BCA

- Team at UWyoming
  - Linda Thunström
  - Steve Newbold
  - Dave Finnoff
  - Madison Ashworth
- Working on vaccines resistance and measles
- Are we doing too much? [back of napkin]
- Dropped everything to address COVID

Motivation

- Are the attempts to slow the rate of COVID-19 infections by social distancing worth the cost?
- We aim to provide insight on this question and estimates of the net benefits of social distancing, based on what is currently known about the potential public health and economic impacts of the epidemic.

◦ Oxford Dictionary word of the year for 2019 was *climate emergency*.
Steve Newbold's prediction for 2020 is *social distancing*.

Overview

- We use an SIR model to project infections and deaths without and with social distancing.
- We calculate the present value of lost GDP based on projections for the economy made by Goldman Sachs.
- In our benchmark case, the present value net benefits = \$5.2 trillion.
- Sensitivity analyses reveal conditions under which $NB > 0$ vs $NB < 0$.

(Mis)Interpretation

- "[Montana Governor] Bullock cited a report from the University of Wyoming that found social distancing will save more than a million lives and cause far less damage to the economy." (4/17/20) (`https://tinyurl.com/BullockPandemic`)

- Our benchmark case indicates social distancing leads to greater damage to "the economy" in terms of lost GDP, but higher net "economic efficiency" accounting also for people's willingness to pay for mortality risk reductions.

SIR model

Susceptible: $S_{t+1} = S_t - \beta S_t I_t$

Infected: $I_{t+1} = I_t + \beta S_t I_t - \gamma I_t - \left\{ \begin{array}{cc} \gamma \frac{\rho_{lo}}{1-\rho_{lo}} I_t, & I_t < \tilde{I} \\ \gamma \left[\frac{\rho_{hi}}{1-\rho_{hi}} \left(I_t - \tilde{I} \right) + \frac{\rho_{lo}}{1-\rho_{lo}} \tilde{I} \right], & I_t \geq \tilde{I} \end{array} \right\}$

Recovered: $R_{t+1} = R_t + \gamma I_t$

β = contact rate

γ = recovery rate

$\tilde{I}$ = health system capacity threshold

ρ_{hi} (ρ_{lo}) = infection fatality rate when the system is (not) overwhelmed

$\{\cdot\}$ = deaths from infection

Basic reproductive number

R_0 = The expected number of new infections by each infected person at the beginning of an outbreak.

In the first time step, the number of new infections per infected person is βN.

The expected duration of an infection is $\frac{1}{\gamma}$ time steps.

Therefore, the expected number of new infections by each infected person before recovery is

$$R_0 = \frac{\beta N}{\gamma}.$$

Net benefits of social distancing

$$NB = VSL\,(D_1 - D_2) - \sum_{t=0}^{T} \big(Y_{1t} - Y_{2t}\big)\big(1 + r\big)^{-t}$$

VSL = the "value per statistical life," i.e., the average marginal willingness to pay for mortality risk reduction (or, VRR "value of risk reduction" for mortality, Simon et al. 2018)

D_1 (D_2) = total expected deaths due to infection without (with) social distancing

Y_{1t} (Y_{2t}) = GDP in year t without (with) social distancing

r = discount rate

Calculating benefits

$R_0 = 2.4$

$\gamma = 6.5$ days

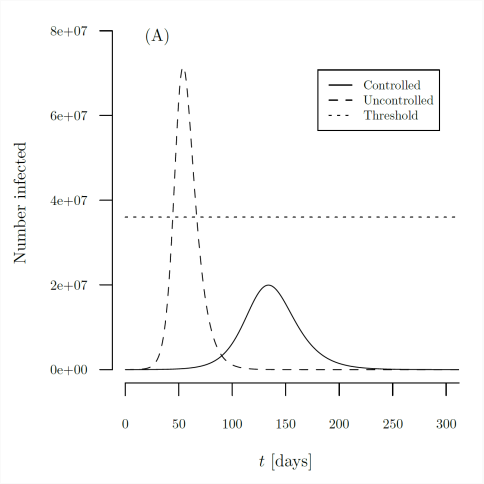
$N = 327$ million

$\rho_{lo} = 0.005$, $\rho_{hi} = 0.015$

$\tilde{I} = \frac{1}{2}(\max\ I_t)$

$\mu = 0.38 \Rightarrow$

$\beta_1 = \frac{\gamma R_0}{N}, \beta_2 = (1-\mu)\frac{\gamma R_0}{N}.$

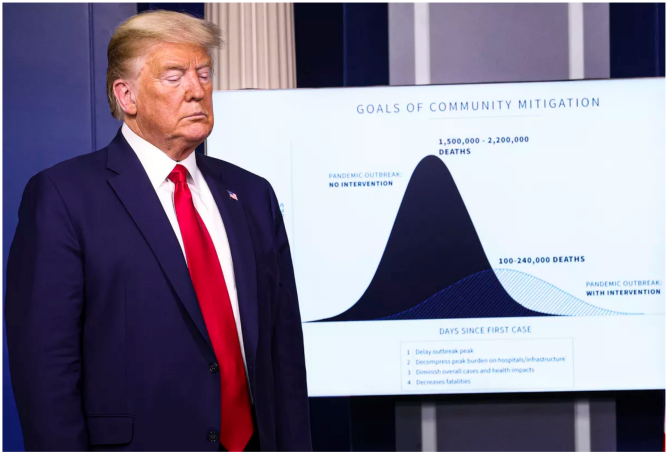


Calculating benefits

Table 1. Benchmark outcomes for the uncontrolled scenario (without social distancing) and controlled scenario (with social distancing).

	Uncontrolled	Controlled
Infections [million]	287	188
Deaths [million]	2.18	0.941
Value of lives lost [trillion US$]	21.8	9.41
Present value of GDP loss [trillion US$]	6.49	13.7
Net benefits [trillion US$]		5.16

Contemporaneous White House projections



Calculating costs

With social distancing
(Goldman-Sachs 3/31/20):

$g_{0,t} = 0.0175$

$g_{2,1} = -0.062$

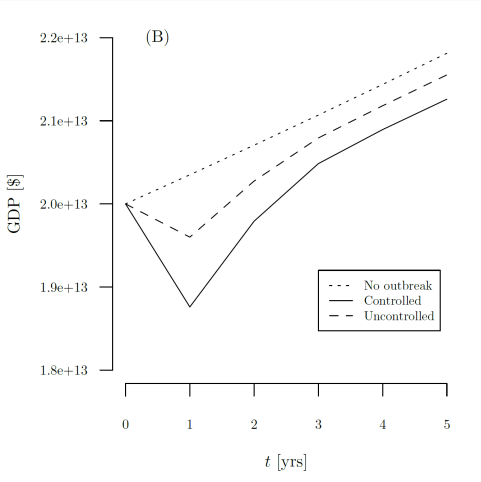
$g_{2,2} = 0.055$

$g_{2,3} = 0.02$

Without social distancing
(McKibbin and Fernando 2020):

$g_{1,1} = -0.02$

Same proportional growth



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Calculating net benefits

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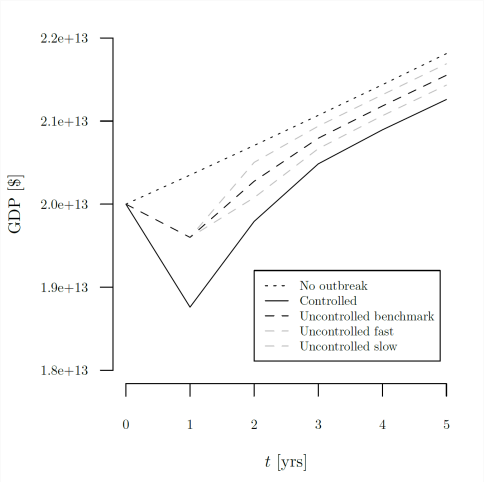
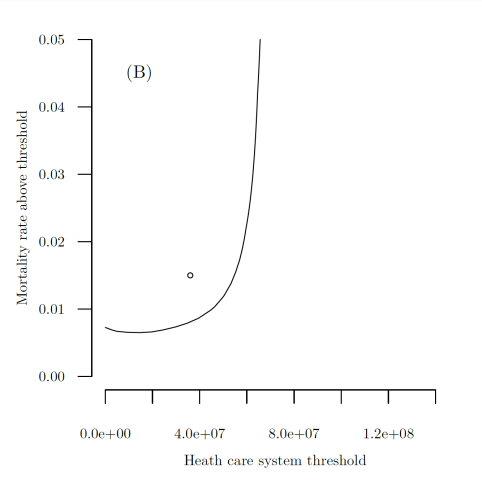
Sensitivity analysis: slower or faster recovery



Sensitivity analysis: break-even parameter values

	Equal rate of recovery	Faster uncontrolled recovery	Slower uncontrolled recovery
Central results			
Value of reduced mortality [trillion US$]	12.4	12.4	12.4
Present value of GDP loss [trillion US$]	7.27	10.3	4.64
Net benefits of control [trillion US$]	5.16	2.11	7.78
Break-even values			
Discount rate [% yr^{-1}]	none	1.7	none
Planning horizon [yr]	63	38	none
R_0	1.33 , 4.46	1.58 , 3.71	1.20, 5.53
Low mortality rate [%]	none	none	none
High mortality rate [%]	0.81	1.22	0.46
Reduction in contact rate [%]	19.6	28.0	13.4
VSL [million US$]	5.85	8.30	3.75
Uncontrolled initial GDP decline [%]	none	0.45	none
Controlled initial GDP decline [%]	8.5	7.0	11.0
Threshold [million infected]	54.6	42.5	none

Sensitivity analysis: break-even curves



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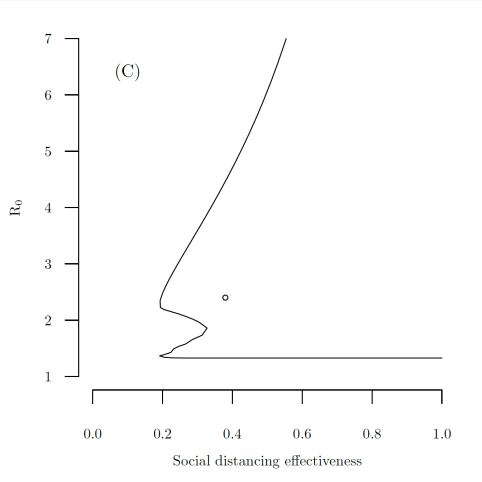

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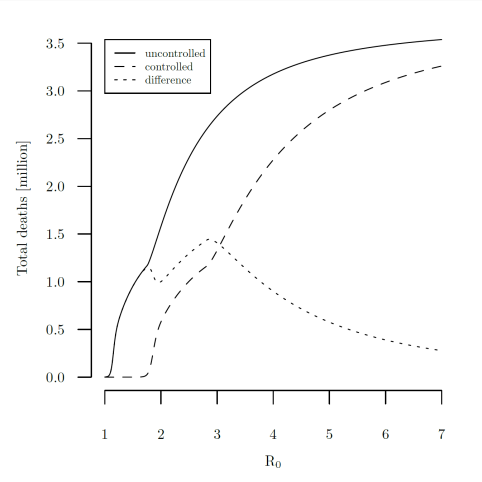

Discussion

- Discounting works 'in reverse' in this case.
- Many 'parameters' are not fixed but rather are endogenous to individual behaviors and public policies.
- Many elements of this problem are uncertain. This means the value of additional information and policy flexibility are high.
- Ongoing challenge is to social distance not too little and not too much.
- Confirmed cases in the U.S. are far fewer than implied by our SIR model. How come?

Take-home messages

- Social distancing saves lives but imposes large costs on society due to decreased economic activity.
- Our projected number of lives saved by social distancing was more conservative than the White House projections.
- And yet, our central results suggest that the value of lives saved safely outweighs the projected losses in GDP.
- This is an ex ante analysis: we expect positive net benefits, but this outcome is not guaranteed. (There are large regions in the parameter space that produce negative net benefits.)

Limitations

- We examine only a single policy, the full suite of social distancing measures (expected to be) put into place.
- Lost GDP is not an ideal measure of social costs.
- We focused on economic efficiency alone, ignoring distributional impacts.
- We assume that social distancing will be sufficient to avoid a second wave before a vaccine is available.

For further research

- When and how should we re-open the economy?
- What is the optimal policy for vaccine trials in the midst of a pandemic?
- What was the impact of social distancing on influenza in 2020?
- What will be the 'new normal' after COVID-19?
- How best to communicate science in real time?
- How to reduce the risks of future outbreaks?
- How to prepare for future outbreaks that cannot be prevented?
- Retrospective BCA in 2021 or later.

20/20 hindsight in 2020:
What might we have ideally done

- (Ir)rational rejection of science
- Optimal self-protection with masks, hand washing, etc
- Optimal social distancing [Newbold et al. *ERE*]
- VSL is adjusted for AGE, QALY, u-shaped [Robinson, Sullivan, Shogren *Risk Analysis*]
- Willingness to test – Super spreaders – less likely to test? NO! Pro-social motives [Thunström et al., *Behavioral Public Policy*]
- Rapid testing and contact tracing policy
- Vaccine hesitation
- Heterogeneity of underlying health conditions

So back to the original question

- Would we have done anything different given our rapid response –
- NO
- USA needed a BCA number – a benchmark to throw flowers or darts at it
- We were willing to serve this function even knowing things would surely change.
- If nothing else, calling forth the flowers and darts may have helped to accelerate, even if only modestly, the rate of knowledge accumulation at this critical time
- Lesson learned from time at CEA – first # on the table has the first-mover advantage for policy –
- Would things had been different if we found NB < 0??